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Technical Report Overview

Report: Greenhills Operations Local Aquatic Effects Monitoring Program 2017 Report

Overview: This report presents the 2017 results of the local aquatic effects monitoring program developed for Teck's Greenhills Operations. The purpose of this program in the first year was to develop a better understanding of a side channel that lies between Greenhills Operations and the Elk River. This is the first report for this program.

This report was prepared for Teck by Minnow Environmental Inc. and Lotic Environmental Ltd.

For More Information

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Future studies will be made available at **teck.com/elkvalley**

2017 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report

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2017 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report

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EXECUTIVE SUMMARY

This first year of the Greenhills Operations (GHO) Local Aquatic Effects Monitoring Program (LAEMP) focused on three key questions designed to address localized concerns in a side channel of the Elk River and its adjacent floodplain complex on the west side of GHO. The GHO LAEMP key questions focused on characterization and understanding of the Elk River side channel hydrology, biology, and environmental quality. The three key questions were:

1. What are the seasonal and spatial patterns of flow in the Elk River side channel? During what months, and where, does the side channel have flow?

2. What is the influence of GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?

3. What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

The Elk River side channel receives flows, either via surface water or groundwater, from the most southerly, mine-influenced, west-side tributaries (e.g., Thompson Creek, Wolfram Creek, Leask Creek, and likely also Mickelson Creek). The side channel was observed to have highly variable flow throughout the year. Portions of the side channel flow went sub-surface during low flow periods, resulting in isolated surface pools with different water quality and biological characteristics than in flowing portions. The side channel flow appeared to be predominantly influenced by the Elk River itself, rather than the tributaries, with the exception of the side channel wetland at the mouth of Thompson Creek.

Within the side channel and its floodplain complex, surveys were completed to identify and document habitat and occurrences of aquatic-dependent biota. Fish spawning habitat was limited downstream of the side channel wetland, but was abundant in parts of the side channel upstream of the wetland. Overwintering habitat was present only in the side channel wetland and potentially one isolated pool. Habitat surveys indicated that limited lentic habitat was available for amphibians during the spring, as much of the side channel and floodplain complex were flooded and flowing. During summer and fall, lentic amphibian habitat was provided by the side channel wetland, with additional limited habitat provided by ephemeral isolated pools that typically persisted for less than a month. Habitat was available for aquatic-feeding birds in the side channel and floodplain complex from spring to fall. Surveys for aquatic-dependent biota determined that the side channel was being used by a variety of fish, amphibian, and bird species.

Water quality and sediment quality were compared between main stem Elk River, Elk River side channel, and isolated pools. Discharges from the west-side tributaries contributed to higher concentrations of Order constituents (i.e., dissolved cadmium, nitrate, total selenium, and sulphate) and nickel in water in the downstream main stem Elk River; however, concentrations measured in the main stem downstream of the side channel were well below EVWQP Level 1 benchmarks (cadmium, nitrate, selenium, and sulphate) and preliminary IC_{25} values (nickel). Water quality at the two most-downstream side channel stations was influenced by Wolfram and Thompson creeks. Water quality in pools was highly dependent on location, with the highest concentrations of Order constituents and nickel occurring in pools in the eastern-most channel downstream of the wetland. The highest concentrations of Order constituents in water occurred in the side channel wetland, which receives flow directly from Thompson Creek. Sediment quality data suggested limited influence of mine-related discharges on sediment chemistry in the side channel and the main stem location downstream of the side channel.

Potential aquatic effects in the side channel and discharges from the west-side tributaries were assessed using benthic invertebrate and fish tissue chemistry (selenium), and benthic invertebrate community structure and biomass endpoints. Some benthic invertebrate tissue selenium samples were above the EVWQP Level 1 benchmarks for either benthic invertebrates, dietary effects to juvenile fish, and/or dietary effects to birds, with highest concentrations measured in the samples collected in the side channel wetland, which is directly influenced by Thompson Creek. Concentrations of selenium in benthic invertebrate tissues were similar at the Elk River main stem station downstream of the side channel and the main stem Elk River reference station. This suggests no influence of the side channel on benthic invertebrate tissue selenium concentrations downstream of the side channel, despite higher concentrations observed in benthic invertebrates within the side channel. Selenium was only measured in a single fish tissue sample, with concentrations well below effect thresholds. Results for the benthic invertebrate community structure, biomass, and abundance data were similar in the side channel and the main stem location downstream of the side channel, and were within normal range, indicating that communities were not adversely affected by mine-related discharges.

Overall, the results indicated that the west-side tributaries had no effect on biota in the main stem Elk River, and minimal effects on biota within the Elk River side channel, side channel wetland, and isolated pools. The key questions associated with the GHO LAEMP will be updated in the 2018 to 2020 study design, and the program will continue to assess relevant site specific issues, as required, until sufficient data have been collected, concerns no longer exist, or monitoring can be incorporated into the RAEMP.

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ACRONYMS AND ABBREVIATIONS

AMP – Adaptive Management Plan

ANOVA – Analysis of Variance

ANCOVA – Analysis of Covariance

BCWQG - British Columbia Water Quality Guidelines

CABIN – Canadian Aquatic Biomonitoring Network

CI – Calcite Index

CMO – Coal Mountain Operation

CPUE – Catch-per-unit-effort

CRC ICP-MS – Collision Reaction Cell Inductively Coupled Plasma-Mass Spectrophotometry

DELT – Deformities, Erosions, Lesions, or Tumors

DO – Dissolved Oxygen

DW – Dry Weight

DOC – Dissolved Organic Carbon

EMC – Environmental Monitoring Committee

ENV – British Columbia Ministry of Environment and Climate Change Strategy (formerly BCMOE)

EPT – Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies)

EVO – Elkview Operation

EVWQP – Elk Valley Water Quality Plan

FHAP – Fish Habitat Assessment Procedure

FRO – Fording River Operation

GC/MS – Gas Chromatography with Mass Spectrometric Detection

GHO – Greenhills Operation

GPS – Global Positioning System

ICP-MS – Inductively Coupled Plasma Mass Spectrometry

ISQG – Interim Sediment Quality Guideline

KNC – Ktunaxa Nation Council

LAEMP – Local Aquatic Effects Monitoring Program

LCO – Line Creek Operation

LEL- Lowest Effect Level

LPL – Lowest Practical Level, referring to taxonomic identification of benthic invertebrates

LSU – Longnose Sucker

LWD – Large Woody Debris

MOD – Magnitude of Difference

NAD – North American Datum

PAH – Polycyclic Aromatic Hydrocarbon

PEL – Probable Effect Level

QA/QC – Quality Assurance / Quality Control

RAEMP – Regional Aquatic Effects Monitoring Program

RISC – Resource Information Standards Committee

SEL – Severe Effect Level

SQG - Sediment Quality Guideline

TIE - Toxicity Identification Evaluation

UTM – Universal Transverse Mercator System

WSRT – Wilcoxon Signed Rank Test

YOY – Young of the Year

1 INTRODUCTION

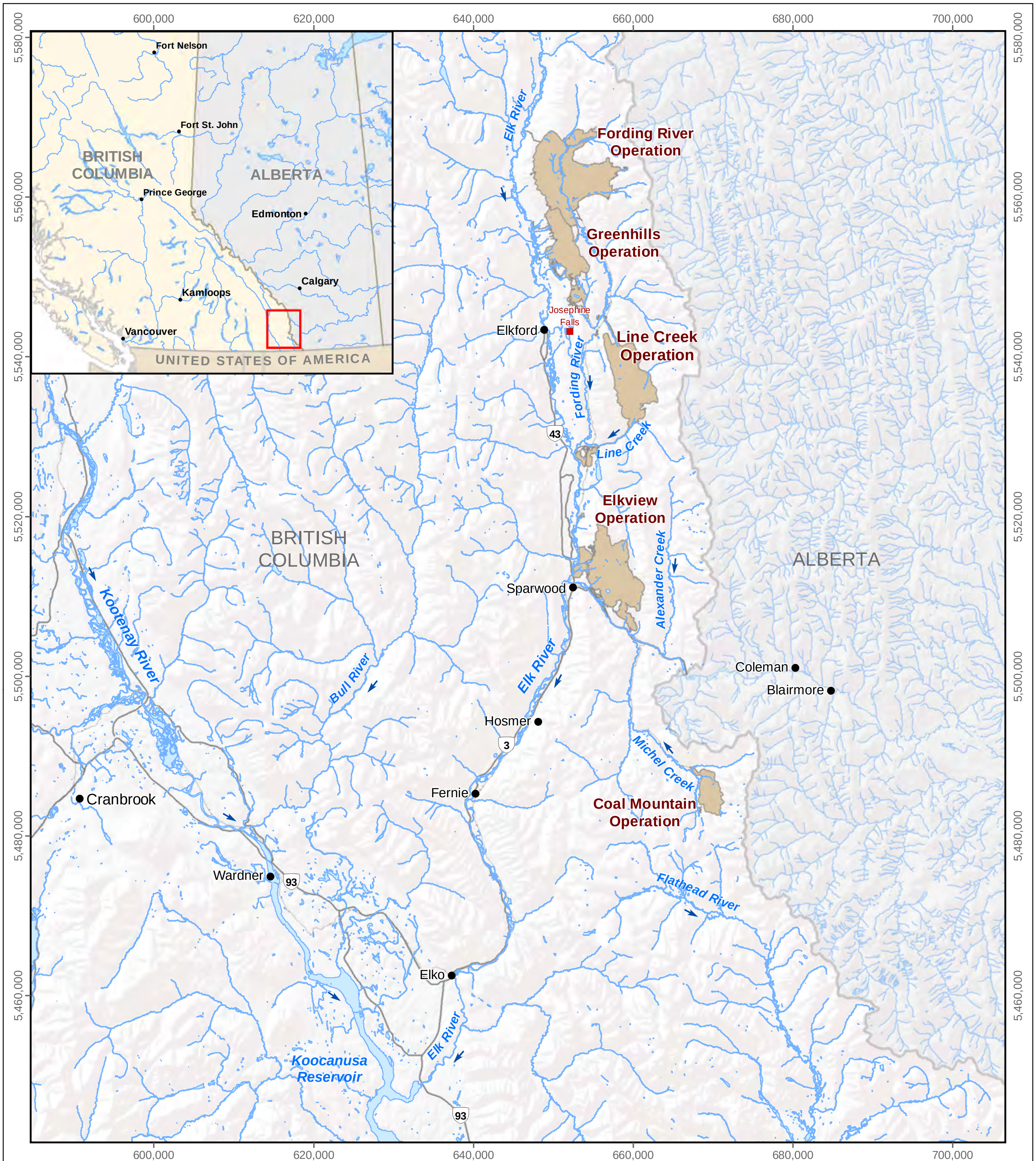
1.1 Background

Teck Resources Limited (Teck) operates five steelmaking coal mines in the Elk River watershed, which are the Fording River Operation (FRO), Greenhills Operation (GHO), Line Creek Operation (LCO), Elkview Operation (EVO), and Coal Mountain Operation (CMO; Figure 1.1). Discharges from the mines to the Elk River watershed are authorized by the British Columbia Ministry of Environment and Climate Change Strategy (ENV) through permits that are issued under provisions of the *Environmental Management Act*. Permit 107517 was issued November 19, 2014, and is periodically amended in response to new learnings, projects, or extensions. The Permit specifies the terms and conditions associated with discharges from the five mine operations.

Teck's Regional Aquatic Effects Monitoring Program (RAEMP) is a requirement under Permit 107517, and provides comprehensive routine monitoring and assessment of potential mine-related effects on the aquatic environment downstream from Teck's mines in the Elk Valley (i.e., every three years, with the most recent cycle of reporting completed January 2018). Teck conducts a variety of additional programs to monitor, evaluate, and/or manage the aquatic effects of mining operations within the Elk Valley at local and regional scales (e.g., site-specific groundwater programs, regional groundwater programs, Water Quality Monitoring Program, Regional Flow Monitoring Plan, Calcite Monitoring Program, Chronic Toxicity Testing Program, Regional Fish and Fish Habitat Management Program, and Tributary Evaluation and Management Plan).

Permit 107517 also requires that Teck develop a local aquatic effects monitoring program (LAEMP) related to GHO (Figure 1.2). Section 9.3.3 of Permit 107517 outlines the LAEMP requirements as follows:

> *The Permittee must complete to the satisfaction of MOE a study design for an LAEMP which will focus on the upper Elk River and the Elk River side channel and tributaries located on the west side of GHO between sites 0200389 [GH_ER2] and E3000090 [GH_ERC] for 2017-2020 by June 1, 2017. The study design must be reviewed by the*



LEGEND

Teck Coal Mine Operation

Teck's Coal Mine Operations within the Elk River Watershed, Southeast British Columbia

0 10 20 40 km

N W E S

Projection: North American Datum 1983 UTM Zone 11
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Figure 1.1

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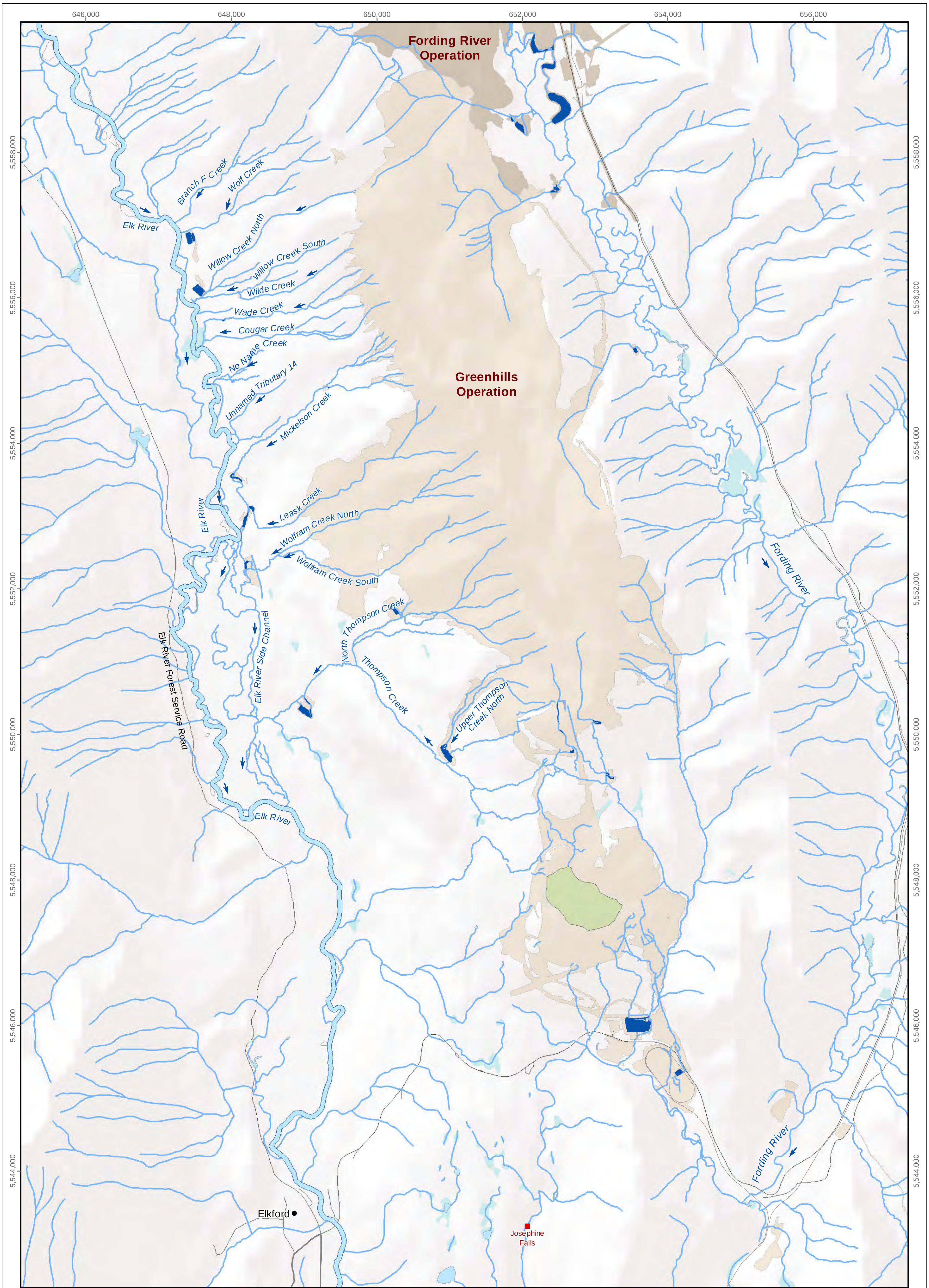

LEGEND

- Settling Pond
- Tailings Pond

Teck's Greenhills Operation

0 0.75 1.5 3
km

N W E S

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Figure 1.2

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EMC[1] and be designed to an appropriate temporal scale to capture short term, local effects to the immediate receiving environment.

Following EMC consultation, a phased approach to the GHO LAEMP study design was approved by ENV. A study design (Minnow and Lotic 2017) was submitted May 31st, 2017 that outlined preliminary reconnaissance work to be conducted from May 2017 to April 2018, and a commitment to submitting an updated study design May 31st, 2018 to cover the 2018 to 2020 period. The 2017 GHO LAEMP was designed to address localized concerns about potential aquatic effects associated with the west spoil development at GHO and to inform an updated study design for 2018 to 2020. Previous evaluations and reports have shown that the majority of the west-side tributaries are high gradient and ephemeral and, with the exception of Thompson Creek, are not fish bearing (Minnow 2016a). Therefore, monitoring of the west-side tributaries has focused on water quality. A side channel of the Elk River and its adjacent floodplain complex were identified as key areas of potential localized concern because they receive flows, either via surface water or groundwater, from the most southerly, mine-influenced, west-side tributaries (e.g., Thompson Creek, Wolfram Creek, Leask Creek, and likely also Mickelson Creek; Figure 1.2). The Elk River side channel has been observed to undergo substantial seasonal flooding and braiding, with highly variable flow throughout the year. Portions of the side channel flow go sub-surface during low flow periods, which results in isolated surface pools with different water quality and biological characteristics than in flowing portions. The first year of the GHO LAEMP was designed to develop a better understanding of the Elk River side channel hydrology, biology, and environmental quality. The results will be used to refine monitoring locations, sampling design, and measurement endpoints that will be most useful for quantifying and tracking short term mine-related local effects to the immediate receiving environment over time in future LAEMP monitoring (specifically for an updated study design for 2018 to 2020).

1.2 Key Questions

In order to focus the scope of the first year of the GHO LAEMP and to provide the reconnaissance data required to inform the 2018 to 2020 study design, key questions were developed in consultation with the Environmental Monitoring Committee (EMC). The key questions, and associated sub-questions, are as follows:

[1] EMC refers to the Environmental Monitoring Committee, which Teck was required to form as per Permit 107517. The EMC consists of representatives from Teck, ENV, the Ministry of Energy and Mines, the Ktunaxa Nation Council (KNC), Interior Health Authority, and an Independent Scientist. Environment Canada has also agreed to provide its perspectives on matters related to Permit 107517 and the Committee's activities, on a case-by-case basis when requested by the Committee. To date, the Committee has not called on Environment Canada to participate. The EMC reviews submissions and provides technical advice to Teck and the ENV Director regarding monitoring programs as stipulated in Section 12.2 of Permit 107517.

1. What are the seasonal and spatial patterns of flow in the Elk River side channel? During what months, and where, does the side channel have flow?
    a. What percentage of channel length is wet each month? (Map wet/dry locations.)
    b. Is there a relationship between % wet channel length (or the onset of portions going to ground) versus flows in the main stem Elk River and/or tributary inputs?
2. What is the influence of GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?
    a. What is the water quality at monitoring stations in the Elk River downstream versus upstream of the west-side tributaries?
    b. What is the water quality at monitoring stations in the Elk River side channel?
    c. What is the water quality in isolated pools in the Elk River side channel that provide potential aquatic habitat for aquatic and/or aquatic-dependent vertebrates (i.e., fish, amphibians, and aquatic-feeding birds)?
3. What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?
    a. How does the distribution of biota change seasonally? Which isolated pools contain biota?
    b. What is the substrate quality?
    c. What are the fish and benthic invertebrate tissue selenium concentrations?
    d. What are benthic invertebrate biomass and community compositions along the side channel? How do benthic invertebrate community compositions compare between perennially wetted and seasonally isolated wet areas?

This report describes the approach, methods, and results produced from the key questions during this first year of the GHO LAEMP. The key questions associated with the GHO LAEMP will be updated in the 2018 to 2020 study design to reflect findings in 2017, and the program will continue to assess relevant site-specific issues, as required, until sufficient data have been collected, concerns no longer exist, or monitoring can be incorporated into the RAEMP.

1.3 Linkages to the Adaptive Management Plan for Teck Coal in the Elk Valley

As required in Permit 107517 Section 11, Teck has developed an Adaptive Management Plan (AMP) to support implementation of the Elk Valley Water Quality Plan (EVWQP) to achieve water quality and calcite targets, ensure that human health and the environment are protected, and where necessary, restored, and to facilitate continual improvement of water quality management in the Elk Valley (Teck 2016). Through EMC review of the 2016 AMP, it was determined that an update to the AMP was required to advance several elements that were in development at the time of the 2016 AMP submission. Teck is currently working in collaboration with the EMC to update AMP content and will submit an updated AMP for acceptance by the director by Dec 21st, 2018. Data from the various LAEMPs (including the present monitoring program) and the RAEMP (Minnow 2018a) will feed into the adaptive management process to address a set of six overarching environmental Management Questions that collectively address the environmental management objectives of the AMP and the EVWQP (Teck 2014a). In addition, the AMP identifies Key Uncertainties under each Management Question, which if reduced, either help confirm that Teck's current management actions are appropriate or lead to adjustments that would better satisfy EVWQP objectives.

As with the RAEMP, monitoring data and evaluations conducted within GHO LAEMP are designed primarily to provide supportive information to help answer AMP Management Question #5 (currently worded as "Does monitoring for mine-related effects indicate that the aquatic ecosystem is healthy?"), and Key Uncertainty 5.1 (currently worded as "How will monitoring data be used to identify potentially important mine-related effects on aquatic ecosystem health at a management unit scale?"). Data and analysis conducted under the LAEMP will also contribute to answering AMP Management Question #2 (currently worded as "Will aquatic ecosystem health be protected by meeting the long-term site performance objectives?") by assessing the aquatic ecosystem under a range of current conditions and identifying areas where biological effects may be occurring due to one or more mine-related constituents.

Data collected as part of the GHO LAEMP have followed and will continue to follow an adaptive management framework, and evaluation of data collected in 2017 for the GHO LAEMP has been used to inform amendments to the 2018 to 2020 GHO study design. Following an adaptive management framework, data collected in 2017 and early 2018 were used to inform the GHO LAEMP study design for 2018 to 2020, and if findings suggest that additional responses are necessary, further investigations or adjustments may be initiated.

2 METHODS

2.1 Overview

The GHO LAEMP key questions were addressed through the collection and analysis of field data as summarized in Tables 2.1 and 2.2. As per Permit 107517 and Permit 6428 requirements, water quality and flow data were monitored weekly/monthly[2] by Teck for the Elk River (water quality only), Elk River side channel, and west-side tributaries (Section 2.3). Monthly inspections from May 2017 to March 2018 of the side channel and floodplain complex allowed for the characterization of seasonal hydrology, habitat, biological communities (i.e., fish, amphibians, and aquatic-feeding birds), and the collection of supporting data (Sections 2.2, 2.5, and 2.6). Additional sampling was conducted in September 2017 pertaining to sediment chemistry, benthic invertebrate and fish tissue chemistry (selenium), and benthic invertebrate community structure and biomass (Sections 2.4, 2.7, 2.8, and 2.9).

2.2 Hydrology

2.2.1 Overview

Hydrology data were primarily collected to address to key question #1: "What are the seasonal and spatial patterns of flow in the Elk River side channel? During what months, and where, does the side channel have flow?". Pertinent data collected in from May 2017 to March 2018 included water levels in the side channel and main stem Elk River, flow in the side channel, and characterization of side channel hydrology features (dry sections, braids, isolated pools, and tributary surface connectivity).

2.2.2 Monthly Hydrology Surveys (Question #1.a)

Monthly surveys were completed by a crew that walked the entire Elk River side channel from the downstream outlet at the Elk River to the side channel inlet near Leask Creek. Monthly surveys were used to evaluate the surface flow conditions within the side channel and to delineate wet/dry areas. Wet/dry areas were marked with a handheld Global Positioning System (GPS) unit (in Universal Transverse Mercator [UTM] coordinates, using North American Datum [NAD] 83) to facilitate mapping. Characteristics of primary interest included:

- dry sections,
- braided or flooded sections,

[2] Sampling is done on a monthly basis (August – March) and/or weekly/monthly basis (March 15 – July 15), as required by Permit 107517 and Permit 6428.

Table 2.1: GHO LAEMP Sampling at Flowing Stations, May 2017 to March 2018

Exposure Type	Stream Type[a]	Stream Name	Water Station Code	ENV EMS Number	Area Description	UTM for Biological Area Code (NAD83, 11U)		Hydrology	Habitat and Biota	Surface Water	Substrate		Benthic Invertebrates			Fish	
								Water Level, Flow, and Temperature Monitoring	Monthly Habitat and Biota Inventory Survey	Chemistry	Calcite Index	Sediment Physical-chemical Attributes	Community Endpoints	Biomass and Densisuty	Tissue Chemistry (Composite taxa)	Fish Inventory	Fish Community
						Easting	Northing	monthly/ continuous	monthly	monthly/ concurrently[b]	July and September 2017	September 2017	September 2017	September 2017	September 2017	2018	2019
	M	Elk River	GH_ER2	200389	u/s Branch Cr. and GHO	646561	5557474	-	-	monthly, concurrently	September 2017	3	1	5	1 composite, 5 taxon-specific	-	-
	M	Elk River	ERUS	200389	u/s side channel			monthly/ continuous	-	monthly, concurrently	-	-	-	-	-	-	-
Mine-exposed	S	Elk River Side Channel	GH_ERSC4	E305878	Elk River side channel u/s of Wolfram Creek	648092	5552589	monthly/ continuous		monthly, concurrently	July and September 2017	3	1	5	3 composite, 5 taxon-specific	yes	yes
	S	Elk River Side Channel	GH_ER1A	E305876	Elk River side channel d/s of Wolfram Creek, u/s of wetland	648382	5551534	monthly/ continuous	side channel survey	monthly, concurrently	July and September 2017	3	1	5	3 composite, 5 taxon-specific	yes	yes
	S	Elk River Side Channel	RG_ERSC5	-	Elk River side channel d/s of Wolfram Creek, u/s of wetland	648275	5550608	-		concurrently	September 2017	3	3	5	3 composite, 5 taxon-specific	-	-
	T	Mickelson Creek	GH_MC1	0200388	Mickelson Creek at LRP Road	648208.6	5553862	-	-	monthly	-	-	-	-	-	-	-
	T	Leask Creek	GH_LC1	E257796	Leask Creek Sed. Pond Decant	648152.8	5552859	-	-	monthly	-	-	-	-	-	-	-
	T	Wolfram Creek	GH_WC1	E257795	Wolfram Creek Sed. Pond Decant	648222.3	5552086	-	-	monthly	-	-	-	-	-	-	-
	T	Thompson Creek	GH_TC2	E207436	lower creek	648596	5550237	-	-	monthly, concurrently	-	-	-	-	-	-	-
	S	Elk River Side Channel	GH_ERSC2	-	Elk River side channel d/s of Thompson Creek	648275	5550608	monthly/ continuous	side channel survey	monthly, concurrently	July 2017[c]	-[c]	-[c]	-[c]	-[c]	yes	yes
	M	Elk River	GH_ERC (Compliance)	E300090	d/s Thompson Cr. and GHO	649146	5548514	monthly/ continuous	-	monthly, concurrently	September 2017	1	1	5	1 composite, 2 taxon-specific	-	-

[a] M-main stem; S-side channel; T-tributary.
[b] Concurrently - water chemistry sampling will be conducted concurrent with sediment and biological sampling. Weekly/monthly - water chemistry sampling and flow monitoring are conducted weekly or monthly through Permit 107517 and Permit 6428.
[c] Station was dry during Septemebr 2017 sampling.

Table 2.2: GHO LAEMP Sampling at Pool and Wetland Stations, May 2017 to March 2018

Exposure Type	Stream Type[a]	Stream Name	Water Station Code	ENV EMS Number	Area Description	UTM for Biological Area Code (NAD83, 11U)		Hydrology	Habitat and Biota	Surface Water	Substrate		Benthic Invertebrates			Fish	
								Water Level, Flow, and Temperature Monitoring	Monthly Habitat and Biota Inventory Survey	Chemistry	Calcite Index	Sediment Physical-chemical Attributes	Community Endpoints	Biomass and Desnisuty	Tissue Chemistry (Composite taxa)	Fish Inventory	Fish Community
						Easting	Northing	monthly/ continuous	monthly	monthly/ concurrently[b]	July and September 2017	September 2017	September 2017	September 2017	September 2017	2018	2019
Mine-exposed	P	side channel pool	Pool-U-1	-	Side channel upstream of GH_ER1A	647843	5552016	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-U-2	-		647833	5551900	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-U-3	-		647873	5551838	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-U-4	-		647906	5551710	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-U-5	-		648214	5551721	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-M-1	-	Side channel downstream of GH_ER1A, upstream of Thompson wetland	648299	5550743	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	P	side channel pool	Pool-M-2	-		648255	5550781	-	monthly	monthly/ concurrently	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]	-[c]
	S	Elk River Side Channel Wetland	RG_GH-SCW1	-	inlet of side channel wetland, upstream of Thompson Creek	648253	5549846	-	monthly	concurrently	-	1	-	-	3 composite		
	S	Elk River Side Channel Wetland	RG_GH-SCW2	-	side channel wetland downstream of Thompson Creek	648380	5549321	-	monthly	concurrently	-	1	-	-	3 composite	yes	yes
	S	Elk River Side Channel Wetland	RG_GH-SCW3	-	side channel wetland downstream of Thompson Creek	648332	5550166	-	monthly	monthly/ concurrently	-	-	-	-	-		
	P	side channel pool	Pool-W-1	-	Western channel downstream of Thompson wetland	648253	5549846	-	monthly	monthly/ concurrently	September		-	-	3 composite	-	-
	P	side channel pool	Pool-W-2			648380	5549321	-	monthly	monthly/ concurrently	September		-	-	3 composite, 3 taxon-specific	-	-
	P	side channel pool	Pool-E-1	-	Eastern channel downstream of Thompson wetland	648492	5549728	-	monthly	monthly/ concurrently	-	-	-	-	-	-	-
	P	side channel pool	Pool-E-2	-		648561	5549475	-	monthly	monthly/ concurrently	September	1	-	-	3 composite	-	-
	P	side channel pool	Pool-E-3	-		648592	5549424	-	monthly	monthly/ concurrently	-	-	-	-	-	-	-
	P	side channel pool	Pool-E-4	-		648634	5549336	-	monthly	monthly/ concurrently	-	-	-	-	-	yes	-
	P	side channel pool	Pool-E-5	-		648656	5549303	-	monthly	monthly/ concurrently	-	-	-	-	-	yes	-
	P	side channel pool	Pool-E-6	-		648675	5549296	-	monthly	monthly/ concurrently	September	2	-	-	3 composite	yes	-
	P	side channel pool	Pool-E-7	-		648782	5549097	-	monthly	monthly/ concurrently	September	1	-	-	3 composite, 3 taxon-specific	yes	-

[a] M-main stem; S-side channel; T-tributary.

[b] Concurrently - water chemistry sampling will be conducted concurrent with sediment and biological sampling. monthly - water chemistry sampling conducted as part of monthly sureveys.

[c] Station was flowing during Septemebr 2017 sampling.

- isolated pools, and
- surface connectivity between tributaries (Mickelson Creek, Leask Creek, Wolfram Creek, and Thompson Creek), the Elk River, and the Elk River side channel.

Maps were created to display monthly conditions in terms of wet/dry sections of the side channel, flooded areas, the surface connectivity of tributaries to the side channel, and between the side channel and main stem Elk River. The percentage of the side channel length (not area) that was wetted was calculated monthly.

2.2.3 Hydrometric and Water Temperature Monitoring (Question #1.b)

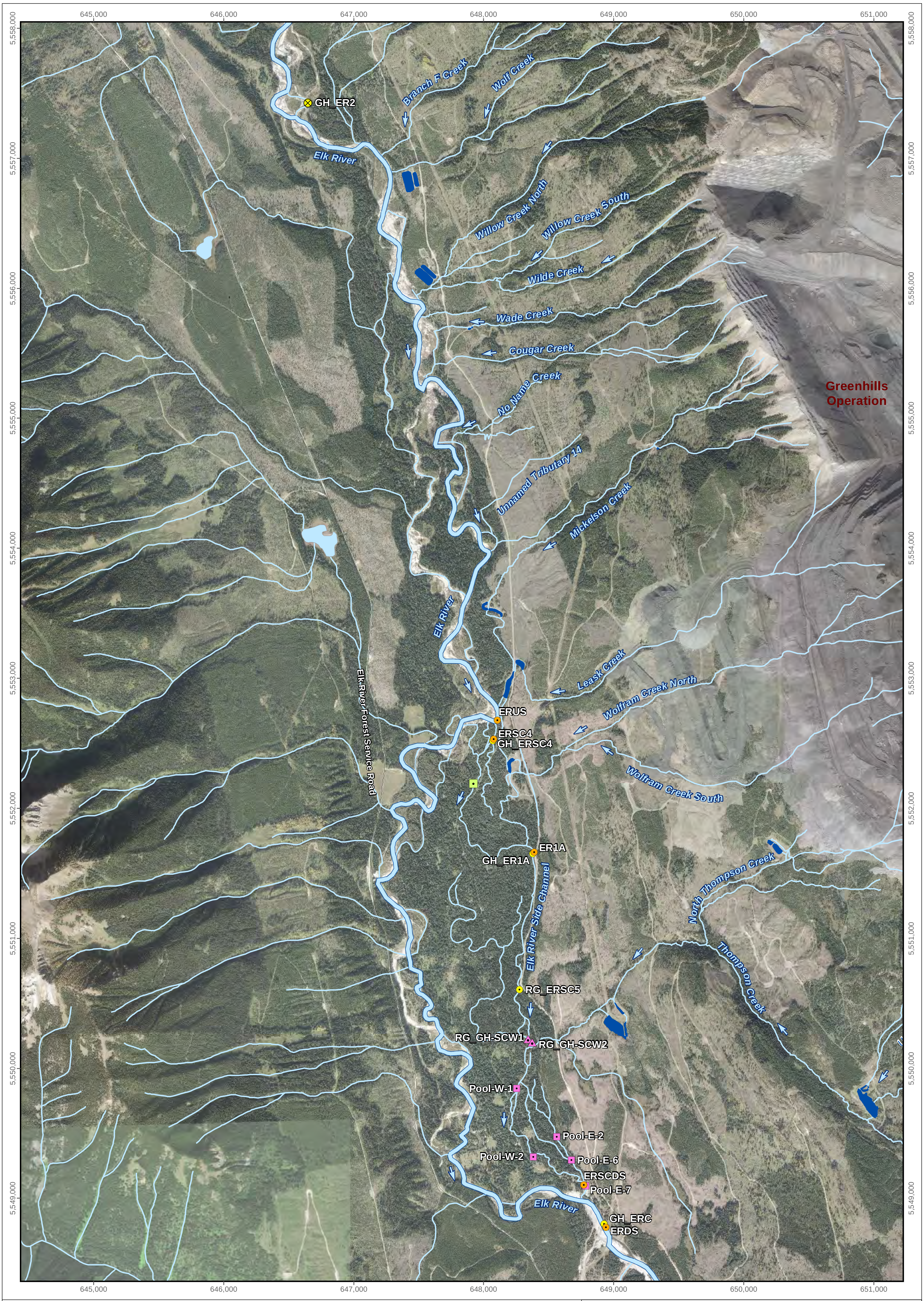
2.2.3.1 Field Monitoring

Water level loggers were installed on May 19, 2017 at ERSCDS[3] and GH_ERSC4, and on June 20, 2017 at ERDS, GH_ER1A, and ERUS (Table 2.1). A barometric logger was installed on May 19, 2017 at GH_ER1A.

Water levels (i.e., stream stage) and temperature were recorded at 15-minute intervals at the three stations within the Elk River side channel (ERSCDS, GH_ER1A, and GH_ERSC4) and at the two stations within the main stem Elk River (ERDS and ERUS; Figure 2.1) using Onset Hobo U 20 Level loggers. The loggers were installed in locations to describe the total surface flow passing by (e.g., no channel braiding) and were set in the deepest part of a channel cross-section, while maintaining some protection to the logger by the bank shape. Loggers were housed in a stilling well attached to angle iron, to which a staff gauge was also attached. The staff gauge was installed to verify pressure transducer readings, and to support the future development of a stage-discharge relationship for each site. One barometric logger was installed on land at GH_ER1A to correct for changes in atmospheric pressure. Benchmark surveys were completed as quality control to assess whether the logger and stilling wells had shifted overtime. Benchmark surveys were completed throughout the sampling period to comply with Resources Information Standards Committee (RISC) standards (RISC 2009). Data was downloaded routinely from the loggers to avoid data loss. During the winter, the loggers were winterized to prevent freezing and damage.

Where feasible, flow measurements were completed at all water level logger stations on the side channel (ERSCDS, GH_ER1A, GH_ERSC4; Figure 2.1) during monthly visits. Streamflow measurements followed the Manual of British Columbia Hydrometric Standards (RISC 2009). Stream depth (m) and velocity (m/s) were measured using a Hach FH950 flow meter. Velocity

[3]GH_ERSC2 (downstream of the confluence of Thompson Creek) was listed in the study design for the installation of a data logger, however in order to get a better understanding of the level/flow near the outlet of the Elk River side channel this location was substituted with ERSCDS (near the outflow of the side channel). GH_ERSC2 was also on a braid and would have missed some of the flow, unlike ERSCDS, which is in a singles channel.



LEGEND

- Water level and temperature loggers, flow monitoring
- Sediment quality and benthic invertebrate tissue selenium
- Sediment, benthic invertebrate tissue selenium, and benthic invertebrate biomass and community
- Fish tissue selenium
- Settling pond

- Side channel station connected to the main stem
- Reference station
- Wetland
- Pool

Hydrology, Sediment Quality, Benthic Invertebrate Tissue Selenium, Benthic Invertebrate Biomass and Community, and Fish Tissue Sampling Stations

0 0.5 1 2
km

N E S W

Projection: North American Datum 1983 UTM Zone 11

Date: May 2018
Project 177202.0024

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Figure 2.1

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig 2.1 Sampling Stations.mxd measurements were collected at 60% of the total depth from the water surface. These flow measurements, combined with staff gauge readings, will be used to build stage-discharge measurements once the required number of flow measurements have been conducted (minimum of ten flow measurements over a range of flow conditions.) Flow measurements were not collected at the Elk River main stem sites due to deep water and high flow conditions.

2.2.3.2 Data Analysis

Water level data were collected and then corrected for barometric pressure using Onset Hoboware Pro (version 3.7.13) and a reference water stage relative to the staff gauge. Since loggers were installed during high flows, the crews could not safely access deeper areas of the channel. As a result, some loggers were later relocated when they became dewatered while flow remained in the channel. The water stage record collected before the relocation was corrected using the difference between the water stage immediately pre- and post-relocation as measured by the staff gauge and benchmark surveys. A continuous record of water stage in metres was produced by correcting the data for atmospheric pressure and for the relocation. Stage cannot be directly used to compare water quantity between sites, as stage was determined using a locally referenced point relative to the staff gauge at each site.

Water stage time series were plotted for each site and qualitatively assessed for similarities between side channel locations and Elk River main stem locations (Figure 2.1). Similar patterns would suggest that side channel flows were influenced by the Elk River hydrograph. A matrix plot was also generated to show each possible pair of locations as linear relationships. Linear regression was run on the site pairings to test for significant relationships between the two hydrographs, and also how strongly the two site records were correlated. R^2 values closer to 1 would suggest more strongly correlated sites, which would also suggest that they were more strongly hydrologically connected. The hydrograph from the Water Survey of Canada station on the Elk River near Natal (station 08NK016) was compared to provide context of the hydrologic conditions experienced in the Elk River in 2017.

Water temperature graphs were also plotted. Temperature graphs provide data to corroborate when loggers were suspected as dewatering and provide data for fish habitat conditions.

Flow (spot measurements) data were assessed to better characterize the surface water/groundwater relationship in the side channel and to identify gaining and losing portions of the channel[4]. Stream discharge (m^3/s) was calculated using stream depth and velocity measurements, and was used for spatial comparisons. A relative decrease in discharge from upstream to downstream would suggest losses to subsurface flows, while a relative discharge increase without major overland contributions would suggest that groundwater likely surfaces and contributes to surface discharge.

2.3 Water Quality

2.3.1 Overview

Water quality analyses were conducted to address key question #2: "What is the influence of GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?" (Section 1.2). Data were evaluated from Teck's routine water quality monitoring, as well as from supplementary sampling conducted during GHO LAEMP field work.

2.3.2 Sample and Data Collection

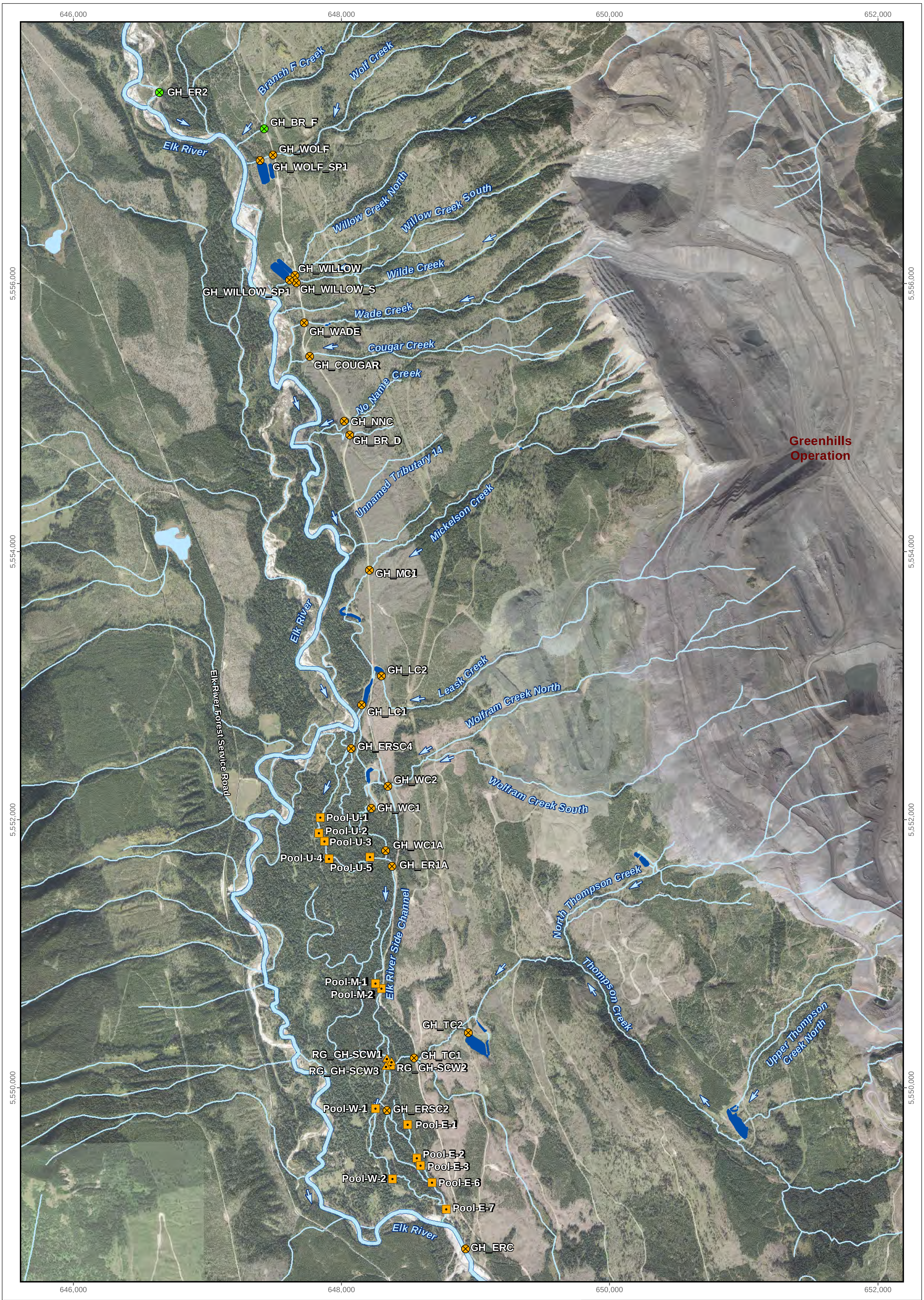
Routine water quality monitoring samples collected weekly/monthly[5] by Teck were analyzed by ALS Environmental in Calgary, AB or Burnaby, B.C., and data were stored in Teck's EQuIS™ database. Monitoring data, along with quality assurance and quality control (QA/QC) associated with water sampling, were presented in Teck's quarterly and annual water quality reports for Permit 107517 and Permit 6428. Water quality monitoring data collected by Teck were downloaded from the database for the water quality stations in the west-side tributaries, the upper Elk River, and the Elk River side channel (Figure 2.2) and were evaluated relative to site-specific benchmarks[6].

Additional water quality samples were collected specifically for the GHO LAEMP from isolated pools along the Elk River side channel from August 2017 to March 2018 (Appendix Table B.1).

[4] The 2017 GHO LAEMP Study Design intended flow measurements to be used to generate stage-discharge relationships and then use discharge to identify gaining and loosing reaches in the side channel. Stage-discharge relationships would have allowed for the continuous water stage record to be converted to continuous discharge, which could be compared between locations. A stage-discharge relationship requires 10-15 measurements; however, this many measurements could not be obtained in 2017 due to high flows in spring and dewatering in the fall. A stage-discharge relationship will be established in the next year of monitoring for the GHO LAEMP.

[5] Sampling is conducted on a monthly basis (August to March) and/or weekly/monthly basis (March 15 to July 15), as required by Permit 107517 and Permit 6428.

[6] In addition to site-specific benchmarks, the 2017 GHO LAEMP study design proposed that water quality be compared to predictions; however, side channel water quality predictions do not exist, and therefore this comparison could not be included in the 2017 GHO LAEMP. Water quality was predicted for the Cougar Pit Extension Permit Amendment Application (Teck 2015) for locations on the west side of GHO, but did not include the side channel, as it was determined to have the same water quality as the main stem Elk River at the time of sampling. However, side channel water quality was only evaluated upstream of Thompson Creek, as sampling was conducted under low flow conditions when the side channel downstream of Thompson Creek was dewatered. Teck will work in collaboration with the EMC to determine how water quality predictions can be incorporated into future monitoring.



LEGEND

- Routine water quality monitoring stations (Permit 107517), Reference
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Mine-exposed water quality sampling location
- Settling pond

Wetland

Pool

Surface Water Quality Monitoring Stations

0 0.5 1 2
km

N W E S

Projection: North American Datum 1983 UTM Zone 11
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Figure 2.2

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig 2.2 Routine WQ Monitoring.mxd

Grab water samples were collected from fourteen isolated pools. Samples were collected monthly following initial identification of isolated pools, until such time the pools became dry or froze to the bottom. Photographs were taken of each pool when samples were collected, and notes on fish presence, pool size, and depth were recorded during ice-free conditions. The location of each pool was marked in UTMs using handheld GPS. Water quality samples were also collected concurrent with benthic invertebrate tissue and community samples in September 2017 (Section 2.7 and 2.9). Water sampling was added to the wetland late in 2017 to support the assessment of water quality in the side channel (key question #2.b). Wetland stations RG_GH-SCW1 and RG_GH-SCW2 (Figure 2.2) were sampled only in September, concurrent with benthic invertebrate tissue and community samples. Wetland station RG_GH-SCW3 (Figure 2.2) was sampled monthly from December to March 2018. RG_GH-SCW1 was located near the side channel inlet of the wetland, RG_GH-SCW2 was located near the Thompson Creek inlet to the wetland, and RG_GH-SCW3 was located near the wetland outlet. RG_GH-SCW3 was sampled with greater frequency instead of RG_GH-SCW2 because it was expected to be an area of greater mixing.

Water samples collected specifically for the GHO LAEMP were collected in clean, pre-labelled containers provided by ALS Environmental Laboratories. Water samples collected in September (concurrent with benthic invertebrate sampling, Section 2.9) to be analyzed for dissolved organic carbon (DOC) and dissolved metals were filtered in the field using a clean syringe affixed with a 0.45 µm membrane. Water samples collected during monthly surveys were filtered in the laboratory. Samples were preserved immediately as required, and once re-capped, bottles were inverted two or three times to mix the preservative with the water sample. Water samples were kept cold and shipped to ALS Environmental Laboratory within 48 hours of collection.

Concurrent with water quality sampling, *in situ* measurements of temperature, dissolved oxygen (DO), pH, and specific conductance were collected using a YSI Pro Plus. The YSI was checked daily and calibrated as needed.

2.3.3 Laboratory Analysis

All water samples were analyzed by ALS Environmental for parameters consistent with Permit 107517 (i.e. conventional parameters, major ions, nutrients, and total and dissolved metals, Table 2.3) using standard methods (Table 2.4). Quality assurance and quality control (QA/QC) associated with water sampling are reported by Teck in the annual reports for Permits 107517 and 6248.

Table 2.3: Water Sample Analyses

Category	Parameters (as per Permit 107517, Appendix 2, Table 25)
Field Parameters	temperature, specific conductance, dissolved oxygen (DO), pH
Conventional Parameters	specific conductance, total dissolved solids, total suspended solids, hardness, alkalinity, dissolved organic carbon, total organic carbon, turbidity
Major Ions	bromide, fluoride, calcium, chloride, magnesium, potassium, sodium, sulphate
Nutrients	ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen (TKN), orthophosphate, total phosphorus
Total and Dissolved Metals	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, zinc

Table 2.4: Analytical Methods for Water Samples

Analyte	Units	Method	Reference
Turbidity	NTU	Nephelometric	APHA 2130 Turbidity
Hardness (as $CaCO_3$)	mg/L	Calculation	APHA 2340B
Total Suspended Solids	mg/L	Gravimetric	APHA 2540 D
Total Dissolved Solids	mg/L	Gravimetric	APHA 2540 C
Alkalinity	mg/L	Potentiometric Titration	APHA 2320
Ammonia (as N)	mg/L	Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
Bromide (Br)	mg/L	Ion Chromatography	APHA 4110 B
Chloride (Cl)	mg/L	Ion Chromatography	APHA 4110 B
Fluoride (F)	mg/L	Ion Chromatography	APHA 4110 B
Total Kjeldahl Nitrogen	mg/L	Fluorescence	APHA 4500-NORG D.
Nitrate (as N)	mg/L	Ion Chromatography	EPA 300.0
Nitrite (as N)	mg/L	Ion Chromatography	EPA 300.0
Phosphorus (P)-Total	mg/L	Colourimetrically	APHA 4500-P Phosphorous
Orthophosphate	mg/L	Colourimetrically	APHA 4500-P Phosphorous (Filter through 0.45 um filter)
Sulphate (SO_4)	mg/L	Ion Chromatography	APHA 4110 B
Dissolved Organic Carbon	mg/L	Combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC) (Filter through 0.45 um membrane filter)
Total Organic Carbon	mg/L	Combustion	APHA 5310 TOC
Total & Dissolved Metals	mg/L	CRC ICPMS (collision cell inductively coupled plasma - mass spectrometry) ICPOES (inductively coupled plasma - optical emission spectrophotometry)	APHA 3030 B&E / EPA SW-846 6020A EPA 3005A/6010B Dissolved metals filtered through a 0.45 um filter

2.3.4 Data Analysis

2.3.4.1 Screening of Water Quality Parameters

To narrow the scope of the 2017 GHO LAEMP, water quality analyses were conducted on a reduced parameter suite: the Order constituents (i.e., dissolved cadmium, nitrate, total selenium, and sulphate) and total nickel. The Order constituents were included because they are named in the EVWQP. Total nickel was included in the 2017 GHO LAEMP water quality analyses based on the results of 2017 quarterly chronic toxicity sampling conducted by Teck (Golder 2018a) which showed adverse effects in invertebrates at nickel concentrations below the BCWQG. Preliminary screening values (IC_{25}) for nickel toxicity were determined through Toxicity Identification Evaluations (TIEs) completed by Nautilus in 2018; the preliminary nickel IC_{25} values developed based on the results of the TIEs were 22.4 and 10.8 µg/L for *Hyalella* and *Ceriodaphnia*, respectively. Ongoing work to evaluate potential nickel toxicity is being completed, including the development of additional screening values based on species sensitivity distribution curves developed by Golder in 2018. As these investigations are refined, the results will be incorporated into future evaluations.

No other parameters were considered noteworthy for 2017, after screening Teck's routine water quality monitoring stations pertinent to the GHO LAEMP (Figure 2.2) against British Columbia Water Quality Guidelines (BCWQG; BCMOE 2018) for the Permit 107517 Annual Water Quality Monitoring Report (Teck 2018). Parameters having concentrations above BCWQG were presented in the Permit 107517 Annual Water Quality Monitoring Report (Teck 2018). In 2017, GH_ER1A exceeded the total iron guideline once and total mercury guideline twice. In 2017, GH_ERSC4 exceeded the total iron guideline once and total mercury guideline once. GH_ERSC2 exceeded the dissolved aluminum guideline three times, and the total mercury guideline six times. Water quality at the main stem Elk River station downstream of the side channel (GH_ERC) did not exceed BCWQG.

2.3.4.2 West-Side Tributaries

Water quality data for monitoring stations located in the west-side tributaries (Figure 2.2) collected from January 2016 to December 2017 were compared to site-specific benchmarks from the EVWQP (Order constituents) and preliminary IC_{25} values (nickel), as applicable.

2.3.4.3 Side Channel Monitoring Stations (Question #2.b)

Water quality of the Elk River side channel was assessed by analyzing data from Teck’s three routine water quality monitoring stations (GH_ERSC4, GH_ER1A, and GH_ERSC2; Figure 2.2). Data from these stations were compared to site-specific benchmarks from the EVWQP (Order constituents) and preliminary IC_{25} values (nickel), as applicable. Data were plotted to investigate seasonal and spatial patterns among stations.

2.3.4.4 Isolated Pools and Wetland Stations (Question #2.c)

Water quality data from the isolated pools and wetland were plotted to show seasonal and temporal patterns of Order constituents and total nickel. Water quality was compared to the water quality observed at routine monitoring stations in the side channel and west-side tributaries, as well as to site specific benchmarks from the EVWQP.

2.3.4.5 Downstream versus Upstream of the West-Side Tributaries (Question #2.a)

Water quality data for the monitoring station in the main stem Elk River downstream of the west-side tributaries (GH_ERC) was compared to the Elk River station upstream of all mine influence (GH_ER2) to assess the overall influence of GHO on water quality in the upper Elk River (Figure 2.2). Data for Order constituents and total nickel from these stations were compared to site-specific benchmarks from the EVWQP, a preliminary IC_{25} value (nickel only), and/or permit limits (GH_ERC only), as applicable. Data were plotted to show seasonal and temporal patterns. Concentrations at the downstream station were compared to upstream using the difference in monthly mean concentrations between stations in a one sample t-test (i.e., paired t-test). If assumptions were not met (i.e., normality of the differences) then the Wilcoxon signed rank test (WSRT) was used, which is a non-parametric equivalent to the paired t-test. Potential changes over time at the downstream station compared to upstream were tested using Analysis of Covariance (ANCOVA) on the differences in monthly mean concentrations between stations, with covariate *Year* and factor *Month*. Lack of interaction would indicate that the slopes for each month were similar, in which case, the slope was tested for year (comparable to the non-parametric seasonal-Kendall test).

2.3.4.6 Main Stem Elk River versus the Side Channel

Water quality data for the monitoring stations in the main stem Elk River downstream of the west side tributaries (GH_ERC) and upstream of all mine influence (GH_ER2) were compared to Teck's three routine water quality monitoring stations in the side channel (GH_ERSC4, GH_ER1A, and GH_ERSC2; Figure 2.2).

Statistical analysis of water quality data focused on monthly mean concentrations for Order constituents and total nickel. Statistical comparisons of concentrations between the side channel stations and the upstream (GH_ER2) and downstream (GH_ERC) stations were conducted to assess differences between years (2016 and 2017) and among stations. The statistical comparisons were conducted on the mathematical differences (side channel – downstream, and side channel – upstream) in monthly mean concentrations to remove the influence of season.

The differences in monthly mean concentrations between areas were tested using a two-way Analysis of Variance (ANOVA) with factors Year, Area (the three side channel stations) and the Area x Year interaction. When the assumption of normality (Shapiro-Wilks' test with significance level [α] = 0.05) was not met for the monthly means or after transformation ($\log_{10}$, square-root, fourth-root), a rank-transformation was applied prior to analysis.

The side channel versus upstream, and side channel versus downstream comparisons were conducted by testing whether differences in monthly mean concentrations between stations were different from zero using a one-sample t-test (or WSRT when assumptions of normality were not met) by testing the hypothesis:

$$H_{01}: \mu d = 0$$

where μd represents the difference in monthly means between side channel stations and upstream or downstream concentrations. The tests for H_{01} were conducted by (1) pooling both years of data and stations when the Area x Year interaction (P-value > 0.1) and Area (P-value > 0.1) factors were not significant, (2) pooling both years of data, but separately by side channel when the Area x Year interaction (P-value > 0.1) was not significant, but Area was significant (P-value < 0.1), or (3) separately by station and year when the Area x Year interaction (P-value < 0.1) term was significant.

When the differences in monthly mean concentrations between the side channel and upstream or downstream stations was significant, the magnitude of difference (MOD) was calculated as:

$$MOD = \frac{(MCT_{SC} - MCT_{US})}{MCT_{US}} \times 100\%$$

or

$$MOD = \frac{(MCT_{SC} - MCT_{DS})}{MCT_{DS}} \times 100\%$$

where MCT_{SC}, MCT_{US} and MCT_{DS} are the measure of central tendency for the side channel, downstream, and upstream stations, respectfully (i.e., mean or median depending on whether the statistical comparison was conducted using a parametric (t-test) or non-parametric (WSRT). The statistical analyses were conducted using R statistical software (R Core Team 2015).

2.4 Substrate Quality (Question #3.b)

2.4.1 Overview

Substrate data were collected and analyzed to answer key question #3.b (Section 1.2): "What is the substrate quality?".

2.4.2 Calcite

2.4.2.1 Data Collection

Calcite coverage was assessed at three locations within the side channel (GH_ERSC4, GH_ER1A, and GH_ERSC2) in July and September 2017[7]. Field measurements were consistent with calcite monitoring conducted for the RAEMP (Minnow 2018a), and followed a modified 100-particle pebble count method developed for Teck's Calcite Monitoring Program (Robinson and Atherton 2016, Teck 2016b), and all field technicians received Teck's calcite monitoring consistency training. For this modified approach, calcite was measured only in riffle habitats on undisturbed substrate in the immediate vicinity of where benthic invertebrate community samples were collected (e.g., roughly 10 m distance). One hundred streambed particles were randomly selected over the study area and were measured for calcite presence/absence and concretion. The presence (score = 1) or absence (score = 0) of calcite was recorded for each of the 100 particles. The degree of concretion was also assessed by determining if the particle was removed with negligible resistance (not concreted; score = 0), noticeable resistance but removable (partially concreted; score = 1), or immovable (fully concreted; score = 2).

The results for the 100 particles surveyed for calcite were expressed as a Calcite Index (CI) based on the following equation:

$$CI = CI_p + CI_c$$

Where:

$$CI = Calcite\ Index$$

$$CI_p = Calcite\ Presence\ Score = \frac{Number\ of\ particles\ with\ calcite}{Number\ of\ particles\ counted}$$

$$CI_c = Calcite\ Concretion\ Score = \frac{Sum\ of\ particle\ concretion\ scores}{Number\ of\ particles\ counted}$$

Calcite was not observed during the study period (Section 5.2), therefore no additional analyses were conducted.

2.4.3 Sediment Quality

2.4.3.1 Sample Collection

Sediment quality samples were collected concurrent with, and at the same locations as, benthic invertebrate samples (Sections 2.7 and 2.9; Figure 2.1). Sediment samples were collected using a stainless steel spoon and were transferred into glass jars for analysis of polycyclic aromatic

[7] The GHO LAEMP Study Design 2017 planned for measuring calcite in spring, summer, and fall. However, no calcite surveys were completed in the spring (May and June) due to deep, turbid waters in the Elk River side channel.

hydrocarbons (PAHs), and into polyethylene bags for all other analyses (see Section 2.4.3.2). Samplers took care to only remove the top 1 to 2 cm of sediment, and continued to collect sediment until sufficient sample volume was retrieved. For QA/QC purposes, duplicate (split) samples were collected at a frequency of approximately 10% of the total number of samples to assess field precision (i.e., two sets of field duplicate samples). Following collection, samples were placed in a refrigerator at approximately 4°C until submission to the analytical laboratory.

2.4.3.2 Laboratory Analysis

Samples for chemical analysis were sent to ALS Environmental (Calgary, AB). The laboratory was instructed to thoroughly homogenize each sediment sample (according to standard laboratory protocols), to ensure the aliquots taken for analysis were representative and comparable.

Sediment samples were analyzed for metals, mercury, total organic carbon (TOC), polycyclic aromatic hydrocarbons (PAHs), particle size distribution, and moisture content using standard methods (Table 2.5).

Table 2.5: Analytical Methods for Sediment Samples

Analyte	Units	Method	Reference
Metals	mg/kg	Collision Reaction Cell Inductively Coupled Plasma-Mass Spectrophotometry (CRC ICP-MS)	EPA 200.2/6020A
Mercury	mg/kg	Cold Vapor-Atomic Absorption (CVAAS)	EPA 200.2/1631E (mod)
Total Organic Carbon (TOC)	%	TOC is calculated by the difference between total carbon (TC) and total inorganic carbon (TIC)	CSSS (2008) 21.2
Polycyclic Aromatic Hydrocarbons (PAHs)	mg/kg %	Rotary extraction using hexane/acetone followed by capillary column gas chromatography with mass spectrometric detection (GC/MS)	EPA 3570/8270
Particle Size Distribution	%	Dry sieving (coarse particles), wet sieving (sand), and the pipette sedimentation method (fine particles)	SSIR-51 METHOD 3.2.1
Moisture Content	%	Determined gravimetrically by drying the sample at 105 °C	CWS for PHC in Soil - Tier 1

2.4.3.3 Data Analysis

QA/QC for sediment samples included the collection of two field duplicates, and assessment of laboratory duplicates, spike recoveries, and certified reference materials. Based on the results provided for QA/QC samples, the sediment data collected for the GHO LAEMP were judged to be of acceptable quality (Appendix C). The sediment quality data were evaluated relative to applicable BC sediment quality guidelines (SQG) and, where applicable, the reference area normal range[8].

2.5 Monthly Aquatic Habitat Surveys (Question #3.a)

2.5.1 Overview

Habitat data were collected to help address key question #3.a (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

a. How does the distribution of biota change seasonally? Which isolated pools contain biota?

These data provide information about seasonal habitat availability for different biota, which gives context for understanding the relative risk of potential exposure pathways.

2.5.2 Reach Identification

For the purposes of the habitat assessment, a stream reach was defined as a relatively homogenous length of stream based on uniform discharge, morphology, and riparian habitat (Johnston and Slaney 1996). Reach identification was conducted in the side channel following Reconnaissance Inventory Standards (RISC 2001) in late July 2017 (post-freshet). Identified Reaches were subsequently used as spatial units to describe biota use and habitat suitability within the side channel.

2.5.3 Level 1 Fish Habitat Assessment Procedure (FHAP)

2.5.3.1 Field Data Collection

Habitat was assessed throughout the side channel using the Fish Habitat Assessment Procedures (FHAP; Johnston and Slaney 1996). The FHAP survey was completed from July 26 to 27, 2017, and began with a delineation survey over each reach of the side channel to determine individual habitat units. The side channel had some highly braided sections; therefore, the

[8] The reference area normal range for sediment is defined as the 2.5th and 97.5th percentiles of 2013 and 2015 reference area data reported in the RAEMP for lentic stations (Minnow 2018a).

delineation survey only covered the side channel sections where the majority of the flow occurred. The survey used a systematic stratified subsampling system to sample every 4th habitat unit of each habitat type (e.g., pool, riffle, glide, and cascade), or 25% of each habitat type. The starting habitat unit was randomly selected for each type and was between the 1st and 4th unit identified. After that, every 4th unit of each type was sampled. Each subsampled habitat unit was marked using a GPS, photographed, and marked in the field with labelled flagging tape to facilitate accurate location identification should subsequent surveys be required. The Level 1-FHAP was completed on the full lengths of both the east and west channels of Reach 1, Reach 2, and Reach 3. Braided sections, primarily in Reach 1, were noted and photographed during monthly surveys (Section 2.5.4). Delineation of habitat type and length provides an absolute estimate of linear proportions of each habitat type. Measurements taken at a habitat unit scale were as follows:

- channel (bankfull) width and depth,
- wetted width and depth,
- residual pool depth,
- qualitative substrate size (Table 2.6),
- spawning habitat potential,
- instream large woody debris (LWD),
- cover elements (Table 2.7), and
- disturbance indicators.

Table 2.6: Stream Substrate Size Classification Based on Johnston and Slaney (1996)

Substrate Type	Substrate Size (mm)
Fines [1]	<2
Gravels	2 - 64
Cobbles	64 - 256
Boulders	256 - 4,000
Bedrock	>4,000

[1] Includes sand, silt and organics.

Table 2.7: Percent and Rating of Total Available Fish Cover Presented in Johnston and Slaney (1996)

Cover %	Rating
<2	Trace
2 - 10	Poor
10 - 20	Fair
>20	Good

Potential spawning habitat was noted during the FHAP survey based on: cover availability, proximity to holding water, adequate flows, and suitable gravel size. Adequate flows were based on depth-velocity ranges reported in McKay and Robinson (2014), and Schmetterling (2000). McKay and Robinson (2014) reported that the average water depth selected by spawning Westslope Cutthroat Trout for redd site location was 0.24 m ± 0.08 and average water velocity was 0.41 m/s ± 0.2 m/s. Similarly, Schmetterling (2000) reported suitable Westslope Cutthroat Trout spawning habitat to have depths ranging from 4.2 to 22.9 cm and velocities ranging from 0.25 to 0.78 m/s. Following the definitions within standard FHAP, suitable salmonid spawning habitat is water depths >0.15 m, water velocity 0.3-1.0 m/s, and spawning gravel for resident salmonids is considered to be 10 to 75 mm in size (Johnston and Slaney 1996).

2.5.3.2 Data Analysis and Interpretation

Data collected during the FHAP survey were first used to describe the types of habitat present (i.e., habitat unit types pool, riffle, glide, cascade) and the spatial distribution of each habitat unit. Habitat proportions were reported as percentages by linear extent. Data were also used to calculate seven channel morphology metrics, which were used to describe habitat quality (Johnston and Slaney 1996):

- bankfull width-to-depth ratio,
- sinuosity,
- channel complexity,
- percent pool (by area),
- pool frequency (mean pool spacing),
- holding pools (adult migration), and
- LWD pieces per channel.

Bankfull width-to-depth ratio and sinuosity help describe channel morphology and can support suspicions of habitat degradation, but do not have ranking in Johnston and Slaney (1996), as do the other five metrics.

2.5.4 Monthly Habitat Assessment

Habitat was assessed as a component of monthly surveys. A crew walked the entire channel from the downstream outlet to the Elk River to the inlet near Leask Creek and documented general habitat conditions (e.g., presence of vegetation, bank condition, substrate type), including morphology/hydrology, as well as any updates of information gathered in the FHAP survey (Section 2.5.3). Channel morphology was described and photographed. Potential fish spawning and overwintering habitat were documented, as well as habitat suitable for other aquatic and aquatic-dependent vertebrates (amphibians and birds).

2.5.5 Overwintering Habitat

Monthly surveys (Sections 2.2.2 and 2.5.4) focused on evaluating overwintering habitat potential in months after freeze-up. The study did not attempt to confirm overwintering by fish capture and observation, but rather by presence of unfrozen, oxygenated pools during ice-over months. Observations of potential overwintering habitat were made during monthly habitat overview surveys (Section 2.5.4). Isolated pools being monitored for water quality (Section 2.3.2) were augured once to determine snow depth, ice thickness, airspace (distance between bottom of ice and water or substrate surface), and water depth (where water existed). *In situ* water quality data was collected using an YSI Pro Plus multi-probe water quality meter to obtain temperature, DO, pH, and specific conductance. The DO values were compared to the BC Water Quality Guidelines (BCMOE 2018a), which states that a DO value of less than 5 mg/L is an acutely toxic level and can only sustain embryo/alevin life for a minimum of 24 hours. Yau and Taylor (2014) reported that juvenile westslope cutthroat trout acclimatized to 15°C had a critical thermal minimum of 1°C (±0.8). Therefore, 1°C was set as the lower threshold of a “good” thermal habitat range.

2.6 Aquatic Vertebrate Inventories (Question #3.a)

2.6.1 Overview

Aquatic vertebrate inventories addressed key question #3.a (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

a. How does the distribution of biota change seasonally? Which isolated pools contain biota?

The seasonal use of the side channel and adjacent floodplain complex by aquatic and aquatic-dependent vertebrates were evaluated during the monthly visits (Sections 2.2.2 and 2.5.4) in which observations of fish, amphibians, and piscivorous birds were documented. Detailed site-specific inventories were also completed, including fish inventories, fish density sampling, and fish spawning surveys.

2.6.2 Amphibian Inventory (Presence/Absence)

Common amphibian species that may use the Elk River side channel are presented in Table 2.8. Amphibian presence/absence was assessed through auditory surveys, visual inspection of the understory for amphibians, and visual inspections along the shore of the wetland for eggs and tadpoles when flows and visibility permitted during the monthly surveys. Amphibian surveys were conducted from May 2017 to the start of winter conditions (November). When amphibians were observed, their life stage and location were recorded, they were identified to species, and a photo was taken (when possible). The locations of observed amphibians were mapped.

Table 2.8: Amphibian Species Potentially Found near the Elk River (Golder 2014; Minnow 2003, 2014; BCMOE 2018a,d,e; Isaac 2018a,b, pers. comm.)

Species Name	Scientific Name
Columbia spotted frog	*Rana luteiventris*
long-toed salamander	*Ambystoma macrodactylum*
Pacific chorus frog	*Pseudacris regilla*
western toad	*Bufo boreas*
wood frog	*Lithobates sylvaticus*

2.6.3 Bird Surveys

Common piscivorous bird species or families that may use the Elk River or Elk River side channel are presented in Table 2.9 (BCMOE 2018f). During monthly surveys of the side channel, all visual and auditory detections of aquatic-dependent birds (including nests, eggs, chicks, adults) were documented. Bird surveys were conducted from May 2017 to the start of winter conditions and ice coverage (November). When birds were observed their location were recorded and they were identified to species.

Table 2.9: Piscivorous Bird Species Potentially Found near the Elk River (BCMOE 2018f)

Species Name	Scientific Name/Family
American dipper	*Cinclus mexicanus*
bald eagle	*Haliaeetus leucocephalus*
common merganser	*Mergus merganser*
common loon	*Gavia immer*
cormorant sp.	Phalacrocoracidae
great blue heron	*Ardea herodias*
grebe sp.	Podicipediformes
kingfisher	*Megaceryle alcyon*
osprey	*Pandion haliaetus*

2.6.4 Fish Inventory (Presence/Absence)

Common fish species that are likely to be found in the Elk River (and possibly the Elk River side channel) according to the Provincial database are listed in Table 2.10 (BCMOE 2018b).

Table 2.10: Fish Species Potentially Found in the Study Area (BC MOE 2018b)

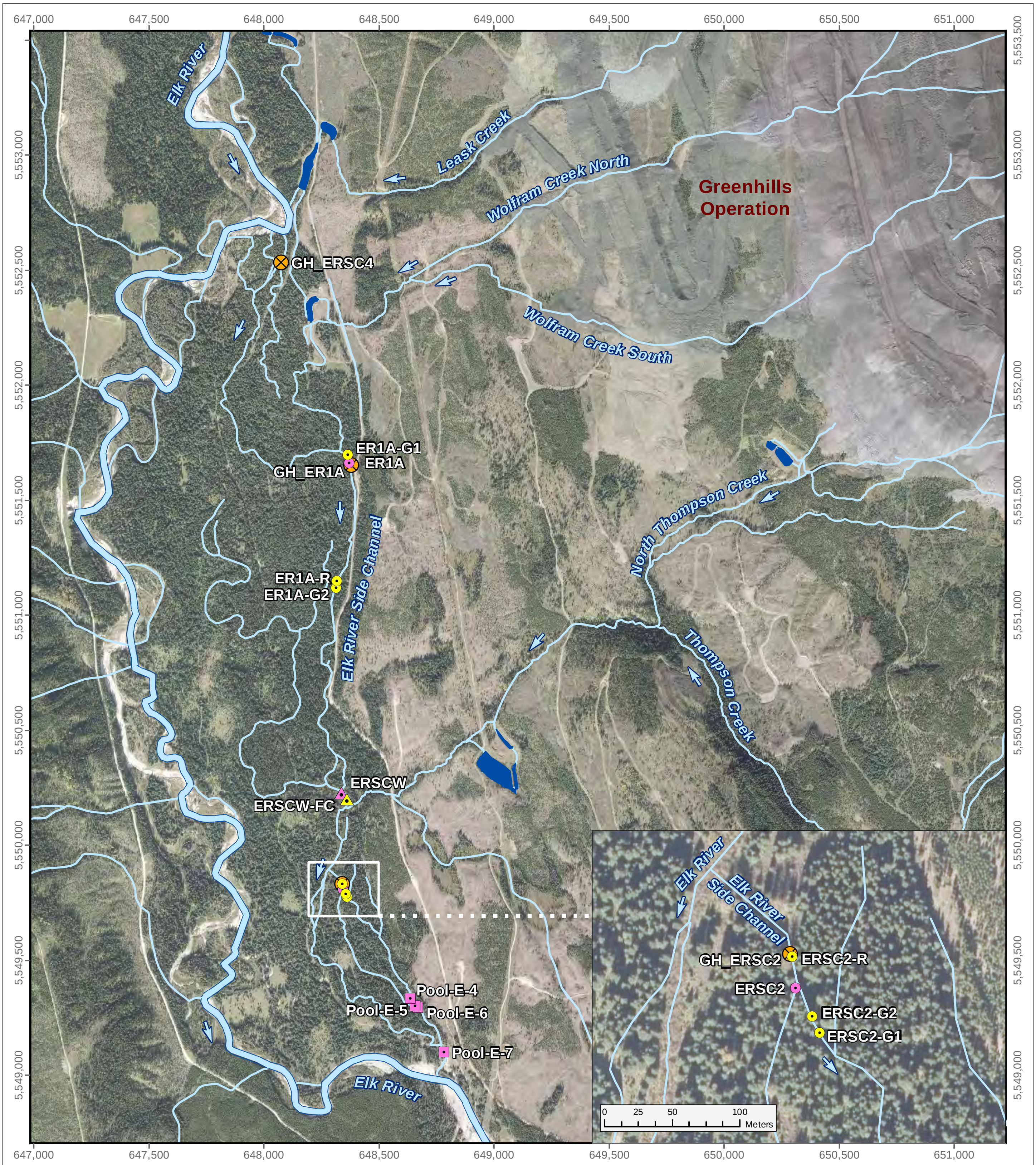
Species Name	Scientific Name	Species Code
westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	WCT
bull trout	*Salvelinus confluentus*	BT
eastern brook trout	*Salvelinus fontinalis*	EB
mountain whitefish	*Prosopium williamsoni*	MW
rainbow trout	*Oncorhynchus mykiss*	RB
longnose dace	*Rhinichthys cataractae*	LNC
longnose sucker	*Catostomus catostomus*	LSU
redside shiner	*Richardsonius balteatus*	RSC

Fish inventory assessments were completed in each reach of the side channel following RISC (2001). Sampling occurred in areas near GH_ERSC2, the side channel wetland, and GH_ER1A (Figure 2.3) in June, July, September, and October 2017. Fish inventory sampling was also conducted on four isolated pools in Reach 1 in September 2017. Fish presence/absence was also visually assessed during all of the ice-free monthly surveys. Inventory surveys had two objectives; 1) to assess fish presence, and if found, to describe the general fish community structure, and 2) to obtain and document general habitat information.

A two-person backpack electrofishing crew completed the fish inventory assessment sampling for lotic sites. Electrofishing was completed as a single, open pass over a site length of 100 m or 10-times the bankfull width (whichever was greater). Two to five baited minnow traps were also set and left overnight at each electrofishing location. For the lentic site in the wetland, only baited minnow traps were set as water depths were too deep to allow for electrofishing. Fish captured were identified to species, measured for fork length (nearest millimetre), weighed (nearest 0.1 g for fish less than 100 mm and nearest 1 g for fish greater than 100 mm), and photographed. Fishing effort and habitat data were collected on the Reconnaissance 1:20,000 fish and site cards, respectively.

Fish inventory assessments were used to document temporal variation of fish distribution, community composition, and habitat characteristics within the side channel. Catch-per-unit-effort (CPUE) was calculated for each sampling event as an index of fish use. Fish presence was described by species and life-stage. Fry, or young-of-the-year (YOY), are fish in their first year (0+) (McPhail 2007), juvenile is commonly used to describe fish from one year of age to the age of maturity, and adult refers to fish that have reached maturity.

Westslope cutthroat trout life stages of fry, juvenile, and adult were assigned based on the length frequency analysis results provided in Robinson (2014) (Table 2.11). Age of maturation for



LEGEND

- Fish inventory (Presence/Absence) survey
- Fish community (Density) survey
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Settling pond
- Side channel station connected to the main stem
- Wetland
- Pool

Fish Inventory and Fish Community Monitoring Locations

0 350 700 1,400 Meters

Projection: North American Datum 1983 UTM Zone 11
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Date: May 2018
Project 177202.0024

minnow environmental inc.

Figure 2.3

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Table 2.11: Westslope Cutthroat Trout Average Fork Length at Age Capture (Robinson 2014)

Stage	Age-class	Fork Length Range (mm)
fry	0+	29 – 67
juvenile	1+	68 – 130
	2+	131 – 170
mature (sub-adult and adult)	3+ and greater	>171

westslope cutthroat trout can vary during years 2-5 by individual, and by gender (Downs et al. 1997). However, this study considered adults to begin at 3+ years of age based on observed similarities in habitat preference of fish 3+ or older, regardless of state of maturation.

Bull trout life stages of fry, juvenile, and adult were assigned based on the length-frequency reported for Line Creek in Smithson and Robinson (2017) (Table 2.12). Line Creek is located approximately 22 km south of the side channel and serves as a spawning stream for this species.

Table 2.12: Bull Trout Fork Length Categories by Life Stage (Smithson and Robinson 2017)

Stage	Age-class	Fork Length Range (mm)
fry	0+	53 – 71
juvenile	1+	128 – 136
	2+	228
sub-adult / adult	>2+	>228

Regional size-at-age data are not known for brook trout. Brook trout life stages of fry, juvenile, and adult were assigned based on the length-frequency reported for the mid elevation stream in Kennedy et al. (2003) (Table 2.13). The mid elevation stream in Kennedy et al. (2003) had an elevation of 2,683 m, which is higher than the side channel (1,319 m); however, the annual mean

Table 2.13: Brook Trout Fork Length Categories by Life Stage for Mid-evaluation Streams (Kennedy et al. 2003)

Stage	Age-class	Fork Length Range (mm)
fry	0+	60 – 75
juvenile	1+	99 – 134
mature (sub adult and adult)	2+	>138

daily water temperatures were similar between the two studies, so the life stages determined in Kennedy et al. (2003) were considered appropriate for the side channel brook trout.

2.6.5 Fish Community (Density)

Fish community (density) assessments were completed from August 14 to 17, 2017 at one area per reach. These areas corresponded with the three fish inventory areas (Section 2.6.4, Figure 2.3). Three individual habitat units (e.g., cascade, glide, pool, or riffle) were identified and sampled at each lotic area (i.e., Reaches 1 and 3). Attempts were made to select habitat units that covered an area of approximately 100 m^2, however, the small size of the side channel limited what was available. Sampling in Reach 2 (lentic habitat) involved blocking off a portion of the available habitat using stop nets.

For lotic sites, fish community (density) assessments were completed using three-pass, depletion removal electrofishing over closed site conditions. Fish density and corresponding fish habitat data were collected at a habitat unit scale. A three-person crew, with one electrofisher, one netter, and one onshore observer, completed fish density assessments. The onshore observer noted the locations where fish were captured within the stream (e.g., stream margins, middle, third) and recorded species and size-class on a sketch. Observations of species, fork length (mm), and weight (g) were made for all fish captured. Any external deformities, erosions (fin and gill), lesions, or tumors observed during processing (i.e., DELT survey; Sanders et al. 1999) were recorded. Photographs of representative fish were also taken, and any mortalities were retained for aging via otoliths.

Fish density estimates in the lentic habitat of Reach 2 required different sampling techniques, as this habitat and fine sediment precluded effective wading or electrofishing without stirring up sediment resulting in reduced visibility. Therefore, a mark-recapture location was set up using methods described by Robinson and Arnett (2014) involving two capture events that spanned 48 hours. Fish were captured using minnow traps and marked with a fin clip during the initial 24 hour sampling event. A second sampling event occurred over the next 24 hours to capture both marked and unmarked fish. With the exception of marking, fish were processed as described above for fish community assessments.

Detailed habitat information was collected for each site using the BC Level 1 FHAP form (Johnson and Slaney 1996; Section 2.5.3). Streambed substrate was described by visual estimates of percent fines, gravel, cobble, boulder, and bedrock, and an estimate of average embeddedness. In lotic areas, depth-velocity profiles were conducted using a Hach FH950 flow meter to measure the depth and velocity at the horizontal mid-point of 10 to 20 evenly spaced intervals across the stream channel. Velocity measurements were collected at 60% of total water column depth measured.

2.6.6 Fish Spawning Surveys

Monthly surveys of spawning habitat were conducted during spring (May/June) and fall (September/October) when spawning fish species are potentially using the side channel. Typical spring spawning fish include westslope cutthroat trout and longnose sucker, while eastern brook trout, bull trout, and mountain whitefish are all fall spawning species. All redds, spawning fish, and other notable features were photographed and described, with coordinates recorded with a hand-held GPS. Redd locations were also described by habitat type, water depth, velocity, and association with cover.

2.7 Benthic Invertebrate Tissue Selenium (Question #3.c)

2.7.1 Overview

Benthic invertebrate tissue was collected to address key question #3.c (Section 1.2): "What are the fish and benthic invertebrate tissue selenium concentrations?".

2.7.2 Sample Collection

Benthic invertebrate tissue samples were collected in September 2017 from three areas in the side channel that were connected to the main stem Elk River (GH_ERSC4, GH_ER1A, RG_ERSC5[9]), the main stem Elk River stations (GH_ERC and GH_ER2), the side channel wetland (RG_GH-SCW1 and RG_GH-SCW2), and five isolated pools (Pool-W-1, Pool-W-2, Pool-E-2, Pool-E-6, and Pool-E-7; Figure 2.1).

Benthic invertebrates were sampled for tissue selenium analysis using the kick and sweep method. Two types of benthic invertebrate samples were collected composite-taxa samples and representative-taxa samples (Ephemeroptera, Perlidae, and Rhyacophila, determined based on availability in the field). Composite-taxa and Perlidae samples were collected in triplicate. Representative-taxa samples were not collected for most wetland and pool stations, as densities of these taxa were low. Benthic invertebrates were picked free of debris in the field, placed into a sterile labelled cryovial, and stored in a cooler with ice packs until transferred to a freezer later in the day.

2.7.3 Laboratory Analysis

The benthic invertebrate tissue samples were kept in a freezer until they were shipped in coolers to SRC Environmental Analytical Laboratories (SRC) in Saskatoon, SK. At the laboratory, the samples were freeze-dried and then analyzed for selenium using Inductively Coupled Plasma-

[9] The study design proposed benthic invertebrate tissue selenium sampling locations at GH_ERSC4, GH_ER1A, and GH_ERSC2; however, GH_ERSC2 was dry at the time of sampling, and therefore a new station, GH_ERSC5, was sampled.

Mass Spectrophotometry (ICP-MS). Results were reported on a dry weight (dw) basis, along with moisture content (based on the difference between wet and freeze-dried sample weights).

2.7.4 Data Analysis

Quality Assurance/Quality Control (QA/QC) for benthic invertebrate tissue samples included the assessment of quality control reference materials. Based on the results provided for QA/QC samples, the benthic invertebrate tissue data collected for the GHO LAEMP were judged to be of acceptable quality (Appendix E).

Tissue selenium concentrations were compared to EVWQP Level 1 and Level 2 benchmarks as well as normal ranges[10] for tissue selenium concentrations defined in the RAEMP. Tissue selenium concentrations were also plotted and spatially compared within and among areas. Additionally, tissue selenium concentrations were compared to the EVWQP selenium bioaccumulation model (Golder 2018b)[11].

2.8 Fish Tissue Selenium (Question #3.c)

2.8.1 Overview

Fish tissue was collected to address key question #3.c (Section 1.2): "What are the fish and benthic invertebrate tissue selenium concentrations?".

2.8.2 Sample Collection

Non-lethal sampling of muscle plugs from adult non-forage species was planned for fish captured during fish inventory and fish community sampling (Section 2.6.4 and 2.6.5, Minnow 2017). However, only one bull trout of sufficient size was captured (Figure 2.1). After capture, the fish was anaesthetized using a solution of clove oil dissolved in ethanol mixed in ambient water. Body weight was measured using a digital scale. Total and fork length were measured with a measuring board equipped with a metre stick (± 1 mm). External fish condition, including a DELT survey, were documented. A biopsy punch (4 mm acu-punch) was used to collect the tissue sample. Skin was removed from the sample with a scalpel and the remaining muscle sample was placed into a sterile microcentrifuge tube. Once the fish recovered from the anesthetic in a recovery bin, it was released back into the water body. The muscle biopsy sample was stored on ice until transferred to a freezer later in the day.

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[10] The reference area normal range for composite benthic invertebrate tissues samples is defined as the 2.5th and 97.5th percentiles of the distribution of reference area (pooled 1996 to 2015 data) reported in the RAEMP (Minnow 2018a).

[11] Due to a reporting error, the equation used herein for the one-step water-to-invertebrate selenium bioaccumulation model differs from that reported by Golder (2018b). This error will be resolved in an updated version of the Golder 2018 report. The equation used for calculation in the present report is consistent with that reported in Teck (2014a).

2.8.3 Laboratory Analysis

The muscle tissue sample was kept in a freezer until they were shipped in coolers to SRC Environmental Analytical Laboratories (SRC) in Saskatoon, SK. At the laboratory, the sample was freeze-dried and then analyzed for selenium using ICP-MS. Results were reported on a dw basis.

2.8.4 Data Analysis

QA/QC for the fish tissue sample included the assessment of quality control reference materials. Based on the results provided for QA/QC samples, the fish tissue data collected for the GHO LAEMP were judged to be of acceptable quality (Appendix E).

The selenium concentration was compared to the benchmarks for effects to aquatic biota developed as part of the EVWQP (Teck 2014a). No effects would be expected at areas where individual tissue selenium concentrations are less than the effect benchmark, whereas effects could potentially occur in areas where concentrations are greater than the effect benchmark.

2.9 Benthic Invertebrate Community and Biomass (Question #3.d)

2.9.1 Overview

Benthic invertebrate community and biomass data were collected to address key question #3.d: "What are benthic invertebrate community compositions and biomass along the side channel? How do benthic invertebrate community compositions compare between perennially wetted and seasonally isolated wet areas?".

2.9.2 Sample Collection

Benthic invertebrate community and biomass samples were collected in September from three areas in the side channel that had flowing water (GH_ERSC4, GH_ER1A, RG_ERSC5[12]; Figure 2.1). Samples were also collected from two stations in the main stem Elk River: downstream of the west-side tributaries (GH_ERC) and upstream of all mine influence (GH_ER2; Figure 2.1). Community structure was sampled using the CABIN kick and sweep method (n = 1 per area, except for RG_ERSC5, where triplicate sampling was conducted), and biomass was sampled using a Hess (n=5 per area).

Kick and sweep benthic invertebrate community samples were collected using the Canadian Aquatic Biomonitoring Network (CABIN) protocol (Environment Canada 2012a, 2014). For the

[12] The study design proposed benthic invertebrate community and biomass sampling locations at GH_ERSC4, GH_ER1A, and GH_ERSC2; however, GH_ERSC2 was dry at the time of sampling, and therefore a new station, GH_ERSC5, was sampled.

CABIN protocol, the field technician conducted a 3-minute travelling kick into a net with a triangular aperture measuring 36 cm per side and mesh having 400 µm openings (Environment Canada 2012a). During sampling, the technician moved across the stream channel (from bank to bank, depending on stream depth and width) in an upstream direction. With the net being held immediately downstream of the technician's feet, the detritus and invertebrates disturbed from the substrate were passively collected in the kick-net by the stream current. After three minutes of sampling time, the sampler returned to the stream bank with the sample.

Each Hess sample was collected by carefully inserting the base of the 500-µm mesh Hess sampler into the substrate to a depth of approximately 5 to 10 cm, after which gravel and cobble contained within the sampler were carefully scrubbed to dislodge organisms while allowing the current to carry the organisms into the mesh collection net.

All organisms collected into the kick net or Hess sampler were carefully rinsed into a labelled wide-mouth plastic jar. Internal labels were used to ensure the correct identity of each sample. Samples were preserved to a level of 10% buffered formalin in ambient water within approximately six hours of collection to ensure that organisms were not lost through predation or decomposition of tissues.

Supporting information was collected concurrent with, and at the same locations as, benthic invertebrate community and biomass sampling, including habitat characteristics, calcite index (Section 2.4.2), sediment sampling (Section 2.4.3), and water sampling (Section 2.3).

2.9.3 Laboratory Analysis

Biomass samples were shipped to ZEAS Inc. (Nobleton, ON). At the laboratory, all preserved organisms in each sample were sorted from the sample debris into groups separated at the family-level of taxonomy for weighing. Each family group of organisms was gently placed onto a fine cloth or paper towel to drain excess surface moisture (preservative) before being weighed to the nearest 0.1 g. Total and family-level biomass, as well as the density of each family of organisms were reported for each sample.

Kick and sweep samples were shipped to Cordillera Consulting Inc. (Summerland, BC) for sorting and taxonomic identification. Organisms were identified to the lowest practical level (LPL) (typically genus or species) using up-to-date taxonomic keys. Following identification, representative specimens of each taxon were placed in separate vials to create a reference collection for the project. At the beginning of the sorting process, each sample was examined and evaluated for an estimation of total invertebrate numbers. If the total number was estimated to be greater than 600, then the sub-sampling protocol was followed. In cases where samples could be analyzed in their entirety, CABIN (Environment Canada 2014) requires that a sufficient number of sub samples be analyzed to result in the sorting of at least 300 organisms (Environment Canada 2012b). Federal monitoring programs conducted under the *Fisheries Act* also require that sorting efficiency and sub-sampling accuracy and precision be quantified (Environment Canada 2014). Although this study was not being conducted under *Fisheries Act* requirements, the laboratory completed the associated QA/QC procedures. Benthic invertebrate community and biomass samples met required laboratory QA/QC for sorting efficiency and sub-sampling error (Appendix F).

2.9.4 Data Analysis

For Hess samples, total biomass, density, and relative abundance of major taxonomic groups were determined and compared within and among areas. For kick and sweep samples, total abundance, richness (LPL), Ephemeroptera Plecoptera Trichoptera (EPT) proportion (% EPT), % Ephemeroptera, and relative abundance of major taxonomic groups were determined and compared within and among areas. Kick and sweep endpoints were compared to normal ranges[13] defined in the RAEMP based on samples collected from reference areas in 2012 and 2015 (Minnow 2018a). Benthic invertebrate community compositions were compared between perennially wetted and seasonally isolated wet areas.

[13] The reference area normal range was defined as the 2.5th and 97.5th percentiles of the distribution of reference area (pooled 2012 and 2015 data) reported in the RAEMP (Minnow 2018a).

3 HYDROLOGY

3.1 Overview

Data evaluated in this section pertain to key question #1 (Section 1.2):

What are the seasonal and spatial patterns of flow in the Elk River side channel? During what months, and where, does the side channel have flow?

a. What percentage of channel length is wet each month? (Map wet/dry locations.)

b. Is there a relationship between % wet channel length (or the onset of portions going to ground) versus flows in the main stem Elk River and/or tributary inputs?

Hydrology data included water levels in the side channel and main stem Elk River, flow in the side channel, and side channel hydrology features (dry sections, braids, isolated pools, and tributary surface connectivity).

Over the year the Elk River side channel displayed flooding of the floodplain complex during freshet, then receded throughout the summer, and was confined to the channel during summer and fall. The most downstream section of the side channel (Reach 1) had three larger channels with minor braiding, the middle section (Reach 2) was a wetland from summer to winter, and the most upstream section (Reach 3) was confined to a single channel at the upstream end of the side channel. From April to May 2017 the whole side channel complex was flooded. In early September all of Reach 1 was dewatered. In October, Reach 3 was dewatering and the wetland was isolated. Throughout the winter, Reach 1 had periodic pooling of water but no flow. The wetland remained wetted all year, and Reach 3 remained dewatered for most of the winter.

3.2 Monthly Hydrology Survey

3.2.1 Percentage wetted channel

Monthly surveys of the side channel were used to document wetted areas, dry areas, and isolated pools, and provide monthly estimates of wetted lengths. Based on FHAP delineation data, the length of available habitat in Reach 1 was 2,540 m. This was the total of the east (1,354.5 m) and west (1,185.9 m) channels. Isolated pool locations and lengths were documented during monthly surveys to provide an estimate of wetted lengths. From May to August Reach 1 was 100% wetted. Dewatering began in September. In September, only 3.1% (or 80 m) was wetted, and from October 2017 to March 2018, less than 0.6% of Reach 1 was wetted (Table 3.1, Appendix Figures A.1 to A.8).

Reach 2 remained wetted throughout the year. Due to the deep depths of the wetland and large irregular shape, it was not possible to obtain an accurate area. In September, the outflow of the

Table 3.1: Monthly Wetted Channel Length Percentage for Reach 1

Year	Month	Total Reach Length (m)	Total Wetted Length (m)	Total Dry Length (m)	Total Wetted Percent (%)	Total Dry Percent (%)
2017	May	2,540	2,540	0	100	0
	June	2,540	2,540	0	100	0
	July	2,540	2,540	0	100	0
	August	2,540	2,540	0	100	0
	September	2,540	80	2,460	3.1	96.9
	October	2,540	3	2,537	<0.1	99.9
	November	2,540	3	2,537	<0.1	99.9
	December	2,540	14	2,526	0.6	99.4
2018	January	2,540	15	2,525	0.6	99.4
	February	2,540	3	2,537	<0.1	99.9
	March	2,540	3	2,537	<0.1	99.9

wetland was dry, with inflow remaining from the side channel and Thompson Creek. In October, the inflow to the wetland from the side channel was dry but continued from Thompson Creek Thompson Creek flowed into the wetland year round as identified in Photo 3.1. In July, there were two wetted channels located on the west side of the wetland. There were standing water areas with no flow (i.e. backwatered areas). The downstream area was approximately 180 m in length and the upstream channel was approximately 380 m, in July. Both areas were reported dry in October.

Photo 3.1: Downstream View of Thompson Creek Water Entering the Wetland in January 2018

Reach 3 was measured in the field to be 3,395.5 m long. Reach 3 was 100% wetted from May to September. Dewatering was first observed in October 2017. The wetted percent decreased in October to 79.9% (or 2,713.5 m), to 16.5% in November, and increased slightly again in December to 27.4%. The increase in wetted percentage from November to December was caused by an increase in daily air temperatures. From January to March, the wetted percent by length was 0% (Table 3.2; Appendix Figures A.1 to A.8).

Table 3.2: Monthly Wetted Channel Length Percentage for Reach 3

Year	Month	Total Reach Length (m)	Total Wetted Length (m)	Total Dry Length (m)	Total Wetted Percent (%)	Total Dry Percent (%)
2017	May	3,396	3,396	0	100	0
	June	3,396	3,396	0	100	0
	July	3,396	3,396	0	100	0
	August	3,396	3,396	0	100	0
	September	3,396	3,396	0	100	0
	October	3,396	2,714	682	79.9	20.1
	November	3,396	560	2,836	16.5	83.5
	December	3,396	932	2,464	27.4	72.6
2018	January	3,396	0	3,396	0	100
	February	3,396	0	3,396	0	100
	March	3,396	0	3,396	0	100

3.2.2 Tributary Connectivity

Leask Creek and Wolfram Creek were not observed to connect to the side channel via surface flow at any time in 2017 (Appendix Figures A.1 to A.8). There was no overflow channel from the Leask Creek sedimentation pond; however, a slightly more defined channel near the outlet of the Wolfram Creek sediment ponds was observed, which can provide an overland connection to the side channel during extreme flows. A potential flow path would guide flow from Wolfram Creek to a backchannel near GH_ER1A, but was dry from May 2017 to March 2018 (Photo 3.2 and Photo 3.3).

3.3 Hydrometric and Water Temperature Monitoring

Water stage plots were generated for all five loggers over the period of record (June 2017 to April 2018; Appendix Figures A.9 to A.14). The plots for stations installed in May indicate that the period of record began just as flows peaked, with the June installed sites showing a consistent descending limb following peak discharge for 2017. The Elk River near Natal station recorded peak daily flow on June 2, 2017 at that location (Figure 3.1), which is comparable to data records from the side channel (e.g., ERSCDS water level peaked June 1-2, 2017).

Photo 3.2: **Backchannel (Red Circle) May Connect to Wolfram Creek during High Flows, July 2017**

Photo 3.3: **Backchannel (Red Circle) was Dry in 2017, but May Connect to Wolfram Creek during High Flows, September 2017**

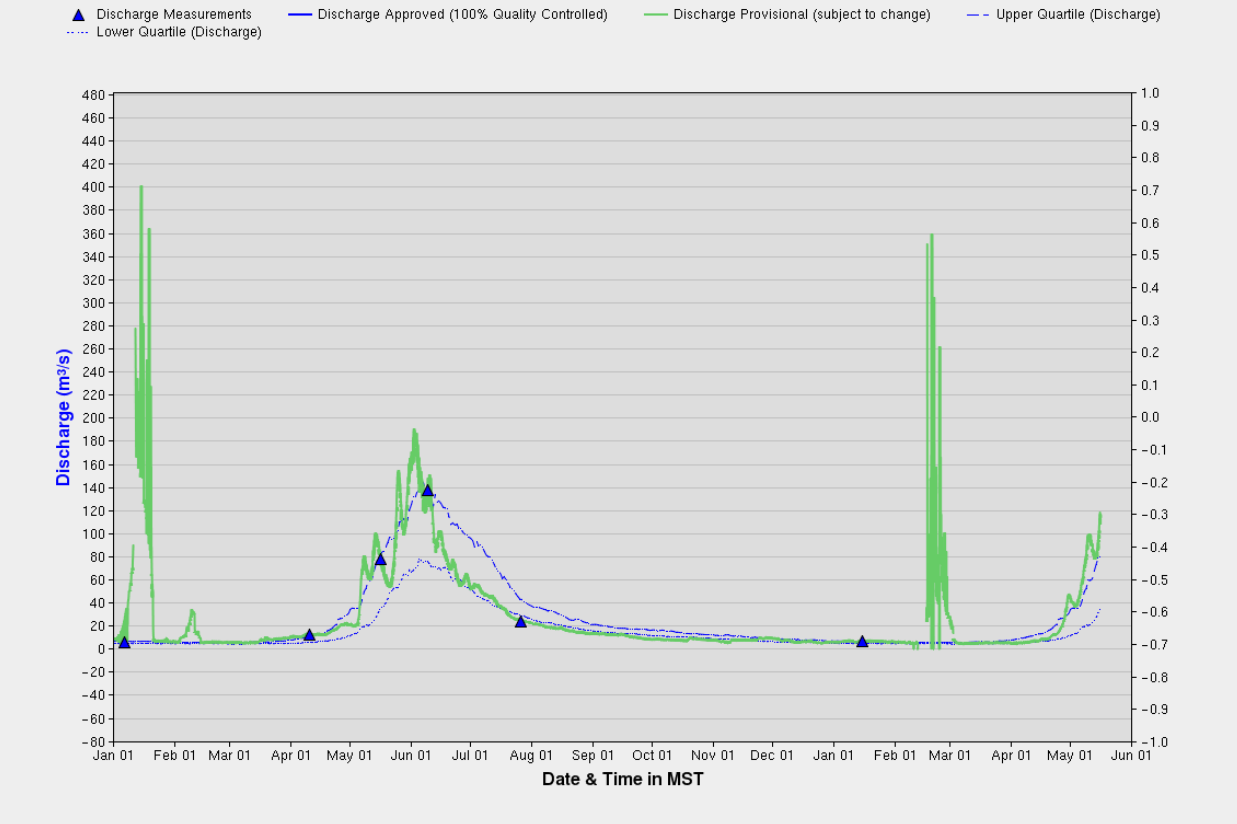


Figure 3.1: Hydrograph for January 2017 to May 2018 from the Water Survey of Canada Elk River near Natal (08NK016)

Water stage plots showed highly similar temporal patterns both within the side channel and comparatively between the Elk River and side channel. Linear regression results showed high correlation between all sites with R^2 values ranging from 0.93 – 0.99 (Figure 3.2). This suggests the flows in the side channel are likely largely controlled by the Elk River and its aquifer.

As discussed in Section 3.2.1, Reach 1 began to dewater between the August and September 2017 monthly surveys, and was essentially fully dewatered when visited in September 2017. The water stage records show more accurately that Reach 1 likely dewatered on August 21, 2017 (Figure 3.3). Reach 3 was first observed to begin dewatering in October in the downstream end near the Reach 2 wetland. It was reported as fully dewatered during the January 2018 survey. The site was reported to have anchor ice forming and water flowing on and in between ice layers for a period preceding January 2018, making for a noisy water stage record. Through a combination of the water stage and temperature logger, it is estimated that Reach 3 dewatered on approximately December 9, 2017 (Figure 3.4 and 3.5).

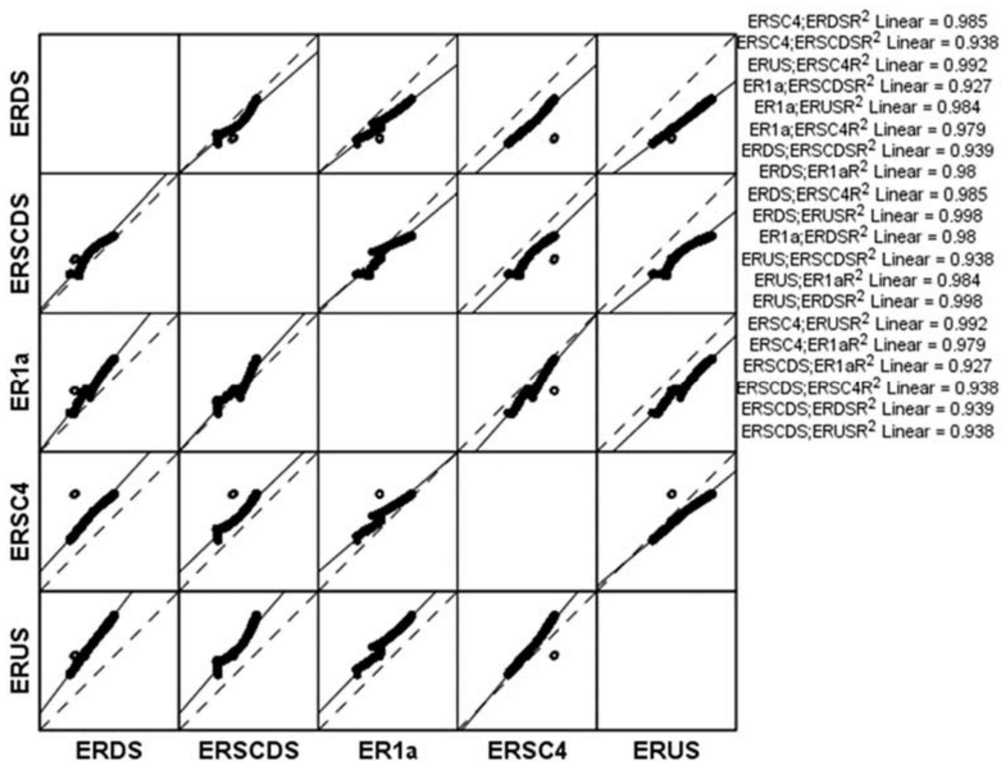


Figure 3.2: Linear Regression Matrix Plot of Water Stage from all Five Hydrometric Stations

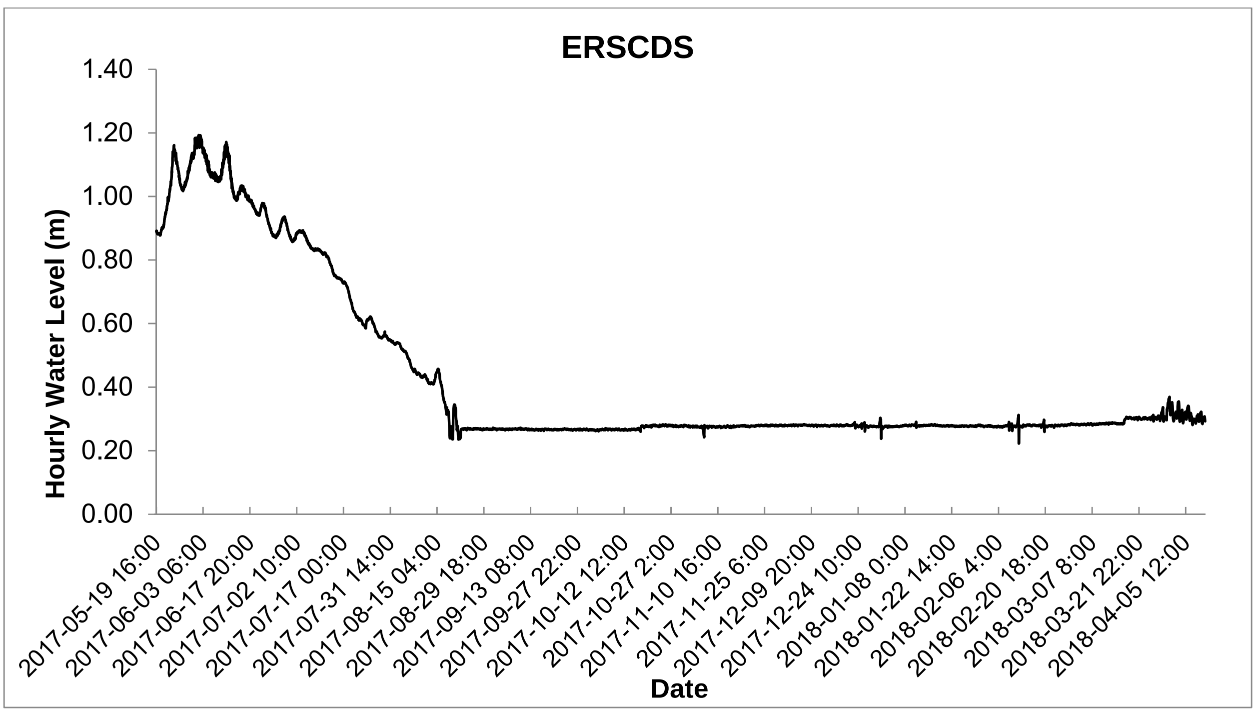


Figure 3.3: Water-stage Record for ERSCDS

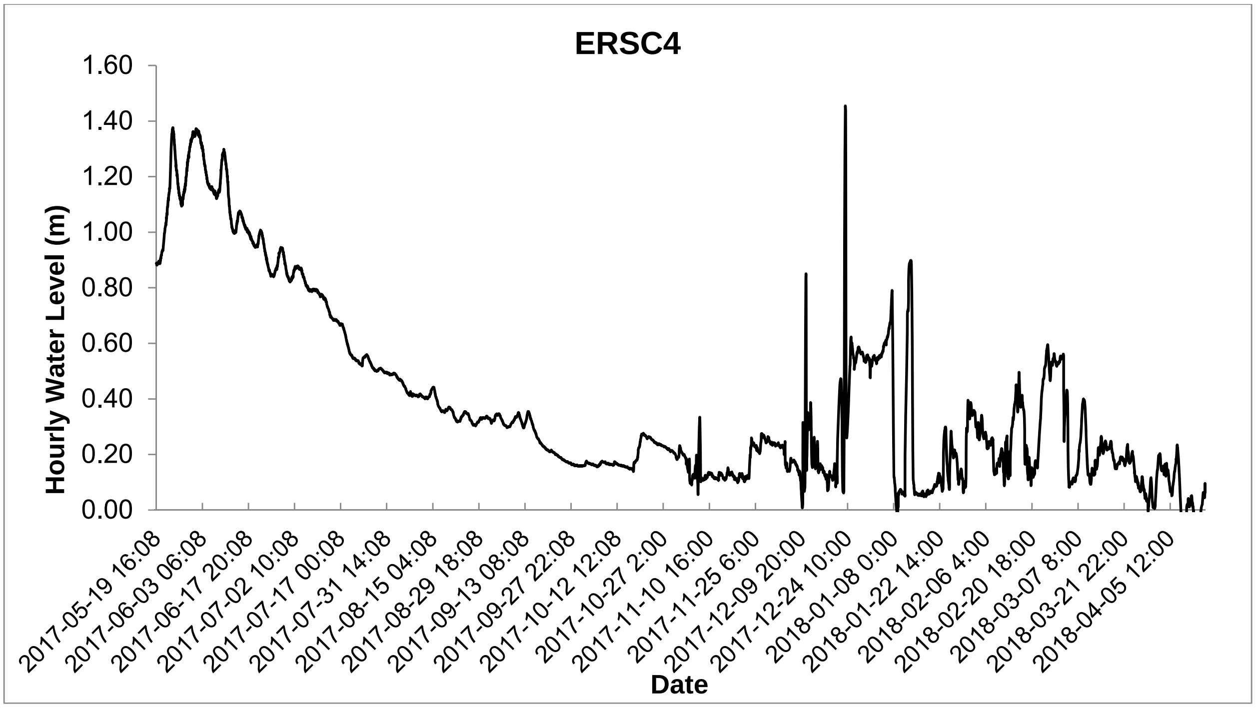


Figure 3.4: Water-stage Record for ERSC4

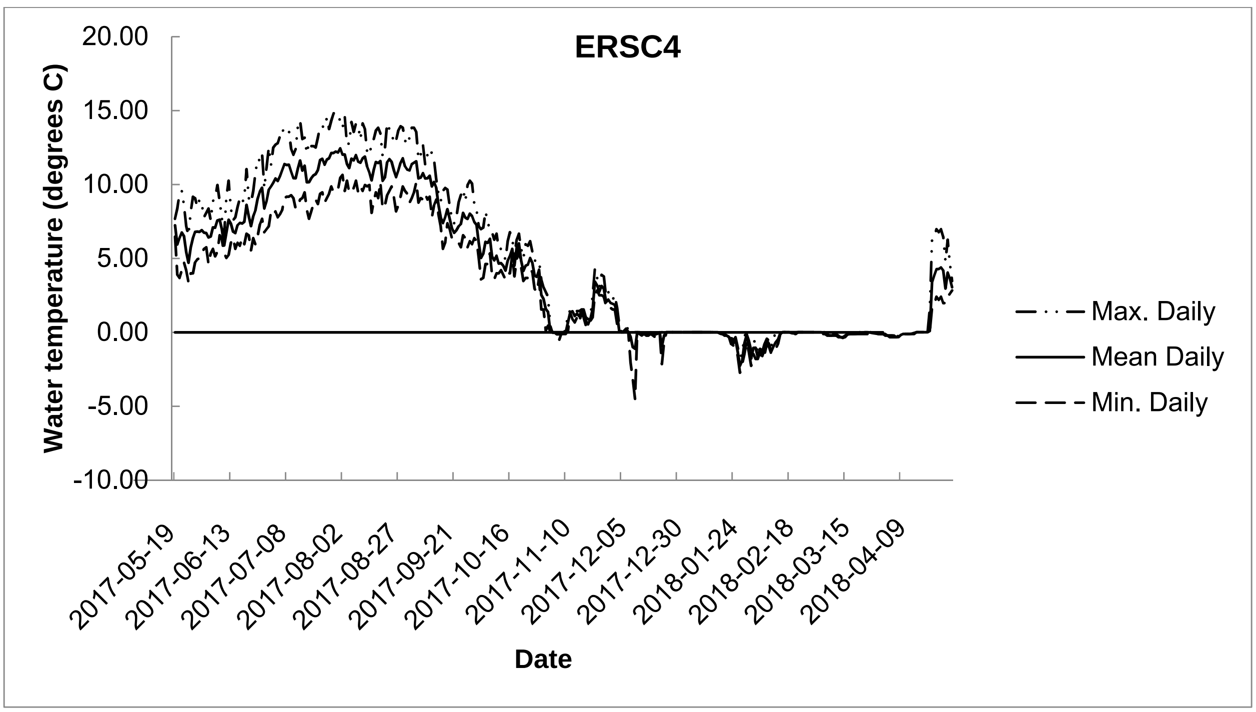


Figure 3.5: Water Temperature Record for ERSC4

The ERSCDS logger was frozen into the stilling well under approximately 0.6 m of ice and was unable to be downloaded until May 2, 2018. However, the barometric logger was downloaded on April 17th. As such, the water stage record is limited to April 17th and does not include the date when flows are suspected to have begun flowing in Reach 3. Water temperature data were recorded up to May 2. Based solely on the water temperature record, it appears that ERSC4 was flowing again on April 23, 2018. All other loggers in the side channel were downloaded during the April 12 survey and remained dewatered at that time. Continued monitoring in 2018 will include downloading the barometric pressure data covering the suspected rewatering period and allowing a more accurate estimate of when flows returned.

As indicated above, Reach 1 was the first area to dewater, and this is suspected to have occurred near August 21, 2017. Provisional data from Water Survey of Canada shows that discharge at the Elk River near Natal (station 08NK016) ranged from 15.0-15.8 m^3/s. Reach 3 was the last to dewater and this is suspected to have occurred on December 9, 2017. Flows returned on April 23, 2018. On these dates, the provisional discharge data from the Elk River at Natal ranged from 6.35 to 6.94 m^3/s and 12.2 to 13.3 m^3/s, respectively.

The hydrograph from the Elk River near Natal provides some context of the hydrologic conditions experienced in the Elk River in 2017 (Figure 3.1). Peak discharge in June were greater than the upper quartile, peaking near 190 m^3/s. Flows receded quickly with a lack of precipitation in June and approached the lower quartile by July. A hot dry summer is suspected to have continued to affect flow with discharge slightly below the lower quartile by mid-August. Flows remained below the lower quartile into November. However, it is worth noting the minor difference between even the upper and lower quartiles during baseflow.

4 WATER QUALITY

4.1 Overview

Data evaluated in this section are related to addressing key question #2 (Section 1.2):

What is the influence of GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?

a. What is the water quality at monitoring stations in the Elk River downstream versus upstream of the west-side tributaries?

b. What is the water quality at monitoring stations in the Elk River side channel?

c. What is the water quality in isolated pools in the Elk River side channel that provide potential aquatic habitat for aquatic and/or aquatic-dependent vertebrates (i.e., fish, amphibians, and aquatic-feeding birds)?

Water quality was assessed for concentrations of Order constituents (i.e., dissolved cadmium, nitrate, total selenium, and sulphate) and total nickel and compared to EVWQP benchmarks and preliminary IC_{25} values developed for *Ceriodaphnia* and *Hyalella* (nickel), for the west-side tributaries, the Elk River side channel flowing stations, side channel isolated pools, the side channel wetland, and the main stem Elk River.

4.2 West-side Tributaries

Water quality data from the west-side tributaries were assessed to support the interpretation of all key question #2 sub-questions. When flowing, Branch F, Wolf, Willow, Wade, Cougar, and No Name creeks flow into the Elk River upstream from the Elk River side channel (Figure 2.2). The downstream ends of Mickelson, Leask, and Wolfram creeks are settling ponds that did not connect overland to the Elk River or Elk River side channel from May 2017 to April 2018 (Figure 2.2, Appendix Figures A.1 to A.8); instead, they likely infiltrated via groundwater in the overburden (SNC-Lavalin 2018). Thompson Creek flows into the Elk River side channel all year at the side channel wetland, located downstream of GH_ER1A and upstream of GH_ERSC2 (Figure 2.2).

Water quality data from the west-side tributaries (Figure 2.2) were assessed for January 2016 to December 2017. Water quality data for Branch F Creek (GH_BR_F), Wolf Creek (GH_WOLF and GH_WOLF_SP1), Willow Creek (GH_WILLOW, GH_WILLOW_S, GH_WILLOW_SP1), Wade Creek (GH_WADE), Cougar Creek (GH_COUGAR), and No Name Creek (GH_NNC, GH_BR_D) were always below EVWQP Level 1 benchmarks for dissolved cadmium, nitrate, total selenium, and sulphate as well as preliminary IC_{25} values for nickel (Figures 4.1 and 4.2).

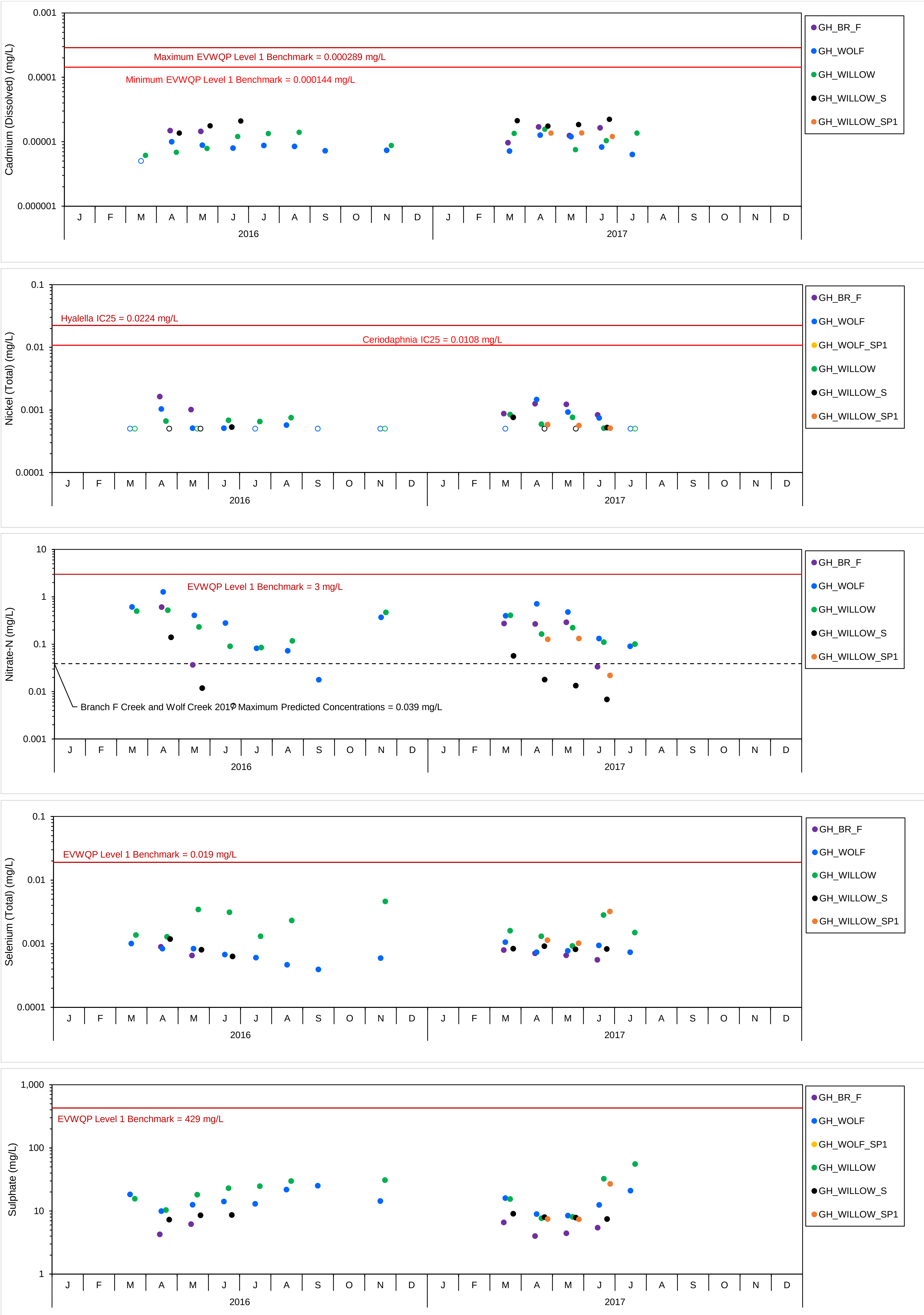


Figure 4.1: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel, Compared to EVWQP Benchmarks and Preliminary IC_{25} Values for the West-side Tributaries Branch F Creek, Wolf Creek, and Willow Creek, 2016 to 2017

Notes: open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Data points are horizontally staggered within each month to allow overlapping points to be differentiated. For dissolved cadmium, minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means.

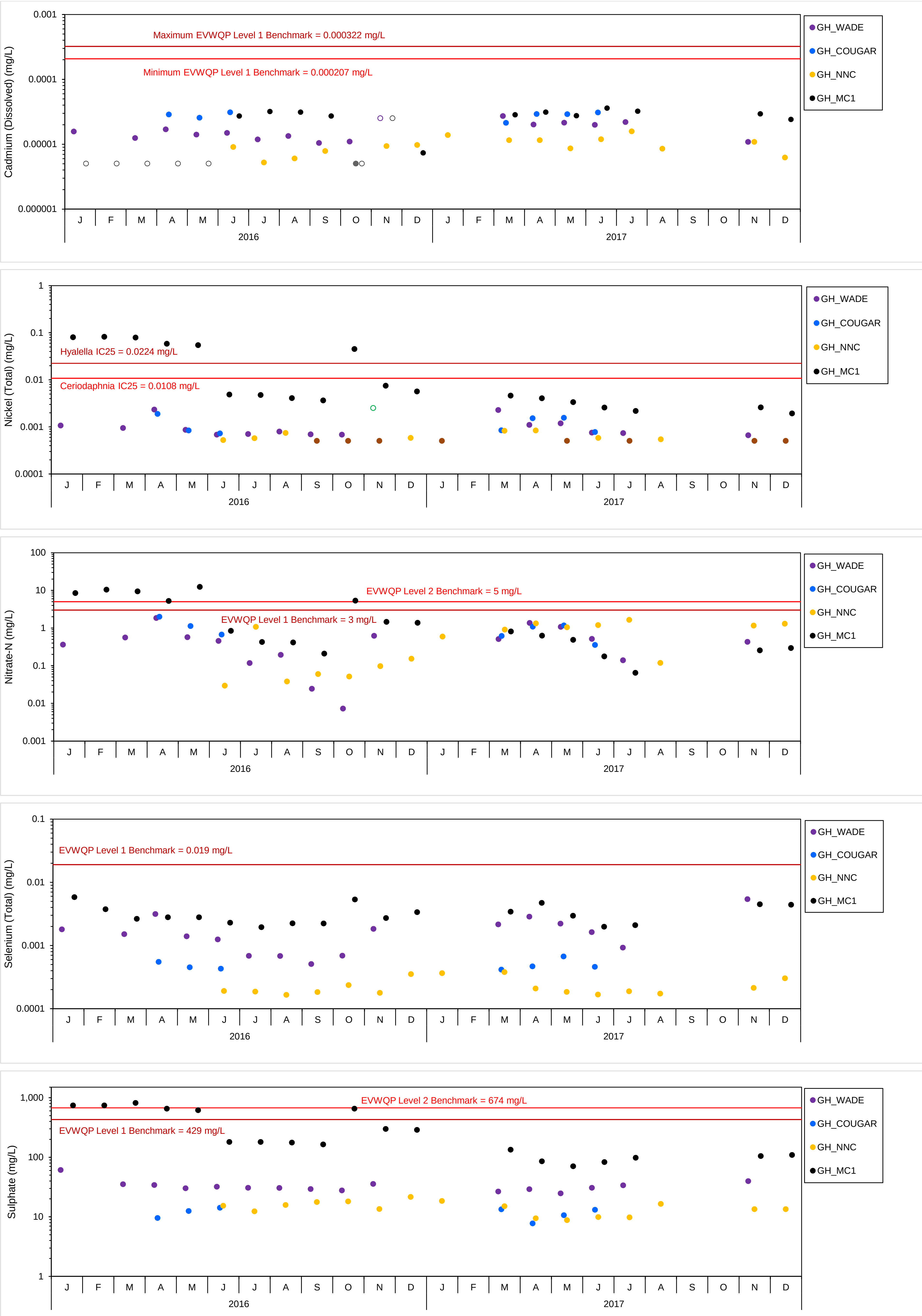


Figure 4.2: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel, Compared to EVWQP Benchmarks Preliminary IC_{25} Values for the West-side Tributaries Wade Creek, Cougar Creek, No Name Creek, and Mickelson Creek, 2016 to 2017

Note: open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Data points are horizontally staggered within each month to allow overlapping points to be differentiated. For dissolved cadmium, minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means.

Water quality in Mickelson (GH_MC1), Leask (GH_LC1, GH_LC2), Wolfram (GH_WC1, GH_WC2, GH_WC1A), and Thompson (GH_TC1, GH_TC2) creeks showed evidence of mine-related influence based on concentrations of nitrate, selenium, and/or sulphate that were often greater than EVWQP benchmarks (Figures 4.2 and 4.3). With the exception of Thompson Creek, concentrations of nickel in water from each of these tributaries also tended to be above the preliminary IC_{25} values (2016 only in Mickelson). In contrast, dissolved cadmium concentrations were consistently below the EVWQP Level 1 benchmark (Figures 4.2 and 4.3).

4.3 Side Channel Monitoring Stations

Water quality in the Elk River side channel was assessed to address key questions #2.b: "What is the water quality at monitoring stations in the Elk River side channel?". Data from Teck's three routine water quality monitoring stations (GH_ERSC4, GH_ER1A, and GH_ERSC2; Figure 4.4) were analyzed. Concentrations of Order constituents and total nickel generally increased from GH_ERSC4 to GH_ER1A to GH_ERSC2 (i.e., from upstream to downstream; Figure 4.4) due to the influence of the west-side tributaries (Figure 4.3, Section 4.2). All cadmium concentrations were below the EVWQP Level 1 benchmark, and sulphate was greater than the EVWQP Level 1 benchmark once in a single GH_ER1A sample from April 2016. Selenium concentrations were above the EVWQP Level 1 benchmark twice (April and May 2017) at GH_ERSC2, the furthest downstream location. Nitrate concentrations were above the EVWQP Level 1 benchmark at GH_ER1A in three samples (April 2016, and April and May 2017).

4.4 Isolated Pools

Water quality in the isolated pools was assessed to address key questions #2.c: "What is the water quality in isolated pools in the Elk River side channel that provide potential aquatic habitat for aquatic and/or aquatic-dependent vertebrates (i.e., fish, amphibians, and aquatic-feeding birds)?". Flow in the Elk River side channel was observed to vary dramatically on a seasonal basis. In spring, portions of the channel overflow and flood the adjacent forest, and both the upstream and downstream ends have surface connectivity to the main stem Elk River. Conversely, by fall, water levels were much lower and there was no longer surface flow connecting to the main stem Elk River. Sections of the side channel became isolated from the main flow, creating pools. Pools occurred in three main areas: (1) upstream of the wetland, (2) in the western-most channel downstream of the wetland, and (3) in the eastern-most channel downstream of the wetland (Figure 2.2).

Most pools only existed for less than a month and thus were only sampled once. Pool-E-7, which is located at the downstream end of the side channel, just upstream from the confluence with the main stem Elk River (Figure 2.2) persisted from September 2017 through March 2018. At

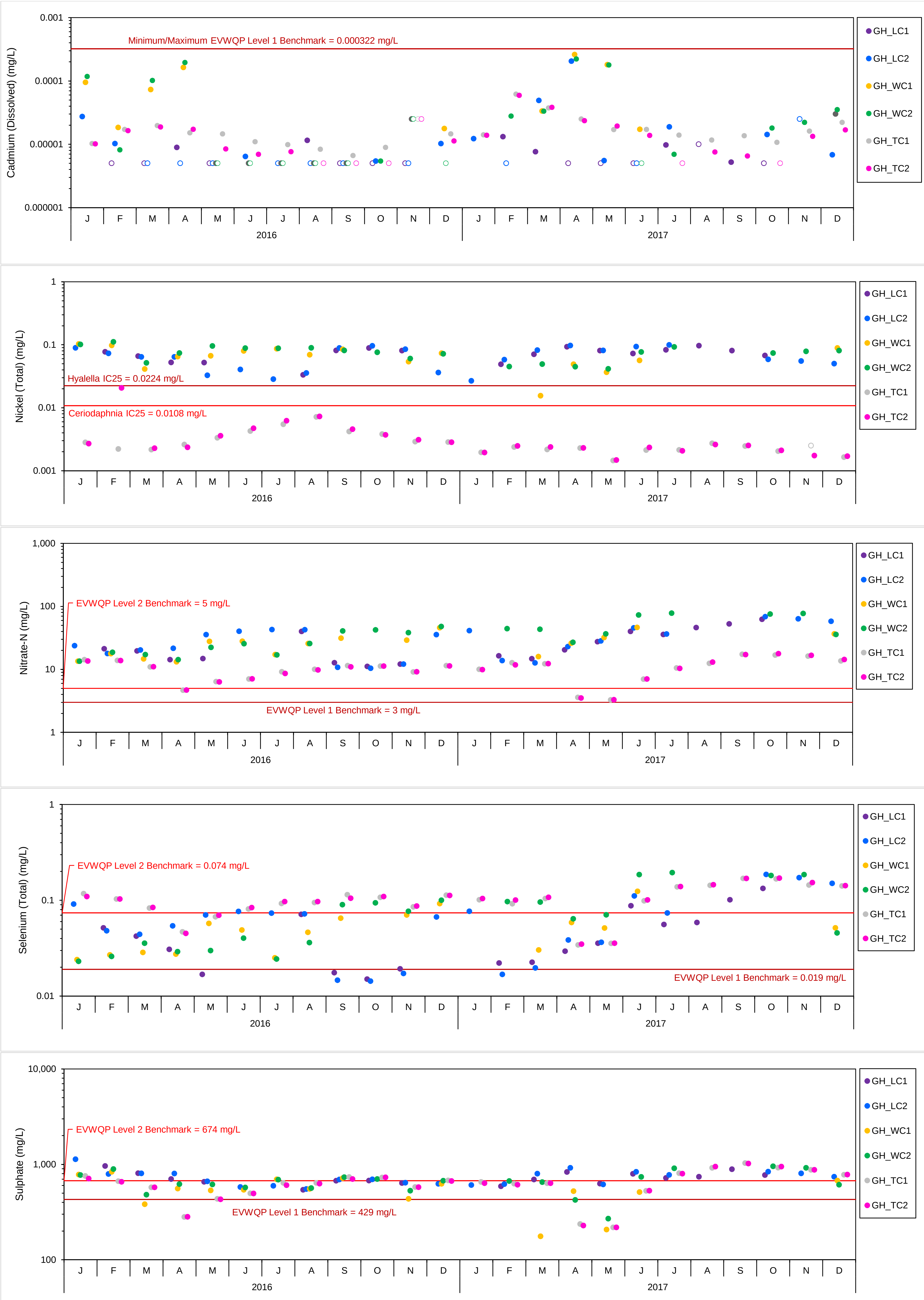


Figure 4.3: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel, Compared to EVWQP Benchmarks Preliminary IC_{25} Values for the West-side Tributaries Leask Creek (GH_LC1 and GH_LC2), Wolfram Creek (GH_WC1 and GH_WC2), and Thompson Creek (GH_TC1 and GH_TC2), 2016 to 2017

Note: open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Data points are horizontally staggered within each month to allow overlapping points to be differentiated. For dissolved cadmium, minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means.

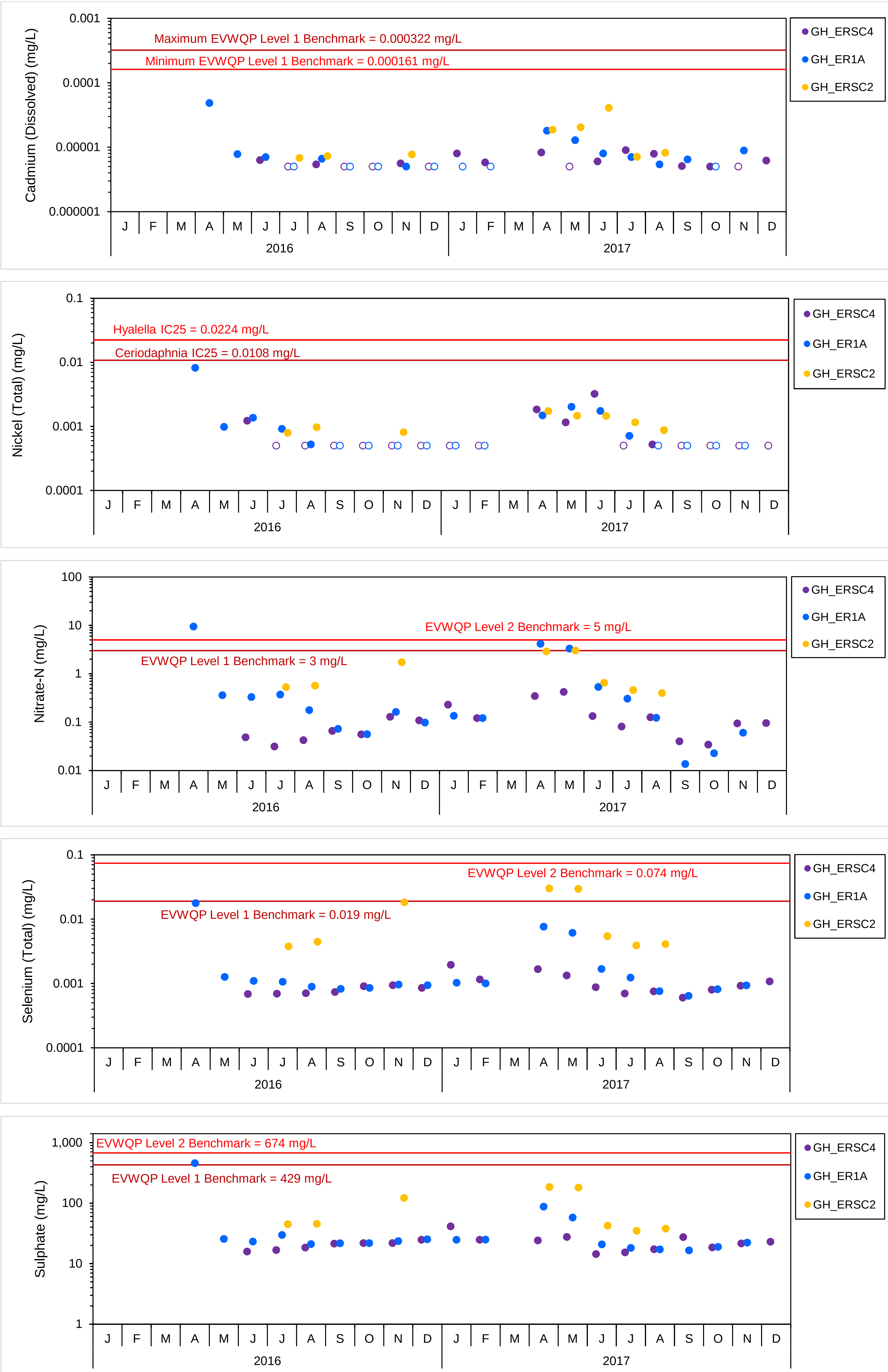


Figure 4.4: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel at Side Channel Monitoring Stations Compared to EVWQP Benchmarks and Preliminary IC_{25} Values, Elk River Side Channel, 2016 to 2017

Note: Open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means. Data points are horizontally staggered within each month to allow overlapping points to be differentiated.

Pool-E-7, concentrations of total nickel, nitrate, total selenium, and sulphate generally increased from September 2017 to January/February/March 2018 likely due to evaporation (Figure 4.5).

Dissolved cadmium and total nickel concentrations were below the EVWQP Level 1 benchmark and preliminary IC_{25} values, respectively, for all isolated pool samples (Figure 4.5). Selenium and nitrate concentrations were greater than the EVWQP Level 1 benchmark and frequently was greater than the Level 2 benchmark for samples collected from pools located in the most eastern channel downstream of the mouth of Thompson Creek (Figure 4.5). At these locations, sulphate concentrations also approaching the EVWQP Level 1 benchmark, with the Pool-E-7 samples collected between October 2017 and March 2018 above the benchmark (Figure 4.5). Overall, pools in the eastern-most channel downstream of the wetland had higher concentrations of total nickel, nitrate, total selenium, and sulphate relative to pools in the western-most channel downstream of the wetland as well as the pools located upstream of the wetland (Figure 4.5).

Pools located upstream of the wetland had water quality generally comparable to GH_ERSC4 and GH_ER1A. Pools in the eastern-most channel downstream of the wetland are influenced by Thompson Creek (Figure 4.3) and the side channel wetland (Figure 4.5), whereas the western channel may receive relatively greater contribution of flow from upstream or from the main stem Elk River (Figure 4.1). Overall, most of the isolated pools persisted for less than a month, and therefore offer limited habitat to aquatic-dependent biota.

4.5 Wetland

Water sampling was added to the wetland late in 2017 to support the assessment of water quality in the side channel (key question #2.b). Water samples were collected in the side channel wetland from three stations. RG_GH-SCW1 was located near the side channel inlet of the wetland, RG_GH-SCW2 was located near the Thompson Creek inlet to the wetland, and RG_GH-SCW3 was located near the wetland outlet. RG_GH-SCW2 and RG_GH-SCW3 were influenced by Thompson Creek, with higher concentrations of dissolved cadmium, nickel, nitrate, total selenium, and sulphate compared to RG_GH-SCW1, and concentrations very similar to Thompson Creek (Figure 4.5). Dissolved cadmium and nickel concentrations were below the EVWQP Level 1 benchmark and preliminary IC_{25} values, respectively, for the three stations, whereas samples collected from September through March at one or more of stations had concentrations of nitrate, selenium, and/or sulphate above EVWQP benchmarks (Figure 4.5). The concentrations at RG_GH-SCW1 were consistently lower than at RG_GH-SCW2 and RG_GH-SCW3.

4.6 Main Stem Elk River Downstream versus Upstream of the West-Side Tributaries

Water quality in the main stem Elk River was assessed to address key question #2.a: "What is the water quality at monitoring stations in the Elk River downstream versus upstream of the

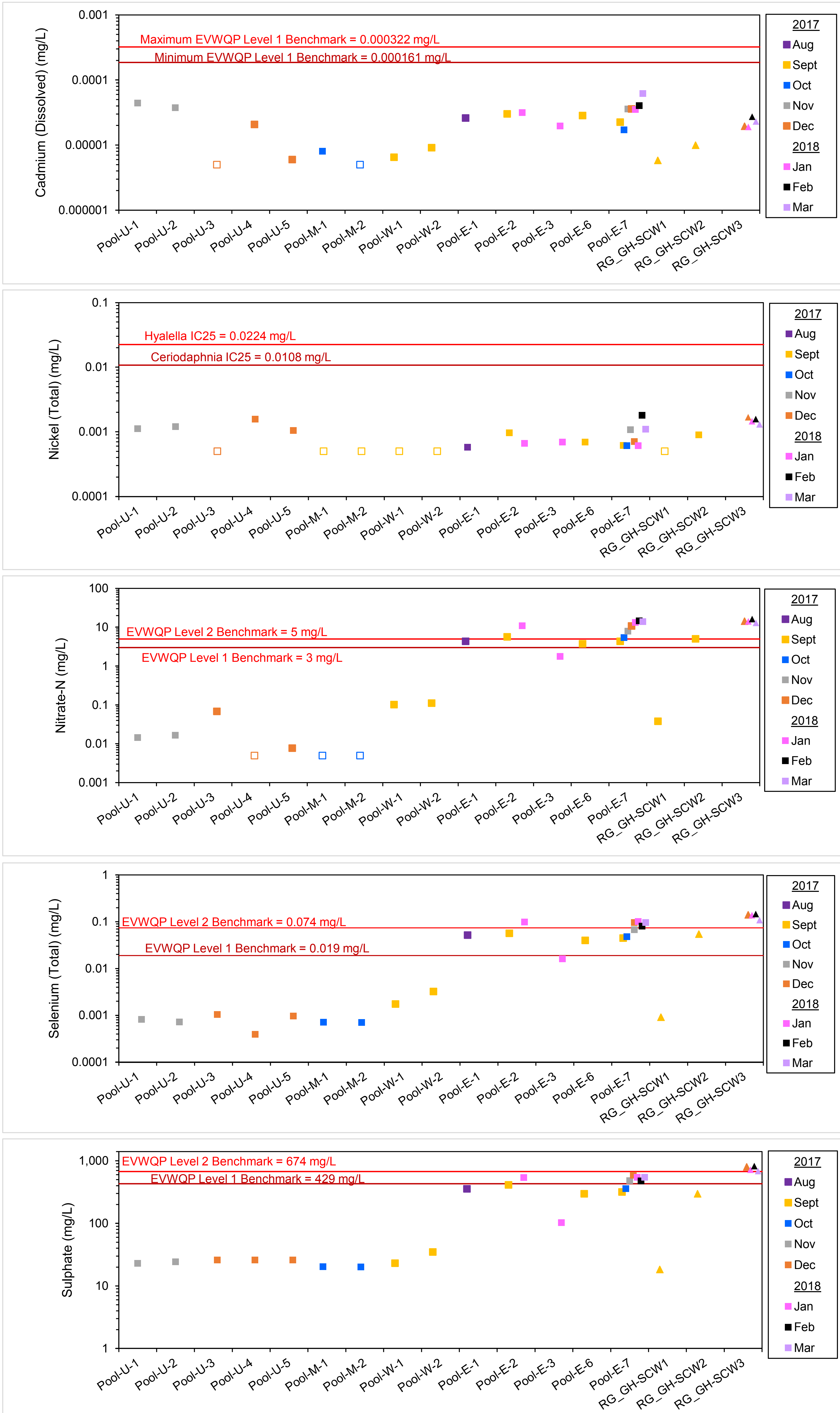


Figure 4.5: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel at Isolated Pool And Wetland Stations Compared to EVWQP Benchmarks and Preliminary IC_{25} Values, 2017 to 2018

Notes: Symbols differentiate station site locations, with squares (□) representing stations in pools and triangles (Δ) representing stations in wetlands. Open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Minimum and maximum EVWQP benchmarks for cadmium represent the range of benchmark values based on hardness for all monthly means. Data points are horizontally staggered within each month to allow overlapping points to be differentiated.

west-side tributaries?". Data for the monitoring station in the main stem Elk River downstream of the west side tributaries (GH_ERC) was compared to the Elk River station upstream of all mine influence (GH_ER2) to assess the overall influence of GHO on water quality in the upper Elk River (Figure 4.6). Concentrations of dissolved cadmium, nitrate, total selenium, and sulphate from these stations were all below EVWQP Level 1 benchmarks and Permit Limits (Figure 4.6). Concentrations at GH_ERC were consistently and significantly greater than at GH_ER2 (Figure 4.6) due to the influence of the west-side tributaries (Figure 4.3 and Appendix Table B.3). Concentrations of Order constituents at both locations showed the same seasonal cycling from 2016 to 2018, with the lowest concentrations of nitrate, total selenium, and sulphate occurring annually in July.

4.7 Side Channel versus Main Stem Elk River

Water quality was compared between the side channel and the main stem Elk River following consultation with the EMC and to support key question #2.a: "What is the water quality at monitoring stations in the Elk River downstream versus upstream of the west side tributaries?". Concentrations of Order constituents and total nickel at the side channel stations (GH_ERSC4, GH_ER1A, and GH_ERSC2) were compared to the upstream reference Elk River station, GH_ER2 (Table 4.1, Appendix Figure B.1). At the most upstream side channel station, GH_ERSC4, dissolved cadmium, total nickel, and total selenium were not significantly different from GH_ER2; however, nitrate and sulphate were significantly greater. At GH_ER1A, dissolved cadmium, total nickel, nitrate, total selenium, and sulphate were significantly higher than reference. At the most downstream side channel station (GH_ERSC2), Order constituents and total nickel were significantly greater than at reference, except for total nickel, which was not significantly different.

The three side channel stations were also compared to the downstream Elk River station, GH_ERC (Table 4.2, Appendix Figure B.2). At the most upstream side channel station, GH_ERSC4, dissolved cadmium, and total nickel were not significantly different from downstream GH_ERC, and nitrate, total selenium, and sulphate were significantly less than concentrations at GH_ERC. Station GH_ER1A was not significantly different from GH_ERC for all key mine related parameters. At the most downstream side channel station (GH_ERSC2), nitrate, total selenium, and sulphate were significantly greater than downstream GH_ERC, while dissolved cadmium and total nickel were not significantly different. This indicates that GH_ERSC2 is influenced by Thompson Creek, but the influence is diluted in the downstream main stem station GH_ERC.

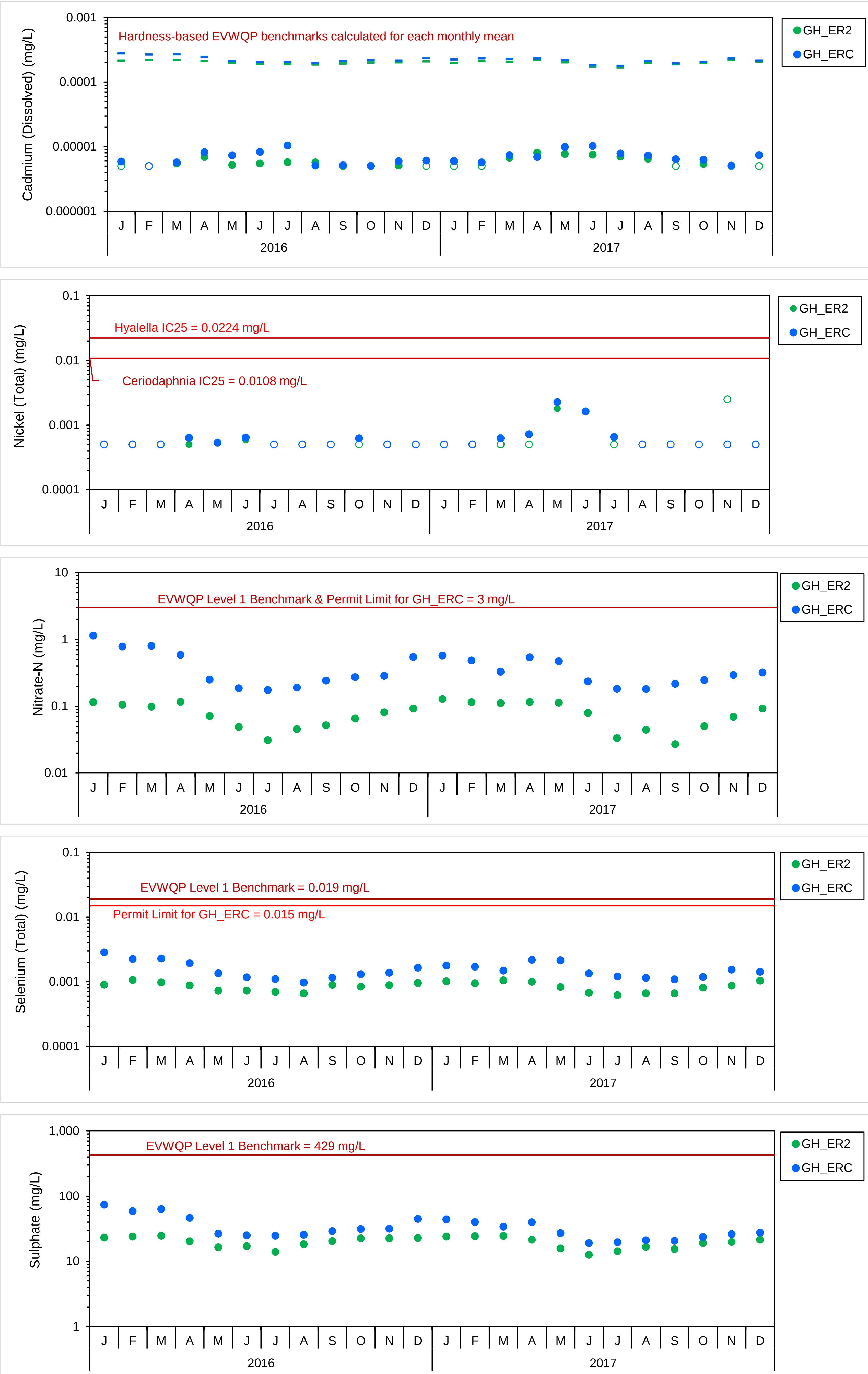


Figure 4.6: Water Quality Temporal Plots of Monthly Means for Order Constituents and Total Aqueous Nickel at Main Stem Elk River Areas Upstream (GH_ER2) and Downstream (GH_ERC) of Mine Activities Compared to EVWQP Benchmarks, Preliminary IC_{25} Values, and Permit Limits, 2016 to 2017

Note: open symbols indicate samples below the laboratory reporting limit (LRL), and were reported as 1×LRL. Dashes denote hardness-based EVWQP benchmarks calculated for each monthly mean.

Table 4.1: Statistical Comparisons of the Differences in Monthly Mean Concentrations Between Side Channel Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and the Main Stem Elk River Reference Station (GH_ER2) for Aqueous Cadmium, Total Nickel, Nitrate, Total Selenium, and Sulphate, 2016 to 2017

Model							Post-hoc Test and Magnitude of Difference (MOD) for Difference Between Side Channel and Main Stem Elk River Refence Station (GH_ER2)														
							GH_ERSC4					GH_ER1A					GH_ERSC2				
Parameter	Units	Transform-ation	Term	DF	F	P-value	GH_ERSC4 Median[a]	Test	P-value	GH_ER2 Median[a]	MOD (%)[b]	GH_ER1A Median[a]	Test	P-value	GH_ER2 Median[a]	MOD (%)[b]	GH_ERSC2 Median[a]	Test	P-value	GH_ER2 Median[a]	MOD (%)[b]
Cadmium (Dissolved)	mg/L	rank	Year	1	0.28	0.601	0.00000550	WSRT	0.358	0.00000526	4.6	0.00000700	WSRT	0.030	0.00000540	30	0.00000795	WSRT	0.008	0.00000678	17
			Station	2	4.1	0.027															
			Year x Station	2	0.25	0.779															
			Error	30	-	-															
Nickel (Total)	mg/L	rank	-[c]				<0.0005	WSRT	0.281	<0.0005	-[d]	<0.0005	WSRT	0.009	<0.0005	-[d]	0.00106	WSRT	0.08	<0.0005	>112
Nitrate-N	mg/L	rank	Year	1	0.14	0.713	0.0947	WSRT	0.004	0.0675	40	0.1610	WSRT	0.002	0.0694	132	0.608	WSRT	0.008	0.0624	874
			Station	2	11	<0.001															
			Year x Station	2	1.3	0.276															
			Error	39	-	-															
Selenium (Total)	mg/L	rank	Year	1	3.0	0.089	0.000861	WSRT	0.0539	0.000834	3.3	0.00100	WSRT	0.003	0.000829	21	0.00493	WSRT	0.008	0.000687	618
			Station	2	15	<0.001															
			Year x Station	2	1.2	0.299															
			Error	39	-	-															
Sulphate	mg/L	rank	Year	1	0.53	0.470	21.7	WSRT	0.009	19.5	11	20.7	WSRT	<0.001	19.1	8	44.8	WSRT	0.008	16.3	176
			Station	2	14	<0.001															
			Year x Station	2	1.5	0.233															
			Error	39	-	-															

(shaded) P-value < 0.01.

[a] Medians reported because all tests were non-parametric; WSRT = Wilcoxon Signed Rank Test.

[b] Magnitude of Difference (MOD) expressed as (Median – GH_ER2 Median) / GH_ER2 Median × 100%.

[c] ANOVA was no conducted for Nickel because of a high percentage of values at the Laboratory Reporting Limit (LRL) and missing data from some months.

[d] MOD could not be caclucated because both median value were less than the LRL.

Table 4.2: Statistical Comparisons of the Differences in Monthly Mean Concentrations Between Side Channel Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and the Main Stem Elk River Station Located Downstream of Mine Activities (GH_ERC), for Aqueous Cadmium, Total Nickel, Nitrate, Total Selenium, and Sulphate, 2016 to 2017

Model							Post-hoc Test and Magnitude of Difference (MOD) for Difference Between Side Channel and the Main Stem Elk River Station Located Downstream of Mine Activities (GH_ERC)														
							GH_ERSC4					GH_ER1A					GH_ERSC2				
Parameter	Units	Transform-ation	Term	DF	F	P-value	GH_ERSC4 Median [a]	Test	P-value	GH_ERC Median[a]	MOD (%)[b]	GH_ER1A Median [a]	Test	P-value	GH_ERC Median[a]	MOD (%)[b]	GH_ERSC2 Median [a]	Test	P-value	GH_ERC Median[a]	MOD (%)[b]
Cadmium (Dissolved)	mg/L	rank	Year	1	0.67	0.418	0.00000550	WSRT	0.130	0.00000634	-13	0.00000645	WSRT	0.738	0.00000640	0.78	0.00000795	WSRT	0.109	0.00000757	5.1
			Station	2	2.8	0.073															
			Year x Station	2	0.34	0.712															
			Error	39	-	-															
Nickel (Total)	mg/L	rank	-[c]				<0.0005	WSRT	0.673	<0.0005	0.0	<0.0005	WSRT	0.067	<0.0005	-[d]	0.00106	WSRT	0.183	0.00058	84
Nitrate-N	mg/L	rank	Year	1	0.12	0.733	0.0947	WSRT	<0.001	0.260	-64	0.161	WSRT	0.798	0.251	-36	0.608	WSRT	0.008	0.213	185
			Station	2	11	<0.001															
			Year x Station	2	0.1	0.877															
			Error	39	-	-															
Selenium (Total)	mg/L	rank	Year	1	0.23	0.6364	0.000861	WSRT	<0.001	0.00133	-35	0.00100	WSRT	0.182	0.00135	-26	0.00493	WSRT	0.008	0.00128	286
			Station	2	16	<0.001															
			Year x Station	2	0.12	0.888															
			Error	39	-	-															
Sulphate	mg/L	rank	Year	1	3.08	0.087	21.7	WSRT	<0.001	26.7	-19	20.7	WSRT	0.241	26.8	-23	44.8	WSRT	0.008	25.2	78
			Station	2	14	<0.001															
			Year x Station	2	1.0	0.387															
			Error	39	-	-															

(shaded) P-value < 0.01

[a] Medians reported because all tests were non-parametric; WSRT = Wilcoxon Signed Rank Test.

[b] Magnitude of Difference (MOD) expressed as (Median – GH_ERC Median) / GH_ERC Median × 100%.

[c] ANOVA was no conducted for Nickel because of a high percentage of values at the Laboratory Reporting Limit (LRL) and missing data from some months.

[d] MOD could not be caclucated because both median value were less than the LRL.

4.8 Summary

Discharges from the west-side tributaries contribute to higher concentrations of Order constituents and total nickel in the downstream main stem Elk River (GH_ERC); however, concentrations measured at GH_ERC remain well below EVWQP Level 1 benchmarks and preliminary IC_{25} values. Water quality at side channel stations GH_ER1A and GH_ERSC2 was influenced by Wolfram and Thompson creeks, showing occasional concentrations of nitrate, total selenium, and sulphate that were greater than EVWQP Level 1 benchmarks. The Elk River side channel has been observed to have highly variable flow throughout the year, with the creation of isolated pools during drier months. Water quality in these pools was highly dependent on location. Pools located upstream of the side channel wetland had water quality comparable to GH_ERSC4 and GH_ER1A. Pools in the eastern-most channel downstream of the wetland are influenced by Thompson Creek, whereas the western channel may receive relatively greater flow from upstream, or from the main stem Elk River. The highest concentrations of mine-relative parameters occurred in the side channel wetland.

5 SUBSTRATE QUALITY

5.1 Overview

Data evaluated in this section pertain to key question #3.b (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

b. What is the substrate quality?

5.2 Calcite

Calcite was not observed at the main stem Elk River stations (GH_ERC and GH_ER2) during surveys conducted in September 2017 or at the Elk River side channel stations (GH_ERSC4, GH_ER1A, and GH_ERSC2) during surveys conducted in July and September 2017, nor was it observed in the side channel during monthly channel surveys (Sections 2.2.2 and 2.5.4).

5.3 Sediment Quality

Sediment TOC and particle size varied among areas, particularly the proportion of sand versus silt, with no obvious pattern observed for pool versus side channel or main stem locations (Figure 5.1).

Sediment metal and PAH concentrations were compared to BC Sediment Quality Guidelines (SQG) and normal ranges[14] (Figure 5.2, Appendix Tables C.1 and C.2). Two levels of guideline are typically defined: a lower interim sediment quality guideline (ISQG) or lowest effect level (LEL), and a higher probable effect level (PEL) or severe effect level (SEL). The lower SQGs (i.e., ISQG/LEL) represent concentrations below which adverse biological effects would not be expected to occur. In contrast, the upper SQGs (i.e., PEL or SEL) represent concentrations above which effects may be frequently observed. The SQGs are not based on cause-effect studies, but rather on levels of toxic substances found in the sediment where biological effects have been measured (BCMOE 2015); such that the exceedance of individual SQGs cannot be interpreted as strong evidence for biological response. Concentrations of all parameters were typically less than the upper SQG, except selenium (four samples at four stations), fluorene (one sample), 2-methylnaphthalene (nine samples from five stations), naphthalene (one sample), and phenanthrene (two samples from one station). Sediment quality was typically within the normal range at all sampling locations, expect for arsenic (two samples at two stations), chromium (four samples at three stations), manganese (in at least one sample at all but one station), chrysene

[14] The reference area normal range for sediment is defined as the 2.5th and 97.5th percentiles of 2013 and 2015 reference area data reported in the RAEMP for lentic stations (Minnow 2018a).

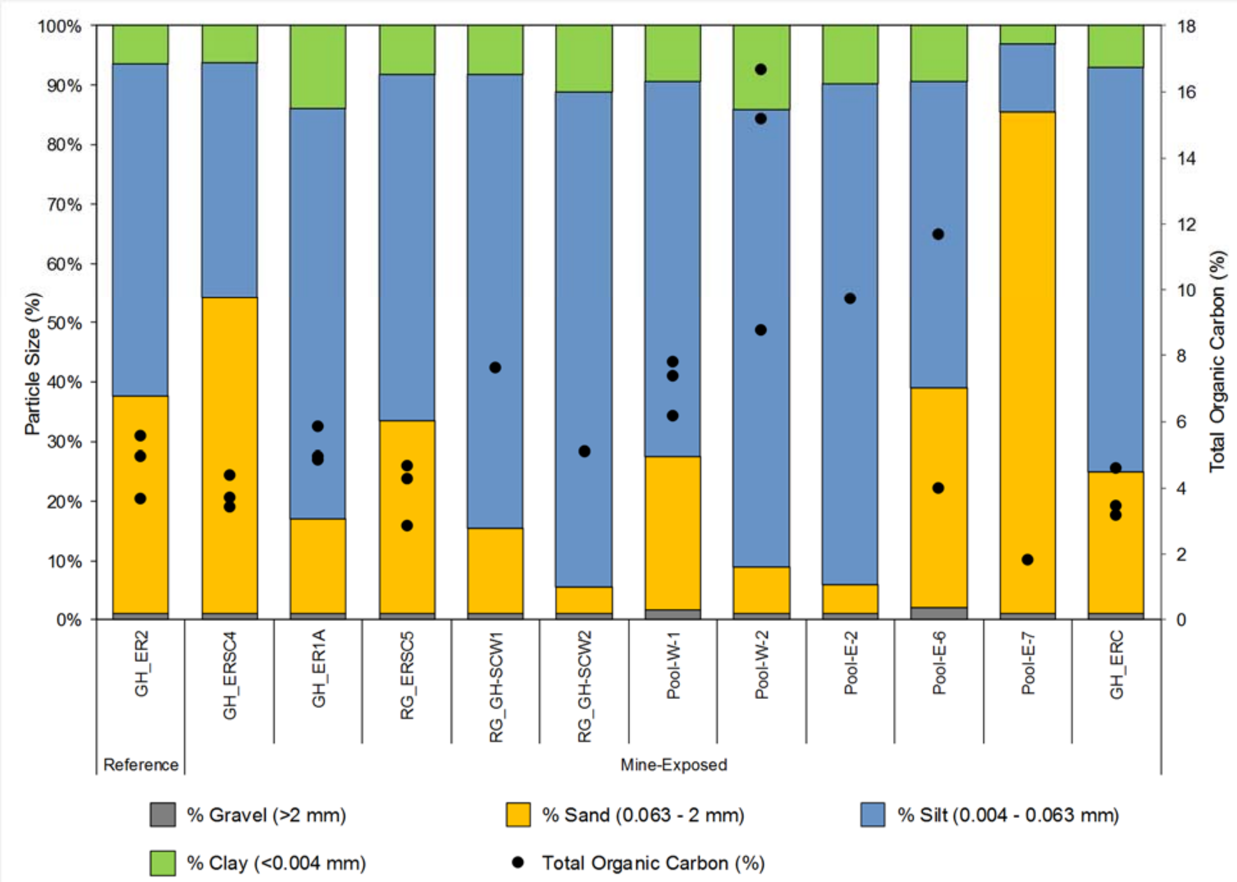


Figure 5.1: **Mean Particle Size (%) and Total Organic Carbon Content (%) in Sediments, September 2017**

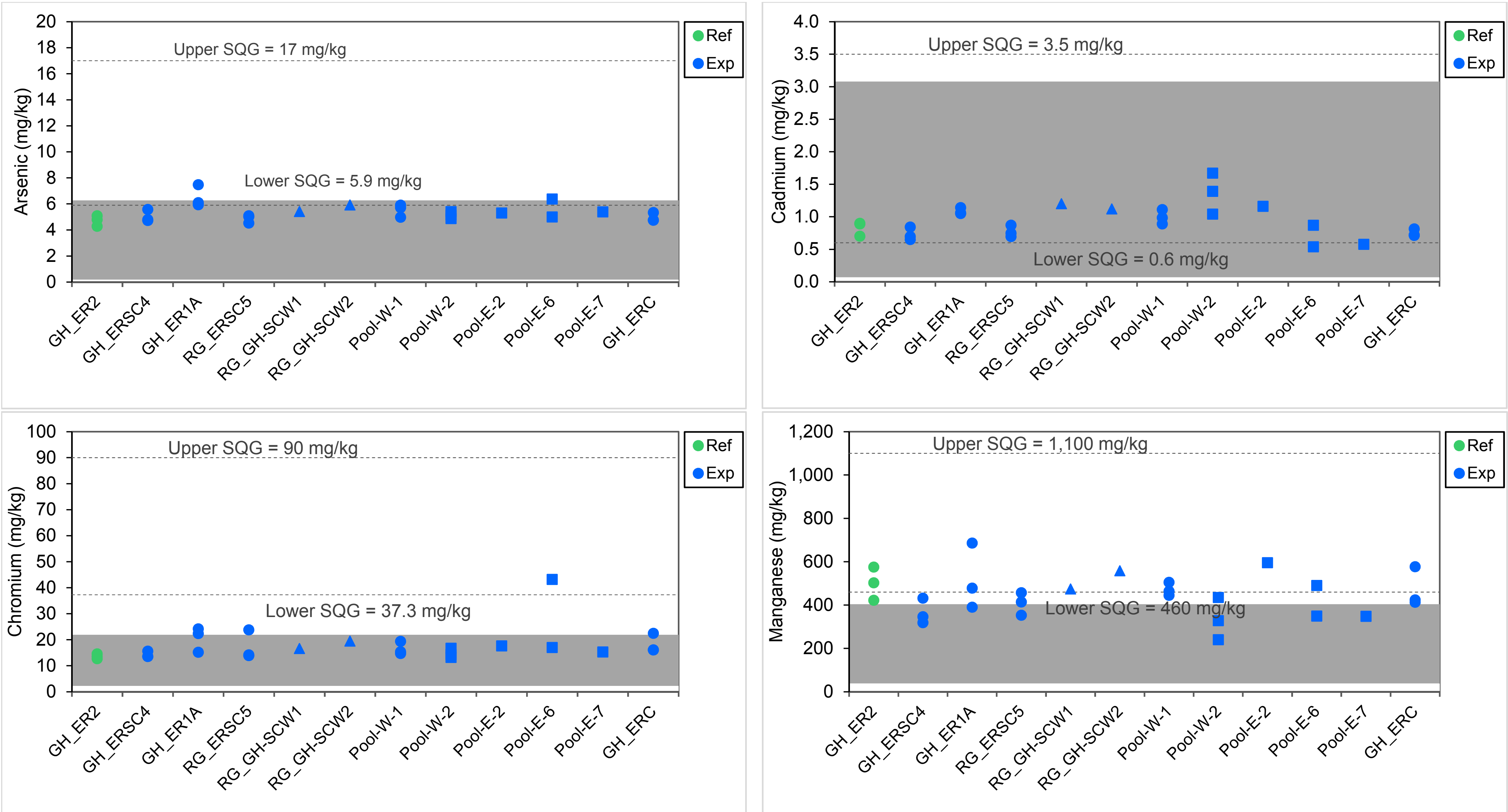


Figure 5.2: Sediment Metal and Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG) and Normal Ranges, 2017

Notes: Symbols differentiate station site locations with circles (○) representing stations in lotic areas, triangles (Δ) representing stations in wetlands, and squares (□) representing pools. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL value. Shading represents the normal range (2.5th and 97.5th percentiles of 2013 and 2015 reference area data collected in the RAEMP, Minnow 2018).

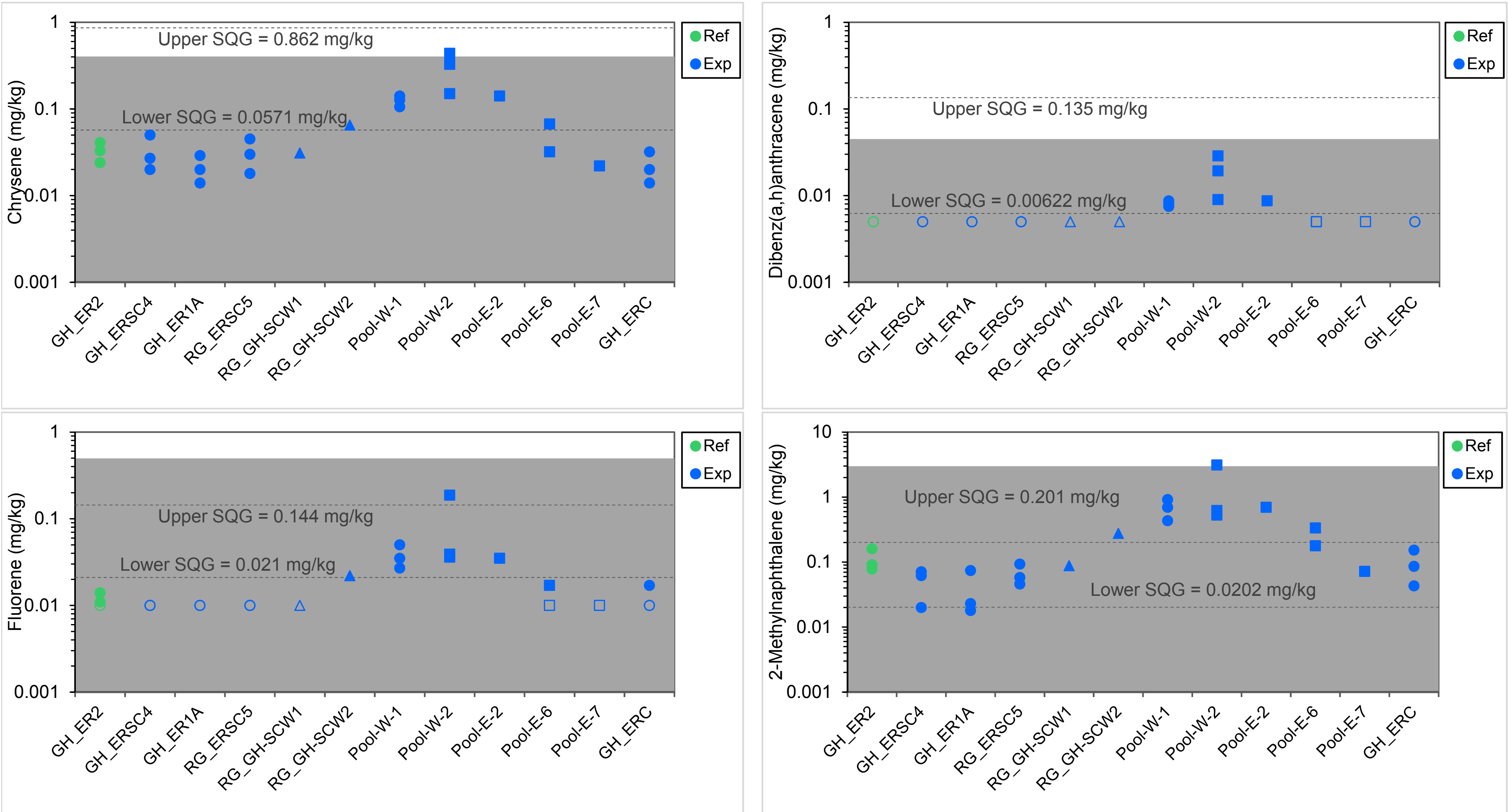


Figure 5.2: Sediment Metal and Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG) and Normal Ranges, 2017

Notes: Symbols differentiate station site locations with circles (○) representing stations in lotic areas, triangles (Δ) representing stations in wetlands, and squares (□) representing pools. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL value. Shading represents the normal range (2.5th and 97.5th percentiles of 2013 and 2015 reference area data collected in the RAEMP, Minnow 2018).

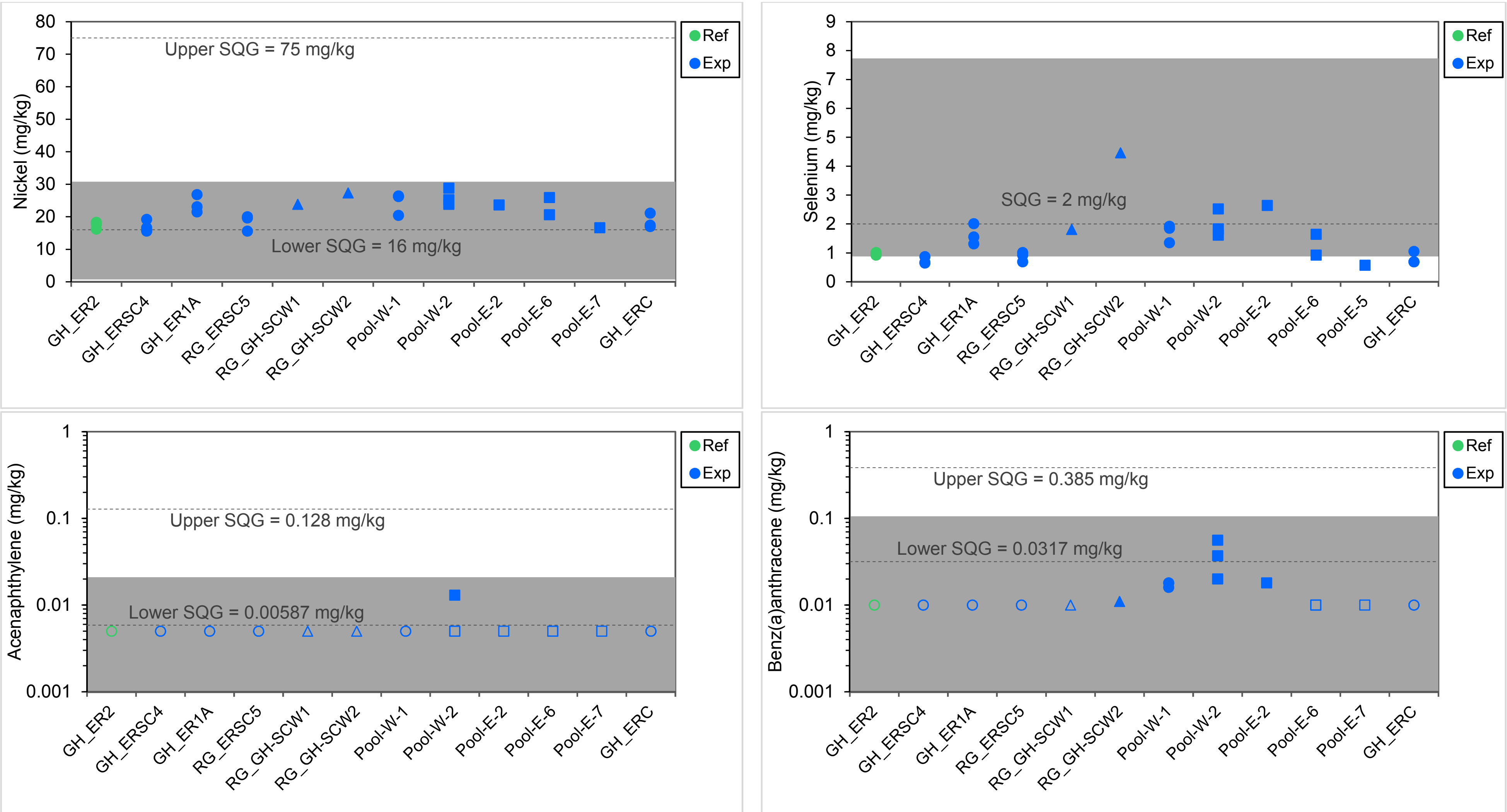


Figure 5.2: Sediment Metal and Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG) and Normal Ranges, 2017

Notes: Symbols differentiate station site locations with circles (○) representing stations in lotic areas, triangles (Δ) representing stations in wetlands, and squares (□) representing pools. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL value. Shading represents the normal range (2.5[th] and 97.5[th] percentiles of 2013 and 2015 reference area data collected in the RAEMP, Minnow 2018).

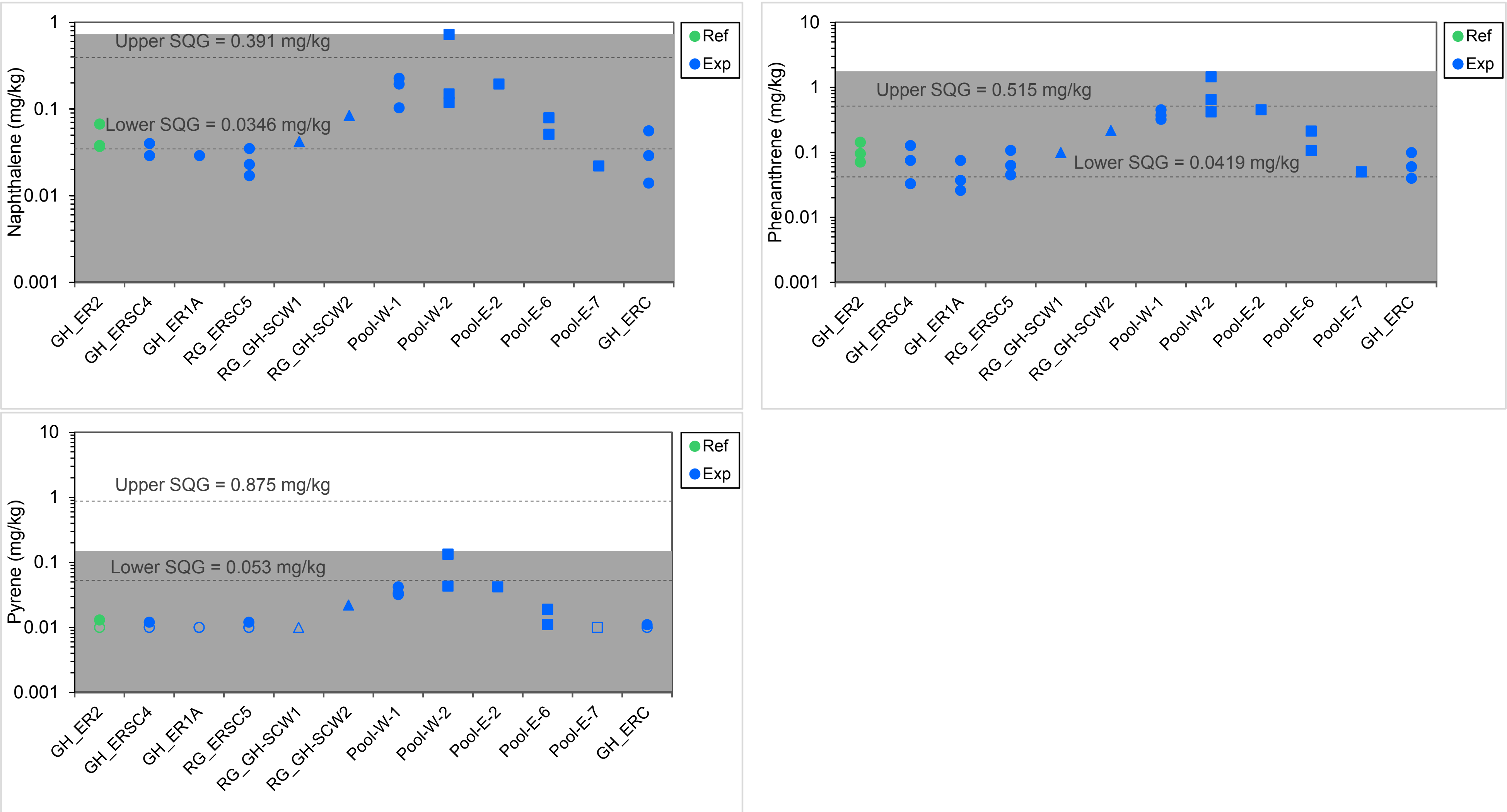


Figure 5.2: Sediment Metal and Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG) and Normal Ranges, 2017

Notes: Symbols differentiate station site locations with circles (○) representing stations in lotic areas, triangles (Δ) representing stations in wetlands, and squares (□) representing pools. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL value. Shading represents the normal range (2.5th and 97.5th percentiles of 2013 and 2015 reference area data collected in the RAEMP, Minnow 2018).

(one sample), and 2-methylnaphthalene (one sample). Although manganese was frequently greater than the normal range, mine-exposed stations were within range of reference station GH_ER2.

Sediment quality in the main stem Elk River upstream (GH_ER2) and downstream of the west side tributaries (GH_ERC) was generally similar (Figure 5.2). Concentrations of PAHs at flowing side channel stations (GH_ERSC4, GH_ER1A, and RG_ERSC5) were also similar to or less than the concentrations at the upstream reference station GH_ER2 (Figure 5.2). Concentrations of arsenic, cadmium, chromium, manganese, nickel, and selenium were all slightly higher at GH_ER1A relative to downstream RG_ERSC5 and upstream reference station GH_ER2 (Figure 5.2). No overland tributary inputs exist between GH_ER1A and RG_ERSC5, so this difference may be due to the higher proportion of fines (silt and clay) in the samples from GH_ER1A relative to RG_ERSC5 (Figure 5.1).

Sediment metal and PAH concentrations were generally higher in pools associated with the most western channel downstream of the wetland (Pool-W-1 and Pool-W-2) relative to pools associated with the most eastern channel (contrary to water quality; Figure 4.6). Pool-W-2 generally had the highest PAH concentrations, likely associated with high TOC concentrations (Figures 5.1 and 5.2). Within the side channel wetland, concentrations of several parameters (selenium included) were higher at RG_GH-SCW2 than RG_GH-SCW1 (Figure 5.2), consistent with its proximity to the mouth of Thompson Creek.

5.4 Summary

Overall, the data suggest sediment quality in the Elk River side channel and in the main stem location downstream of the side channel (GH_ERC) are not adversely affected by mine-related discharges.

6 HABITAT

6.1 Overview

Data are evaluated to address key question #3.a (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

a. How does the distribution of biota change seasonally? Which isolated pools contain biota?

These data provide information about seasonal habitat availability for different biota, which gives context for understanding the relative risk of potential exposure pathways. Habitat data were collected during monthly surveys from May 2017 to April 2018, with reach identification and the FHAP survey occurring in July.

6.2 Reach Identification

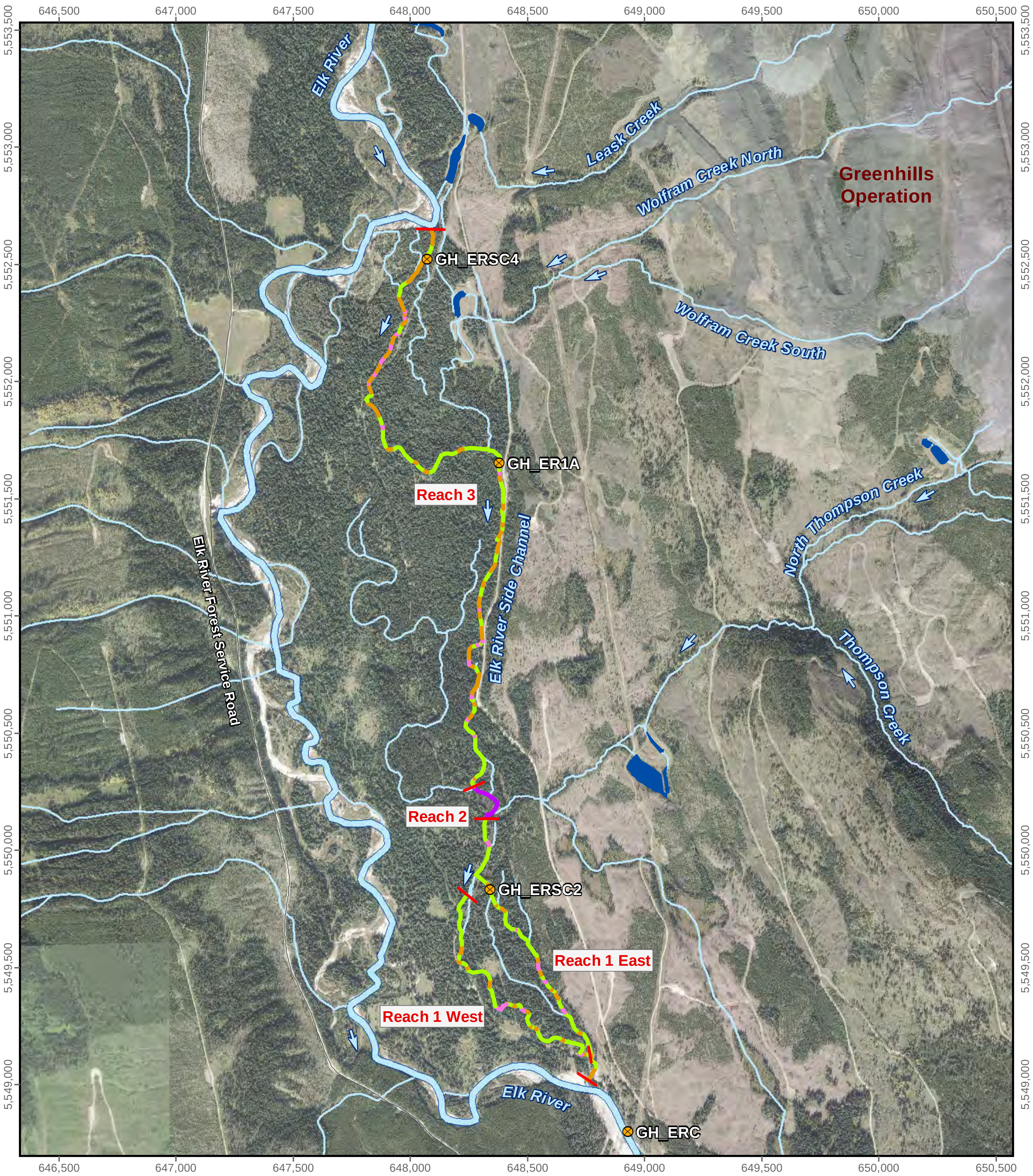
There were three reaches identified along the side channel. Reach 1 began at the downstream confluence with the Elk River and ended where the side channel transitioned into wetland habitat. Reach 1 was the downstream-most reach and was classified as having a riffle-pool morphology. There was extensive braiding in Reach 1 where there were three larger "main" channels identified (east channel, west channel, and middle channel, Figure 6.1). Reach 1 was the first to dewater in September 2017 (Section 3.2). Reach 2 was classified as wetland habitat and had inflow from both the side channel and Thompson Creek from the east from May to October 2017 (Figure 6.1). However, from October 2017 to the end of April 2018 only Thompson Creek was flowing into the wetland. Reach 3 began at the wetland inflow and ended at the upstream Elk River confluence (Figure 6.1). Reach 3 was the upstream-most reach and was classified as having a riffle-pool morphology that remained confined to one channel. Wolfram Creek was a tributary that approached Reach 3 near the GH_ER1A site; however, at no point in the 2017 surveys was it connected to the side channel via surface flow.

6.3 Level 1 Fish Habitat Assessment Procedure (FHAP)

FHAP surveys were completed for lotic Reaches 1 and 3, as FHAP surveys are not applicable to lentic habitat (Reach 2).

6.3.1 Reach 1 – East Channel

The habitat composition for the 1,354.5 m long Reach 1 east channel was: 72% glide, 19% riffle, 8% pool and 0% cascade (Table 6.1). Average gradient was 1%. These results are consistent with the Reach 1 classification of riffle-pool morphology. The average bankfull width was 6.91 m



LEGEND

- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond

Habitat Type

- Glide
- Other - Wetland
- Pool
- Riffle

Habitat of the Elk River Side Channel

0 375 750 1,500 Meters

N E S W

Projection: North American Datum 1983 UTM Zone 11
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Date: May 2018
Project 177202.0024

minnow environmental inc.

Figure 6.1

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig 6.1 Habitat of Elk Side Channel.mxd

Table 6.1: Level 1 - FHAP Summary Table for the Reach 1 East Channel

Distance Surveyed (m)	Bankfull Width (m)	Bankfull Depth (m)	Wetted Width (m)	Wetted Depth (m)	% Cascade	% Glide	% Pool	% Riffle
1,355	6.91	0.95	4.69	0.39	0	72	8	19

and the average wetted width was 4.69 m (range of 2.64 to 7.48 m). The bankfull width-to-depth ratio of 6.8 was considered low for a riffle-pool morphology, suggesting that the channel was likely incised. However, this may also be typical morphology for a side channel to a large river. The side channel had (prior to recent logging, which was not conducted by Teck) mature riparian forest that could have provided bank stability and allowed for a low width-to-depth ratio to develop by promoting more bed scour than bank erosion. The width-to-depth ratio may increase in the future as a result of the recent logging. Few areas of suitable salmonid spawning habitat were noted in Reach 1 as suitable spawning gravel was limited throughout the reach, because the interstitial substrate was predominantly fines.

Metrics describing habitat quality ranged from poor to fair (Table 6.2), with overall habitat quality generally considered to be fair-poor. As noted above, the low width-to-depth ratio suggests the channel is likely incised. This means that connectivity to the floodplain may be compromised, resulting in higher than expected flows within the channel, which could potentially increase bank erosion and therefore degrade habitat. Channel complexity, % area by pool, and pool frequency were all poor, indicating a disturbed state. Channel complexity was low with 1.4 mesohabitat units/10x bankfull length. The number of holding pools for adult fish was the only metric that was ranked as good. Four pools were identified in the east channel. All four pools had depths greater than 1 m. There were 0.5 pieces of LWD per bankfull width, which was considered poor (Table 6.2).

6.3.2 Reach 1 – West Channel

The habitat composition for the Reach 1 west channel was: 73% glide, 18% riffle, 9% pool, and 0% cascade (Table 6.3). Mean channel gradient was 1.2%. This channel was classified as riffle-pool morphology. The average bankfull width was 5.24 m (range to 4.05 to 6.10 m) and the average wetted width was 4.04 m (range of 3.12 to 6.05 m). There were only a few areas of suitable salmonid spawning habitat as suitable spawning gravel was limited throughout the reach and the interstitial substrate was predominantly fines.

Metrics describing habitat quality were either poor or good within the Reach 1 west channel (Table 6.4). Overall habitat quality was considered to be poor and degraded. The low width-to-depth ratio (4.5) suggests the channel is likely incised. Similar to the Reach 1 east channel (Section 6.3.1), this has the potential to increase bank erosion and therefore degrade habitat. The poor channel complexity, % area by pool, and pool frequency also suggest that this channel is in a disturbed state. The number of holding pools for adult fish was the only metric that was ranked as good. Three pools were identified in the west channel, all of which had depths greater than 1 m. There were 0.1 pieces of LWD per bankfull width, which was considered poor.

Table 6.2: Habitat Quality Metrics for the Reach 1 East Channel

Metric	Value	Quality Rating
Bankfull width:depth	6.8	n/a
Sinuosity	1.2	n/a
Channel complexity (# habitat units/10x bankfull width)	1.4	Poor
% Pool (by area)	7%	Poor
Pool frequency (mean pool spacing) (channel widths/pool)	36.2	Poor
Holding pools (adult migration) (pools/km >1 m deep)	14.8	Good
LWD pieces per bankfull width	0.5	Poor
% wood cover in pools	5	Fair

Table 6.3: Level 1 - FHAP Summary Table for the Reach 1 West Channel

Distance Surveyed (m)	Bankfull Width (m)	Bankfull Depth (m)	Wetted Width (m)	Wetted Depth (m)	% Cascade	% Glide	% Pool	% Riffle
1,186	5.24	1.15	4.04	0.26	0	73	9	18

Table 6.4: Habitat Quality Metrics for the Reach 1 West Channel

Metric	Value	Quality Rating
Bankfull width:depth	4.5	n/a
Sinuosity	1.5	n/a
Channel complexity (# habitat units/10x bankfull width)	1.1	Poor
% Pool (by area)	0%	Poor
Pool frequency (mean pool spacing) (channel widths/pool)	0	Poor
Holding pools (adult migration) (pools/km >1 m deep)	2.5	Good
LWD pieces per bankfull width	0.1	Poor
% wood cover in pools	0	Poor

6.3.3 Reach 3

The habitat composition for the 3,399.5 m long Reach 3 was: 48% glide, 44% riffle, 8% pool and 0% cascade (Table 6.5). The average bankfull width was 7.66 m (range of 4.60 to 11.85 m) and the average wetted width was 6.33 m (range of 3.78 to 10.78 m). Mean channel gradient was 1.0%. Reach 3 also had a riffle-pool morphology, and areas of suitable salmonid spawning habitat reported in both abundant and low amounts of spawning gravel as described by habitat unit during the FHAP survey. Reach 3 provided the highest quality spawning habitat out of all three reaches.

Table 6.5: Level 1 - FHAP Summary Table for Reach 3

Distance Surveyed (m)	Bankfull Width (m)	Bankfull Depth (m)	Wetted Width (m)	Wetted Depth (m)	% Cascade	% Glide	% Pool	% Riffle
3,400	7.66	1.3	6.33	0.53	0	48	8	44

Metrics describing habitat quality were either poor or good (Table 6.6). Overall habitat quality was considered to be poor-fair. The low width-to-depth ratio (5.9) suggests the channel may be incised, as with Reach 1 east and west channels (Sections 6.3.1 and 6.3.2). As noted in Reach 1, this may also be typical for a side channel with a mature riparian forest that may provide the bank stability necessary to allow for a low width-to-depth ratio to develop. Channel complexity was poor with 1.7 mesohabitat units/10x bankfull length. Both % area by pool, and pool frequency were also poor, suggesting that this channel is in a disturbed state. There were 0.2 pieces of LWD per bankfull width, which was considered poor. However, the amount of LWD that acted as cover in pools was considered fair. There were 17 pools identified, 16 of which had depths greater than 1 m. The percentage of pools by area was 9%.

Table 6.6: Habitat Quality Metrics for Reach 3

Metric	Value	Quality Rating
Bankfull width:depth	5.9	Good
Sinuosity	1.4	Good
Channel complexity (# habitat units/10x bankfull width)	1.7	Poor
% Pool (by area)	9%	Poor
Pool frequency (mean pool spacing) (channel widths/pool)	21.9	Poor
Holding pools (adult migration) (pools/km >1 m deep)	10.6	Good
LWD pieces per bankfull width	0.2	Poor
% wood cover in pools	5.5	Fair

6.4 Monthly Habitat Assessment

Habitat was assessed as a component of monthly surveys to document general habitat conditions, channel morphology, potential fish spawning and overwintering habitat, and habitat suitable for other aquatic and aquatic-dependent vertebrates (amphibians and piscivorous birds). *In situ* water quality parameters were collected during monthly habitat assessments (Appendix Tables D.1 and D.2).

6.4.1 May and June 2017 (Spring Season)

May and June were dominated by very high flows with the channel bankfull width exceeded and water flowing into the surrounding vegetation above the banks. The water was exceptionally turbid, which limited the effectiveness of spawning surveys since the majority of the substrate could not be viewed. The substrate for all reaches appeared to be dominated by fines. However, potential fish-spawning habitat was noted for Reaches 1 and 3, with Reach 1 being more likely to be used for spawning due to slower velocities at the time. Reach 1 was highly braided, while Reach 3 had vegetated islands. Reach 2 was classified as wetland habitat due to a very low gradient, slower velocities, and a lack of channelization with terrestrial shrubs spread throughout. Reach 2 had the highest likelihood of amphibian use based on habitat. Thompson Creek was flowing into the wetland. Leask Creek and Wolfram Creek had no overland connection.

6.4.2 July and August 2017 (Summer Season)

Flows had receded by July and August, and the east, west, and middle channels of Reach 1 were more defined. Some of the braids in Reach 1 had dried up, especially in August. In July, two wetted channels with no flow were discovered west of the wetland (Section 3.2). Reach 1 had wetted widths ranging from 2.64 to 7.48 m and depths greater than 1 m reported in pools. Reach 3 had wetted widths ranging from 3.78 to 10.78 m. Areas where the water depth was greater than 1 m still remained. At the time of the summer surveys, Thompson Creek was flowing into the wetland. Logging (not conducted by Teck) on the side channel began in July.

Reach 1 substrate was mainly fines and gravel, Reach 2 substrate was predominantly fines, and Reach 3 was predominantly gravel with some cobble. Channel banks were mainly composed of fines for all reaches. Moderate amounts of fish cover were noted for Reaches 1 and 3. In-stream cover was primarily provided by large and small woody debris, and overhanging vegetation. There were suitable sections of salmonid spawning habitat noted in Reach 3, along with two deep (e.g., 1 to 2 m depth) pools (Pool-U-2 and Pool-U-3) that were connected to the main stem Elk River during the summer surveys. These pools went dry from January to April 2018, but would possibly stay wetted in wetter years.

In August, the first isolated pool (Pool-E-1) was located in Reach 1, and was sampled for water quality (Section 4.4). The DO value for the pool was 4.65 mg/L, which is low compared to the BC Water Quality Guideline value of 5 mg/L (Appendix Table D.2), therefore, this pool was not expected to provide long-term habitat for aquatic life.

In August, an additional survey was completed over the floodplain area west of the side channel to the Elk River, as this could not be accessed during high flows in June and July. The area was a complex floodplain with multiple channels and isolated pools. Several wetted and dry braids were documented to split off from the main stem Elk River. None of the braids reconnected with the side channel during the survey. Five isolated pools within the floodplain were found to have stranded fish. One unidentified amphibian (frog or toad) was observed along the Elk River. The floodplain complex was identified as suitable amphibian habitat during the summer.

6.4.3 September and October 2017 (Fall Season)

Flows continued to recede in the fall, and all three channels of Reach 1 were dewatered in September. A survey was conducted in early September as part of benthic invertebrate and sediment sampling (Sections 5, 8.2, and 9), which identified eight pools in the west channel and five pools in the east channel of Reach 1. When the formal monthly habitat assessment was conducted later in September, conditions were drier and there was only one pool on the west channel (Pool-W-2) and seven pools on the east channel (Pool-E-2 to 7, and one unnamed pool that was not sampled for water). Some of these pools included overhead cover for fish provided by small woody debris. The pools were all fairly shallow and likely would not provide overwintering potential. Dissolved oxygen in the east channel pools ranged from 3.51 to 5.29 mg/L, which was at or below the 5 mg/L reported in BC Water Quality Guidelines for embryo/alevin survival. Pool-W-2 had a DO of 11.94 mg/L (Appendix Table D.2), which is suitable for embryo/alevin survival. The outflow of the wetland (i.e., flow from Reach 2 to Reach 1) was also dry in September. The inlet to the wetland still received flow from Reach 3. Reach 3 had a wetted width of 5.73 m near GH_ER1A, and there was moderate fish cover provided by LWD.

A lack of flow prevented identifying any suitable spawning habitat in Reach 1. Reach 3 had suitable spawning habitat, and a potential redd (Figure 6.2), likely from a brook trout, in September (Photo 6.1), though the redd was dry by the October survey.

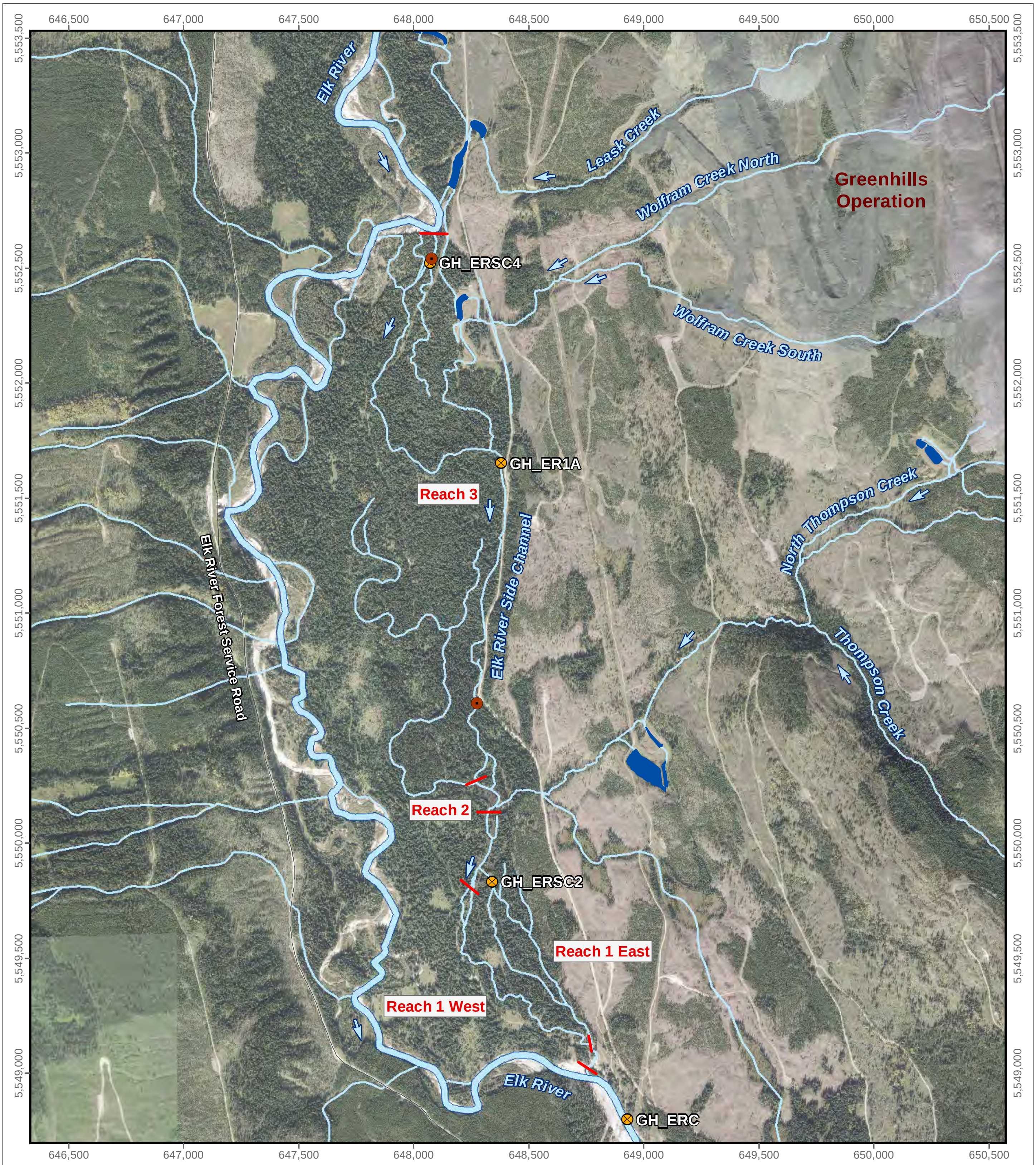
Thompson Creek was observed to flow into the wetland (Reach 2) throughout September and October surveys.

In October, Reach 1 had one isolated pool (Pool-E-7), and there were five isolated pools observed in Reach 3 (Pool-M-1, Pool-M-2, and three non-sampled). Pool-E-7, Pool-M-1, and Pool-M-2 had DO levels ranging from 6.23 to 9.09 mg/L (Appendix Table D.2). The inflow to the wetland was dry, however, Thompson Creek was still flowing into the wetland. The two wetted channels on the wetland identified in July were dry. The wetted width in Reach 3 at GH_ER1A had reduced to 5.6 m. The deep pools (Pool-U-2 and Pool-U-3) in Reach 3 were still present. With Reach 3 dewatering there was less spawning opportunities for fish.

Thompson Creek was observed to flow into the wetland (Reach 2) throughout October surveys.

6.4.4 November 2017 to April 2018 (Winter Season)

Reach 1 had a single pool (Pool-E-7) for the months of November, February, and March. In December, warmer air temperatures lead to the creation of five pools in Reach 1, and four pools in January.



LEGEND

- Possible Redd Location
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond

Fish Spawning Habitat

0 375 750 1,500 Meters

Projection: North American Datum 1983 UTM Zone 11
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Figure 6.2

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig 6.2 Fish Spawning.mxd

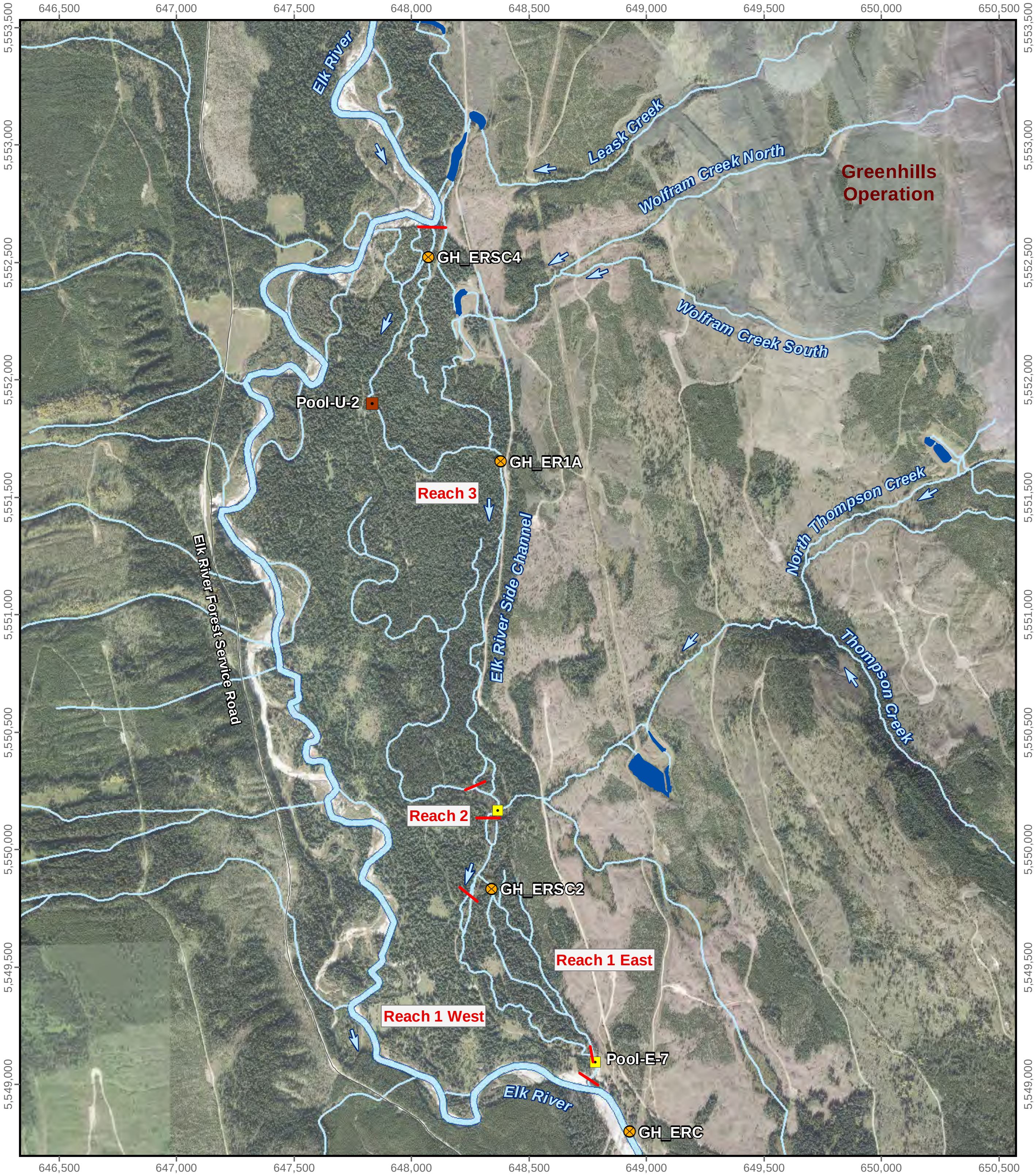
Photo 6.1: Potential Redd in Reach 3

Reach 2 remained consistent in November to April. Inflow from Reach 3 had stopped, but flow from Thompson Creek persisted. Westslope cutthroat trout were the only vertebrate observed in this reach throughout this period (see Section 6.4).

Dewatering within Reach 3 was first noted in November and first occurred at the downstream end of that reach. Isolated pools were formed and water quality was sampled (Section 2.3.2). With each successive month larger sections of Reach 3 were becoming dewatered. Again, with warmer weather in December 2017, 21 pools were identified in Reach 3. From January to March, Reach 3 had no isolated pools and was dry the entire distance to the Elk River inlet. Snow and ice covered the entire stream.

6.5 Overwintering Habitat

Suitable overwintering habitat was determined based on areas that remained wetted all year (Figure 6.3), with moderate to high DO concentrations (i.e., ideally greater than 5 mg/L). Every isolated pool dewatered at least once from August 2017 to March 2018, with the exception of Pool-E-7 in Reach 1 (downstream of where the east and west channels join Pool-E-7 had low DO values (i.e., 4.14 to 4.81 mg/L) in September, November, and December 2017; however still had open water (approximately 1 m^2) and had a DO of 9.31 mg/L in January 2018. In January the water depth was 0.2 m, which would support overwintering for smaller bodied fish. Fish were observed Pool-E-7 in the fall, but winter observations were prevented by snow.



LEGEND

- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Overwintering habitat identified winter 2017/2018
- Potential overwintering habitat (dewatered winter 2017/2018)
- Reach break
- Settling pond

Fish Overwintering Habitat

0 375 750 1,500 Meters

Projection: North American Datum 1983 UTM Zone 11

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Figure 6.3

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig 6.3 Fish overwintering habitat.mxd

The overwintering potential of the side channel wetland was assessed, and confirmed by observations of three westslope cutthroat trout juveniles during December 2017. In January 2018, the water temperature was 0.3°C, which was low, however other parameters were: DO was 12.50 mg/L, the pH was 7.71, and the specific conductance was 1,709 µs/cm (Appendix Table D.1). The ice thickness was 0.30 m and there was no air space. During the winter, the only water entering the wetland was from Thompson Creek.

Reach 3 was found to be fully dewatered during the January habitat survey and therefore provided no overwintering potential. Pool-U-2 was deeper than 1 m in the summer and fall, and therefore could possibly provide overwintering habitat in wetter years.

7 DISTRIBUTION OF BIOTA

7.1 Overview

Data evaluated in this section are related to addressing key question #3.a (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

b. How does the distribution of biota change seasonally? Which isolated pools contain biota?

These data provide information about seasonal habitat use by different biota, which gives context for understanding the relative risk of potential exposure pathways.

7.2 Distribution of Biota

From May 2017 to April 2018, monthly observations were made for biota residing in and along the Elk River, and the Elk River side channel (Table 7.1). The majority of amphibians (Figure 7.1) and birds were observed in Reach 1 and Reach 3. Fish were observed in all three reaches. Isolated pools in Reach 1 and Reach 3 in the fall season (September and October) were found to contain stranded fish. Snow and ice covering the stream prevented biota observations from November 2017 to April 2018, however, in December three juvenile westslope cutthroat trout were observed in the wetland.

7.3 Fish Inventory

Fish inventory sampling was completed in June, July, September, and October (Appendix Tables D.3 to D.5, Appendix D Photo Group 1) at stations ERSC2, ERSCW, and ER1A (Figure 2.3).

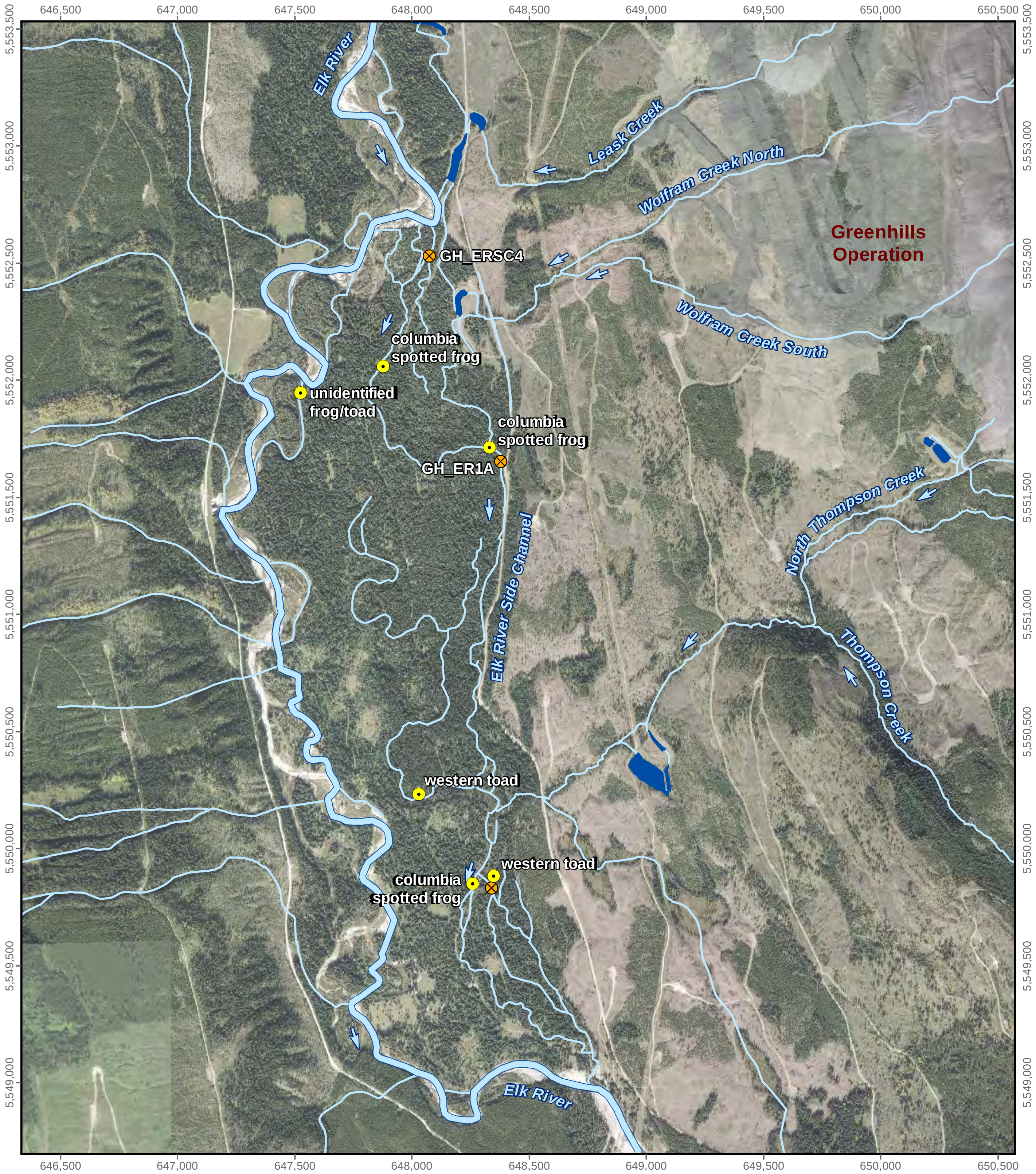
Electrofishing could not be conducted in June due to high flows, so only minnow traps were used. No fish were captured in June (Table 7.2 and 7.3). In July, no fish were caught at ERSCW or ER1A, but three species (westslope cutthroat trout, bull trout, and mountain whitefish) were caught at ERSC2 (Table 7.3).

In September, Reach 1 was dewatered with the exception of isolated pools, therefore ERSC2 could not be fished. ERSCW had a minnow trapping CPUE for September with 0.129 fish/hr with all fish being mountain whitefish fry (Table 7.2). The highest monthly electrofishing CPUE for ER1A was also in September at 0.027 fish/s using electrofishing. In Reach 1, four isolated pools were sampled. The CPUE for the four pools ranged from 0.00 to 0.40 fish/s using electrofishing and there were westslope cutthroat trout, brook trout, and mountain whitefish captured (Table 7.4). Mountain whitefish were the dominate species captured.

Table 7.1: Monthly Biota Observations, May 2017 to April 2018

Observation		2017 June	2017 July	2017 August	2017 September	2017 October
Reach 1						
Fish	unidentified fry	-	25	30	multiple	-
	unidentified juvenile	-	-	-	multiple	-
	unidentified adult	-	1	-	-	-
Amphibian	Columbia spotted frog	-	1	1	-	-
	western toad	1	-	-	-	-
Birds	mallard	-	-	multiple	-	-
Reach 2						
Fish	unidentified fry	-	25	-	-	-
Amphibian	western toad	-	1	-	-	-
Reach 3						
Fish	mountain whitefish	-	-	-	-	80
	westslope cutthroat trout	-	1	2	-	-
	unidentified adult	-	-	3	-	-
Amphibian	Columbia spotted frog	-	-	1	-	1
Birds	American dipper	-	-	multiple	-	-
Elk River						
Amphibian	unidentified	-	-	1	-	-

Note: No biota were observed in May 2017, or throughout the winter season (November 2017 to April 2018) due to snow and ice cover.



LEGEND

- Amphibian observation
- Routine water quality monitoring station (Permit 107517), Mine-exposed
- Settling pond

Amphibian Observations

0 375 750 1,500 Meters

Projection: North American Datum 1983 UTM Zone 11

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Figure 7.1

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Table 7.2: Fish Inventory Minnow Trapping Summary, June, July, September, and October 2017

Site	# of Traps	Set Date	Pull Date	Species	Total Number Caught	Min. Length (mm)	Max Length (mm)	CPUE (fish/hr)
ERSC2	5	19-Jun-17	21-Jun-17	NFC	0	-	-	-
	4	24-Jul-17	25-Jul-17	NFC	0	-	-	-
ERSCW	5	19-Jun-17	21-Jun-17	NFC	0	-	-	-
	4	24-Jul-17	25-Jul-17	NFC	0	-	-	-
	10	26-Sep-17	27-Sep-17	MW	32	50	60	0.129
	5	16-Oct-17	17-Oct-17	MW	3	57	65	0.029
				LSU	4	46	51	0.039
ER1A	5	19-Jun-17	21-Jun-17	NFC	0	-	-	-
	4	24-Jul-17	25-Jul-17	NFC	0	-	-	-
	5	26-Sep-17	27-Sep-17	MW	10	51	65	0.082
	5	16-Oct-17	17-Oct-17	MW	1	63	63	0.01

CPUE - catch-per-unit-effort.
NFC - no fish caught.
MW - mountain whitefish.
LSU - longnose sucker.

Table 7.3: Fish Inventory Electrofishing at Side Channel Stations in July, September, and October 2017

Site	Date	Distance (m)	Electrofishing Effort (s)	Species	Total Number Caught	Min. Length (mm)	Max Length (mm)	CPUE each species (fish/s)	CPUE all species (fish/s)
ERSC2	24-Jul-17	100	420	WCT	1	100	100	0.002	0.017
				BT	2	135	148	0.005	
				MW	4	40	41	0.01	
ER1A	24-Jul-17	100	470	NFC	0	-	-	-	-
	26-Sep-17	100	476	EB	5	67	85	0.01	0.027
				MW	8	50	60	0.02	
	16-Oct-17	100	581	EB	4	69	80	0.007	0.012
				MW	3	54	62	0.005	

CPUE - catch-per-unit-effort.
WCT - westslope cutthroat trout.
BT - bull trout.
MW - mountain whitefish.
EB - brook trout.
NFC - no fish caught.

Table 7.4: Fish Inventory Electrofishing in Isolated Pools in September 2017

Site	Date	Distance (m)	Electrofishing Effort (s)	Species	Total Number Caught	Min. Length (mm)	Max Length (mm)	CPUE each species (fish/s)	CPUE all species (fish/s)
Pool-E-7	26-Sep-17	8	100	NFC	0	-	-	-	-
Pool-E-6	26-Sep-17	5	80	WCT	4	95	119	0.05	0.13
				EB	3	121	164	0.04	
				MW	3	51	60	0.04	
Pool-E-5	26-Sep-17	4	82	WCT	1	43	43	0.01	0.23
				MW	18	45	65	0.22	
Pool-E-4	26-Sep-17	2	30	WCT	7	37	110	0.23	0.40
				EB	3	79	144	0.10	
				MW	2	46	58	0.07	

CPUE - catch-per-unit-effort.
WCT - westslope cutthroat trout.
BT - bull trout.
MW - mountain whitefish.
EB - brook trout.
NFC - no fish caught.

In October, The first longnose suckers were captured. ERSCW had the highest CPUE of 0.029 MW/hr and 0.39 LSU/hr using minnow trapping. ER1A had a CPUE of 0.012 fish/s and both brook trout and mountain whitefish were captured using electrofishing.

As water levels receded in reaches 1 and 3, the CPUE of ERSCW was the highest. This may suggest that Reach 2 provides important late season fish habitat.

7.4 Fish Community

Additional biota distribution data were collected using fish community (density) surveys in two main areas: ERSC2 and ER1A (Figure 2.3, Appendix Tables D.6 and D.7). Within ERSC2, three habitat units were sampled: two glides and one riffle. Mountain whitefish fry were most abundant in this area, but a single adult brook trout was also captured (Table 7.5). Fish density was greatest at the second glide (ERSC2-G2; Table 7.5). At ERSCW, the fish density survey was conducted using a mark and recapture method (Appendix Table D.8); however, density could not be calculated, as none of the fish were recaptured. Twenty-one mountain whitefish fry were captured in the area (Appendix Tables D.6 and D.7). Within the ER1A area, the fish community survey was completed on two glides and one riffle (Table 7.5). In total, seven whitefish fry were captured (Table 7.5, Appendix Tables D.6 and D.7). Fish were found throughout the side channel, with mountain whitefish fry most abundant, and density much higher at area ERSC2 compared to ERA1 (Table 7.5).

Table 7.5: Fish Community Electrofishing Sampling Summary

Reach	Habitat Type	Site Code	Sample Length (m)	Total EF Seconds	Species	Total Caught	Min (mm)	Max (mm)	Density (fish/100m²)
1	G	ERSC2-G1	28.8	1,032	MW	3	46	55	2.99
1	R	ERSC2-R	28.9	1,619	EB	1	157	157	0.53
1	R	ERSC2-R	28.9	1,619	MW	9	46	54	4.8
1	G	ERSC2-G2	14.52	926	MW	35	45	55	54.1
3	G	ER1A-G1	15.67	1,054	MW	1	45	45	0.85
3	G	ER1A-G2	24.7	1,291	MW	3	48	53	3.03
3	R	ER1A-R	23.2	1,007	MW	3	54	57	1.87

EF - electrofishing.
G - glide.
R - riffle.
MW - mountain whitefish.
EB - brook trout.

8 SELENIUM IN TISSUE

8.1 Overview

Data evaluated in this section pertain to key question #3.c (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

c. What are the fish and benthic invertebrate tissue selenium concentrations?

8.2 Benthic Tissue Selenium

Benthic invertebrate tissue samples were collected in September for analysis of selenium concentrations from main stem Elk River stations, side channel stations, isolated pools, and the side channel wetland (Figure 2.1). At the time of sampling, isolated pools were only located in Reach 1 West and Reach 1 East (Appendix Figure A.3), and Reaches 1 and 2 were entirely wetted. Selenium concentrations in benthic invertebrate composite tissue samples were compared to EVWQP Level 1 benchmarks and the normal range (Figure 8.1, Appendix Tables E.1 to E.6). Although the EVWQP Level 1 benchmarks and the normal range were calculated based on community composites, and are therefore not directly applicable to taxa-specific samples, the benchmarks and normal range were also provided for comparison to taxa-specific samples (Figure 8.1).

Selenium concentrations of some of samples collected from RG_ERSC5, RG_GH-SCW2, Pool-E-2, and Pool-E-6 were greater than the EVWQP Level 1 benchmarks for either benthic invertebrates, dietary effects to juvenile fish, and/or dietary effects to birds, with highest concentrations measured in the samples collected at RG_GH-SCW2, which is directly influenced by Thompson Creek on the side channel wetland (Figure 8.1). The elevated concentrations measured at RG_ERSC5 were likely due to a higher proportion of annelids (segmented worms) in the samples relative to other areas. Annelids have previously been shown to exhibit higher concentrations of selenium compared to other benthic organisms, even at reference areas (Minnow 2016b, 2018).

Concentrations of selenium in tissues were variable within stations, but were generally similar between community composite samples and single taxon samples (Figure 8.2). Triplicate individual Perlidae samples showed similar variability within stations as composites, indicating that single taxon samples would not provide greater resolution for tracking changes over time (Figures 8.1 and 8.2; Minnow 2018a).

Within isolated pools, composite tissue selenium concentrations were higher in samples from the most eastern channel relative to samples from the western channel (Figure 8.1), which

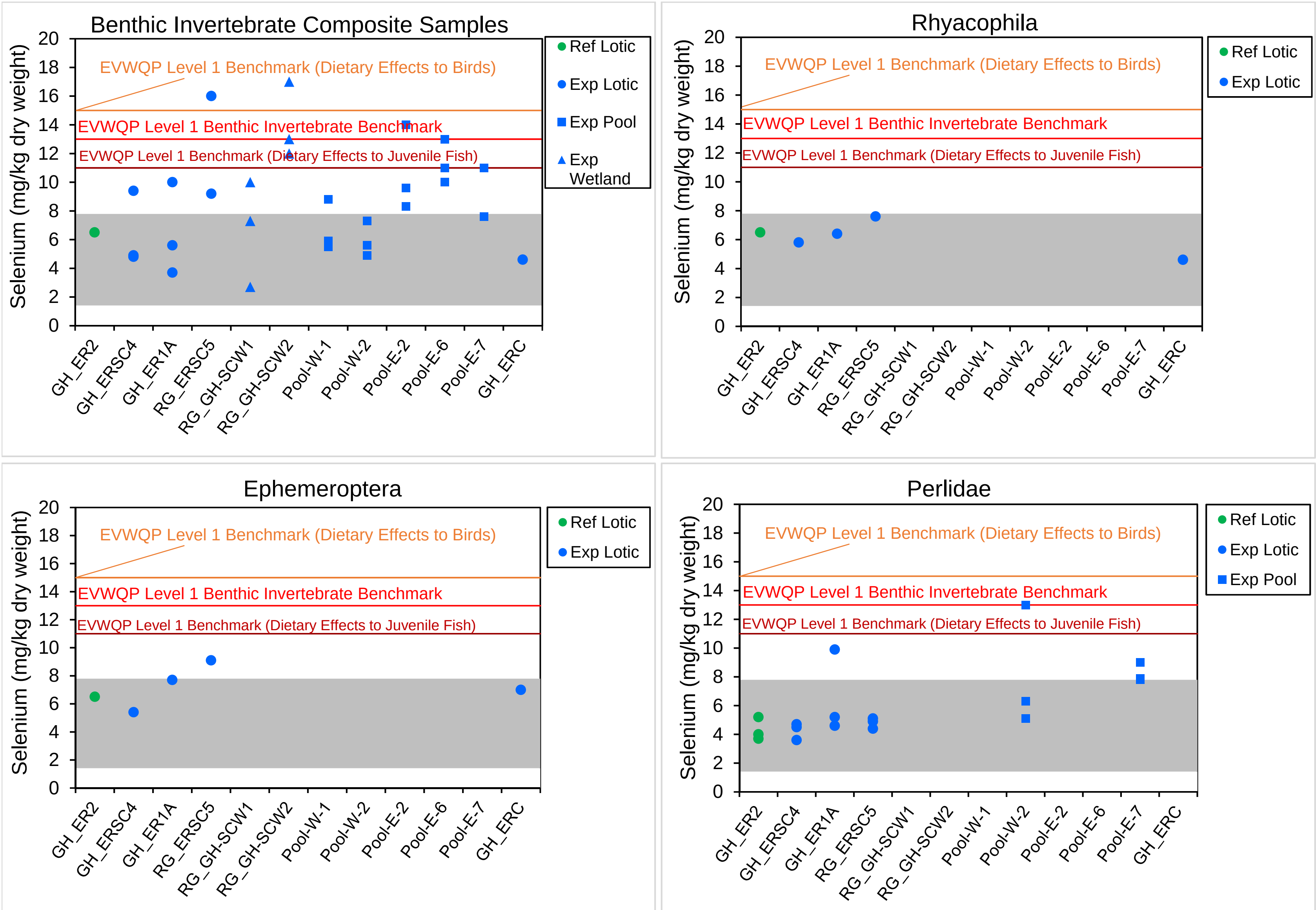

Figure 8.1: Selenium Concentrations in Benthic Invertebrate Samples, 2017

Note: Gray shading represents the reference area normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area (pooled 1996 to 2015 data) reported in the RAEMP (Minnow 2018). Benchmarks and the reference area normal range were calculated for community composite samples, but are provided on taxa-specific samples for comparison.

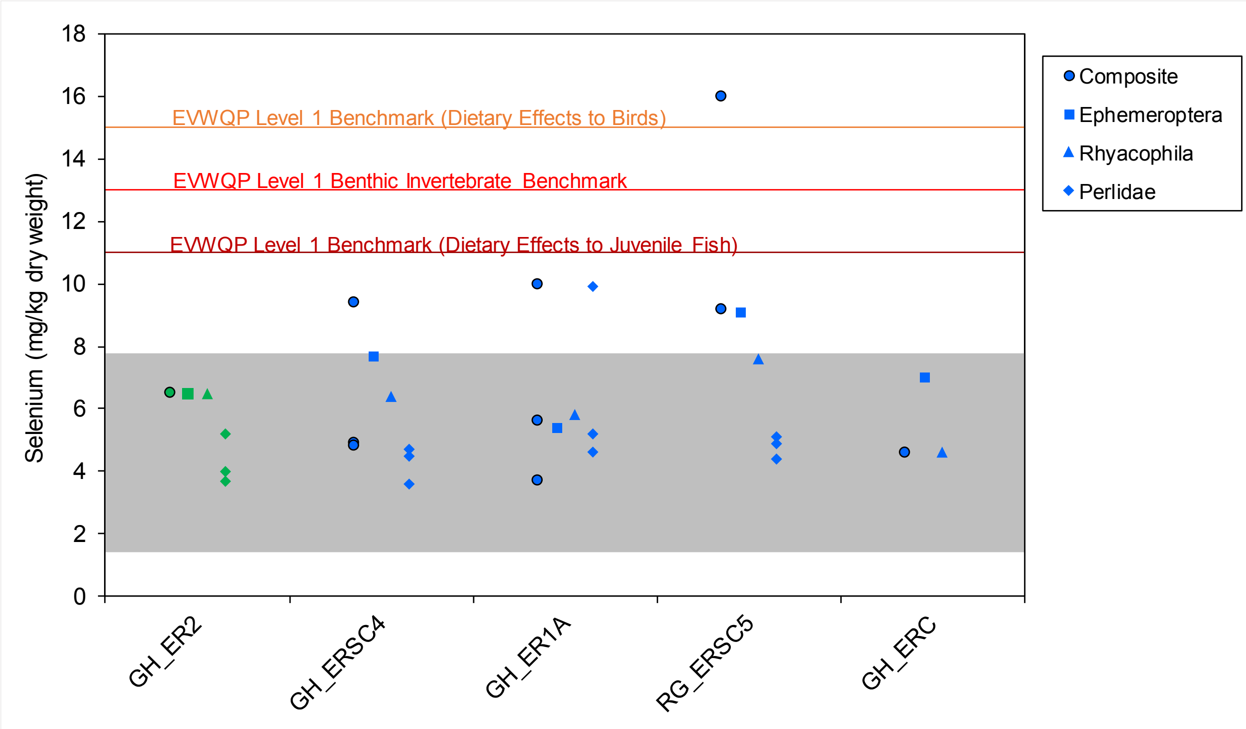

Figure 8.2: Selenium Concentrations in Benthic Invertebrate Samples, 2017

Note: Gray shading represents the reference area normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area (pooled 1996 to 2015 data) reported in the RAEMP (Minnow 2018). Benchmarks and the reference area normal range were calculated for community composite samples. Reference sites are shown in green.

corresponds with the patterns observed in water quality (Figure 4.5), but not sediment quality (Figure 5.2).

Concentrations of selenium in tissues were similar at the downstream main stem station (GH_ERC) and the mainstem reference station (GH_ER2), suggesting no influence on benthic invertebrates downstream of the side channel, despite relatively higher concentrations occurring in benthic invertebrates within the side channel (Figure 8.1 and 8.2).

Benthic invertebrate tissue selenium data collected for the 2017 GHO LAEMP were evaluated relative to the EVWQP selenium bioaccumulation model (Golder 2018b). Generally, the 2017 GHO LAEMP data were within the scatter of data used to create the model (Figure 8.3).

8.3 Fish Tissue Selenium

Extensive effort was given to fishing the side channel (Sections 7.3 and 7.4), but only a single fish was caught that was the correct size and species to sample for tissue. The single bull trout muscle sample had a selenium concentration of 5.9 mg/kg dw, which was well below the EVWQP Level 1 effect benchmark (Teck 2014a).

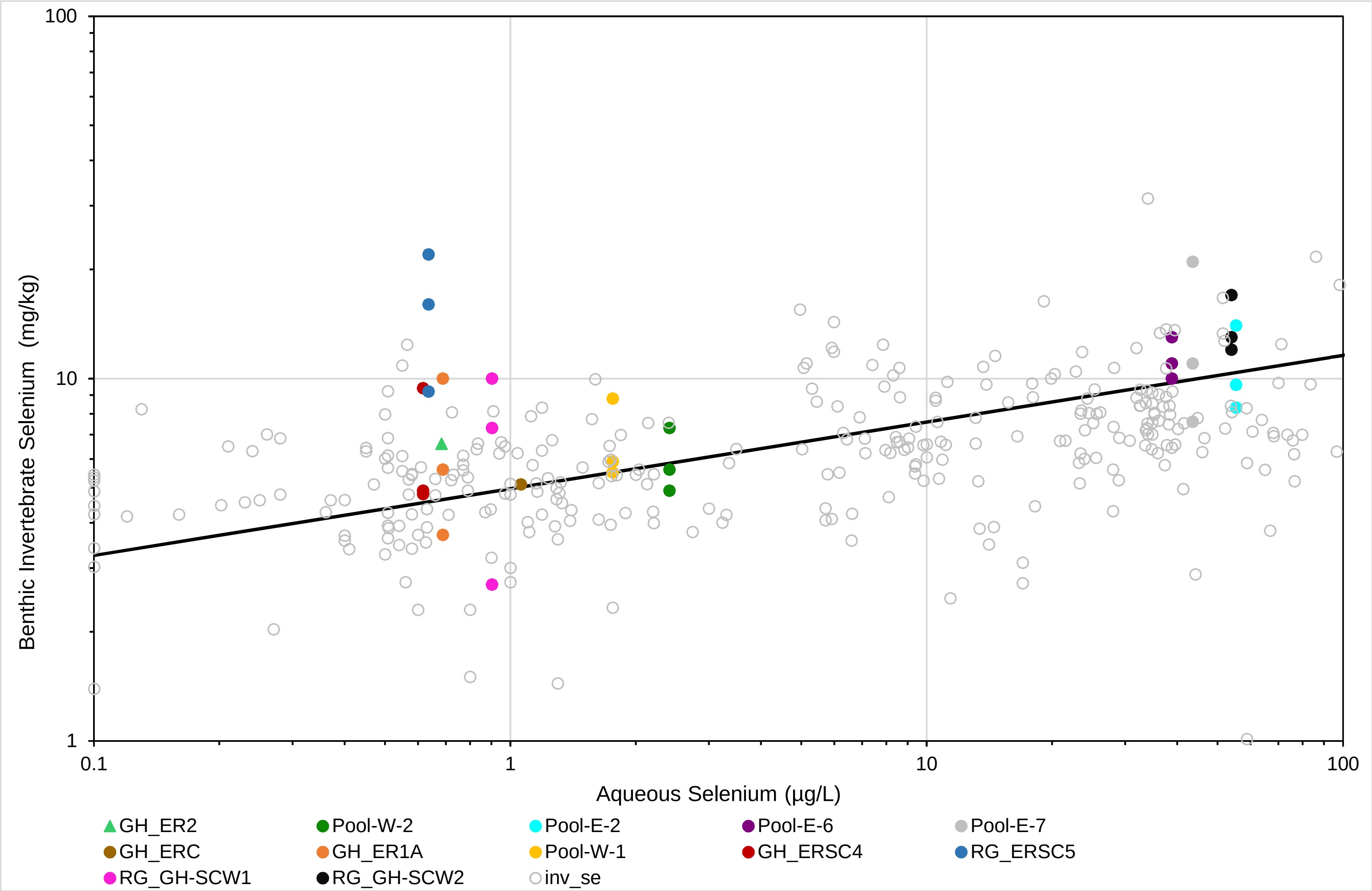

Figure 8.3: Observed and Modelled[a] Selenium Concentrations in Benthic Invertebrate Composite Samples Relative to Aqueous Selenium Concentrations At Stations Upstream and Downstream of Greenhills Operations, September 2017

Modelled Benthic Invertebrate Selenium Concentration

[a] Benthic invertebrate selenium concentrations were estimated using a one-step water to benthic invertebrate selenium accumulation model: $\log_{10}[Se]_{benthicinvertebrate}=0.696+0.184x\log_{10}[Se]_{aq}$ (Golder 2018).

Note: Triangles indicate reference stations and circles indicate mine-exposed stations.

9 BENTHIC INVERTEBRATE COMMUNITY AND BIOMASS

9.1 Overview

Data evaluated in this section pertain to key question #3.d (Section 1.2):

What are the effects of GHO discharges from the west-side tributaries on biota (i.e., fish, amphibians, aquatic-feeding birds) in the Elk River and the Elk River side channel?

d. What are benthic invertebrate community compositions and biomass along the side channel? How do benthic invertebrate community compositions compare between perennially wetted and seasonally isolated wet areas?

Benthic invertebrate community samples were collected using kick and sweep (Appendix Table F.3) as well as Hess (Appendix Table F.4) methods for perennially wetted main stem stations GH_ER2 and GH_ERC, and for side channel stations GH_ERSC4, GH_ER1A, and RG_ERSC5.

9.2 Community

Benthic invertebrate community endpoints determined from kick and sweep samples were compared to the normal range (Figure 9.1). Total abundance, richness, % EPT and % Ephemeroptera (% E) were within or above the normal range at all stations/areas. Community endpoints also did not differ greatly between perennially-wetted main stem stations GH_ER2 and GH_ERC, and seasonally-isolated side channel stations GH_ERSC4, GH_ER1A, and RG_ERSC5. % E and % EPT were the same upstream (GH_ER2) and downstream (GH_ERC) of the side channel, while total abundance and richness were slightly higher downstream (Figure 9.1), suggesting minimal (if any) influence of the west side tributaries/side channel on main stem benthic invertebrate communities.

Comparison of the composition of major benthic invertebrate taxonomic groups among mine-exposed and reference areas indicated that proportions were generally consistent between areas (Figure 9.2 and 9.3). Proportions were also generally consistent among perennially wetted stations (GH_ER2 and GH_ERC) and seasonally wetted stations (GH_ERSC4, GHER1A, and GH_ERSC5), except for a greater proportion of Coleoptera in samples from the seasonally wetted stations (Figure 9.2 and 9.3). Proportions were also similar between sample methods (Figures 9.2 and 9.3). Overall, the data suggest that the benthic invertebrate communities in the side channel and at the main stem location downstream of the side channel are not adversely affected by mine-related discharges.

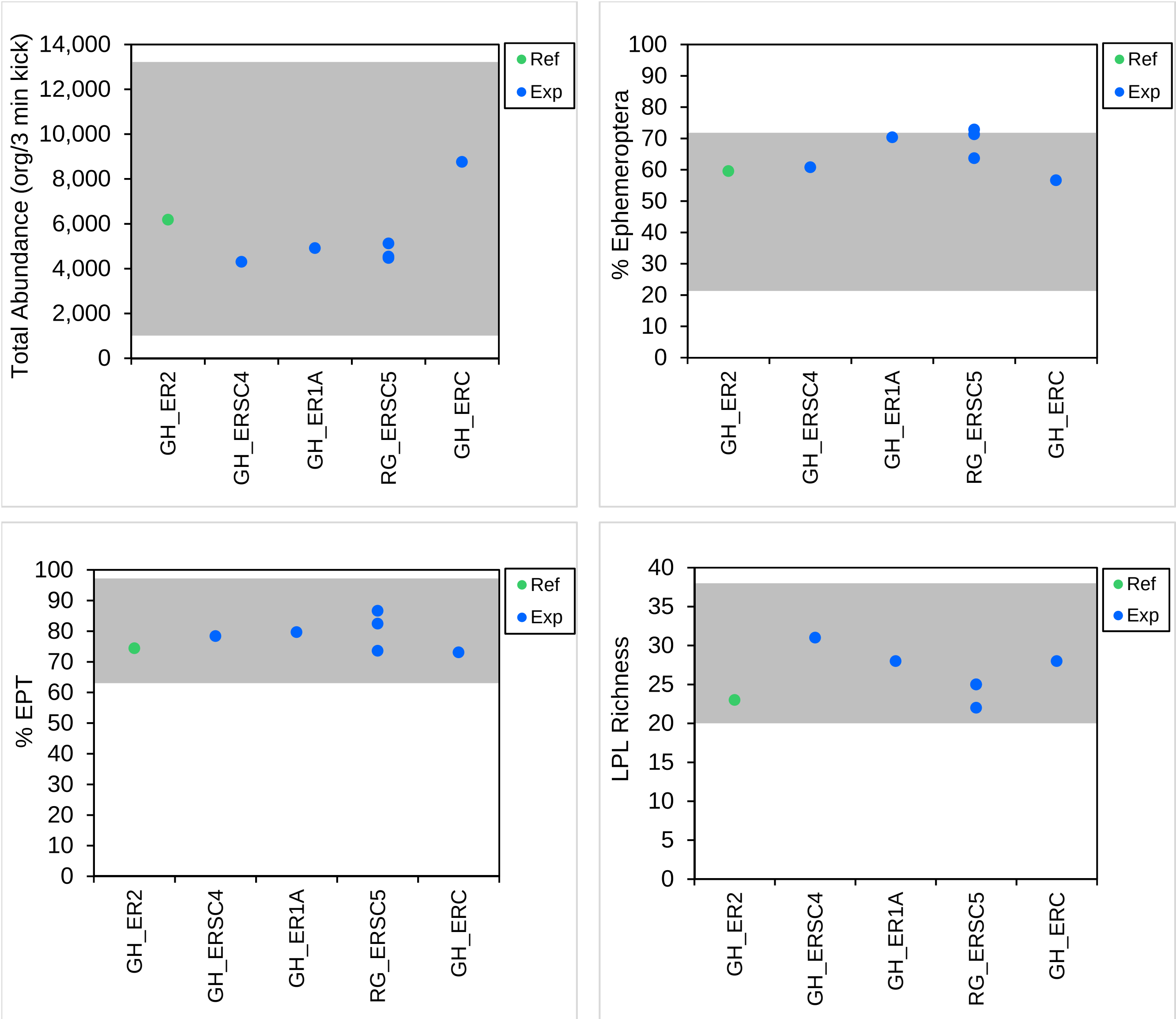

Figure 9.1: Key Benthic Invertebrate Community Endpoints for Reference and Mine-exposed Areas Collected by the CABIN Kick and Sweep Method, Relative to the Normal Range, 2017

Note: Gray shading represents the reference area normal range defined as the 2.5th and 97.5th percentiles of the distribution of reference area (pooled 2012 and 2015 data) reported in the RAEMP (Minnow 2018).

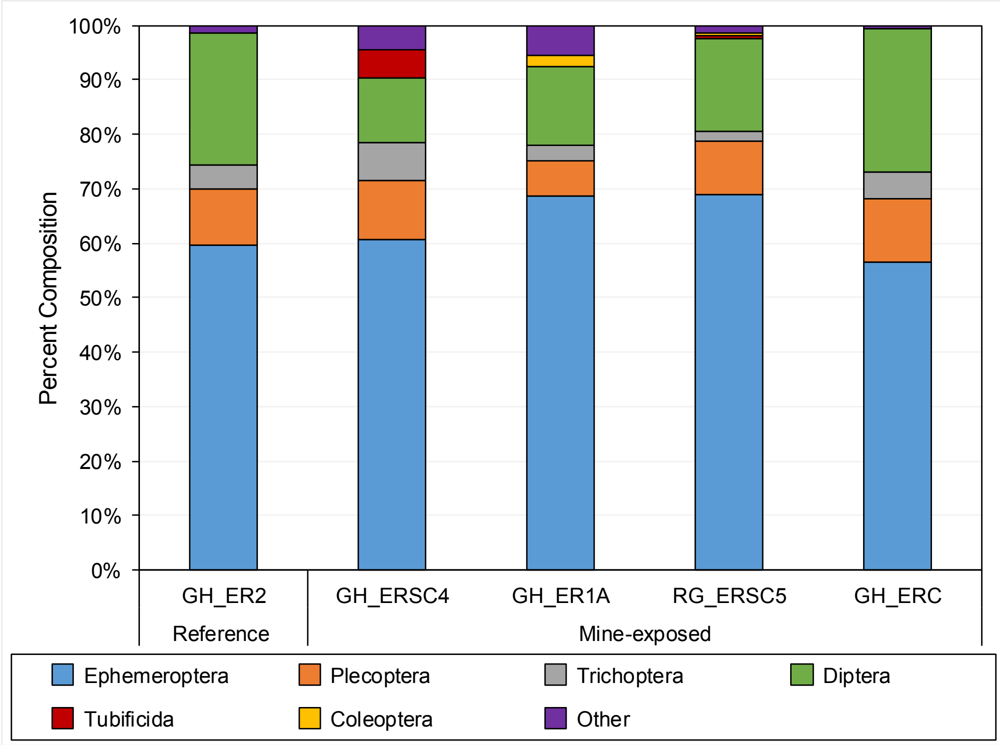

Figure 9.2: Percent Composition of Major Benthic Invertebrate Taxonomic Groups among Reference and Mine-exposed Areas using the CABIN Kick and Sweep Method, September 2017

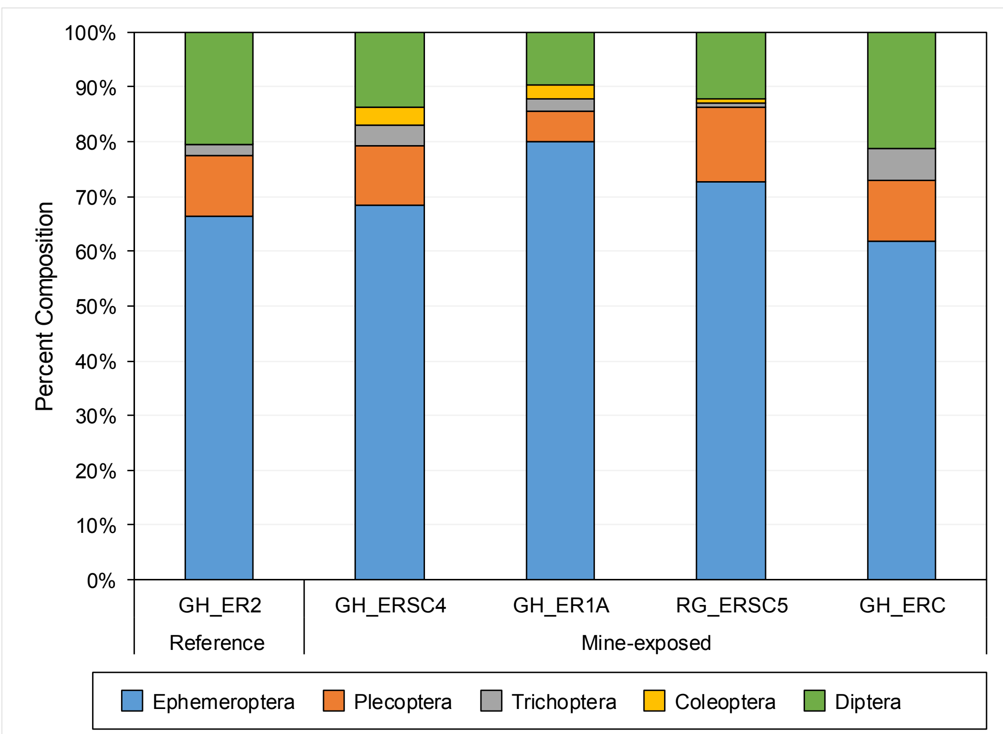

Figure 9.3: Percent Composition of Major Benthic Invertebrate Taxonomic Groups among Reference and Mine-exposed Areas using Hess Sampling, September 2017

9.3 Biomass and Density

Benthic invertebrate total biomass and density were determined for Hess samples (Figure 9.4). Side channel biomass and density means were lower than the mean for the upstream main stem reference station GH_ER2, while the downstream main stem station GH_ERC means were greater than reference. The ranges of biomass values generally overlapped for all stations. The ranges of density values were smaller for side channel stations compared to the main stem stations. The ranges of density values at the three side channel station overlapped with the GH_ER2 range, but were lower than the GH_ERC range. Biomass and density at the side channel stations are likely lower due to the seasonality of the side channel, with these three stations becoming dry for several months of the year (Section 3.2, Appendix Figures A.1 to A.8). Overall, the data suggest that benthic invertebrate biomass and density in the side channel and at GH_ERC are not adversely affected by mine-related discharges.

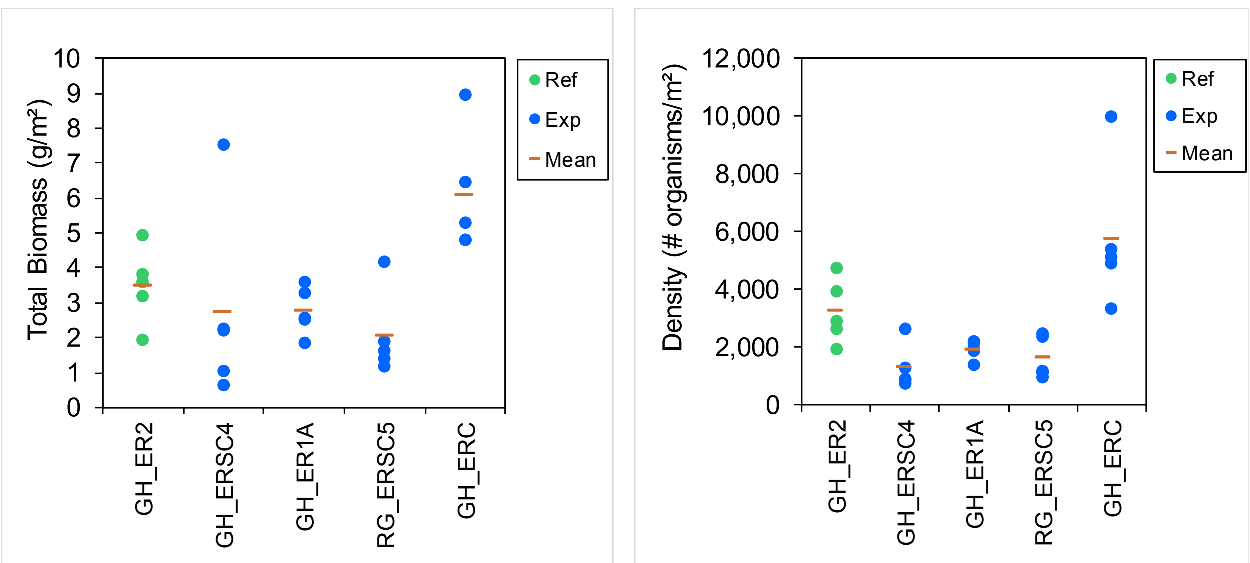

Figure 9.4: Total Biomass and Density of Benthic Invertebrates for Reference and Mine-exposed Areas Collected by Hess Sampling, 2017

10 INTEGRATED SUMMARY AND RECOMMENDATIONS

The Elk River side channel was observed to undergo substantial seasonal flooding and braiding, with highly variable flow throughout the year. Portions of the side channel flow went sub-surface during low flow periods, resulting in isolated surface pools with different water quality and biological characteristics than in flowing portions. Hydrology surveys and water quality assessments suggested that the side channel flow was predominantly influenced by the Elk River itself, rather than the tributaries, with the exception of the side channel wetland at the mouth of Thompson Creek.

Within the side channel and its floodplain complex, surveys were completed to identify and document habitat and occurrences of aquatic-dependent biota. Fish spawning habitat was limited downstream of the side channel wetland, but was abundant in parts of the side channel upstream of the wetland. Overwintering habitat was present only in the side channel wetland and potentially one isolated pool (Pool-E-7). Habitat surveys indicated that limited lentic habitat was available for amphibians during the spring, as much of the side channel and floodplain complex were flooded and flowing. During summer and fall, and lentic amphibian habitat was provided by the side channel wetland, with additional limited habitat provided by ephemeral isolated pools that typically persisted for less than a month. During this time, the side channel complex was dry. Habitat was available for aquatic-feeding birds in the side channel and floodplain complex from spring to fall. Surveys for aquatic-dependent biota determined that the side channel was being used by a variety of fish (bull trout, eastern brook trout, longnose sucker, mountain whitefish, and westslope cutthroat trout), amphibians (Columbia spotted frog, western toad), and birds (American dipper, mallard).

Water quality and sediment quality were compared between main stem Elk River, Elk River side channel, and isolated pools. Discharges from the west-side tributaries contributed to higher concentrations of Order constituents (i.e., dissolved cadmium, nitrate, total selenium, and sulphate) and total nickel in water in the downstream main stem Elk River (GH_ERC); however, concentrations measured at GH_ERC were well below EVWQP Level 1 benchmarks (cadmium, nitrate, selenium, and sulphate) and preliminary IC_{25} values for nickel. Water quality at side channel stations GH_ER1A and GH_ERSC2 was influenced by Wolfram and Thompson creeks. Water quality in pools was highly dependent on location, with the highest concentrations of Order constituents occurring in pools in the eastern-most channel downstream of the wetland. The highest concentrations of Order constituents occurred in the side channel wetland (receives flow directly from Thompson Creek). Sediment quality data suggested limited influence of mine-related discharges on sediment chemistry in the side channel and the main stem location downstream of the side channel.

Effects of the side channel and discharges from the west-side tributaries on aquatic health were assessed using benthic invertebrate and fish tissue chemistry (selenium), and benthic invertebrate community structure and biomass endpoints. Some benthic invertebrate tissue selenium samples collected from RG_ERSC5, RG_GH-SCW2, Pool-E-2, and Pool-E-6 were above the EVWQP Level 1 benchmarks for either benthic invertebrates, dietary effects to juvenile fish, and/or dietary effects to birds, with highest concentrations measured in the samples collected at RG_GH-SCW2. RG_GH-SCW2 is in the side channel wetland and is directly influenced by Thompson Creek. Concentrations of selenium in benthic invertebrate tissues were similar at the downstream main stem station and the main stem reference station, suggesting no influence of the side channel on benthic invertebrate tissue selenium downstream of the side channel, despite higher concentrations observed in benthic invertebrates within the side channel. Selenium was only measured in a single fish (bull trout) tissue sample collected in the side channel, with concentrations well below effect thresholds. Results for the benthic invertebrate community structure, biomass, and abundance data were similar in the side channel and the main stem location downstream of the side channel, and were within normal range, indicating that communities were not adversely affected by mine-related discharges.

Overall, the results indicated that the west-side tributaries had no effect on biota in the main stem Elk River, and minimal effects on biota within the Elk River side channel, side channel wetland, and isolated pools. The key questions associated with the GHO LAEMP will be updated in the 2018 to 2020 study design, and the program will continue to assess relevant site-specific issues, as required, until sufficient data have been collected, concerns no longer exist, or monitoring can be incorporated into the RAEMP.

The following recommendations are made for the 2018 to 2020 GHO LAEMP study design:

- Design the program to address AMP Management Questions #2 (currently worded as "Will aquatic ecosystem health be protected by meeting the long-term site performance objectives?") and #5 (currently worded as "Does monitoring for mine-related effects indicate that the aquatic ecosystem is healthy?").
- Conduct an additional year of surface water hydrology monitoring to better understand the connection between the west-side tributaries, Elk River side channel, and main stem Elk River;
- Conduct an additional year of vertebrate surveys throughout the side channel to characterize use by biota;
- Continue to assess surface water quality;

- Assess the interaction between surface water and groundwater in the Elk River side channel using data from the GHO Annual Groundwater Study. Update the GHO Groundwater monitoring program to address any data gaps relating to the GHO LAEMP.
- Monitor benthic invertebrate community structure and tissue chemistry in the side channel and main stem Elk River over time.
- Complete an in-depth assessment of the side channel wetland (to be conducted as part of the Lentic Area Supporting Study; Minnow 2018b).

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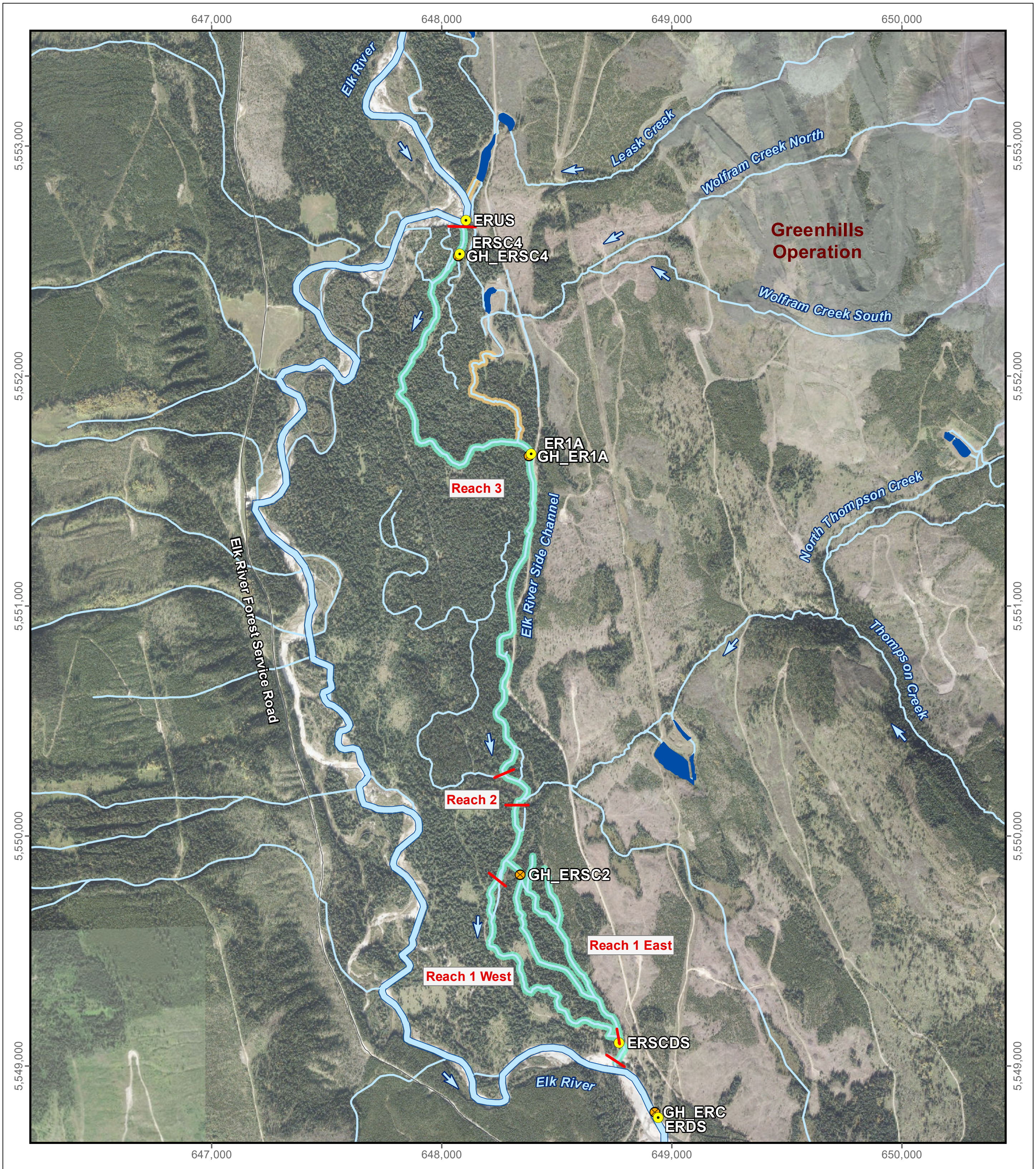
APPENDIX A

HYDROLOGY



LEGEND

- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Wetted channel
- Dry channel
- Settling pond

Elk River Side Channel Wet and Dry Locations, May to July 2017

0 375 750 1,500 Meters

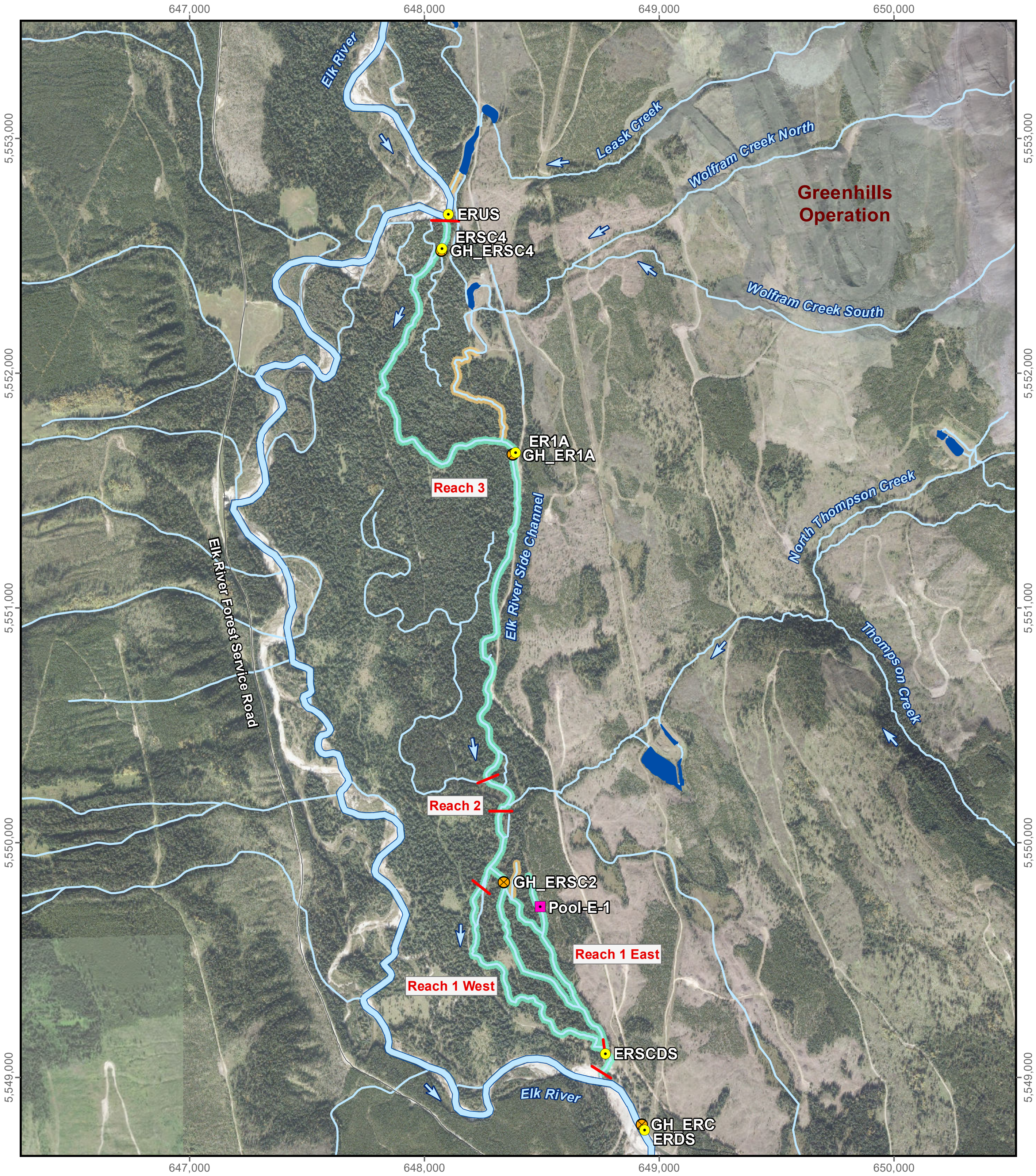
Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

minnow environmental inc.

Figure A.1

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.1 Elk Side Channel Wet and Dry.mxd



LEGEND

- Pool, water quality sampling
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, August 2017

0 375 750 1,500 Meters

N W E S

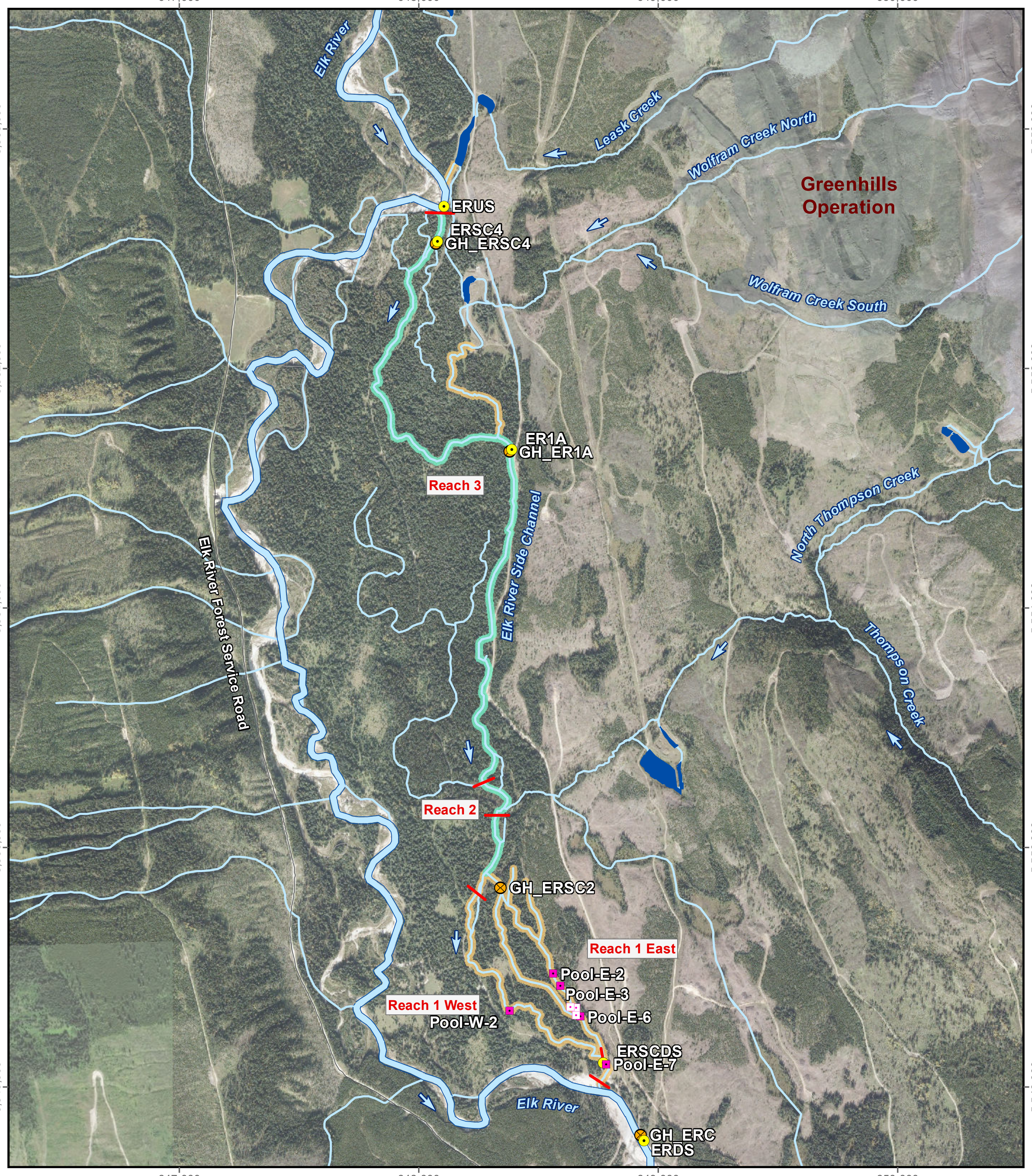
Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

minnow environmental inc.

Figure A.2

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.2 Elk Side Channel Wet and Dry.mxd



LEGEND

- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, September 2017

0 375 750 1,500 Meters

N W E S

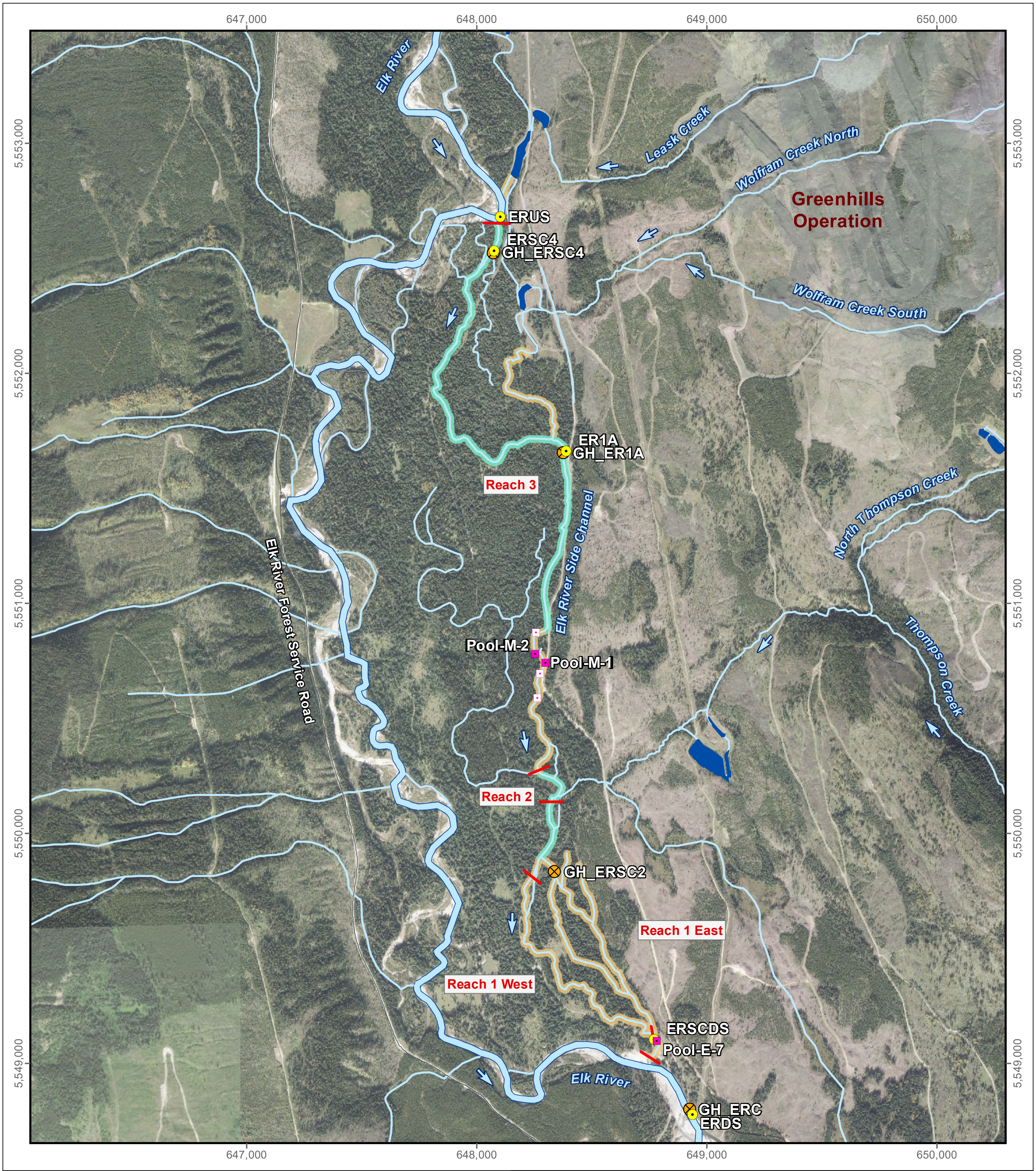
Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

minnow environmental inc.

Figure A.3

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.3 Elk Side Channel Wet and Dry.mxd



LEGEND

- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, October 2017

0 0.4 0.8 1.6 km

Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

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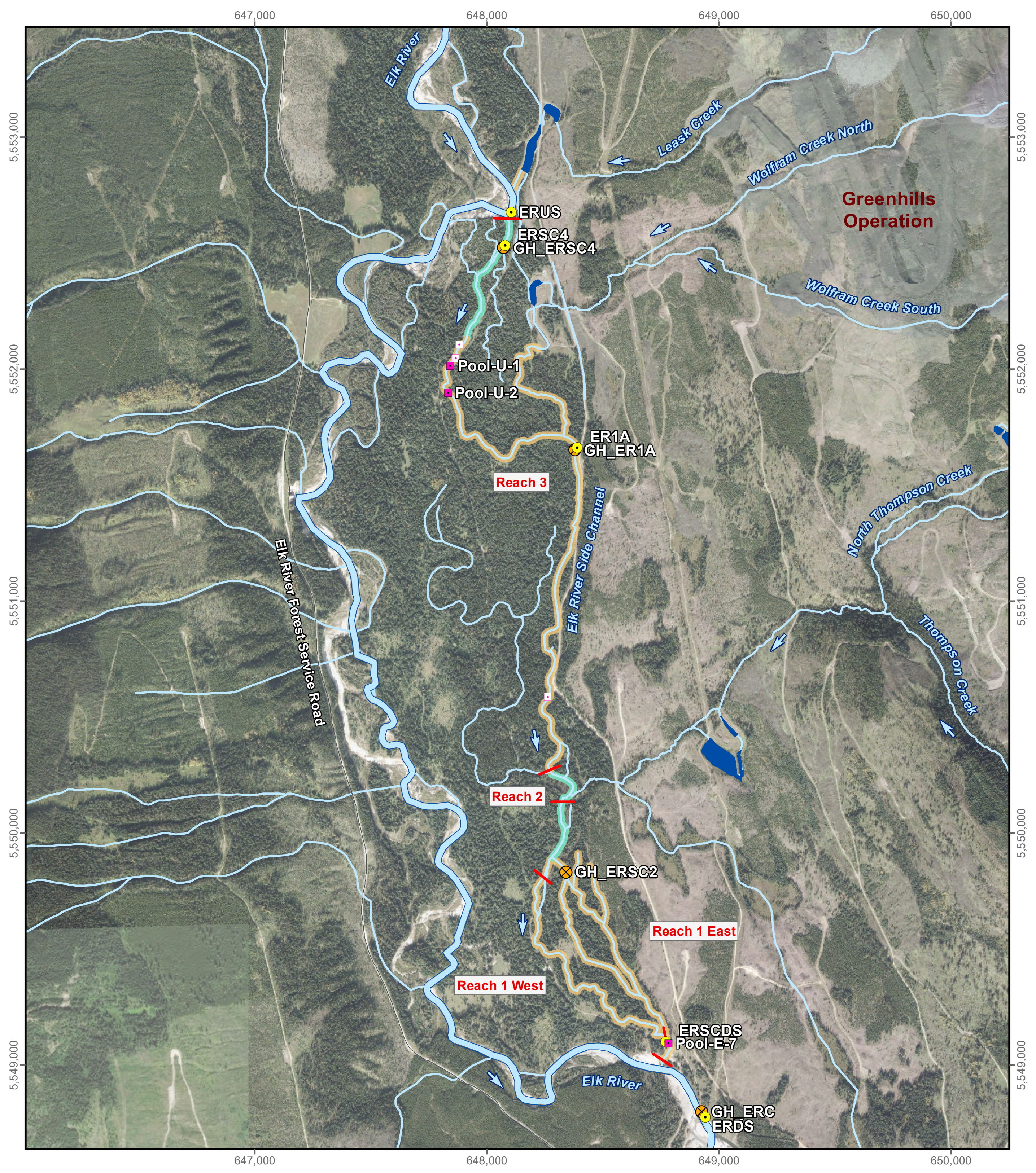
Figure A.4

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.4 Elk Side Channel Wet and Dry.mxd



LEGEND

- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, November 2017

0 375 750 1,500 Meters

N E S W

Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

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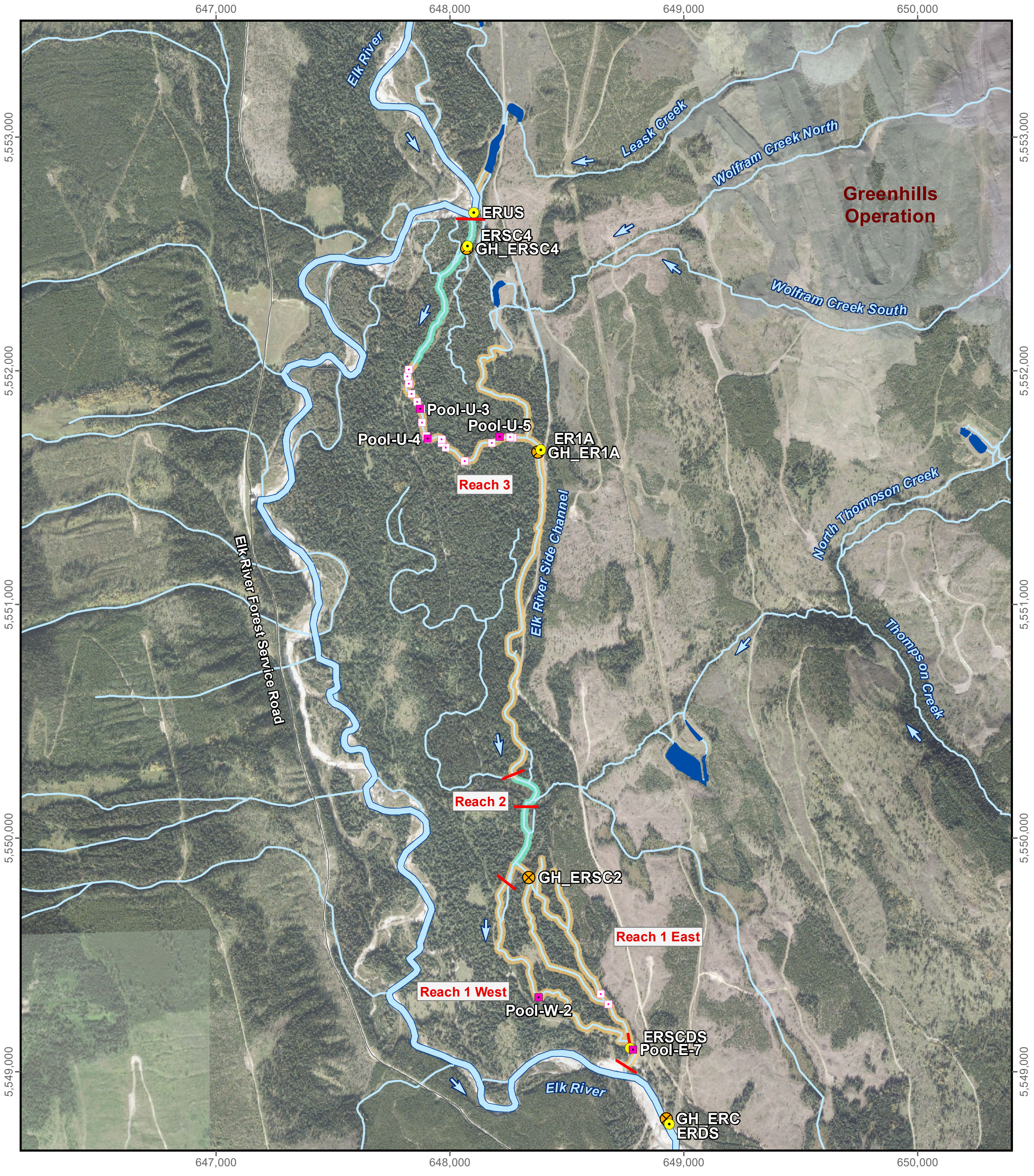
Figure A.5



LEGEND

- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, December 2017

0 375 750 1,500 Meters

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N
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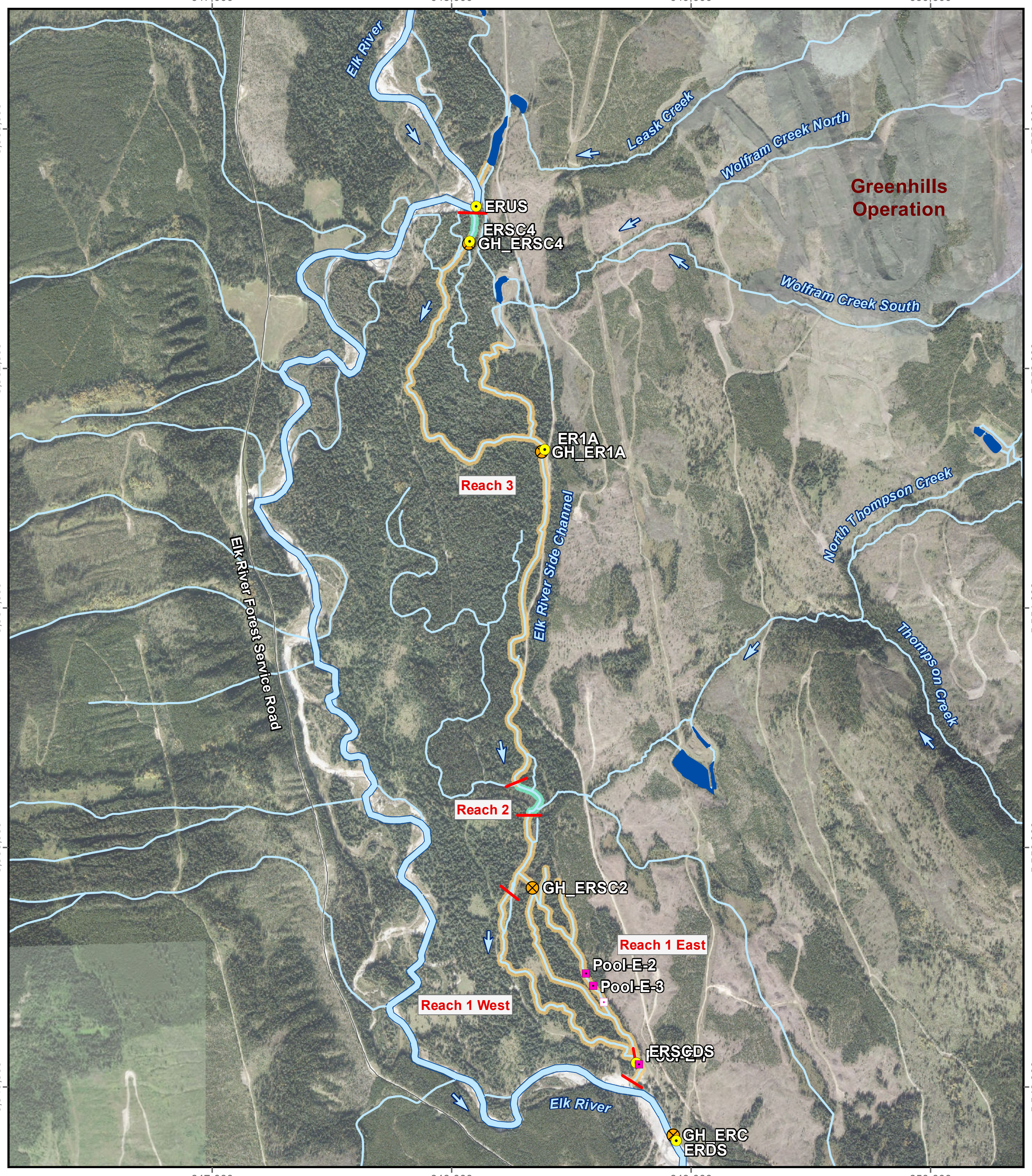
Figure A.6

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.6 Elk Side Channel Wet and Dry.mxd



LEGEND

- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Reach break
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, January 2018

0 0.4 0.8 1.6 km

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

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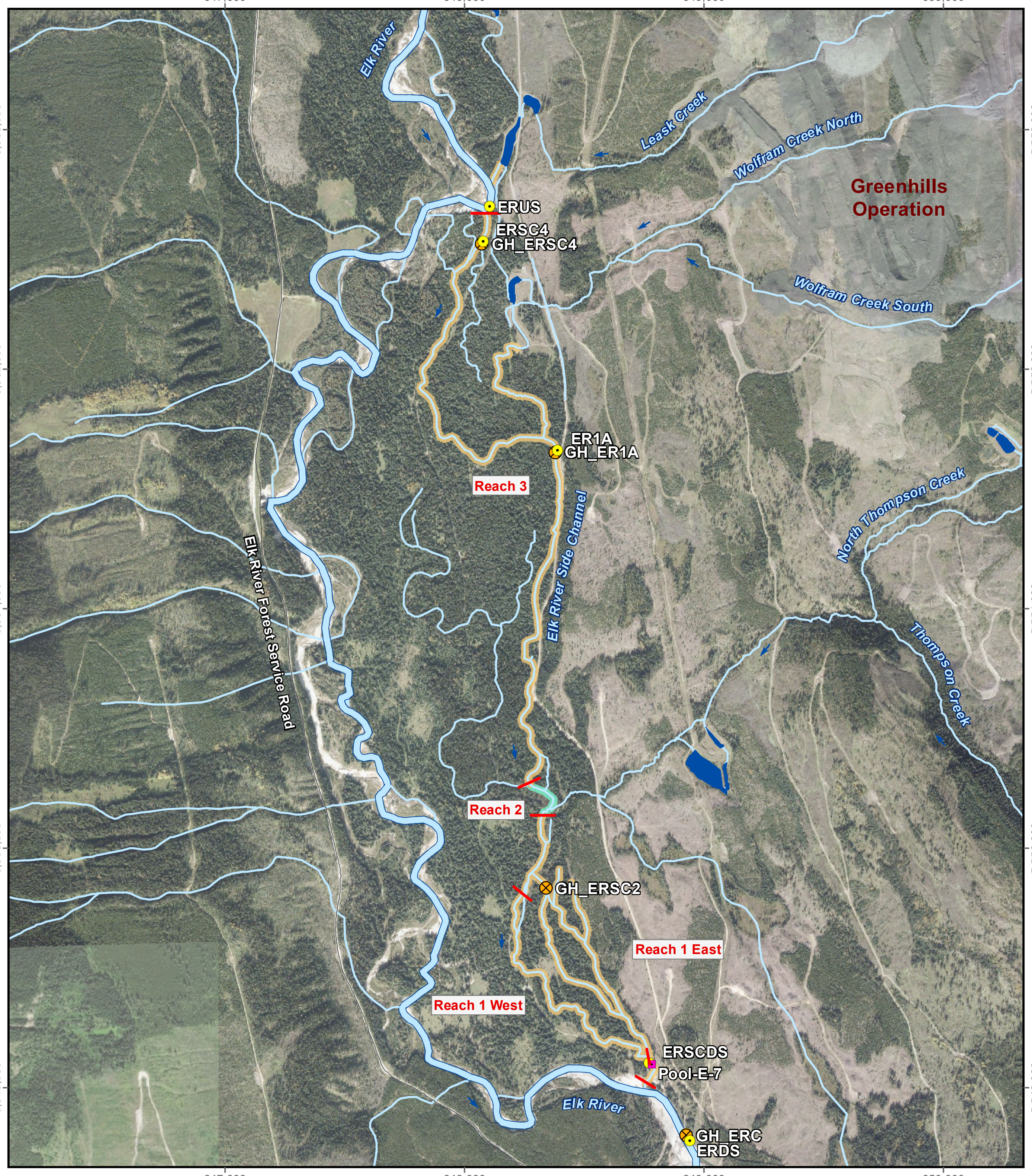
Figure A.7

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.7 Elk Side Channel Wet and Dry.mxd



LEGEND

- Reach break
- Pool, water quality sampling
- Pool
- Water level and temperature loggers, flow monitoring
- Routine water quality monitoring stations (Permit 107517), Mine-exposed
- Settling pond
- Wetted channel
- Dry channel

Elk River Side Channel Wet and Dry Locations, February to March 2018

0 375 750 1,500 Meters

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N

Date: May 2018
Project 177202.0024

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Figure A.8

Document Path: S:\Projects\177202\177202.0024 - Teck 2017 GHO LAEMP Implementation\6 - GIS\Report\17-24 Fig A.8 Elk Side Channel Wet and Dry.mxd

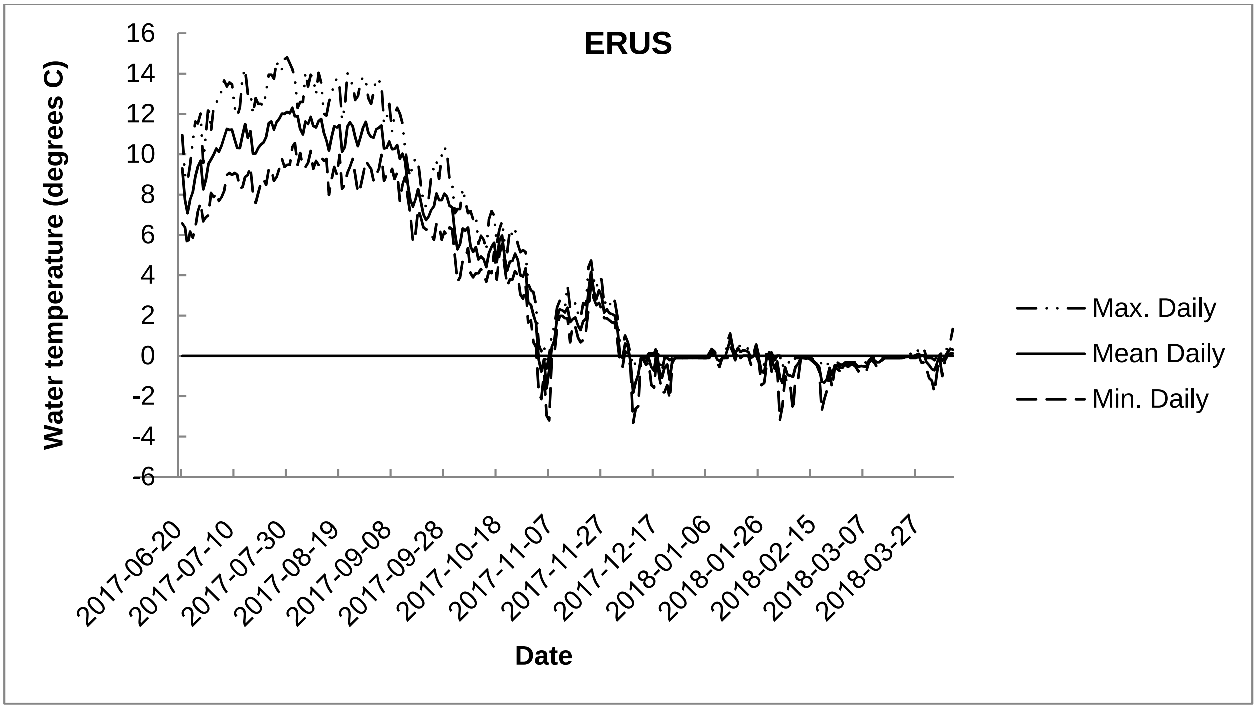

Figure A.9: Water Temperature Record for ERUS

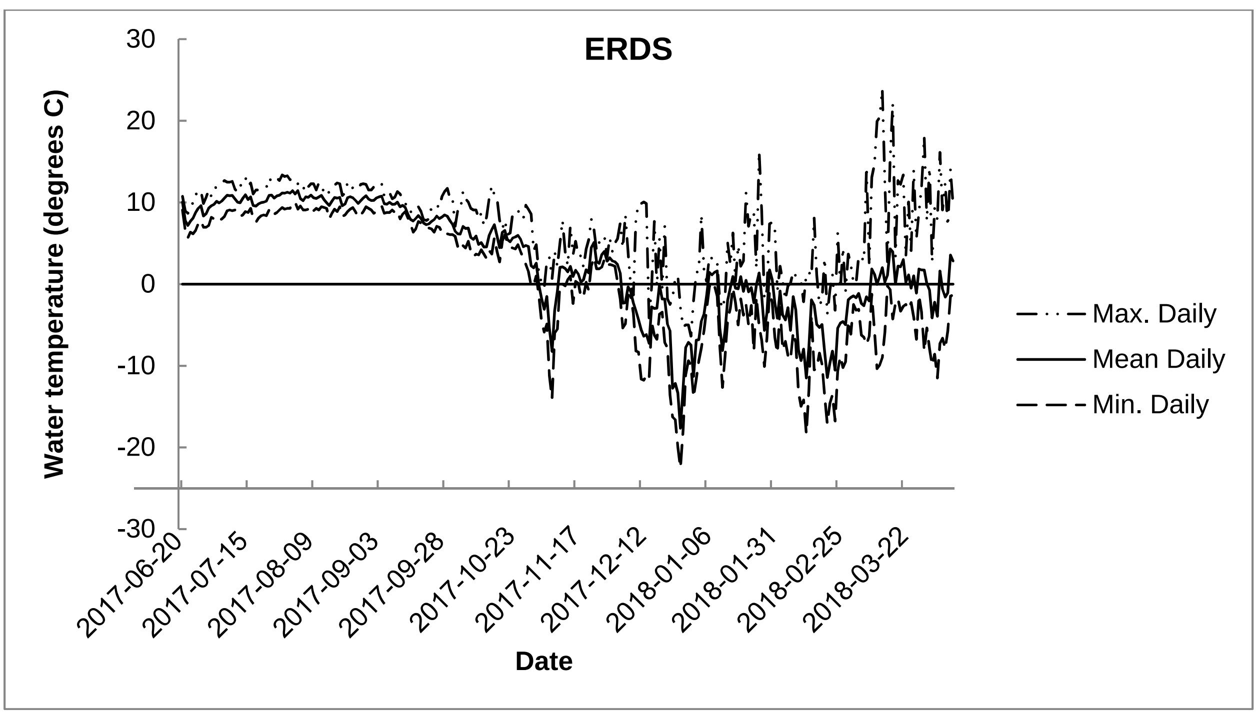

Figure A.10: Water Temperature Record for ERDS

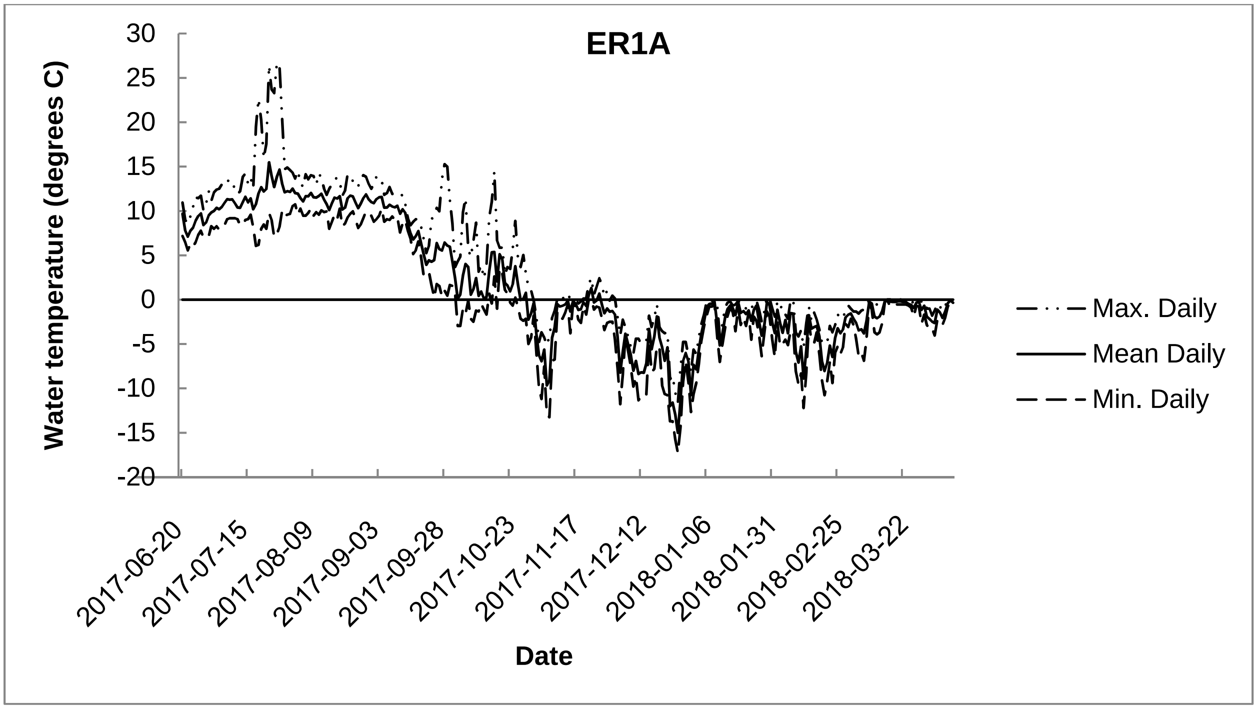

Figure A.11: Water Temperature Record for ER1A

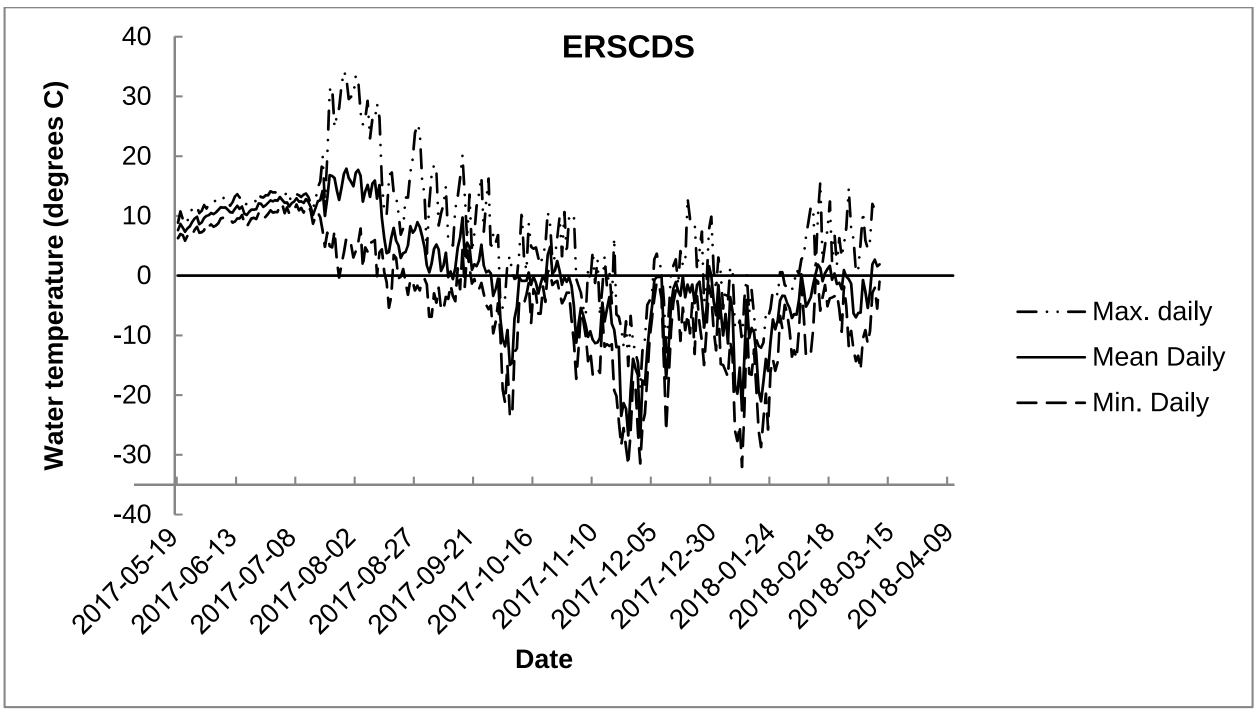

Figure A.12: Water Temperature Record for ERSCDS

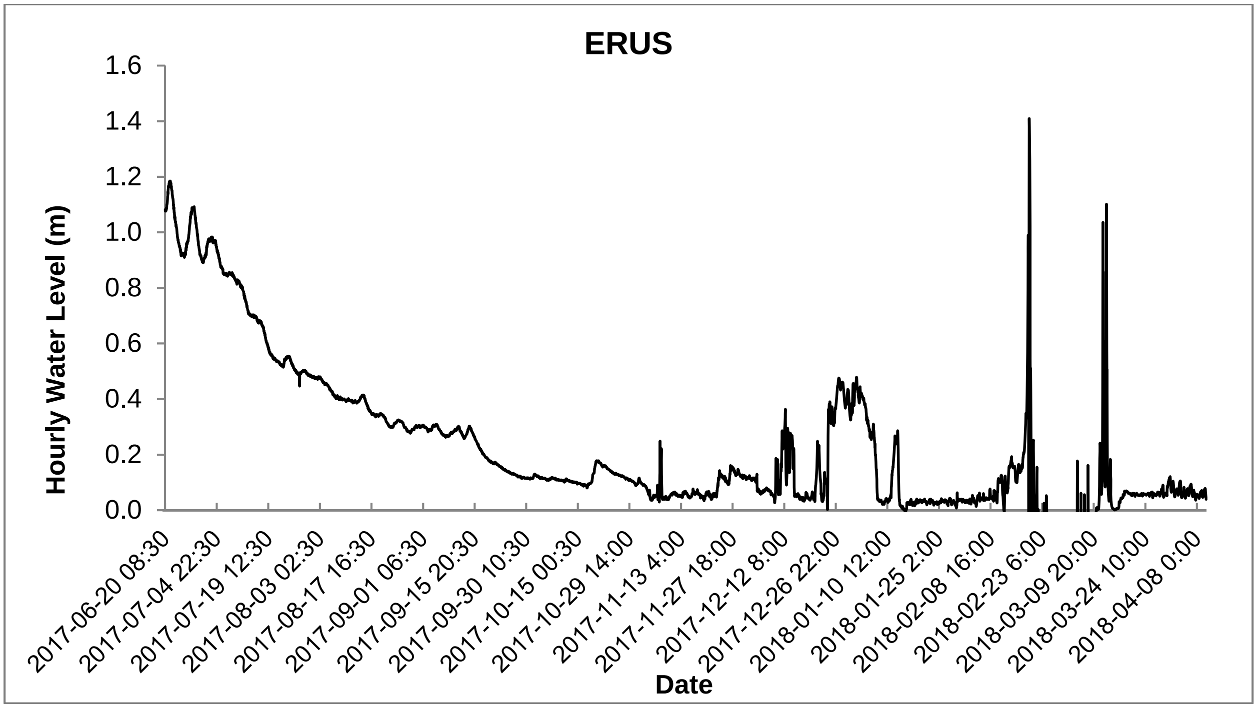

Figure A.13: Water Stage Record for ERUS

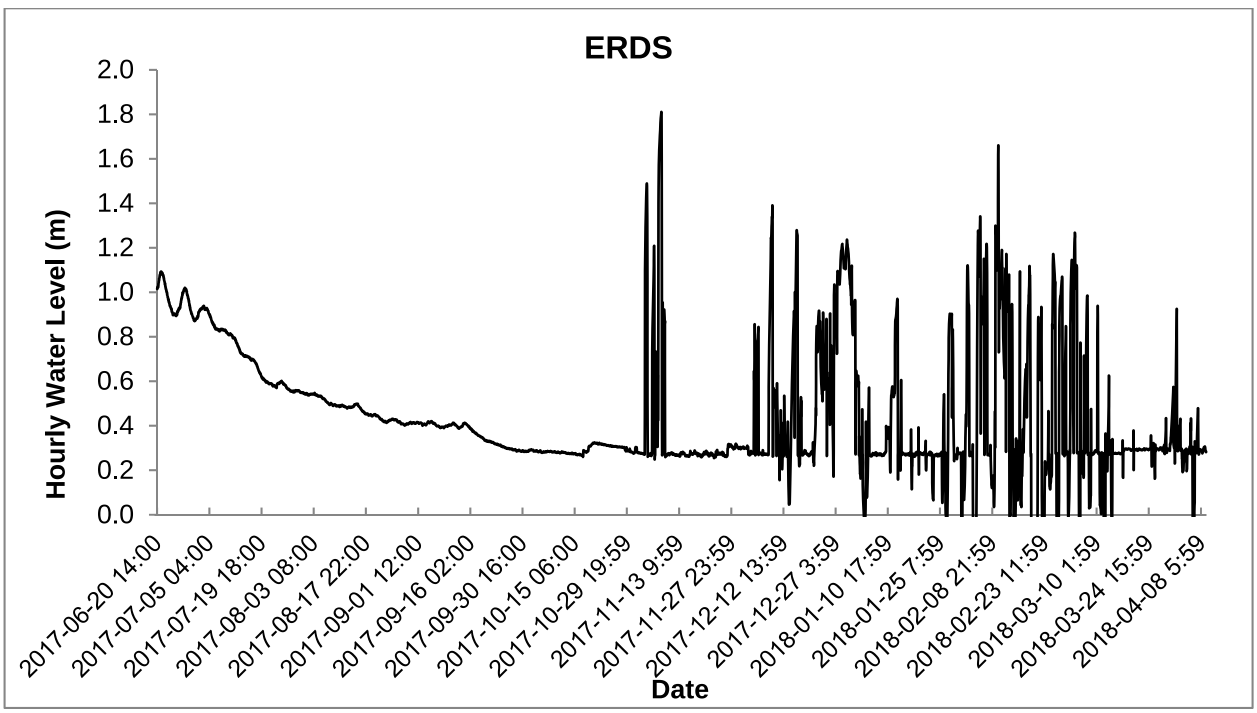

Figure A.14: Water Stage Record for ERDS

APPENDIX B

WATER QUALITY

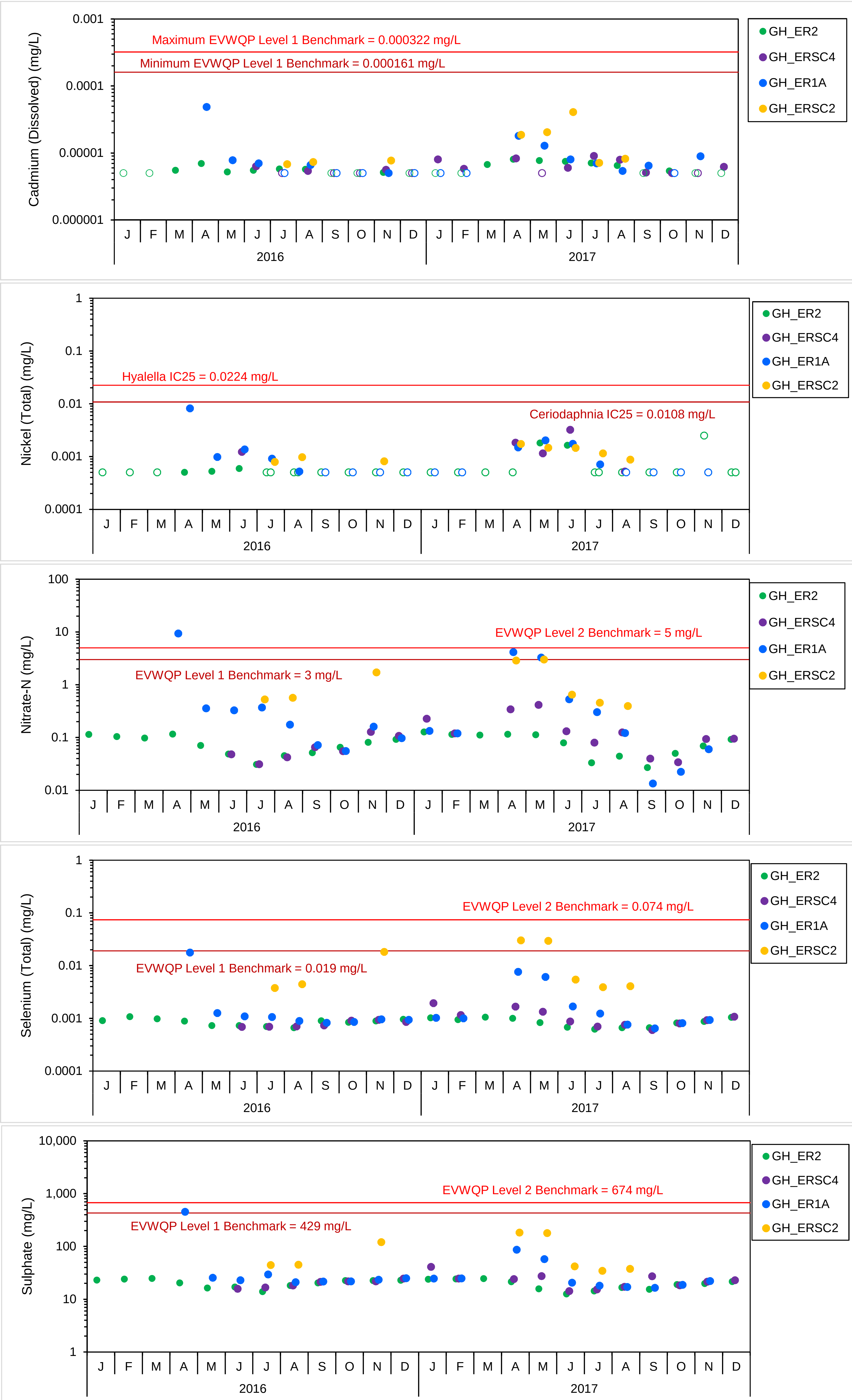

Figure B.1: Temporal Plots of Monthly Mean Concentrations at Side Channel Monitoring Stations (GH_ERSC4, GH_ER1SA, GH_ERSC2) and the Main Stem Elk River Reference Station (GH_ER2), 2016 to 2017

Note: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means. Data points are horizontally staggered within each month to allow overlapping points to be differentiated.

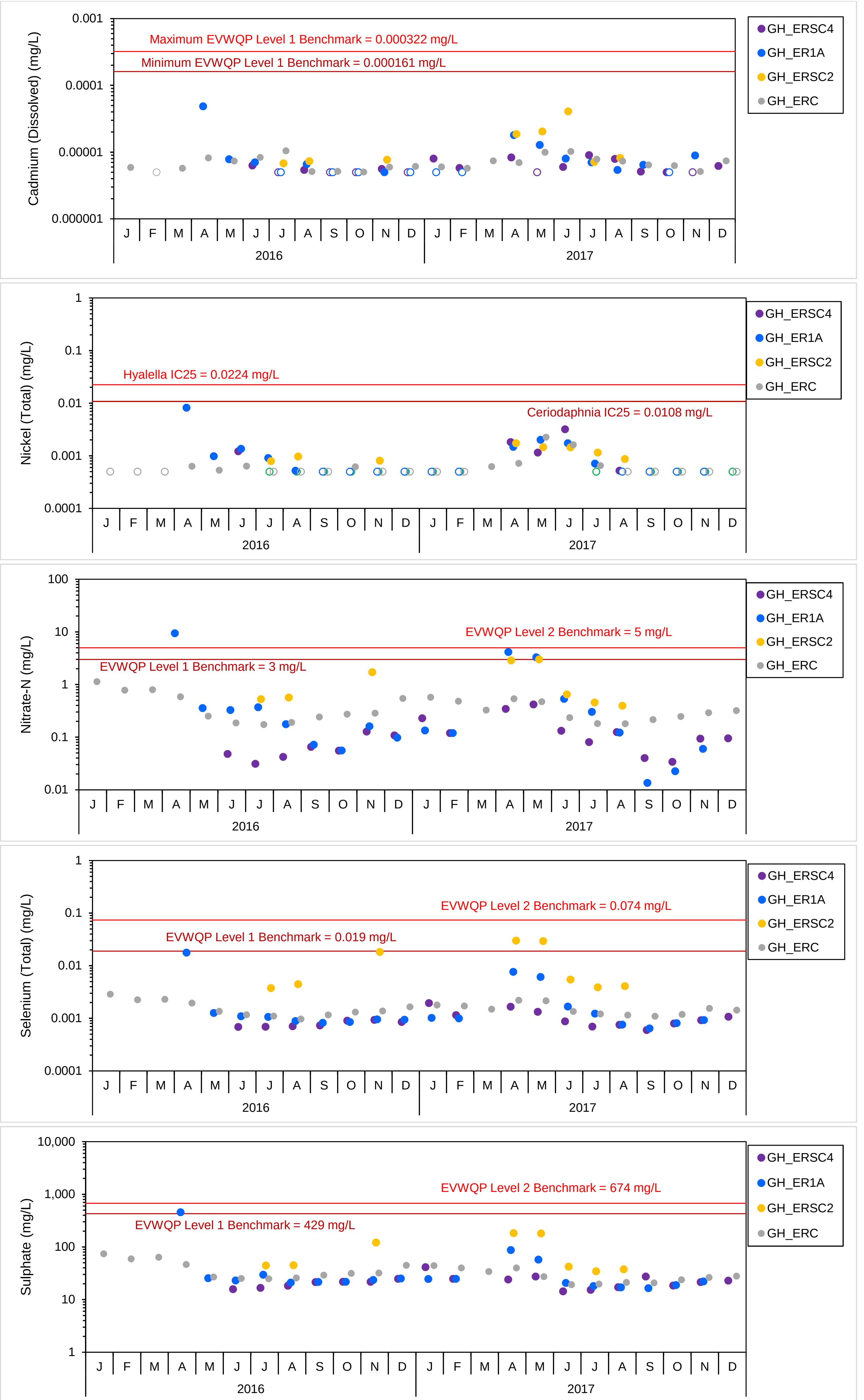

Figure B.2: Temporal Plots of Monthly Mean Concentrations at Side Channel Monitoring Stations(GH_ERSC4, GH_ER1SA, GH_ERSC2) and the Downstream Main Stem Elk River Station (GH_ERC), 2016 to 2017

Note: Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Minimum and maximum EVWQP benchmarks represent the range of benchmark values based on hardness for all monthly means. Data points are horizontally staggered within each month to allow overlapping points to be differentiated.

Table B.1: Identification used for GHO Pool Sampling Locations

Location Description	Water Station ID[1]	GHO LAEMP Report ID[2]	UTM (11U)	
			Easting	Northing
Side channel upstream of GH_ER1A	RG_GH-SC3-P7	Pool-U-1	647843	5552016
	RG_GH-SC3-P6	Pool-U-2	647833	5551900
	RG_GH-SC3-P10	Pool-U-3	647873	5551838
	RG_GH-SC3-P9	Pool-U-4	647906	5551710
	RG_GH-SC3-P8	Pool-U-5	648214	5551721
Side channel downstream of GH_ER1A, upstream of Thompson wetland	RG_GH-SC3-P3	Pool-M-1	648299	5550743
	RG_GH-SC3-P4	Pool-M-2	648255	5550781
Western channel downstream of Thompson wetland	RG_GH-SC1-P2	Pool-W-1	648253	5549846
	RG_GH-SC1-P1	Pool-W-2	648380	5549321
Eastern channel downstream of Thompson wetland	RG_GH-SC2-P4	Pool-E-1	648492	5549728
	RG_GH-SC2-P1	Pool-E-2	648561	5549475
	RG_GH-SC2-P5	Pool-E-3	648592	5549424
	RG_GH-SC2-P2	Pool-E-6	648675	5549296
	RG_GH-SC2-P3	Pool-E-7	648782	5549097

[1] Identification used in Teck's EQuIS[TM] database.
[2] Identification used throughout this report.

Table B.2: ***In Situ*** **Water Quality Measurements at Elk River and Side Channel Stations, GHO LAEMP, September 2017**

Characteristics	Reference	Mine-Exposed			
	GH_ER2	**GH_ERSC4**	**GH_ER1A**	**GH_ERSC5**	**GH_ERC**
Date	10-Sep-17	08-Sep-17	09-Sep-17	09-Sep-17	10-Sep-17
Station Type	main stem	side channel	side channel	side channel	main stem
Temperature (°C)	6.68	8.21	8.46	7.89	5.84
Specific Conductivity (uS/cm)	273	285	284	285	310
Conductivity (uS/cm)	177	193	194	192	196
pH	7.89	7.46	7.79	7.74	7.71
Dissolved Oxygen (mg/L)	9.71	10.51	10.35	9.58	12.9
Dissolved Oxygen (%)	80.0	89.2	88.4	80.8	103.3

Table B.3: ***In Situ*** **Water Quality Measurements at Wetladn Stations and Isolated Pools,**

Characteristics	Mine-Exposed						
	RG_GH-SCW1	**RG_GH-SCW2**	**Pool-W-1**	**Pool-W-2**	**Pool-E-2**	**Pool-E-6**	**Pool-E-7**
Date	16-Sep-17	16-Sep-17	11-Sep-17	11-Sep-17	11-Sep-17	12-Sep-17	12-Sep-17
Station Type	wetland	wetland	side channel	pool	pool	pool	pool
Temperature (°C)	2.90	3.48	6.56	7.23	6.92	9.12	8.32
Specific Conductivity (uS/cm)	290	1,856	298	310	1,049	912	893
Conductivity (uS/cm)	168	1,111	193	205	687	599	608
pH	7.90	8.07	7.58	7.62	7.30	7.28	7.19
Dissolved Oxygen (mg/L)	14.61	13.52	12.53	13.6	8.4	8.93	7.58
Dissolved Oxygen (%)	108.7	102.8	103.0	112.0	69.3	73.5	64.5

Table B.4: Statistical Comparisons of Aqueous Cadmium, Nitrate, Total Selenium, and Sulphate Concentrations between Stations Located Upstream (GH_ER2) and Downstream (GH_ERC) of Mine Activities, Elk River, 2016 to 2017

Parameter	Units	Mean or Median[a]				H_{01}: Is the difference between the downstream concentrations and upstream concentrations equal in all years?		H_{02}: Is the downstream concentration equal to the upstream concentration?			Magnitude of Difference (Downstream - Upstream/Downstream) (mean or median[a])	
		2016		2017		Test for Relative Difference between Areas (Downstream - Upstream River) Between Years		Test for Relative Difference Between Areas (Downstream - Upstream River) = 0			%[b]	
								Test	P-value[b]			
		EH_ERC	GH_ER2	EH_ERC	GH_ER2	Test	P-value		2016	2017	2016	2017
Cadmium (Dissolved)	mg/L	0.00000593	0.00000516	0.00000713	0.00000595	2 sample t	0.743	1 sample t	<0.001		19	
Nitrate-N	mg/L	0.280	0.07623	0.307	0.0861	MW	0.671	WSRT	<0.001		260	
Selenium (Total)	mg/L	0.00137	0.0008836	0.00146	0.000849	MW	0.977	WSRT	<0.001		61	
Sulphate	mg/L	31.58	21.57	26.72	19.49	MW	0.026	WSRT	<0.001	0.002	46	34

[shaded] P-value < 0.05.

[a] Means reported when t-test was conducted and medians when MW test was conducted; t = t-test; MW = Mann Whitney test.

[b] Results reported separately by year when the test for H_{01} was significant.

APPENDIX C
SUBSTRATE QUALITY

Table C.1: Sediment Quality in Lotic Areas and Associated Summary Statistics

	Analyte	Units	MDL	BC Sediment Quality Guidelines [a]		Reference							
						GH_ER2							
				Lower SQG	Upper SQG	GH_ER2-1	GH_ER2-2	GH_ER2-3	Minimum	Median	Maximum	Mean	Standard Deviation
						10-Sep-17	10-Sep-17	10-Sep-17					
Physical Tests	Moisture	%	0.25	-	-	56.5	46.9	51.7	46.9	51.7	56.5	51.7	4.8
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	2.9	6.7	<1.0	<1.0	2.9	6.7	3.53	2.53
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	2.9	22.2	10.3	2.9	10.3	22.2	11.8	9.74
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	6.1	8.6	18.3	6.1	8.6	18.3	11	6.44
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	13.1	7.9	8.7	7.9	8.7	13.1	9.9	2.8
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	30.2	21.3	25.1	21.3	25.1	30.2	25.5	4.47
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	36.4	27.1	30.4	27.1	30.4	36.4	31.3	4.71
	% Clay (<4 µm)	%	1.0	-	-	7.5	6.0	6.4	6.0	6.4	7.5	6.63	0.777
	Texture	-		-	-	Silt loam	Sandy loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	4.96	3.7	5.57	3.7	4.96	5.57	4.74	0.954
Metals	Aluminum (Al)	mg/kg	50	-	-	5,100	4,360	4,490	4,360	4,490	5,100	4,650	395
	Antimony (Sb)	mg/kg	0.10	-	-	0.35	0.5	0.48	0.35	0.48	0.5	0.443	0.0814
	Arsenic (As)	mg/kg	0.10	5.9	17	4.28	5.09	4.79	4.28	4.79	5.09	4.72	0.41
	Barium (Ba)	mg/kg	0.50	-	-	114	98.2	111	98.2	111	114	108	8.39
	Beryllium (Be)	mg/kg	0.10	-	-	0.43	0.44	0.45	0.43	0.44	0.45	0.44	0.01
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	6.9	5.2	<5.0	<5.0	5.2	6.9	5.7	1.13
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	0.889	0.702	0.899	0.702	0.889	0.899	0.83	0.111
	Calcium (Ca)	mg/kg	50	-	-	63,600	78,600	59,800	59,800	63,600	78,600	67,300	9,940
	Chromium (Cr)	mg/kg	0.50	37.3	90	14.6	12.7	13.6	12.7	13.6	14.6	13.6	0.95
	Cobalt (Co)	mg/kg	0.10	-	-	4.19	3.57	4.25	3.57	4.19	4.25	4	0.376
	Copper (Cu)	mg/kg	0.50	35.7	197	10.5	8.74	11	8.74	10.5	11	10.1	1.19
	Iron (Fe)	mg/kg	50	21,200	43,766	10,700	10,400	11,200	10,400	10,700	11,200	10,800	404
	Lead (Pb)	mg/kg	0.50	35	91.3	7.00	5.88	7.17	5.88	7.00	7.17	6.68	0.701
	Lithium (Li)	mg/kg	2.0	-	-	9.1	7.7	8.2	7.7	8.2	9.1	8.33	0.709
	Magnesium (Mg)	mg/kg	20	-	-	12,700	12,000	11,500	11,500	12,000	12,700	12,100	603
	Manganese (Mn)	mg/kg	1.0	460	1,100	575	422	503	422	503	575	500	76.5
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0399	0.0258	0.0365	0.0258	0.0365	0.0399	0.0341	0.00736
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.15	1.35	1.21	1.15	1.21	1.35	1.24	0.103
	Nickel (Ni)	mg/kg	0.50	16	75	17.7	16.2	18.3	16.2	17.7	18.3	17.4	1.08
	Phosphorus (P)	mg/kg	50	-	-	1,190	1,240	1,200	1,190	1,200	1,240	1,210	27
	Potassium (K)	mg/kg	100	-	-	1,200	1,030	970	970	1,030	1,200	1,070	119
	Selenium (Se)	mg/kg	0.20	2	2	1.01	0.96	0.92	0.92	0.96	1.01	0.963	0.0451
	Silver (Ag)	mg/kg	0.10	0.5	-	0.16	0.14	0.17	0.14	0.16	0.17	0.157	0.0153
	Sodium (Na)	mg/kg	50	-	-	83	79	73	73	79	83	78.3	5.03
	Strontium (Sr)	mg/kg	0.50	-	-	103	116	98.2	98.2	103	116	106	9.21
	Sulfur (S)	mg/kg	1,000	-	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.166	0.15	0.162	0.15	0.162	0.166	0.159	0.00833
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	13.8	9.5	7.1	7.1	9.5	13.8	10.1	3.39
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.02	0.992	1.1	0.992	1.02	1.1	1.04	0.056
	Vanadium (V)	mg/kg	0.20	-	-	22.6	23.8	22.5	22.5	22.6	23.8	23	0.723
	Zinc (Zn)	mg/kg	2.0	123	315	78.9	71.5	80.1	71.5	78.9	80.1	76.8	4.66
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0060	<0.0050	<0.0050	<0.0050	<0.0050	<0.0060	<0.0060	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.018	0.014	0.011	0.011	0.014	0.018	0.0143	0.00351
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.020	<0.020	<0.010	<0.010	<0.020	<0.020	<0.020	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.041	0.033	0.024	0.024	0.033	0.041	0.0327	0.0085
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Fluoranthene	mg/kg	0.010	0.111	2.355	0.011	<0.010	<0.010	<0.010	<0.010	0.011	0.0103	-
	Fluorene	mg/kg	0.010	0.021	0.144	0.014	<0.010	0.011	<0.010	0.011	0.014	0.0117	0.002
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.107	0.065	0.053	0.053	0.065	0.107	0.075	0.0284
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.16	0.091	0.078	0.078	0.091	0.16	0.11	0.0441
	Naphthalene	mg/kg	0.010	0.0346	0.391	0.067	0.037	0.038	0.037	0.038	0.067	0.0473	0.017
	Perylene	mg/kg	0.010	-	-	0.023	<0.020	0.025	<0.020	0.023	0.025	0.0227	0.00133
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.143	0.096	0.071	0.071	0.096	0.143	0.103	0.0366
	Pyrene	mg/kg	0.010	0.053	0.875	0.013	<0.010	<0.010	<0.010	<0.010	0.013	0.011	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	78.7	75.7	81.7	75.7	78.7	81.7	78.7	3.0
	d12-Chrysene	%	-	-	-	82.1	82.9	91.7	82.1	82.9	91.7	85.6	5.33
	d8-Naphthalene	%	-	-	-	74.2	71.3	81.4	71.3	74.2	81.4	75.6	5.2
	d10-Phenanthrene	%	-	-	-	82.8	84.5	92.2	82.8	84.5	92.2	86.5	5.01
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
	IACR (CCME)	mg/kg	0.15	-	-	0.2	0.18	0.15	0.15	0.18	0.2	0.177	0.0252

[a] Working sediment quality guidelines (BC MOE 2015).

" - " = no data or standard deviation not estimated.

(blue shading) concentration exceeds lower SQG.

(grey shading) concentration exceeds upper SQG.

Table C.1: Sediment Quality in Lotic Areas and Associated Summary Statistics

Analyte		Units	MDL	BC Sediment Quality Guidelines [a]		Mine-exposed							
						GH_ERSC4							
				Lower SQG	Upper SQG	GH_ERSC4-1	GH_ERSC4-2	GH_ERSC4-3	Minimum	Median	Maximum	Mean	Standard Deviation
						08-Sep-17	08-Sep-17	08-Sep-17					
Physical Tests	Moisture	%	0.25	-	-	38.2	40.4	37.5	37.5	38.2	40.4	38.7	1.51
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	1.7	<1.0	<1.0	1.7	1.23	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	3.8	1.6	3.6	1.6	3.6	3.8	3	1.22
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	11.7	8.4	7.1	7.1	8.4	11.7	9.07	2.37
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	19.1	16.3	30.2	16.3	19.1	30.2	21.9	7.35
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	18	17.3	21.1	17.3	18	21.1	18.8	2.02
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	18.8	21.8	14.1	14.1	18.8	21.8	18.2	3.88
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	21.8	26.7	16.8	16.8	21.8	26.7	21.8	4.95
	% Clay (<4 µm)	%	1.0	-	-	6.3	7.3	5.3	5.3	6.3	7.3	6.3	1.0
	Texture	-		-	-	Sandy loam	Sandy loam	Sandy loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	4.42	3.74	3.46	3.46	3.74	4.42	3.87	0.494
Metals	Aluminum (Al)	mg/kg	50	-	-	5,210	5,730	5,430	5,210	5,430	5,730	5,460	261
	Antimony (Sb)	mg/kg	0.10	-	-	0.43	0.49	0.41	0.41	0.43	0.49	0.443	0.0416
	Arsenic (As)	mg/kg	0.10	5.9	17	4.79	5.57	4.73	4.73	4.79	5.57	5.03	0.469
	Barium (Ba)	mg/kg	0.50	-	-	105	115	109	105	109	115	110	5.03
	Beryllium (Be)	mg/kg	0.10	-	-	0.46	0.57	0.41	0.41	0.46	0.57	0.48	0.0819
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	<5.0	6	6.2	<5.0	6	6.2	5.73	0.133
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	0.695	0.842	0.65	0.65	0.695	0.842	0.729	0.10
	Calcium (Ca)	mg/kg	50	-	-	61,300	62,000	60,200	60,200	61,300	62,000	61,200	907
	Chromium (Cr)	mg/kg	0.50	37.3	90	13.6	15.6	13.6	13.6	13.6	15.6	14.3	1.15
	Cobalt (Co)	mg/kg	0.10	-	-	3.92	4.39	3.72	3.72	3.92	4.39	4.01	0.344
	Copper (Cu)	mg/kg	0.50	35.7	197	9.81	10.7	8.9	8.9	9.81	10.7	9.8	0.9
	Iron (Fe)	mg/kg	50	21,200	43,766	11,200	12,200	10,600	10,600	11,200	12,200	11,300	808
	Lead (Pb)	mg/kg	0.50	35	91.3	6.56	7.52	6.24	6.24	6.56	7.52	6.77	0.666
	Lithium (Li)	mg/kg	2.0	-	-	8.6	10	9.2	8.6	9.2	10	9.27	0.702
	Magnesium (Mg)	mg/kg	20	-	-	11,900	14,300	11,600	11,600	11,900	14,300	12,600	1,480
	Manganese (Mn)	mg/kg	1.0	460	1,100	346	432	319	319	346	432	366	59
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0257	0.0307	0.0271	0.0257	0.0271	0.0307	0.0278	0.00258
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.18	1.36	1.14	1.14	1.18	1.36	1.23	0.117
	Nickel (Ni)	mg/kg	0.50	16	75	16.6	19.2	15.6	15.6	16.6	19.2	17.1	1.86
	Phosphorus (P)	mg/kg	50	-	-	1,220	1,350	1,350	1,220	1,350	1,350	1,310	75
	Potassium (K)	mg/kg	100	-	-	1,110	1,220	1,220	1,110	1,220	1,220	1,180	64
	Selenium (Se)	mg/kg	0.20	2	2	0.65	0.87	0.67	0.65	0.67	0.87	0.73	0.122
	Silver (Ag)	mg/kg	0.10	0.5	-	0.14	0.16	0.12	0.12	0.14	0.16	0.14	0.02
	Sodium (Na)	mg/kg	50	-	-	75	79	75	75	75	79	76.3	2.31
	Strontium (Sr)	mg/kg	0.50	-	-	89.3	94.1	86.6	86.6	89.3	94.1	90	3.8
	Sulfur (S)	mg/kg	1,000	-	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.167	0.201	0.166	0.166	0.167	0.201	0.178	0.0199
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	10.8	11.6	11.4	10.8	11.4	11.6	11.3	0.416
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.03	1.11	0.954	0.954	1.03	1.11	1.03	0.078
	Vanadium (V)	mg/kg	0.20	-	-	23.3	26.7	23.8	23.3	23.8	26.7	24.6	1.84
	Zinc (Zn)	mg/kg	2.0	123	315	71	82.6	69.5	69.5	71	82.6	74.4	7.17
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.012	<0.010	0.022	<0.010	0.012	0.022	0.0147	0.00667
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.010	<0.010	<0.020	<0.010	<0.010	<0.020	<0.020	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.027	0.02	0.05	0.02	0.027	0.05	0.0323	0.0157
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Fluoranthene	mg/kg	0.010	0.111	2.355	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Fluorene	mg/kg	0.010	0.021	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.049	0.017	0.062	0.017	0.049	0.062	0.0427	0.0232
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.062	0.02	0.071	0.02	0.062	0.071	0.051	0.0272
	Naphthalene	mg/kg	0.010	0.0346	0.391	0.029	<0.010	0.04	<0.010	0.029	0.04	0.0263	0.00733
	Perylene	mg/kg	0.010	-	-	<0.020	<0.020	0.022	<0.020	<0.020	0.022	0.0207	0.00133
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.075	0.033	0.127	0.033	0.075	0.127	0.0783	0.0471
	Pyrene	mg/kg	0.010	0.053	0.875	<0.010	<0.010	0.012	<0.010	<0.010	0.012	0.0107	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	76.9	76.8	89.6	76.8	76.9	89.6	81.1	7.36
	d12-Chrysene	%	-	-	-	85.5	82.8	113.3	82.8	85.5	113	93.9	16.9
	d8-Naphthalene	%	-	-	-	73.6	73.3	81.3	73.3	73.6	81.3	76.1	4.53
	d10-Phenanthrene	%	-	-	-	81.7	81.2	98.9	81.2	81.7	98.9	87.3	10.1
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
	IACR (CCME)	mg/kg	0.15	-	-	0.16	<0.15	0.23	<0.15	0.16	0.23	0.18	0.0467

[a] Working sediment quality guidelines (BC MOE 2015).
" - " = no data or standard deviation not estimated.
(blue shading) concentration exceeds lower SQG.
(grey shading) concentration exceeds upper SQG.

Table C.1: Sediment Quality in Lotic Areas and Associated Summary Statistics

	Analyte	Units	MDL	BC Sediment Quality Guidelines [a]		Mine-exposed							
						GH_ER1A							
				Lower SQG	Upper SQG	GH_ER1A-1	GH_ER1A-2	GH_ER1A-3	Minimum	Median	Maximum	Mean	Standard Deviation
						09-Sep-17	09-Sep-17	09-Sep-17					
Physical Tests	Moisture	%	0.25	-	-	46.8	42.7	46.0	42.7	46	46.8	45.2	2.17
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	<1.0	3.7	<1.0	<1.0	<1.0	3.7	1.9	9.74
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	2.6	13.6	<1.0	<1.0	2.6	13.6	5.73	7.33
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	6.7	12.8	1.3	1.3	6.7	12.8	6.93	5.75
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	27.3	22.2	26	22.2	26	27.3	25.2	2.65
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	47	35.6	56	35.6	47	56	46.2	10.2
	% Clay (<4 µm)	%	1.0	-	-	15.4	11.8	15.8	11.8	15.4	15.8	14.3	2.2
	Texture	-		-	-	Silt loam	Silt loam	Silt	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	5.85	4.99	4.88	4.88	4.99	5.85	5.24	0.531
Metals	Aluminum (Al)	mg/kg	50	-	-	8,130	6,620	9,550	6,620	8,130	9,550	8,100	1,470
	Antimony (Sb)	mg/kg	0.10	-	-	0.61	0.57	0.69	0.57	0.61	0.69	0.623	0.0611
	Arsenic (As)	mg/kg	0.10	5.9	17	6.1	5.94	7.48	5.94	6.1	7.48	6.51	0.847
	Barium (Ba)	mg/kg	0.50	-	-	151	159	177	151	159	177	162	13.3
	Beryllium (Be)	mg/kg	0.10	-	-	0.58	0.58	0.66	0.58	0.58	0.66	0.607	0.0462
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	8.7	6	10.1	6	8.7	10.1	8.27	2.08
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	1.06	1.05	1.14	1.05	1.06	1.14	1.08	0.0493
	Calcium (Ca)	mg/kg	50	-	-	47,800	48,600	51,600	47,800	48,600	51,600	49,300	2,000
	Chromium (Cr)	mg/kg	0.50	37.3	90	22.4	15.2	24.2	15.2	22.4	24.2	20.6	4.76
	Cobalt (Co)	mg/kg	0.10	-	-	5.42	5.6	6.39	5.42	5.6	6.39	5.8	0.516
	Copper (Cu)	mg/kg	0.50	35.7	197	15.4	14.6	17	14.6	15.4	17	15.7	1.22
	Iron (Fe)	mg/kg	50	21,200	43,766	14,400	14,400	16,700	14,400	14,400	16,700	15,200	1,330
	Lead (Pb)	mg/kg	0.50	35	91.3	9.38	8.83	10.1	8.83	9.38	10.1	9.44	0.637
	Lithium (Li)	mg/kg	2.0	-	-	14.4	11.1	17.1	11.1	14.4	17.1	14.2	3.0
	Magnesium (Mg)	mg/kg	20	-	-	15,300	12,600	16,900	12,600	15,300	16,900	14,900	2,170
	Manganese (Mn)	mg/kg	1.0	460	1,100	478	390	686	390	478	686	518	152
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0681	0.0534	0.0812	0.0534	0.0681	0.0812	0.0676	0.0139
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.56	1.36	1.85	1.36	1.56	1.85	1.59	0.246
	Nickel (Ni)	mg/kg	0.50	16	75	23.1	21.5	26.8	21.5	23.1	26.8	23.8	2.72
	Phosphorus (P)	mg/kg	50	-	-	1,440	1,240	1,410	1,240	1,410	1,440	1,360	108
	Potassium (K)	mg/kg	100	-	-	1,890	1,360	2,240	1,360	1,890	2,240	1,830	443
	Selenium (Se)	mg/kg	0.20	2	2	2.01	1.31	1.55	1.31	1.55	2.01	1.62	0.356
	Silver (Ag)	mg/kg	0.10	0.5	-	0.25	0.24	0.3	0.24	0.25	0.3	0.263	0.0321
	Sodium (Na)	mg/kg	50	-	-	83	72	92	72	83	92	82.3	10
	Strontium (Sr)	mg/kg	0.50	-	-	82.7	85.9	86.1	82.7	85.9	86.1	84.9	1.91
	Sulfur (S)	mg/kg	1,000	-	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.27	0.218	0.307	0.218	0.27	0.307	0.265	0.0447
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	14.7	10.8	15.6	10.8	14.7	15.6	13.7	2.55
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.36	1.11	1.29	1.11	1.29	1.36	1.25	0.129
	Vanadium (V)	mg/kg	0.20	-	-	35.3	28.2	40.9	28.2	35.3	40.9	34.8	6.36
	Zinc (Zn)	mg/kg	2.0	123	315	105	95.3	119	95.3	105	119	106	11.9
	Zirconium (Zr)	mg/kg	1.0	-	-	1.1	<1.0	1.1	<1.0	1.1	1.1	1.07	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	<0.010	0.012	<0.010	<0.010	<0.010	0.012	0.0107	0.00351
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.010	0.011	<0.010	<0.010	<0.010	0.011	0.0103	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.014	0.029	0.02	0.014	0.02	0.029	0.021	0.00755
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Fluoranthene	mg/kg	0.010	0.111	2.355	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Fluorene	mg/kg	0.010	0.021	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.015	0.047	0.02	0.015	0.02	0.047	0.0273	0.0172
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.018	0.074	0.023	0.018	0.023	0.074	0.0383	0.031
	Naphthalene	mg/kg	0.010	0.0346	0.391	<0.010	0.029	<0.010	<0.010	<0.010	0.029	0.0163	0.017
	Perylene	mg/kg	0.010	-	-	<0.010	0.01	<0.010	<0.010	<0.010	0.01	0.01	0.00133
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.026	0.075	0.037	0.026	0.037	0.075	0.046	0.0257
	Pyrene	mg/kg	0.010	0.053	0.875	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	81.4	80.7	79.8	79.8	80.7	81.4	80.6	0.802
	d12-Chrysene	%	-	-	-	94.9	93.6	89.9	89.9	93.6	94.9	92.8	2.59
	d8-Naphthalene	%	-	-	-	83.7	82.4	81.5	81.5	82.4	83.7	82.5	1.11
	d10-Phenanthrene	%	-	-	-	91.2	89.8	89.6	89.6	89.8	91.2	90.2	0.872
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
	IACR (CCME)	mg/kg	0.15	-	-	<0.15	0.16	<0.15	<0.15	<0.15	0.16	0.153	0.0252

[a] Working sediment quality guidelines (BC MOE 2015).
" - " = no data or standard deviation not estimated.
(blue shading) concentration exceeds lower SQG.
(grey shading) concentration exceeds upper SQG.

Table C.1: Sediment Quality in Lotic Areas and Associated Summary Statistics

	Analyte	Units	MDL	BC Sediment Quality Guidelines [a]		Mine-exposed							
						RG_ERSC5							
				Lower SQG	Upper SQG	RG_ERSC5-1	RG_ERSC5-2	RG_ERSC5-3	Minimum	Median	Maximum	Mean	Standard Deviation
						09-Sep-17	09-Sep-17	09-Sep-17					
Physical Tests	Moisture	%	0.25	-	-	43.5	37.3	45.5	37.3	43.5	45.5	42.1	4.28
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	1.1	<1.0	<1.0	<1.0	<1.0	1.1	1.03	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	1.8	<1.0	<1.0	<1.0	<1.0	1.8	1.27	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	1.7	<1.0	<1.0	<1.0	<1.0	1.7	1.23	1.22
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	3.8	8.9	1.8	1.8	3.8	8.9	4.83	3.66
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	9.8	23.9	7.8	7.8	9.8	23.9	13.8	8.78
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	10.6	14.7	9.8	9.8	10.6	14.7	11.7	2.63
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	24.7	19.1	30.8	19.1	24.7	30.8	24.9	5.85
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	36.9	25.5	40.7	25.5	36.9	40.7	34.4	7.91
	% Clay (<4 µm)	%	1.0	-	-	9.6	7.1	8.6	7.1	8.6	9.6	8.43	1.26
	Texture	-		-	-	Silt loam	Sandy loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	4.7	2.89	4.29	2.89	4.29	4.7	3.96	0.949
Metals	Aluminum (Al)	mg/kg	50	-	-	6,910	5,930	5,780	5,780	5,930	6,910	6,210	614
	Antimony (Sb)	mg/kg	0.10	-	-	0.44	0.42	0.48	0.42	0.44	0.48	0.447	0.0306
	Arsenic (As)	mg/kg	0.10	5.9	17	5.02	4.53	5.09	4.53	5.02	5.09	4.88	0.305
	Barium (Ba)	mg/kg	0.50	-	-	115	111	119	111	115	119	115	4
	Beryllium (Be)	mg/kg	0.10	-	-	0.48	0.46	0.52	0.46	0.48	0.52	0.487	0.0306
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	8.7	7	6.2	6.2	7	8.7	7.3	1.28
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	0.747	0.696	0.871	0.696	0.747	0.871	0.771	0.09
	Calcium (Ca)	mg/kg	50	-	-	57,400	61,600	52,500	52,500	57,400	61,600	57,200	4,550
	Chromium (Cr)	mg/kg	0.50	37.3	90	23.8	13.9	14.2	13.9	14.2	23.8	17.3	5.63
	Cobalt (Co)	mg/kg	0.10	-	-	4.3	3.8	4.59	3.8	4.3	4.59	4.23	0.4
	Copper (Cu)	mg/kg	0.50	35.7	197	10.1	8.5	11.6	8.5	10.1	11.6	10.1	1.55
	Iron (Fe)	mg/kg	50	21,200	43,766	11,200	10,300	11,700	10,300	11,200	11,700	11,100	709
	Lead (Pb)	mg/kg	0.50	35	91.3	6.54	6.31	7.64	6.31	6.54	7.64	6.83	0.711
	Lithium (Li)	mg/kg	2.0	-	-	11.2	9.3	10.5	9.3	10.5	11.2	10.3	0.961
	Magnesium (Mg)	mg/kg	20	-	-	13,500	12,900	13,500	12,900	13,500	13,500	13,300	346
	Manganese (Mn)	mg/kg	1.0	460	1,100	414	353	457	353	414	457	408	52.3
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0372	0.0303	0.0488	0.0303	0.0372	0.0488	0.0388	0.00935
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.46	1.16	1.31	1.16	1.31	1.46	1.31	0.15
	Nickel (Ni)	mg/kg	0.50	16	75	20	15.6	19.6	15.6	19.6	20	18.4	2.43
	Phosphorus (P)	mg/kg	50	-	-	1,250	1,340	1,320	1,250	1,320	1,340	1,300	47
	Potassium (K)	mg/kg	100	-	-	1,670	1,420	1,200	1,200	1,420	1,670	1,430	235
	Selenium (Se)	mg/kg	0.20	2	2	0.92	0.69	1.01	0.69	0.92	1.01	0.873	0.165
	Silver (Ag)	mg/kg	0.10	0.5	-	0.16	0.12	0.19	0.12	0.16	0.19	0.157	0.0351
	Sodium (Na)	mg/kg	50	-	-	79	77	70	70	77	79	75.3	4.73
	Strontium (Sr)	mg/kg	0.50	-	-	84.3	85.6	79.1	79.1	84.3	85.6	83	3.44
	Sulfur (S)	mg/kg	1,000	-	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.2	0.181	0.205	0.181	0.2	0.205	0.195	0.0127
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	13.2	10.8	11	10.8	11	13.2	11.7	1.33
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.05	0.992	1.09	0.992	1.05	1.09	1.04	0.0493
	Vanadium (V)	mg/kg	0.20	-	-	29	26	24.9	24.9	26	29	26.6	2.12
	Zinc (Zn)	mg/kg	2.0	123	315	72.1	67.5	80.5	67.5	72.1	80.5	73.4	6.59
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.022	<0.010	0.015	<0.010	0.015	0.022	0.0157	0.00467
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.020	<0.010	<0.020	<0.010	<0.020	<0.020	<0.020	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.045	0.018	0.03	0.018	0.03	0.045	0.031	0.0135
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Fluoranthene	mg/kg	0.010	0.111	2.355	0.01	<0.010	<0.010	<0.010	<0.010	0.01	0.01	-
	Fluorene	mg/kg	0.010	0.021	0.144	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.064	0.032	0.042	0.032	0.042	0.064	0.046	0.0164
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.093	0.046	0.058	0.046	0.058	0.093	0.0657	0.0244
	Naphthalene	mg/kg	0.010	0.0346	0.391	0.035	0.017	0.023	0.017	0.023	0.035	0.025	0.00917
	Perylene	mg/kg	0.010	-	-	<0.020	<0.010	<0.020	<0.010	<0.020	<0.020	<0.020	-
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.107	0.045	0.063	0.045	0.063	0.107	0.0717	0.0319
	Pyrene	mg/kg	0.010	0.053	0.875	0.012	<0.010	<0.010	<0.010	<0.010	0.012	0.0107	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	77.3	72.7	83.9	72.7	77.3	83.9	78	5.63
	d12-Chrysene	%	-	-	-	90.1	86	93.3	86	90.1	93.3	89.8	3.66
	d8-Naphthalene	%	-	-	-	71.8	70.7	81.4	70.7	71.8	81.4	74.6	5.89
	d10-Phenanthrene	%	-	-	-	86.4	78.9	89.4	78.9	86.4	89.4	84.9	5.41
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
	IACR (CCME)	mg/kg	0.15	-	-	0.23	<0.15	0.18	<0.15	0.18	0.23	0.187	0.0333

[a] Working sediment quality guidelines (BC MOE 2015).
" - " = no data or standard deviation not estimated.
(blue shading) concentration exceeds lower SQG.
(grey shading) concentration exceeds upper SQG.

Table C.1: Sediment Quality in Lotic Areas and Associated Summary Statistics

	Analyte	Units	MDL	BC Sediment Quality Guidelines [a]		Mine-exposed							
						GH_ERC							
				Lower SQG	Upper SQG	GH_ERC-1	GH_ERC-2	GH_ERC-3	Minimum	Median	Maximum	Mean	Standard Deviation
						10-Sep-17	10-Sep-17	10-Sep-17					
Physical Tests	Moisture	%	0.25	-	-	65.1	41.3	38.2	38.2	41.3	65.1	48.2	14.7
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	<1.0	3.2	1.4	<1.0	1.4	3.2	1.87	1.2
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	3.4	10.4	4	3.4	4	10.4	5.93	3.88
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	8.7	19.2	16.6	8.7	16.6	19.2	14.8	5.47
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	35.2	28	32.7	28	32.7	35.2	32	3.66
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	43.8	32.2	38.3	32.2	38.3	43.8	38.1	5.8
	% Clay (<4 µm)	%	1.0	-	-	8.2	6.7	6.6	6.6	6.7	8.2	7.17	0.896
	Texture	-		-	-	Silt	Silt loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	4.62	3.48	3.21	3.21	3.48	4.62	3.77	0.748
Metals	Aluminum (Al)	mg/kg	50	-	-	6,860	6,540	6,530	6,530	6,540	6,860	6,640	188
	Antimony (Sb)	mg/kg	0.10	-	-	0.43	0.44	0.39	0.39	0.43	0.44	0.42	0.0265
	Arsenic (As)	mg/kg	0.10	5.9	17	5.34	4.76	4.75	4.75	4.76	5.34	4.95	0.338
	Barium (Ba)	mg/kg	0.50	-	-	133	124	117	117	124	133	125	8.02
	Beryllium (Be)	mg/kg	0.10	-	-	0.54	0.53	0.47	0.47	0.53	0.54	0.513	0.0379
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	9.1	7.4	8	7.4	8	9.1	8.17	0.862
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	0.814	0.72	0.713	0.713	0.72	0.814	0.749	0.0564
	Calcium (Ca)	mg/kg	50	-	-	63,500	54,400	55,000	54,400	55,000	63,500	57,600	5,090
	Chromium (Cr)	mg/kg	0.50	37.3	90	22.5	16.1	16.1	16.1	16.1	22.5	18.2	3.7
	Cobalt (Co)	mg/kg	0.10	-	-	4.56	4.21	3.99	3.99	4.21	4.56	4.25	0.287
	Copper (Cu)	mg/kg	0.50	35.7	197	11.4	10.1	9.35	9.35	10.1	11.4	10.3	1.04
	Iron (Fe)	mg/kg	50	21,200	43,766	12,200	11,100	10,700	10,700	11,100	12,200	11,300	777
	Lead (Pb)	mg/kg	0.50	35	91.3	7.5	6.66	6.14	6.14	6.66	7.5	6.77	0.686
	Lithium (Li)	mg/kg	2.0	-	-	11.7	10.7	10.5	10.5	10.7	11.7	11	0.643
	Magnesium (Mg)	mg/kg	20	-	-	14,900	13,100	14,400	13,100	14,400	14,900	14,100	929
	Manganese (Mn)	mg/kg	1.0	460	1,100	577	424	413	413	424	577	471	91.7
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0377	0.036	0.0283	0.0283	0.036	0.0377	0.034	0.00501
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.47	1.22	1.23	1.22	1.23	1.47	1.31	0.142
	Nickel (Ni)	mg/kg	0.50	16	75	21.1	17.4	17	17	17.4	21.1	18.5	2.26
	Phosphorus (P)	mg/kg	50	-	-	1,380	1,200	1,210	1,200	1,210	1,380	1,260	101
	Potassium (K)	mg/kg	100	-	-	1,630	1,570	1,600	1,570	1,600	1,630	1,600	30
	Selenium (Se)	mg/kg	0.20	2	2	1.05	0.69	0.69	0.69	0.69	1.05	0.81	0.208
	Silver (Ag)	mg/kg	0.10	0.5	-	0.17	0.15	0.14	0.14	0.15	0.17	0.153	0.0153
	Sodium (Na)	mg/kg	50	-	-	90	82	80	80	82	90	84	5.29
	Strontium (Sr)	mg/kg	0.50	-	-	98.8	80.2	80.3	80.2	80.3	98.8	86.4	10.7
	Sulfur (S)	mg/kg	1,000	-	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.221	0.208	0.198	0.198	0.208	0.221	0.209	0.0115
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	14.2	12.4	15.7	12.4	14.2	15.7	14.1	1.65
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.12	0.944	0.943	0.943	0.944	1.12	1	0.102
	Vanadium (V)	mg/kg	0.20	-	-	28.6	28	27.5	27.5	28	28.6	28	0.551
	Zinc (Zn)	mg/kg	2.0	123	315	81	73.9	69.6	69.6	73.9	81	74.8	5.76
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0070	<0.0050	<0.0050	<0.0050	<0.0050	<0.0070	<0.0070	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.015	<0.010	<0.010	<0.010	<0.010	0.015	0.0117	0.00667
	Benzo(e)pyrene	mg/kg	0.010	-	-	0.013	<0.010	<0.010	<0.010	<0.010	0.013	0.011	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.032	0.02	0.014	0.014	0.02	0.032	0.022	0.00917
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Fluoranthene	mg/kg	0.010	0.111	2.355	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Fluorene	mg/kg	0.010	0.021	0.144	0.017	<0.010	<0.010	<0.010	<0.010	0.017	0.0123	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.09	0.053	0.028	0.028	0.053	0.09	0.057	0.0312
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.153	0.086	0.043	0.043	0.086	0.153	0.094	0.0554
	Naphthalene	mg/kg	0.010	0.0346	0.391	0.056	0.029	0.014	0.014	0.029	0.056	0.033	0.0213
	Perylene	mg/kg	0.010	-	-	0.013	<0.010	<0.010	<0.010	<0.010	0.013	0.011	-
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.099	0.06	0.04	0.04	0.06	0.099	0.0663	0.03
	Pyrene	mg/kg	0.010	0.053	0.875	0.011	<0.010	<0.010	<0.010	<0.010	0.011	0.0103	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	76.4	83.3	77.8	76.4	77.8	83.3	79.2	3.65
	d12-Chrysene	%	-	-	-	87.3	96.4	97	87.3	96.4	97	93.6	5.44
	d8-Naphthalene	%	-	-	-	77.2	84.2	73.8	73.8	77.2	84.2	78.4	5.3
	d10-Phenanthrene	%	-	-	-	87	93.4	95.3	87	93.4	95.3	91.9	4.35
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
	IACR (CCME)	mg/kg	0.15	-	-	0.18	<0.15	<0.15	<0.15	<0.15	0.18	0.16	0.0467

[a] Working sediment quality guidelines (BC MOE 2015).
" - " = no data or standard deviation not estimated.
(blue shading) concentration exceeds lower SQG.
(grey shading) concentration exceeds upper SQG.

Table C.2: Sediment Quality in Lentic Areas and Associated Summary Statistics

Analyte		Units	MDL	BC Sediment Quality Guidelines [a]		Mine-exposed Wetland							Mine-exposed							
						RG_GH-SCW							Pool-W-1							
				Lower SQG	Upper SQG	RG_GH-SCW1 16-Sep-17	RG_GH-SCW2 16-Sep-17	Minimum	Median	Maximum	Mean	Standard Deviation	RG_GH-SC1-P2-1 11-Sep-17	RG_GH-SC1-P2-2 11-Sep-17	RG_GH-SC1-P2-3 11-Sep-17	Minimum	Median	Maximum	Mean	Standard Deviation
Physical Tests	Moisture	%	0.25	-	-	53.7	58.6	53.7	56.15	58.6	56.15	3.5	47.2	35.6	48.0	35.6	47.2	48	43.6	6.94
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	2.8	<1.0	<1.0	<1.0	2.8	1.6	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	10.1	2.2	<1.0	2.2	10.1	4.43	5.27
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	15.4	2.5	<1.0	2.5	15.4	6.3	8.6
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	1.5	6.8	1.8	1.5	1.8	6.8	3.37	2.98
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	4.1	<1.0	<1.0	2.55	4.1	2.55	-	4.8	5.7	2	2	4.8	5.7	4.17	1.93
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	7.9	<1.0	<1.0	4.45	7.9	4.45	-	11.8	7.2	5	5	7.2	11.8	8	3.47
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	35.1	33.4	33.4	34.25	35.1	34.25	1.20	31.5	18.4	27.6	18.4	27.6	31.5	25.8	6.73
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	44	54.4	44	49.2	54.4	49.2	7.35	43	26	45.2	26	43	45.2	38.1	10.5
	% Clay (<4 µm)	%	1.0	-	-	8.5	11.9	8.5	10.2	11.9	10.2	2.40	7.3	7.6	13.6	7.3	7.6	13.6	9.5	3.55
	Texture	-		-	-	Silt	Silt	-	-	-	-	-	Silt loam	Sandy loam	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	0.050	-	-	7.63	5.1	5.1	6.365	7.63	6.365	1.79	6.18	7.38	7.82	6.18	7.38	7.82	7.13	0.849
Metals	Aluminum (Al)	mg/kg	50	-	-	8,080	9,820	8,080	8,950	9,820	8,950	1,230	7,210	7,760	9,800	7,210	7,760	9,800	8,260	1,360
	Antimony (Sb)	mg/kg	0.10	-	-	0.64	0.63	0.63	0.635	0.64	0.635	0.01	0.45	0.62	0.6	0.45	0.6	0.62	0.557	0.0929
	Arsenic (As)	mg/kg	0.10	5.9	17	5.41	5.92	5.41	5.665	5.92	5.665	0.36	4.98	5.91	5.72	4.98	5.72	5.91	5.54	0.491
	Barium (Ba)	mg/kg	0.50	-	-	152	151	151	152	152	152	0.71	140	194	183	140	183	194	172	28.5
	Beryllium (Be)	mg/kg	0.10	-	-	0.53	0.63	0.53	0.58	0.63	0.58	0.07	0.58	0.73	0.71	0.58	0.71	0.73	0.673	0.0814
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.0	-	-	11	13	11	12	13	12	1.41	8.2	6.3	11.3	6.3	8.2	11.3	8.6	2.52
	Cadmium (Cd)	mg/kg	0.020	0.6	3.5	1.2	1.12	1.12	1.16	1.2	1.16	0.06	0.89	0.985	1.11	0.89	0.985	1.11	0.995	0.11
	Calcium (Ca)	mg/kg	50	-	-	53,300	71,300	53,300	62,300	71,300	62,300	12,728	54,000	31,400	38,100	31,400	38,100	54,000	41,200	11,600
	Chromium (Cr)	mg/kg	0.50	37.3	90	16.6	19.5	16.6	18.05	19.5	18.05	2.05	15.4	14.7	19.4	14.7	15.4	19.4	16.5	2.54
	Cobalt (Co)	mg/kg	0.10	-	-	5.46	5.96	5.46	5.71	5.96	5.71	0.35	4.84	7.12	6.45	4.84	6.45	7.12	6.14	1.17
	Copper (Cu)	mg/kg	0.50	35.7	197	15.9	15.6	15.6	15.75	15.9	15.75	0.21	12.7	16.2	16.7	12.7	16.2	16.7	15.2	2.18
	Iron (Fe)	mg/kg	50	21,200	43,766	12,700	13,400	12,700	13,050	13,400	13,050	495	11,600	16,400	14,700	11,600	14,700	16,400	14,200	2,430
	Lead (Pb)	mg/kg	0.50	35	91.3	7.78	8	7.78	7.89	8	7.89	0.16	7.77	10.5	10.2	7.77	10.2	10.5	9.49	1.5
	Lithium (Li)	mg/kg	2.0	-	-	12.6	16	12.6	14.3	16	14.3	2.40	11.8	12.1	14	11.8	12.1	14	12.6	1.19
	Magnesium (Mg)	mg/kg	20	-	-	12,300	18,600	12,300	15,450	18,600	15,450	4,455	13,300	8,390	10,900	8,390	10,900	13,300	10,900	2,460
	Manganese (Mn)	mg/kg	1.0	460	1,100	474	558	474	516	558	516	59.40	445	464	505	445	464	505	471	30.7
	Mercury (Hg)	mg/kg	0.0050	0.17	0.486	0.0525	0.0527	0.0525	0.0526	0.0527	0.0526	0.000141	0.0567	0.0463	0.0772	0.0463	0.0567	0.0772	0.0601	0.0157
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.49	1.76	1.49	1.625	1.76	1.625	0.19	1.37	1.49	1.77	1.37	1.49	1.77	1.54	0.205
	Nickel (Ni)	mg/kg	0.50	16	75	23.8	27.3	23.8	25.55	27.3	25.55	2.47	20.4	26.2	26.4	20.4	26.2	26.4	24.3	3.41
	Phosphorus (P)	mg/kg	50	-	-	1,180	1,320	1,180	1,250	1,320	1,250	99.0	1,230	1,330	1,220	1,220	1,230	1,330	1,260	61
	Potassium (K)	mg/kg	100	-	-	2,020	2,580	2,020	2,300	2,580	2,300	396	1,630	1,550	2,210	1,550	1,630	2,210	1,800	360
	Selenium (Se)	mg/kg	0.20	2	2	1.81	4.46	1.81	3.135	4.46	3.135	1.87	1.35	1.92	1.85	1.35	1.85	1.92	1.71	0.311
	Silver (Ag)	mg/kg	0.10	0.5	-	0.25	0.24	0.24	0.245	0.25	0.245	0.01	0.18	0.19	0.24	0.18	0.19	0.24	0.203	0.0321
	Sodium (Na)	mg/kg	50	-	-	87	126	87	107	126	107	27.58	78	71	84	71	78	84	77.7	6.51
	Strontium (Sr)	mg/kg	0.50	-	-	100	106	100	103	106	103	4.38	85.4	77.8	76.8	76.8	77.8	85.4	80	4.7
	Sulfur (S)	mg/kg	1,000	-	-	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	-	<1000	<1000	<1000	<1000	<1000	<1000	<1000	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.255	0.274	0.255	0.2645	0.274	0.2645	0.01	0.223	0.205	0.296	0.205	0.223	0.296	0.241	0.0482
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	1.0	-	-	14.5	17.2	14.5	15.85	17.2	15.85	1.91	12.3	10.4	15.2	10.4	12.3	15.2	12.6	2.42
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	0.050	-	-	1.29	1.3	1.29	1.295	1.3	1.295	0.01	0.999	0.942	1.11	0.942	0.999	1.11	1.02	0.0854
	Vanadium (V)	mg/kg	0.20	-	-	33.2	39.3	33.2	36.25	39.3	36.25	4.31	28.8	30.4	36.7	28.8	30.4	36.7	32	4.18
	Zinc (Zn)	mg/kg	2.0	123	315	92.2	108	92.2	100	108	100	11.17	83.6	113	97.6	83.6	97.6	113	98.1	14.7
	Zirconium (Zr)	mg/kg	1.0	-	-	1.1	<1.0	<1.0	1.05	1.1	1.05	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.00671	0.0889	<0.0050	<0.014	<0.0050	-	<0.014	-	-	<0.028	<0.035	<0.022	<0.022	<0.028	<0.035	<0.035	-
	Acenaphthylene	mg/kg	0.0050	0.00587	0.128	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-
	Acridine	mg/kg	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0040	0.0469	0.245	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-
	Benz(a)anthracene	mg/kg	0.010	0.0317	0.385	<0.010	0.011	<0.010	0.011	0.011	0.011	-	0.018	0.018	0.016	0.016	0.018	0.018	0.0173	0.00115
	Benzo(a)pyrene	mg/kg	0.010	0.0319	0.782	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.014	0.029	0.014	0.0215	0.029	0.0215	0.011	0.051	0.039	0.054	0.039	0.051	0.054	0.048	0.00794
	Benzo(e)pyrene	mg/kg	0.010	-	-	0.012	0.025	0.012	0.0185	0.025	0.0185	0.009	0.044	0.035	0.045	0.035	0.044	0.045	0.0413	0.00551
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	0.013	0.011	0.014	0.011	0.013	0.014	0.0127	0.00153
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Chrysene	mg/kg	0.010	0.0571	0.862	0.031	0.065	0.031	0.048	0.065	0.048	0.024	0.141	0.106	0.127	0.106	0.127	0.141	0.125	0.0176
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.00622	0.135	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	0.0087	0.0075	0.0081	0.0075	0.0081	0.0087	0.0081	0.0006
	Fluoranthene	mg/kg	0.010	0.111	2.355	<0.010	0.014	<0.010	0.012	0.014	0.012	-	0.024	0.019	0.02	0.019	0.02	0.024	0.021	0.00265
	Fluorene	mg/kg	0.010	0.021	0.144	<0.010	0.022	<0.010	0.022	0.022	0.022	-	0.035	0.05	0.027	0.027	0.035	0.05	0.0373	0.0117
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.2	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.065	0.159	0.065	0.112	0.159	0.112	0.066	0.378	0.478	0.244	0.244	0.378	0.478	0.367	0.117
	2-Methylnaphthalene	mg/kg	0.010	0.0202	0.201	0.088	0.276	0.088	0.182	0.276	0.182	0.133	0.696	0.919	0.433	0.433	0.696	0.919	0.683	0.243
	Naphthalene	mg/kg	0.010	0.0346	0.391	0.042	0.084	0.042	0.063	0.084	0.063	0.030	0.194	0.226	0.103	0.103	0.194	0.226	0.174	0.0638
	Perylene	mg/kg	0.010	-	-	0.018	0.018	0.018	0.018	0.018	0.018	-	0.015	<0.010	0.011	<0.010	0.011	0.015	0.012	0.00267
	Phenanthrene	mg/kg	0.010	0.0419	0.515	0.099	0.216	0.099	0.1575	0.216	0.1575	0.083	0.451	0.372	0.322	0.322	0.372	0.451	0.382	0.065
	Pyrene	mg/kg	0.010	0.053	0.875	<0.010	0.022	<0.010	0.016	0.022	0.016	-	0.042	0.032	0.034	0.032	0.034	0.042	0.036	0.00529
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	-	-	-	79.7	88	79.7	83.85	88	83.85	5.87	84.9	76.2	79.7	76.2	79.7	84.9	80.3	4.38
	d12-Chrysene	%	-	-	-	89.7	96	89.7	92.85	96	92.85	4.45	91.6	88	90.5	88	90.5	91.6	90	1.84
	d8-Naphthalene	%	-	-	-	77.1	84	77.1	80.55	84	80.55	4.88	79	71.4	75	71.4	75	79	75.1	3.8
	d10-Phenanthrene	%	-	-	-	85.5	93	85.5	89.25	93	89.25	5.30	89.9	80.8	87.9	80.8	87.9	89.9	86.2	4.78
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	0.023	0.02	0.023	0.02	0.023	0.023	0.022	0.00173
	IACR (CCME)	mg/kg	0.15	-	-	0.18	0.3	0.18	0.24	0.3	0.24	0.085	0.53	0.43	0.53	0.43	0.53	0.53	0.497	0.0577

[a] Working sediment quality guidelines (BC MOE 2015).

" - " = no data or standard deviation not estimated.

(blue shading) concentration exceeds lower SQG.

(grey shading) concentration exceeds upper SQG.

Table C.2: Sediment Quality in Lentic Areas and Associated Summary Statistics

Group	Analyte	Units	Mine-exposed Pool							
			Pool-W-2							
			RG_GH-SC1-P1-1 11-Sep-17	RG_GH-SC1-P1-2 11-Sep-17	RG_GH-SC1-P1-3 11-Sep-17	Minimum	Median	Maximum	Mean	Standard Deviation
Physical Tests	Moisture	%	49.6	47.2	46.4	46.4	47.2	49.6	47.7	1.67
Particle Size	% Gravel (>2 mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (2.00 mm - 1.00 mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (1.00 mm - 0.50 mm)	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
	% Sand (0.50 mm - 0.25 mm)	%	1.7	<1.0	<1.0	<1.0	<1.0	1.7	1.23	-
	% Sand (0.25 mm - 0.125 mm)	%	1.9	2.5	<1.0	<1.0	1.9	2.5	1.8	0.4
	% Sand (0.125 mm - 0.063 mm)	%	2.7	6.1	<1.0	<1.0	2.7	6.1	3.27	2.27
	% Silt (0.063 mm - 0.0312 mm)	%	26.3	33.5	30.6	26.3	30.6	33.5	30.1	3.62
	% Silt (0.0312 mm - 0.004 mm)	%	49.7	47.3	51.5	47.3	49.7	51.5	49.5	2.11
	% Clay (<4 µm)	%	16.8	10.1	17.2	10.1	16.8	17.2	14.7	3.99
	Texture	-	Silt	Silt	Silt loam	-	-	-	-	-
Organic Carbon	Total Organic Carbon	%	16.7	8.77	15.2	8.77	15.2	16.7	13.6	4.21
Metals	Aluminum (Al)	mg/kg	6,800	8,700	7,580	6,800	7,580	8,700	7,690	955
	Antimony (Sb)	mg/kg	0.65	0.56	0.76	0.56	0.65	0.76	0.657	0.1
	Arsenic (As)	mg/kg	4.87	5.4	5.14	4.87	5.14	5.4	5.14	0.265
	Barium (Ba)	mg/kg	190	175	211	175	190	211	192	18.1
	Beryllium (Be)	mg/kg	0.77	0.66	0.83	0.66	0.77	0.83	0.753	0.0862
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	5.4	8.8	5.6	5.4	5.6	8.8	6.6	1.91
	Cadmium (Cd)	mg/kg	1.39	1.04	1.67	1.04	1.39	1.67	1.37	0.316
	Calcium (Ca)	mg/kg	30,700	44,700	20,900	20,900	30,700	44,700	32,100	12,000
	Chromium (Cr)	mg/kg	13.2	16.7	14.3	13.2	14.3	16.7	14.7	1.79
	Cobalt (Co)	mg/kg	6.96	5.88	8.09	5.88	6.96	8.09	6.98	1.11
	Copper (Cu)	mg/kg	20.3	15.9	26.2	15.9	20.3	26.2	20.8	5.17
	Iron (Fe)	mg/kg	12,000	13,800	14,100	12,000	13,800	14,100	13,300	1,140
	Lead (Pb)	mg/kg	11.7	9.33	13	9.33	11.7	13	11.3	1.86
	Lithium (Li)	mg/kg	10.3	13.2	10	10	10.3	13.2	11.2	1.77
	Magnesium (Mg)	mg/kg	7,250	12,100	4,470	4,470	7,250	12,100	7,940	3,860
	Manganese (Mn)	mg/kg	328	435	240	240	328	435	334	97.7
	Mercury (Hg)	mg/kg	0.0897	0.07	0.12	0.07	0.0897	0.12	0.0932	0.0252
	Molybdenum (Mo)	mg/kg	1.39	1.51	1.3	1.3	1.39	1.51	1.4	0.105
	Nickel (Ni)	mg/kg	25.2	23.8	28.8	23.8	25.2	28.8	25.9	2.58
	Phosphorus (P)	mg/kg	1,100	1,390	1,000	1,000	1,100	1,390	1,160	203
	Potassium (K)	mg/kg	1,370	1,870	1,550	1,370	1,550	1,870	1,600	253
	Selenium (Se)	mg/kg	2.52	1.61	1.83	1.61	1.83	2.52	1.99	0.475
	Silver (Ag)	mg/kg	0.28	0.2	0.35	0.2	0.28	0.35	0.277	0.0751
	Sodium (Na)	mg/kg	58	79	<50	<50	58	79	62.3	14
	Strontium (Sr)	mg/kg	81.9	84.6	84.4	81.9	84.4	84.6	83.6	1.5
	Sulfur (S)	mg/kg	<1,000	<1,000	<1,000	-	-	-	-	-
	Thallium (Tl)	mg/kg	0.166	0.23	0.153	0.153	0.166	0.23	0.183	0.0412
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	6.3	15.3	18.6	6.3	15.3	18.6	13.4	6.37
	Tungsten (W)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-
	Uranium (U)	mg/kg	1.03	1.05	0.899	0.899	1.03	1.05	0.993	0.082
	Vanadium (V)	mg/kg	26.9	32.7	29.6	26.9	29.6	32.7	29.7	2.9
	Zinc (Zn)	mg/kg	98.5	96	106	96	98.5	106	100	5.2
	Zirconium (Zr)	mg/kg	1.1	<1.0	1.2	<1.0	1.1	1.2	1.1	0.0667
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	<0.14	<0.030	<0.039	<0.030	<0.039	<0.14	-	-
	Acenaphthylene	mg/kg	0.013	<0.0050	<0.0050	<0.0050	<0.0050	0.013	0.00767	-
	Acridine	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	Anthracene	mg/kg	0.0094	<0.0040	0.0057	<0.0040	0.0057	0.0094	0.00637	0.00247
	Benz(a)anthracene	mg/kg	0.056	0.02	0.037	0.02	0.037	0.056	0.0377	0.018
	Benzo(a)pyrene	mg/kg	0.023	<0.010	<0.010	<0.010	<0.010	0.023	0.0143	-
	Benzo(b&j)fluoranthene	mg/kg	0.165	0.057	0.14	0.057	0.14	0.165	0.121	0.0565
	Benzo(e)pyrene	mg/kg	0.141	0.049	0.101	0.049	0.101	0.141	0.097	0.0461
	Benzo(g,h,i)perylene	mg/kg	0.038	0.014	0.023	0.014	0.023	0.038	0.025	0.0121
	Benzo(k)fluoranthene	mg/kg	0.011	<0.010	<0.010	<0.010	<0.010	0.011	0.0103	-
	Chrysene	mg/kg	0.438	0.15	0.327	0.15	0.327	0.438	0.305	0.145
	Dibenz(a,h)anthracene	mg/kg	0.0287	0.009	0.0193	0.009	0.0193	0.0287	0.019	0.00985
	Fluoranthene	mg/kg	0.079	0.027	0.085	0.027	0.079	0.085	0.0637	0.0319
	Fluorene	mg/kg	0.187	0.036	0.039	0.036	0.039	0.187	0.0873	0.0863
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.012	<0.010	<0.010	<0.010	<0.010	0.012	0.0107	-
	1-Methylnaphthalene	mg/kg	1.67	0.344	0.327	0.327	0.344	1.67	0.78	0.771
	2-Methylnaphthalene	mg/kg	3.12	0.621	0.529	0.529	0.621	3.12	1.42	1.47
	Naphthalene	mg/kg	0.722	0.149	0.119	0.119	0.149	0.722	0.33	0.34
	Perylene	mg/kg	<0.010	<0.020	<0.010	<0.010	<0.010	<0.020	<0.020	-
	Phenanthrene	mg/kg	1.45	0.419	0.647	0.419	0.647	1.45	0.839	0.542
	Pyrene	mg/kg	0.133	0.043	0.134	0.043	0.133	0.134	0.103	0.0523
	Quinoline	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
	d10-Acenaphthene	%	87.1	79.1	71.8	71.8	79.1	87.1	79.3	7.65
	d12-Chrysene	%	83.6	86.2	73.9	73.9	83.6	86.2	81.2	6.48
	d8-Naphthalene	%	74.6	73.2	68	68	73.2	74.6	71.9	3.48
	d10-Phenanthrene	%	85.2	85	73.2	73.2	85	85.2	81.1	6.87
	B(a)P Total Potency Equivalent	mg/kg	0.081	0.024	0.046	0.024	0.046	0.081	0.0503	0.0287
	IACR (CCME)	mg/kg	1.67	0.58	1.27	0.58	1.27	1.67	1.17	0.551

[a] Working sediment quality guidelines (BC MOE 2015).

" - " = no data or standard deviation not estimated.

(blue) concentration exceeds lower SQG.

(grey) concentration exceeds upper SQG.

Table C.2: Sediment Quality in Lentic Areas and Associated Summary Statistics

	Analyte	Units	Mine-exposed Pool								
			Pool-E-2	Pool-E-6							Pool-E-7
			RG_GH-SC2-P1-1	RG_GH-SC2-P2-1	RG_GH-SC2-P2-2	Minimum	Median	Maximum	Mean	Standard Deviation	RG_GH-SC2-P3-1
			11-Sep-17	11-Sep-17	11-Sep-17						11-Sep-17
Physical Tests	Moisture	%	57.9	38	43.8	38	40.9	43.8	40.9	4.10	21.1
Particle Size	% Gravel (>2 mm)	%	<1.0	1.2	2.7	1.2	1.95	2.7	1.95	1.06	<1.0
	% Sand (2.00 mm - 1.00 mm)	%	<1.0	4	10.3	4	7.15	10.3	7.15	4.45	13.6
	% Sand (1.00 mm - 0.50 mm)	%	<1.0	7.5	7.4	7.4	7.45	7.5	7.45	0.07	32.5
	% Sand (0.50 mm - 0.25 mm)	%	<1.0	8.7	4.2	4.2	6.45	8.7	6.45	3.18	31.6
	% Sand (0.25 mm - 0.125 mm)	%	<1.0	6.2	11.1	6.2	8.65	11.1	8.65	3.46	5.2
	% Sand (0.125 mm - 0.063 mm)	%	1.2	3.9	10.8	3.9	7.35	10.8	7.35	4.88	2.4
	% Silt (0.063 mm - 0.0312 mm)	%	35.4	20.3	18.5	18.5	19.4	20.3	19.4	1.27	4.1
	% Silt (0.0312 mm - 0.004 mm)	%	52.9	36.4	28.2	28.2	32.3	36.4	32.3	5.8	7.6
	% Clay (<4 µm)	%	10.3	11.8	7	7	9.4	11.8	9.4	3.4	3
	Texture	-	Silt	Silt loam	Sandy loam	-	-	-	-	-	Loamy sand
Organic Carbon	Total Organic Carbon	%	9.76	11.7	4.01	4.01	7.855	11.7	7.855	5.44	1.86
Metals	Aluminum (Al)	mg/kg	8,180	8,080	6,470	6,470	7,275	8,080	7,275	1,138	5,980
	Antimony (Sb)	mg/kg	0.52	0.55	0.36	0.36	0.455	0.55	0.455	0.13	0.41
	Arsenic (As)	mg/kg	5.3	6.37	4.99	4.99	5.68	6.37	5.68	0.98	5.38
	Barium (Ba)	mg/kg	153	142	96.2	96.2	119	142	119	32.4	97.2
	Beryllium (Be)	mg/kg	0.63	0.59	0.48	0.48	0.535	0.59	0.535	0.08	0.47
	Bismuth (Bi)	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	<0.20
	Boron (B)	mg/kg	10.5	9.2	6.3	6.3	7.75	9.2	7.75	2.05	5.8
	Cadmium (Cd)	mg/kg	1.16	0.869	0.538	0.538	0.7035	0.869	0.7035	0.23	0.576
	Calcium (Ca)	mg/kg	48,300	47,500	57,600	47,500	52,550	57,600	52,550	7,142	68,200
	Chromium (Cr)	mg/kg	17.6	17	43.2	17	30.1	43.2	30.1	18.53	15.3
	Cobalt (Co)	mg/kg	5.42	5.58	4.28	4.28	4.93	5.58	4.93	0.92	4.18
	Copper (Cu)	mg/kg	15.1	12.2	10.7	10.7	11.45	12.2	11.45	1.06	9.14
	Iron (Fe)	mg/kg	12,300	13,700	12,400	12,400	13,050	13,700	13,050	919	12,900
	Lead (Pb)	mg/kg	8.27	8.24	6.62	6.62	7.43	8.24	7.43	1.15	6.36
	Lithium (Li)	mg/kg	12.8	11.7	11.1	11.1	11.4	11.7	11.4	0.42	9.6
	Magnesium (Mg)	mg/kg	11,900	10,500	12,700	10,500	11,600	12,700	11,600	1,556	11,300
	Manganese (Mn)	mg/kg	595	490	349	349	420	490	420	100	348
	Mercury (Hg)	mg/kg	0.0696	0.0502	0.0286	0.0286	0.0394	0.0502	0.0394	0.02	0.016
	Molybdenum (Mo)	mg/kg	1.48	1.53	1.82	1.53	1.675	1.82	1.675	0.21	1.35
	Nickel (Ni)	mg/kg	23.6	20.6	25.9	20.6	23.25	25.9	23.25	3.7	16.6
	Phosphorus (P)	mg/kg	1,220	1,370	1,050	1,050	1,210	1,370	1,210	226	1,130
	Potassium (K)	mg/kg	1,910	1,860	1,340	1,340	1,600	1,860	1,600	368	1,240
	Selenium (Se)	mg/kg	2.64	1.64	0.92	0.92	1.28	1.64	1.28	0.51	0.57
	Silver (Ag)	mg/kg	0.21	0.17	0.1	0.1	0.135	0.17	0.135	0.05	<0.10
	Sodium (Na)	mg/kg	84	79	77	77	78	79	78	1.41	83
	Strontium (Sr)	mg/kg	82.3	80.9	70.4	70.4	75.65	80.9	75.65	7.42	95.2
	Sulfur (S)	mg/kg	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	-	<1,000
	Thallium (Tl)	mg/kg	0.25	0.218	0.158	0.158	0.188	0.218	0.188	0.04	0.145
	Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0
	Titanium (Ti)	mg/kg	13.5	13	13.2	13	13.1	13.2	13.1	0.14	11.6
	Tungsten (W)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	<0.50
	Uranium (U)	mg/kg	1.32	1.11	0.879	0.879	0.9945	1.11	0.9945	0.16	0.889
	Vanadium (V)	mg/kg	31.9	32.5	23	23	27.75	32.5	27.75	6.72	22.7
	Zinc (Zn)	mg/kg	89.1	83.5	57.6	57.6	70.55	83.5	70.55	18.31	61.4
	Zirconium (Zr)	mg/kg	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	<0.028	<0.016	<0.0080	<0.0080	-	<0.016	-	-	<0.0050
	Acenaphthylene	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	<0.0050
	Acridine	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	Anthracene	mg/kg	<0.0040	<0.0040	<0.0040	<0.0040	-	<0.0040	-	-	<0.0040
	Benz(a)anthracene	mg/kg	0.018	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	Benzo(a)pyrene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	Benzo(b&j)fluoranthene	mg/kg	0.051	0.027	0.013	0.013	0.02	0.027	0.02	0.010	0.01
	Benzo(e)pyrene	mg/kg	0.044	0.023	0.011	0.011	0.017	0.023	0.017	0.008	<0.010
	Benzo(g,h,i)perylene	mg/kg	0.013	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	Chrysene	mg/kg	0.141	0.067	0.032	0.032	0.0495	0.067	0.0495	0.0247	0.022
	Dibenz(a,h)anthracene	mg/kg	0.0087	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	-	<0.0050
	Fluoranthene	mg/kg	0.024	0.012	<0.010	<0.010	0.012	0.012	0.012	-	<0.010
	Fluorene	mg/kg	0.035	0.017	<0.010	<0.010	0.017	0.017	0.017	-	<0.010
	Indeno(1,2,3-c,d)pyrene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	1-Methylnaphthalene	mg/kg	0.378	0.181	0.105	0.105	0.143	0.181	0.143	0.0537	0.041
	2-Methylnaphthalene	mg/kg	0.696	0.335	0.178	0.178	0.2565	0.335	0.2565	0.1110	0.072
	Naphthalene	mg/kg	0.194	0.079	0.051	0.051	0.065	0.079	0.065	0.0198	0.022
	Perylene	mg/kg	0.015	0.026	0.03	0.026	0.028	0.03	0.028	0.0028	<0.010
	Phenanthrene	mg/kg	0.451	0.212	0.106	0.106	0.159	0.212	0.159	0.0750	0.05
	Pyrene	mg/kg	0.042	0.019	0.011	0.011	0.015	0.019	0.015	0.0057	<0.010
	Quinoline	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010
	d10-Acenaphthene	%	84.9	80.9	83.1	80.9	82	83.1	82	1.56	73
	d12-Chrysene	%	91.6	89.9	94.5	89.9	92.2	94.5	92.2	3.25	80.8
	d8-Naphthalene	%	79	75.5	78.7	75.5	77.1	78.7	77.1	2.26	70.2
	d10-Phenanthrene	%	89.9	86.9	88.5	86.9	87.7	88.5	87.7	1.13	75
	B(a)P Total Potency Equivalent	mg/kg	0.023	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-	<0.020
	IACR (CCME)	mg/kg	0.53	0.27	0.17	0.17	0.22	0.27	0.22	0.071	<0.15

[a] Working sediment quality guidelines (BC MOE 2015).

" - " = no data or standard deviation not estimated.

(blue shading) concentration exceeds lower SQG.

(grey shading) concentration exceeds upper SQG.

Table C.3: **Field Duplicate (Split Sample) Results for Sediment Chemistry Samples**

Analyte		Units	GH_ERSC2			GH_ERSC4		
			L1992278			L1992278		
			GH_ERSC2-3	GH_ERSC2-X	RPD	GH_ERSC4-3	GH_ERSC4-X	RPD
			11-Sep-17	11-Sep-17	-	08-Sep-17	08-Sep-17	-
Physical Tests	Moisture	%	48.0	47.5	1%	37.5	36.4	3%
Particle Size	% Gravel (>2 mm)	%	<1.0	<1.0	0%	<1.0	<1.0	0%
	% Sand (2.00 mm - 1.00 mm)	%	2.2	1.1	67%	1.7	<1.0	41%
	% Sand (1.00 mm - 0.50 mm)	%	2.5	1.8	33%	3.6	2.0	57%
	% Sand (0.50 mm - 0.25 mm)	%	1.8	1.5	18%	7.1	5.6	24%
	% Sand (0.25 mm - 0.125 mm)	%	2.0	2.0	0%	30.2	29.3	3%
	% Sand (0.125 mm - 0.063 mm)	%	5.0	4.3	15%	21.1	18.9	11%
	% Silt (0.063 mm - 0.0312 mm)	%	27.6	28.1	2%	14.1	16.8	17%
	% Silt (0.0312 mm - 0.004 mm)	%	45.2	47.1	4%	16.8	20.6	20%
	% Clay (<4 µm)	%	13.6	14.0	3%	5.3	6.2	16%
	Texture	-	Silt loam	Silt loam / Silt	-	Sandy loam	Sandy loam	-
Organic Carbon	Total Organic Carbon	%	7.82	7.62	3%	3.46	3.64	5%
Total Metals	Aluminum (Al)	mg/kg	9,800	12,300	23%	5,430	5,150	5%
	Antimony (Sb)	mg/kg	0.60	0.96	46%	0.41	0.40	2%
	Arsenic (As)	mg/kg	5.72	7.72	30%	4.73	4.63	2%
	Barium (Ba)	mg/kg	183	249	31%	109	107	2%
	Beryllium (Be)	mg/kg	0.71	1.04	38%	0.41	0.45	9%
	Bismuth (Bi)	mg/kg	<0.20	0.23	13%	<0.20	<0.20	0%
	Boron (B)	mg/kg	11.3	16.1	35%	6.2	5.0	21%
	Cadmium (Cd)	mg/kg	1.11	1.40	23%	0.650	0.711	9%
	Calcium (Ca)	mg/kg	38,100	55,800	38%	60,200	59,600	1%
	Chromium (Cr)	mg/kg	19.4	22.5	15%	13.6	12.4	9%
	Cobalt (Co)	mg/kg	6.45	8.62	29%	3.72	3.85	3%
	Copper (Cu)	mg/kg	16.7	22.2	28%	8.90	9.06	2%
	Iron (Fe)	mg/kg	14,700	19,900	30%	10,600	10,700	1%
	Lead (Pb)	mg/kg	10.2	15.6	42%	6.24	6.38	2%
	Lithium (Li)	mg/kg	14.0	22.1	45%	9.2	8.8	4%
	Magnesium (Mg)	mg/kg	10,900	13,800	23%	11,600	11,600	0%
	Manganese (Mn)	mg/kg	505	678	29%	319	340	6%
	Mercury (Hg)	mg/kg	0.0772	0.0877	13%	0.0271	0.0270	0%
	Molybdenum (Mo)	mg/kg	1.77	2.66	40%	1.14	1.08	5%
	Nickel (Ni)	mg/kg	26.4	34.9	28%	15.6	16.1	3%
	Phosphorus (P)	mg/kg	1,220	1,580	26%	1,350	1,200	12%
	Potassium (K)	mg/kg	2,210	2,580	15%	1,220	1,070	13%
	Selenium (Se)	mg/kg	1.85	2.35	24%	0.67	0.60	11%
	Silver (Ag)	mg/kg	0.24	0.34	34%	0.12	0.12	0%
	Sodium (Na)	mg/kg	84	94	11%	75	72	4%
	Strontium (Sr)	mg/kg	76.8	117	41%	86.6	85.2	2%
	Sulfur (S)	mg/kg	<1000	<1000	0%	<1000	<1000	0%
	Thallium (Tl)	mg/kg	0.296	0.435	38%	0.166	0.161	3%
	Tin (Sn)	mg/kg	<2.0	<2.0	0%	<2.0	<2.0	0%
	Titanium (Ti)	mg/kg	15.2	16.8	10%	11.4	11.2	2%
	Tungsten (W)	mg/kg	<0.50	<0.50	0%	<0.50	<0.50	0%
	Uranium (U)	mg/kg	1.11	1.62	37%	0.954	0.985	3%
	Vanadium (V)	mg/kg	36.7	45.7	22%	23.8	22.6	5%
	Zinc (Zn)	mg/kg	97.6	137	34%	69.5	70.1	1%
	Zirconium (Zr)	mg/kg	<1.0	1.6	38%	<1.0	<1.0	0%
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	<0.022	<0.025	0%	<0.0050	<0.0050	0%
	Acenaphthylene	mg/kg	<0.0050	<0.0050	0%	<0.0050	<0.0050	0%
	Acridine	mg/kg	<0.010	<0.010	0%	<0.010	<0.010	0%
	Anthracene	mg/kg	<0.0040	<0.0040	0%	<0.0040	<0.0040	0%
	Benz(a)anthracene	mg/kg	0.016	0.018	12%	<0.010	<0.010	0%
	Benzo(a)pyrene	mg/kg	<0.010	<0.010	0%	<0.010	<0.010	0%
	Benzo(b&j)fluoranthene	mg/kg	0.054	0.054	0%	0.022	<0.010	55%
	Benzo(e)pyrene	mg/kg	0.045	<0.050	11%	<0.020	<0.010	0%
	Benzo(g,h,i)perylene	mg/kg	0.014	0.014	0%	<0.010	<0.010	0%
	Benzo(k)fluoranthene	mg/kg	<0.010	<0.010	0%	<0.010	<0.010	0%
	Chrysene	mg/kg	0.127	0.130	2%	0.050	0.011	128%
	Dibenz(a,h)anthracene	mg/kg	0.0081	0.0081	0%	<0.0050	<0.0050	0%
	Fluoranthene	mg/kg	0.020	0.021	5%	<0.010	<0.010	0%
	Fluorene	mg/kg	0.027	0.030	11%	<0.010	<0.010	0%
	Indeno(1,2,3-c,d)pyrene	mg/kg	<0.010	<0.010	0%	<0.010	<0.010	0%
	1-Methylnaphthalene	mg/kg	0.244	0.271	10%	0.062	0.025	85%
	2-Methylnaphthalene	mg/kg	0.433	0.480	10%	0.071	0.033	73%
	Naphthalene	mg/kg	0.103	0.117	13%	0.040	0.015	91%
	Perylene	mg/kg	0.011	<0.020	82%	0.022	<0.010	55%
	Phenanthrene	mg/kg	0.322	0.347	7%	0.127	0.031	122%
	Pyrene	mg/kg	0.034	0.035	3%	0.012	<0.010	17%
	Quinoline	mg/kg	<0.010	<0.010	0%	<0.010	<0.010	0%
	d10-Acenaphthene	%	79.7	83.5	5%	89.6	73.5	20%
	d12-Chrysene	%	90.5	93.4	3%	113.3	82.5	31%
	d8-Naphthalene	%	75.0	78.9	5%	81.3	68.4	17%
	d10-Phenanthrene	%	87.9	92.0	5%	98.9	72.9	30%
	B(a)P Total Potency Equivalent	mg/kg	0.023	0.023	0%	<0.020	<0.020	0%
	IACR (CCME)	mg/kg	0.53	0.54	2%	0.23	<0.15	35%

[shaded box] Relative Percent Difference greater than 40%.

Note: For calculation of the RPD, method detection limit (MDL) values were used in cases where the reported value was below the MDL.

SUBSTRATE QUALITY

Laboratory Reports

MINNOW ENVIRONMENTAL INC.
ATTN: Jess Tester
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 15-SEP-17
Report Date: 02-OCT-17 15:01 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1992278

Project P.O. #: NOT SUBMITTED
Job Reference: 17-24
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 29-SEP-17 16:11

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1992278-1	L1992278-2	L1992278-3	L1992278-4	L1992278-5
	Sample ID	L1992278-1	L1992278-2	L1992278-3	L1992278-4	L1992278-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17
	Sampled Time					
	Client ID	GH_ERSC2-1	GH_ERSC2-2	GH_ERSC2-X	GH_ERSC2-3	GH_SC2-P1-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	47.2	35.6	47.5	48.0	57.9
Particle Size	% Gravel (>2mm) (%)	<1.0	2.8	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	10.1	1.1	2.2	<1.0
	% Sand (1.00mm - 0.50mm) (%)	<1.0	15.4	1.8	2.5	<1.0
	% Sand (0.50mm - 0.25mm) (%)	1.5	6.8	1.5	1.8	<1.0
	% Sand (0.25mm - 0.125mm) (%)	4.8	5.7	2.0	2.0	<1.0
	% Sand (0.125mm - 0.063mm) (%)	11.8	7.2	4.3	5.0	1.2
	% Silt (0.063mm - 0.0312mm) (%)	31.5	18.4	28.1	27.6	35.4
	% Silt (0.0312mm - 0.004mm) (%)	43.0	26.0	47.1	45.2	52.9
	% Clay (<4um) (%)	7.3	7.6	14.0	13.6	10.3
	Texture	Silt loam	Sandy loam	Silt loam / Silt	Silt loam	Silt
Organic / Inorganic Carbon	Total Organic Carbon (%)	6.18	7.38	7.62	7.82	9.76
Metals	Aluminum (Al) (mg/kg)	7210	7760	12300	9800	8180
	Antimony (Sb) (mg/kg)	0.45	0.62	0.96	0.60	0.52
	Arsenic (As) (mg/kg)	4.98	5.91	7.72	5.72	5.30
	Barium (Ba) (mg/kg)	140	194	249	183	153
	Beryllium (Be) (mg/kg)	0.58	0.73	1.04	0.71	0.63
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	0.23	<0.20	<0.20
	Boron (B) (mg/kg)	8.2	6.3	16.1	11.3	10.5
	Cadmium (Cd) (mg/kg)	0.890	0.985	1.40	1.11	1.16
	Calcium (Ca) (mg/kg)	54000	31400	55800	38100	48300
	Chromium (Cr) (mg/kg)	15.4	14.7	22.5	19.4	17.6
	Cobalt (Co) (mg/kg)	4.84	7.12	8.62	6.45	5.42
	Copper (Cu) (mg/kg)	12.7	16.2	22.2	16.7	15.1
	Iron (Fe) (mg/kg)	11600	16400	19900	14700	12300
	Lead (Pb) (mg/kg)	7.77	10.5	15.6	10.2	8.27
	Lithium (Li) (mg/kg)	11.8	12.1	22.1	14.0	12.8
	Magnesium (Mg) (mg/kg)	13300	8390	13800	10900	11900
	Manganese (Mn) (mg/kg)	445	464	678	505	595
	Mercury (Hg) (mg/kg)	0.0567	0.0463	0.0877	0.0772	0.0696
	Molybdenum (Mo) (mg/kg)	1.37	1.49	2.66	1.77	1.48
	Nickel (Ni) (mg/kg)	20.4	26.2	34.9	26.4	23.6
	Phosphorus (P) (mg/kg)	1230	1330	1580	1220	1220
	Potassium (K) (mg/kg)	1630	1550	2580	2210	1910
	Selenium (Se) (mg/kg)	1.35	1.92	2.35	1.85	2.64
	Silver (Ag) (mg/kg)	0.18	0.19	0.34	0.24	0.21
	Sodium (Na) (mg/kg)	78	71	94	84	84

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992278-6 SEDIMENT 11-SEP-17 GH_SC2-P2-1	L1992278-7 SEDIMENT 11-SEP-17 GH_SC2-P2-2	L1992278-8 SEDIMENT 11-SEP-17 GH_SC2-P3-1	L1992278-9 SEDIMENT 11-SEP-17 GH_SC1-P1-1	L1992278-10 SEDIMENT 11-SEP-17 GH_SC1-P1-2
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	38.0	43.8	21.1	49.6	47.2
Particle Size	% Gravel (>2mm) (%)	1.2	2.7	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	4.0	10.3	13.6	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	7.5	7.4	32.5	<1.0	<1.0
	% Sand (0.50mm - 0.25mm) (%)	8.7	4.2	31.6	1.7	<1.0
	% Sand (0.25mm - 0.125mm) (%)	6.2	11.1	5.2	1.9	2.5
	% Sand (0.125mm - 0.063mm) (%)	3.9	10.8	2.4	2.7	6.1
	% Silt (0.063mm - 0.0312mm) (%)	20.3	18.5	4.1	26.3	33.5
	% Silt (0.0312mm - 0.004mm) (%)	36.4	28.2	7.6	49.7	47.3
	% Clay (<4um) (%)	11.8	7.0	3.0	16.8	10.1
	Texture	Silt loam	Sandy loam	Loamy sand	Silt	Silt
Organic / Inorganic Carbon	Total Organic Carbon (%)	11.7	4.01	1.86	16.7	8.77
Metals	Aluminum (Al) (mg/kg)	8080	6470	5980	6800	8700
	Antimony (Sb) (mg/kg)	0.55	0.36	0.41	0.65	0.56
	Arsenic (As) (mg/kg)	6.37	4.99	5.38	4.87	5.40
	Barium (Ba) (mg/kg)	142	96.2	97.2	190	175
	Beryllium (Be) (mg/kg)	0.59	0.48	0.47	0.77	0.66
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	9.2	6.3	5.8	5.4	8.8
	Cadmium (Cd) (mg/kg)	0.869	0.538	0.576	1.39	1.04
	Calcium (Ca) (mg/kg)	47500	57600	68200	30700	44700
	Chromium (Cr) (mg/kg)	17.0	43.2	15.3	13.2	16.7
	Cobalt (Co) (mg/kg)	5.58	4.28	4.18	6.96	5.88
	Copper (Cu) (mg/kg)	12.2	10.7	9.14	20.3	15.9
	Iron (Fe) (mg/kg)	13700	12400	12900	12000	13800
	Lead (Pb) (mg/kg)	8.24	6.62	6.36	11.7	9.33
	Lithium (Li) (mg/kg)	11.7	11.1	9.6	10.3	13.2
	Magnesium (Mg) (mg/kg)	10500	12700	11300	7250	12100
	Manganese (Mn) (mg/kg)	490	349	348	328	435
	Mercury (Hg) (mg/kg)	0.0502	0.0286	0.0160	0.0897	0.0700
	Molybdenum (Mo) (mg/kg)	1.53	1.82	1.35	1.39	1.51
	Nickel (Ni) (mg/kg)	20.6	25.9	16.6	25.2	23.8
	Phosphorus (P) (mg/kg)	1370	1050	1130	1100	1390
	Potassium (K) (mg/kg)	1860	1340	1240	1370	1870
	Selenium (Se) (mg/kg)	1.64	0.92	0.57	2.52	1.61
	Silver (Ag) (mg/kg)	0.17	0.10	<0.10	0.28	0.20
	Sodium (Na) (mg/kg)	79	77	83	58	79

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-11	L1992278-12	L1992278-13	L1992278-14	L1992278-15
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	09-SEP-17	09-SEP-17	09-SEP-17	08-SEP-17
	Sampled Time					
	Client ID	GH_SC1-P1-3	GH_ERSC5-1	GH_ERSC5-2	GH_ERSC5-3	GH_ERSC4-X
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	46.4	43.5	37.3	45.5	36.4
Particle Size	% Gravel (>2mm) (%)	<1.0	1.1	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	1.8	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	<1.0	1.7	<1.0	<1.0	2.0
	% Sand (0.50mm - 0.25mm) (%)	<1.0	3.8	8.9	1.8	5.6
	% Sand (0.25mm - 0.125mm) (%)	<1.0	9.8	23.9	7.8	29.3
	% Sand (0.125mm - 0.063mm) (%)	<1.0	10.6	14.7	9.8	18.9
	% Silt (0.063mm - 0.0312mm) (%)	30.6	24.7	19.1	30.8	16.8
	% Silt (0.0312mm - 0.004mm) (%)	51.5	36.9	25.5	40.7	20.6
	% Clay (<4um) (%)	17.2	9.6	7.1	8.6	6.2
	Texture	Silt loam	Silt loam	Sandy loam	Silt loam	Sandy loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	15.2	4.70	2.89	4.29	3.64
Metals	Aluminum (Al) (mg/kg)	7580	6910	5930	5780	5150
	Antimony (Sb) (mg/kg)	0.76	0.44	0.42	0.48	0.40
	Arsenic (As) (mg/kg)	5.14	5.02	4.53	5.09	4.63
	Barium (Ba) (mg/kg)	211	115	111	119	107
	Beryllium (Be) (mg/kg)	0.83	0.48	0.46	0.52	0.45
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	5.6	8.7	7.0	6.2	5.0
	Cadmium (Cd) (mg/kg)	1.67	0.747	0.696	0.871	0.711
	Calcium (Ca) (mg/kg)	20900	57400	61600	52500	59600
	Chromium (Cr) (mg/kg)	14.3	23.8	13.9	14.2	12.4
	Cobalt (Co) (mg/kg)	8.09	4.30	3.80	4.59	3.85
	Copper (Cu) (mg/kg)	26.2	10.1	8.50	11.6	9.06
	Iron (Fe) (mg/kg)	14100	11200	10300	11700	10700
	Lead (Pb) (mg/kg)	13.0	6.54	6.31	7.64	6.38
	Lithium (Li) (mg/kg)	10.0	11.2	9.3	10.5	8.8
	Magnesium (Mg) (mg/kg)	4470	13500	12900	13500	11600
	Manganese (Mn) (mg/kg)	240	414	353	457	340
	Mercury (Hg) (mg/kg)	0.120	0.0372	0.0303	0.0488	0.0270
	Molybdenum (Mo) (mg/kg)	1.30	1.46	1.16	1.31	1.08
	Nickel (Ni) (mg/kg)	28.8	20.0	15.6	19.6	16.1
	Phosphorus (P) (mg/kg)	1000	1250	1340	1320	1200
	Potassium (K) (mg/kg)	1550	1670	1420	1200	1070
	Selenium (Se) (mg/kg)	1.83	0.92	0.69	1.01	0.60
	Silver (Ag) (mg/kg)	0.35	0.16	0.12	0.19	0.12
	Sodium (Na) (mg/kg)	<50	79	77	70	72

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992278-16 SEDIMENT 08-SEP-17 GH_ERSC4-1	L1992278-17 SEDIMENT 08-SEP-17 GH_ERSC4-2	L1992278-18 SEDIMENT 08-SEP-17 GH_ERSC4-3	L1992278-19 SEDIMENT 10-SEP-17 GH_ER2-1	L1992278-20 SEDIMENT 10-SEP-17 GH_ER2-2
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	38.2	40.4	37.5	56.5	46.9
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	1.7	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	3.8	1.6	3.6	2.9	6.7
	% Sand (0.50mm - 0.25mm) (%)	11.7	8.4	7.1	2.9	22.2
	% Sand (0.25mm - 0.125mm) (%)	19.1	16.3	30.2	6.1	8.6
	% Sand (0.125mm - 0.063mm) (%)	18.0	17.3	21.1	13.1	7.9
	% Silt (0.063mm - 0.0312mm) (%)	18.8	21.8	14.1	30.2	21.3
	% Silt (0.0312mm - 0.004mm) (%)	21.8	26.7	16.8	36.4	27.1
	% Clay (<4um) (%)	6.3	7.3	5.3	7.5	6.0
	Texture	Sandy loam	Sandy loam	Sandy loam	Silt loam	Sandy loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	4.42	3.74	3.46	4.96	3.7
Metals	Aluminum (Al) (mg/kg)	5210	5730	5430	5100	4360
	Antimony (Sb) (mg/kg)	0.43	0.49	0.41	0.35	0.50
	Arsenic (As) (mg/kg)	4.79	5.57	4.73	4.28	5.09
	Barium (Ba) (mg/kg)	105	115	109	114	98.2
	Beryllium (Be) (mg/kg)	0.46	0.57	0.41	0.43	0.44
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	6.0	6.2	6.9	5.2
	Cadmium (Cd) (mg/kg)	0.695	0.842	0.650	0.889	0.702
	Calcium (Ca) (mg/kg)	61300	62000	60200	63600	78600
	Chromium (Cr) (mg/kg)	13.6	15.6	13.6	14.6	12.7
	Cobalt (Co) (mg/kg)	3.92	4.39	3.72	4.19	3.57
	Copper (Cu) (mg/kg)	9.81	10.7	8.90	10.5	8.74
	Iron (Fe) (mg/kg)	11200	12200	10600	10700	10400
	Lead (Pb) (mg/kg)	6.56	7.52	6.24	7.00	5.88
	Lithium (Li) (mg/kg)	8.6	10.0	9.2	9.1	7.7
	Magnesium (Mg) (mg/kg)	11900	14300	11600	12700	12000
	Manganese (Mn) (mg/kg)	346	432	319	575	422
	Mercury (Hg) (mg/kg)	0.0257	0.0307	0.0271	0.0399	0.0258
	Molybdenum (Mo) (mg/kg)	1.18	1.36	1.14	1.15	1.35
	Nickel (Ni) (mg/kg)	16.6	19.2	15.6	17.7	16.2
	Phosphorus (P) (mg/kg)	1220	1350	1350	1190	1240
	Potassium (K) (mg/kg)	1110	1220	1220	1200	1030
	Selenium (Se) (mg/kg)	0.65	0.87	0.67	1.01	0.96
	Silver (Ag) (mg/kg)	0.14	0.16	0.12	0.16	0.14
	Sodium (Na) (mg/kg)	75	79	75	83	79

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-21	L1992278-25	L1992278-26	L1992278-27	L1992278-28
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	10-SEP-17	09-SEP-17	09-SEP-17	09-SEP-17	10-SEP-17
	Sampled Time					
	Client ID	GH_ER2-3	GH_ER1A-1	GH_ER1A-2	GH_ER1A-3	GH_ERC-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	51.7	46.8	42.7	46.0	65.1
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (0.50mm - 0.25mm) (%)	10.3	<1.0	3.7	<1.0	<1.0
	% Sand (0.25mm - 0.125mm) (%)	18.3	2.6	13.6	<1.0	3.4
	% Sand (0.125mm - 0.063mm) (%)	8.7	6.7	12.8	1.3	8.7
	% Silt (0.063mm - 0.0312mm) (%)	25.1	27.3	22.2	26.0	35.2
	% Silt (0.0312mm - 0.004mm) (%)	30.4	47.0	35.6	56.0	43.8
	% Clay (<4um) (%)	6.4	15.4	11.8	15.8	8.2
	Texture	Silt loam	Silt loam	Silt loam	Silt	Silt
Organic / Inorganic Carbon	Total Organic Carbon (%)	5.57	5.85	4.99	4.88	4.62
Metals	Aluminum (Al) (mg/kg)	4490	8130	6620	9550	6860
	Antimony (Sb) (mg/kg)	0.48	0.61	0.57	0.69	0.43
	Arsenic (As) (mg/kg)	4.79	6.10	5.94	7.48	5.34
	Barium (Ba) (mg/kg)	111	151	159	177	133
	Beryllium (Be) (mg/kg)	0.45	0.58	0.58	0.66	0.54
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	8.7	6.0	10.1	9.1
	Cadmium (Cd) (mg/kg)	0.899	1.06	1.05	1.14	0.814
	Calcium (Ca) (mg/kg)	59800	47800	48600	51600	63500
	Chromium (Cr) (mg/kg)	13.6	22.4	15.2	24.2	22.5
	Cobalt (Co) (mg/kg)	4.25	5.42	5.60	6.39	4.56
	Copper (Cu) (mg/kg)	11.0	15.4	14.6	17.0	11.4
	Iron (Fe) (mg/kg)	11200	14400	14400	16700	12200
	Lead (Pb) (mg/kg)	7.17	9.38	8.83	10.1	7.50
	Lithium (Li) (mg/kg)	8.2	14.4	11.1	17.1	11.7
	Magnesium (Mg) (mg/kg)	11500	15300	12600	16900	14900
	Manganese (Mn) (mg/kg)	503	478	390	686	577
	Mercury (Hg) (mg/kg)	0.0365	0.0681	0.0534	0.0812	0.0377
	Molybdenum (Mo) (mg/kg)	1.21	1.56	1.36	1.85	1.47
	Nickel (Ni) (mg/kg)	18.3	23.1	21.5	26.8	21.1
	Phosphorus (P) (mg/kg)	1200	1440	1240	1410	1380
	Potassium (K) (mg/kg)	970	1890	1360	2240	1630
	Selenium (Se) (mg/kg)	0.92	2.01	1.31	1.55	1.05
	Silver (Ag) (mg/kg)	0.17	0.25	0.24	0.30	0.17
	Sodium (Na) (mg/kg)	73	83	72	92	90

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-29	L1992278-30			
	Description	SEDIMENT	SEDIMENT			
	Sampled Date	10-SEP-17	10-SEP-17			
	Sampled Time					
	Client ID	GH_ERC-2	GH_ERC-3			
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	41.3	38.2			
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0			
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0			
	% Sand (1.00mm - 0.50mm) (%)	<1.0	<1.0			
	% Sand (0.50mm - 0.25mm) (%)	3.2	1.4			
	% Sand (0.25mm - 0.125mm) (%)	10.4	4.0			
	% Sand (0.125mm - 0.063mm) (%)	19.2	16.6			
	% Silt (0.063mm - 0.0312mm) (%)	28.0	32.7			
	% Silt (0.0312mm - 0.004mm) (%)	32.2	38.3			
	% Clay (<4um) (%)	6.7	6.6			
	Texture	Silt loam	Silt loam			
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.48	3.21			
Metals	Aluminum (Al) (mg/kg)	6540	6530			
	Antimony (Sb) (mg/kg)	0.44	0.39			
	Arsenic (As) (mg/kg)	4.76	4.75			
	Barium (Ba) (mg/kg)	124	117			
	Beryllium (Be) (mg/kg)	0.53	0.47			
	Bismuth (Bi) (mg/kg)	<0.20	<0.20			
	Boron (B) (mg/kg)	7.4	8.0			
	Cadmium (Cd) (mg/kg)	0.720	0.713			
	Calcium (Ca) (mg/kg)	54400	55000			
	Chromium (Cr) (mg/kg)	16.1	16.1			
	Cobalt (Co) (mg/kg)	4.21	3.99			
	Copper (Cu) (mg/kg)	10.1	9.35			
	Iron (Fe) (mg/kg)	11100	10700			
	Lead (Pb) (mg/kg)	6.66	6.14			
	Lithium (Li) (mg/kg)	10.7	10.5			
	Magnesium (Mg) (mg/kg)	13100	14400			
	Manganese (Mn) (mg/kg)	424	413			
	Mercury (Hg) (mg/kg)	0.0360	0.0283			
	Molybdenum (Mo) (mg/kg)	1.22	1.23			
	Nickel (Ni) (mg/kg)	17.4	17.0			
	Phosphorus (P) (mg/kg)	1200	1210			
	Potassium (K) (mg/kg)	1570	1600			
	Selenium (Se) (mg/kg)	0.69	0.69			
	Silver (Ag) (mg/kg)	0.15	0.14			
	Sodium (Na) (mg/kg)	82	80			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID / Description / Sampled Date / Sampled Time / Client ID	L1992278-1 SEDIMENT 11-SEP-17 GH_ERSC2-1	L1992278-2 SEDIMENT 11-SEP-17 GH_ERSC2-2	L1992278-3 SEDIMENT 11-SEP-17 GH_ERSC2-X	L1992278-4 SEDIMENT 11-SEP-17 GH_ERSC2-3	L1992278-5 SEDIMENT 11-SEP-17 GH_SC2-P1-1
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	85.4	77.8	117	76.8	82.3
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.223	0.205	0.435	0.296	0.250
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	12.3	10.4	16.8	15.2	13.5
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.999	0.942	1.62	1.11	1.32
	Vanadium (V) (mg/kg)	28.8	30.4	45.7	36.7	31.9
	Zinc (Zn) (mg/kg)	83.6	113	137	97.6	89.1
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	1.6	<1.0	1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.028 DLQ	<0.035 DLQ	<0.025 DLQ	<0.022 DLQ	<0.013 DLQ
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	0.018	0.018	0.018	0.016	0.011
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.051	0.039	0.054	0.054	0.034
	Benzo(e)pyrene (mg/kg)	0.044	0.035	<0.050 DLCI	0.045	0.027
	Benzo(g,h,i)perylene (mg/kg)	0.013	0.011	0.014	0.014	<0.010
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.141	0.106	0.130	0.127	0.080
	Dibenz(a,h)anthracene (mg/kg)	0.0087	0.0075	0.0081	0.0081	0.0053
	Fluoranthene (mg/kg)	0.024	0.019	0.021	0.020	0.013
	Fluorene (mg/kg)	0.035	0.050	0.030	0.027	0.016
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.378	0.478	0.271	0.244	0.186
	2-Methylnaphthalene (mg/kg)	0.696	0.919	0.480	0.433	0.324
	Naphthalene (mg/kg)	0.194	0.226	0.117	0.103	0.087
	Perylene (mg/kg)	0.015	<0.010	<0.020 DLCI	0.011	<0.020 DLCI
	Phenanthrene (mg/kg)	0.451	0.372	0.347	0.322	0.215
	Pyrene (mg/kg)	0.042	0.032	0.035	0.034	0.020
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	84.9	76.2	83.5	79.7	77.5
	Surrogate: d12-Chrysene (%)	91.6	88.0	93.4	90.5	83.0
	Surrogate: d8-Naphthalene (%)	79.0	71.4	78.9	75.0	74.0
	Surrogate: d10-Phenanthrene (%)	89.9	80.8	92.0	87.9	81.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992278-6 SEDIMENT 11-SEP-17 GH_SC2-P2-1	L1992278-7 SEDIMENT 11-SEP-17 GH_SC2-P2-2	L1992278-8 SEDIMENT 11-SEP-17 GH_SC2-P3-1	L1992278-9 SEDIMENT 11-SEP-17 GH_SC1-P1-1	L1992278-10 SEDIMENT 11-SEP-17 GH_SC1-P1-2
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	80.9	70.4	95.2	81.9	84.6
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.218	0.158	0.145	0.166	0.230
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	13.0	13.2	11.6	6.3	15.3
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.11	0.879	0.889	1.03	1.05
	Vanadium (V) (mg/kg)	32.5	23.0	22.7	26.9	32.7
	Zinc (Zn) (mg/kg)	83.5	57.6	61.4	98.5	96.0
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	1.1	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.016	DLQ <0.0080	<0.0050	DLQ <0.14	DLQ <0.030
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	0.0130	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	0.0094	<0.0040
	Benz(a)anthracene (mg/kg)	<0.010	<0.010	<0.010	0.056	0.020
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	0.023	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.027	0.013	0.010	0.165	0.057
	Benzo(e)pyrene (mg/kg)	0.023	0.011	<0.010	0.141	0.049
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010	<0.010	0.038	0.014
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	0.011	<0.010
	Chrysene (mg/kg)	0.067	0.032	0.022	0.438	0.150
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050	<0.0050	0.0287	0.0090
	Fluoranthene (mg/kg)	0.012	<0.010	<0.010	0.079	0.027
	Fluorene (mg/kg)	0.017	<0.010	<0.010	0.187	0.036
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	0.012	<0.010
	1-Methylnaphthalene (mg/kg)	0.181	0.105	0.041	1.67	0.344
	2-Methylnaphthalene (mg/kg)	0.335	0.178	0.072	3.12	0.621
	Naphthalene (mg/kg)	0.079	0.051	0.022	0.722	0.149
	Perylene (mg/kg)	0.026	0.030	<0.010	<0.010	DLCI <0.020
	Phenanthrene (mg/kg)	0.212	0.106	0.050	1.45	0.419
	Pyrene (mg/kg)	0.019	0.011	<0.010	0.133	0.043
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	80.9	83.1	73.0	87.1	79.1
	Surrogate: d12-Chrysene (%)	89.9	94.5	80.8	83.6	86.2
	Surrogate: d8-Naphthalene (%)	75.5	78.7	70.2	74.6	73.2
	Surrogate: d10-Phenanthrene (%)	86.9	88.5	75.0	85.2	85.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1992278-11	L1992278-12	L1992278-13	L1992278-14	L1992278-15
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	09-SEP-17	09-SEP-17	09-SEP-17	08-SEP-17
	Sampled Time					
	Client ID	GH_SC1-P1-3	GH_ERSC5-1	GH_ERSC5-2	GH_ERSC5-3	GH_ERSC4-X
SOIL						
Metals	Strontium (Sr) (mg/kg)	84.4	84.3	85.6	79.1	85.2
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.153	0.200	0.181	0.205	0.161
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	18.6	13.2	10.8	11.0	11.2
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.899	1.05	0.992	1.09	0.985
	Vanadium (V) (mg/kg)	29.6	29.0	26.0	24.9	22.6
	Zinc (Zn) (mg/kg)	106	72.1	67.5	80.5	70.1
	Zirconium (Zr) (mg/kg)	1.2	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	DLQ <0.039	<0.0050	<0.0050	<0.0050	<0.0050
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	0.0057	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	0.037	<0.010	<0.010	<0.010	<0.010
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.140	0.022	<0.010	0.015	<0.010
	Benzo(e)pyrene (mg/kg)	0.101	DLCI <0.020	<0.010	DLCI <0.020	<0.010
	Benzo(g,h,i)perylene (mg/kg)	0.023	<0.010	<0.010	<0.010	<0.010
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.327	0.045	0.018	0.030	0.011
	Dibenz(a,h)anthracene (mg/kg)	0.0193	<0.0050	<0.0050	<0.0050	<0.0050
	Fluoranthene (mg/kg)	0.085	0.010	<0.010	<0.010	<0.010
	Fluorene (mg/kg)	0.039	<0.010	<0.010	<0.010	<0.010
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.327	0.064	0.032	0.042	0.025
	2-Methylnaphthalene (mg/kg)	0.529	0.093	0.046	0.058	0.033
	Naphthalene (mg/kg)	0.119	0.035	0.017	0.023	0.015
	Perylene (mg/kg)	<0.010	DLCI <0.020	<0.010	DLCI <0.020	<0.010
	Phenanthrene (mg/kg)	0.647	0.107	0.045	0.063	0.031
	Pyrene (mg/kg)	0.134	0.012	<0.010	<0.010	<0.010
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	71.8	77.3	72.7	83.9	73.5
	Surrogate: d12-Chrysene (%)	73.9	90.1	86.0	93.3	82.5
	Surrogate: d8-Naphthalene (%)	68.0	71.8	70.7	81.4	68.4
	Surrogate: d10-Phenanthrene (%)	73.2	86.4	78.9	89.4	72.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992278-16 SEDIMENT 08-SEP-17 GH_ERSC4-1	L1992278-17 SEDIMENT 08-SEP-17 GH_ERSC4-2	L1992278-18 SEDIMENT 08-SEP-17 GH_ERSC4-3	L1992278-19 SEDIMENT 10-SEP-17 GH_ER2-1	L1992278-20 SEDIMENT 10-SEP-17 GH_ER2-2
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	89.3	94.1	86.6	103	116
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.167	0.201	0.166	0.166	0.150
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	10.8	11.6	11.4	13.8	9.5
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.03	1.11	0.954	1.02	0.992
	Vanadium (V) (mg/kg)	23.3	26.7	23.8	22.6	23.8
	Zinc (Zn) (mg/kg)	71.0	82.6	69.5	78.9	71.5
	Zirconium (Zr) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0060 DLQ	<0.0050
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.012	<0.010	0.022	0.018	0.014
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010	<0.020 DLCI	<0.020 DLCI	<0.020 DLCI
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.027	0.020	0.050	0.041	0.033
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Fluoranthene (mg/kg)	<0.010	<0.010	<0.010	0.011	<0.010
	Fluorene (mg/kg)	<0.010	<0.010	<0.010	0.014	<0.010
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.049	0.017	0.062	0.107	0.065
	2-Methylnaphthalene (mg/kg)	0.062	0.020	0.071	0.160	0.091
	Naphthalene (mg/kg)	0.029	<0.010	0.040	0.067	0.037
	Perylene (mg/kg)	<0.020 DLCI	<0.020 DLCI	0.022	0.023	<0.020 DLCI
	Phenanthrene (mg/kg)	0.075	0.033	0.127	0.143	0.096
	Pyrene (mg/kg)	<0.010	<0.010	0.012	0.013	<0.010
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	76.9	76.8	89.6	78.7	75.7
	Surrogate: d12-Chrysene (%)	85.5	82.8	113.3	82.1	82.9
	Surrogate: d8-Naphthalene (%)	73.6	73.3	81.3	74.2	71.3
	Surrogate: d10-Phenanthrene (%)	81.7	81.2	98.9	82.8	84.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1992278-21 SEDIMENT 10-SEP-17 GH_ER2-3	L1992278-25 SEDIMENT 09-SEP-17 GH_ER1A-1	L1992278-26 SEDIMENT 09-SEP-17 GH_ER1A-2	L1992278-27 SEDIMENT 09-SEP-17 GH_ER1A-3	L1992278-28 SEDIMENT 10-SEP-17 GH_ERC-1
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	98.2	82.7	85.9	86.1	98.8
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.162	0.270	0.218	0.307	0.221
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	7.1	14.7	10.8	15.6	14.2
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.10	1.36	1.11	1.29	1.12
	Vanadium (V) (mg/kg)	22.5	35.3	28.2	40.9	28.6
	Zinc (Zn) (mg/kg)	80.1	105	95.3	119	81.0
	Zirconium (Zr) (mg/kg)	<1.0	1.1	<1.0	1.1	<1.0
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0070 DLQ
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Acridine (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Benz(a)anthracene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b&j)fluoranthene (mg/kg)	0.011	<0.010	0.012	<0.010	0.015
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010	0.011	<0.010	0.013
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Chrysene (mg/kg)	0.024	0.014	0.029	0.020	0.032
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Fluoranthene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Fluorene (mg/kg)	0.011	<0.010	<0.010	<0.010	0.017
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	1-Methylnaphthalene (mg/kg)	0.053	0.015	0.047	0.020	0.090
	2-Methylnaphthalene (mg/kg)	0.078	0.018	0.074	0.023	0.153
	Naphthalene (mg/kg)	0.038	<0.010	0.029	<0.010	0.056
	Perylene (mg/kg)	0.025	<0.010	0.010	<0.010	0.013
	Phenanthrene (mg/kg)	0.071	0.026	0.075	0.037	0.099
	Pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	0.011
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	81.7	81.4	80.7	79.8	76.4
	Surrogate: d12-Chrysene (%)	91.7	94.9	93.6	89.9	87.3
	Surrogate: d8-Naphthalene (%)	81.4	83.7	82.4	81.5	77.2
	Surrogate: d10-Phenanthrene (%)	92.2	91.2	89.8	89.6	87.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-29	L1992278-30			
	Description	SEDIMENT	SEDIMENT			
	Sampled Date	10-SEP-17	10-SEP-17			
	Sampled Time					
	Client ID	GH_ERC-2	GH_ERC-3			
Grouping	**Analyte**					
SOIL						
Metals	Strontium (Sr) (mg/kg)	80.2	80.3			
	Sulfur (S) (mg/kg)	<1000	<1000			
	Thallium (Tl) (mg/kg)	0.208	0.198			
	Tin (Sn) (mg/kg)	<2.0	<2.0			
	Titanium (Ti) (mg/kg)	12.4	15.7			
	Tungsten (W) (mg/kg)	<0.50	<0.50			
	Uranium (U) (mg/kg)	0.944	0.943			
	Vanadium (V) (mg/kg)	28.0	27.5			
	Zinc (Zn) (mg/kg)	73.9	69.6			
	Zirconium (Zr) (mg/kg)	<1.0	<1.0			
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050	<0.0050			
	Acenaphthylene (mg/kg)	<0.0050	<0.0050			
	Acridine (mg/kg)	<0.010	<0.010			
	Anthracene (mg/kg)	<0.0040	<0.0040			
	Benz(a)anthracene (mg/kg)	<0.010	<0.010			
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010			
	Benzo(b&j)fluoranthene (mg/kg)	<0.010	<0.010			
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010			
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010			
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010			
	Chrysene (mg/kg)	0.020	0.014			
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050			
	Fluoranthene (mg/kg)	<0.010	<0.010			
	Fluorene (mg/kg)	<0.010	<0.010			
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010			
	1-Methylnaphthalene (mg/kg)	0.053	0.028			
	2-Methylnaphthalene (mg/kg)	0.086	0.043			
	Naphthalene (mg/kg)	0.029	0.014			
	Perylene (mg/kg)	<0.010	<0.010			
	Phenanthrene (mg/kg)	0.060	0.040			
	Pyrene (mg/kg)	<0.010	<0.010			
	Quinoline (mg/kg)	<0.010	<0.010			
	Surrogate: d10-Acenaphthene (%)	83.3	77.8			
	Surrogate: d12-Chrysene (%)	96.4	97.0			
	Surrogate: d8-Naphthalene (%)	84.2	73.8			
	Surrogate: d10-Phenanthrene (%)	93.4	95.3			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-1	L1992278-2	L1992278-3	L1992278-4	L1992278-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17
	Sampled Time					
	Client ID	GH_ERSC2-1	GH_ERSC2-2	GH_ERSC2-X	GH_ERSC2-3	GH_SC2-P1-1
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	0.023	0.020	0.023	0.023	<0.020
	IACR (CCME) (mg/kg)	0.53	0.43	0.54	0.53	0.35

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID / Description / Sampled Date / Sampled Time / Client ID	L1992278-6	L1992278-7	L1992278-8	L1992278-9	L1992278-10
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17	11-SEP-17
	Sampled Time					
	Client ID	GH_SC2-P2-1	GH_SC2-P2-2	GH_SC2-P3-1	GH_SC1-P1-1	GH_SC1-P1-2
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	0.081	0.024
	IACR (CCME) (mg/kg)	0.27	0.17	<0.15	1.67	0.58

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-11	L1992278-12	L1992278-13	L1992278-14	L1992278-15
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	11-SEP-17	09-SEP-17	09-SEP-17	09-SEP-17	08-SEP-17
	Sampled Time					
	Client ID	GH_SC1-P1-3	GH_ERSC5-1	GH_ERSC5-2	GH_ERSC5-3	GH_ERSC4-X
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	0.046	<0.020	<0.020	<0.020	<0.020
	IACR (CCME) (mg/kg)	1.27	0.23	<0.15	0.18	<0.15

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-16	L1992278-17	L1992278-18	L1992278-19	L1992278-20
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	08-SEP-17	08-SEP-17	08-SEP-17	10-SEP-17	10-SEP-17
	Sampled Time					
	Client ID	GH_ERSC4-1	GH_ERSC4-2	GH_ERSC4-3	GH_ER2-1	GH_ER2-2
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME) (mg/kg)	0.16	<0.15	0.23	0.20	0.18

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-21	L1992278-25	L1992278-26	L1992278-27	L1992278-28
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	10-SEP-17	09-SEP-17	09-SEP-17	09-SEP-17	10-SEP-17
	Sampled Time					
	Client ID	GH_ER2-3	GH_ER1A-1	GH_ER1A-2	GH_ER1A-3	GH_ERC-1
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME) (mg/kg)	0.15	<0.15	0.16	<0.15	0.18

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1992278-29	L1992278-30			
	Description	SEDIMENT	SEDIMENT			
	Sampled Date	10-SEP-17	10-SEP-17			
	Sampled Time					
	Client ID	GH_ERC-2	GH_ERC-3			
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020			
	IACR (CCME) (mg/kg)	<0.15	<0.15			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1992278-19	GH_ER2-1	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1992278-28	GH_ERC-1	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1992278-29	GH_ERC-2	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1992278-30	GH_ERC-3	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLQ	Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAA-CL	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference**
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
MET-200.2-CCMS-CL	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-CL	Soil	% Moisture	CWS for PHC in Soil - Tier 1

This analysis is carried out gravimetrically by drying the sample at 105 C

ALS Test Code	Matrix	Test Description	Method Reference**
PAH-TMB-D/A-MS-CL	Soil	PAH by Tumbler Extraction (DCM/Acetone)	EPA 3570/8270

Polycyclic Aromatic Hydrocarbons in Sediment/Soil
This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of DCM and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

ALS Test Code	Matrix	Test Description	Method Reference**
PSA-PIPET-DETAIL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Reference Information

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1992278 Report Date: 02-OCT-17

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9
Contact: Jess Tester

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R3835038								
WG2619933-1 DUP		**L1992278-7**						
Inorganic Carbon		1.35	1.32		%	1.9	20	21-SEP-17
WG2619933-2 LCS								
Inorganic Carbon			99.1		%		80-120	21-SEP-17
WG2619933-3 MB								
Inorganic Carbon			<0.050		%		0.05	21-SEP-17
Batch R3836083								
WG2619935-2 LCS								
Inorganic Carbon			108.4		%		80-120	22-SEP-17
WG2619935-3 MB								
Inorganic Carbon			<0.050		%		0.05	22-SEP-17
C-TOT-LECO-SK	**Soil**							
Batch R3835239								
WG2619835-1 DUP		**L1992278-10**						
Total Carbon by Combustion		9.91	9.89		%	0.2	20	21-SEP-17
WG2619835-2 IRM		**08-109 SOIL**						
Total Carbon by Combustion			96.7		%		80-120	21-SEP-17
WG2619835-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	21-SEP-17
Batch R3836726								
WG2619864-1 DUP		**L1992278-25**						
Total Carbon by Combustion		7.10	6.82		%	4.1	20	21-SEP-17
WG2619864-2 IRM		**08-109 SOIL**						
Total Carbon by Combustion			100.0		%		80-120	21-SEP-17
WG2619864-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	21-SEP-17
HG-200.2-CVAA-CL	**Soil**							
Batch R3835117								
WG2621450-13 CRM		**TILL-1**						
Mercury (Hg)			100.1		%		70-130	21-SEP-17
WG2621450-18 CRM		**TILL-1**						
Mercury (Hg)			109.1		%		70-130	21-SEP-17
WG2621450-8 CRM		**TILL-1**						
Mercury (Hg)			110.9		%		70-130	21-SEP-17
WG2621450-15 DUP		**L1992278-8**						
Mercury (Hg)		0.0160	0.0183		mg/kg	13	40	21-SEP-17
WG2621450-20 DUP		**L1992278-25**						
Mercury (Hg)		0.0681	0.0683		mg/kg	0.4	40	21-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAA-CL	**Soil**							
Batch R3835117								
WG2621450-14 LCS								
Mercury (Hg)			101.0		%		80-120	21-SEP-17
WG2621450-19 LCS								
Mercury (Hg)			110.0		%		80-120	21-SEP-17
WG2621450-9 LCS								
Mercury (Hg)			108.0		%		80-120	21-SEP-17
WG2621450-11 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	21-SEP-17
WG2621450-16 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	21-SEP-17
WG2621450-6 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	21-SEP-17
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-13 CRM		**TILL-1**						
Aluminum (Al)			112.7		%		70-130	25-SEP-17
Antimony (Sb)			105.3		%		70-130	25-SEP-17
Arsenic (As)			107.7		%		70-130	25-SEP-17
Barium (Ba)			102.0		%		70-130	25-SEP-17
Beryllium (Be)			110.8		%		70-130	25-SEP-17
Bismuth (Bi)			107.8		%		70-130	25-SEP-17
Boron (B)			2.6		mg/kg		0-8.2	25-SEP-17
Cadmium (Cd)			110.1		%		70-130	25-SEP-17
Calcium (Ca)			105.8		%		70-130	25-SEP-17
Chromium (Cr)			113.8		%		70-130	25-SEP-17
Cobalt (Co)			113.3		%		70-130	25-SEP-17
Copper (Cu)			113.1		%		70-130	25-SEP-17
Iron (Fe)			111.3		%		70-130	25-SEP-17
Lead (Pb)			111.9		%		70-130	25-SEP-17
Lithium (Li)			113.8		%		70-130	25-SEP-17
Magnesium (Mg)			113.8		%		70-130	25-SEP-17
Manganese (Mn)			117.6		%		70-130	25-SEP-17
Molybdenum (Mo)			107.7		%		70-130	25-SEP-17
Nickel (Ni)			111.8		%		70-130	25-SEP-17
Phosphorus (P)			111.5		%		70-130	25-SEP-17
Potassium (K)			99.9		%		70-130	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-13 CRM		**TILL-1**						
Selenium (Se)			0.32		mg/kg		0.11-0.51	25-SEP-17
Silver (Ag)			0.23		mg/kg		0.13-0.33	25-SEP-17
Sodium (Na)			98.3		%		70-130	25-SEP-17
Strontium (Sr)			105.6		%		70-130	25-SEP-17
Thallium (Tl)			0.135		mg/kg		0.077-0.18	25-SEP-17
Tin (Sn)			1.1		mg/kg		0-3.1	25-SEP-17
Titanium (Ti)			102.2		%		70-130	25-SEP-17
Tungsten (W)			0.15		mg/kg		0-0.66	25-SEP-17
Uranium (U)			107.1		%		70-130	25-SEP-17
Vanadium (V)			108.3		%		70-130	25-SEP-17
Zinc (Zn)			110.9		%		70-130	25-SEP-17
Zirconium (Zr)			0.8		mg/kg		0-1.8	25-SEP-17
WG2621450-18 CRM		**TILL-1**						
Aluminum (Al)			110.2		%		70-130	25-SEP-17
Antimony (Sb)			100.8		%		70-130	25-SEP-17
Arsenic (As)			107.5		%		70-130	25-SEP-17
Barium (Ba)			101.0		%		70-130	25-SEP-17
Beryllium (Be)			92.1		%		70-130	25-SEP-17
Bismuth (Bi)			103.3		%		70-130	25-SEP-17
Boron (B)			3.0		mg/kg		0-8.2	25-SEP-17
Cadmium (Cd)			108.6		%		70-130	25-SEP-17
Calcium (Ca)			109.7		%		70-130	25-SEP-17
Chromium (Cr)			110.4		%		70-130	25-SEP-17
Cobalt (Co)			109.2		%		70-130	25-SEP-17
Copper (Cu)			107.5		%		70-130	25-SEP-17
Iron (Fe)			107.6		%		70-130	25-SEP-17
Lead (Pb)			108.3		%		70-130	25-SEP-17
Lithium (Li)			110.7		%		70-130	25-SEP-17
Magnesium (Mg)			112.4		%		70-130	25-SEP-17
Manganese (Mn)			110.8		%		70-130	25-SEP-17
Molybdenum (Mo)			101.3		%		70-130	25-SEP-17
Nickel (Ni)			108.3		%		70-130	25-SEP-17
Phosphorus (P)			121.3		%		70-130	25-SEP-17
Potassium (K)			104.7		%		70-130	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-18 CRM		**TILL-1**						
Selenium (Se)			0.29		mg/kg		0.11-0.51	25-SEP-17
Silver (Ag)			0.23		mg/kg		0.13-0.33	25-SEP-17
Sodium (Na)			103.4		%		70-130	25-SEP-17
Strontium (Sr)			110.0		%		70-130	25-SEP-17
Thallium (Tl)			0.129		mg/kg		0.077-0.18	25-SEP-17
Tin (Sn)			1.1		mg/kg		0-3.1	25-SEP-17
Titanium (Ti)			116.8		%		70-130	25-SEP-17
Tungsten (W)			0.16		mg/kg		0-0.66	25-SEP-17
Uranium (U)			107.6		%		70-130	25-SEP-17
Vanadium (V)			108.7		%		70-130	25-SEP-17
Zinc (Zn)			105.4		%		70-130	25-SEP-17
Zirconium (Zr)			0.7		mg/kg		0-1.8	25-SEP-17
WG2621450-8 CRM		**TILL-1**						
Aluminum (Al)			96.9		%		70-130	25-SEP-17
Antimony (Sb)			95.9		%		70-130	25-SEP-17
Arsenic (As)			93.4		%		70-130	25-SEP-17
Barium (Ba)			93.8		%		70-130	25-SEP-17
Beryllium (Be)			100.5		%		70-130	25-SEP-17
Bismuth (Bi)			92.2		%		70-130	25-SEP-17
Boron (B)			2.7		mg/kg		0-8.2	25-SEP-17
Cadmium (Cd)			100.2		%		70-130	25-SEP-17
Calcium (Ca)			98.2		%		70-130	25-SEP-17
Chromium (Cr)			94.7		%		70-130	25-SEP-17
Cobalt (Co)			97.2		%		70-130	25-SEP-17
Copper (Cu)			97.2		%		70-130	25-SEP-17
Iron (Fe)			90.2		%		70-130	25-SEP-17
Lead (Pb)			96.4		%		70-130	25-SEP-17
Lithium (Li)			97.3		%		70-130	25-SEP-17
Magnesium (Mg)			97.6		%		70-130	25-SEP-17
Manganese (Mn)			98.5		%		70-130	25-SEP-17
Molybdenum (Mo)			96.3		%		70-130	25-SEP-17
Nickel (Ni)			95.3		%		70-130	25-SEP-17
Phosphorus (P)			98.0		%		70-130	25-SEP-17
Potassium (K)			87.2		%		70-130	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-8 CRM		**TILL-1**						
Selenium (Se)			0.31		mg/kg		0.11-0.51	25-SEP-17
Silver (Ag)			0.22		mg/kg		0.13-0.33	25-SEP-17
Sodium (Na)			85.3		%		70-130	25-SEP-17
Strontium (Sr)			92.8		%		70-130	25-SEP-17
Thallium (Tl)			0.112		mg/kg		0.077-0.18	25-SEP-17
Tin (Sn)			1.0		mg/kg		0-3.1	25-SEP-17
Titanium (Ti)			87.2		%		70-130	25-SEP-17
Tungsten (W)			0.13		mg/kg		0-0.66	25-SEP-17
Uranium (U)			96.6		%		70-130	25-SEP-17
Vanadium (V)			95.3		%		70-130	25-SEP-17
Zinc (Zn)			90.7		%		70-130	25-SEP-17
Zirconium (Zr)			0.7		mg/kg		0-1.8	25-SEP-17
WG2621450-15 DUP		**L1992278-8**						
Aluminum (Al)		5980	5310		mg/kg	12	40	25-SEP-17
Antimony (Sb)		0.41	0.41		mg/kg	1.1	30	25-SEP-17
Arsenic (As)		5.38	5.25		mg/kg	2.5	30	25-SEP-17
Barium (Ba)		97.2	96.7		mg/kg	0.5	40	25-SEP-17
Beryllium (Be)		0.47	0.44		mg/kg	6.0	30	25-SEP-17
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	25-SEP-17
Boron (B)		5.8	<5.0	RPD-NA	mg/kg	N/A	30	25-SEP-17
Cadmium (Cd)		0.576	0.594		mg/kg	2.9	30	25-SEP-17
Calcium (Ca)		68200	62900		mg/kg	8.0	30	25-SEP-17
Chromium (Cr)		15.3	14.1		mg/kg	8.3	30	25-SEP-17
Cobalt (Co)		4.18	4.68		mg/kg	11	30	25-SEP-17
Copper (Cu)		9.14	8.96		mg/kg	1.9	30	25-SEP-17
Iron (Fe)		12900	12700		mg/kg	1.8	30	25-SEP-17
Lead (Pb)		6.36	6.42		mg/kg	0.9	40	25-SEP-17
Lithium (Li)		9.6	9.4		mg/kg	1.9	30	25-SEP-17
Magnesium (Mg)		11300	11200		mg/kg	1.1	30	25-SEP-17
Manganese (Mn)		348	386		mg/kg	10	30	25-SEP-17
Molybdenum (Mo)		1.35	1.35		mg/kg	0.2	40	25-SEP-17
Nickel (Ni)		16.6	16.7		mg/kg	0.2	30	25-SEP-17
Phosphorus (P)		1130	1180		mg/kg	4.3	30	25-SEP-17
Potassium (K)		1240	1000		mg/kg	21	40	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-15 DUP		**L1992278-8**						
Selenium (Se)		0.57	0.55		mg/kg	2.9	30	25-SEP-17
Silver (Ag)		<0.10	<0.10	RPD-NA	mg/kg	N/A	40	25-SEP-17
Sodium (Na)		83	76		mg/kg	9.1	40	25-SEP-17
Strontium (Sr)		95.2	87.5		mg/kg	8.4	40	25-SEP-17
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	25-SEP-17
Thallium (Tl)		0.145	0.142		mg/kg	2.2	30	25-SEP-17
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	25-SEP-17
Titanium (Ti)		11.6	8.8		mg/kg	28	40	25-SEP-17
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	25-SEP-17
Uranium (U)		0.889	0.885		mg/kg	0.4	30	25-SEP-17
Vanadium (V)		22.7	21.4		mg/kg	5.7	30	25-SEP-17
Zinc (Zn)		61.4	63.8		mg/kg	3.9	30	25-SEP-17
Zirconium (Zr)		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	25-SEP-17
WG2621450-20 DUP		**L1992278-25**						
Aluminum (Al)		8130	6620		mg/kg	20	40	25-SEP-17
Antimony (Sb)		0.61	0.58		mg/kg	4.1	30	25-SEP-17
Arsenic (As)		6.10	6.16		mg/kg	1.0	30	25-SEP-17
Barium (Ba)		151	140		mg/kg	7.9	40	25-SEP-17
Beryllium (Be)		0.58	0.60		mg/kg	2.8	30	25-SEP-17
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	25-SEP-17
Boron (B)		8.7	6.3	J	mg/kg	2.4	10	25-SEP-17
Cadmium (Cd)		1.06	1.05		mg/kg	1.0	30	25-SEP-17
Calcium (Ca)		47800	48700		mg/kg	1.7	30	25-SEP-17
Chromium (Cr)		22.4	18.9		mg/kg	17	30	25-SEP-17
Cobalt (Co)		5.42	5.40		mg/kg	0.3	30	25-SEP-17
Copper (Cu)		15.4	15.3		mg/kg	0.6	30	25-SEP-17
Iron (Fe)		14400	14300		mg/kg	0.6	30	25-SEP-17
Lead (Pb)		9.38	9.04		mg/kg	3.6	40	25-SEP-17
Lithium (Li)		14.4	12.9		mg/kg	11	30	25-SEP-17
Magnesium (Mg)		15300	15600		mg/kg	1.9	30	25-SEP-17
Manganese (Mn)		478	471		mg/kg	1.5	30	25-SEP-17
Molybdenum (Mo)		1.56	1.58		mg/kg	1.6	40	25-SEP-17
Nickel (Ni)		23.1	22.5		mg/kg	2.7	30	25-SEP-17
Phosphorus (P)		1440	1330		mg/kg	8.0	30	25-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-20 DUP		**L1992278-25**						
Potassium (K)		1890	1340		mg/kg	34	40	25-SEP-17
Selenium (Se)		2.01	1.84		mg/kg	9.0	30	25-SEP-17
Silver (Ag)		0.25	0.24		mg/kg	1.8	40	25-SEP-17
Sodium (Na)		83	78		mg/kg	6.2	40	25-SEP-17
Strontium (Sr)		82.7	78.4		mg/kg	5.3	40	25-SEP-17
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	25-SEP-17
Thallium (Tl)		0.270	0.236		mg/kg	13	30	25-SEP-17
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	25-SEP-17
Titanium (Ti)		14.7	16.8		mg/kg	13	40	25-SEP-17
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	25-SEP-17
Uranium (U)		1.36	1.29		mg/kg	5.7	30	25-SEP-17
Vanadium (V)		35.3	29.7		mg/kg	17	30	25-SEP-17
Zinc (Zn)		105	102		mg/kg	3.1	30	25-SEP-17
Zirconium (Zr)		1.1	1.3		mg/kg	18	30	25-SEP-17
WG2621450-14 LCS								
Aluminum (Al)			96.2		%		80-120	25-SEP-17
Antimony (Sb)			97.5		%		80-120	25-SEP-17
Arsenic (As)			99.5		%		80-120	25-SEP-17
Barium (Ba)			94.2		%		80-120	25-SEP-17
Beryllium (Be)			98.6		%		80-120	25-SEP-17
Bismuth (Bi)			97.3		%		80-120	25-SEP-17
Boron (B)			94.6		%		80-120	25-SEP-17
Cadmium (Cd)			96.5		%		80-120	25-SEP-17
Calcium (Ca)			95.9		%		80-120	25-SEP-17
Chromium (Cr)			97.0		%		80-120	25-SEP-17
Cobalt (Co)			97.0		%		80-120	25-SEP-17
Copper (Cu)			95.8		%		80-120	25-SEP-17
Iron (Fe)			109.9		%		80-120	25-SEP-17
Lead (Pb)			99.8		%		80-120	25-SEP-17
Lithium (Li)			97.6		%		80-120	25-SEP-17
Magnesium (Mg)			98.0		%		80-120	25-SEP-17
Manganese (Mn)			99.8		%		80-120	25-SEP-17
Molybdenum (Mo)			98.1		%		80-120	25-SEP-17
Nickel (Ni)			95.2		%		80-120	25-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-14 LCS								
Potassium (K)			95.0		%		80-120	25-SEP-17
Selenium (Se)			95.1		%		80-120	25-SEP-17
Silver (Ag)			93.7		%		80-120	25-SEP-17
Sodium (Na)			93.8		%		80-120	25-SEP-17
Strontium (Sr)			96.5		%		80-120	25-SEP-17
Sulfur (S)			84.9		%		80-120	25-SEP-17
Thallium (Tl)			95.8		%		80-120	25-SEP-17
Tin (Sn)			95.9		%		80-120	25-SEP-17
Titanium (Ti)			90.4		%		80-120	25-SEP-17
Tungsten (W)			96.9		%		80-120	25-SEP-17
Uranium (U)			94.4		%		80-120	25-SEP-17
Vanadium (V)			95.5		%		80-120	25-SEP-17
Zinc (Zn)			91.9		%		80-120	25-SEP-17
Zirconium (Zr)			98.5		%		80-120	25-SEP-17
WG2621450-19 LCS								
Aluminum (Al)			105.1		%		80-120	26-SEP-17
Antimony (Sb)			100.3		%		80-120	26-SEP-17
Arsenic (As)			98.3		%		80-120	26-SEP-17
Barium (Ba)			93.7		%		80-120	26-SEP-17
Beryllium (Be)			88.4		%		80-120	26-SEP-17
Bismuth (Bi)			92.5		%		80-120	26-SEP-17
Boron (B)			94.3		%		80-120	26-SEP-17
Cadmium (Cd)			95.0		%		80-120	26-SEP-17
Calcium (Ca)			94.7		%		80-120	26-SEP-17
Chromium (Cr)			98.5		%		80-120	26-SEP-17
Cobalt (Co)			95.6		%		80-120	26-SEP-17
Copper (Cu)			92.4		%		80-120	26-SEP-17
Lead (Pb)			95.1		%		80-120	26-SEP-17
Lithium (Li)			93.8		%		80-120	26-SEP-17
Magnesium (Mg)			102.3		%		80-120	26-SEP-17
Manganese (Mn)			99.8		%		80-120	26-SEP-17
Molybdenum (Mo)			90.8		%		80-120	26-SEP-17
Nickel (Ni)			95.3		%		80-120	26-SEP-17
Potassium (K)			97.9		%		80-120	26-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-19 LCS								
Selenium (Se)			90.7		%		80-120	26-SEP-17
Silver (Ag)			84.1		%		80-120	26-SEP-17
Sodium (Na)			106.0		%		80-120	26-SEP-17
Strontium (Sr)			89.2		%		80-120	26-SEP-17
Sulfur (S)			88.6		%		80-120	26-SEP-17
Thallium (Tl)			91.8		%		80-120	26-SEP-17
Tin (Sn)			95.9		%		80-120	26-SEP-17
Titanium (Ti)			96.1		%		80-120	26-SEP-17
Tungsten (W)			101.4		%		80-120	26-SEP-17
Uranium (U)			91.7		%		80-120	26-SEP-17
Vanadium (V)			99.9		%		80-120	26-SEP-17
Zinc (Zn)			89.9		%		80-120	26-SEP-17
Zirconium (Zr)			91.9		%		80-120	26-SEP-17
WG2621450-9 LCS								
Aluminum (Al)			95.8		%		80-120	25-SEP-17
Antimony (Sb)			99.2		%		80-120	25-SEP-17
Arsenic (As)			95.0		%		80-120	25-SEP-17
Barium (Ba)			94.5		%		80-120	25-SEP-17
Beryllium (Be)			94.1		%		80-120	25-SEP-17
Bismuth (Bi)			89.4		%		80-120	25-SEP-17
Boron (B)			99.2		%		80-120	25-SEP-17
Cadmium (Cd)			93.9		%		80-120	25-SEP-17
Calcium (Ca)			95.8		%		80-120	25-SEP-17
Chromium (Cr)			85.1		%		80-120	25-SEP-17
Cobalt (Co)			94.0		%		80-120	25-SEP-17
Copper (Cu)			91.8		%		80-120	25-SEP-17
Iron (Fe)			100.5		%		80-120	25-SEP-17
Lead (Pb)			91.5		%		80-120	25-SEP-17
Lithium (Li)			94.6		%		80-120	25-SEP-17
Magnesium (Mg)			94.0		%		80-120	25-SEP-17
Manganese (Mn)			95.7		%		80-120	25-SEP-17
Molybdenum (Mo)			97.1		%		80-120	25-SEP-17
Nickel (Ni)			92.1		%		80-120	25-SEP-17
Potassium (K)			90.2		%		80-120	25-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-9 LCS								
Selenium (Se)			90.7		%		80-120	25-SEP-17
Silver (Ag)			84.3		%		80-120	25-SEP-17
Sodium (Na)			89.9		%		80-120	25-SEP-17
Strontium (Sr)			93.2		%		80-120	25-SEP-17
Sulfur (S)			90.3		%		80-120	25-SEP-17
Thallium (Tl)			92.8		%		80-120	25-SEP-17
Tin (Sn)			96.4		%		80-120	25-SEP-17
Titanium (Ti)			88.4		%		80-120	25-SEP-17
Tungsten (W)			94.1		%		80-120	25-SEP-17
Uranium (U)			89.7		%		80-120	25-SEP-17
Vanadium (V)			93.5		%		80-120	25-SEP-17
Zinc (Zn)			85.1		%		80-120	25-SEP-17
Zirconium (Zr)			97.2		%		80-120	25-SEP-17
WG2621450-11 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-17
Boron (B)			<5.0		mg/kg		5	25-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-17
Calcium (Ca)			<50		mg/kg		50	25-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-17
Iron (Fe)			<50		mg/kg		50	25-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-17
Lithium (Li)			<2.0		mg/kg		2	25-SEP-17
Magnesium (Mg)			<20		mg/kg		20	25-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-17
Phosphorus (P)			<50		mg/kg		50	25-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-11 MB								
Potassium (K)			<100		mg/kg		100	25-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-17
Sodium (Na)			<50		mg/kg		50	25-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-17
Sulfur (S)			<1000		mg/kg		1000	25-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-17
Tin (Sn)			<2.0		mg/kg		2	25-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-17
WG2621450-16 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-17
Boron (B)			<5.0		mg/kg		5	25-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-17
Calcium (Ca)			<50		mg/kg		50	25-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-17
Iron (Fe)			<50		mg/kg		50	25-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-17
Lithium (Li)			<2.0		mg/kg		2	25-SEP-17
Magnesium (Mg)			<20		mg/kg		20	25-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-16 MB								
Phosphorus (P)			<50		mg/kg		50	25-SEP-17
Potassium (K)			<100		mg/kg		100	25-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-17
Sodium (Na)			<50		mg/kg		50	25-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-17
Sulfur (S)			<1000		mg/kg		1000	25-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-17
Tin (Sn)			<2.0		mg/kg		2	25-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-17
WG2621450-6 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-17
Boron (B)			<5.0		mg/kg		5	25-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-17
Calcium (Ca)			<50		mg/kg		50	25-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-17
Iron (Fe)			<50		mg/kg		50	25-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-17
Lithium (Li)			<2.0		mg/kg		2	25-SEP-17
Magnesium (Mg)			<20		mg/kg		20	25-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3837593								
WG2621450-6 MB								
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-17
Phosphorus (P)			<50		mg/kg		50	25-SEP-17
Potassium (K)			<100		mg/kg		100	25-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-17
Sodium (Na)			<50		mg/kg		50	25-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-17
Sulfur (S)			<1000		mg/kg		1000	25-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-17
Tin (Sn)			<2.0		mg/kg		2	25-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-17
MOISTURE-CL	**Soil**							
Batch R3834706								
WG2620584-2 LCS								
Moisture			100.1		%		90-110	21-SEP-17
WG2620584-1 MB								
Moisture			<0.25		%		0.25	21-SEP-17
Batch R3835851								
WG2618959-3 DUP		**L1992278-1**						
Moisture		47.2	44.0		%	7.1	20	22-SEP-17
WG2618959-2 LCS								
Moisture			104.1		%		90-110	22-SEP-17
WG2618959-1 MB								
Moisture			<0.25		%		0.25	22-SEP-17
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3843369								
WG2630049-3 DUP		**L1992278-1**						
Acenaphthene		<0.028	<0.028	RPD-NA	mg/kg	N/A	50	20-SEP-17
Acenaphthylene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	20-SEP-17
Acridine		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	20-SEP-17

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3843369								
WG2630049-3 DUP		**L1992278-1**						
Anthracene		<0.0040	<0.0040	RPD-NA	mg/kg	N/A	50	20-SEP-17
Benz(a)anthracene		0.018	0.018		mg/kg	5.0	50	20-SEP-17
Benzo(a)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	20-SEP-17
Benzo(b&j)fluoranthene		0.051	0.047		mg/kg	8.7	50	20-SEP-17
Benzo(g,h,i)perylene		0.013	0.012		mg/kg	9.5	50	20-SEP-17
Benzo(k)fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	20-SEP-17
Benzo(e)pyrene		0.044	0.040		mg/kg	10	50	20-SEP-17
Chrysene		0.141	0.120		mg/kg	16	50	20-SEP-17
Dibenz(a,h)anthracene		0.0087	0.0072		mg/kg	19	50	20-SEP-17
Fluoranthene		0.024	0.021		mg/kg	15	50	20-SEP-17
Fluorene		0.035	0.031		mg/kg	13	50	20-SEP-17
Indeno(1,2,3-c,d)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	20-SEP-17
1-Methylnaphthalene		0.378	0.321		mg/kg	16	50	20-SEP-17
2-Methylnaphthalene		0.696	0.584		mg/kg	18	50	20-SEP-17
Naphthalene		0.194	0.155		mg/kg	22	50	20-SEP-17
Perylene		0.015	0.013		mg/kg	12	50	20-SEP-17
Phenanthrene		0.451	0.364		mg/kg	21	50	20-SEP-17
Pyrene		0.042	0.034		mg/kg	21	50	20-SEP-17
Quinoline		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	20-SEP-17
WG2630049-2 LCS								
Acenaphthene			87.0		%		60-130	20-SEP-17
Acenaphthylene			89.9		%		60-130	20-SEP-17
Acridine			96.0		%		50-150	20-SEP-17
Anthracene			92.7		%		60-130	20-SEP-17
Benz(a)anthracene			99.2		%		60-130	20-SEP-17
Benzo(a)pyrene			99.8		%		60-130	20-SEP-17
Benzo(b&j)fluoranthene			98.8		%		60-130	20-SEP-17
Benzo(g,h,i)perylene			103.5		%		60-130	20-SEP-17
Benzo(k)fluoranthene			99.3		%		60-130	20-SEP-17
Benzo(e)pyrene			101.4		%		50-150	20-SEP-17
Chrysene			103.9		%		60-130	20-SEP-17
Dibenz(a,h)anthracene			105.4		%		60-130	20-SEP-17
Fluoranthene			96.1		%		60-130	20-SEP-17
Fluorene			90.4		%		60-130	20-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3843369								
WG2630049-2 LCS								
Indeno(1,2,3-c,d)pyrene			99.6		%		60-130	20-SEP-17
1-Methylnaphthalene			93.0		%		50-150	20-SEP-17
2-Methylnaphthalene			95.7		%		60-130	20-SEP-17
Naphthalene			92.1		%		50-130	20-SEP-17
Perylene			106.6		%		50-150	20-SEP-17
Phenanthrene			91.0		%		60-130	20-SEP-17
Pyrene			96.2		%		60-130	20-SEP-17
Quinoline			94.5		%		50-150	20-SEP-17
WG2630049-1 MB								
Acenaphthene			<0.0050		mg/kg		0.005	20-SEP-17
Acenaphthylene			<0.0050		mg/kg		0.005	20-SEP-17
Acridine			<0.010		mg/kg		0.01	20-SEP-17
Anthracene			<0.0040		mg/kg		0.004	20-SEP-17
Benz(a)anthracene			<0.010		mg/kg		0.01	20-SEP-17
Benzo(a)pyrene			<0.010		mg/kg		0.01	20-SEP-17
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	20-SEP-17
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	20-SEP-17
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	20-SEP-17
Benzo(e)pyrene			<0.010		mg/kg		0.01	20-SEP-17
Chrysene			<0.010		mg/kg		0.01	20-SEP-17
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	20-SEP-17
Fluoranthene			<0.010		mg/kg		0.01	20-SEP-17
Fluorene			<0.010		mg/kg		0.01	20-SEP-17
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	20-SEP-17
1-Methylnaphthalene			<0.010		mg/kg		0.01	20-SEP-17
2-Methylnaphthalene			<0.010		mg/kg		0.01	20-SEP-17
Naphthalene			<0.010		mg/kg		0.01	20-SEP-17
Perylene			<0.010		mg/kg		0.01	20-SEP-17
Phenanthrene			<0.010		mg/kg		0.01	20-SEP-17
Pyrene			<0.010		mg/kg		0.01	20-SEP-17
Quinoline			<0.010		mg/kg		0.01	20-SEP-17
Surrogate: d8-Naphthalene			101.9		%		50-130	20-SEP-17
Surrogate: d10-Acenaphthene			102.1		%		50-150	20-SEP-17
Surrogate: d10-Phenanthrene			98.4		%		60-130	20-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3843369								
WG2630049-1 MB								
Surrogate: d12-Chrysene			105.4		%		50-150	20-SEP-17
WG2630049-4 MS		**L1992278-2**						
Acenaphthene			81.1		%		50-150	20-SEP-17
Acenaphthylene			84.1		%		50-150	20-SEP-17
Acridine			102.2		%		50-150	20-SEP-17
Anthracene			90.8		%		50-150	20-SEP-17
Benz(a)anthracene			99.1		%		50-150	20-SEP-17
Benzo(a)pyrene			93.2		%		50-150	20-SEP-17
Benzo(b&j)fluoranthene			98.9		%		50-150	20-SEP-17
Benzo(g,h,i)perylene			84.7		%		50-150	20-SEP-17
Benzo(k)fluoranthene			93.2		%		50-150	20-SEP-17
Benzo(e)pyrene			97.8		%		50-150	20-SEP-17
Chrysene			108.2		%		50-150	20-SEP-17
Dibenz(a,h)anthracene			94.1		%		50-150	20-SEP-17
Fluoranthene			94.6		%		50-150	20-SEP-17
Fluorene			85.0		%		50-150	20-SEP-17
Indeno(1,2,3-c,d)pyrene			85.6		%		50-150	20-SEP-17
1-Methylnaphthalene			98.2		%		50-150	20-SEP-17
2-Methylnaphthalene			87.8		%		50-150	20-SEP-17
Naphthalene			83.6		%		50-150	20-SEP-17
Perylene			98.0		%		50-150	20-SEP-17
Phenanthrene			120.8		%		50-150	20-SEP-17
Pyrene			97.1		%		50-150	20-SEP-17
Quinoline			75.7		%		50-150	20-SEP-17
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3835249								
WG2619925-3 DUP		**L1992278-2**						
% Gravel (>2mm)		2.8	2.8		%	0.0	25	21-SEP-17
% Sand (2.00mm - 1.00mm)		10.1	10.2	J	%	0.1	5	21-SEP-17
% Sand (1.00mm - 0.50mm)		15.4	15.9	J	%	0.5	5	21-SEP-17
% Sand (0.50mm - 0.25mm)		6.8	7.2	J	%	0.3	5	21-SEP-17
% Sand (0.25mm - 0.125mm)		5.7	5.8	J	%	0.1	5	21-SEP-17
% Sand (0.125mm - 0.063mm)		7.2	7.4	J	%	0.2	5	21-SEP-17
% Silt (0.063mm - 0.0312mm)		18.4	16.6	J	%	1.8	5	21-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3835249								
WG2619925-3 DUP		**L1992278-2**						
% Silt (0.0312mm - 0.004mm)		26.0	27.0	J	%	1.0	5	21-SEP-17
% Clay (<4um)		7.6	7.2	J	%	0.5	5	21-SEP-17
WG2619925-4 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			3.1		%		0-7.6	21-SEP-17
% Sand (1.00mm - 0.50mm)			3.7		%		0-8.9	21-SEP-17
% Sand (0.50mm - 0.25mm)			10.6		%		5.3-15.3	21-SEP-17
% Sand (0.25mm - 0.125mm)			16.0		%		10-20	21-SEP-17
% Sand (0.125mm - 0.063mm)			13.4		%		7.3-17.3	21-SEP-17
% Silt (0.063mm - 0.0312mm)			13.1		%		9.9-19.9	21-SEP-17
% Silt (0.0312mm - 0.004mm)			20.6		%		17.6-27.6	21-SEP-17
% Clay (<4um)			19.6		%		13.4-23.4	21-SEP-17
Batch R3837216								
WG2619927-1 DUP		**L1992278-16**						
% Gravel (>2mm)		<1.0	<1.0	RPD-NA	%	N/A	25	22-SEP-17
% Sand (2.00mm - 1.00mm)		<1.0	<1.0	RPD-NA	%	N/A	5	22-SEP-17
% Sand (1.00mm - 0.50mm)		3.8	3.4	J	%	0.4	5	22-SEP-17
% Sand (0.50mm - 0.25mm)		11.7	11.8	J	%	0.0	5	22-SEP-17
% Sand (0.25mm - 0.125mm)		19.1	19.1	J	%	0.0	5	22-SEP-17
% Sand (0.125mm - 0.063mm)		18.0	16.9	J	%	1.1	5	22-SEP-17
% Silt (0.063mm - 0.0312mm)		18.8	19.0	J	%	0.1	5	22-SEP-17
% Silt (0.0312mm - 0.004mm)		21.8	22.9	J	%	1.1	5	22-SEP-17
% Clay (<4um)		6.3	6.2	J	%	0.1	5	22-SEP-17
WG2619927-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			3.1		%		0-7.6	22-SEP-17
% Sand (1.00mm - 0.50mm)			3.9		%		0-8.9	22-SEP-17
% Sand (0.50mm - 0.25mm)			10.3		%		5.3-15.3	22-SEP-17
% Sand (0.25mm - 0.125mm)			14.7		%		10-20	22-SEP-17
% Sand (0.125mm - 0.063mm)			12.8		%		7.3-17.3	22-SEP-17
% Silt (0.063mm - 0.0312mm)			13.9		%		9.9-19.9	22-SEP-17
% Silt (0.0312mm - 0.004mm)			22.6		%		17.6-27.6	22-SEP-17
% Clay (<4um)			18.8		%		13.4-23.4	22-SEP-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1992278-COFC

COC Number: 15 -

Page 1 of 3

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	[redacted] Jess Tester
Phone:	(905) 873-3371 ext. [redacted] 227
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	[redacted]
Email 2	[redacted]
Email 3	jtester@minnow.ca
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	[redacted] JTESTER@
Email 2	[redacted] MINNOW.CA

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply	
PRIORITY (Business Days)	4 day [P4] ☐	EMERGENCY: 1 Business day [E1] ☐
	3 day [P3] ☐	Same Day, Weekend or Statutory holiday [E0] ☐
	2 day [P2] ☐	
Date and Time Required for all E&P TATs:		

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information	
ALS Account # / Quote #:	Q51889
Job #:	17-24
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Lyuda Shvets	Sampler: JT/SW

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	[redacted]	[redacted]	moisture	metals	total organic carbon	[redacted]	[redacted]	[redacted]	particle size	[redacted]			Number of Containers
1	GH_ERSC2-1	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
2	GH_ERSC2-2	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
3	GH_ERSC2-X	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
4	GH_ERSC2-3	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
5	GH_SC2-P1-1	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
6	GH_SC2-P2-1	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
7	GH_SC2-P2-2	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
8	GH_SC2-P3-1	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
9	GH_SC1-P1-1	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
10	GH_SC1-P1-2	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
11	GH_SC1-P1-3	11-Sep-17		Sediment	✓			✓	✓	✓				✓				2
12	GH-ERSC 5-1	9-Sep-17		Sediment	✓			✓	✓	✓				✓				2

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Samples previously freeze dried

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐ No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated ☐			
INITIAL COOLER TEMPERATURES °C	6	FINAL COOLER TEMPERATURES °C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [redacted] Jess Tester	Date: [redacted] 14-SEP-17	Time: 8AM	Received by: [signature]	Date: 9/15	Time: 9:35	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1992278-COFC

COC Number: 15 -

Page 2 of 3

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	[redacted] JESS TESTER
Phone:	(905) 873-3371 ext. [redacted] 227
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	[redacted]
Email 2	[redacted]
Email 3	jtester@minnow.ca
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	[redacted] JTESTER@
Email 2	[redacted] MINNOW.CA

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply			
Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days) 4 day [P4]	☐	EMERGENCY 1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		
Date and Time Required for all E&P TATs:			

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information	
ALS Account # / Quote #:	Q51889
Job #:	17-24
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Lyuda Shvets	Sampler:

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type
15	GH_ERSC5-2	09-Sep-17		Sediment
	GH_ER SC5-3	09-Sep-17		Sediment
	GH_ERSC 4-X	08-Sep-17		Sediment
	GH_ERSC 4-1	08-Sep-17		Sediment
	GH_ERSC4-2	08-Sep-17		Sediment
	GH_ERSC4-3	08-Sep-17		Sediment
	GH_ER2-1	10-Sep-17		Sediment
	GH_ER2-2	10-Sep-17		Sediment
	GH_ER2-3	10-Sep-17		Sediment
	GH_ER2-1	10-Sep-17		Sediment
	GH_ER2-2 written twice.	10-Sep-17		Sediment
24	GH_ER2-3 JR 09/15	10-Sep-17		Sediment

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

Sample	PAH	[redacted]	[redacted]	moisture	metals [redacted]	total organic carbon	[redacted]	[redacted]	[redacted]	particle size	[redacted]			Number of Containers
GH_ERSC5-2	✓			✓	✓	✓				✓				2
GH_ER SC5-3	✓			✓	✓	✓				✓				2
GH_ERSC 4-X	✓			✓	✓	✓				✓				2
GH_ERSC 4-1	✓			✓	✓	✓				✓				2
GH_ERSC4-2	✓			✓	✓	✓				✓				1
GH_ERSC4-3	✓			✓	✓	✓				✓				2
GH_ER2-1	✓			✓	✓	✓				✓				2
GH_ER2-2	✓			✓	✓	✓				✓				2
GH_ER2-3	✓			✓	✓	✓				✓				2
GH_ER2-1	✓			✓	✓	✓				✓				2
GH_ER2-2	✓			✓	✓	✓				✓				2
GH_ER2-3	✓			✓	✓	✓				✓				2

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Samples previously freeze dried

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐	No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated ☐				

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [redacted] Jess Tester	Date: [redacted] 14-SEP-17	Time: 8AM	Received by: [signature]	Date: 9/15	Time: 7:35	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1992278-COFC

COC Number: 15 -

Page 3 of 3

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	[redacted] JESS TESTER
Phone:	(905) 873-3371 ext. [redacted] 227
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax [redacted]

Email 2 [redacted]

Email 3 jtester@minnow.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax [redacted] JTESTER

Email 2 [redacted] @MINNOW.CA

Service Level ... all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	Q51889
Job #:	17-24
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Lyuda Shvets	Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	[redacted]	[redacted]	moisture	metals[redacted]	total organic carbon ✓	[redacted]	[redacted]	[redacted]	particle size ✓	[redacted]			Number of Containers
5	GH_ER1A-1	09-Sep-17		Sediment	✓			✓	✓	✓				✓				2
6	GH_ER1A-2	09-Sep-17		Sediment	✓			✓	✓	✓				✓				2
7	GH_ER1A-3	09-Sep-17		Sediment	✓			✓	✓	✓				✓				2
8	GH_ERC-1	10-Sep-17		Sediment	✓			✓	✓	✓				✓				2
9	GH_ERC-2	10-Sep-17		Sediment	✓			✓	✓	✓				✓				2
10	GH_ERC-3	10-Sep-17		Sediment	✓			✓	✓	✓				✓				2
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Samples previously freeze dried

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [redacted] Jess Tester	Date: [redacted] 14-SEP-17	Time: 8AM	Received by: [illegible]	Date: [illegible]	Time: 9:36	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

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1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MINNOW ENVIRONMENTAL INC.
ATTN: Shari Weech
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 18-SEP-17
Report Date: 29-SEP-17 15:41 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1993047
Project P.O. #: NOT SUBMITTED
Job Reference: 17-24
C of C Numbers:
Legal Site Desc:

Comments:

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1993047-1 SEDIMENT 16-SEP-17 GH-SCW1	L1993047-2 SEDIMENT 16-SEP-17 GH-SCW2			
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	53.7	58.6			
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0			
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0			
	% Sand (1.00mm - 0.50mm) (%)	<1.0	<1.0			
	% Sand (0.50mm - 0.25mm) (%)	<1.0	<1.0			
	% Sand (0.25mm - 0.125mm) (%)	4.1	<1.0			
	% Sand (0.125mm - 0.063mm) (%)	7.9	<1.0			
	% Silt (0.063mm - 0.0312mm) (%)	35.1	33.4			
	% Silt (0.0312mm - 0.004mm) (%)	44.0	54.4			
	% Clay (<4um) (%)	8.5	11.9			
	Texture	Silt	Silt			
Organic / Inorganic Carbon	Total Organic Carbon (%)	7.63	5.10			
Metals	Aluminum (Al) (mg/kg)	8080	9820			
	Antimony (Sb) (mg/kg)	0.64	0.63			
	Arsenic (As) (mg/kg)	5.41	5.92			
	Barium (Ba) (mg/kg)	152	151			
	Beryllium (Be) (mg/kg)	0.53	0.63			
	Bismuth (Bi) (mg/kg)	<0.20	<0.20			
	Boron (B) (mg/kg)	11.0	13.0			
	Cadmium (Cd) (mg/kg)	1.20	1.12			
	Calcium (Ca) (mg/kg)	53300	71300			
	Chromium (Cr) (mg/kg)	16.6	19.5			
	Cobalt (Co) (mg/kg)	5.46	5.96			
	Copper (Cu) (mg/kg)	15.9	15.6			
	Iron (Fe) (mg/kg)	12700	13400			
	Lead (Pb) (mg/kg)	7.78	8.00			
	Lithium (Li) (mg/kg)	12.6	16.0			
	Magnesium (Mg) (mg/kg)	12300	18600			
	Manganese (Mn) (mg/kg)	474	558			
	Mercury (Hg) (mg/kg)	0.0525	0.0527			
	Molybdenum (Mo) (mg/kg)	1.49	1.76			
	Nickel (Ni) (mg/kg)	23.8	27.3			
	Phosphorus (P) (mg/kg)	1180	1320			
	Potassium (K) (mg/kg)	2020	2580			
	Selenium (Se) (mg/kg)	1.81	4.46			
	Silver (Ag) (mg/kg)	0.25	0.24			
	Sodium (Na) (mg/kg)	87	126			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1993047-1	L1993047-2				
	Description	SEDIMENT	SEDIMENT				
	Sampled Date	16-SEP-17	16-SEP-17				
	Sampled Time						
	Client ID	GH-SCW1	GH-SCW2				
Grouping	**Analyte**						
SOIL							
Metals	Strontium (Sr) (mg/kg)	99.8	106				
	Sulfur (S) (mg/kg)	<1000	<1000				
	Thallium (Tl) (mg/kg)	0.255	0.274				
	Tin (Sn) (mg/kg)	<2.0	<2.0				
	Titanium (Ti) (mg/kg)	14.5	17.2				
	Tungsten (W) (mg/kg)	<0.50	<0.50				
	Uranium (U) (mg/kg)	1.29	1.30				
	Vanadium (V) (mg/kg)	33.2	39.3				
	Zinc (Zn) (mg/kg)	92.2	108				
	Zirconium (Zr) (mg/kg)	1.1	<1.0				
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050	<0.014 DLQ				
	Acenaphthylene (mg/kg)	<0.0050	<0.0050				
	Acridine (mg/kg)	<0.010	<0.010				
	Anthracene (mg/kg)	<0.0040	<0.0040				
	Benz(a)anthracene (mg/kg)	<0.010	0.011				
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010				
	Benzo(b&j)fluoranthene (mg/kg)	0.014	0.029				
	Benzo(e)pyrene (mg/kg)	0.012	0.025				
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010				
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010				
	Chrysene (mg/kg)	0.031	0.065				
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050				
	Fluoranthene (mg/kg)	<0.010	0.014				
	Fluorene (mg/kg)	<0.010	0.022				
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010				
	1-Methylnaphthalene (mg/kg)	0.065	0.159				
	2-Methylnaphthalene (mg/kg)	0.088	0.276				
	Naphthalene (mg/kg)	0.042	0.084				
	Perylene (mg/kg)	0.018	0.018				
	Phenanthrene (mg/kg)	0.099	0.216				
	Pyrene (mg/kg)	<0.010	0.022				
	Quinoline (mg/kg)	<0.010	<0.010				
	Surrogate: d10-Acenaphthene (%)	79.7	88.0				
	Surrogate: d12-Chrysene (%)	89.7	96.0				
	Surrogate: d8-Naphthalene (%)	77.1	84.0				
	Surrogate: d10-Phenanthrene (%)	85.5	93.0				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1993047-1 SEDIMENT 16-SEP-17 GH-SCW1	L1993047-2 SEDIMENT 16-SEP-17 GH-SCW2			
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020			
	IACR (CCME) (mg/kg)	0.18	0.30			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1993047-1	GH-SCW1	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.
L1993047-2	GH-SCW2	PSAL	Limited sample was available for PSA (100g minimum is standard). Measurement Uncertainty for PSA results may be higher than usual.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Phosphorus (P)	MES	L1993047-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLQ	Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAA-CL	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference**
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
MET-200.2-CCMS-CL	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-CL	Soil	% Moisture	CWS for PHC in Soil - Tier 1

This analysis is carried out gravimetrically by drying the sample at 105 C

ALS Test Code	Matrix	Test Description	Method Reference**
PAH-TMB-D/A-MS-CL	Soil	PAH by Tumbler Extraction (DCM/Acetone)	EPA 3570/8270

Polycyclic Aromatic Hydrocarbons in Sediment/Soil
This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3570 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses a mechanical shaking technique to extract a subsample of the sediment/soil with a 1:1 mixture of DCM and acetone. The extract is then solvent exchanged to toluene. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS). Surrogate recoveries may not be reported in cases where interferences from the sample matrix prevent accurate quantitation. Because the two isomers cannot be readily chromatographically separated, benzo(j)fluoranthene is reported as part of the benzo(b)fluoranthene parameter.

ALS Test Code	Matrix	Test Description	Method Reference**
PSA-PIPET-DETAIL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Quality Control Report

Workorder: L1993047 Report Date: 29-SEP-17

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9

Contact: Shari Weech

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R3836087								
WG2620966-2 LCS								
Inorganic Carbon			104.2		%		80-120	22-SEP-17
WG2620966-3 MB								
Inorganic Carbon			<0.050		%		0.05	22-SEP-17
C-TOT-LECO-SK	**Soil**							
Batch R3836726								
WG2619864-2 IRM		**08-109 SOIL**						
Total Carbon by Combustion			100.0		%		80-120	21-SEP-17
WG2619864-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	21-SEP-17
HG-200.2-CVAA-CL	**Soil**							
Batch R3837366								
WG2623528-4 CRM		**TILL-1**						
Mercury (Hg)			93.8		%		70-130	25-SEP-17
WG2623528-3 LCS								
Mercury (Hg)			105.0		%		80-120	25-SEP-17
WG2623528-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	25-SEP-17
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-4 CRM		**TILL-1**						
Aluminum (Al)			122.7		%		70-130	26-SEP-17
Antimony (Sb)			114.8		%		70-130	26-SEP-17
Arsenic (As)			108.8		%		70-130	26-SEP-17
Barium (Ba)			106.7		%		70-130	26-SEP-17
Beryllium (Be)			108.5		%		70-130	26-SEP-17
Bismuth (Bi)			101.6		%		70-130	26-SEP-17
Boron (B)			7.6		mg/kg		0-8.2	26-SEP-17
Cadmium (Cd)			112.5		%		70-130	26-SEP-17
Calcium (Ca)			122.3		%		70-130	26-SEP-17
Chromium (Cr)			110.2		%		70-130	26-SEP-17
Cobalt (Co)			117.8		%		70-130	26-SEP-17
Copper (Cu)			117.4		%		70-130	26-SEP-17
Iron (Fe)			113.2		%		70-130	26-SEP-17
Lead (Pb)			107.1		%		70-130	26-SEP-17
Lithium (Li)			123.8		%		70-130	26-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-4 CRM		**TILL-1**						
Magnesium (Mg)			122.8		%		70-130	26-SEP-17
Manganese (Mn)			117.2		%		70-130	26-SEP-17
Molybdenum (Mo)			113.3		%		70-130	26-SEP-17
Nickel (Ni)			116.4		%		70-130	26-SEP-17
Phosphorus (P)			121.5		%		70-130	26-SEP-17
Potassium (K)			125.2		%		70-130	26-SEP-17
Selenium (Se)			0.38		mg/kg		0.11-0.51	26-SEP-17
Silver (Ag)			0.27		mg/kg		0.13-0.33	26-SEP-17
Sodium (Na)			127.4		%		70-130	26-SEP-17
Strontium (Sr)			127.4		%		70-130	26-SEP-17
Thallium (Tl)			0.139		mg/kg		0.077-0.18	26-SEP-17
Tin (Sn)			1.3		mg/kg		0-3.1	26-SEP-17
Titanium (Ti)			129.4		%		70-130	26-SEP-17
Tungsten (W)			0.16		mg/kg		0-0.66	26-SEP-17
Uranium (U)			109.5		%		70-130	26-SEP-17
Vanadium (V)			121.1		%		70-130	26-SEP-17
Zinc (Zn)			118.7		%		70-130	26-SEP-17
Zirconium (Zr)			1.0		mg/kg		0-1.8	26-SEP-17
WG2623528-3 LCS								
Aluminum (Al)			116.6		%		80-120	26-SEP-17
Antimony (Sb)			102.5		%		80-120	26-SEP-17
Arsenic (As)			98.8		%		80-120	26-SEP-17
Barium (Ba)			97.1		%		80-120	26-SEP-17
Beryllium (Be)			100.7		%		80-120	26-SEP-17
Bismuth (Bi)			95.0		%		80-120	26-SEP-17
Boron (B)			107.2		%		80-120	26-SEP-17
Cadmium (Cd)			95.1		%		80-120	26-SEP-17
Calcium (Ca)			102.7		%		80-120	26-SEP-17
Chromium (Cr)			90.9		%		80-120	26-SEP-17
Cobalt (Co)			100.3		%		80-120	26-SEP-17
Copper (Cu)			98.1		%		80-120	26-SEP-17
Iron (Fe)			110.9		%		80-120	26-SEP-17
Lead (Pb)			96.0		%		80-120	26-SEP-17
Lithium (Li)			101.2		%		80-120	26-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-3 LCS								
Magnesium (Mg)			101.6		%		80-120	26-SEP-17
Manganese (Mn)			99.7		%		80-120	26-SEP-17
Molybdenum (Mo)			101.4		%		80-120	26-SEP-17
Nickel (Ni)			97.8		%		80-120	26-SEP-17
Potassium (K)			101.6		%		80-120	26-SEP-17
Selenium (Se)			95.9		%		80-120	26-SEP-17
Silver (Ag)			100.0		%		80-120	26-SEP-17
Sodium (Na)			101.2		%		80-120	26-SEP-17
Strontium (Sr)			105.0		%		80-120	26-SEP-17
Sulfur (S)			101.3		%		80-120	26-SEP-17
Thallium (Tl)			91.0		%		80-120	26-SEP-17
Tin (Sn)			97.8		%		80-120	26-SEP-17
Titanium (Ti)			91.7		%		80-120	26-SEP-17
Tungsten (W)			99.3		%		80-120	26-SEP-17
Uranium (U)			90.4		%		80-120	26-SEP-17
Vanadium (V)			101.8		%		80-120	26-SEP-17
Zinc (Zn)			97.4		%		80-120	26-SEP-17
Zirconium (Zr)			99.0		%		80-120	26-SEP-17
WG2623528-1 MB								
Aluminum (Al)			<50		mg/kg		50	26-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	26-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	26-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	26-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	26-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	26-SEP-17
Boron (B)			<5.0		mg/kg		5	26-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	26-SEP-17
Calcium (Ca)			<50		mg/kg		50	26-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	26-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	26-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	26-SEP-17
Iron (Fe)			<50		mg/kg		50	26-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	26-SEP-17
Lithium (Li)			<2.0		mg/kg		2	26-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R3838457								
WG2623528-1 MB								
Magnesium (Mg)			<20		mg/kg		20	26-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	26-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	26-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	26-SEP-17
Phosphorus (P)			<50		mg/kg		50	26-SEP-17
Potassium (K)			<100		mg/kg		100	26-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	26-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	26-SEP-17
Sodium (Na)			<50		mg/kg		50	26-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	26-SEP-17
Sulfur (S)			<1000		mg/kg		1000	26-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	26-SEP-17
Tin (Sn)			<2.0		mg/kg		2	26-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	26-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	26-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	26-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	26-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	26-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	26-SEP-17
MOISTURE-CL	**Soil**							
Batch R3836537								
WG2622365-2 LCS								
Moisture			103.8		%		90-110	23-SEP-17
WG2622365-1 MB								
Moisture			<0.25		%		0.25	23-SEP-17
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3839079								
WG2626356-1 MB								
Acenaphthene			<0.0050		mg/kg		0.005	24-SEP-17
Acenaphthylene			<0.0050		mg/kg		0.005	24-SEP-17
Acridine			<0.010		mg/kg		0.01	24-SEP-17
Anthracene			<0.0040		mg/kg		0.004	24-SEP-17
Benz(a)anthracene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(a)pyrene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	24-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R3839079								
WG2626356-1 MB								
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	24-SEP-17
Benzo(e)pyrene			<0.010		mg/kg		0.01	24-SEP-17
Chrysene			<0.010		mg/kg		0.01	24-SEP-17
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	24-SEP-17
Fluoranthene			<0.010		mg/kg		0.01	24-SEP-17
Fluorene			<0.010		mg/kg		0.01	24-SEP-17
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	24-SEP-17
1-Methylnaphthalene			<0.010		mg/kg		0.01	24-SEP-17
2-Methylnaphthalene			<0.010		mg/kg		0.01	24-SEP-17
Naphthalene			<0.010		mg/kg		0.01	24-SEP-17
Perylene			<0.010		mg/kg		0.01	24-SEP-17
Phenanthrene			<0.010		mg/kg		0.01	24-SEP-17
Pyrene			<0.010		mg/kg		0.01	24-SEP-17
Quinoline			<0.010		mg/kg		0.01	24-SEP-17
Surrogate: d8-Naphthalene			80.4		%		50-130	24-SEP-17
Surrogate: d10-Acenaphthene			79.7		%		50-150	24-SEP-17
Surrogate: d10-Phenanthrene			74.4		%		60-130	24-SEP-17
Surrogate: d12-Chrysene			88.6		%		50-150	24-SEP-17
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R3837770								
WG2620961-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			2.9		%		0-7.6	25-SEP-17
% Sand (1.00mm - 0.50mm)			3.8		%		0-8.9	25-SEP-17
% Sand (0.50mm - 0.25mm)			9.9		%		5.3-15.3	25-SEP-17
% Sand (0.25mm - 0.125mm)			14.1		%		10-20	25-SEP-17
% Sand (0.125mm - 0.063mm)			12.9		%		7.3-17.3	25-SEP-17
% Silt (0.063mm - 0.0312mm)			14.4		%		9.9-19.9	25-SEP-17
% Silt (0.0312mm - 0.004mm)			22.5		%		17.6-27.6	25-SEP-17
% Clay (<4um)			19.6		%		13.4-23.4	25-SEP-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1993047-COFC

COC Number: 15 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	~~Tyrell Worrall~~ JESS TESTER
Phone:	(905) 873-3371 ext. ~~234~~ 227
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, Ontario
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ~~tworrall@minnow.ca~~

Email 2 sweech@minnow.ca

Email 3 jtester@minnow.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ~~tworrall@minnow.ca~~ jtester@minnow.ca

Email 2 sweech@minnow.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐; 3 day [P3] ☐; 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐; Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:	Q51889
Job #:	17-24
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Lyuda Shvets

Sampler: JT/SW.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	PAH	[redacted]	[redacted]	moisture	metals [redacted]	total organic carbon	[redacted]	[redacted]	[redacted]	particle size	[redacted]			Number of Containers
	GH-SCW1	16-SEP-17	—	Sediment	✓			✓	✓					✓				2
	GH-SCW2	16-SEP-17	—	Sediment	✓			✓	✓					✓				2
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1
				Sediment														1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

~~Samples previously freeze dried~~

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 4°C - 7°C

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: ~~Tyrell Worrall~~ Jess Tester	Date: ~~Oct 25, 2016~~ 18-SEP-17	Time:	Received by: KC	Date: 9/18/2017	Time: 13:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

OCTOBER 2015 FRONT

APPENDIX D

HABITAT AND DISTRIBUTION OF BIOTA

Photo Group 1: Fish Inventory Photo Documentation

Photo #	Date	Site	Photo Description
DSCN3120	Jul 24, 2017	ERSC2	Downstream view of site in Reach 1
DSCN2525	Sep 27, 2017	ERSC2	Upstream view of dry site in Reach 1
DSCN2504	Sep 27, 2017	Pool 4	Isolated pool sampled in Reach 1
DSCN3114	Jul 24, 2017	ERSC2	Bull trout juvenile (135 mm)
DSCN3116	Jul 24, 2017	ERSC2	Mountain whitefish fry (40 mm)
DSCN2544	Sep 27, 2017	ERSC2	Westslope cutthroat trout juvenile (95 mm)
DSCN3196	Jul 24, 2017	ERSCW	Across view of wetland site Reach 2
DSCN1061	Oct 17, 2017	ERSCW	Upstream view of wetland site Reach 2
DSCN1068	Oct 17, 2017	ERSCW	Longnose sucker (47 mm)
DSCN1070	Oct 17, 2017	ERSCW	Mountain whitefish fry (61 mm)
DSCN3112	Jul 24, 2017	ER1A	Across view of site in Reach 3
DSCN1055	Oct 17, 2017	ER1A	Downstream view of site in Reach 3
DSCN1078	Oct 17, 2017	ER1A	Mountain whitefish fry (54 mm)
DSCN1081	Oct 17, 2017	ER1A	Eastern brook trout fry (69 mm)

Fish Inventory Reach 1


DSCN3120


DSCN2525


DSCN2504


DSCN3114


DSCN3116


DSCN2544

Fish Inventory Reach 2

DSCN3196

DSCN1061

DSCN1068

DSCN1070

Fish Inventory Reach 3


DSCN3112


DSCN1055


DSCN1078


DSCN1081

Photo Group 2: Fish Community Photo Documentation

Photo #	Date	Site	Photo Description
DSCN0364	Aug 15, 2017	ERSC2-G1	Upstream view of glide 1 in Reach 1
DSCN0374	Aug 15, 2017	ERSC2-R	Upstream view of riffle in Reach 1
DSCN0369	Aug 15, 2017	ERSC2-G2	Upstream view of glide 2 in Reach 1
DSCN0378	Aug 15, 2017	ERSC2-R	Eastern brook trout adult (157 mm)
DSCN0368	Aug 15, 2017	ERSC2-G1	Mountain whitefish fry (50 mm)
DSCN0385	Aug 16, 2017	ERSCW	Upstream view of wetland site in Reach 2
DSCN0386	Aug 16, 2017	ERSCW	Downstream view of wetland site in Reach 2
DSCN0418	Aug 17, 2017	ERSCW	Mountain whitefish fry (57 mm)
DSCN0358	Aug 14, 2017	ER1A-G1	Upstream view of glide 1 in Reach 3
DSCN0335	Aug 14, 2017	ER1A-R	Upstream view of riffle in Reach 3
DSCN0380	Aug 15, 2017	ER1A-G2	Upstream view of glide 2 in Reach 3
DSCN0341	Aug 14, 2017	ER1A-R	Mountain whitefish fry (57 mm)

Fish Community Reach 1

DSCN0364

DSCN0374

DSCN0369

DSCN0378

DSCN0368

Fish Community Reach 2

DSCN0385

DSCN0386

DSCN0418

Fish Community Reach 3

DSCN0358

DSCN0335

DSCN0380

DSCN0341

Table D.1: ***In Situ* Water Quality Measurements at Elk River and Side Channel Stations, 2017 and 2018**

Site Location		Date	Temperature (°C)	Dissolved Oxygen		Specific Conductivity (µS/cm)	pH	Redox (mV)
				(%)	(mg/L)			
Elk River	ERUS	28-Jul-17	10.3	90.2	10.1	491	8.02	-113
		18-Aug-17	9.2	87.7	10.1	286	7.43	177
		17-Oct-17	4.5	86.9	11.1	283	7.96	64
		23-Jan-18	1.2	101	14.2	314	7.85	140
Side Channel	ER1A	28-Jul-17	10.4	93.0	10.3	488	8.14	-107
		18-Aug-17	9.2	90.3	10.4	283	8.19	177
		18-Oct-17	2.9	78.7	10.7	284	7.48	79
	ERSC4	28-Jul-17	10.2	93.5	10.5	488	8.09	-110
		18-Aug-17	9.1	86.2	9.87	284	7.62	200
		18-Oct-17	3.8	77.3	10.2	289	8.00	35
	Wetland	7-Dec-17	0.0	80.9	11.7	1,740	6.86	272
		24-Jan-18	0.3	86.8	12.5	1,709	7.71	163
		15-Feb-18	-0.1	78.9	11.4	1,912	8.09	145
		15-Mar-18	0.4	61.9	8.75	1,637	8.32	143
	ERSCDS	28-Jul-17	13.5	90.7	9.45	598	8.09	-192
		18-Aug-17	10.2	67.3	7.63	389	7.53	202
Elk River	ERDS	28-Jul-17	13.6	88.8	9.14	513	7.94	-199
		18-Aug-17	9.1	82.4	9.54	305	7.91	198
		17-Oct-17	6.3	73.0	8.99	302	7.88	49
		23-Jan-18	3.0	93.6	12.6	336	7.11	134

Table D.2: ***In Situ* Water Quality Measurements, Fish Presence, and Pool Dimensions Taken at Pools in 2017 and 2018**

Pool Name	Date	Temperature (°C)	Dissolved Oxygen		Specific Conductivity (μS/cm)	pH	Redox (mV)	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Depth (m)
			(%)	(mg/L)							
Pool-E-1	17-Aug-17	11.8	43.1	4.65	990	7.45	173	Yes	60.1	1.5	0.20
Pool-E-2	26-Sep-17	4.0	40.3	5.29	1,097	6.53	176	Yes	-	-	-
Pool-E-6	26-Sep-17	5.2	27.9	3.51	892	6.31	181	Yes	-	-	-
Pool-E-7	26-Sep-17	6.0	33.3	4.14	922	6.99	171	No	-	-	-
Pool-W-2	26-Sep-17	4.6	92.6	11.9	316	7.00	155	Yes	-	-	-
Pool-E-7	18-Oct-17	5.7	49.8	6.23	901	6.87	114	Yes	3.0	2.0	0.20
Pool-M-1	18-Oct-17	4.3	70.2	9.09	344	6.63	153	Yes	8.0	2.5	0.35
Pool-M-2	18-Oct-17	2.5	60.7	8.25	312	6.98	128	Yes	15.0	2.0	0.35
Pool-E-7	20-Nov-17	0.7	32.2	4.60	1,143	7.09	183	- [a]	3.0	2.0	0.2
Pool-U-1	20-Nov-17	2.1	33.0	4.52	393	7.21	173	- [a]	-	-	-
Pool-U-2	20-Nov-17	0.3	25.1	4.60	1,143	7.09	183	- [a]	-	-	-
Pool-E-7	7-Dec-17	2.3	35.6	4.81	1,399	6.64	245	- [a]	3.0	2.0	0.18
Pool-U-3	7-Dec-17	0.3	76.7	11.0	396	6.75	264	- [a]	7.0	2.0	0.15
Pool-U-4	7-Dec-17	0.2	28.7	4.11	468	6.58	265	- [a]	12.0	2.0	0.40
Pool-U-5	7-Dec-17	0.3	50.6	7.27	487	5.78	277	- [a]	20.0	2.0	0.50
Pool-E-2	24-Jan-18	1.0	66.7	9.38	1,350	7.06	160	- [a]	3.0	2.0	0.20
Pool-E-3	24-Jan-18	1.1	53.3	7.63	677	7.20	142	- [a]	7.0	1.5	0.30
Pool-E-7	24-Jan-18	3.2	70.3	9.31	1,445	7.08	134	- [a]	3.0	2.0	0.20
Pool-E-7	14-Feb-18	-0.1	50.9	6.98	1,374	6.80	201	- [a]	-	-	0.08
Pool-E-7	15-Mar-18	0.3	40.8	5.66	1,341	7.09	172	- [a]	-	-	0.08

[a] The pool was ice covered, so an effective assessment of fish presence could not be completed.

Table D.3: Habitat Summary at Fish Sampling Sites for Fish Inventory Sampling, GHO LAEMP 2017

Sampling Month	Reach	Site	Morphology						Cover										Substrate	
			Avg. Channel Width (m)	Avg. Wetted Width (m)	Average Residual Pool Depth (m)	Average Bankfull Depth (m)	Average Gradient (%)	Morphology	Total Cover	Small Woody Debris	Large Woody Debris	Boulders	Undercut Banks	Deep Pools	Overhanging Vegetation	Instream Vegetation	Crown Closure	Functional LWD	Bed Material Dominant	Bed Material Subdominant
June	1	ERSC2	-	-	-	-	1.50%	riffle-pool	moderate	5%	5%	0%	0%	0%	5%	5%	21-40%	few	fines	gravels
June	2	ERSCW	-	-	-	-	1.00%	riffle-pool	moderate	5%	5%	0%	0%	2%	5%	15%	1-20%	few	fines	gravels
June	3	ER1A	9.75	-	-	-	1.00%	riffle-pool	moderate	5%	20%	0%	5%	0%	0%	0%	21-40%	few	fines	cobbles
July	1	ERSC2	5.65	4.12	-	0.60	1.50%	riffle-pool	moderate	20%	5%	0%	0%	0%	0%	0%	21-40%	few	fines	gravels
July	3	ER1A	9.02	7.09	-	1.50	1.00%	riffle-pool	moderate	5%	30%	0%	0%	0%	0%	0%	21-40%	few	fines	cobbles
September	3	ER1A	7.90	5.73	-	1.50	1.00%	riffle-pool	moderate	5%	30%	0%	0%	0%	0%	0%	21-40%	few	fines	cobbles

Table D.4: Sampling Summary for Electrofishing and Minnow Trapping Efforts for Fish Inventory Sampling, GHO LAEMP, June to October, 2017

Reach Number	Site ID	Sampling Month	Method	Trap #	Trap Depth	Date In	Time In	Date Out	Time Out	EF Seconds	Length (m)	Width (m)	Voltage	Frequency	Pulse	Make	Model	Species	Stage	# Fish Caught	Min Length (mm)	Max Length (mm)
1	ERSC2	June	MT	1	0.2	19-Jun-17	14:50	21-Jun-17	8:07	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	June	MT	2	0.3	19-Jun-17	14:45	21-Jun-17	8:06	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	June	MT	3	0.3	19-Jun-17	14:40	21-Jun-17	8:05	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	June	MT	4	0.3	19-Jun-17	14:37	21-Jun-17	8:02	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	June	MT	5	0.5	19-Jun-17	14:29	21-Jun-17	8:00	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	July	EF	-	-	-	-	-	-	420	100.0	4.0	250	60	15	SR	LR24	WCT	Juvenile	1	100	100
1	ERSC2	July	EF	-	-	-	-	-	-	420	100.0	4.0	250	60	15	SR	LR24	BT	Juvenile	2	135	148
1	ERSC2	July	EF	-	-	-	-	-	-	420	100.0	4.0	250	60	15	SR	LR24	MW	Fry	4	40	41
1	ERSC2	July	MT	1	0.3	24-Jul-17	14:01	25-Jul-17	14:46	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	July	MT	2	0.5	24-Jul-17	13:56	25-Jul-17	14:45	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	July	MT	3	0.3	24-Jul-17	13:50	25-Jul-17	14:50	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	ERSC2	July	MT	4	0.4	24-Jul-17	13:40	25-Jul-17	14:53	-	-	-	-	-	-	-	-	NFC	-	0	-	-
1	Pool-E-7	September	EF	-	-	-	-	-	-	100	8.0	4.0	230	50	15	SR	LR24	NFC	-	0	-	-
1	Pool-E-6	September	EF	-	-	-	-	-	-	80	5.0	4.0	230	50	15	SR	LR24	WCT	Juvenile	4	95	119
1	Pool-E-6	September	EF	-	-	-	-	-	-	80	5.0	4.0	230	50	15	SR	LR24	EB	Adult	2	143	164
1	Pool-E-6	September	EF	-	-	-	-	-	-	80	5.0	4.0	230	50	15	SR	LR24	EB	Juvenile	1	121	121
1	Pool-E-6	September	EF	-	-	-	-	-	-	80	5.0	4.0	230	50	15	SR	LR24	MW	Fry	3	51	60
1	Pool-E-5	September	EF	-	-	-	-	-	-	82	4.0	1.0	180	50	15	SR	LR24	MW	Fry	18	45-65	-
1	Pool-E-5	September	EF	-	-	-	-	-	-	82	4.0	1.0	180	50	15	SR	LR24	WCT	Fry	1	43	43
1	Pool-E-4	September	EF	-	-	-	-	-	-	30	2.0	1.0	180	50	15	SR	LR24	EB	Adult	1	144	144
1	Pool-E-4	September	EF	-	-	-	-	-	-	30	2.0	1.0	180	50	15	SR	LR24	EB	Fry	2	79	84
1	Pool-E-4	September	EF	-	-	-	-	-	-	30	2.0	1.0	180	50	15	SR	LR24	WCT	Juvenile	5	100	110
1	Pool-E-4	September	EF	-	-	-	-	-	-	30	2.0	1.0	180	50	15	SR	LR24	WCT	Fry	2	37	43
1	Pool-E-4	September	EF	-	-	-	-	-	-	30	2.0	1.0	180	50	15	SR	LR24	MW	Fry	2	46	58
2	ERSCW	June	MT	1	0.5	19-Jun-17	13:18	21-Jun-17	8:24	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	June	MT	2	0.3	19-Jun-17	13:20	21-Jun-17	8:25	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	June	MT	3	0.4	19-Jun-17	13:28	21-Jun-17	8:27	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	June	MT	4	0.6	19-Jun-17	13:26	21-Jun-17	8:29	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	June	MT	5	0.3	19-Jun-17	13:28	21-Jun-17	8:34	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	July	MT	1	0.5	24-Jul-17	13:11	25-Jul-17	16:18	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	July	MT	2	0.4	24-Jul-17	13:09	25-Jul-17	16:13	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	July	MT	3	0.3	24-Jul-17	13:07	25-Jul-17	16:14	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	July	MT	4	0.6	24-Jul-17	12:58	25-Jul-17	16:22	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	September	MT	1	0.7	26-Sep-17	13:16	27-Sep-17	14:09	-	-	-	-	-	-	-	-	MW	fry	4	50-60	-
2	ERSCW	September	MT	2	0.6	26-Sep-17	13:18	27-Sep-17	14:08	-	-	-	-	-	-	-	-	MW	fry	1	50-60	-
2	ERSCW	September	MT	3	0.4	26-Sep-17	13:22	27-Sep-17	14:12	-	-	-	-	-	-	-	-	MW	fry	1	50-60	-
2	ERSCW	September	MT	4	0.3	26-Sep-17	13:31	27-Sep-17	14:24	-	-	-	-	-	-	-	-	MW	fry	3	50-60	-
2	ERSCW	September	MT	5	0.4	26-Sep-17	13:37	27-Sep-17	14:18	-	-	-	-	-	-	-	-	MW	fry	11	50-60	-
2	ERSCW	September	MT	6	0.3	26-Sep-17	13:41	27-Sep-17	14:16	-	-	-	-	-	-	-	-	MW	fry	2	50-60	-
2	ERSCW	September	MT	7	0.6	26-Sep-17	13:45	27-Sep-17	14:21	-	-	-	-	-	-	-	-	MW	fry	5	50-60	-
2	ERSCW	September	MT	8	0.7	26-Sep-17	13:48	27-Sep-17	14:27	-	-	-	-	-	-	-	-	MW	fry	4	50-60	-
2	ERSCW	September	MT	9	0.4	26-Sep-17	13:55	27-Sep-17	14:34	-	-	-	-	-	-	-	-	MW	fry	1	50-60	-
2	ERSCW	September	MT	10	0.4	26-Sep-17	13:57	27-Sep-17	14:30	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW	October	MT	1	0.6	16-Oct-17	13:05	17-Oct-17	9:26	-	-	-	-	-	-	-	-	MW	fry	2	57	65
2	ERSCW	October	MT	1	0.6	16-Oct-17	13:05	17-Oct-17	9:26	-	-	-	-	-	-	-	-	LSU	-	1	46	46
2	ERSCW	October	MT	2	0.5	16-Oct-17	13:07	17-Oct-17	9:31	-	-	-	-	-	-	-	-	LSU	-	1	47	47
2	ERSCW	October	MT	3	0.4	16-Oct-17	13:09	17-Oct-17	9:35	-	-	-	-	-	-	-	-	LSU	-	1	47	47
2	ERSCW	October	MT	4	0.5	16-Oct-17	13:10	17-Oct-17	9:37	-	-	-	-	-	-	-	-	LSU	-	1	51	51
2	ERSCW	October	MT	5	0.6	16-Oct-17	13:12	17-Oct-17	9:40	-	-	-	-	-	-	-	-	MW	fry	1	61	61
3	ER1A	June	MT	1	0.4	19-Jun-17	11:10	21-Jun-17	7:32	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	June	MT	2	0.7	19-Jun-17	11:27	21-Jun-17	7:32	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	June	MT	3	0.7	19-Jun-17	11:31	21-Jun-17	7:34	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	June	MT	4	0.2	19-Jun-17	11:45	21-Jun-17	7:35	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	June	MT	5	0.5	19-Jun-17	11:45	21-Jun-17	7:37	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	July	EF	-	-	-	-	-	-	470	100.0	5.0	250	40	15	SR	LR24	NFC	-	0	-	-
3	ER1A	July	MT	1	0.4	24-Jul-17	9:10	25-Jul-17	12:53	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	July	MT	2	0.6	24-Jul-17	9:13	25-Jul-17	12:54	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	July	MT	3	0.6	24-Jul-17	9:15	25-Jul-17	12:56	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	July	MT	4	0.4	24-Jul-17	9:19	25-Jul-17	12:58	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	September	EF	-	-	-	-	-	-	476	100.0	6.0	250	50	15	SR	LR24	EB	fry	5	67	85
3	ER1A	September	EF	-	-	-	-	-	-	476	100.0	6.0	250	50	15	SR	LR24	MW	fry	8	50-60	-
3	ER1A	September	MT	1	0.4	26-Sep-17	11:36	27-Sep-17	12:08	-	-	-	-	-	-	-	-	MW	fry	7	51	65
3	ER1A	September	MT	2	0.4	26-Sep-17	11:42	27-Sep-17	12:11	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	September	MT	3	0.5	26-Sep-17	11:45	27-Sep-17	12:13	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	September	MT	4	0.3	26-Sep-17	11:52	27-Sep-17	12:16	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	September	MT	5	0.5	26-Sep-17	11:52	27-Sep-17	12:17	-	-	-	-	-	-	-	-	MW	fry	3	50-60	-
3	ER1A	October	EF	-	-	-	-	-	-	581	100.0	3.0	300	50	15	SR	LR24	MW	fry	3	54	62
3	ER1A	October	EF	-	-	-	-	-	-	581	100.0	3.0	300	50	15	SR	LR24	EB	fry	4	69	80
3	ER1A	October	MT	1	0.3	16-Oct-17	14:47	17-Oct-17	11:19	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	October	MT	2	0.3	16-Oct-17	14:51	17-Oct-17	11:21	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	October	MT	3	0.4	16-Oct-17	14:56	17-Oct-17	11:23	-	-	-	-	-	-	-	-	NFC	-	0	-	-
3	ER1A	October	MT	4	0.5	16-Oct-17	14:57	17-Oct-17	11:24	-	-	-	-	-	-	-	-	MW	fry	1	63	63
3	ER1A	October	MT	5	0.3	16-Oct-17	14:59	17-Oct-17	11:26	-	-	-	-	-	-	-	-	NFC	-	0	-	-

Notes: BT = Bull Trout; EF = electrofishing; EB = Brook Trout; I = immature; LSU = Longnose Sucker; M = mature; MW = Mountian Whitefish; NFC = xxxx; U = undetermined; WCT = Westlope Cutthroat.

Table D.5: Physical Measurements and Sex Determination for Individual Fish Collected by Electrofishing for Fish Inventory Sampling, GHO LAEMP, July and September, 2017

Reach Number	Site ID	Sampling Month	Method	Method Number	Species	Length (mm)	Width (g)	Sex	Maturity
1	ERSC2	July	EF	-	WCT	100	42.7	U	I
1	ERSC2	July	EF	-	BT	135	32.3	U	I
1	ERSC2	July	EF	-	BT	148	48.6	U	I
1	ERSC2	July	EF	-	MW	40	-	U	I
1	ERSC2	July	EF	-	MW	41	-	U	I
1	ERSC2	July	EF	-	MW	40	-	U	I
1	ERSC2	July	EF	-	MW	40	-	U	I
1	Pool 2	September	EF	-	WCT	119	13.0	U	I
1	Pool 2	September	EF	-	EB	164	47.0	U	M
1	Pool 2	September	EF	-	MW	57	2.0	U	I
1	Pool 2	September	EF	-	WCT	116	16.0	U	I
1	Pool 2	September	EF	-	WCT	115	16.0	U	I
1	Pool 2	September	EF	-	EB	143	32.0	U	M
1	Pool 2	September	EF	-	EB	121	21.0	U	I
1	Pool 2	September	EF	-	WCT	95	9.0	U	I
1	Pool 2	September	EF	-	MW	51	1.0	U	I
1	Pool 2	September	EF	-	MW	60	2.0	U	I
1	Pool 3	September	EF	-	WCT	43	1.0	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 3	September	EF	-	MW	45-65	-	U	I
1	Pool 4	September	EF	-	EB	144	33	U	M
1	Pool 4	September	EF	-	WCT	110	16	U	I
1	Pool 4	September	EF	-	WCT	110	16	U	I
1	Pool 4	September	EF	-	WCT	105	13	U	I
1	Pool 4	September	EF	-	EB	84	6	U	I
1	Pool 4	September	EF	-	WCT	101	10	U	I
1	Pool 4	September	EF	-	WCT	100	11	U	I
1	Pool 4	September	EF	-	EB	79	5	U	I
1	Pool 4	September	EF	-	MW	58	2	U	I
1	Pool 4	September	EF	-	MW	46	-	U	I
1	Pool 4	September	EF	-	WCT	43	-	U	I
1	Pool 4	September	EF	-	WCT	37	-	U	I
2	Wetland	September	MT	1	MW	50	-	U	I
2	Wetland	September	MT	1	MW	50-60	-	U	I
2	Wetland	September	MT	1	MW	50-60	-	U	I
2	Wetland	September	MT	1	MW	50-60	-	U	I
2	Wetland	September	MT	1	MW	50-60	-	U	I
2	Wetland	September	MT	2	MW	50-60	-	U	I
2	Wetland	September	MT	3	MW	50-60	-	U	I
2	Wetland	September	MT	4	MW	50-60	-	U	I
2	Wetland	September	MT	4	MW	50-60	-	U	I
2	Wetland	September	MT	4	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	5	MW	50-60	-	U	I
2	Wetland	September	MT	6	MW	50-60	-	U	I
2	Wetland	September	MT	6	MW	50-60	-	U	I
2	Wetland	September	MT	7	MW	50-60	-	U	I
2	Wetland	September	MT	7	MW	50-60	-	U	I
2	Wetland	September	MT	7	MW	50-60	-	U	I
2	Wetland	September	MT	7	MW	50-60	-	U	I
2	Wetland	September	MT	7	MW	50-60	-	U	I
2	Wetland	September	MT	8	MW	50-60	-	U	I
2	Wetland	September	MT	8	MW	50-60	-	U	I
2	Wetland	September	MT	8	MW	50-60	-	U	I
2	Wetland	September	MT	8	MW	50-60	-	U	I
2	Wetland	September	MT	9	MW	50-60	-	U	I

Table D.5: Physical Measurements and Sex Determination for Individual Fish Collected by Electrofishing for Fish Inventory Sampling, GHO LAEMP, July and September, 2017

Reach Number	Site ID	Sampling Month	Method	Method Number	Species	Length (mm)	Width (g)	Sex	Maturity
2	Wetland	October	MT	1	MW	65	2.1	U	I
2	Wetland	October	MT	1	MW	57	1.4	U	I
2	Wetland	October	MT	1	LSU	46	0.9	U	I
2	Wetland	October	MT	2	LSU	47	1.0	U	I
2	Wetland	October	MT	3	LSU	47	1.0	U	I
2	Wetland	October	MT	4	LSU	51	1.1	U	I
2	Wetland	October	MT	5	MW	61	1.2	U	I
3	ERSC1A	September	EF	-	EB	70	4.0	U	I
3	ERSC1A	September	EF	-	EB	85	6.0	U	I
3	ERSC1A	September	EF	-	EB	73	5.0	U	I
3	ERSC1A	September	EF	-	EB	67	4.0	U	I
3	ERSC1A	September	EF	-	EB	79	5.0	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	EF	-	MW	50-60	-	U	I
3	ERSC1A	September	MT	1	MW	51	1	U	I
3	ERSC1A	September	MT	1	MW	54	1	U	I
3	ERSC1A	September	MT	1	MW	65	2	U	I
3	ERSC1A	September	MT	1	MW	64	2	U	I
3	ERSC1A	September	MT	1	MW	56	1	U	I
3	ERSC1A	September	MT	1	MW	64	2	U	I
3	ERSC1A	September	MT	1	MW	58	2	U	I
3	ERSC1A	September	MT	5	MW	50-60	-	U	I
3	ERSC1A	September	MT	5	MW	50-60	-	U	I
3	ERSC1A	September	MT	5	MW	50-60	-	U	I
3	ERSC1A	October	EF	-	MW	54	1.5	U	I
3	ERSC1A	October	EF	-	EB	71	3.4	U	I
3	ERSC1A	October	EF	-	EB	80	5.3	U	I
3	ERSC1A	October	EF	-	EB	69	3.3	U	I
3	ERSC1A	October	EF	-	MW	57	-	U	I
3	ERSC1A	October	EF	-	MW	62	-	U	I
3	ERSC1A	October	EF	-	EB	78	-	U	I
3	ERSC1A	October	MT	4	MW	63	-	U	I

Notes:

BT = Bull Trout; EF = electrofishing; EB = Brook Trout; I = immature; LSU = Longnose Sucker; M = mature; MW = Mountian Whitefish; U = undetermined; WCT = Westlope Cutthroat.

Table D.6: Sampling Summary for Fish Collected by Electrofishing and Minnow Trapping for Fish Community (Density) Sampling, GHO LAEMP, August 2017

Reach Number	Site ID	Sample Date	Method	Haul Number	Trap #	Trap Depth (m)	Date In	Time In	Date Out	Time Out	Number of Passes	EF Seconds	Length (m)	Width (m)	Voltage	Frequency	Pulse	Make	Model	Species	Stage	# Fish Caught	Min Length (mm)	Max Length (mm)
1	ERSC2-G1	15-Aug-17	EF	-	-	-	-	-	-	-	3	1,032	28.80	3.48	250	40	15	SR	LR-24	MW	Fry	3	46	55
1	ERSC2-R	15-Aug-17	EF	-	-	-	-	-	-	-	3	1,619	28.90	6.49	250	60	15	SR	LR-24	EB	Adult	1	157	157
1	ERSC2-R	15-Aug-17	EF	-	-	-	-	-	-	-	3	1,619	28.90	6.49	250	60	15	SR	LR-24	MW	Fry	9	46	54
1	ERSC2-G2	15-Aug-17	EF	-	-	-	-	-	-	-	3	926	14.52	5.47	250	60	15	SR	LR-24	MW	Fry	35	45	55
2	ERSCW-FC	16-Aug-17	MT	1	1	0.6	16-Aug-17	10:49	17-Aug-17	10:52	-	-	-	-	-	-	-	-	-	MW	Fry	4	48	51
2	ERSCW-FC	16-Aug-17	MT	1	2	0.6	16-Aug-17	10:50	17-Aug-17	11:02	-	-	-	-	-	-	-	-	-	MW	Fry	1	49	49
2	ERSCW-FC	16-Aug-17	MT	1	3	1.0	16-Aug-17	10:52	17-Aug-17	11:07	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	16-Aug-17	MT	1	4	1.0	16-Aug-17	10:53	17-Aug-17	11:10	-	-	-	-	-	-	-	-	-	MW	Fry	2	47	54
2	ERSCW-FC	16-Aug-17	MT	1	5	1.2	16-Aug-17	10:55	17-Aug-17	11:15	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	16-Aug-17	MT	1	6	1.0	16-Aug-17	10:58	17-Aug-17	11:18	-	-	-	-	-	-	-	-	-	MW	Fry	1	51	51
2	ERSCW-FC	16-Aug-17	MT	1	7	1.2	16-Aug-17	11:00	17-Aug-17	11:19	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	16-Aug-17	MT	1	8	0.8	16-Aug-17	11:20	17-Aug-17	11:50	-	-	-	-	-	-	-	-	-	MW	Fry	2	48	51
2	ERSCW-FC	16-Aug-17	MT	1	9	0.4	16-Aug-17	11:18	17-Aug-17	11:49	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	16-Aug-17	MT	1	10	0.8	16-Aug-17	11:17	17-Aug-17	11:49	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	16-Aug-17	MT	1	11	0.6	16-Aug-17	11:14	17-Aug-17	11:46	-	-	-	-	-	-	-	-	-	MW	Fry	1	53	53
2	ERSCW-FC	16-Aug-17	MT	1	12	1.0	16-Aug-17	11:11	17-Aug-17	11:45	-	-	-	-	-	-	-	-	-	MW	Fry	1	52	52
2	ERSCW-FC	16-Aug-17	MT	1	13	0.6	16-Aug-17	11:10	17-Aug-17	11:44	-	-	-	-	-	-	-	-	-	MW	Fry	1	47	47
2	ERSCW-FC	16-Aug-17	MT	1	14	0.6	16-Aug-17	11:09	17-Aug-17	11:35	-	-	-	-	-	-	-	-	-	MW	Fry	4	44	57
2	ERSCW-FC	16-Aug-17	MT	1	15	0.5	16-Aug-17	11:09	17-Aug-17	11:25	-	-	-	-	-	-	-	-	-	MW	Fry	4	43	48
2	ERSCW-FC	17-Aug-17	MT	2	1	0.6	17-Aug-17	11:12	18-Aug-17	11:04	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	2	0.6	17-Aug-17	11:04	18-Aug-17	11:06	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	3	1.0	17-Aug-17	11:07	18-Aug-17	11:06	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	4	1.0	17-Aug-17	11:11	18-Aug-17	11:07	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	5	1.2	17-Aug-17	11:16	18-Aug-17	11:09	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	6	1.0	17-Aug-17	11:19	18-Aug-17	11:11	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	7	1.2	17-Aug-17	11:20	18-Aug-17	11:12	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	8	0.8	17-Aug-17	11:51	18-Aug-17	11:14	-	-	-	-	-	-	-	-	-	MW	Fry	1	50	50
2	ERSCW-FC	17-Aug-17	MT	2	9	0.4	17-Aug-17	11:49	18-Aug-17	11:15	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	10	0.8	17-Aug-17	11:49	18-Aug-17	11:16	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	11	0.6	17-Aug-17	11:47	18-Aug-17	11:17	-	-	-	-	-	-	-	-	-	MW	Fry	1	49	50
2	ERSCW-FC	17-Aug-17	MT	2	12	1.0	17-Aug-17	11:46	18-Aug-17	11:19	-	-	-	-	-	-	-	-	-	NFC	-	0	-	-
2	ERSCW-FC	17-Aug-17	MT	2	13	0.6	17-Aug-17	11:45	18-Aug-17	11:20	-	-	-	-	-	-	-	-	-	MW	Fry	2	51	54
2	ERSCW-FC	17-Aug-17	MT	2	14	0.6	17-Aug-17	11:36	18-Aug-17	11:22	-	-	-	-	-	-	-	-	-	MW	Fry	1	46	46
2	ERSCW-FC	17-Aug-17	MT	2	15	0.5	17-Aug-17	11:26	18-Aug-17	11:22	-	-	-	-	-	-	-	-	-	MW	Fry	1	51	51
3	ER1A-G1	14-Aug-17	EF	-	-	-	-	-	-	-	3	1,054	15.67	5.69	280	40	15	SR	LR-24	MW	Fry	1	45	45
3	ER1A-G2	15-Aug-17	EF	-	-	-	-	-	-	-	3	1,291	24.70	6.48	413	60	15	SR	LR-24	MW	Fry	3	48	53
3	ER1A-R	14-Aug-17	EF	-	-	-	-	-	-	-	3	1,007	23.20	5.69	300	40	15	SR	LR-24	MW	Fry	3	54	57

Notes: EB = brook trout; EF = electrofishing; MT = minnow trap; MW = mountain whitefish; NFC = no fish caught.

Table D.7: Physical Measurements and Sex Determination for Individual Fish Collected by Electrofishing for Fish Community (Density) Sampling, GHO LAEMP, August 2017

Reach Number	Site ID	Sample Date	Method	Trap Number	Species	Length (mm)	Weight (g)	Sex	Maturity
1	ERSC2-G1	15-Aug-17	EF	-	MW	50	1.3	U	I
1	ERSC2-G1	15-Aug-17	EF	-	MW	55	1.5	U	I
1	ERSC2-G1	15-Aug-17	EF	-	MW	46	1.1	U	I
1	ERSC2-R	15-Aug-17	EF	-	EB	157	54	U	M
1	ERSC2-R	15-Aug-17	EF	-	MW	50	1.1	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	54	1.4	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	46	0.8	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	52	1.1	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	54	1.2	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	50	1.1	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	50	-	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	52	-	U	I
1	ERSC2-R	15-Aug-17	EF	-	MW	51	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	53	1.4	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	51	1.3	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	45	0.8	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	46	1.1	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	53	1.5	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	54	1.3	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	48	1.2	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	49	0.8	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	55	1.8	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	50	1.1	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
1	ERSC2-G2	15-Aug-17	EF	-	MW	-	-	U	I
2	ERSCW-FC	16-Aug-17	MT	1	MW	51	0.9	U	I
2	ERSCW-FC	16-Aug-17	MT	1	MW	50	1.1	U	I
2	ERSCW-FC	16-Aug-17	MT	1	MW	48	1.0	U	I
2	ERSCW-FC	16-Aug-17	MT	1	MW	50	1.2	U	I
2	ERSCW-FC	16-Aug-17	MT	2	MW	49	1.1	U	I
2	ERSCW-FC	16-Aug-17	MT	4	MW	54	1.2	U	I
2	ERSCW-FC	16-Aug-17	MT	4	MW	47	1.0	U	I
2	ERSCW-FC	16-Aug-17	MT	6	MW	51	1.1	U	I
2	ERSCW-FC	16-Aug-17	MT	8	MW	48	1.0	U	I
2	ERSCW-FC	16-Aug-17	MT	8	MW	51	1.1	U	I
2	ERSCW-FC	16-Aug-17	MT	11	MW	53	1.4	U	I
2	ERSCW-FC	16-Aug-17	MT	12	MW	52	1.2	U	I
2	ERSCW-FC	16-Aug-17	MT	13	MW	47	0.9	U	I
2	ERSCW-FC	16-Aug-17	MT	14	MW	46	0.9	U	I
2	ERSCW-FC	16-Aug-17	MT	14	MW	57	2.0	U	I
2	ERSCW-FC	16-Aug-17	MT	14	MW	49	1.0	U	I
2	ERSCW-FC	16-Aug-17	MT	14	MW	44	0.9	U	I
2	ERSCW-FC	16-Aug-17	MT	15	MW	48	1.1	U	I
2	ERSCW-FC	16-Aug-17	MT	15	MW	48	1.0	U	I
2	ERSCW-FC	16-Aug-17	MT	15	MW	43	0.8	U	I
2	ERSCW-FC	16-Aug-17	MT	15	MW	48	1.0	U	I
2	ERSCW-FC	17-Aug-17	MT	8	MW	50	-	U	I
2	ERSCW-FC	17-Aug-17	MT	11	MW	49	-	U	I
2	ERSCW-FC	17-Aug-17	MT	11	MW	50	-	U	I
2	ERSCW-FC	17-Aug-17	MT	13	MW	54	-	U	I
2	ERSCW-FC	17-Aug-17	MT	13	MW	51	-	U	I
2	ERSCW-FC	17-Aug-17	MT	14	MW	46	-	U	I
2	ERSCW-FC	17-Aug-17	MT	15	MW	51	-	U	I
3	ER1A-G1	14-Aug-17	EF	-	MW	45	1.0	U	I
3	ER1A-G2	15-Aug-17	EF	-	MW	48	0.8	U	I
3	ER1A-G2	15-Aug-17	EF	-	MW	53	1.1	U	I
3	ER1A-G2	15-Aug-17	EF	-	MW	50	-	U	I
3	ER1A-R	14-Aug-17	EF	-	MW	57	1.7	U	I
3	ER1A-R	14-Aug-17	EF	-	MW	54	1.5	U	I
3	ER1A-R	14-Aug-17	EF	-	MW	50	1.4	U	I

Notes: I = immature; M = mature; U = unknown.

Table D.8: Sampling Summary for Fish Collected by Minnow Trapping for Fish Community (Density) Sampling in the Side Channel Wetland, GHO LAEMP, 2017

Site	Set Date	Pull Date	Area (m^2)	Trapping Event Number	Trap Hours	Species	Number of Fish	CPUE (fish/hr)
ERSCW	16-Aug-17	17-Aug-17	716	1	365.7	MW	21	0.057
ERSCW	17-Aug-17	18-Aug-17	716	2	356.0	MW	7	0.020

Note: MW - Mountain Whitefish; CPUE - Catch-per-unit-effort.

APPENDIX E

SELENIUM IN TISSUE

Table E.1: Selenium Concentrations in Composite Benthic Invertebrate Tissue Samples from Lotic Areas

Exposure Type	Station ID	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Reference	GH_ER2	ELUGH-BIT	10-Sep-17	84.33	6.6
Mine-exposed	GH_ERSC4	GH-ERSC4-BIT-01	08-Sep-17	85.25	9.4
		GH-ERSC4-BIT-02	08-Sep-17	80.04	4.9
		GH-ERSC4-BIT-03	08-Sep-17	84.29	4.8
	GH_ER1A	GH-ER1A-BIT-01	09-Sep-17	88.10	3.7
		GH-ER1A-BIT-02	09-Sep-17	86.16	5.6
		GH-ER1A-BIT-03	09-Sep-17	84.73	10
	RG_ERSC5	GH-ERSC5-BIT-01	09-Sep-17	75.52	22
		GH-ERSC5-BIT-02	09-Sep-17	84.93	9.2
		GH-ERSC5-BIT-03	09-Sep-17	84.64	16
	GH_ERC	EL20-BIT	10-Sep-17	84.03	5.1

[blue] Value > EVWQP level 1 benchmark of 11 mg/kg dw for dietary effects to fish (Teck 2014a). (Level 1 benchmark for effects to invertebrates is 13 mg/kg dw.)

[grey] Value > upper limit of normal range of (7.79 mg/kg dw; Minnow 2018a).

Table E.3: Selenium Concentrations in Perlidae Benthic Invertebrate Tissue Samples from Lotic Areas

Exposure Type	Station ID	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Reference	GH_ER2	ELUGH-PERL-1	10-Sep-17	72.44	4.0
		ELUGH-PERL-2	10-Sep-17	72.90	5.2
		ELUGH-PERL-3	10-Sep-17	65.32	3.7
Mine-exposed	GH_ERSC4	GH-ERSC4-PERL-01	08-Sep-17	71.63	4.5
		GH-ERSC4-PERL-02	08-Sep-17	77.30	3.6
		GH-ERSC4-PERL-03	08-Sep-17	72.39	4.7
	GH_ER1A	GH-ER1A-PERL-01	09-Sep-17	77.73	4.6
		GH-ER1A-PERL-02	09-Sep-17	69.65	5.2
		GH-ER1A-PERL-03	09-Sep-17	70.63	9.9
	RG_ERSC5	GH-ERSC5-PERL-01	09-Sep-17	70.00	4.9
		GH-ERSC5-PERL-02	09-Sep-17	80.40	5.1
		GH-ERSC5-PERL-03	09-Sep-17	74.02	4.4

Table E.4: Selenium Concentrations in Perlidae Benthic Invertebrate Tissue Samples from Lentic Areas

Exposure Status	Station ID	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Mine-exposed	Pool-W-2	GH-SC1-P1-PERL-01	11-Sep-17	81.50	13
		GH-SC1-P1-PERL-02	11-Sep-17	82.68	5.1
		GH-SC1-P1-PERL-03	11-Sep-17	74.03	6.3
	Pool-E-7	GH-SC2-P3-PERL-01	12-Sep-17	76.87	7.9
		GH-SC2-P3-PERL-02	12-Sep-17	76.22	9.0
		GH-SC2-P3-PERL-03	12-Sep-17	80.78	7.8

Table E.5: Selenium Concentrations in *Rhyacophila* Benthic Invertebrate Tissue Samples from Lotic Areas

Exposure Type	Station ID	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Reference	GH_ER2	ELUGH-RHYAC	10-Sep-17	79.73	4.6
Mine-exposed	GH_ERSC4	GH-ERSC4-RHYAC	08-Sep-17	75.76	5.8
	GH_ER1A	GH-ER1A-RHYAC	09-Sep-17	62.24	6.4
	RG_ERSC5	GH-ERSC5-RHYAC	09-Sep-17	73.03	7.6
	GH_ERC	EL20-RHYAC	10-Sep-17	74.24	4.6

Table E.6: Selenium Concentrations in Ephemeroptera Benthic Invertebrate Tissue Samples from Lotic Areas

Exposure Type	Station ID	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Reference	GH_ER2	ELUGH-MF	10-Sep-17	81.97	6.0
Mine-exposed	GH_ERSC4	GH-ERSC4-MF	08-Sep-17	85.38	5.4
	GH_ER1A	GH-ER1A-MF	09-Sep-17	84.44	7.7
	RG_ERSC5	GH-ERSC5-MF	09-Sep-17	83.48	9.1
	GH_ERC	EL20-MF	10-Sep-17	82.86	7.0

Table E.7: Selenium Concentrations in Fish Tissue Samples from Lotic Areas

Exposure Type	Location	Species	Sample ID	Date Sampled	% Moisture	Selenium (mg/kg dry weight)
Mine-exposed	Elk River Side Channel	Bull trout	GH-GHSC-2017-BT01	27-Sep-17	84.75	5.9

[Legend: blue-shaded box] Value > EVWQP level 1 effect benchmark of 9 mg/kg dw for muscle, developed for “other fish” species (Teck 2014). Note that the sex of this fish was indeterminable, and that the benchmark is based on a conversion from ovary concentration to muscle concentration

SELENIUM IN TISSUE

Laboratory Reports

SASKATCHEWAN RESEARCH COUNCIL
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SRC Group # 2017-10993

Oct 18, 2017

Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Sep-19-2017 Client P.O.: 17-24

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Sections 1 and 2 have been authorized by Keith Gipman, Supervisor
Results from Lab Section 3 have been authorized by Pat Moser, Supervisor
Results from Lab Sections 4 and 5 have been authorized by Vicky Snook, Supervisor
Results from Lab Section 6 have been authorized by Marion McConnell, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

This is a final report.

SRC SASKATCHEWAN RESEARCH COUNCIL

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SRC Group # 2017-10993

Oct 18, 2017

Minnow Environmental Inc.

2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Sep-19-2017

Client P.O.: 17-24

37997	**09/16/2017 GH-SCW1-BIT-01**	***TISSUE***
37998	**09/16/2017 GH-SCW1-BIT-02**	***TISSUE***
37999	**09/16/2017 GH-SCW1-BIT-03**	***TISSUE***

Analyte	Units	37997	37998	37999
Lab Section 2 (ICP)				
Selenium	ug/g	2.7	7.3	10
Lab Section 6 (Misc.)				
Moisture	%	82.50	85.43	85.84

Results are reported on a dry basis.

SRC SASKATCHEWAN RESEARCH COUNCIL

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SRC Group # 2017-10993

Oct 18, 2017

Minnow Environmental Inc.

38000 **09/16/2017 GH-SCW2-BIT-01 *TISSUE***
38001 **09/16/2017 GH-SCW2-BIT-02 *TISSUE***
38002 **09/16/2017 GH-SCW2-BIT-03 *TISSUE***

Analyte	Units	38000	38001	38002
Lab Section 2 (ICP)				
Selenium	ug/g	17	12	13
Lab Section 6 (Misc.)				
Moisture	%	83.10	88.37	87.17

Results are reported on a dry basis.

SRC SASKATCHEWAN RESEARCH COUNCIL
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Oct 18, 2017

This report was generated for samples included in SRC Group # 2017-10993

Quality Control Report

Jess Tester
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Selenium	ug/g	3.45	3.76

Please note, duplicates could not be analyzed due to insufficient sample available.

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

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SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Sep-14-2017 Client P.O.: 17-24

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Sections 1 and 2 have been authorized by Keith Gipman, Supervisor
Results from Lab Section 3 have been authorized by Pat Moser, Supervisor
Results from Lab Sections 4 and 5 have been authorized by Vicky Snook, Supervisor
Results from Lab Section 6 have been authorized by Marion McConnell, Supervisor

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

This is a final report.

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SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Sep-14-2017 Client P.O.: 17-24

37322 **09/09/2017 GH - ER1A - BIT - 01 *TISSUE***
37323 **09/09/2017 GH - ER1A - BIT - 02 *TISSUE***
37324 **09/09/2017 GH - ER1A - BIT - 03 *TISSUE***

Analyte	Units	37322	37323	37324
Lab Section 2 (ICP)				
Selenium	ug/g	3.7	5.6	10
Lab Section 6 (Misc.)				
Moisture	%	88.10	86.16	84.73

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37325 **09/09/2017 GH - ER1A - PERL - 01 *TISSUE***
37326 **09/09/2017 GH - ER1A - PERL - 02 *TISSUE***
37327 **09/09/2017 GH - ER1A - PERL - 03 *TISSUE***

Analyte	Units	37325	37326	37327
Lab Section 2 (ICP)				
Selenium	ug/g	4.6	5.2	9.9
Lab Section 6 (Misc.)				
Moisture	%	77.73	69.65	70.63

Results are reported on a dry basis.

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SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37328 **09/09/2017 GH - ER1A - RHYAC *TISSUE***
37329 **09/09/2017 GH - ER1A - MF *TISSUE***
37330 **09/11/2017 GH - ERSC2 - BIT - 01 *TISSUE***

Analyte	Units	37328	37329	37330
Lab Section 2 (ICP)				
Selenium	ug/g	6.4	7.7	5.5
Lab Section 6 (Misc.)				
Moisture	%	62.24	84.44	84.97

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37331 **09/11/2017 GH - ERSC2 - BIT - 02 *TISSUE***
37332 **09/11/2017 GH - ERSC2 - BIT - 03 *TISSUE***
37333 **09/08/2017 GH - ERSC4 - BIT - 01 *TISSUE***

Analyte	Units	37331	37332	37333
Lab Section 2 (ICP)				
Selenium	ug/g	5.9	8.8	9.4
Lab Section 6 (Misc.)				
Moisture	%	86.79	91.00	85.25

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37334 **09/08/2017 GH - ERSC4 - BIT - 02 *TISSUE***
37335 **09/08/2017 GH - ERSC4 - BIT - 03 *TISSUE***
37336 **09/08/2017 GH - ERSC4 - PERL - 01 *TISSUE***

Analyte	Units	37334	37335	37336
Lab Section 2 (ICP)				
Selenium	ug/g	4.9	4.8	4.5
Lab Section 6 (Misc.)				
Moisture	%	80.04	84.29	71.63

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37337 **09/08/2017 GH - ERSC4 - PERL - 02 *TISSUE***
37338 **09/08/2017 GH - ERSC4 - PERL - 03 *TISSUE***
37339 **09/08/2017 GH - ERSC4 - RHYAC *TISSUE***

Analyte	Units	37337	37338	37339
Lab Section 2 (ICP)				
Selenium	ug/g	3.6	4.7	5.8
Lab Section 6 (Misc.)				
Moisture	%	77.30	72.39	75.76

Results are reported on a dry basis.

Minnow Environmental Inc.

37340 **09/08/2017 GH - ERSC4 - MF *TISSUE***
37341 **09/09/2017 GH - ERSC5 - RHYAC *TISSUE***
37342 **09/09/2017 GH - ERSC5 - MF *TISSUE***

Analyte	Units	37340	37341	37342
Lab Section 2 (ICP)				
Selenium	ug/g	5.4	7.6	9.1
Lab Section 6 (Misc.)				
Moisture	%	85.38	73.03	83.48

Results are reported on a dry basis.

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SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37343 **09/09/2017 GH - ERSC5 - PERL - 01 *TISSUE***
37344 **09/09/2017 GH - ERSC5 - PERL - 02 *TISSUE***
37345 **09/09/2017 GH - ERSC5 - PERL - 03 *TISSUE***

Analyte	Units	37343	37344	37345
Lab Section 2 (ICP)				
Selenium	ug/g	4.9	5.1	4.4
Lab Section 6 (Misc.)				
Moisture	%	70.00	80.40	74.02

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37346 **09/09/2017 GH - ERSC5 - BIT - 01 *TISSUE***
37347 **09/09/2017 GH - ERSC5 - BIT - 02 *TISSUE***
37348 **09/09/2017 GH - ERSC5 - BIT - 03 *TISSUE***

Analyte	Units	37346	37347	37348
Lab Section 2 (ICP)				
Selenium	ug/g	22	9.2	16
Lab Section 6 (Misc.)				
Moisture	%	75.52	84.93	84.64

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37349 **09/11/2017 GH - SC1 - P1 - BIT - 01 *TISSUE***
37350 **09/11/2017 GH - SC1 - P1 - BIT - 02 *TISSUE***
37351 **09/11/2017 GH - SC1 - P1 - BIT - 03 *TISSUE***

Analyte	Units	37349	37350	37351
Lab Section 2 (ICP)				
Selenium	ug/g	7.3	4.9	5.6
Lab Section 6 (Misc.)				
Moisture	%	81.02	78.37	76.69

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37352 **09/11/2017 GH - SC1 - P1 - PERL - 01 *TISSUE***
37353 **09/11/2017 GH - SC1 - P1 - PERL - 02 *TISSUE***
37354 **09/11/2017 GH - SC1 - P1 - PERL - 03 *TISSUE***

Analyte	Units	37352	37353	37354
Lab Section 2 (ICP)				
Selenium	ug/g	13	5.1	6.3
Lab Section 6 (Misc.)				
Moisture	%	81.50	82.68	74.03

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37355 **09/11/2017 GH - SC2 - P1 - BIT - 01 *TISSUE***
37356 **09/11/2017 GH - SC2 - P1 - BIT - 02 *TISSUE***
37357 **09/11/2017 GH - SC2 - P1 - BIT - 03 *TISSUE***

Analyte	Units	37355	37356	37357
Lab Section 2 (ICP)				
Selenium	ug/g	9.6	8.3	14
Lab Section 6 (Misc.)				
Moisture	%	83.71	86.08	80.68

Results are reported on a dry basis.

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Oct 30, 2017

Minnow Environmental Inc.

37358 **09/12/2017 GH - SC2 - P2 - BIT - 01 *TISSUE***
37359 **09/12/2017 GH - SC2 - P2 - BIT - 02 *TISSUE***
37360 **09/12/2017 GH - SC2 - P2 - BIT - 03 *TISSUE***

Analyte	Units	37358	37359	37360
Lab Section 2 (ICP)				
Selenium	ug/g	13	10	11
Lab Section 6 (Misc.)				
Moisture	%	86.23	87.14	84.02

Results are reported on a dry basis.

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SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37361	**09/12/2017 GH - SC2 - P3 - BIT - 01 *TISSUE***
37362	**09/12/2017 GH - SC2 - P3 - BIT - 02 *TISSUE***
37363	**09/12/2017 GH - SC2 - P3 - BIT - 03 *TISSUE***

Analyte	Units	37361	37362	37363
Lab Section 2 (ICP)				
Selenium	ug/g	7.6	11	21
Lab Section 6 (Misc.)				
Moisture	%	82.59	83.72	82.15

Results are reported on a dry basis.

SRC Group # 2017-10863

Oct 30, 2017

Minnow Environmental Inc.

37364 **09/12/2017 GH - SC2 - P3 - PERL - 01 *TISSUE***
37365 **09/12/2017 GH - SC2 - P3 - PERL - 02 *TISSUE***
37366 **09/12/2017 GH - SC2 - P3 - PERL - 03 *TISSUE***

Analyte	Units	37364	37365	37366
Lab Section 2 (ICP)				
Selenium	ug/g	7.9	9.0	7.8
Lab Section 6 (Misc.)				
Moisture	%	76.87	76.22	80.78

Results are reported on a dry basis.

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Oct 30, 2017

This report was generated for samples included in SRC Group # 2017-10863

Quality Control Report

Jess Tester
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Selenium	ug/g	3.45	3.39
Selenium	ug/g	3.45	3.07

Please note, duplicates could not be analyzed due to insufficient sample available.

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

SASKATCHEWAN RESEARCH COUNCIL
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SRC Group # 2017-14712

Dec 22, 2017

Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Dec-12-2017 Client P.O.: 17-24

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Sections 1 and 2 have been authorized by Keith Gipman, Supervisor
Results from Lab Section 3 have been authorized by Pat Moser, Supervisor
Results from Lab Sections 4 and 5 have been authorized by Vicky Snook, Supervisor
Results from Lab Section 6 have been authorized by Marion McConnell, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

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* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

This is a final report.

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SRC Group # 2017-14712

Dec 22, 2017

Minnow Environmental Inc.

2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jess Tester

Date Samples Received: Dec-12-2017

Client P.O.: 17-24

51122 09/27/2017 GH-GHSC-2017-BT01 *Freeze Dried Tissue 0.005g to 50mL*

Analyte	Units	51122
Lab Section 2 (ICP)		
Selenium	ug/g	5.9
Lab Section 6 (Misc.)		
Moisture	%	84.75

Results are reported on a dry basis.

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Dec 22, 2017

This report was generated for samples included in SRC Group # 2017-14712

Quality Control Report

Jess Tester
Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON   L7G 3M9

Reference Materials and Standards:

A reference material of known concentration is used whenever possible as either a control sample or control standard and analyzed with each batch of samples. These "QC" results are used to assess the performance of the method and must be within clearly defined limits; otherwise corrective action is required.

QC Analysis	Units	Target Value	Obtained Value
Selenium	ug/g	3.45	3.74

All quality control results were within the specified limits and considered acceptable.

Roxane Ortmann - Quality Assurance Supervisor

APPENDIX F

BENTHIC INVERTEBRATE COMMUNITY AND BIOMASS

Table F.1: Habitat Information Associated with Lotic Areas Sampled during the Benthic Invertebrate Survey, September 2017

Station ID		Reference	Mine-exposed			
		GH_ER2	GH_ERSC4	GH_ER1A	RG_ERSC5	GH_ERC
Waterbody		Elk River	Elk River Side Channel	Elk River Side Channel	Elk River Side Channel	Elk River
Date Sampled		10-Sep-17	8-Sep-17	8-Sep-17	9-Sep-17	16-Sep-17
Zone 11 UTMs - E		646739	648111	648378	648275	648926
Zone 11 UTMs - N		5557609	5552523	5551654	5550608	5548802
Samplers' Initials		JT/SW	JT/SW	JT/SW	JT/SW	JT/SW
Habitat Characteristics						
Surrounding Land Use		forest, livestock, logging	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining
Length of Reach Assessed (m)		100	30	150	100	100
Habitat	% Riffle	50	30	30	40	45
	% Run	35	60	60	45	50
	% Rapids	-	-	-	-	-
	% Pool/Back Eddy	15	10	10	15	5
Substrate	% Bedrock	-	-	-	-	-
	% Boulder	5	-	-	-	5
	% Cobble	60	10	15	35	50
	% Pebble	15	25	20	35	30
	% Gravel	10	25	15	20	10
	% Sand/Finer	5	40	50	5	5
	% Organic	5	-	-	5	-
Canopy Coverage (%)		0	79	44	66	0
Streamside Vegetation (most dominant first)		shrubs, ferns/grass, deciduous trees, coniferous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees
Macrophyte Coverage (%)		0	0	0	0	0
Periphyton Coverage		1	2	3	2	2
Bank Stability		moderate	moderate	moderate	moderate	moderate
Water Colour & Clarity		colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear
Channel Measurements						
Bankfull Width (m)		50	12.9	8	8.3	46
Wetted Width (m)		17	5.6	5.5	6.8	28
Bankfull-Wetted Depth (cm)		2	0.80	0.73	1	150
Gradient (%)		1	1	1	1	1.5
CABIN						
Samplers' Initials		JT	JT	JT	JT	JT
Sampling Time (min)		3	3	3	3	3
Total Kick Distance (m)		12	14	15	14	11
Number of Replicates		1	1	1	3	1
Number of Jars		1	1	1	1	1
Number of transects		0.75	3	3	2	incomplete transects
Distance from shore (m)		10	-	-	-	10

Table F.2: Habitat Information Associated with Mine-exposed Lentic Areas Sampled during the Benthic Invertebrate Survey, September 2017

Station ID		Mine-exposed						
		RG_GH-SCW1	**RG_GH-SCW2**	**Pool-W-1**	**Pool-W-2**	**Pool-E-2**	**Pool-E-6**	**Pool-E-7**
Waterbody		**Elk River Side Channel Wetland**	**Elk River Side Channel Wetland**	**Elk River Side Channel Pool**	**Elk River Side Channel Pool**	**Elk River Side Channel Pool**	**Elk River Side Channel Pool**	**Elk River Side Channel Pool**
Date Sampled		16-Sep-17	16-Sep-17	12-Sep-17	12-Sep-17	12-Sep-17	12-Sep-17	12-Sep-17
Zone 11 UTMs - E		648340	648375	648253	648380	648561	648675	648782
Zone 11 UTMs - N		5550224	5550200	5549846	5549321	5549475	5549296	5549097
Samplers' Initials		JT/SW	JT/SW	JT/SW	JT/SW	JT/SW	JT/SW	JT/SW
Habitat Characteristics								
Surrounding Land Use		forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining	forest, livestock, logging, mining
Length of Reach Assessed (m)		50	50	50	30	30	30	30
Habitat	% Riffle	-	-	-	-	-	-	-
	% Run	-	-	-	-	-	-	-
	% Rapids	-	-	-	-	-	-	-
	% Pool/Back Eddy	100	100	100	100	100	100	100
Substrate	% Bedrock	-	-	-	-	-	0	-
	% Boulder	-	-	-	-	-	0	-
	% Cobble	5	5	5	5	45	35	40
	% Pebble	5	5	10	25	30	25	30
	% Gravel	5	5	10	25	10	20	20
	% Sand/Finer	80	80	65	40	10	10	5
	% Organic	8	8	10	5	5	5	5
Canopy Coverage (%)		60	60	31.75	70.25	61	75	77
Streamside Vegetation (most dominant first)		coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs	coniferous trees, ferns/grass, shrubs, deciduous trees	coniferous trees, ferns/grass, shrubs
Macrophyte Coverage (%)		0	0	0	0	1 - 25	0	0
Periphyton Coverage		1	1	1	1	1	1	1
Bank Stability		stable, no erosion	stable, no erosion	moderate	moderate	stable, no erosion	stable, no erosion	stable, no erosion
Water Colour & Clarity		colourless, clear	colourless, clear	colourless, clear	colourless, cloudy	colourless, clear	colourless, clear	colourless, clear

Table F.3: Total Benthic Invertabrate Abundance in 3-Minute Travelling Kick Samples Collected at Lotic Stations, Based on Lowest Practical Level of Taxonomy

Organism Identification	Reference	Mine-exposed					
	GH_ER2	GH_ER1A	GH_ERSC4	RG_ERSC5-1	RG_ERSC5-2	RG_ERSC5-3	GH_ERC
Phylum: Arthropoda	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0
Ameletus	0	14	50	0	57	14	0
| Family: Baetidae	0	0	138	33	29	71	1,080
Acentrella	0	14	0	0	0	0	0
Baetis	420	714	500	633	314	343	1,420
Baetis rhodani group	180	143	113	67	43	114	640
| Family: Ephemerellidae	120	71	250	100	114	143	160
Drunella	0	29	13	0	29	29	60
Drunella doddsii	660	100	175	150	114	114	240
Drunella spinifera	0	0	13	0	0	0	0
Ephemerella excrucians complex	0	0	13	0	0	0	0
| Family: Heptageniidae	1,900	1,686	1,125	2,467	1,929	2,029	1,180
Cinygmula	0	29	50	0	0	14	0
Epeorus	80	57	0	17	0	29	60
Rhithrogena	320	600	175	183	257	357	120
| Order: Plecoptera	60	0	0	0	0	0	20
| Family: Capniidae	60	0	50	133	57	43	200
| Family: Chloroperlidae	120	57	0	33	0	29	40
Neaviperla	0	0	0	0	14	0	0
Sweltsa	0	0	0	67	29	43	40
| Family: Leuctridae	0	0	0	0	0	0	20
| Family: Nemouridae	140	0	13	50	0	29	20
Zapada	0	0	88	117	0	0	0
Zapada cinctipes	0	43	138	67	86	114	100
Zapada columbiana	0	0	13	0	0	0	0
| Family: Perlidae	0	57	38	67	0	43	200
Hesperoperla	80	14	13	50	57	29	0
| Family: Perlodidae	0	0	50	33	43	14	200
Kogotus	0	14	13	0	14	0	0
Megarcys	20	0	0	0	0	0	0
| Family: Taeniopterygidae	0	0	0	0	29	0	40
Taenionema	160	129	50	33	57	57	140
| Order: Trichoptera	0	0	0	0	29	0	80
| Family: Brachycentridae	120	29	150	50	14	14	100
Micrasema	0	0	0	0	0	14	0
| Family: Glossosomatidae	0	0	0	17	0	0	0
Glossosoma	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	13	17	0	0	20
Arctopsyche	120	0	38	0	14	0	40
| Family: Polycentropodidae	0	0	0	0	0	0	0
Neureclipsis	0	14	0	0	0	0	0
| Family: Rhyacophilidae	0	0	0	0	0	0	0
Rhyacophila	0	100	13	33	0	0	140
Rhyacophila betteni group	0	0	13	0	0	0	0
Rhyacophila brunnea/vemna group	40	0	63	17	14	0	40
| Order: Coleoptera	0	0	0	0	0	0	0
| Family: Curculionidae	0	0	0	0	14	0	0
| Family: Elmidae	0	86	0	17	29	0	0
Heterlimnius	0	29	0	0	14	0	0
| Order: Diptera	0	0	0	0	0	0	0
| Family: Chironomidae	20	0	50	0	43	29	240
| Subfamily: Chironominae	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0
Constempellina sp. C	60	0	0	0	14	0	0
Micropsectra	60	14	25	67	43	43	180
Stempellinella	0	0	13	0	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0
Diamesa	0	0	0	0	0	0	40
Pagastia	60	14	0	0	0	0	60
Pseudodiamesa	0	0	0	0	14	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0
Brillia	0	14	0	0	14	0	0
Corynoneura	0	0	0	0	14	0	0
Eukiefferiella	20	14	25	33	0	14	340
Hydrobaenus	0	0	13	17	57	0	0
Limnophyes	0	14	0	17	0	0	0
Orthocladius complex	120	0	38	0	0	14	940
Orthocladius lignicola	0	14	0	0	0	0	0
Rheocricotopus	0	14	0	83	14	43	0
Tvetenia	0	0	25	0	0	0	120
Monodiamesa	0	0	0	0	0	0	0
| Subfamily: Tanypodinae	0	0	0	0	0	0	0
| Tribe: Pentaneurini	0	0	0	0	0	0	0
Thienemannimyia group	0	0	13	0	0	14	0
| Family: Empididae	20	29	13	0	0	0	0
Neoplasta	20	43	38	33	0	29	20
Wiedemannia	0	0	0	0	0	0	20
Glutops	0	0	0	0	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	1,100	543	238	367	857	514	280
| Family: Simuliidae	0	0	0	17	0	0	20
Tabanus	0	0	0	0	0	0	0
| Family: Tipulidae	0	14	0	0	0	0	0
Antocha	0	0	25	0	0	0	0
Dicranota	0	0	0	0	0	0	40
Hexatoma	20	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	13	0	0	0	0
Aturus	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0
Atractides	0	14	13	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0
Lebertia	60	143	100	17	71	29	20

Table F.3: Total Benthic Invertabrate Abundance in 3-Minute Travelling Kick Samples Collected at Lotic Stations, Based on Lowest Practical Level of Taxonomy

Organism Identification	Reference	Mine-exposed					
	GH_ER2	GH_ER1A	GH_ERSC4	RG_ERSC5-1	RG_ERSC5-2	RG_ERSC5-3	GH_ERC
| Family: Sperchontidae	0	0	0	0	0	0	0
Sperchon	0	0	0	17	0	0	20
Sperchonopsis	0	0	0	0	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0
Testudacarus	0	0	63	0	0	0	20
| Order: Sarcoptiformes	0	0	0	0	0	0	0
| Order: Oribatida	20	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0
Enchytraeus	0	0	225	0	0	57	0
Totals:	**6,180**	**4,913**	**4,301**	**5,119**	**4,541**	**4,472**	**8,760**

Taxa present but not included:							
Phylum: *Arthropoda*	0	0	0	0	0	0	0
Subphylum: *Crustacea*	0	0	0	0	0	0	0
| Class: *Ostracoda*	20	14	13	17	14	0	0
Phylum: *Annelida*	0	0	0	0	0	0	0
Subphylum: *Clitellata*	0	0	0	0	0	0	0
| Class: *Oligochaeta*	0	0	0	0	0	0	0
| Order: *Tubificida*	0	0	0	0	0	0	0
| Family: *Lumbricidae*	20	0	0	0	14	0	0
Phylum: *Nemata*	20	14	13	17	14	14	20
Phylum: *Platyhelminthes*	0	0	0	0	0	0	0
| Class: *Turbellaria*	0	14	13	0	14	14	0
Totals:	**60**	**42**	**39**	**34**	**56**	**28**	**20**

Table F.4: Total Benthic Invertabrate Abundance[a] and Biomass in Hess Samples Collected at Lotic Stations, Based on Family Level of Taxonomy

Taxa	GH_ER2									
	1		2		3		4		5	
	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass
ROUNDWORMS										
P. Nemata	40	0.0007	40	0.0013	70	0.0009	10	0.0010	100	0.0021
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
F. Planariidae	-	-	-	-	-	-	-	-	-	-
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	-	-	-	-	-	-	-	-	-	-
F. Lumbricidae	-	-	-	-	-	-	10	0.0019	-	-
F. Sparganophilidae	-	-	-	-	-	-	-	-	-	-
ARTHROPODS										
MITES										
Cl. Arachnida										
Subcl. Acari	20	0.0006	180	0.0042	70	0.0013	60	0.0014	30	0.0008
SEED SHRIMPS										
Cl. Ostracoda	-	-	10	0.0005	-	-	-	-	10	0.0007
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Elmidae	-	-	10	0.0002	-	-	-	-	-	-
MAYFLIES										
O. Ephemeroptera										
F. Ameletidae	-	-	20	0.0024	10	0.0002	40	0.0529	20	0.0346
F. Baetidae	120	0.0184	340	0.0381	170	0.0214	90	0.0045	220	0.0229
F. Ephemerellidae	400	0.0665	750	0.1121	690	0.0832	350	0.0497	670	0.1050
F. Heptageniidae	1000	0.1395	1310	0.1181	2620	0.2341	590	0.0365	1170	0.0784
STONEFLIES										
O. Plecoptera										
F. Capniidae	40	0.0014	60	0.0043	160	0.0068	50	0.0012	60	0.0023
F. Chloroperlidae	40	0.0049	30	0.0051	10	0.0003	20	0.0012	10	0.0020
F. Leuctridae	10	0.0014	-	-	10	0.0004	10	0.0001	-	-
F. Nemouridae	10	0.0005	90	0.0044	10	0.0003	20	0.0001	20	0.0005
F. Perlidae	20	0.0383	40	0.0238	10	0.0724	10	0.0002	30	0.0240
F. Perlodidae	40	0.0116	20	0.0022	60	0.0306	-	-	20	0.0066
F. Taeniopterygidae	180	0.0059	200	0.0089	270	0.0076	70	0.0019	120	0.0064
CADDISFLIES										
O. Trichoptera										
F. Apataniidae	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	10	0.0004	-	-	10	0.0001	10	0.0004	20	0.0001
F. Glossosomatidae	20	0.0022	10	0.0012	-	-	-	-	10	0.0002
F. Hydropsychidae	40	0.0037	30	0.0036	20	0.0012	10	0.0006	10	0.0010
F. Lepidostomatidae	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae	10	0.0005	-	-	-	-	-	-	-	-
F. Rhyacophilidae	20	0.0299	20	0.0174	20	0.0068	10	0.0240	10	0.0021
TRUE FLIES										
O. Diptera										
F. Ceratopogonidae	-	-	10	0.0008	-	-	10	0.0002	-	-
F. Chironomidae	170	0.0100	400	0.0190	200	0.0156	290	0.0058	290	0.0244
F. Empididae	10	0.0004	-	-	10	0.0012	50	0.0046	10	0.0004
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	430	0.0206	360	0.0132	330	0.0095	210	0.0065	100	0.0031
F. Simuliidae	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	10	0.0007	10	0.0003	-	-	10	0.0004	-	-
Total Number of Organisms	**2640**		**3940**		**4750**		**1930**		**2930**	
Total Number of Taxa [b]	**21**		**21**		**19**		**21**		**20**	
Total Biomass (g)		**0.3581**		**0.3811**		**0.4939**		**0.1951**		**0.3176**

[a] Densities expressed per m^2.
[b] Bold entries excluded from taxa count.

Table F.4: Total Benthic Invertabrate Abundance[a] and Biomass in Hess Samples Collected at Lotic Stations, Based on Family Level of Taxonomy

Taxa	GH_ER1A									
	1		2		3		4		5	
	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass
ROUNDWORMS										
P. Nemata	20	0.0006	80	0.0128	70	0.0013	20	0.0015	50	0.0006
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
F. Planariidae	-	-	-	-	-	-	-	-	-	-
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	-	-	10	0.0006	-	-	-	-	-	-
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-
F. Sparganophilidae	-	-	-	-	-	-	-	-	-	-
ARTHROPODS										
MITES										
Cl. Arachnida										
Subcl. Acari	10	0.0005	-	-	30	0.0006	110	0.0020	30	0.0007
SEED SHRIMPS										
Cl. Ostracoda	-	-	-	-	10	0.0003	-	-	-	-
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Elmidae	120	0.0054	10	0.0006	10	0.0002	50	0.0026	10	0.0002
MAYFLIES										
O. Ephemeroptera										
F. Ameletidae	50	0.0462	10	0.0206	150	0.1711	100	0.1227	10	0.0060
F. Baetidae	50	0.0075	510	0.0501	140	0.0162	170	0.0180	120	0.0203
F. Ephemerellidae	50	0.0045	70	0.0055	250	0.0220	120	0.0109	140	0.0105
F. Heptageniidae	860	0.0368	910	0.1348	1300	0.0876	1220	0.1564	1120	0.0872
STONEFLIES										
O. Plecoptera										
F. Capniidae	-	-	-	-	10	0.0001	-	-	10	0.0002
F. Chloroperlidae	30	0.0006	30	0.0017	-	-	10	0.0010	20	0.0014
F. Leuctridae	-	-	-	-	-	-	-	-	10	0.0007
F. Nemouridae	10	0.0006	-	-	20	0.0010	20	0.0013	50	0.0015
F. Perlidae	20	0.1344	20	0.0065	40	0.0147	30	0.0314	80	0.0287
F. Perlodidae	-	-	-	-	-	-	20	0.0007	10	0.0006
F. Taeniopterygidae	-	-	60	0.0017	-	-	-	-	-	-
CADDISFLIES										
O. Trichoptera										
F. Apataniidae	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	-	-	10	0.0102	-	-	-	-	80	0.0114
F. Glossosomatidae	-	-	10	0.0006	-	-	10	0.0002	-	-
F. Hydropsychidae	-	-	-	-	-	-	-	-	-	-
F. Lepidostomatidae	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae	-	-	10	0.0006	-	-	-	-	-	-
F. Rhyacophilidae	30	0.0124	10	0.0005	30	0.0088	10	0.0001	20	0.0061
TRUE FLIES										
O. Diptera										
F. Ceratopogonidae	-	-	-	-	-	-	-	-	-	-
F. Chironomidae	30	0.0009	10	0.0007	30	0.0012	80	0.0024	60	0.0012
F. Empididae	30	0.0009	10	0.0011	20	0.0019	50	0.0041	50	0.0030
F. Pelecorhyncidae	-	-	-	-	-	-	10	0.0006	-	-
F. Psychodidae	80	0.0018	50	0.0022	80	0.0022	120	0.0023	80	0.0012
F. Simuliidae	-	-	40	0.0059	10	0.0010	-	-	10	0.0018
F. Tipulidae	-	-	10	0.0012	-	-	10	0.0001	-	-
Total Number of Organisms	**1390**		**1870**		**2200**		**2160**		**1960**	
Total Number of Taxa [b]	**14**		**19**		**16**		**18**		**19**	
Total Biomass (g)		**0.2531**		**0.2579**		**0.3302**		**0.3583**		**0.1833**

[a] Densities expressed per m^2.

[b] Bold entries excluded from taxa count.

Table F.4: Total Benthic Invertabrate Abundance[a] and Biomass in Hess Samples Collected at Lotic Stations, Based on Family Level of Taxonomy

Taxa	GH_ERSC4									
	1		2		3		4		5	
	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass
ROUNDWORMS										
P. Nemata	40	0.0005	10	0.0004	120	0.0074	10	0.0001	20	0.0001
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
F. Planariidae	-	-	20	0.0067	-	-	30	0.0037	10	0.0006
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	30	0.0002	80	0.0010	20	0.0002	50	0.0002	90	0.0009
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-
F. Sparganophilidae	10	0.0442	-	-	-	-	-	-	-	-
ARTHROPODS										
MITES										
Cl. Arachnida										
Subcl. Acari	60	0.0007	-	-	20	0.0012	60	0.0009	50	0.0009
SEED SHRIMPS										
Cl. Ostracoda	-	-	-	-	-	-	10	0.0001	10	0.0002
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Elmidae	-	-	-	-	20	0.0060	30	0.0020	70	0.0058
MAYFLIES										
O. Ephemeroptera										
F. Ameletidae	30	0.0065	-	-	20	0.0452	90	0.0354	-	-
F. Baetidae	100	0.0219	50	0.0074	20	0.0068	140	0.0214	30	0.0082
F. Ephemerellidae	140	0.0105	170	0.0254	320	0.0430	150	0.0103	150	0.0106
F. Heptageniidae	170	0.0053	370	0.0262	1600	0.1178	510	0.0148	110	0.0022
STONEFLIES										
O. Plecoptera										
F. Capniidae	10	0.0004	-	-	-	-	-	-	-	-
F. Chloroperlidae	20	0.0025	-	-	220	0.0356	20	0.0024	40	0.0046
F. Leuctridae	-	-	-	-	20	0.0026	-	-	-	-
F. Nemouridae	40	0.0013	20	0.0016	40	0.0086	40	0.0033	30	0.0011
F. Perlidae	-	-	20	0.1253	50	0.4140	30	0.0834	-	-
F. Perlodidae	30	0.0011	-	-	-	-	-	-	-	-
F. Taeniopterygidae	20	0.0004	-	-	-	-	-	-	-	-
CADDISFLIES										
O. Trichoptera										
F. Apataniidae	-	-	-	-	-	-	-	-	10	0.0055
F. Brachycentridae	10	0.0001	-	-	10	0.0004	-	-	10	0.0001
F. Glossosomatidae	10	0.0008	-	-	-	-	-	-	10	0.0017
F. Hydropsychidae	10	0.0003	10	0.0012	-	-	-	-	-	-
F. Lepidostomatidae	-	-	-	-	-	-	-	-	-	-
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	10	0.0038	30	0.0192	20	0.0606	10	0.0277	10	0.0197
TRUE FLIES										
O. Diptera										
F. Ceratopogonidae	-	-	-	-	-	-	-	-	-	-
F. Chironomidae	90	0.0012	10	0.0006	80	0.0038	-	-	40	0.0017
F. Empididae	30	0.0004	20	0.0017	-	-	50	0.0023	10	0.0003
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	10	0.0002	40	0.0008	60	0.0014	60	0.0016	60	0.0015
F. Simuliidae	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	50	0.0009	10	0.0047	-	-	10	0.0137	-	-
Total Number of Organisms	**920**		**860**		**2640**		**1300**		**760**	
Total Number of Taxa [b]	**21**		**14**		**16**		**17**		**18**	
Total Biomass (g)		**0.1032**		**0.2222**		**0.7546**		**0.2233**		**0.0657**

[a] Densities expressed per m^2.

[b] Bold entries excluded from taxa count.

Table F.4: Total Benthic Invertabrate Abundance[a] and Biomass in Hess Samples Collected at Lotic Stations, Based on Family Level of Taxonomy

Taxa	RG_ERSC5									
	1		2		3		4		5	
	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass
ROUNDWORMS										
P. Nemata	-	-	40	0.0009	20	0.0014	50	0.0003	-	-
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
F. Planariidae	-	-	-	-	-	-	10	0.0012	-	-
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	-	-	10	0.0001	20	0.0004	60	0.0006	-	-
F. Lumbricidae	-	-	-	-	-	-	-	-	20	0.0130
F. Sparganophilidae	-	-	-	-	-	-	-	-	-	-
ARTHROPODS										
MITES										
Cl. Arachnida										
Subcl. Acari	-	-	-	-	-	-	30	0.0004	10	0.0002
SEED SHRIMPS										
Cl. Ostracoda	-	-	10	0.0005	-	-	-	-	80	0.0038
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Elmidae	20	0.0003	-	-	20	0.0008	10	0.0001	-	-
MAYFLIES										
O. Ephemeroptera										
F. Ameletidae	-	-	-	-	20	0.0352	-	-	40	0.0536
F. Baetidae	180	0.0142	140	0.0084	40	0.0106	190	0.0158	100	0.0164
F. Ephemerellidae	150	0.0149	110	0.0099	100	0.0070	90	0.0077	260	0.0266
F. Heptageniidae	1310	0.0945	610	0.0679	420	0.0402	540	0.0372	1340	0.1532
STONEFLIES										
O. Plecoptera										
F. Capniidae	60	0.0023	-	-	40	0.0066	10	0.0004	20	0.0032
F. Chloroperlidae	40	0.0022	20	0.0014	-	-	-	-	20	0.0040
F. Leuctridae	10	0.0013	-	-	-	-	-	-	20	0.0034
F. Nemouridae	150	0.0063	100	0.0051	40	0.0032	20	0.0005	60	0.0054
F. Perlidae	60	0.0162	50	0.0133	100	0.0540	70	0.0738	50	0.1126
F. Perlodidae	-	-	-	-	-	-	-	-	-	-
F. Taeniopterygidae	20	0.0004	10	0.0002	-	-	20	0.0004	-	-
CADDISFLIES										
O. Trichoptera										
F. Apataniidae	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	10	0.0176	-	-	-	-	-	-	-	-
F. Glossosomatidae	-	-	-	-	-	-	-	-	-	-
F. Hydropsychidae	-	-	-	-	-	-	-	-	-	-
F. Lepidostomatidae	-	-	-	-	-	-	-	-	20	0.0002
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	10	0.0077	10	0.0052	-	-	-	-	20	0.0122
TRUE FLIES										
O. Diptera										
F. Ceratopogonidae	-	-	-	-	-	-	10	0.0004	-	-
F. Chironomidae	120	0.0025	20	0.0014	100	0.0038	30	0.0007	200	0.0070
F. Empididae	10	0.0007	10	0.0013	-	-	-	-	-	-
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	230	0.0064	50	0.0015	60	0.0012	-	-	200	0.0050
F. Simuliidae	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	10	0.0006	-	-	-	-	-	-	-	-
Total Number of Organisms	**2390**		**1190**		**980**		**1140**		**2460**	
Total Number of Taxa [b]	**16**		**14**		**12**		**14**		**16**	
Total Biomass (g)		**0.1881**		**0.1171**		**0.1644**		**0.1395**		**0.4198**

[a] Densities expressed per m^2.
[b] Bold entries excluded from taxa count.

Table F.4: Total Benthic Invertabrate Abundance[a] and Biomass in Hess Samples Collected at Lotic Stations, Based on Family Level of Taxonomy

Taxa	GH_ERC									
	1		2		3		4		5	
	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass	Organisms	Biomass
ROUNDWORMS										
P. Nemata	60	0.0010	80	0.0008	20	0.0012	60	0.0007	20	0.0022
FLATWORMS										
P. Platyhelminthes										
Cl. Turbellaria										
F. Planariidae	-	-	-	-	-	-	-	-	-	-
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Enchytraeidae	-	-	-	-	-	-	10	0.0003	-	-
F. Lumbricidae	-	-	-	-	-	-	-	-	-	-
F. Sparganophilidae	-	-	-	-	-	-	-	-	-	-
ARTHROPODS										
MITES										
Cl. Arachnida										
Subcl. Acari	-	-	240	0.0072	40	0.0010	-	-	-	-
SEED SHRIMPS										
Cl. Ostracoda	-	-	20	0.0002	-	-	10	0.0001	-	-
INSECTS										
Cl. Insecta										
BEETLES										
O. Coleoptera										
F. Elmidae	-	-	-	-	-	-	-	-	-	-
MAYFLIES										
O. Ephemeroptera										
F. Ameletidae	20	0.0012	20	0.0002	-	-	10	0.0001	-	-
F. Baetidae	860	0.0682	2120	0.1948	860	0.0862	1100	0.1098	640	0.0686
F. Ephemerellidae	220	0.0174	440	0.0350	520	0.0622	440	0.0368	240	0.0326
F. Heptageniidae	2560	0.2088	900	0.1456	2100	0.2262	1720	0.3040	1380	0.2308
STONEFLIES										
O. Plecoptera										
F. Capniidae	360	0.0142	200	0.0082	80	0.0108	120	0.0071	120	0.0102
F. Chloroperlidae	40	0.0072	20	0.0036	60	0.0116	40	0.0027	20	0.0038
F. Leuctridae	-	-	-	-	-	-	20	0.0012	-	-
F. Nemouridae	20	0.0004	120	0.0058	100	0.0120	40	0.0013	120	0.0068
F. Perlidae	60	0.0278	180	0.0458	120	0.0232	150	0.0692	100	0.0326
F. Perlodidae	100	0.0178	310	0.0584	40	0.0374	20	0.0024	-	-
F. Taeniopterygidae	180	0.0044	140	0.0034	100	0.0062	100	0.0036	40	0.0034
CADDISFLIES										
O. Trichoptera										
F. Apataniidae	-	-	-	-	-	-	-	-	-	-
F. Brachycentridae	60	0.0008	440	0.0044	220	0.0020	190	0.0076	20	0.0004
F. Glossosomatidae	60	0.0062	20	0.0006	20	0.0006	10	0.0001	20	0.0008
F. Hydropsychidae	20	0.0032	20	0.0006	20	0.0018	160	0.0311	100	0.0656
F. Lepidostomatidae	-	-	-	-	20	0.0004	-	-	-	-
F. Limnephilidae	-	-	-	-	-	-	-	-	-	-
F. Rhyacophilidae	80	0.0712	180	0.0708	-	-	20	0.0310	20	0.0004
TRUE FLIES										
O. Diptera										
F. Ceratopogonidae	-	-	-	-	20	0.0008	-	-	-	-
F. Chironomidae	520	0.0246	4460	0.3050	440	0.0288	490	0.0283	320	0.0162
F. Empididae	-	-	20	0.0060	40	0.0052	40	0.0042	20	0.0012
F. Pelecorhyncidae	-	-	-	-	-	-	-	-	-	-
F. Psychodidae	180	0.0042	60	0.0012	320	0.0102	160	0.0042	160	0.0068
F. Simuliidae	-	-	-	-	-	-	-	-	-	-
F. Tipulidae	-	-	-	-	-	-	-	-	-	-
Total Number of Organisms	**5400**		**9990**		**5140**		**4910**		**3340**	
Total Number of Taxa [b]	**17**		**20**		**19**		**21**		**16**	
Total Biomass (g)		**0.4786**		**0.8976**		**0.5278**		**0.6458**		**0.4824**

[a] Densities expressed per m^2.

[b] Bold entries excluded from taxa count.

BENTHIC INVERTEBRATE COMMUNITY AND BIOMASS

Laboratory Report

Methods and QC Report 2017

Project ID: Teck

Client: Minnow Environmental

Prepared by:
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Sample Reception

On September 22, 2017, Cordillera Consulting received 58 samples from Minnow Environmental. These samples were divided into 4 sections: Teck Line Creek, Teck Greenhills, Teck Fording Swift LAEMP and Teck RAEMP. When samples arrived to Cordillera Consulting, exterior packaging was initially inspected for damage or wet spots that would have indicated damage to the interior containers.

Samples were logged into a proprietary software database (INSTAR1) where the clients assigned sample name was recorded along with a Cordillera Consulting (CC) number for cross-reference. Each sample was checked to ensure that all sites and replicates recorded on field sheets or packing lists were delivered intact and with adequate preservative. Any missing, mislabelled or extra samples were reported to the client immediately to confirm the total numbers and correct names on the sample jars. The client representative was notified of the arrival of the shipment and provided a sample inventory once intake was completed.
See table below for sample inventory:

Table 1: Summary of sample information including Cordillera Consulting (CC) number

Teck Line Creek LAEMP					
Sample	**Site Code**	**CC#**	**Date**	**Size**	**# of Jars**
LI8-BIC	LI8-BIC	CC181023	9/8/2017	400µM	1
LISP24-BIC	LISP24-BIC	CC181024	9/11/2017	400µM	1
LIDCOM-BIC	LIDCOM-BIC	CC181025	9/10/2017	400µM	1
FO23-BIC	FO23-BIC	CC181026	9/13/2017	400µM	1
SLINE-BIC	SLINE-BIC	CC181027	9/9/2017	400µM	1

LIDSL-BIC-01	LIDSL-BIC	CC181028	9/10/2017	400μM	1
LIDSL-BIC-02	LIDSL-BIC	CC181029	9/10/2017	400μM	1
LIDSL-BIC-03	LIDSL-BIC	CC181030	9/10/2017	400μM	1
LISP23-BIC	LISP23-BIC	CC181031	9/11/2017	400μM	1
LILC3-BIC	LILC3-BIC	CC181032	9/9/2017	400μM	1
LI24-BIC	LI24-BIC	CC181033	9/11/2017	400μM	1
LCUT-BIC	LCUT-BIC	CC181034	9/10/2017	400μM	1
FRUL-BIC	FRUL-BIC	CC181035	9/13/2017	400μM	1
Teck Greenhills					
Sample	**Site Code**	**CC#**	**Date**	**Size**	**# of Jars**
GH_ER2-BIC	GH_ER2-BIC	CC181036	9/10/2017	400μM	1
GH_ER1A-BIC	GH_ER1A-BIC	CC181037	9/8/2017	400μM	1
GH_ERSC4-BIC	GH_ERSC4-BIC	CC181038	9/8/2017	400μM	1
GH_ERSC5-BIC-1	GH_ERSC5-BIC	CC181039	9/9/2017	400μM	1
GH_ERSC5-BIC-2	GH_ERSC5-BIC	CC181040	9/9/2017	400μM	1
GH_ERSC5-BIC-3	GH_ERSC5-BIC	CC181041	9/9/2017	400μM	1
Teck Fording Swift					
Sample	**Site Code**	**CC#**	**Date**	**Size**	**# of Jars**
FOBCP-BIC	FOBCP-BIC	CC181042	9/14/2017	400μM	1
MP1-BIC	MP1-BIC	CC181043	9/12/2017	400μM	1
FODNGD-BIC	FODNGD-BIC	CC181044	9/16/2017	400μM	1
FODHE-BIC	FODHE-BIC	CC181045	9/15/2017	400μM	1
FOBSC-BIC	FOBSC-BIC	CC181046	9/15/2017	400μM	1
FRCP1SW-BIC	FRCP1SW-BIC	CC181047	9/14/2017	400μM	1
FO22-BIC	FO22-BIC	CC181048	9/14/2017	400μM	2
FOBKS-BIC-1	FOBKS-BIC	CC181049	9/13/2017	400μM	1
FOBKS-BIC-2	FOBKS-BIC	CC181050	9/13/2017	400μM	1
FOBKS-BIC-3	FOBKS-BIC	CC181051	9/13/2017	400μM	1
FRUPO-BIC	FRUPO-BIC	CC181052	9/15/2017	400μM	1
FOUEW-BIC	FOUEW-BIC	CC181053	9/13/2017	400μM	1
FOUKI-BIC-1	FOUKI-BIC	CC181054	9/12/2017	400μM	1
FOUKI-BIC-2	FOUKI-BIC	CC181055	9/12/2017	400μM	1
FOUKI-BIC-3	FOUKI-BIC	CC181056	9/12/2017	400μM	1
HENUP-BIC	HENUP-BIC	CC181057	9/15/2017	400μM	1
FO26-BIC	FO26-BIC	CC181058	9/12/2017	400μM	1
FOUSH-BIC	FOUSH-BIC	CC181059	9/14/2017	400μM	1
FOUNGD-BIC	FOUNGD-BIC	CC181060	9/16/2017	400μM	1
FODPO-BIC	FODPO-BIC	CC181061	9/13/2017	400μM	1
Teck RAEMP					
Sample	**Site Code**	**CC#**	**Date**	**Size**	**# of Jars**
ELUFE-BIC	ELUFE-BIC	CC181062	9/15/2017	400μM	1
MIDCO-BIC	MIDCO-BIC	CC181063	9/14/2017	400μM	1
ALUSM-BIC	ALUSM-BIC	CC181064	9/16/2017	400μM	1

MIUCO-BIC	MIUCO-BIC	CC181065	9/14/2017	400μM	1
MI2-MIC	MI2-MIC	CC181066	9/13/2017	400μM	1
ELELKO-BIC	ELELKO-BIC	CC181067	9/15/2017	400μM	1
EL19-BIC	EL19-BIC	CC181068	9/13/2017	400μM	1
CORCK-BIC	CORCK-BIC	CC181069	9/14/2017	400μM	2
MI25-BIC	MI25-BIC	CC181070	9/14/2017	400μM	1
EL20-BIC	EL20-BIC	CC181071	9/10/2017	400μM	1
MI3-BIC	MI3-BIC	CC181072	9/16/2017	400μM	1
FO29-BIC	FO29-BIC	CC181073	9/16/2017	400μM	1
HACKDS-BIC	HACKDS-BIC	CC181074	9/16/2017	400μM	1
ELH93-BIC	ELH93-BIC	CC181075	9/15/2017	400μM	1
FODGH-BIC	FODGH-BIC	CC181076	9/12/2017	400μM	1
EL1-BIC	EL1-BIC	CC181077	9/17/2017	400μM	1
LC_DCDS-BIC	LC_DCDS-BIC	CC181078	9/17/2017	400μM	1
LC_DC1-BIC	LC_DC1-BIC	CC181079	9/17/2017	400μM	1
LC_FRUS-BIC	LC_FRUS-BIC	CC181080	9/17/2017	400μM	1

Sample Sorting

- Using a gridded Petri dish, fine forceps and a low power stereo-microscope (Olympus, Nikon, Leica) the sorting technicians removed the invertebrates and sorted them into family/orders.
- The sorting technician kept a running tally of total numbers excluding organisms from Porifera, Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera and terrestrial drop-ins such as aphids. These organisms were marked for their presence (given a value of 1) only and left in the sample. They were not included towards the 300-organism subsample count.
- Where specimens are broken or damaged, only heads were counted.
- Subsampling was conducted with the use of a Marchant Box.
- When using the Marchant box, cells were extracted at the same time in the order indicated by a random number table. If the 300th organism was found part way into sorting a cell then the balance of that cell was sorted. If the organism count had not reached 300 by the 50th cell then the entire sample was sorted.
- The total number of cells sorted and the number of organisms removed were recorded manually on a bench sheet and then recorded into INSTAR1
- Organisms were stored in vials containing 80% ethanol and an interior label indicating the site names, date of sampling, site code numbers and portion subsampled. This information was also recorded on the laboratory bench sheet and on INSTAR1.
- The sorted portion of the debris was preserved and labeled separately from the unsorted portion and was tested for sorting efficiency (Sorting Quality Control – Sorting Efficiency). The unsorted portion was also labeled and preserved in separate jars.

Percent sub-sampled and total countable invertebrates pulled from the samples were summarized in the table below.

Table 2: Percent sub-sample and invertebrate count for each sample

Teck Line Creek LAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
LI8-BIC	08-Sep-17	CC181023	5%	589
LISP24-BIC	11-Sep-17	CC181024	5%	575
LIDCOM-BIC	10-Sep-17	CC181025	5%	1000
FO23-BIC	13-Sep-17	CC181026	10%	417
SLINE-BIC	09-Sep-17	CC181027	5%	328
LIDSL-BIC-01	10-Sep-17	CC181028	5%	638
LIDSL-BIC-02	10-Sep-17	CC181029	5%	806
LIDSL-BIC-03	10-Sep-17	CC181030	5%	378
LISP23-BIC	11-Sep-17	CC181031	5%	579
LILC3-BIC	09-Sep-17	CC181032	5%	649
LI24-BIC	11-Sep-17	CC181033	5%	310
LCUT-BIC	10-Sep-17	CC181034	5%	512
FRUL-BIC	13-Sep-17	CC181035	5%	300
Teck Greenhills				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
GH_ER2-BIC	10-Sep-17	CC181036	5%	309
GH_ER1A-BIC	08-Sep-17	CC181037	7%	344
GH_ERSC4-BIC	08-Sep-17	CC181038	8%	343
GH_ERSC5-BIC-1	09-Sep-17	CC181039	6%	308
GH_ERSC5-BIC-2	09-Sep-17	CC181040	7%	317
GH_ERSC5-BIC-3	09-Sep-17	CC181041	7%	313
Teck Fording Swift LAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
FOBCP-BIC	14-Sep-17	CC181042	7%	364
MP1-BIC	12-Sep-17	CC181043	5%	624
FODNGD-BIC	16-Sep-17	CC181044	5%	388
FODHE-BIC	15-Sep-	CC181045	5%	627

	17			
FOBSC-BIC	15-Sep-17	CC181046	10%	388
FRCP1SW-BIC	14-Sep-17	CC181047	20%	460
FO22-BIC	14-Sep-17	CC181048	5%	1170
FOBKS-BIC-1	13-Sep-17	CC181049	15%	502
FOBKS-BIC-2	13-Sep-17	CC181050	10%	303
FOBKS-BIC-3	13-Sep-17	CC181051	7%	342
FRUPO-BIC	15-Sep-17	CC181052	5%	326
FOUEW-BIC	13-Sep-17	CC181053	5%	416
FOUKI-BIC-1	12-Sep-17	CC181054	5%	306
FOUKI-BIC-2	12-Sep-17	CC181055	100%	57
FOUKI-BIC-3	12-Sep-17	CC181056	11%	441
HENUP-BIC	15-Sep-17	CC181057	5%	562
FO26-BIC	12-Sep-17	CC181058	5%	771
FOUSH-BIC	14-Sep-17	CC181059	8%	343
FOUNGD-BIC	16-Sep-17	CC181060	5%	361
FODPO-BIC	13-Sep-17	CC181061	5%	779
Teck RAEMP				
Sample	**Date**	**CC#**	**400 micron fraction**	
			% Sampled	**# Invertebrates**
ELUFE-BIC	15-Sep-17	CC181062	5%	1231
MIDCO-BIC	14-Sep-17	CC181063	5%	879
ALUSM-BIC	16-Sep-17	CC181064	6%	348
MIUCO-BIC	14-Sep-17	CC181065	5%	356
MI2-MIC	13-Sep-17	CC181066	10%	429
ELELKO-BIC	15-Sep-17	CC181067	5%	373
EL19-BIC	13-Sep-17	CC181068	5%	319
CORCK-BIC	14-Sep-17	CC181069	5%	500
MI25-BIC	14-Sep-17	CC181070	5%	1260
EL20-BIC	10-Sep-17	CC181071	5%	438
MI3-BIC	16-Sep-17	CC181072	5%	482
FO29-BIC	16-Sep-17	CC181073	5%	470
HACKDS-BIC	16-Sep-17	CC181074	5%	1269
ELH93-BIC	15-Sep-17	CC181075	50%	386
FODGH-BIC	12-Sep-17	CC181076	5%	849

EL1-BIC	17-Sep-17	CC181077	5%	387
LC_DCDS-BIC	17-Sep-17	CC181078	5%	894
LC_DC1-BIC	17-Sep-17	CC181079	5%	726
LC_FRUS-BIC	17-Sep-17	CC181080	5%	323

Sorting Quality Control - Sorting Efficiency

As a part of Cordillera's laboratory policy, all projects undergo sorting efficiency checks.

- As sorting progresses, 10% of samples were randomly chosen from the group of four Teck projects by senior members of the sorting team for resorting.
- All sorters working on a project had at least 1 sample resorted by another sorter.
- An efficiency of 90 % was expected.
- If 90/95% efficiency was not met, samples from that sorter were resorted.
- To calculated sorting efficiency the following formula was used:

$$\frac{\#OrganismsMissed}{TotalOrganismsFound} * 100 = \%OM$$

Table 3: Summary of sorting efficiency

CC #	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
CC181052	326	3	99%
CC181061	779	4	99%
CC181040	318	2	99%
CC181023	589	26	96%
CC181067	373	1	100%
CC181072	482	3	99%
Average Recovery			99%

Sorting Quality Control - Sub-Sampling QC

Certain Provincial and Mining projects require additional sorting checks in the form of sub-sampling QC, (Environmental Effects Monitoring (EEM) protocol). This ensured that any fraction of the total sample that was examined was actually an accurate representation of the number of total organisms. Organisms from the additional sub-samples were not identified; rather total organism count only was compared.

Sub-Sampling efficiency was measured on 10% of the number of sub-sampled samples in the group of 4 Teck projects. Ex. In a project where 50 of 100 total samples were processed through subsampling using a Marchant box, then 10% of 50; or 5 samples were used for sub sampling efficiency. There was one sample in this group which had not been subsampled. Therefore in this group of 58 samples, 6 samples were chosen to measure sub-sample QC. The 6 samples chosen represent the variation of subsample sizes in the project.

Sub-Sampling efficiency was performed by fractioning the entire sample into sub-sample percentages. On each sub-sampled portion, a total organism count was recorded and compared to the rest of the sub-samples. In order to pass, all fractions were required to be within 20% of total organism count.

Example: If 300 organisms are found in 10% of the sample, the sorter will continue to sample in 10% fractions until the entire sample is separated. They will then count the total number of organisms in each of the 10 fractions of 10% and compare the organism count.

When divergence is >20% the sorting manager examines for the source of the problem and takes steps to correct it. With the Marchant box, the problem typically rested with how the box is flipped back to the upright position. For this reason subsampling was performed by experienced employees only. Another common source of area would be the type of debris in the sample. Samples with algae or heavy with periphyton have a higher incident of failure due to clumping than clear samples.