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Technical Report Overview

Report: 2019 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report

Overview: This report presents the 2019 results of the local aquatic effects monitoring program developed for Teck's Greenhill Operations. The 2019 program was designed to address questions associated with potential aquatic effects at a localized area downstream of the west spoil development and Cougar Pit extension.

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**

2019 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report

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2019 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report

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EXECUTIVE SUMMARY

The 2019 Greenhills Operations (GHO) Local Aquatic Effects Monitoring Program (LAEMP) is designed to address questions associated with potential aquatic effects at a localized area downstream of the west spoil development and Cougar Pit extension at GHO. The GHO LAEMP focused on the Elk River (upstream and downstream of GHO), tributaries on the west side of the Greenhills Ridge, as well as a side channel of the Elk River that receives flows, via surface water and/or groundwater, from the mine influenced west-side tributaries (e.g., Thompson, Wolfram, and Leask creeks). The Elk River side channel is located between the Elk River and the west side of Greenhills Ridge. It branches off from the Elk River just south of Leask Creek, flows south over the Elk River floodplain, and converges back with the Elk River roughly 1.2 km downstream from Thompson Creek.

Six study questions (discussed in detail in the paragraphs that follow) were developed to address concerns related to the local study area. The study questions focused on characterization and understanding of hydrology, water quality, habitat quality/availability, and benthic invertebrate community structure and tissue chemistry.

Hydrology data collected from 2017 to 2019 answered study question #1 (What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?). In all study years, the Elk River side channel demonstrated a snowmelt-driven hydrograph with seasonal increase in flow and corresponding flooding and braiding in spring, then receding to base flow and drying of sections by late summer. Flows in the main stem Elk River and flows in the Elk River side channel were strongly correlated, except for Reach 2, which remained wetted throughout the year predominantly due to overland flows from Thompson Creek and potentially also due to groundwater inputs. The side channel was fully wetted for three to four months of each study year. Water from the main stem Elk River flowed overland into the side channel from freshet until winter, during which time stream flow decreased both in the main stem Elk River and in the Elk River side channel. Stream flow was lowest in the main stem Elk River from winter until freshet; at this time the side channel was disconnected from the main stem Elk River, and Reach 1 (the downstream end of the side channel) and Reach 3 (the upstream end of the side channel) slowly dried. Isolated pools were documented as drying occurred. Although a few pools persisted throughout most of the year as Reach 1 receded, most pools persisted for less than three months. This, as well as water quality data, indicated that most of the pools were stagnant water resulting from seasonal drying of the side channel. A few of the isolated pools were determined to be groundwater-fed. The data collected from 2017 to 2019 have answered study question #1, and therefore it is recommended that no further work is done on this question.

Within the side channel and its floodplain complex, over thirty multi-day field visits were completed in all seasons from 2017 to 2019 to identify and document habitat and occurrences of aquatic-dependent biota. These data were used to answer study question #2 (What is the seasonal habitat availability for aquatic-dependent biota [i.e., fish, amphibians, and aquatic-feeding birds] in the Elk River side channel?). The results were generally consistent over the three years of study. Seasonal changes in flow (described above) affected habitat availability (e.g., lentic habitat was only observed in fall and winter, and only in Reach 2). The Elk River side channel limited habitat potentially suitable for amphibian breeding, as much of the side channel and floodplain complex were flooded and swiftly flowing in the spring and early summer. However, breeding habitat may be present elsewhere in the area, and several amphibians (Columbia spotted frog, western toad, long-toed salamander) were observed throughout the side channel in late spring and summer. Suitable habitat was available for all life stages of fish and aquatic-dependent birds in the side channel and floodplain complex from spring through fall, as well as in Reach 2 during winter. The side channel was used by a variety of fish (bull trout, eastern brook trout, longnose sucker, mountain whitefish, and westslope cutthroat trout) and birds (American bittern, American dipper, bald eagle, bank swallow, belted kingfisher, blue heron, Canada goose, common yellowthroat, killdeer, northern waterthrush, spotted sandpiper, mallard). Availability of habitat and use by biota have been thoroughly documented and additional years of surveys would not further the understanding of use by fish and aquatic-dependent birds. Uncertainties around amphibian use of Reach 2 have been identified, as dead larval long-toed salamanders were found in this area, suggesting the area may have suitable amphibian breeding habitat that has been previously undiscovered, perhaps due to accessibility issues. To reflect these findings and uncertainties, it is recommended that study question #2 is reworded to: "What is the seasonal habitat availability for amphibians in Reach 2 of the Elk River side channel?".

Water quality was assessed for stations in the west-side tributaries, the main stem Elk River, Elk River side channel, and isolated pools of the side channel to address study question #3 (What is the influence of the GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?). Water quality at the two furthest-downstream side channel stations (GH_ER1A and GH_ERSC2) was influenced by Wolfram and Thompson creeks. Concentrations of constituents were typically lower at the upstream side channel station (GH_ERSC4), located upstream of Wolfram and Thompson creeks, compared to the two downstream stations. Within the side channel and main stem Elk River, the highest concentrations of constituents generally occurred in Reach 2 (RG_GH-SCW3), which receives flow directly from Thompson Creek. Water quality in isolated pools was highly dependent on location, with the highest concentrations of constituents generally occurring in pools downstream of Reach 2. Discharges from the west-side tributaries contributed to higher concentrations of some mine-related constituents in the main stem Elk River downstream of GHO (GH_ERC) relative to the upstream reference (GH_ER2); however, with the exception of selenium, constituent concentrations measured at the downstream station were typically below British Columbia Water Quality Guidelines (BCWQG), Elk Valley Water Quality Plan (EVWQP) benchmarks, and/or screening values, or were comparable to the upstream reference. These general water quality results were consistent from 2017 to 2019. At the downstream main stem Elk River station (GH_ERC), total selenium concentrations increased in 2018 and 2019, and nitrate concentrations increased in 2019, as compared to previous years. At the Reach 2 outlet, total nickel decreased in 2019 compared to 2018. For the west-side tributaries, total selenium, sulphate, and TDS have been increasing in Leask and Wolfram creeks, while total nickel has been increasing in Leask Creek. In Thompson Creek, sulphate has increased in recent years, whereas total nickel has decreased. Based on these findings, continued monitoring of water quality in the west-side tributaries, Elk River side channel (including Reach 2), and the main stem Elk River, in support of study question #3a, #3b, and #3c is recommended. However, it is recommended that no further work be done on study question #3d (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]?). Three years of study have determined that isolated pools provide relatively limited habitat, as pools typically persisted for less than a month, had small surface areas, and were shallow. The water quality of most isolated pools reflected side channel water quality because isolated pools were formed by water that persisted as the side channel dried. Side channel water quality will continue to be monitored under study question #3b. Water quality indicated that as many as four of the isolated pools that were sampled for water quality were formed via localized areas of groundwater discharge, occurring near the confluence with Wolfram Creek and occurring downstream of Thompson Creek. Groundwater quality will continue to be monitored under groundwater programs outside of the GHO LAEMP.

To answer study question #4 (What is the interaction between surface water and groundwater in the Elk River side channel?), an updated hydrogeological review and analysis of available groundwater and surface water data was conducted by SNC Lavalin in 2020 using 2019 data from the west side of GHO along the Elk River side channel. The data review indicated that surface water of the side channel predominantly infiltrated to ground and recharged groundwater. Localized areas of groundwater discharge appeared to occur near the confluence with Wolfram Creek as well as downstream of Thompson Creek, creating two to four of the isolated pools were sampled for water quality and that persisted when the side channel was otherwise dry. These discharge areas did not result in sustained flows in the side channel. The objective of study question #4 is to fill data gaps/uncertainties associated with groundwater-surface water interaction along the Elk River side channel. Several of the gaps are planned to be addressed by new monitoring well installations in 2020 and collection of additional groundwater data as part of other on-going programs, such as the Site-Specific Groundwater Monitoring Program (SSGMP), the Regional Groundwater Monitoring Program (RGMP), the Cougar Pit Phase 2 Expansion Project (CPX2), the Mass Balance Investigation (MBI) Program. Data from these projects will continue to be pulled together to address study question #4 in an annually updated hydrogeological review and analysis of available groundwater and surface water data.

Benthic invertebrate community data collected in 2017, 2018, and 2019 furthered the understanding of study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?). Benthic invertebrate community endpoints did not differ greatly between perennially-wetted main stem stations (GH_ER2 and GH_ERC) and side channel stations (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC). In 2019, benthic invertebrate community metrics that had normal ranges were within or above the normal range for main stem Elk River and side channel stations, except for % Trichoptera at RG_SCDTC (the most-downstream benthic invertebrate side channel station) and % Plecoptera at GH_ERC (the downstream main stem station) in one of three samples each. Overall, benthic invertebrate communities in the main stem Elk River and the Elk River side channel did not appear to be adversely affected by mine-related discharges.

In addition to benthic invertebrate community data, the tissue chemistry (selenium) data collected from 2017 to 2019 also furthered the understanding of study question #5. Selenium concentrations in benthic invertebrates at the downstream main stem Elk River station (GH_ERC) were similar to concentrations at the upstream reference station (GH_ER2). Within the side channel, selenium concentrations in benthic invertebrates increased from GH_ERSC4 (upstream of Wolfram Creek) and GH_ER1A (downstream of Wolfram Creek) to GH_ERSC5 (downstream of GH_ER1A) to Reach 2 (RG_GH-SCW3, immediately downstream of Thompson Creek). Further downstream in the side channel at stations GH_ERSC2 and RG_SCDTC, concentrations were similar to GH_ER1A. Some benthic invertebrate tissue samples collected in 2019 from Thompson Creek (RG_THCK; all three samples) and Reach 2 (RG_GH-SCW3; one out of three samples) had selenium concentrations above the EVWQP Level 3 selenium benchmarks for benthic invertebrates, dietary effects to juvenile fish, and dietary effects to birds. Selenium concentrations in benthic invertebrate tissue collected in 2019 from RG_ERSC5 and GH_ERSC2 were higher than the EVWQP Level 1 dietary benchmark for fish in one of three replicates from each area, whereas concentrations in all other samples were below the Level 1 benchmarks. The evaluation of benthic invertebrate community characteristics and tissue chemistry are important components for assessing potential mine-related effects on the aquatic ecosystem, therefore benthic invertebrate community, benthic invertebrate tissue chemistry, and supporting data (i.e., habitat data, calcite index, and, for some areas, sediment quality) will continue to be monitored to address study question #5.

In support of study question #5 and to better understand potential mine-related effects on benthic invertebrate communities and tissue chemistry, sediment quality was assessed in the main stem Elk River upstream and downstream of the side channel, and in Reach 2 of the side channel, and was generally consistent from 2017 to 2019. Except for arsenic in one of five samples collected at Reach 2 and manganese in two of five samples each from Reach 2 and GH_ERC, concentrations of constituents were within the normal range for samples collected in 2019. Concentrations of constituents were below the upper (or only in the case of selenium) sediment quality guideline (SQG) in all sediment samples, except for selenium in samples collected in 2019 from Reach 2. In general, the data indicated limited influence of mine-related discharges on sediment chemistry in the main stem Elk River downstream of the side channel. As noted above, supporting data, including sediment quality, will continue to be monitored to address study question #5.

Habitat characterization, biota observations, water quality, sediment quality, and benthic invertebrate tissue chemistry data collected from Reach 2 from 2017 to 2019 for the GHO LAEMP addressed study question #6 (Is the mine-related influence on Reach 2 having an effect on aquatic dependent biota [benthic invertebrates, fish, amphibians, and aquatic-feeding birds]?). A Fish Habitat Assessment Procedure (FHAP) survey completed in 2017 and detailed monthly surveys from 2017 to 2019 confirmed that Reach 2 provides some habitat for fish, adult amphibians, and aquatic-dependent birds, but is not expected to provide optimal habitat for breeding amphibians (due to swiftly flowing water during the breeding season). Most water quality constituents were below BCWQG, EVWQP Level 1 benchmarks, and/or interim screening values. Aqueous concentrations of TDS and sulphate were frequently above the BCWQG and/or EVWQP Level 1 benchmarks, while concentrations of nitrate and total selenium were frequently above the EVWQP Level 2 benchmarks. In sediment at Reach 2, concentrations of constituents were below the upper or only SQG, except for selenium, and were either similar to the upstream reference or within the normal range. Benthic invertebrate tissue selenium concentrations varied greatly, with two samples below all EVWQP Level 1 benchmarks, and one sample higher than the EVWQP Level 3 benchmarks for benthic invertebrates and dietary effects to birds and juvenile fish. Elevated selenium may result from the presence of annelids in the sample and/or greater bioavailability of selenium species present. The data for Reach 2 indicate potential for localized exposure to elevated dietary selenium to fish, amphibians, and aquatic feeding birds. Within the 2018 and 2019 GHO LAEMP reports, reporting of Reach 2 data has been repetitive, with results first presented under study questions #2, #3, and #5, and then the same results summarized again under study question #6. To reduce this redundancy, it is recommended that study questions #6 is removed, and Reach 2 data be assessed within the context of the rest of the side channel. Water quality will continue to be assessed under study question #3b and study question #4. Sediment quality and benthic invertebrate tissue chemistry will continue to be assessed under study question #5.

The GHO LAEMP 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 Regional Aquatic Effects Monitoring Program (RAEMP), the SSGMP, the RGMP, the CPX2, the MBI program, and/or other existing monitoring programs, as appropriate.

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ACRONYMS AND ABBREVIATIONS

AMP – Adaptive Management Plan

ANOVA – Analysis of Variance

BCWQG - British Columbia Water Quality Guidelines

CABIN – Canadian Aquatic Biomonitoring Network

CI – Calcite Index

CMO – Coal Mountain Operation

CPX2 – Cougar Pit Phase 2 Expansion Project

CRC ICP-MS – Collision Cell Inductively Coupled Plasma Mass Spectrometry

CSM – Conceptual Site Model

CVAAS – Cold Vapor Atomic Absorption Spectrophotometry

DO – Dissolved Oxygen

DW – Dry Weight

EMC – Environmental Monitoring Committee

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

E – Ephemeroptera (mayflies)

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

EVO – Elkview Operation

EVWQP – Elk Valley Water Quality Plan

EWT - Early Warning Trigger

FHAP – Fish Habitat Assessment Procedure

FRO – Fording River Operation

GHO – Greenhills Operation

GPS – Global Positioning System

GC/MS – Gas Chromatography with Mass Spectrometric Detection

HSD – Honestly Significant Difference

ICP-MS – Inductively Coupled Plasma-Mass Spectrophotometry

ICPOES – Inductively Coupled Plasma - Optical Emission Spectrophotometry

K-M – Kaplan-Meier

KNC – Ktunaxa Nation Council

LAEMP – Local Aquatic Effects Monitoring Program

LCO – Line Creek Operation

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

LRL – Laboratory Reporting Limit

LSU – Longnose Sucker

MBI – Mass Balance Investigation

MOD – Magnitude of Difference

MOE / BCMOE – former name of the British Columbia Ministry of Environment and Climate Change Strategy (now ENV)

NAD – North American Datum

P – Plecoptera (stoneflies)

PAH – Polycyclic Aromatic Hydrocarbon

PEL – Probable Effect Level

QA/QC – Quality Assurance / Quality Control

RAEMP – Regional Aquatic Effects Monitoring Program

RGMP – Regional Groundwater Monitoring Program

RISC – Resource Information Standards Committee

SEL – Severe Effect Level

SEV – Scale of the Severity (Newcombe and Jensen 1996)

SPO – Site Performance Objective

SRC – Saskatchewan Research Council

SSGMP – Site-Specific Groundwater Monitoring Program

SQG – Sediment Quality Guideline

T – Trichoptera (caddisflies)

TDS – Total Dissolved Solids

TKN – Total Kjeldahl Nitrogen

TOC – Total Organic Carbon

TSS – Total Suspended Solids

UTM – Universal Transverse Mercator System

WSC – Water Survey of Canada

1 INTRODUCTION

1.1 Background

Teck Coal 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; formerly Ministry of Environment [BCMOE]) through permits that are issued under provisions of the *Environmental Management Act*. Permit 107517, issued November 19, 2014 and amended as required, specifies the terms and conditions associated with discharges from the five mine operations.

Through issuance of Permit 107517, ENV required 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]*[1] *for 2017-2020 by June 1, 2017*[2]*. The study design must be reviewed by the EMC*[3] *and be designed to an appropriate temporal scale to capture short term, local effects to the immediate receiving environment.*

In addition to monitoring under the LAEMP, Teck conducts the Regional Aquatic Effects Monitoring Program (RAEMP) under Permit 107517. The RAEMP provides comprehensive routine monitoring and assessment of potential mine-related effects on the aquatic environment downstream from Teck's mines in the Elk Valley. Annual sampling and more comprehensive monitoring every three years is completed under the RAEMP, with the most recent cycle of sampling completed in December 2019, and the next cycle of sampling to be completed by December 2022. Teck conducts a variety of additional programs to monitor, evaluate, and/or

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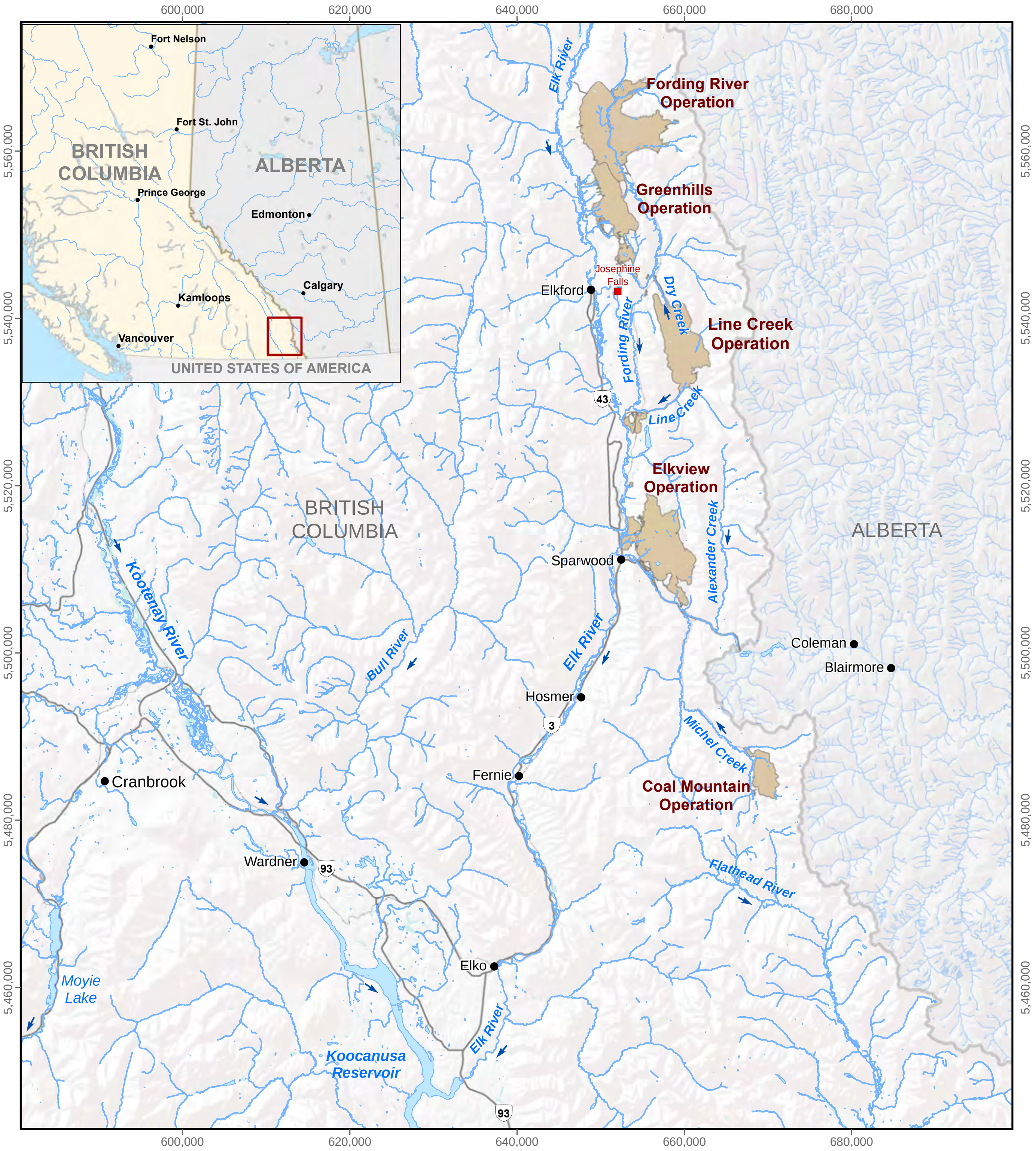
[1] Herein referred to as the west-side tributaries.

[2] A study design for the 2017 LAEMP was submitted May 31, 2017.

[3] 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.



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
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

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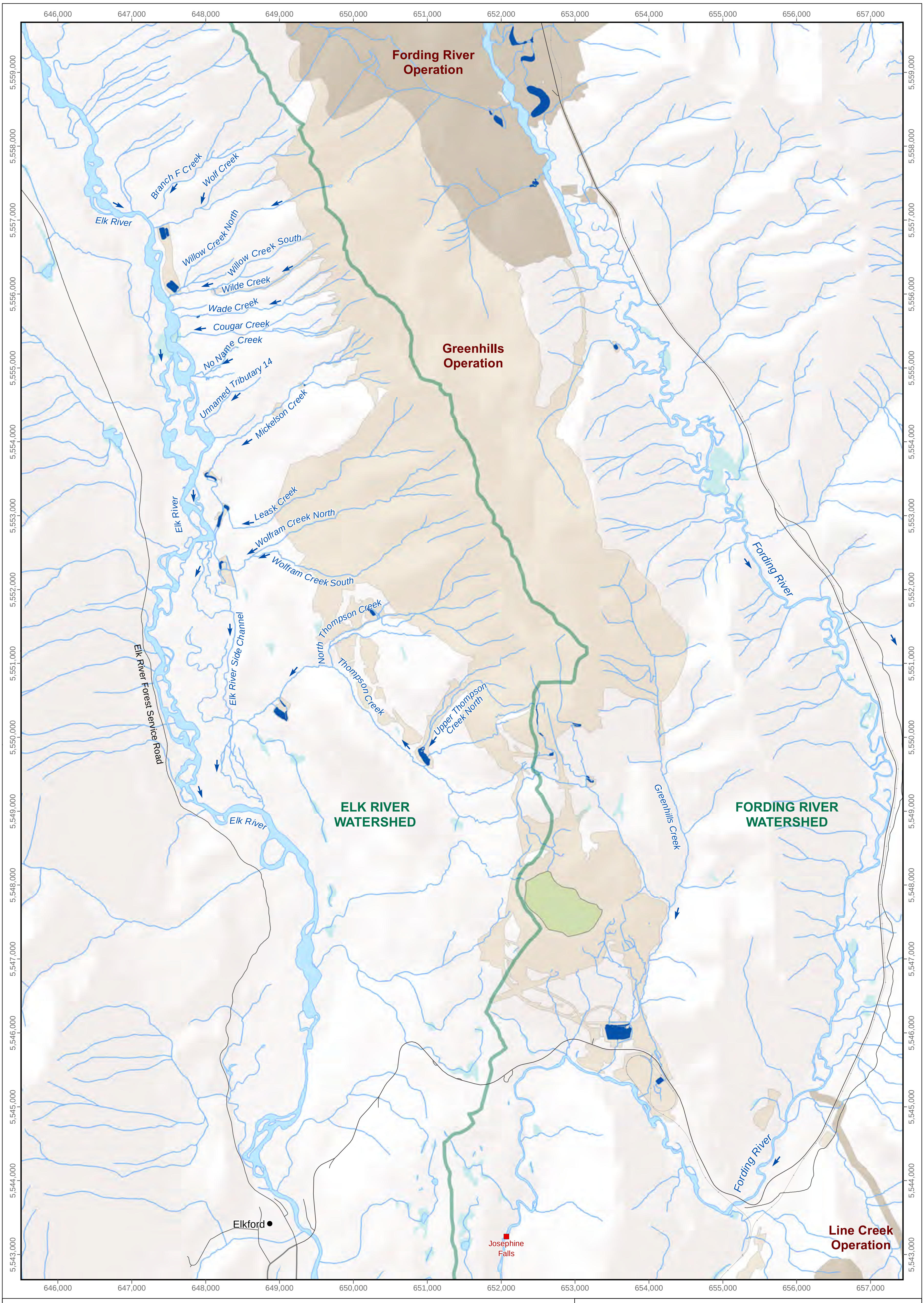
Figure 1.1

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 1.1 Teck Coal Limited Operation.mxd



LEGEND

□ Watershed Boundary

🟦 Settling Pond

🟩 Tailings Pond

Teck's Greenhills Operation

0	0.75	1.5	3

km

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Figure 1.2

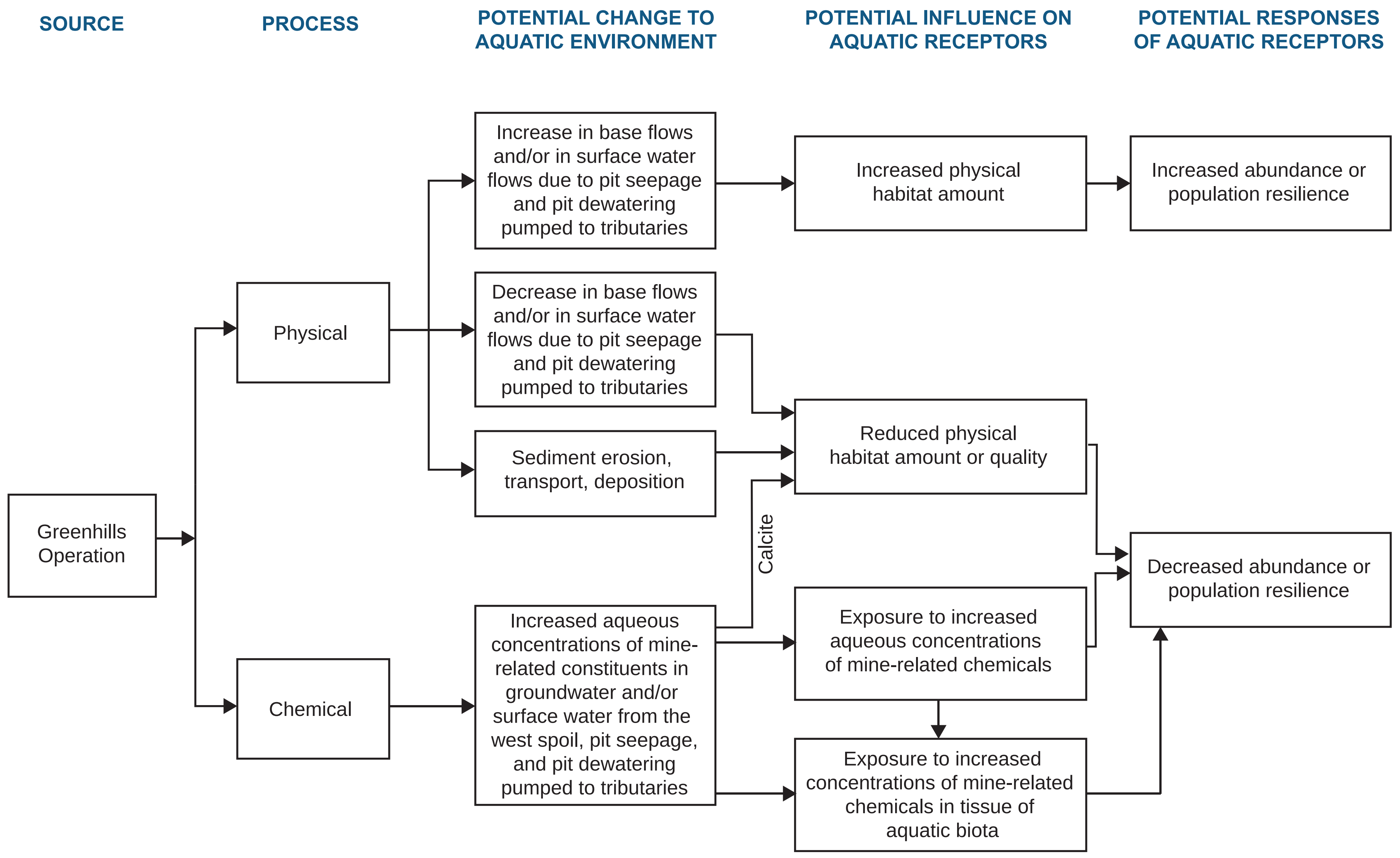
Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 1.2 Teck GHO.mxd manage the aquatic effects of mining operations within the Elk Valley at local and regional scales, including:

- water quality monitoring;
- calcite monitoring;
- chronic toxicity testing;
- fish and fish habitat management;
- Regional Aquatic Effects Monitoring Program (RAEMP);
- tributary management (through the Tributary Management Plan); and
- various supporting studies.

Following discussion with and advice from the Environmental Monitoring Committee (EMC), a phased approach to the GHO LAEMP study design was approved by ENV. A study design (Minnow and Lotic 2017) was submitted on May 31st, 2017, and preliminary reconnaissance work was conducted from May 2017 to April 2018. An updated study design was submitted on May 31st, 2018 that covered the 2018 to 2020 period (Minnow and Lotic 2018b). The GHO LAEMP is designed to address questions associated with potential aquatic effects at a localized area downstream of the west spoil development and Cougar Pit extension at GHO. The study questions focus on furthering the understanding of hydrology, habitat use by biota, water quality, surface water/groundwater interactions, benthic invertebrate communities and tissue chemistry, and investigating whether biota in Reach 2 (formerly referred to as the “side channel wetland”) are influenced by mine-related activities. The results of the data collected from January to December 2019 are described herein.

1.2 Conceptual Site Model

A conceptual site model (CSM) is a written and/or illustrative depiction of relationships between human activities that disturb the environment and the ways such disturbances can alter the ecosystem and affect biological receptors. Figure 1.3 presents a CSM for potential effects on aquatic receptors related to the Elk River, Elk River side channel, and the west-side tributaries associated with Greenhills Operation. As illustrated by the CSM, mining may affect aquatic receptors through physical and/or chemical processes; these general processes are explained in-depth in the RAEMP Study Design (Minnow 2018c). With respect to this LAEMP, mine-related physical and chemical stressors in the west-side tributaries, upper Elk River, and Elk River side channel arise from:



Conceptual Site Model for Potential Mine-Related Effects on the Aquatic Ecosystem

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Figure 1.3

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- landscape restructuring, potentially occurring due to re-location of soils and rock material (e.g., waste rock piles), re-sloping of the topography, and diversion of water;
- sediment transport in streams, potentially occurring as a combination of:
    - bedload (the coarsest transported material, moving along the bottom),
    - suspended load (materials lifted above the bed by the flow and transported in the water column), and
    - washload (the finest-grained fraction of the suspension; Polzin 1998);
- increases or decreases to base flow and surface water flows, potentially occurring due to pit seepage and pit water pumped to tributaries; and
- increased concentrations of mine-related constituents in water and sediment, potentially originating from the West spoil, pit seepage, and pit water pumped to tributaries.

The CSM identified potential influences of mining activities on aquatic receptors (Figure 1.3), which were used to develop study questions (Section 1.3) and assessment endpoints based on potential responses (Table 1.1). As illustrated in the CSM (Figure 1.3), potential mining effects on receptors may manifest as changes in population abundance of sensitive receptors, which also results in changes to relative community structure. Therefore, the GHO LAEMP study questions focus on assessing potential mine-related effects on focal species or population groups (Table 1.1), while also allowing for collection of relevant background information (i.e., characterization of side channel hydrology and aquatic-dependent biota distributions; Section 1.3).

1.3 Study Questions

To focus the scope of the 2018 to 2020 study design, study questions were developed in consultation with the EMC. The study questions and associated sub-questions are as follows:

1. What is the relationship between flows in the main stem Elk River and flows (including connectivity, intermittence, and pools) in the Elk River side channel?
2. What is the seasonal habitat availability for aquatic-dependent biota (i.e., fish, amphibians, and aquatic-feeding birds) in the Elk River side channel?
3. What is the influence of the 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 in the west-side tributaries, and how is it changing over time?

Table 1.1: Summary of Receptors, Assessment Endpoints, Measurement Endpoints, and Evaluation Criteria for the GHO LAEMP, 2019

Receptor Group	Assessment Endpoint	Measurement Endpoint[a]	Evaluation Criteria[a,b]	Indicator Type[c]
Fish	Population abundance or resilience	Surface water chemistry	Concentrations of constituents relative to effect benchmarks, guidelines, and past observations (SQ #1, #3, and #4)	Indirect
		Sediment chemistry	Concentrations of constituents relative to guidelines, reference areas, and past observations (SQ #5 and 6)	Indirect
	Fish population effects related to selenium	Benthic invertebrate tissue selenium concentrations	Concentrations relative to effect benchmarks (SQ #5)	Direct
Benthic Invertebrates	Benthic invertebrate abundance and assemblage (lotic habitats)	Abundance	Comparison to reference areas and past observations (SQ #5)	Direct
		Richness		
		% EPT		
		% Ephemeroptera		
		Tissue selenium concentrations	Concentrations relative to effect benchmarks and past observations (SQ #5)	Indirect
		Surface water chemistry	Concentrations of constituents relative to effect benchmarks and past observations (SQ #1, #3, and #4)	Indirect
		Calcite	Calcite index relative to known or suspected effect levels and past observations (SQ #5)	Indirect
		Sediment chemistry	Concentrations of constituents relative to guidelines, reference areas, and past observations (SQ #5 and #6)	Indirect
	Benthic invertebrate abundance and assemblage (lentic habitats)	Tissue selenium concentrations	Concentrations relative to effect benchmarks and past observations (SQ #5)	Direct
		Surface water chemistry	Concentrations of constituents relative to effect benchmarks, guidelines, and past observations (SQ #1, #3, and #4)	Indirect
		Calcite	Calcite index relative to known or suspected effect levels and past observations (SQ #5)	Indirect
		Sediment chemistry	Concentrations of constituents relative to guidelines, reference areas, and past observations (SQ #5 and #6)	Indirect
Amphibians	Amphibian population effects related to selenium	Surface water chemistry	Concentrations of constituents relative to effect benchmarks, guidelines, and past observations (SQ #1, #3, and #4)	Indirect
		Benthic invertebrate tissue selenium concentrations	Concentrations relative to effect benchmarks (SQ #5)	Direct
Birds	Bird population effects related to selenium	Surface water chemistry	Concentrations of constituents relative to effect benchmarks, guidelines, and past observations (SQ #1, #3, and #4)	Indirect
		Benthic invertebrate tissue selenium concentrations	Concentrations relative to effect benchmarks (SQ #5)	Direct

[a] Some endpoints/criteria apply to only selected habitats or sampling areas. See text for details.

[b] (SQ #) indicates the study question(s) that are addressed (directly or indirectly) by the listed evaluation criteria.

[c] Indicators (i.e., Measurement endpoints) are identified as either direct or indirect. Direct indicators are biological measurements that relate directly to the populations or communities of benthic invertebrates. Indirect indicators are abiotic endpoints measuring mine-related physical anc chemical stressors, and act as corroborating or explanatory evidence of observed effects or lack of effects on receptors. See the Study Design for the RAEMP 2018 to 2020 (Minnow 2018c) for further detail.

   b. What is the water quality at monitoring stations in the Elk River side channel, is it changing over time, and how does it compare to water quality in the main stem Elk River?

   c. What is the water quality at monitoring stations in the Elk River downstream versus upstream of the west-side tributaries, and is it changing over time?

   d. 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)?

4. What is the interaction between surface water and groundwater in the Elk River side channel?
5. What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?
6. Is the mine-related influence on Reach 2[4] having an effect on aquatic-dependent biota (benthic invertebrates, fish, amphibians, and aquatic-feeding birds)?

This report describes the approach, methods, and results used to address the study questions associated with the 2019 data collection.

1.4 Summary of the 2017 and 2018 GHO LAEMPs

A side channel of the Elk River and its adjacent floodplain complex were identified as the local study area because they receive flows, either via surface water or groundwater, from the mine-influenced west-side tributaries (e.g., Thompson Creek, Wolfram Creek, Leask Creek, and likely also Mickelson Creek; Figure 1.2). The study also addressed the west-side tributaries and the main stem Elk River upstream and downstream of the side channel. Located between the Elk River and the west side of the Greenhills Ridge, the Elk River side channel branches off from the Elk River just south of Leask Creek, flows south, and converges back with the Elk River roughly 1.2 km downstream from Thompson Creek. The Elk River side channel was observed to undergo seasonal flooding and braiding, with variable flow throughout the year. In addition to mine-related influences, the area has also been subject to logging and is used as rangeland for cattle.

Results from the first two years of the GHO LAEMP 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

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[4] The area that has previously been referred to as the “side channel wetland” is herein called Reach 2, as it is not a true wetland (see Section 8 and Minnow and Lotic 2019).

side channel and isolated pools (Minnow and Lotic 2018a, 2019). The area most likely to experience mine-related effects was Reach 2 (the side channel area at the confluence with Thompson Creek), based on its lentic nature during part of the year[5]. Data collected to date indicate this area is perennially-wetted, and, relative to other reaches within the side channel, has elevated concentrations of one or more mine-related constituents in water, sediment, and benthic invertebrate tissue (Minnow and Lotic 2018a, 2019).

1.5 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). The purpose of the AMP is to support implementation of the Elk Valley Water Quality Plan (EVWQP) to achieve water quality and calcite targets, to be protective of human health and the environment, and where necessary, restorative, and to facilitate continuous improvement of water quality in the Elk Valley (Teck 2018). Following an adaptive management framework, the AMP identifies six Management Questions that will be re-evaluated at regular intervals as part of AMP updates throughout EVWQP implementation. Data from the RAEMP (Minnow 2018c) and the various LAEMPs (including the present monitoring program) will feed into the adaptive management process to address these Management Questions that collectively address the environmental management objectives of the AMP (Teck 2018) and the EVWQP (Teck 2014). The AMP also identifies key uncertainties that need to be reduced to fill gaps in current understanding and support achievement of the EVWQP objectives.

The GHO LAEMP monitors conditions associated with the West spoil development and historical mining operations at GHO and answer specific questions on an annual basis (Section 1.3). During or at the conclusion of each annual LAEMP cycle (results are reported on May 31st of each year for the preceding calendar year), the adaptive management response framework may be triggered based on the findings of the LAEMP. For example, during the 2017 GHO LAEMP, monitoring of surface water hydrology and the formation of isolated pools in the side channel lead to questions regarding water losses to ground and the potential for groundwater to contribute to the formation of pools (Minnow and Lotic 2018a). This prompted the addition of a new study question: “What is the interaction between surface water and groundwater in the Elk River side channel?” which was added to the 2018 to 2020 GHO LAEMP study design (Minnow and Lotic 2018b). This also prompted Teck to initiate gap analyses of the regional groundwater monitoring program, the GHO site-specific groundwater monitoring program, and the

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[5] Reach 2 displays characteristics of both lotic and lentic systems, depending on the season. Lotic ecosystems are flowing freshwater systems with unidirectional water movement along a slope in response to gravity. In contrast, lentic ecosystems are differentiated by still water. Reach 2 was swiftly flowing from freshet until early summer (i.e., lotic), had moderate channelization with slow flow from late summer until fall, and, once the area became isolated in late fall through winter, water pooled at the mouth of Thompson Creek (i.e., lentic). See Section 3 and Section 8.

GHO LAEMP. The gap analyses resulted in recommended modifications to the approach to hydrological and groundwater monitoring, which will be considered for implementation (SNC-Lavalin 2019). Monitoring and data analysis will continue to adapt to findings in the field, and data and information needs associated with Teck's operations.

In addition to addressing questions specific to the GHO LAEMP on an annual basis, monitoring data from the LAEMP will contribute to the broader data set assessed every three years within the RAEMP. The RAEMP is designed to evaluate AMP Management Question #5 (i.e., Does monitoring indicate that mine-related changes in aquatic ecosystem conditions are consistent with expectations?). During the development of the AMP, several uncertainties related to Management Question #5 were identified that were summed up as Key Uncertainty 5.1 (i.e., How will monitoring data be used to identify potentially important mine-related effects on the aquatic ecosystem?). Teck is working with its consultants and the EMC to develop the methodology that will address Key Uncertainty 5.1 and its underlying uncertainties prior to the next RAEMP report in 2020.

Data from the LAEMPs and RAEMP will also contribute to answering AMP Management Question #2, (i.e., Will aquatic ecosystem health be protected by meeting the long-term site performance objectives?). A Key Uncertainty associated with Management Question #2 is "How will the science-based benchmarks be validated and updated?" with underlying uncertainty about how aquatic monitoring data will be used to validate and update the benchmarks. Progress on reducing these uncertainties, and associated learnings, will be described in Annual AMP Reports.

The first annual AMP report was submitted in July 2019 and included data from 2018 (Teck 2019b). This report indicated that no responses were taken or were needed under the AMP response framework based on the results of the 2018 GHO LAEMP. For more information on the adaptive management framework, the Management Questions, the key uncertainties, the Response Framework, Continuous Improvement, linkages between the AMP and other EVWQP programs, and AMP reporting, refer to the AMP (Teck 2018) and the 2018 Annual AMP report (Teck 2019b).

2 METHODS

2.1 Overview

Monitoring of the upper Elk River, the Elk River side channel, and west-side tributaries is currently conducted under several programs (Tables 2.1 to 2.3), including the GHO LAEMP, regional and site-specific groundwater monitoring programs, and the RAEMP. Routine water quality and flow data are also monitored weekly/monthly[6] by Teck in the Elk River (water quality only), Elk River side channel, and west-side tributaries, as per Permit 107517 and Permit 6428 requirements. Under the annual GHO site-specific groundwater monitoring program and the Regional Groundwater Monitoring Program, groundwater quality and interactions with surface water continue to be monitored (Section 6).

For the RAEMP, the main stem Elk River stations and Thompson Creek were sampled in September 2019 for benthic invertebrate community composition and tissue chemistry, as well as supporting habitat and substrate information (Sections 2.6, 2.7, 2.8, and 7).

GHO LAEMP side channel surveys were completed monthly from January to December 2019 to characterize the Elk River side channel hydrology and seasonality of wet and dry sections (Sections 2.2 and 3), habitat availability (Section 2.3 and 4), and use by aquatic dependent-biota (Sections 2.3 and 4). In September 2019, benthic invertebrate community composition (Sections 2.6 and 7), benthic invertebrate tissue chemistry (Sections 2.7 and 7), and supporting data were collected (Sections 2.8 and 7.4). All relevant monitoring data are compiled herein for 2019 (Tables 2.1 to 2.3), and compared to previous data where appropriate, to address the study questions (Section 1.3).

2.2 Hydrology (Question #1)

2.2.1 Overview

Hydrology data were primarily collected to address study question #1: What is the relationship between flows in the main stem Elk River and flows (including connectivity, intermittence, and pools) in the Elk River side channel? Data collection in 2019 was consistent with 2017 and 2018, and followed methods described in the 2018 to 2020 Study Design (Minnow and Lotic 2018a). Data collection continued from January 2019 through to December 2019 and included: water levels in the side channel and main stem Elk River, flow in the side channel

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[6] Sampling is done 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.

Table 2.1: Summary of Hydrology and Biota Surveys, Water and Sediment Quality Sampling, and Biological Sampling Conducted for the GHO LAEMP, 2018 to 2020

Exposure Type	Stream Type[a]	Stream Name	Water Station Code	Biological Area Code or Staff Gauge Location Code	ENV EMS Number	Area Description	UTM for Biological Area Code (NAD83, 11U)		Status	Hydrology	Habitat	Ground-water	Surface Water	Substrate		Benthic Invertebrates		Amphibians		Birds	Fish
										Water Level, Flow, and Temperature Monitoring	Monthly Habitat and Biota Survey	Chemistry	Chemistry	Calcite Index	Sediment Physical-chemical Attributes	Community Endpoints	Tissue Chemistry (Composite taxa)	Survey	Egg Tissue	Survey	Survey
							Easting	Northing		2018, 2019	2018, 2019	Annually 2018-2020	Annually 2018-2020	Annually 2018-2020	2018	Annually 2018-2020	Annually 2018-2020	2018	2018	2018	2018
Reference	M	Elk River	GH_ER2	RG_ELUGH	200389	u/s Branch Cr. and GHO	646739	5557609	Core RAEMP Reference	-	-	-[b]	monthly[c], concurrently[c]	3 Annually	3	3 Annually	3 Annually	-	-	-	-
	M	Elk River	-	ERUS	-	Elk River u/s side channel	648114	5552674	GHO LAEMP	monthly/ continuous	-	-	-	-	-	-	-	-	-	-	-
Mine-exposed	S	Elk River Side Channel	GH_ERSC4	GH_ERSC4	E305878	Elk River side channel u/s of Wolfram Creek	648111	5552522	GHO LAEMP	monthly/ continuous	side channel survey	-[b]	monthly[c], concurrently[c]	3 Annually	-	3 Annually	3 Annually	-	-	-	-
	S	Elk River Side Channel	GH_ER1A	GH_ER1A	E305876	Elk River side channel d/s of Wolfram Creek, u/s of wetland	648379	5551653	GHO LAEMP	monthly/ continuous		-[b]	monthly[c], concurrently[c]	3 Annually	-	3 Annually	3 Annually	-	-	-	-
	S	Elk River Side Channel	RG_ERSC5	RG_ERSC5	-	Elk River side channel d/s of Wolfram Creek, u/s of wetland	648275	5550608	GHO LAEMP	-		-[b]	concurrently[c]	3 Annually	-	3 Annually	3 Annually	-	-	-	-
	T	Mickelson Creek	GH_MC1	GH_MC1	0200388	Mickelson Creek at LRP Road	648209	5553862	GHO LAEMP	-	-	-[b]	monthly[c]	-	-	-	-	-	-	-	-
	T	Leask Creek	GH_LC1	GH_LC1	E257796	Leask Creek Sed. Pond Decant	648153	5552859	GHO LAEMP	-	-	-[b]	monthly[c]	-	-	-	-	-	-	-	-
	T	Wolfram Creek	GH_WC1	GH_WC1	E257795	Wolfram Creek Sed. Pond Decant	648222	5552086	GHO LAEMP	-	-	-[b]	monthly[c]	-	-	-	-	-	-	-	-
	T	Thompson Creek	GH_TC2	THCK	E207436	Lower Thompson Creek	648596	5550237	RAEMP	-	-	-[b]	monthly[c], concurrently[c]	1 (2018) 3 (2019, 2020) Annually	-	1 (2018) 3 (2019, 2020) Annually	1 (2018) 3 (2019, 2020) Annually	-	-	-	-
	Le	Elk River Side Channel Wetland	RG_GH-SCW1	RG_GH-SCW1	-	Inlet of Reach 2 in the Elk River side channel downstream of Thompson Creek	648317	5550334	Lentic Area Supporting Study 2018	-	side channel survey	-[b]	monthly[d]	-	-	-	-	-	-	-	-
	Le	Elk River Side Channel Wetland	RG_GH-SCW3	RG_GH-SCW3	-	Oulet of Reach 2 in the Elk River side channel downstream of Thompson Creek	648332	5550166	Lentic Area Supporting Study 2018	-		-[b]	monthly[d], concurrently[c]	3 Annually	5	-	3 Annually	June, July 2018 (targeting different life stages)	-[e]	2 surveys in June 2018	July/ August 2018
	S	Elk River Side Channel	GH_ERSC2	GH_ERSC2	E305877	Elk River side channel d/s of Thompson Creek	648341	5549812	GHO LAEMP	monthly/ continuous		-[b]	monthly[c], concurrently[c]	3 Annually[f]	-	3 Annually[f]	3 Annually[f]		-	-	-
	S	Elk River Side Channel	-	RG_SCDTC	-	Elk River side channel d/s of Thompson Creek	648226	5549603	GHO LAEMP	-		-[b]	concurrently[c]	3 Annually	-	3 Annually	3 Annually		-	-	-
	S	Elk River Side Channel	-	RG_ERSCDS	-	Elk River u/s side channel	648771	5549103	GHO LAEMP	monthly/ continuous	-	-	-	-	-	-	-	-	-	-	-
	S	Elk River Side Channel	-	RG_ERC	-	Elk River u/s side channel	648939	5548778	GHO LAEMP	monthly/ continuous	-	-	-	-	-	-	-	-	-	-	-
	M	Elk River	GH_ERC (Compliance)	RG_EL20	E300090	d/s Thompson Cr. and GHO	649146	5548514	Core RAEMP Mine-exposed	monthly/ continuous	-	-[b]	monthly/weekly[c], concurrently[c]	5 Annually	5	5 Annually	5 Annually	-	-	-	-

🟨 Sampling conducted for, and reported under, the GHO LAEMP 2018 to 2020.
🟩 Sampling conducted for, and reported under, the Lentic Area Supporting Study (Minnow 2018b). Data also reported and interpreted under the GHO LAEMP 2018 to 2020.
🟦 Sampling conducted for, and reported under, the RAEMP. Data also reported and interpreted under the GHO LAEMP 2018 to 2020.
🟧 Sampling conducted for, and reported under, the site-specific GHO groundwater program. As required, data may be included in the GHO LAEMP to help address the key questions.

Note: "-" indicates no work conducted.

[a] M-main stem (lotic); S-side channel (lotic); Le - side channel (semi-lentic); T-tributary (lotic).

[b] The site-specific GHO groundwater program will be updated to address GHO LAEMP data needs.

[c] 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.

[d] Collected monthly concurrent with monthly hydrology surveys.

[e] Area was swiftly flowing and inaccessible in June 2018, and therefore likely provided limited breeding habitat. No eggs were found or sampled in 2018.

[f] Was not wetted during September 2018 and therefore could not be sampled. In September 2019, this station was depositional and therefore could be sampled for benthic invertebrate tissue chemistry, but not benthic invertebrate community.

Table 2.2: **Pools Assessed for Habitat, Biota, and Water Chemistry, GHO LAEMP** [a]

General Pool Area Description	Water Station Code			UTM (NAD83, 11U)		Wetted and Flowing (W), Wetted Isolated Pool (P), and Dry (D)																															
						2017								2018												2019											
	EQuIS	2018 / 2019 GHO LAEMP Report	2017 GHO LAEMP Report[b]	Easting	Northing	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December
Side channel upstream of station GH_ER1A	RG_GH-SC3-P7	SC3-P7	Pool-U-1	647843	5552016	W	W	W	W	W	W	P	D	D	D	D	D	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	D
	RG_GH-SC3-P6	SC3-P6	Pool-U-2	647833	5551900	W	W	W	W	W	W	P	D	D	D	D	P	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	P
	RG_GH-SC3-P10	SC3-P10	Pool-U-3	647873	5551838	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	D
	RG_GH-SC3-P9	SC3-P9	Pool-U-4	647906	5551710	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	W	D	D	D	D	D	W	W	W	W	W	W	W	P
	RG_GH-SC3-P14	SC3-P14	- [c]	648076	5551622	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	D	D	W	W	W	W	W	D	D
	RG_GH-SC3-P8	SC3-P8	Pool-U-5	648214	5551721	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	D	D
	RG_GH-SC3-P13	SC3-P13	- [c]	648271	5551718	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	P	P	W	W	W	W	W	D	D
Side channel downstream of station GH_ER1A, upstream of Thompson wetland	RG_GH-SC3-P11	SC3-P11	- [c]	648374	5551627	W	W	W	W	W	P	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	P	W	W	W	W	D	P	D
	RG_GH-SC3-P12	SC3-P12	- [c]	648336	5551170	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC3-P15	SC3-P15	- [c]	648278	5550864	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	P	D	W	W	W	W	D	D	D
	RG_GH-SC3-P4	SC3-P4	Pool-M-2	648255	5550781	W	W	W	W	W	P	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC3-P3	SC3-P3	Pool-M-1	648299	5550743	W	W	W	W	W	D	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	D	D	D
Western channel downstream of Thompson wetland	RG_GH-SC1-P1	SC1-P1	Pool-W-2	648380	5549321	W	W	W	W	P	D	D	P	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	W	W	P	D	D
	RG_GH-SC1-P2	SC1-P2	Pool-W-1	648730	5549114	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	P	P	P	D	D	D	D	D	P	P	W	W	P	P	P	D	D
Middle channel downstream of Thompson wetland	RG_GH-SC4-P1	SC4-P1	- [c]	648589	5549393	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	P	P	D	D	D	D	D	D	P	P	W	W	W	P	D	D	D
Eastern channel downstream of Thompson wetland	RG_GH-SC2-P4	SC2-P4	Pool-E-1	648492	5549728	W	W	W	P	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	D	D	D	D	D
	RG_GH-SC2-P1	SC2-P1	Pool-E-2	648559	5549470	W	W	W	W	P	D	D	D	P	D	D	D	W	W	W	W	P	P	P	P	P	P	D	P	P	W	W	W	P	P	P	P
	RG_GH-SC2-P5	SC2-P5	Pool-E-3	648592	5549424	W	W	W	W	P	D	D	D	P	D	D	P	W	W	W	W	P	P	P	P	D	D	P	P	P	W	W	W	W	P	P	P
	RG_GH-SC2-P6	SC2-P6	- [c]	648609	5549390	W	W	W	W	D	D	D	D	D	D	D	P	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC2-P10	SC2-P10	- [c]	648635	5549343	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	P	W	W	W	W	P	P	P
	RG_GH-SC2-P7	SC2-P7	- [c]	648652	5549329	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	P	D	D	W	W	W	W	P	P	P
	RG_GH-SC2-P2	SC2-P2	Pool-E-6	648668	5549294	W	W	W	W	P	D	D	D	D	D	D	D	W	W	W	W	D	P	P	P	P	P	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC2-P3	SC2-P3	Pool-E-7	648782	5549097	W	W	W	W	P	P	P	P	P	P	P	P	W	W	W	W	P	P	P	P	P	P	P	P	P	W	W	W	W	P	P	P

W	Location was wetted and flowing (i.e., water connected to the upstream/downstream channel, and not an isolated pool).
P	Location was a wetted isolated pool.
D	Location was dry.

[a] This table excludes isolated pools that were not sampled for water quality. See Appendix Figures A.1 to A.28 and Appendix Tables B.8 to B.17.

[b] Relative to this report, a different naming convention was used in the 2017 GHO LAEMP, and is provided here for context. Pool samples are listed with the prefix "RG_GH-" in EQuIS, but for simplicity the prefix is not displayed in the 2018 GHO LAEMP. The 2018 naming convention follows "field logic" and pools were numbered as they were observed.

[c] Pool was not sampled for the 2017 GHO LAEMP (Minnow and Lotic 2018a).

Table 2.3: West-side Tributary Water Quality Monitoring Stations in the GHO LAEMP, 2019

Exposure Type	Tributary Name	Water Station Code	ENV EMS Number	Area Description	UTM (NAD83, 11U)	
					Easting	Northing
Reference	Branch F Creek	GH_BR_F	E287437	Branch F at LRP Road	647423	5557155
Mine-exposed	Wolf Creek	GH_WOLF	E305855	Wolf Creek Sed. Pond Decant	647490	5556959
	Willow Creek	GH_WILLOW	-[a]	Willow Creek at LRP Road	647654	5556061
		GH_WILLOW_SP1	E305854	Willow Sediment Pond Decant	647604	5556029
		GH_WILLOW_S	-[a]	Willow South Creek at LRP Road	647663	5556006
	Wade Creek	GH_WADE	E287433	Wade Creek at LRP Road	647723	5555707
	Cougar Creek	GH_COUGAR	E287432	Cougar Creek at LRP Road	647765	5555457
	No Name Creek	GH_NNC	E305875	No Name Creek	648055	5554967
	Branch D	GH_BR_D	-[a]	Branch D Creek	648062	5554869
	Mickelson Creek	GH_MC1	0200388	Mickelson Creek at LRP Road	648209	5553862
	Leask Creek	GH_LC2	-[a]	Leask Creek upstream of Sed. Pond	648297	5553064
		GH_LC1	E257796	Leask Creek Sed. Pond Decant	648153	5552859
	Wolfram Creek	GH_WC2	-[a]	Wolfram Creek upstream of Sed. Pond	648347	5552251
		GH_WC1	E257795	Wolfram Creek Sed. Pond Decant	648222	5552086
	Thompson Creek	GH_TC2	E207436	Thompson Creek Sed. Pond Decant	648596	5550237
		GH_TC1	E102714	Thompson Creek at LRP Road	648550	5550221

Note: The west-side tributaries are listed from upstream to downstream. The side channel branches off from the main stem Elk River downstream of Leask Creek and upstream of Wolfram Creek (delineated in this table by the double line; see Figure 2.2).

[a] No ENV EMS number.

(i.e., discharge), and characterization of side channel hydrology features (dry sections, braids, isolated pools, and tributary surface connectivity).

2.2.2 Side Channel Mapping

Monthly surveys were completed along the Elk River side channel from the downstream outlet at the Elk River to the side channel inlet near Leask Creek, covering roughly 7.3 km. Monthly surveys were used to evaluate the seasonality of surface flow conditions within the side channel and connectivity to upslope tributaries. The spatial extents of wetted and dry areas were marked with a handheld Global Positioning System (GPS) unit (in Universal Transverse Mercator System [UTM] coordinates, using North American Datum [NAD] 83) to facilitate mapping. Characteristics of primary interest included:

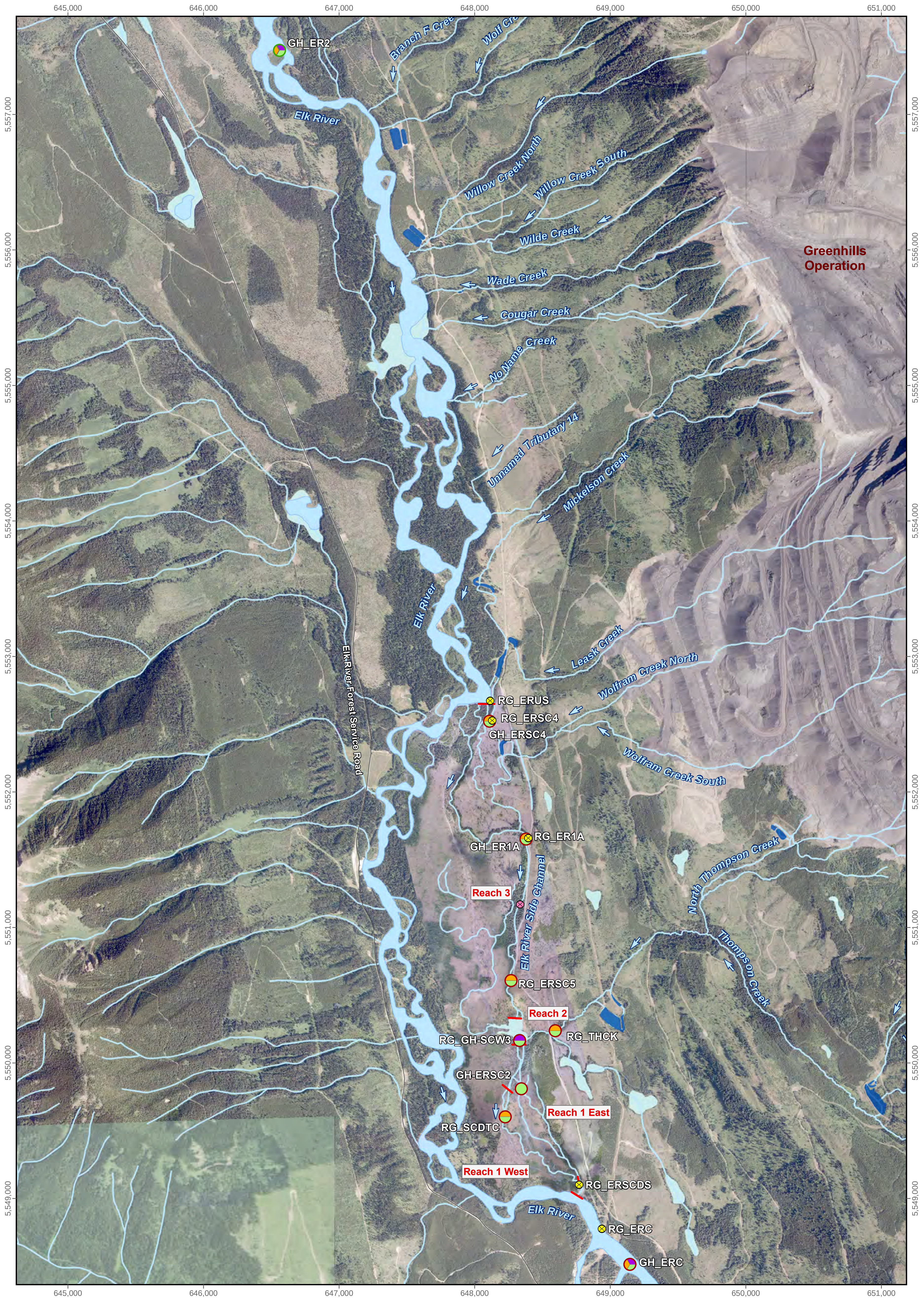
- dry sections;
- braided or flooded sections;
- isolated pools; and
- surface connectivity between tributaries (Wolfram Creek and Thompson Creek), the Elk River, and the Elk River side channel.

Maps were created to display monthly conditions in terms of wetted and 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

2.2.3.1 Field Monitoring

Water levels were assessed in the Elk River side channel and main stem Elk River upstream and downstream of the side channel to characterize the relationship between flows in the side channel and in the main stem Elk River. In 2017, water level and temperature loggers (Onset Hobo U 20 Level loggers) were installed at RG_ERUS, GH_ERSC4, GH_ER1A, RG_ERSCDS, and GH_ERC (Figure 2.1). Water level and temperature data were used to confirm dry periods. Loggers were housed in a stilling well. A staff gauge (i.e., a ruler to measure water surface elevation) was also attached to each stilling well. Additionally, a barometric logger was installed at GH_ER1A (Minnow and Lotic 2018a). Barometric data were used to correct submerged water level loggers for changes in atmospheric pressure. Loggers and staff gauges were maintained through 2018 and 2019. The staff gauge at RG_ERSCDS was damaged in late April 2018 and was submerged in a pool until it could be reinstalled in July 2018. No maintenance



LEGEND

Sampling Type

Mine-exposed

Reference

🟪 Sediment Quality

🟧 Benthic Invertebrate Community

🟩 Benthic Invertebrate Tissue Chemistry

⊗ Staff Gauge Location

⊗ Barometric Logger

— Reach Break

🟦 Settling Pond

Staff Gauge Locations, and Sediment Quality, Benthic Invertebrate Community, and Benthic Invertebrate Tissue Chemistry Sampling Stations

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 11
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Date: May 2020
Project 197202.0011

minnow environmental inc.

Figure 2.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 2.1 Staff Gauge Locations.mxd

was required in 2019. Data were downloaded routinely from the loggers to avoid data loss. Loggers were winterized before winter to prevent freezing and damage (October or November). They were de-winterized and downloaded as conditions became ice-free in spring (April or May).

Water levels (i.e., stream stage) and temperature were recorded at 15-minute intervals at the three stations within the Elk River side channel throughout 2018 and 2019. Flow measurements were completed at all water level logger stations on the side channel (RG_ERSCDS, GH_ER1A, GH_ERSC4; Figure 2.1) during monthly visits when sites were free from ice and could be measured safely. Flow measurements were not collected at the Elk River main stem sites due to deep water and high flow conditions. Streamflow measurements were collected following the Manual of British Columbia Hydrometric Standards (RISC 2009). Stream depth (m) and velocity (m/s) were measured using a Hach FH950 flow meter or salting. Velocity measurements were collected with the Hach meter at a depth of 60% of the total depth from the water surface. These flow measurements, combined with staff gauge readings, were used to build stage discharge measurements. Benchmark surveys were completed throughout the sampling period to comply with Resource Information Standards Committee (RISC) standards (RISC 2009).

2.2.3.2 Data Analysis

Water level data were collected and corrected for barometric pressure using Onset Hoboware Pro (version 3.7.13) and a reference water stage relative to the staff gauge. Water stage was then converted to a discharge from site-specific stage discharge rating curves. A log-linear stage-discharge curve was generated using manual stage and discharge measurements for each site. Stage (m) and discharge (m^3/s) values were manually verified and qualitatively determined outliers or measurements with high uncertainty were removed from further analyses. All stage measurements below 0.001 m were treated as ‘dry’ and were excluded. A discharge time series (i.e., hydrograph) was plotted for each site and qualitatively assessed for locations along the side channel.

The hydrological signals of the side channel hydrometric gauges were determined by comparing daily streamflow records against records from the Elk River near Natal Water Survey of Canada (WSC) hydrometric gauge (08NK016). Daily data were available until the end of 2018 from wateroffice.gc.ca and preliminary (hourly) data were available for 2019.

MacHydro (a hydrological consulting company retained by Lotic for senior review) provided a quality assurance / quality control (QA/QC) review of the hydrological data and assigned a grade value for the quality of the data. Grades were assigned following British Columbia Ministry of Environment Hydrological RISC Standards (RISC 2009). The rating curves produced a varying quality grade of B or C (Appendix Table A.1). Instrumentation and field procedures were of good quality, while the discharge curve accuracy grade was good (i.e., B grade) for RG_ER1A and

RG_ERSC4 and modest (i.e., C grade) for RG_ERSCDS. The interim curves have modest grades due to the relatively few manual observations during high flow conditions, and therefore should be interpreted with caution, as they may either over- or under-estimate discharge at higher stages.

2.3 Habitat and Biota (Question #2 and #6)

2.3.1 Overview

Habitat and observations of aquatic-dependent biota were documented during monthly surveys to address study question #2 (What is the seasonal habitat availability for aquatic-dependent biota [i.e., fish, amphibians, and aquatic-feeding birds] in the Elk River side channel?) and study question #6 (Is the mine related influence on Reach 2 having an effect on aquatic dependent biota (benthic invertebrates, fish, amphibians, and aquatic-feeding birds?). Previous studies have shown that the majority of the GHO west-side tributaries have steep gradients, are ephemeral, and, except for Thompson Creek, are not fish-bearing (Lotic 2015; Minnow 2016a). Prior to the GHO LAEMP, the habitat of the Elk River side channel had not been evaluated. Therefore, monthly surveys conducted for the GHO LAEMP targeted the side channel and its floodplain complex. Monthly surveys were completed from January to December 2019 consistent with previous years. These data, along with 2017 and 2018 observations (Minnow and Lotic 2018a, 2019), provide information about seasonal habitat availability for different aquatic-dependant biota.

2.3.2 Habitat Availability

Habitat was assessed as a component of monthly surveys. Field crews 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, and substrate type), stream morphology/hydrology observations, presence of isolated pools, as well as updates to information gathered in the 2017 Fish Habitat Assessment Procedures (FHAP) survey (Minnow and Lotic 2018b, 2019). During spring and fall surveys, surveyors were watchful for redds and spawning fish. During winter surveys, overwintering habitat was documented. *In situ* water quality parameters were measured monthly in isolated pools and at the level logger stations and were compared to British Columbia Water Quality Guidelines (BCWQG; ENV 2018).

2.3.3 Distribution of Aquatic-dependent Biota

During monthly surveys, the side channel was traversed to document any aquatic or aquatic-dependant species utilizing the side channel. This included observations of fish (including eggs, fry, young-of-the-year, juveniles, and adults, as well as spawning fish and redds during spring and fall surveys), visual and auditory detections of amphibians (including eggs, tadpoles, and adults), and visual and auditory detections of aquatic-dependent birds (including nests, eggs, chicks, and adults). In addition to monthly surveys, fish, amphibians, and aquatic-dependent birds observed in Reach 2 as part of the Lentic Area Supporting Study in 2018 (Minnow 2019) were included in the GHO LAEMP dataset.

2.4 Water Quality (Questions #3, #4, and #6)

2.4.1 Overview

Water quality data were used to address three study questions (Section 1.3):

- What is the influence of GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel? (study question #3 and its sub-questions),
- What is the interaction between surface water and groundwater in the Elk River side channel? (study question #4), and
- Is the mine-related influence on Reach 2 having an effect on aquatic-dependent biota (benthic invertebrates, fish, amphibians, and aquatic-feeding birds)? (study question #6).

Data from Teck's surface water quality monitoring under Permit 107517 and Permit 6428 as well as supplementary sampling conducted concurrent with GHO LAEMP field sampling were evaluated. (Tables 2.1 to 2.3).

2.4.2 Sample and Data Collection

Water quality samples were collected weekly/monthly[7] by Teck as part of the permitted water quality sampling program. Water quality data were downloaded from Teck's EQuIS^{TM} database for the water quality stations in the west-side tributaries, the upper Elk River, and the Elk River side channel (Figure 2.2). Additional water quality samples were collected specifically for the GHO LAEMP to evaluate the influence of the tributaries and main stem Elk River on the side channel. Between January 2019 and December 2019, grab samples were collected from thirteen isolated pools along the Elk River side channel. Larger pools and pools containing fish were targeted. Samples were collected monthly following initial identification of isolated pools, until the pools became dry or froze to the bottom. The location of each pool was marked in UTMs using a handheld GPS and notes on fish presence, pool size, and depth were recorded during ice-free conditions. Water quality samples were collected concurrent with benthic invertebrate community and tissue chemistry samples in September 2019 (Section 2.6 and 2.7), a well as

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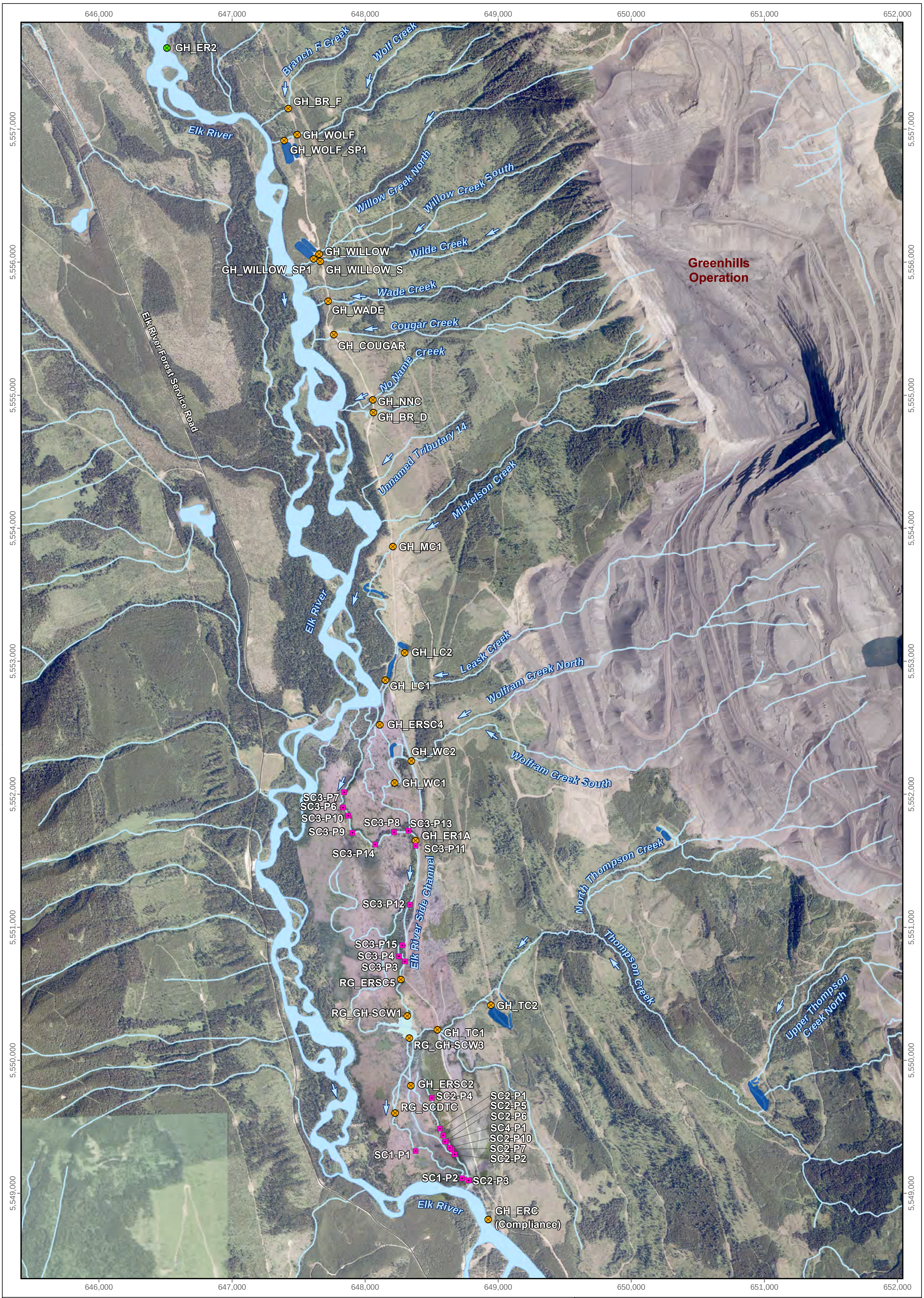
[7] Sampling is conducted on a monthly basis (August to March) and/or weekly/monthly basis (March 15 to July 15), as required by Permit 107517 and Permit 6428.



LEGEND

- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Reference
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ■ GHO LAEMP Mine-exposed Water Quality Sampling Location, Isolated Pool
- ▬ Settling Pond

Surface Water Quality Monitoring Stations

0 0.5 1 2
km

N
W E
S

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Figure 2.2

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 2.2 Surface WQ.mxd monthly at the inlet (RG-GHSCW1) and outlet (RG_GHSCW3) of Reach 2 to support the assessment of water quality in the side channel (study question #2.b).

Water samples were collected into clean, pre-labelled containers provided by the analytical 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 the analytical laboratory. Concurrent with water quality sampling, *in situ* measurements of temperature, dissolved oxygen (DO), pH, and specific conductance were collected using a multi-probe water quality meter.

As open-pit mining progresses at GHO, water collects in the pits due to surface water runoff and groundwater infiltration as operations extend below the groundwater table. To dewater the GHO pits, water has been pumped and discharged into several of the west-side tributaries: Mickelson, Leask, and Wolfram creeks. Pit pumping discharge data were reviewed with the GHO water management team. Detailed discharge records as per a pit pumping plan exist for 2018 to 2019 (Teck 2019a). Mickelson Creek received pit pumping discharge in 2015 only, Leask Creek received discharge from 2016 to present, and Wolfram Creek received discharge from 2011 to present. The other west side tributaries (including Thompson Creek) have not received pit pumping discharge (Teck 2019a). Typical discharge rates were 3,000 to 5,000 m^3/day during most of the year and up to 15,000 m^3/day in peak freshet prior to 2018. Detailed documentation of discharge began in 2018 and will be ongoing (Appendix Table C.1).

Selenium speciation data have been collected in 2017, 2018, and 2019 in the main stem Elk River (GH_ER2 and GH_ERC), the Elk River side channel (GH_ER1A), and three of the west-side tributaries (Leask [GH_LC1, GH_LC2], Wolfram [GH_WC1, GH_WC2], and Thompson [GH_TC1, GH_TC2] creeks) to support other monitoring programs, but was not a component of the 2018 to 2020 GHO LAEMP study design. As a result, September speciation data were typically not available for direct comparison to tissue chemistry data of benthic invertebrates collected in September. Although less directly linked, speciation data from other months were assessed as available. Available selenium speciation data are provided for GHO LAEMP stations (Appendix Table C.2), per EMC request.

2.4.3 Laboratory Analysis

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 2.4) using standard methods (Table 2.5). QA/QC associated with water sampling are reported by Teck in the annual reports for Permits 107517 and 6248.

Table 2.4: 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, TDS, hardness, alkalinity, dissolved organic carbon, total organic carbon (TOC), 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 2.5: 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 (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

2.4.4 Screening and Plotting of Water Quality Constituents

Water quality assessment focused on constituents that were identified as mine-related in the Adaptive Management Plan and had EWTs defined (Azimuth 2019; i.e., dissolved cadmium, nitrate, total selenium, sulphate, total antimony, total barium, total boron, dissolved cobalt, total lithium, total manganese, total molybdenum, total nickel, nitrite, total dissolved solids [TDS], total uranium, and total zinc). For this 2019 GHO LAEMP report, dissolved nickel, phosphorus, orthophosphate, and TSS were also assessed based on EMC input. Dissolved nickel, which is the more bioavailable fraction, was presented to determine whether this fraction is above interim screening values. Phosphorus and orthophosphate were presented because environmental assessments completed as part of the Cougar Pit extension predicted elevated concentrations of phosphorus in Wolf, Willow, and Wolfram creeks. Total suspended solids was added to assess the potential effects of total suspended solids on fish use and habitat availability.

These constituents were compared to BCWQG and/or EVWQP benchmarks, as well as interim screening values for nickel, as applicable, for the 2019 calendar year (Appendix Table C.3). Within the GHO LAEMP, the most conservative (i.e., lowest) EVWQP Level 1 and Level 2 Benchmarks were used for screening. The Level 1 benchmark for cadmium is hardness-based and is based on reproductive toxicity to planktonic crustacean *Daphnia magna* (HDR 2014). For nitrate, the Level 1 and Level 2 benchmarks are based on reproductive toxicity to the water flea *Ceriodaphnia dubia* (Golder 2014b). For total selenium, the Level 1 and Level 2 benchmarks are based on reproductive toxicity to sensitive fish species (Golder 2014a). The Level 1 and Level 2 benchmarks for sulphate are hardness-based, and are based on toxicity to rainbow trout early life-stage survival and development (Golder 2014b). Per EMC request in July 2019, concentrations of TSS were assessed using the Newcombe and Jensen 1996 model to determine the potential for effects on fish use and habitat availability in the Elk River side channel. The model uses a severity scale produced from a dose-response relationship based on TSS concentrations and exposure time. Concentrations of TSS were compared to the model Scale of the Severity (SEV) 7, which is the level where moderate habitat degradation and impaired homing are predicted (Appendix Table C.4; Newcombe and Jensen 1996). The TSS concentration for each SEV level (including SEV 7) was calculated using the model assuming one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5 to 250 µm (i.e., Group 1 from Newcombe and Jensen 1996). Expose duration was selected to be conservative, based on water sampling weekly/monthly frequency (Section 2.4.2). Salmonids (as opposed to non-salmonids) was selected due to the presence of salmonids in the side channel (Section 4.3). It is assumed that all life stages could be present in the side channel, and both fry and adults have been observed in the side channel (Section 4.3). Particle size selection was conservative by assuming presence of both fine and coarse sediments, which, respectively can impact fish via passing through gill membranes into interlamellar spaces of gill tissues and via mechanical abrasion of gills. The following model was used:

$$z = a + b(\log_e x) + c(\log_e y)$$

Where z is the severity of ill effect, x is duration of exposure (hours), and y is concentration of suspended sediment (mg SS/L). In this model, the intercept (a) and slope coefficients (b and c) were determined by the model group, which was for Group 1 for this project, where a = 1.0642, b = 0.6068, and c = 0.7384 (Newcombe and Jensen 1996).

Plots of constituent concentrations from 2012 to 2019 were prepared individually for each monitoring station relative to BCWQG, EVWQP benchmarks, and/or interim screening values (where applicable), and also as combined plots to allow for visual comparison among stations.

Plots were qualitatively assessed for seasonal and temporal patterns. Water quality data were assessed for:

- the west-side tributaries (study question #3a);
- the Elk River side channel lotic stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Reach 2 (RG_GH-SW1, RG_GH-SCW3) (study question #3b);
- the main stem Elk River downstream (GH_ERC) and upstream (GH_ER2) of the west-side tributaries (study question #3c); and
- isolated pools in the Elk River side channel (study question #3d).

2.4.5 Statistical Analyses

2.4.5.1 Monthly Means

Statistical analyses of water quality parameters were conducted using monthly means. Monthly mean concentrations were estimated using the Kaplan-Meier (K-M) method. The method involves transforming the left censored (i.e., < value) dataset to a right censored (i.e., > value) dataset, and then using the K-M estimator (used to estimate the mean survival time in survival analysis) to estimate the mean. The calculation was conducted using the survfit() function in the survival package (Therneau 2017) in R (R Core Team 2019) and involves calculating the area under the K-M survival curve. The K-M method is non-parametric and can accommodate multiple laboratory reporting limits (LRLs). The method of estimating the mean is equivalent to using the distribution of detectable values below the LRL to represent values that are < LRL. For example, the mean of the data set {1, 2, <4, 5} is estimated as the mean of 1, 2, [½×1 + ½×2], and 5 which is 2.375. The value <4 is replaced by the distribution of values below 4 (i.e., 1 and 2 with equal weight of ½). Similarly, the mean of the data set {1, 1.6, 2, 2.1, <4, 5} is estimated as the mean of 1, 1.6, 2, 2.1, [¼×1 + ¼×1.6 + ¼×2 + ¼×2.1], and 5 which is 2.229. Again, the value <4 is replaced by the distribution of values below 4 (i.e., 1, 1.6, 2, and 2.1 with equal weight of ¼). If there is only one LRL and no detected values below the LRL, then the K-M estimate of the mean is equivalent to replacing the value below the LRL with the LRL (i.e., the best estimate for the values < LRL is the LRL).

2.4.5.2 Temporal Trends

Temporal changes in monthly mean water concentrations were evaluated for each station (reference and mine-exposed) from 2012 to 2019. Data analysis included only years with at least 6 months and included only stations with at least 3 years of data. Due to the presence of LRLs for most parameters, a censored regression Analysis of Variance (ANOVA) model with factors *Year* and *Month* and assuming a log-normal distribution of the response variable was fit with maximum likelihood estimation for each station. The significance of each term in the model was assessed using likelihood-ratio tests to determine if there is a significant change in log-likelihood with the addition of the term in the model. This tested for an overall difference among years and including the *Month* term in the model controlled for seasonal effects within a year. If the year term was significant ($\alpha = 0.05$) then post-hoc contrasts were conducted to test for all pairwise differences among years with an $\alpha = 0.05$ in a Tukey's Honestly Significant Difference test (HSD) which corrects for the number of comparisons.

For each year, for statistically significant differences, a percent magnitude of difference (MOD) from the base year (i.e., first year with minimum number of months) was calculated as:

$$\frac{Year_i - Base\ Year}{Base\ Year} \times 100\ \%$$

and the significant difference between 2019 and all other years and between 2019 and 2018 was assessed. All statistics were conducted in R (R Core Team 2019).

2.4.5.3 Main Stem Elk River versus the Side Channel (Question #3b)

Statistical comparisons of water quality between the side channel stations (GH_ERSC2, GH_ER1A, GH_ERSC4) and the upstream (GH_ER2) and downstream (GH_ERC) stations were conducted to assess differences among years (from 2016 to 2019) and among stations. Statistical analysis of water quality data focussed on monthly mean concentrations of constituents with EWTs and total suspended solids. The statistical comparisons were conducted on the mathematical differences (side channel – downstream, and side channel – upstream) in $\log_{10}$ monthly mean concentrations to remove the influence of season. The differences in $\log_{10}$ monthly mean concentrations between areas were tested using a two-way ANOVA with factors Year, Area (the three side channel stations), and the Area x Year interaction.

The side channel versus upstream and side channel versus downstream comparisons were conducted by testing whether differences in $\log_{10}$ monthly mean concentrations between stations were different from zero using a one-sample t-test by testing the hypothesis (H_{01}):

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

where µd represented the difference in monthly means between side channel stations and upstream or downstream stations. The tests for H_{01} were conducted by: 1) pooling three years of data and stations when the Area x Year interaction (P-value > 0.1) and Area (P-value > 0.05) factors were not significant; 2) pooling three years of data, but separately by side channel station when the Area x Year interaction (P-value > 0.05) 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 < 0.05) term was significant.

When the differences in monthly mean concentrations between the side channel and upstream or downstream stations were significant, the 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} were the geometric mean MCT for the side channel, downstream, and upstream stations, respectfully.

2.4.5.4 Main Stem Elk River Downstream versus Upstream of the West-Side Tributaries (Question #3c)

Concentrations at the Elk River downstream station (GH_ERC) were compared to upstream (GH_ER2) using the difference in $\log_{10}$ monthly mean concentrations between stations. Potential changes over time at the downstream station compared to upstream were tested using an ANOVA on the differences in $\log_{10}$ monthly mean concentrations between stations, with Year as a co-variate. When the Year term was not significant, the difference between the upstream and downstream stations was tested using a using a one sample t-test (see section 2.4.5.3). When Year was significant, it suggested the difference between the upstream and downstream stations varied by year, and a t-test was run separately for each year. When the difference in monthly mean concentrations between the upstream and downstream stations was significant overall, or for an individual year, the magnitude of difference (MOD) was calculated as:

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

where MCT_{DS}, and MCT_{US} were the geometric means for the downstream and upstream stations, respectively.

2.5 Surface Water and Groundwater Interaction (Question #4)

SNC-Lavalin (2020) completed a report describing the updated understanding of groundwater-surface water interaction along the Elk River side channel to support study question #4 (What is the interaction between surface water and groundwater in the Elk River side channel?).

To assess this, available groundwater data and surface water data were compiled. Groundwater data were collected in 2019 as part of other on-going programs such as the GHO Site-Specific Groundwater Monitoring Program (SSGMP), the Regional Groundwater Monitoring Program

(RGMP), and the Cougar Pit Expansion Phase 2 (CPX2) Program. Surface water level data were collected (Section 2.2.3.1), and instantaneous flow and water quality data were collected by Teck as part of on-going surface water monitoring programs at GHO. A detailed description of data collected in support of study question #4 is provided in Appendix D.

The assessment included:

- spatial and temporal comparison of groundwater elevations in monitoring wells to surface water levels in the adjacent side channel and tributaries (including sedimentation ponds) and the Elk River;
- spatial and temporal comparison of groundwater chemistry (including mine-related constituents and major ions) from monitoring wells to surface water chemistry data from the side channel, tributaries, isolated pools, and the Elk River;
- assessment of the presence and seasonality of isolated pools and wetted areas with respect to the potential for groundwater to be contributing to water quality for the pools; and
- an updated characterization of the spatial distribution of wetted areas over time in the context of side channel hydrology and hydrogeology.

2.6 Benthic Invertebrate Community (Question #5 and #6)

2.6.1 Overview

Benthic invertebrate community structure data were assessed to address study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?) and study question #6 (Is the mine related influence on Reach 2 having an effect on aquatic dependent biota [benthic invertebrates, fish, amphibians, and aquatic-feeding birds?]).

2.6.2 Sample Collection

Benthic invertebrate community samples were collected from four areas in the side channel connected to the Elk River (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC[8]; 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 mine influence (GH_ER2; Figure 2.1). Based on

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[8] The study design proposed benthic invertebrate tissue chemistry sampling areas at GH_ERSC4, GH_ER1A, RG_ERSC5, and GH_ERSC2; however, GH_ERSC2 was dry at the time of sampling in 2018 and depositional (all fines) in 2019, and therefore a new station downstream of the confluence with Thompson Creek (RG_SCDTC) was sampled in 2018 and 2019.

power analysis in the RAEMP study design (Minnow 2018c), it was determined that five samples would be collected at core RAEMP monitoring areas (i.e., Compliance and Order stations; GH_ERC) and three samples would be collected at core RAEMP reference areas (i.e., GH_ER2). At some GHO LAEMP stations in 2017 and/or 2018, a single sample was collected based on the RAEMP study design. To give greater power to detect changes over time, additional replicates (three samples rather than one) were added to support the GHO LAEMP at side channel stations GH_ERSC4, GH_ER1A, and RG_ERSC5 in 2018 and 2019, as well as in 2019 at side channel station RG_SCDTC and tributary station THCK (GH_TC2). Samples were collected using the Canadian Aquatic Biomonitoring Network (CABIN) protocol for kick and sweep (Environment Canada 2012a, 2014) - 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. 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 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.

Organisms collected into the kick net were carefully rinsed into a labelled wide-mouth plastic jar. Internal labels were used to confirm 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.

Supporting information was collected concurrent with, and at the same locations as, benthic invertebrate community samples, including habitat characteristics (Section 2.8.1), calcite coverage (Section 2.8.2), water quality samples (Section 2.4), and sediment quality samples (Section 2.8.3).

2.6.3 Laboratory Analysis

Benthic invertebrate community samples were shipped to Cordillera Consulting Inc. (Summerland, British Columbia) for sorting and taxonomic identification. Organisms were identified to the lowest practicable level (LPL; typically genus or species) using up-to-date taxonomic keys. At the beginning of the sorting process, each sample was examined and evaluated to estimate total invertebrate numbers. If the total number was estimated to be greater than 600, then samples were sub-sampled for sorting and enumeration. A minimum of 5% of each sample was sorted, consistent with requirements specified by Environment Canada (2012b, 2014). Following identification, representative specimens of each taxon were placed in separate vials to create a reference collection for the project. Sorting efficiency and sub-sampling accuracy and precision were quantified using methods specified by Environment Canada (2014)

(Appendix E). Based on the results provided for QA/QC samples, the benthic invertebrate community data collected for the GHO LAEMP were judged to be of acceptable quality (Appendix E).

2.6.4 Data Analysis

For benthic invertebrate community samples, total abundance, richness (LPL), Ephemeroptera, Plecoptera, and Trichoptera (EPT) proportion (% EPT), % Ephemeroptera, % Plecoptera, % Trichoptera, and relative abundance of major taxonomic groups were determined and compared within and among areas. Community endpoints were also compared to normal ranges[9] defined in the RAEMP based on samples collected from regional reference areas in 2012 and 2015 (Minnow 2018a), as well as to the upstream main stem Elk River reference station (GH_ER2). Benthic invertebrate community endpoints from 2012 to 2019 were visually compared, where data were available.

2.7 Benthic Invertebrate Tissue Chemistry (Question #5 and #6)

2.7.1 Overview

Benthic invertebrate tissue chemistry data were assessed to address study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?) and study question #6 (Is the mine related influence on Reach 2 having an effect on aquatic dependent biota [benthic invertebrates, fish, amphibians, and aquatic-feeding birds?]).

2.7.2 Sample Collection

Benthic invertebrate tissue samples were collected in September 2019 from four riffle areas in the side channel (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC), from two depositional areas of the side channel (i.e., substrate was predominantly fines rather than a habitat of riffle and cobble; GH_ERSC2 and Reach 2 at RG_GH-SCW3), and from the main stem Elk River stations (GH_ERC and GH_ER2; Figure 2.1). Samples were taxa-composites collected in triplicate at each area using the kick and sweep method. The taxa present in the samples were documented. 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 transfer to a freezer later in the day.

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

Supporting information was collected concurrent with, and at the same locations as, benthic invertebrate tissue samples, including habitat characteristics, calcite coverage, water quality samples (Section 2.4), and sediment quality samples (Section 2.8.3).

2.7.3 Laboratory Analysis

Benthic invertebrate tissue samples were kept in a freezer until they were shipped in coolers to the Saskatchewan Research Council (SRC) laboratory in Saskatoon, Saskatchewan. At the laboratory, the samples were freeze-dried and then analyzed for metals using Inductively Coupled Plasma Mass Spectrometry (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).

The QA/QC procedures for benthic invertebrate tissue samples included the assessment of laboratory duplicates, and quality control reference materials and standards. 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 F).

2.7.4 Data Analysis

Benthic invertebrate tissue selenium concentrations were compared to EVWQP Level 1, Level 2, and Level 3 benchmarks as well as normal ranges[10] defined in the RAEMP. Tissue selenium concentrations were also plotted and spatially compared within and among areas and were compared to the selenium bioaccumulation model (Teck 2014).

2.8 Supporting Information

2.8.1 Habitat

Habitat characteristic were documented, including: photographs, channel depth and velocity (measured using a Hach FH950 flow meter, 15 cm above the substrate), substrate characteristics (i.e., 100 pebble count, consistent with CABIN protocol), surrounding land use, anthropogenic activity, bank stability, bankfull width, and wetted width.

2.8.2 Calcite

Calcite coverage was assessed as part of pebble counts at the two main stem stations (GH_ER2 and GH_ERC), the three side channel stations (GH_ERSC4, GH_ER1A, and RG_SCDTC), and Thompson Creek (RG_THCK) in September 2019. Pebble counts were not conducted at the side channel stations GH_ERSC2 and RG_GH-SCW3, as the areas were predominantly fines with no calcification or concretion. Field measurements were consistent with

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

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 2016). 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., no more than 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). 100-particles were measured for each Calcite Index (CI) determination. Consistent with the RAEMP, CI was determined for each benthic invertebrate community sampling location, and therefore was collected in triplicate for most GHO LAEMP stations, except GH_ERC, where five calcite index counts were conducted.

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

$$CI = CI_p + CI_c$$

Where:

$$CI = Calcite\ Index$$

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

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

2.8.3 Sediment Quality

2.8.3.1 Sample Collection

Sediment quality samples were collected concurrent with benthic invertebrate samples at the two main stem Elk River stations (GH_ER2 and GH_ERC) and at Reach 2 (RG_GH-SCW3), the semi-lentic depositional area of the side channel at the confluence with Thompson Creek (Figure 2.1). Sediment samples were collected using a stainless-steel spoon and were transferred into glass jars for analysis of polycyclic aromatic hydrocarbons (PAHs), and into polyethylene bags for all other analyses (see Section 2.8.3.2). 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.

2.8.3.2 Laboratory Analysis

Samples for chemical analysis were sent to ALS Environmental (Calgary, Alberta). 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, TOC, PAHs, particle size distribution, and moisture content using standard methods (Table 2.6).

In addition to collection of field duplicate samples, QA/QC included assessment of laboratory duplicates, spike recoveries, and certified reference materials. Based on the QA/QC results provided, the sediment data were judged to be of acceptable quality (Appendix G).

Table 2.6: **Analytical Methods for Sediment Samples**

Analyte	Units	Method	Reference
Metals	mg/kg	Collision Reaction Cell Inductively Coupled Plasma Mass Spectrometry (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 and total inorganic carbon	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

2.8.3.3 Data Analysis

Sediment quality data were evaluated relative to BC working sediment quality guidelines (SQG) and, where applicable, the reference area normal range (i.e., the 2.5th to 97.5th percentiles of 2013 and 2015 reference area data reported in the RAEMP for lentic stations; Minnow 2018a). Two levels of guideline are typically defined: a lower SQG and an upper SQG. The lower SQG represents concentrations below which adverse biological effects would not be expected to occur. In contrast, the upper SQGs (i.e., probable effect level [PEL] or severe effect level [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 (ENV 2017), such that the exceedance of individual SQGs cannot be interpreted as strong evidence for biological response.

3 STUDY QUESTION #1

3.1 Overview

Data evaluated in this section pertain to study question #1 (What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?). The following data were collected in support of this question:

- side channel hydrology features (wetted areas, dry sections, braids, isolated pools, and tributary surface connectivity);
- flow in the side channel; and
- water levels in the side channel and main stem Elk River.

3.2 Side Channel Mapping

Monthly surveys of the side channel were used to document field conditions as the side channel flows changed over the year. This included documenting wetted areas, dry areas, and isolated pools, and to provide monthly estimates of side channel wetted lengths, which included the lengths of wetted isolated pools (Table 3.1, Appendix Figures A.1 and A.28). General patterns of wet and dry were consistent among the three study years. The most downstream section of the side channel (Reach 1) had three larger channels with minor braiding. The middle section (Reach 2; previously referred to as the “side channel wetland”) had both lotic and lentic characteristics, depending on the time of year and remained wetted all year. The most upstream section (Reach 3) was confined to a single channel.

Similar to 2017 and 2018 (Minnow and Lotic 2018a, 2019), the side channel was mostly dry from January to March 2019, with a small percentage of the length being wetted (attributable to isolated pools and Reach 2; Table 3.1, Appendix Figures A.18 to A.20, Tables B.8 to B.17). Then, in May and June 2019, the Elk River side channel floodplain complex was flooded because of freshet (Appendix Figures A.22 and A.23). Flooding receded throughout the summer and the flow was confined to the channel during summer and fall (Table 3.1; Appendix Figures A.1 to A.28). The side channel was fully wetted for three to four months of each study year: May to August in 2017, May to July in 2018, and June to August in 2019 (Table 3.1; Appendix Figures A.1 to A.28; Minnow and Lotic 2018a, 2019). In all study years, Reach 1 (the downstream end of the side channel) began to dry earlier than Reach 3 (Table 3.1), such that the side channel was connected to the main stem Elk River at the upstream end, but not the downstream end. Within each of these reaches, drying progressed from downstream to upstream.

Table 3.1: Monthly Wetted Length Percentage, Elk River Side Channel, 2017 to 2019

Year	Month	Reach 1[a]			Reach 2			Reach 3			Total Side Channel		
		Total Reach Length (m)	Total Wetted Length (m)	Total Wetted Percent (%)	Total Reach Length (m)	Total Wetted Length (m)	Total Wetted Percent (%)	Total Reach Length (m)	Total Wetted Length (m)	Total Wetted Percent (%)	Total Reach Length (m)	Total Wetted Length (m)	Total Wetted Percent (%)
2017	May	3,609	3,609	100	145	145	100	3,396	3,396	100	7,150	7,150	100
	June		3,609	100		145	100		3,396	100		7,150	100
	July		3,609	100		145	100		3,396	100		7,150	100
	August		3,609	100		145	100		3,396	100		7,150	100
	September		80	2.2		145	100		3,396	100		3,621	51
	October		3	0.08		145	100		2,714	80		2,862	40
	November		3	0.08		145	100		560	17		708	10
	December		14	0.4		145	100		932	27		1,091	15
2018	January	3,740	15	0.4	145	145	100	3,396	0	0	7,281	160	2
	February		3	0.08		145	100		0	0		148	2
	March		3	0.08		145	100		0	0		148	2
	April		10	0.3		145	100		22	0.6		177	2
	May		3,740	100		145	100		3,396	100		7,281	100
	June		3,740	100		145	100		3,396	100		7,281	100
	July		3,740	100		145	100		3,396	100		7,281	100
	August		3,352	90		145	100		3,396	100		6,893	95
	September		1,617	43		145	100		3,396	100		5,158	71
	October		1,143	31		145	100		3,396	100		4,684	64
	November		38	1		145	100		1,458	43		1,641	23
	December		10	0.3		145	100		693	20		848	12
2019	January	3,740	20	1.0	145	145	100	3,396	2,952	87	7,281	3,117	43
	February		18	0.5		145	100		0	0		163	2
	March		12	0.3		145	100		0	0		157	2
	April		502	13		145	100		87	3		734	10
	May		811	22		145	100		1,314	39		2,270	31
	June		3,740	100		145	100		3,396	100		7,281	100
	July		3,740	100		145	100		3,396	100		7,281	100
	August		3,656	98		145	100		3,396	100		7,197	99
	September		2,486	66		145	100		3,396	100		6,027	83
	October		408	11		145	100		3,396	100		3,949	54
	November		179	5		145	100		1,720	51		2,044	28
	December		18	0.5		145	100		823	24		986	14

[a] Reach lengths were first determined during the 2017 FHAP assessment (Minnow and Lotic 2018a), and at that time Reach 1 total length was determined to be 3,609 m (the combined lengths of the east and west channels plus the length of the middle channel and two seepage channels). In 2018, an additional 131 m was added to the Reach 1 total length to reflect the new overflow channel that was discovered in May 2018 west of RG_ERSCDS.

As sections of the side channel dried, isolated pools remained (Appendix Figures A.1 to A.28). Water quality indicated that a few of the isolated pools were localized areas of groundwater discharge, occurring near the confluence with Wolfram Creek (SC3-P13) and downstream of Thompson Creek (SC2-P3, SC2-P1, and SC2-P2; Section 6; SNC-Lavalin 2020). Otherwise, pools that were sampled for water quality were determined to be stagnant surface water remaining as the channel dried (Section 6; SNC-Lavalin 2020). Isolated pools typically persisted for less than a month (Table 2.2). In 2019, three pools (SC2-P3, SC2-P1, and SC2-P5) in Reach 1 remained wetted for most or all of the time when Reach 1 was otherwise dry (Table 2.2). These pools were then flushed out during freshet when the side channel flooded and became fully flooded once again (Table 2.2). These pools covered relatively small surface areas, with SC2-P3 ranging from 7 m^2 to 36 m^2, SC2-P1 ranging from 1.5 m^2 to 426 m^2, and SC2-P5 ranging from 16 m^2 to 108 m^2. They were also typically shallow, with depth ranges of 10 to 60 cm, 20 to 40 cm, and 8 to 25 cm for pools SC2-P3, SC2-P1, and SC2-P5, respectively (Appendix Tables B.8 to B.17).

From late fall to December, Reach 1 and Reach 3 were dry except for isolated pools. Throughout 2017 to 2019, Reach 2 remained wetted year-round and received surface water flows from Thompson Creek, but was disconnected from the side channel surface flow from fall (October 2017 and 2019, November 2018) until spring (late April in 2017 and 2018, and late May/June in 2019).

3.3 Connectivity to Main Stem Elk River and West-side Tributaries

Reach 1 flowed overland into the downstream main stem Elk River from May to August in 2017, from May to July in 2018, and from June to September in 2019. Reach 1 was dry (i.e., not flowing) from September 2017 to April 2018, from August 2018 to May 2019, and again from October to December 2019.

Three of the west-side tributaries (Leask, Wolfram, and Thompson creeks) have the potential to contribute loadings directly to the Elk River side channel via overland and/or groundwater pathways (Figure 2.1). Leask Creek flows into a sedimentation pond, which has an overflow channel that connects to the Elk River just upstream of the side channel (Figure 2.1). The overflow channel is typically dry but may connect to the Elk River in times of high flow. Wolfram Creek (downstream of its sedimentation pond) has an overland connection, which has been highly disturbed by recent logging, that flows through a recent cutblock to the side channel upstream of GH_ER1A (within Reach 3). From 2017 to 2019, Wolfram Creek was connected to the side channel via surface flow in May 2018 and from June to July 2019, only. Although a surface water connection may not be present during all months, water from Wolfram Creek enters the side channel via shallow subsurface pathways, as suggested by water chemistry data.

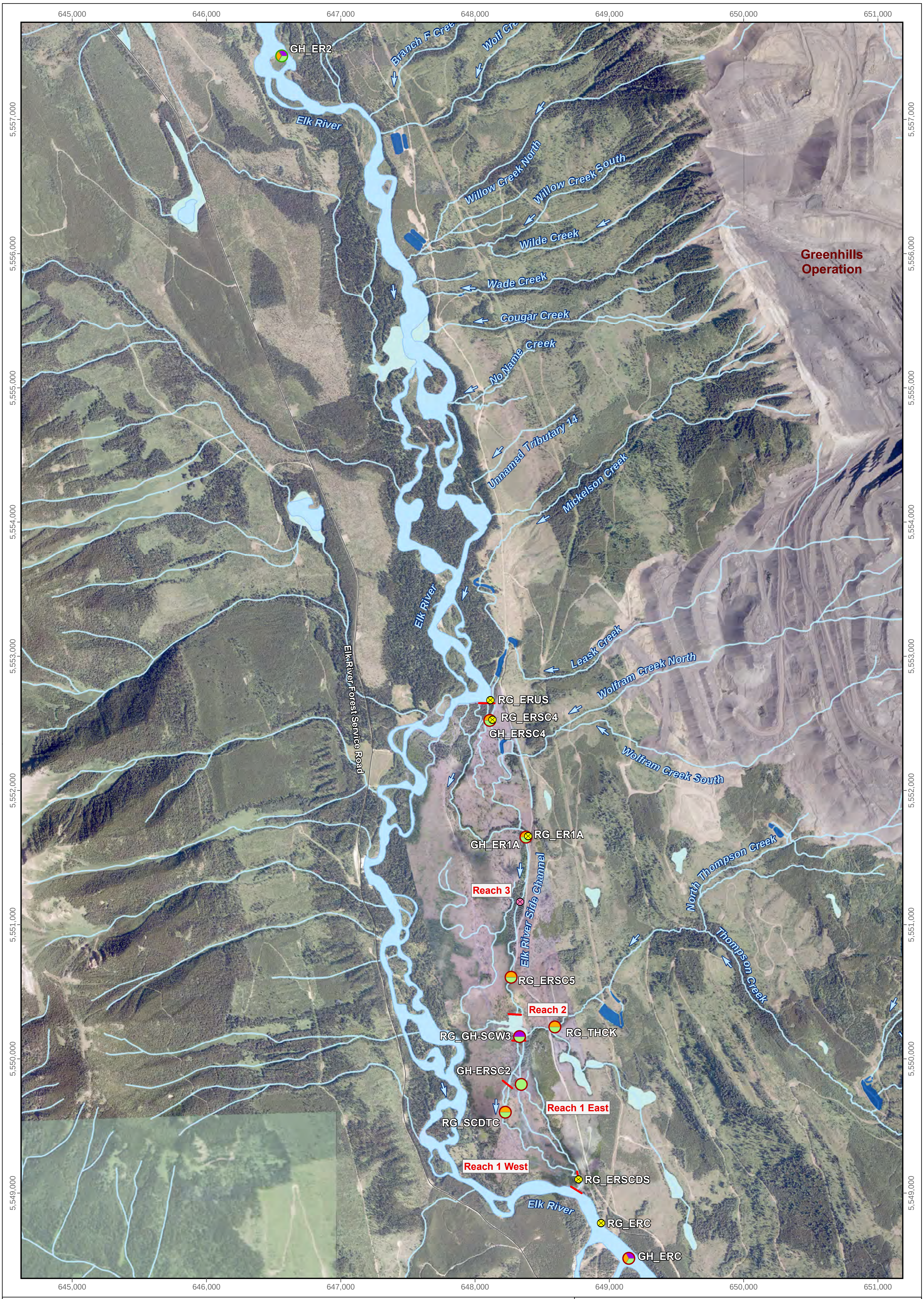
From 2017 to 2019, Thompson Creek surface water flowed year-round into Reach 2 of the side channel.

3.4 Hydrometric Monitoring

Stage-discharge relationships developed in the 2018 GHO LAEMP were updated with 2019 data collected from water level loggers located at staff gauge locations (Figures 3.1 to 3.4). Power functions fit to the data had good fit (R^2> 0.97 for all three relationships) and were graded B following BCMOE Hydrological RISC Standards (RISC 2009). The three side channel flow stations were compared to the Elk River near Natal (WSC 08NK016; Figures 3.5 and 3.6). In all three study years, the discharge at the Elk River station near Natal was highly correlated with discharges at RG_ER1A and RG_ERSC4 (both upstream from Reach 2), and to a lesser extent, with RG_ERSCDS (Figures 3.5 and 3.6). RG_ERSCDS is likely less similar to the Elk River station due to the influence of Thompson Creek, and possibly due to pooling in the vicinity of this station (SNC-Lavalin 2019). Periods when the side channel was dry coincided with the lowest discharge rates in the main stem Elk River (Figure 3.6). Overall, the three side channel hydrographs exhibited consistent temporal patterns with the Elk River near Natal hydrograph from 2017 to 2019, with the timing of peak flows and low flows generally aligned at the side channel stations and the main stem Elk River station (Figure 3.5 and 3.6).

3.5 Summary

Data collected in 2017, 2018, and 2019 answered study question #1 (What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?). Flows in the main stem Elk River and flows in the Elk River side channel were strongly correlated. Water from the main stem Elk River flowed overland into the side channel from freshet until winter when stream flow decreased both in the main stem Elk River and at the three side channel stations. Stream flow was lowest in the main stem Elk River from winter until freshet; at this time, the side channel became disconnected from the main stem Elk River and Reaches 1 and 3 slowly dried. Isolated pools were documented as areas dried. Water quality indicated that four of the isolated pools were localized areas of groundwater discharge (SNC-Lavalin 2020). Otherwise, pools were determined to be stagnant surface water resulting from seasonal drying of the side channel (SNC-Lavalin 2020). Although a few isolated pools persisted for much of the year when Reach 1 was otherwise dry, pools typically persisted for less than three months. Reach 2 at the confluence of the side channel and Thompson Creek remained wetted throughout the year due to flows from Thompson Creek.



LEGEND

Sampling Type

● Mine-exposed ● Reference

🟪 Sediment Quality

🟧 Benthic Invertebrate Community

🟩 Benthic Invertebrate Tissue Chemistry

⊗ Staff Gauge Location

⊗ Barometric Logger

— Reach Break

🟦 Settling Pond

Staff Gauge Locations, and Sediment Quality, Benthic Invertebrate Community, and Benthic Invertebrate Tissue Chemistry Sampling Stations

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 11
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Date: May 2020
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Figure 3.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 3.1 Staff Gauge Locations.mxd

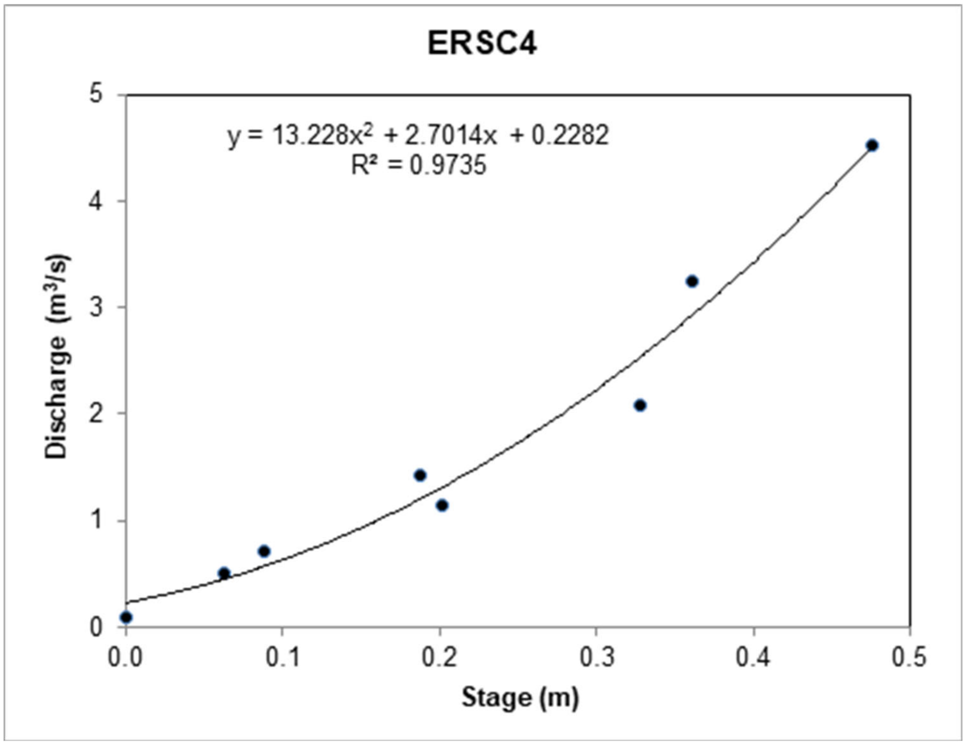


Figure 3.2: Stage-discharge Graph for RG_ERSC4 (Located in Reach 3 of the Side Channel)

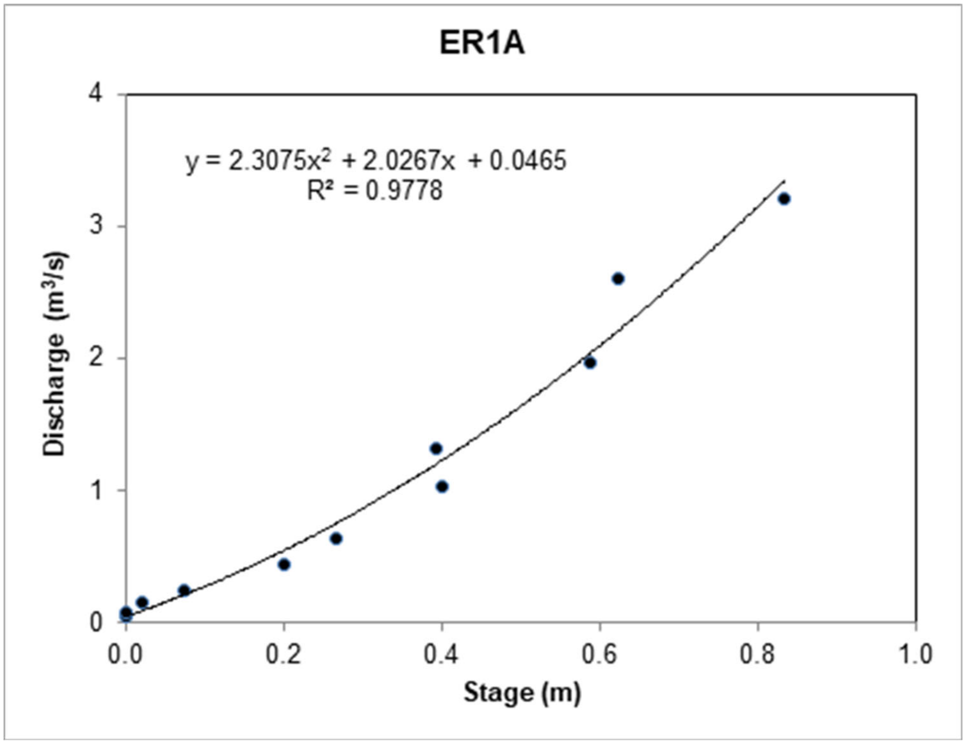


Figure 3.3: Stage-discharge Graph for RG_ER1A (Located in Reach 3 of the Side Channel)

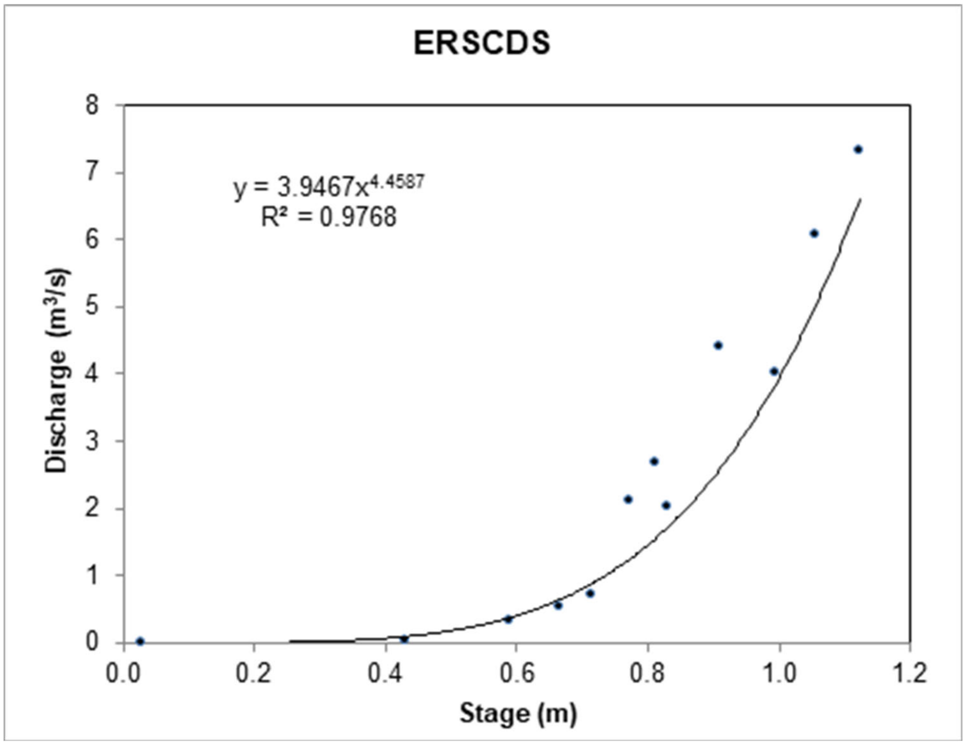


Figure 3.4: **Stage-discharge Graph for RG_ERSCDS (Located in Reach 1 of the Side Channel)**

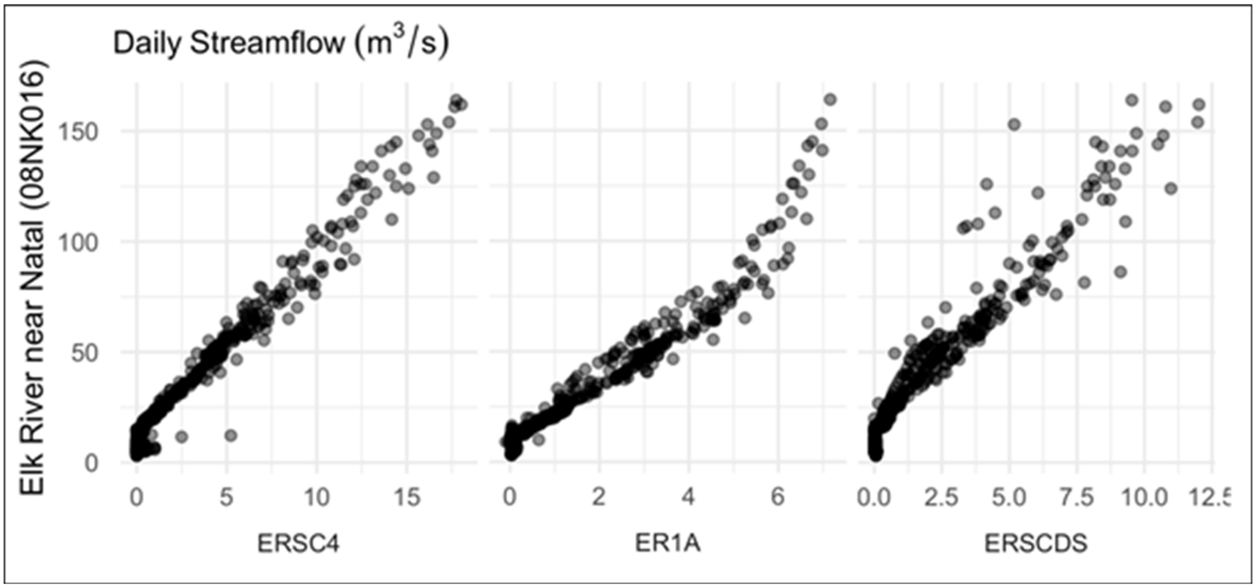


Figure 3.5: **Daily Streamflow (Discharge) Comparison between the Side Channel Sites and the Main Stem Elk River (WSC 08NK016)**

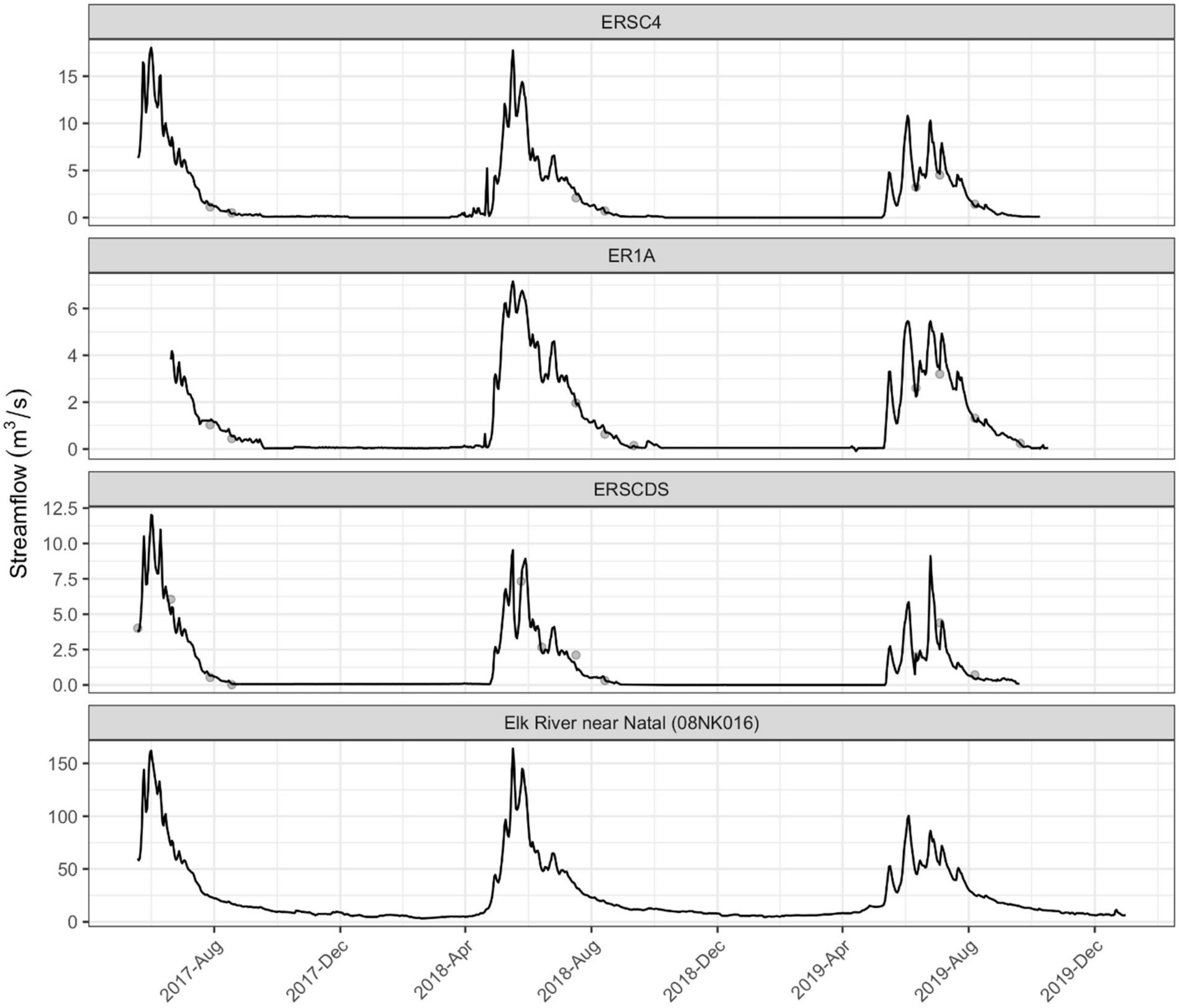


Figure 3.6: **Streamflow Comparison between the Side Channel Sites and the Main Stem Elk River near Natal (WSC 08NK016)**

4 STUDY QUESTION #2

4.1 Overview

Data were evaluated to address study question #2 (What is the seasonal habitat availability for aquatic-dependent biota [i.e., fish, amphibians, and aquatic-feeding birds] in the Elk River side channel?). These data provide information about seasonal habitat availability for different biota in the side channel, which gives context for understanding the potential exposure pathways. Habitat data were collected during monthly surveys since May 2017.

4.2 Habitat Availability

The FHAP survey (first conducted in 2017) categorized fish habitat quality in the two main channels of Reach 1 as poor-fair and poor-degraded, while Reach 3 was categorized as poor-fair (Minnow and Lotic 2018a, 2019, Appendix Figure B.1). Reach 2 provided overwintering habitat for fish, remained wetted throughout the study period, and consistently received flows from Thompson Creek. Fish habitat quality was consistent from 2017 to 2019.

Surveyors looked for redds and spawning fish during spring and fall surveys of the side channel. Possible redds were observed in September 2017 in Reach 3 (Minnow and Lotic 2018a), but no redds were observed in 2018 or 2019. Turbidity in the side channel reduced visibility in 2018 and 2019. High turbidity during spring freshet is normal in the Elk River system, but was likely further exacerbated by extensive clearcut logging of the Elk River floodplain in the vicinity of the side channel that occurred independent of Teck throughout the winter 2017/2018 and spring 2018.

Monthly habitat assessment results for the wetted areas were generally consistent from 2017 to 2019, with availability of wetted habitat varying greatly throughout each year (Section 3.3; Minnow and Lotic 2018a; Appendix Figures A.1 to A.28). During the three study years, in spring and early summer, high water velocity in the side channel likely resulted in limited habitat for amphibian breeding and early life stages. Fish passage from the main stem Elk River into Reach 1 was possible from spring to late summer (June to August in 2019). Fish could also migrate into the side channel via Reach 3 from spring to late fall (June to November in 2019). Summer through winter, the wetted areas of the side channel provided suitable habitat for fish, adult amphibians, and aquatic-dependent birds. In late fall and winter, wetted habitat was sparse; Reach 2 and isolated pools provided the only potential overwintering areas. Isolated pools were typically iced over through winter.

Isolated pools typically persisted for less than a month (Appendix Photos B.1 to B.17), except for three pools (SC2-P3, SC2-P1, and SC2-P5; Photos 4.1 to 4.6; Section 3.2) in Reach 1 that

Photo 4.1: Isolated Pool SC2-P3, September 2018

Photo 4.2: Isolated Pool SC2-P3, September 2017

Photo 4.3: **Isolated Pool SC2-P1, September 2017**

Photo 4.4: **Isolated Pool SC2-P1, September 2017**

Photo 4.5: **Isolated Pool SC2-P1, October 2019**

Photo 4.6: **Isolated Pool SC2-P5, October 2018**

remained wetted for most or all of the time when Reach 1 was otherwise dry, providing potential overwintering area (Table 2.2). Isolated pools were small, with nearly half of the pools having a surface area of 10 m^2 or less, and 87% of pools having a surface area of 40 m^2 or less (Table 4.1, Appendix Tables B.8 to B.17, Section 3.2). All pools were shallow, with the deepest pool being 60 cm deep, and 71% of pools having a depth of 20 cm or less (Table 4.2, Appendix Tables B.8 to B.17). Isolated pools had substrates of cobble and/or fines, with no macrophytes (Photos 4.1 to 4.6, Appendix Photos B.1 to B.17). In all years, side channel stations and fish-bearing pools were typically well-oxygenated (i.e., had dissolved oxygen concentrations above the BCWQG value of 5 mg/L) and had appropriate pH for aquatic life (i.e., pH between 6.5 and 9.0; Appendix Tables B.1 to B.17). During the winter, most amphibians are hibernating, and most birds have migrated out of the area. Reach 2 provided the best quality aquatic habitat within the side channel, as it was wetted year-round.

Table 4.1: Summary of Isolated Pool Surface Areas, 2019

Isolated Pool Surface Area (m^2)		Isolated Pools within the Surface Area Range	
Greater Than (>)	**Less than or Equal to (≤)**	**Number of Pools**	**Percentage of Pools (%)**
0	10	39	51
10	20	12	16
20	40	17	22
40	100	3	4
100	875	6	8
	Total	77	100

Note: Detailed records of pool lengths, widths, and surface areas are provided in Appendix Tables B.8 to B.17. For the purpose of this summary table each month of measurement for one pool is tallied as a separate pool (e.g., pool SC2-P3 persisted during 8 months, and it's length and width was measured during 6 months, therefore 6 of the 77 total pools that were measured are SC2-P3). In January and February 2019, lengths and widths (and therefore surface areas) of the pools could not be determined due to snow cover.

Table 4.2: Summary of Isolated Pool Depths, 2019

Isolated Pool Depth (cm)		Isolated Pools within the Depth Range	
Greater Than (>)	Less than or Equal to (≤)	Number of Pools	Percentage of Pools (%)
0	10	27	33
10	20	32	39
20	40	22	27
40	60	2	2
	Total	83	100

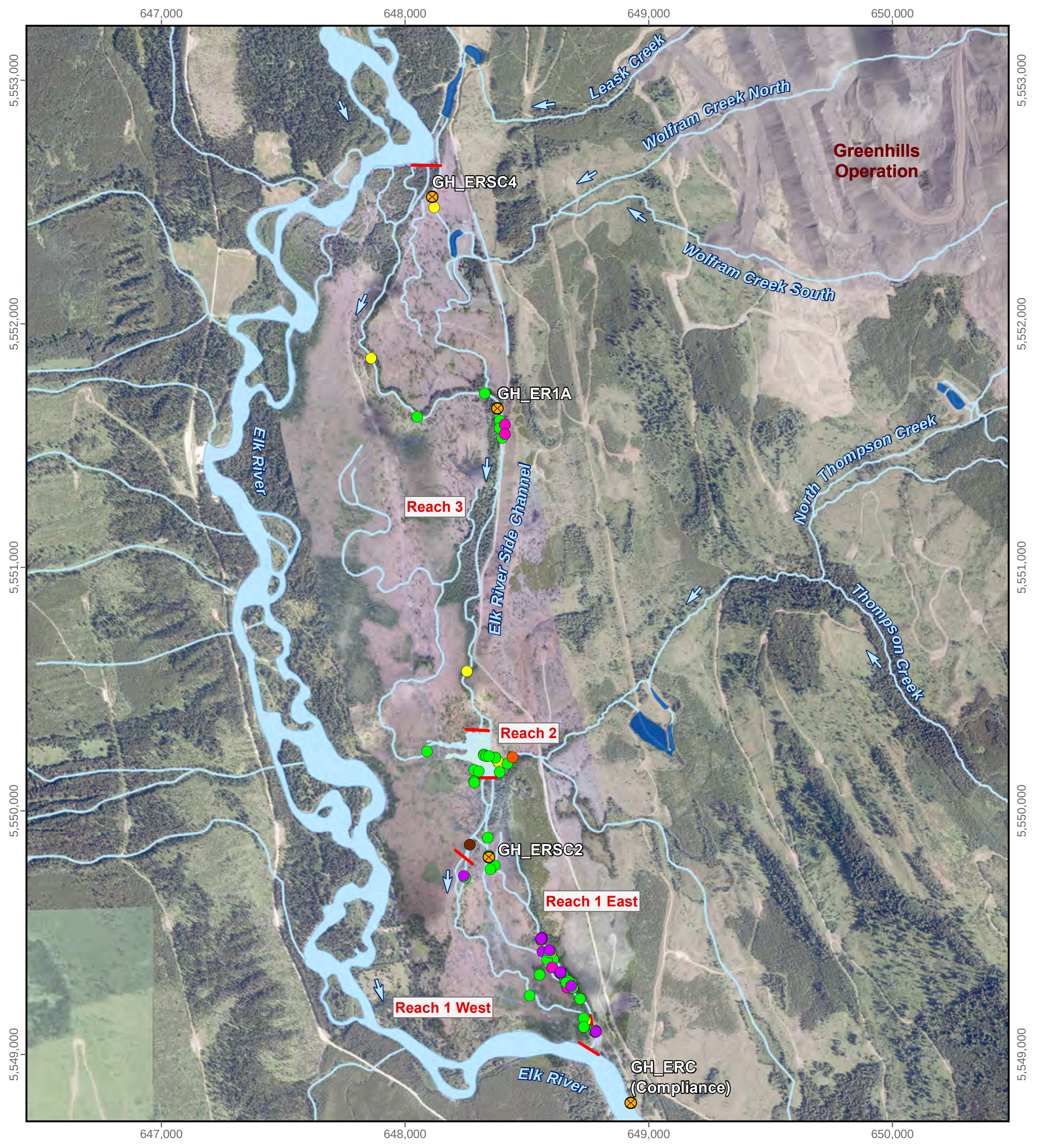
Note: Detailed records of pool depths are provided in Appendix Tables B.8 to B.17. For the purpose of this summary table each month of measurement for one pool is tallied as a separate pool (e.g., pool SC2-P3 persisted during 8 months, and it's depth was measured during 7 months, therefore 7 of the 83 total pools that were measured were pool SC2-P3). In January 2019, depths of the pools could not be determined due to snow cover.

4.3 Distribution of Biota

From 2017 to 2019, the side channel was being used by a variety of fish species (i.e., bull trout, eastern brook trout, longnose sucker, mountain whitefish, and westslope cutthroat trout; Figure 4.1; Appendix Table B.18). Most of the fish observed were in the fry or juvenile age classes, and mountain whitefish fry were the most abundant fish observed. As flows decreased in the side channel, isolated pools were found to contain fish. Snow and ice covering the stream during the winter (January to April and November to December in 2019) reduced visibility within the side channel and pools. However, fry and juvenile mountain whitefish and westslope cutthroat trout were observed in isolated pools as late as December, confirming overwintering use of the side channel (Appendix Tables B.8 to B.17). Adult fish were not observed in isolated pools, likely because the pools were too small and too ephemeral to provide appropriate overwintering habitat.

Over the three study years, amphibians (adult Columbia spotted frog, adult western toads, and larval long-toed salamanders) were observed throughout the side channel, with the majority of observations occurring in Reach 1 and Reach 2 from June to September (Figure 4.2; Appendix Table B.19). Western toads were the most common amphibian species, with adults observed on ten occasions during the three years of monthly surveys during the GHO LAEMP study (Appendix Table B.19).

Aquatic-dependent birds were documented based on visual and auditory detections during monthly surveys throughout the side channel, including: American bittern, American dipper, bald



LEGEND

- 🟢 Mountain Whitefish
- 🟡 Unidentified
- 🟣 Westslope Cutthroat Trout
- 🟠 Longnose Sucker
- ● Eastern Brook Trout
- 🟤 Bull Trout
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ▬ Reach Break
- 🟦 Settling Pond

Fish Observations, May 2017 to December 2019

0 250 500 1,000 Meters

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N W E S

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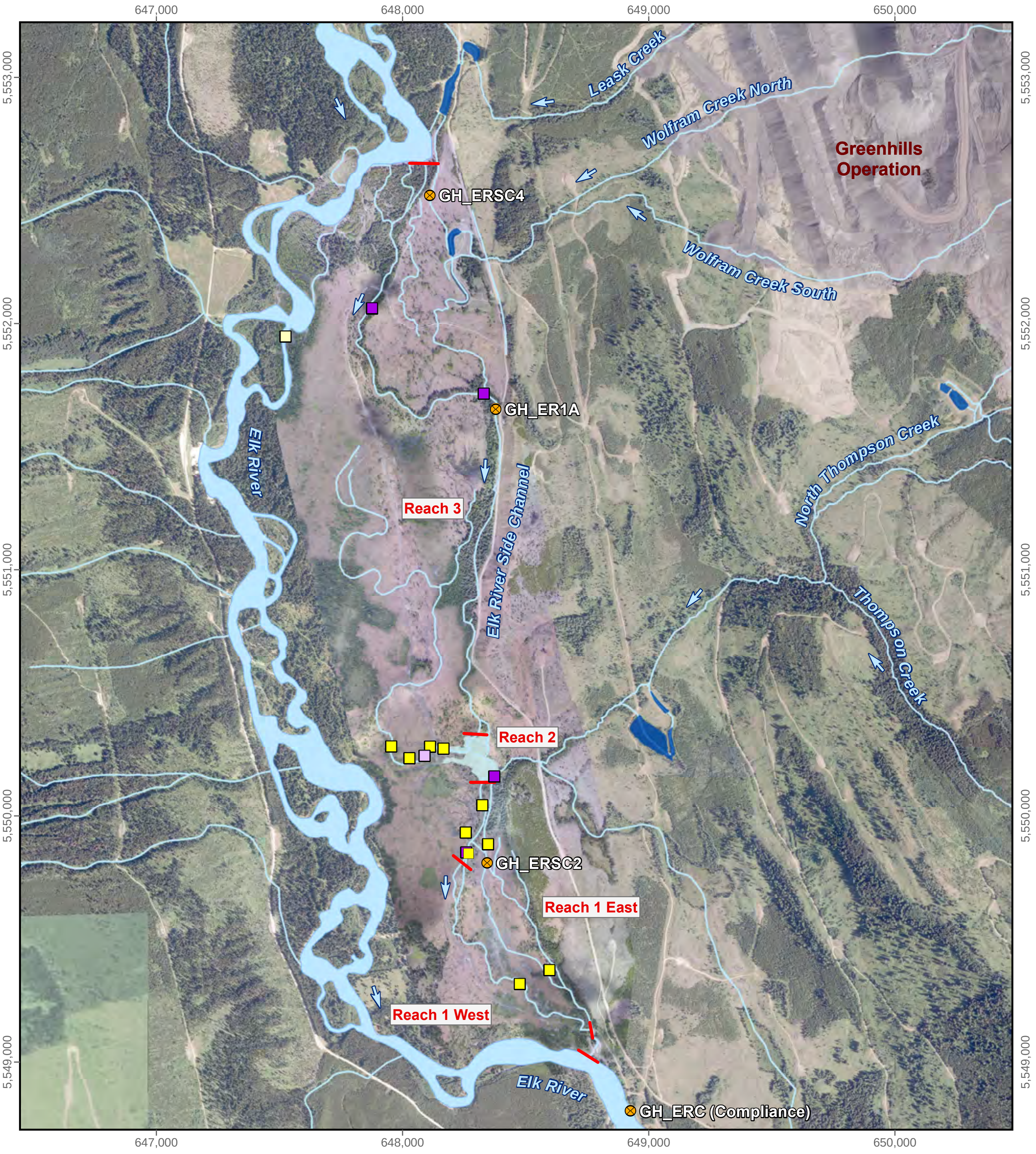
Figure 4.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 4.1 Fish Observations.mxd



LEGEND

🟪	Long-toed Salamander	🟥	Reach Break
🟪	Columbia Spotted Frog	🟦	Settling Pond
🟨	Unidentified Frog/Toad		
🟨	Western Toad		
●	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed		

Amphibian Observations, May 2017 to December 2019

0 250 500 1,000 Meters

N W E S

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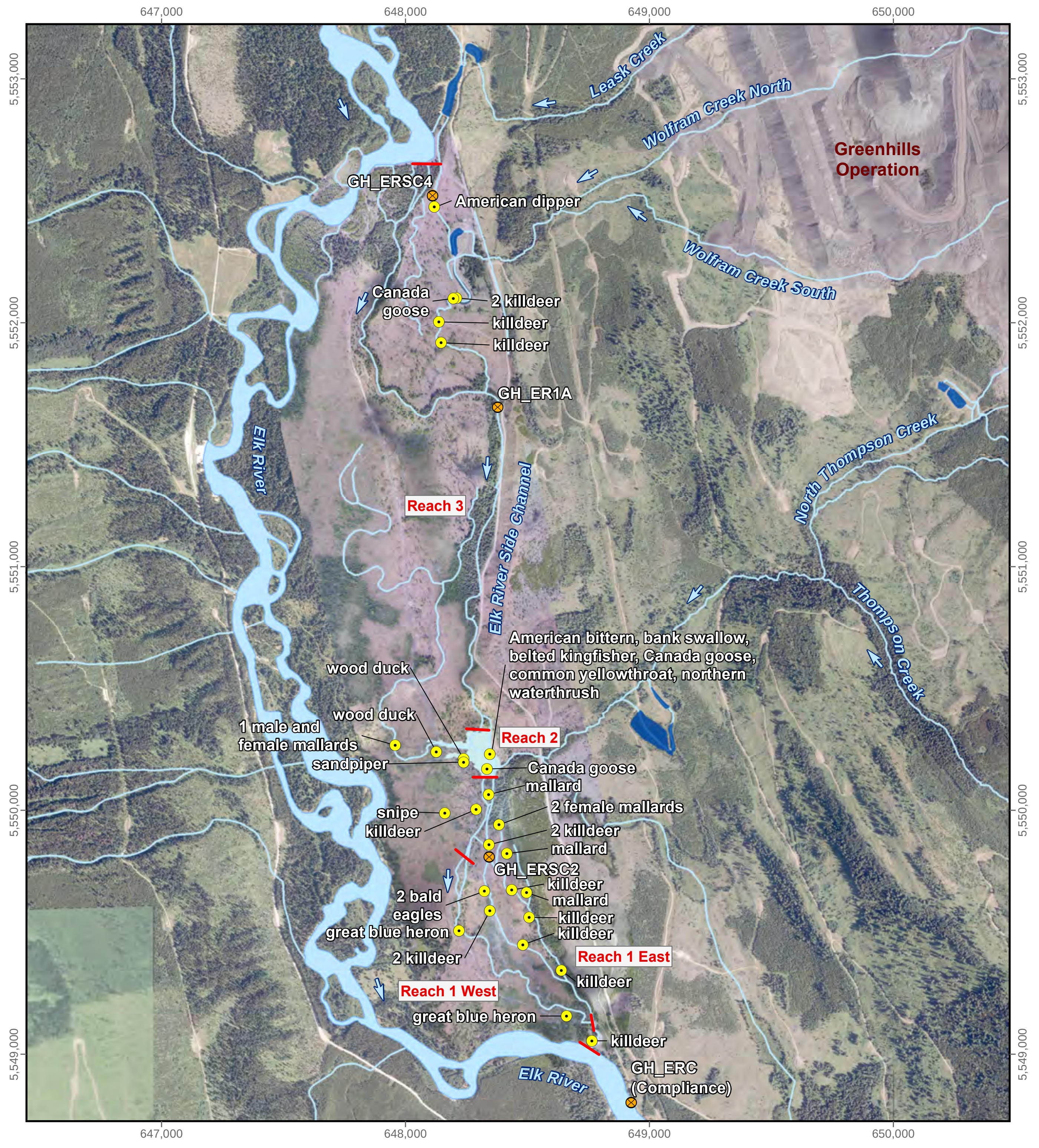
Figure 4.2

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 4.2 Amphibian Observations.mxd eagle, bank swallow, belted kingfisher, blue heron, Canada goose, common yellowthroat, killdeer, northern waterthrush, spotted sandpiper, and mallard (Figure 4.3; Appendix Table B.20). Canada goose, bank swallow, northern waterthrush, and killdeer were the most common bird species observed (respectively 19, 16, 16, and 15 individuals observed).

4.4 Summary

Surveys from 2017 to 2019 confirmed that the side channel was used by a variety of fish, amphibians, and aquatic-feeding birds, confirming seasonal habitat is available, and answering study question #2 (What is the seasonal habitat availability for aquatic-dependent biota [i.e., fish, amphibians, and aquatic-feeding birds] in the Elk River side channel?). Abundant wetted area was available to aquatic-dependent biota from spring to summer when the side channel was flowing and connected to the main stem Elk River. In the fall, aquatic habitat became more limited as the side channel began to dry. Later in the fall, the side channel sections downstream and upstream of Reach 2 were dry and remained dry throughout the winter. Reach 2 remained wetted throughout three years of the study and consistently received flows from Thompson Creek, providing some lentic habitat in the fall and winter. Additional sparse/patchy habitat was provided by ephemeral isolated pools that remained as the side channel dried, and typically persisted for less than a month, with only three pools persisting for most of the year when Reach 1 was otherwise dry.

Reach 2 was generally not considered suitable breeding habitat for amphibians, as much of the side channel and floodplain complex were flooded and swiftly flowing in the spring and early summer. However, larval stage amphibians were observed near Reach 2 in September 2018, and a few adults were observed throughout the side channel in late spring and summer. Suitable habitat was available for all life stages of fish and aquatic-dependent birds in the side channel and floodplain complex from spring through fall, as well as in Reach 2 during winter. Habitat and observations were documented over three years, during over 30 multi-day field visits that occurred in all seasons. Ultimately, there are no barriers to use of the side channel complex by aquatic biota (with the exception of dry reaches in late fall/winter, which are barriers to fish passage at that time of year), and therefore it is expected that the area is used by a variety of aquatic-dependent fish, amphibians, and birds.



LEGEND

- ⊙ Aquatic-dependent Bird Observation
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- — Reach Break
- ▬ Settling Pond

Bird Observations, May 2017 to December 2019

0 250 500 1,000 Meters

N E S W

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Figure 4.3

5 STUDY QUESTION #3

5.1 Overview

Data evaluated in this section are related to study question #3:

What is the influence of the 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 in the west-side tributaries, and how is it changing over time?

b. What is the water quality at monitoring stations in the Elk River side channel, is it changing over time, and how does it compare to water quality in the main stem Elk River?

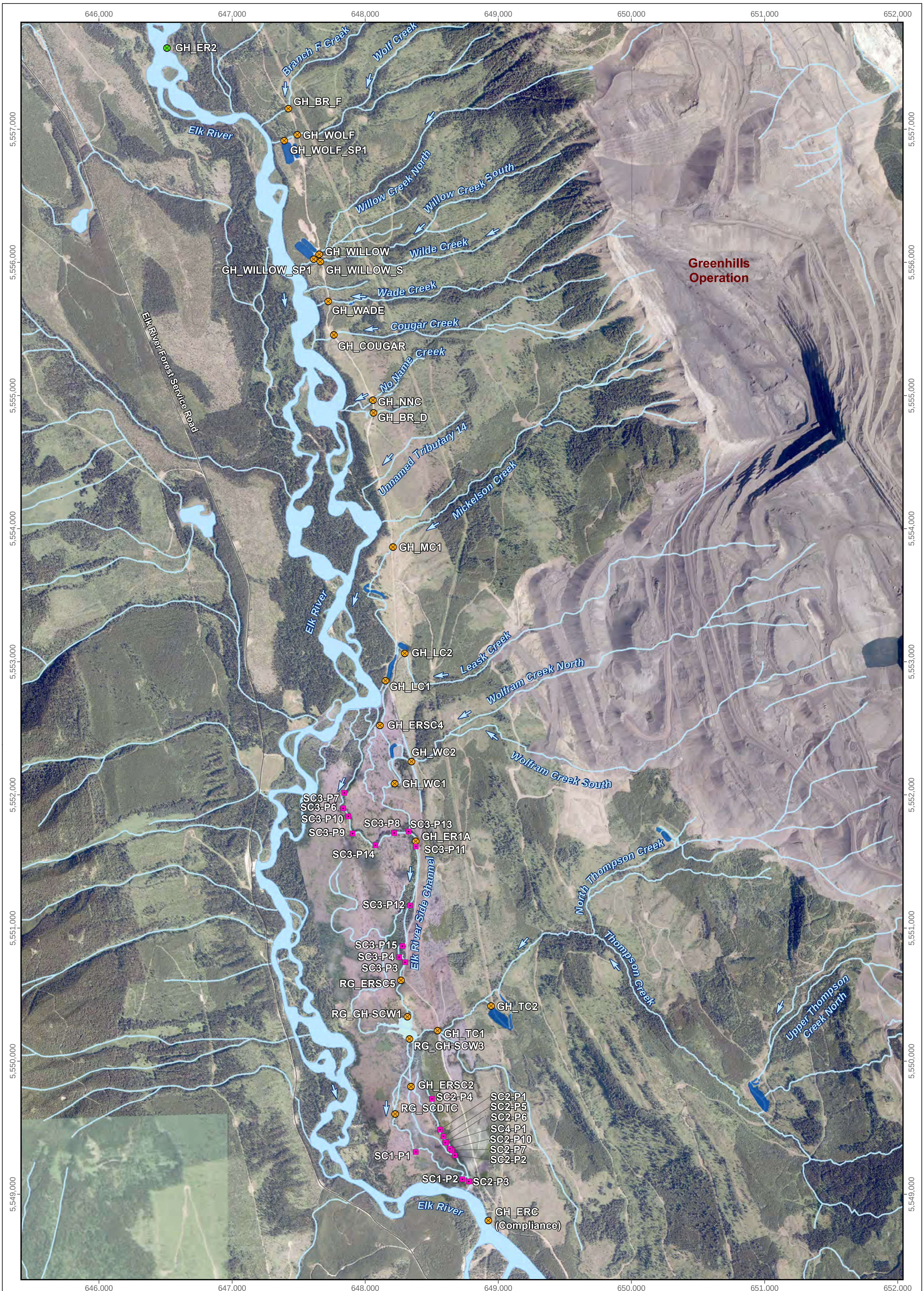
c. What is the water quality at monitoring stations in the Elk River downstream versus upstream of the west-side tributaries, and is it changing over time?

d. 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)?

Evaluation of water quality included assessment of constituents with EWTs (i.e., dissolved cadmium, nitrate, total selenium, sulphate, total antimony, total barium, total boron, dissolved cobalt, total lithium, total manganese, total molybdenum, total nickel, nitrite, TDS, total uranium, and total zinc), as well as dissolved nickel, phosphorus, orthophosphate, and TSS.

5.2 West-side Tributaries

When flowing, Branch F, Wolf, Willow, Wade, Cougar, and No Name creeks (northern west-side tributaries) enter the Elk River upstream from the Elk River side channel (Figure 5.1, Table 2.3). The downstream ends of Mickelson and Leask creeks are sedimentation ponds, which have overflow channels that may connect to the Elk River when water levels are high (Figure 5.1) and may also influence water quality in the main stem Elk River and/or side channel via groundwater flow paths. Wolfram Creek (downstream of the sedimentation pond) connected to the side channel overland during May 2018 and June to July 2019 only (Minnow and Lotic 2019, Section 3.3), and likely also influenced water quality through groundwater flow paths (SNC-Lavalin 2020). Mickelson Creek received pit pumping discharge in 2015 only, Leask Creek received discharge from 2016 to present, and Wolfram Creek received discharge from 2011 to present (Appendix Table C.1). Thompson Creek flowed into Reach 2 of the Elk River side channel all year, located downstream of GH_ER1A and upstream of GH_ERSC2



LEGEND

⊗	Routine Water Quality Monitoring Station (Permit 107517), Reference
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
■	GHO LAEMP Mine-exposed Water Quality Sampling Location, Isolated Pool
▬	Settling Pond

Surface Water Quality Monitoring Stations

0 0.5 1 2
km

N
W E
S

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Figure 5.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 5.1 Surface WQ.mxd

(Figure 5.1, Table 2.3). Pit pumping discharge may have impacted water quality in Mickelson, Leask, and Wolfram creeks.

Water quality data collected in 2019 from the west-side tributaries were compared to applicable BCWQG, EVWQP benchmarks, and/or interim screening values (Appendix Table C.5; Appendix Figures C.1 to C.19 and C.39 to C.57). In more northern west-side tributaries (Branch F, Wolf, Willow, Wade, Cougar, No Name, Branch D, and Mickelson creeks), concentrations were typically below applicable BCWQG and EVWQP benchmarks for most constituents (Appendix Table C.5). Water quality in the three southern-most west-side tributaries, Leask (GH_LC1, GH_LC2), Wolfram (GH_WC1, GH_WC2), and Thompson (GH_TC1, GH_TC2) creeks, indicated mine influence based on concentrations of total nickel, nitrate, total selenium, sulphate, TDS, and/or total uranium, which were frequently (greater than 50% of samples) above BCWQG, applicable EVWQP benchmarks, and/or interim screening values (Appendix Table C.5; Appendix Figures C.9, C.10, C.14, C.15, C.16, and C.18). In 2019, total nickel concentrations were above the Level 3 interim screening value and total uranium concentrations were above the BCWQG in Leask and Wolfram creeks, but not Thompson Creek (Appendix Table C.5, Appendix Figures C.9 and C.18). Nitrate concentrations were also frequently or always above the BCWQG, total selenium concentrations were above the Level 2 EVWQP benchmark, and sulphate and TDS were frequently or always above the Level 1 EVWQP benchmarks in Leask, Wolfram, and Thompson creeks in 2019 (Appendix Table C.5, Appendix Figures C.9, C.14, and C.15). Ammonia concentrations were occasionally above BCWQG in Leask Creek (7% of samples), Wolfram Creek (9% of samples), and Thompson Creek (29% of samples; Appendix Table C.5). Nitrite concentrations were also occasionally above BCWQG in Leask Creek (29% of samples) and Wolfram Creek (9% of samples; Appendix Table C.5, Appendix Figure C.10). Available selenium speciation data for Leask, Wolfram, and Thompson creeks indicate detectable concentrations of organoselenium species that could affect localized patterns of bioaccumulation (Appendix Table C.2).

In Mickelson Creek, the influence of pit pumping was evident in 2015 and 2016, when the concentrations of nitrate, total selenium, sulphate, TDS, and total uranium were significantly higher than other years, including 2019 (Appendix Table C.6, Appendix Figures C.10, C.14, C.15, C.16, and C.18). In Leask Creek, concentrations of total selenium increased in 2018 and 2019 compared to previous years, whereas nitrate concentrations were higher in 2018 compared to other years (Appendix Table C.6, Appendix Figures C.14 and C.10). Also in Leask Creek, total nickel, sulphate, TDS, and uranium concentrations increased from 2012 to 2015, and then remained elevated into 2019 (Appendix Table C.6, Appendix Figures C.9, C.15, C.16, and C.18). Nitrate and total selenium concentrations were significantly higher in 2017, 2018, and 2019 in Wolfram Creek compared to previous years (Appendix Table C.6, Appendix Figures C.10

and C.14). Concentrations of sulphate and TDS were elevated in Wolfram Creek in 2015, 2016, and 2017 compared to previous years, and continued to increase in 2018 and 2019 (Appendix Table C.6, Appendix Figures C.15 and C.16). Total nickel concentrations were relatively stable from 2012 to 2017, and then rose in 2018 and 2019 (Appendix Table C.6, Appendix Figure C.9). In Thompson Creek, sulphate increased in 2018 and 2019 compared to previous years, whereas total nickel increased in 2013 and 2014 compared to 2012, then decreased from 2014 to 2016 and decreased further from 2017 to 2019 (Appendix Table C.6). Overall, total selenium, sulphate, and TDS appear to be increasing in Leask and Wolfram creeks, while total nickel is also increasing in Leask Creek (Appendix Table C.6). In Thompson Creek, sulphate has increased in recent years, whereas total nickel has decreased.

5.3 Side Channel Monitoring Stations

In 2019, water quality constituents were typically lower than BCWQG, EVWQP benchmarks, and/or interim screening values at the side channel monitoring stations (i.e., GH_ERSC4, GH_ER1A, GH_ERSC2, and the Reach 2 stations RG_GH-SCW1 and RG_GH-SCW3; Figure 5.1), except for total selenium at GH_ERSC2 and nitrate-N, total selenium, and sulphate at the outlet of Reach 2 (RG_GH-SCW3; Appendix Table C.7, Appendix Figures C.20 to C.57). Concentrations of nitrate, sulphate, TDS, total lithium, total selenium, and dissolved cadmium generally increased from GH_ERSC4 to GH_ER1A to RG_GH SCW3 (i.e., from upstream to downstream) likely associated with the influence of Wolfram and Thompson creeks (Appendix Table C.7). Further downstream, concentrations of mine-related constituents at GH_ERSC2 were typically higher than GH_ER1A, but lower than RG_GH-SCW3. Total nickel concentrations were higher in Reach 2 in 2019 compared to 2018, but otherwise there were no apparent temporal trends in water quality at these stations (Appendix Table C.8, Appendix Figures C.20 to C.57). Total selenium at station GH_ER1A, which was typically below the BCWQG (Appendix Figure C.33, Appendix Table C.7), was composed almost entirely of selenate in samples collected in April, May, and July 2019 (Appendix Table C.2). Concentrations of selenium species were not measured for the other side channel stations.

Input from the EMC indicated a desire to understand how land-use activities are influencing habitat availability, specifically how TSS inputs in the Elk River side channel influence fish habitat use. The EMC also indicated that the high turbidity events were likely a result of logging operations that occurred in the winter 2017/2018 and spring 2018, as documented by the study team. Concentrations of TSS were compared to the Newcombe and Jensen 1996 model Scale of the Severity (SEV) 7, which is the level where moderate habitat degradation and impaired homing are predicted (Appendix Table C.4). Concentrations of TSS in the side channel were typically below SEV 7, except during spring (Appendix Figure C.36), suggesting that fish use may be affected at that time. Concentrations of TSS also peaked above SEV 7 during freshet at the upstream main stem Elk River reference station (GH_ER2; Appendix Figure C.58), suggesting that these increases are in part natural. Concentrations of TSS in the side channel were higher than at the reference station (MOD of 73%; Appendix Table C.9) but were not different from concentrations in the downstream main stem Elk River station (GH_ERC; Appendix Table C.10). Elevated concentrations of TSS in the side channel and downstream Elk River relative to reference were likely due to runoff travelling through cutblocks in the riparian areas. Cutblocks in the riparian areas have resulted in reduced vegetative buffer (see satellite imagery around the side channel in Figure 5.1, Photos 5.1 to 5.3, Appendix Table G.7), likely causing reduced bank stability and soil retention, as well as increased amounts of soil carried into the streams by runoff, which would result in increased TSS.

Water quality at the side channel stations was compared to the main stem stations upstream (GH_ER2) and downstream (GH_ERC) of the side channel, using data from 2016 to 2019 (Appendix Tables C.9 and C.10, Appendix Figures C.39 to C.57). Concentrations of constituents were typically higher in the side channel compared to the upstream main stem reference station (GH_ER2), with nitrate, nitrite, sulphate, total lithium, and total selenium having the greatest magnitude of difference (Appendix Table C.9). At the most upstream side channel station (GH_ERSC4, which is upstream of the influence of Wolfram and Thompson creeks), nitrate, sulphate, total dissolved solids, total barium, total lithium, total selenium, and dissolved cadmium were significantly lower than concentrations at the downstream main stem station (GH_ERC; Appendix Table C.10). Water quality at station GH_ER1A was not significantly different from GH_ERC for most constituents, except for higher concentrations of nitrite, total molybdenum, and total uranium (Appendix Table C.10). At the most downstream side channel station (GH_ERSC2), nitrate, nitrite, sulphate, total dissolved solids, dissolved cadmium, total lithium, total molybdenum, total selenium, and total uranium were significantly greater than GH_ERC (Appendix Table C.10). This is likely a result of GH_ERSC2 being more directly influenced by surface water flows from Thompson Creek, as well as possibly through groundwater.

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

Data from 2016 to 2019 for the monitoring stations in the main stem Elk River downstream of the west side tributaries (GH_ERC) was compared to the Elk River station upstream of mine influence (GH_ER2) to assess the overall influence of GHO on water quality in the upper Elk River (Figure 5.1, Appendix Figure C.58). In 2019, concentrations of constituents were below applicable BCWQG, EVWQP benchmarks, and/or interim screening values except for total selenium and dissolved copper (Appendix Table C.11, Appendix Figure C.58). Dissolved copper concentrations were greater than BCWQG at both the downstream and upstream stations,

Photo 5.1: Elk River Side Channel Braid in Reach 1 near GH_ERCS2, September 2018

Photo 5.2: Logging impacts near GH_ERCS2, September 2019

Photo 5.3: **Tree Stumps and Machine Ruts between the Riparian Buffer Indicator Tape and the Elk River Side Channel East Channel Reach 1, September 2018**

suggesting that copper is naturally elevated (Appendix Table C.11, Appendix Figure C.58). In 2019, total selenium concentrations at the downstream station (GH_ERC) exceeded the BCWQG in 62% of samples, but all were below the EVWQP Benchmarks (Appendix Table C.11). Selenium speciation data for GH_ERC indicate that aqueous selenium in the Elk River was predominantly or entirely detected in the oxidized form (selenate), with no detectable organoselenium (Appendix Table C.2). Total selenium concentrations increased in 2018 and 2019 compared to previous years at the downstream main stem station (GH_ERC), whereas at the main stem reference station (GH_ER2) total selenium increased in 2016 compared to previous years, and then remained elevated into 2019 (Appendix Table C.12, Appendix Figure C.58). Similarly, nitrate concentrations increased in 2019 compared to previous years at GH_ERC, whereas at the reference station nitrate concentrations increased in 2014 compared to previous years and then remained elevated into 2019 (Appendix Table C.12, Appendix Figure C.58).

Concentrations at the downstream station (GH_ERC) were significantly greater than at the reference station (GH_ER2; Appendix Table C.13) for nitrate, sulphate, total dissolved solids, total suspended solids, dissolved cadmium, total barium, total lithium, total molybdenum, total nickel, total selenium, and total uranium due to the influence of GHO via the west-side tributaries. The greatest difference between the mine-exposed (downstream) and reference main stem Elk River stations (upstream) was for nitrate (i.e., MOD 424%; Appendix Table C.13). Concentrations of manganese were lower at the downstream station compared to reference (Appendix Table C.13).

5.5 Isolated Pools

Thirteen isolated pools were sampled for water quality in 2019 (Figure 5.1). Most pools existed for less than three months in 2019, whereas in 2017 and 2018 most pools persisted for less than one month (Appendix Figures A.1 to A.30; Sections 3.2 and 4.2). Pools SC2-P3, SC2-P1, and SC2-P5 (located in Reach 1 at the downstream end of the side channel; Figure 5.1) persisted throughout all or most of 2019 when the side channel was otherwise mostly dry (Appendix Figures A.20 to A.30; Sections 3.2 and 4.2). Concentrations of constituents were typically below applicable BCWQG, EVWQP benchmarks, and/or interim screening values except for concentrations of nitrate, total selenium, sulphate, and TDS, which were frequently greater in pools downstream of the confluence with Thompson Creek and GH_ERSC2 (Appendix Figures C.59 to C.78). Pools located upstream of Reach 2 generally had water quality comparable to GH_ERSC4 and GH_ER1A (Appendix Figures C.59 to C.78). These pools were formed by seasonal drying of the side channel (i.e., infiltration) rather than groundwater, except for SC2-P13, located on the side channel near the confluence with Wolfram Creek (Figure 5.1;

Section 6; SNC-Lavalin 2020). The pools located downstream from GH_ERSC2 often had poorer water quality than GH_ERSC2 when flowing (Appendix Figures C.59 to C.78). Of the pools sampled for water quality, most in Reach 1 were stagnant water resulting from seasonal drying of the side channel, except for SC2-P3, as well as possibly SC2-P1 and SC2-P2, which appeared to be groundwater fed (Section 6; SNC-Lavalin 2020). Overall, most of the isolated pools persisted for less than a month and covered a relatively small surface area (Sections 3.2 and 4.2), and therefore, despite higher concentrations of some constituents, are likely a minor exposure pathway to aquatic-dependent biota.

5.6 Summary

Water quality in the more northern west-side tributaries (i.e., Branch F, Wolf Creek, Willow Creek, Wade Creek, Cougar Creek, No Name Creek, and Mickelson Creek) was typically below BCWQG, EVWQP benchmarks, and/or interim screening values. Water quality in Leask, Wolfram, and Thompson creeks showed evidence of mine influence based on concentrations of total nickel, nitrate, total selenium, sulphate, TDS, and total uranium, which were frequently above applicable BCWQG, EVWQP benchmarks, and/or interim screening values. Total selenium, sulphate, and TDS appear to be increasing in Leask and Wolfram creeks, while total nickel is increasing in Leask Creek. In Thompson Creek, sulphate has increased in recent years, whereas total nickel has decreased.

Water quality at side channel stations GH_ER1A and GH_ERSC2 was influenced by Wolfram and Thompson creeks, showing occasional concentrations of ammonia, total chromium, nitrate, and total selenium that were greater than BCWQG and/or applicable EVWQP benchmarks (Level 2 for total selenium, Level 1 for other constituents). The highest concentrations of mine-related constituents occurred in Reach 2 at the confluence of Thompson Creek and the Elk River side channel. At the Reach 2 outlet, total nickel increased in 2019 compared to 2018. Water quality at side channel station GH_ER1A was comparable to the downstream main stem Elk River station, whereas at the furthest downstream side channel station (GH_ERSC2), concentrations of some mine-related constituents were higher than the downstream main stem Elk River station (due to the influence of Thompson Creek).

Water quality at the main stem Elk River station downstream of the side channel (GH_ERC) had higher concentrations of nitrate, sulphate, total dissolved solids, total suspended solids, dissolved cadmium, total barium, total lithium, total molybdenum, total nickel, total selenium, and total uranium relative to the main stem upstream reference station (GH_ER2). However, concentrations of constituents in the main stem Elk River stations were typically below applicable BCWQG, EVQWP benchmarks, and/or interim screening values, except for dissolved copper (which was also elevated in the reference area) and total selenium. Total selenium concentrations increased in 2018 and 2019, and nitrate concentrations increased in 2019, as compared to previous years at the downstream main stem station (GH_ERC).

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 indicated that most of the isolated pools were stagnant water that remained after the side channel dewatered, except for SC3-P13 and SC2-P3, as well as possibly SC2-P1 and SC2-P2, which appeared to be groundwater fed (SNC-Lavalin 2020). Water quality in these pools was highly dependent on location. Pools located upstream of Reach 2 had water quality comparable to GH_ERSC4 and GH_ER1A, whereas pools downstream of Reach 2 exhibited influence from Thompson Creek. Pools downstream of Reach 2 had concentrations of nitrate, total selenium, sulphate, and TDS that were frequently higher than BCWQG, EVWQP benchmarks, and/or interim screening values.

6 STUDY QUESTION #4

Data evaluated in this section address study question #4 (What is the interaction between surface water and groundwater in the Elk River side channel?). A hydrogeological review and analysis of available groundwater and surface water data for the west side of GHO was conducted by SNC Lavalin in 2019 and an updated assessment was completed in 2020 (SNC-Lavalin 2020). Detailed interpretation and conclusions are provided in Appendix D (SNC Lavalin 2020), and a summary is provided below.

The Elk River is interpreted to influence surface water quality along the course of the side channel, except for localized areas where shallow groundwater discharge may be occurring. Increasing concentrations of constituents of interest along the side channel flow path were inferred to result predominantly from loading from mine-exposed tributaries, which feed into the side channel. At times of peak flows at Wolfram Creek, mine-influenced water from the drainage is inferred to influence surface water quality in the side channel and the transport path is mainly suspected to be from shallow groundwater. Mine-influenced Thompson Creek was a permanent source of surface water to the side channel at Reach 2.

Most isolated pools in the side channel were interpreted to result from natural seasonal drying of the side channel (i.e., infiltration) and not from groundwater discharge. Exceptions to this include isolated pools SC3-P13, SC2-P3 and possibly SC2-P1 and SC2-P2. Pool SC3-P13, located near the confluence with Wolfram Creek, appears to represent a shallow groundwater flow path. Pools SC2-P1, SC2-P2, and SC2-P3 are in the eastern channel of Reach 1 at the downstream end of the side channel. Pool SC2-P3 has remained wetted year-round (when Reach 1 is otherwise dry) since 2017, while pools SC2-P1 and SC2-P2 were wetted for most of, or possibly all of, 2019. All three pools contained elevated concentrations of mine-related constituents and groundwater discharge to these pools is inferred. The origin of the southern pools is inferred to be from the Thompson Drainage, which is the closest west-side drainage. These groundwater discharge areas do not result in sustained base flows in the side channel.

Overall, the updated assessment continued to support the findings and conceptual mode described in the 2019 gap assessment (SNC-Lavalin 2019), indicating that the side channel predominantly infiltrates to ground and recharges groundwater with localized areas of shallow groundwater discharge. Based on recommendations made in the 2018 GHO LAEMP report, gaps and uncertainties associated with groundwater–surface water interaction along the Elk River side channel will be addressed by monitoring wells to be installed as part of the Mass Balance Investigation (MBI), with ongoing monitoring of groundwater also conducted under GHO SSGMP, RGMP, and CPX2.

7 STUDY QUESTION #5

7.1 Overview

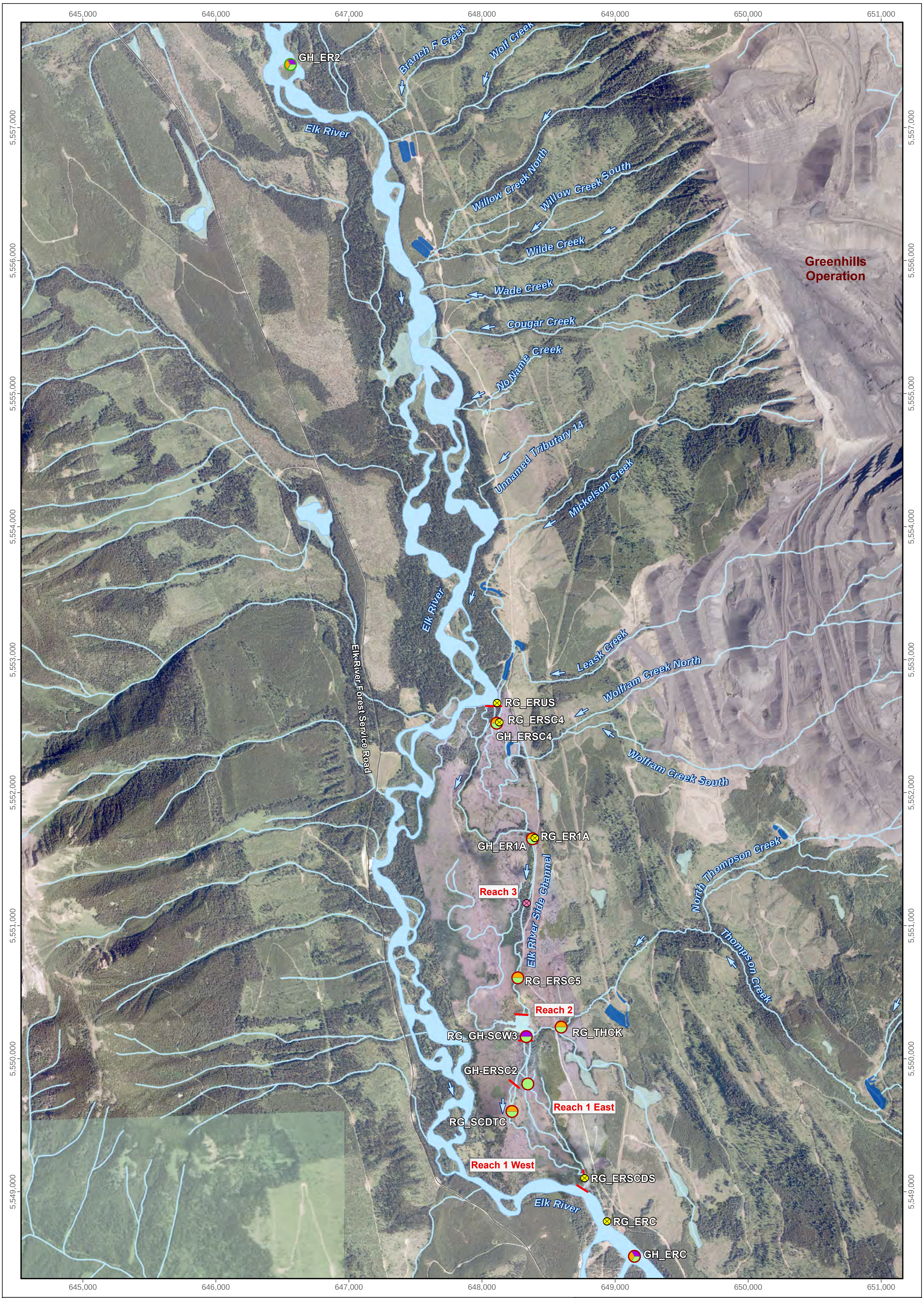
Data evaluated in this section for Elk River side channel and main stem Elk River stations pertain to study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?). Thompson Creek was also evaluated, per EMC discussions.

7.2 Benthic Invertebrate Community Composition

Benthic invertebrate community samples collected in September were compared between and within stations in the main stem Elk and Elk River side channel (Figure 7.1; Appendix Table E.1). Consistent with previous years, community endpoints generally did not differ greatly between perennially-wetted main stem stations (GH_ER2 and GH_ERC) and side channel stations (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC), except for Coleoptera and Oligochaeta, which were present in the side channel, but largely absent from the main stem stations (Figure 7.2). Compared to the main stem and side channel stations, the samples collected from Thompson Creek (RG_THCK) had greater proportions of Coleoptera and Diptera, and a lower proportion of Ephemeroptera (Figure 7.2); differences between main stem Elk River samples and a tributary samples are expected due to habitat differences. Water quality differences, such as differences in selenium speciation (Section 5) may also play a role. Percent Diptera was also higher in the main stem Elk River downstream of the side channel compared to the main stem reference station in two out of five samples (Figure 7.2 and 7.3).

At all main stem and side channel stations, total abundance, LPL richness, % EPT, % Ephemeroptera (% E), % Plecoptera (% P), and % Trichoptera (% T) were within or above the normal range (Figures 7.3 to 7.6), except for % T at RG_SCDTC in one of three samples and % P at GH_ERC in one of three samples. At Thompson Creek (RG_THCK), most endpoints were within the normal range, except for % EPT, % E, and % P (which were below normal range) and % Diptera, which was above the normal range (Figures 7.3 to 7.6).

There were no apparent patterns in benthic invertebrate community endpoints from 2012 to 2019, except at the downstream main stem station GH_ERC, where there was an apparent decrease in % P from 2015 to 2019 (Appendix Figures E.1 to E.8). Single samples were collected each year from 2015 to 2017, so the apparent trend may simply be natural variation (as demonstrated by the within station variability measured in 2018 and 2019 at reference station GH_ER2). Despite the downward trend, % P at GH_ERC remained within the normal range as well as within



LEGEND

Sampling Type

- Mine-exposed
- Reference
- 🟪 Sediment Quality
- 🟧 Benthic Invertebrate Community
- 🟩 Benthic Invertebrate Tissue Chemistry

- ⊗ Staff Gauge Location
- ⊗ Barometric Logger
- — Reach Break
- 🟦 Settling Pond

Staff Gauge Locations, and Sediment Quality, Benthic Invertebrate Community, and Benthic Invertebrate Tissue Chemistry Sampling Stations

Projection: North American Datum 1983 UTM Zone 11
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minnow environmental inc.

Figure 7.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig 7.1 Staff Gauge Locations.mxd

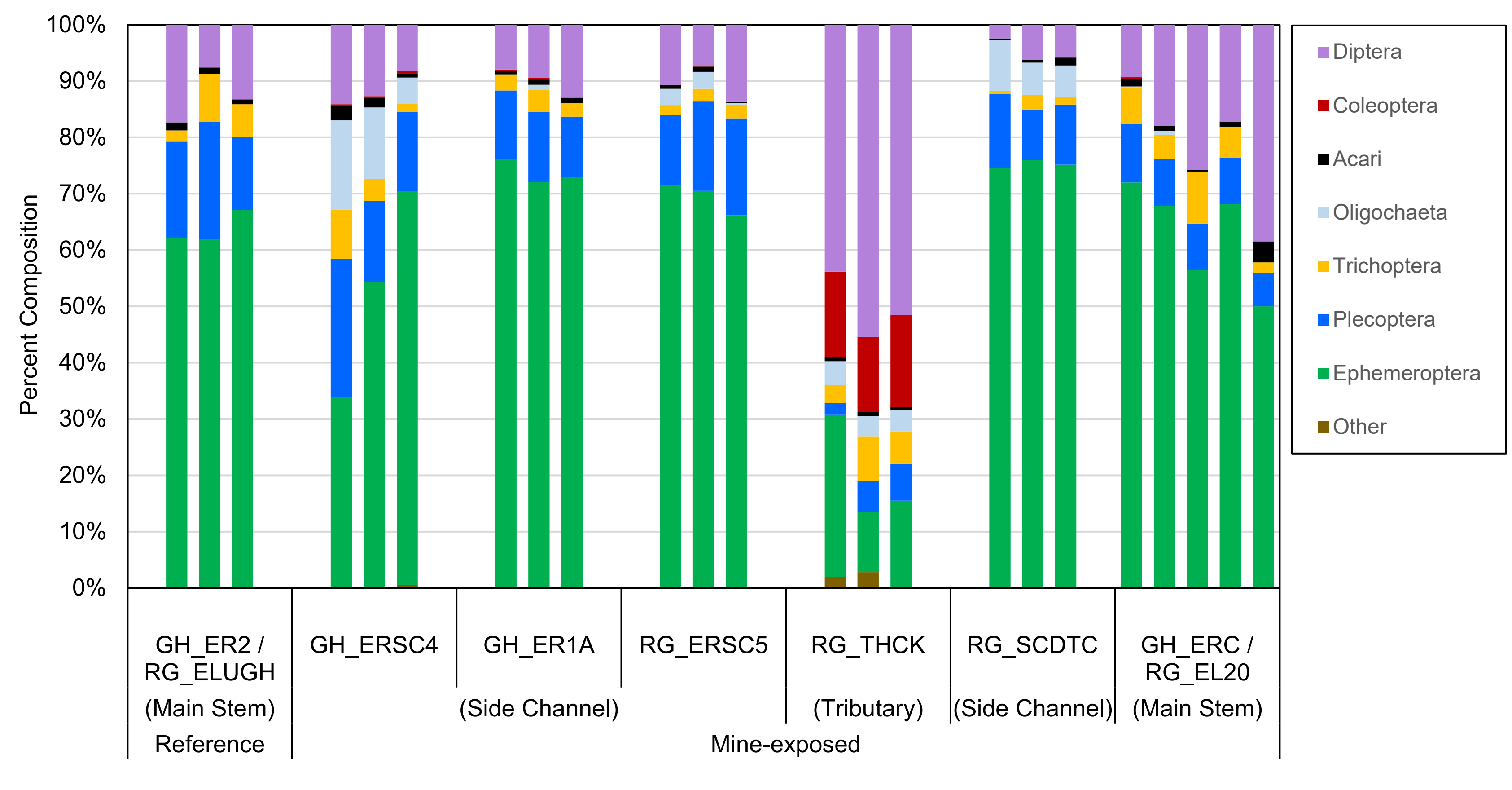

Figure 7.2: **Benthic Invertebrate Community Composition, GHO LAEMP, September 2019**

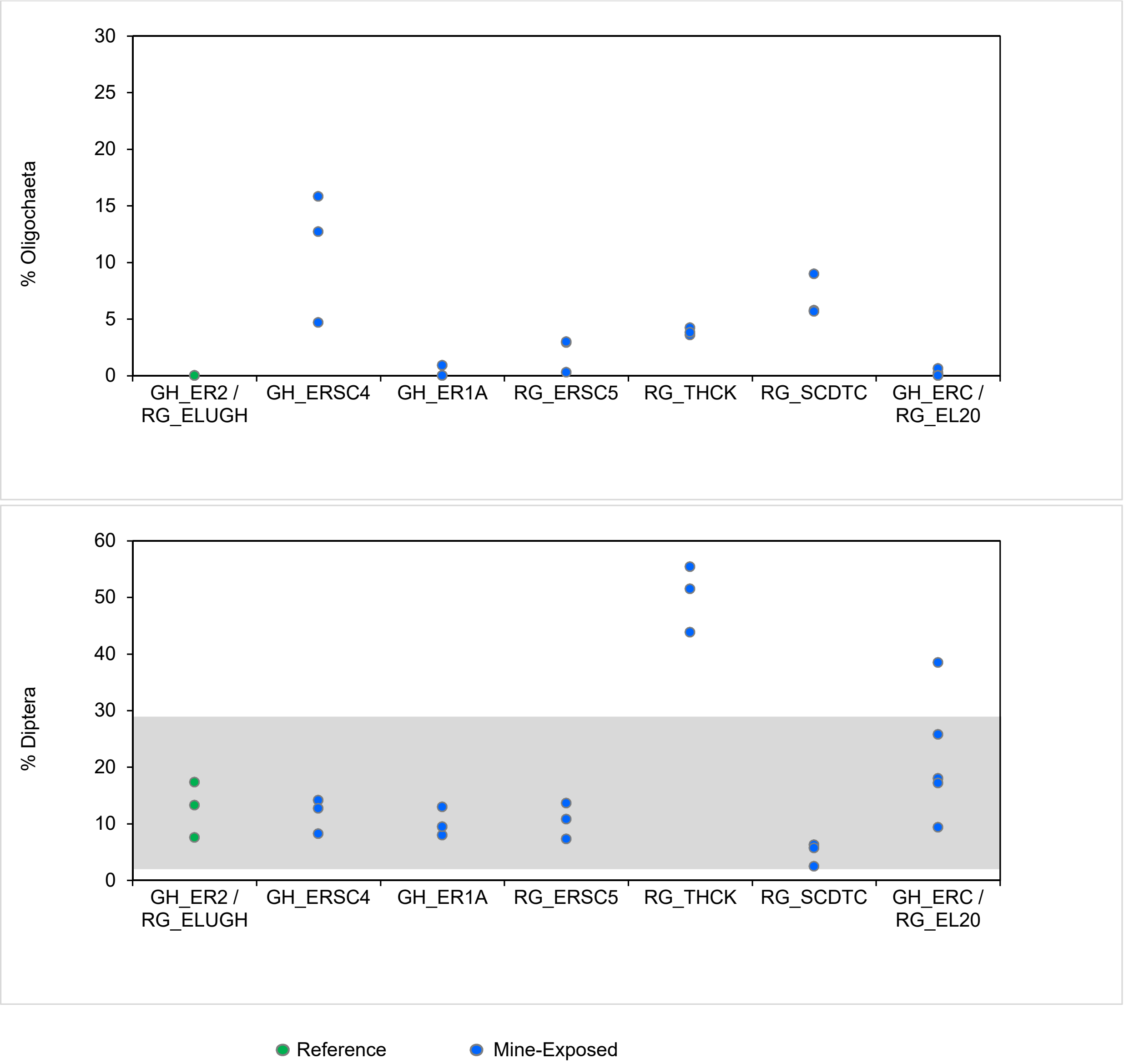

Figure 7.3: Benthic Invertebrate % Oligochaeta and % Diptera Abundance, GHO LAEMP, September 2019

Note: Grey shading represent the upper and lower limits of the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP).

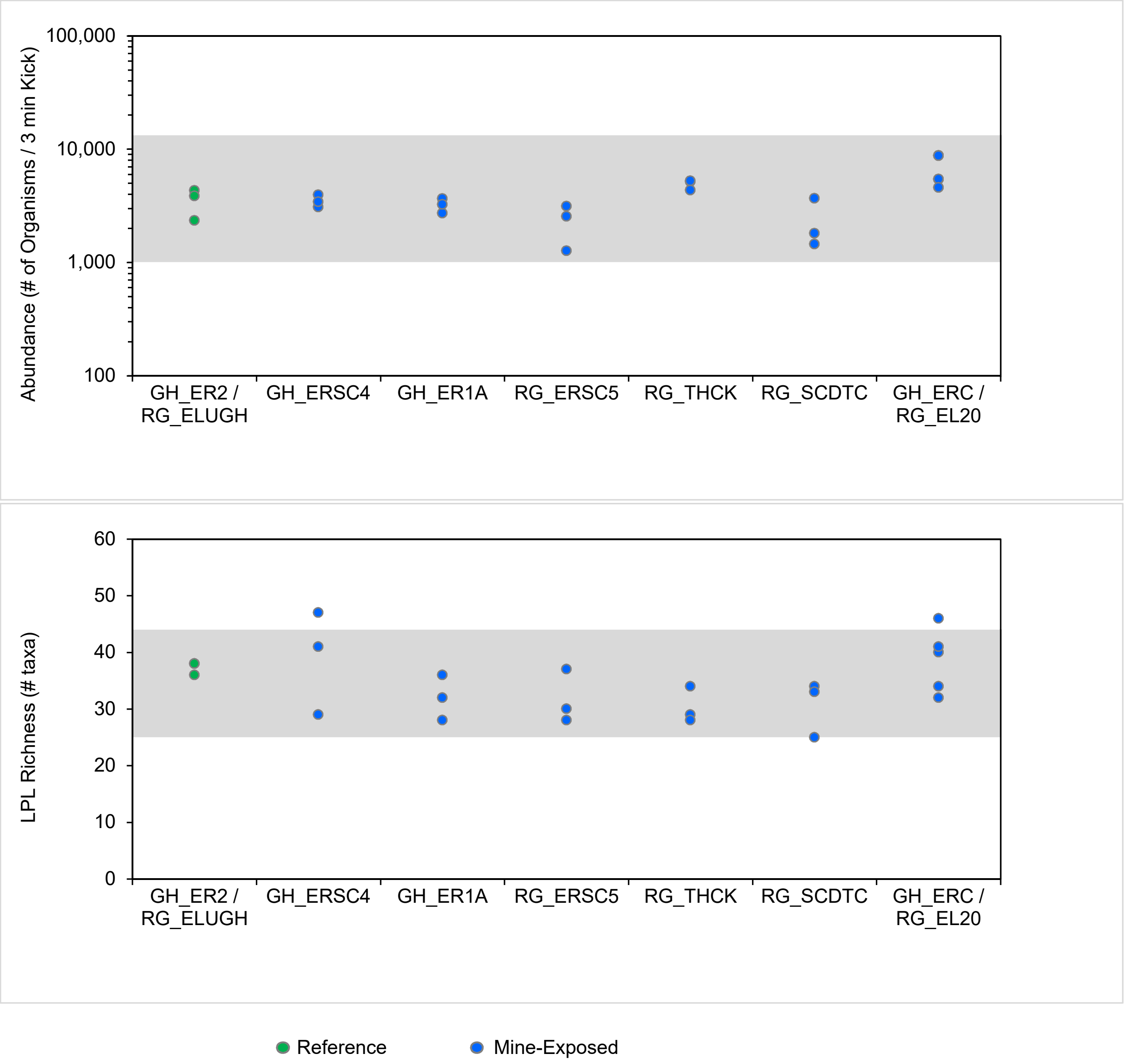

Figure 7.4: **Benthic Invertebrate Community Abundance and LPL Richness, GHO LAEMP, September 2019**

Note: Grey shading represent the upper and lower limits of the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP).

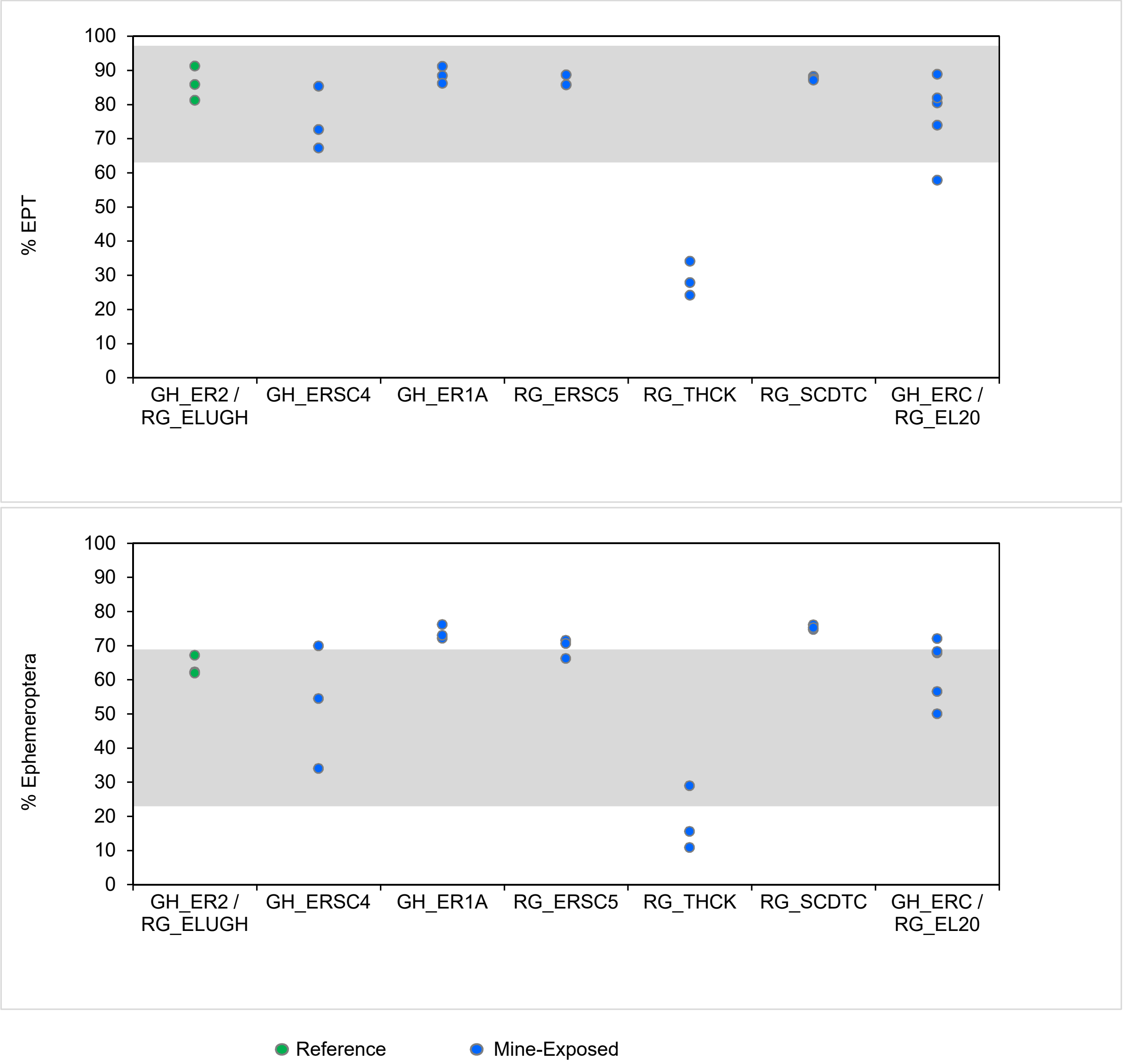

Figure 7.5: **Benthic Invertebrate Community %EPT and % Ephemeroptera, GHO LAEMP, September 2019**

Note: Grey shading represent the upper and lower limits of the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP).

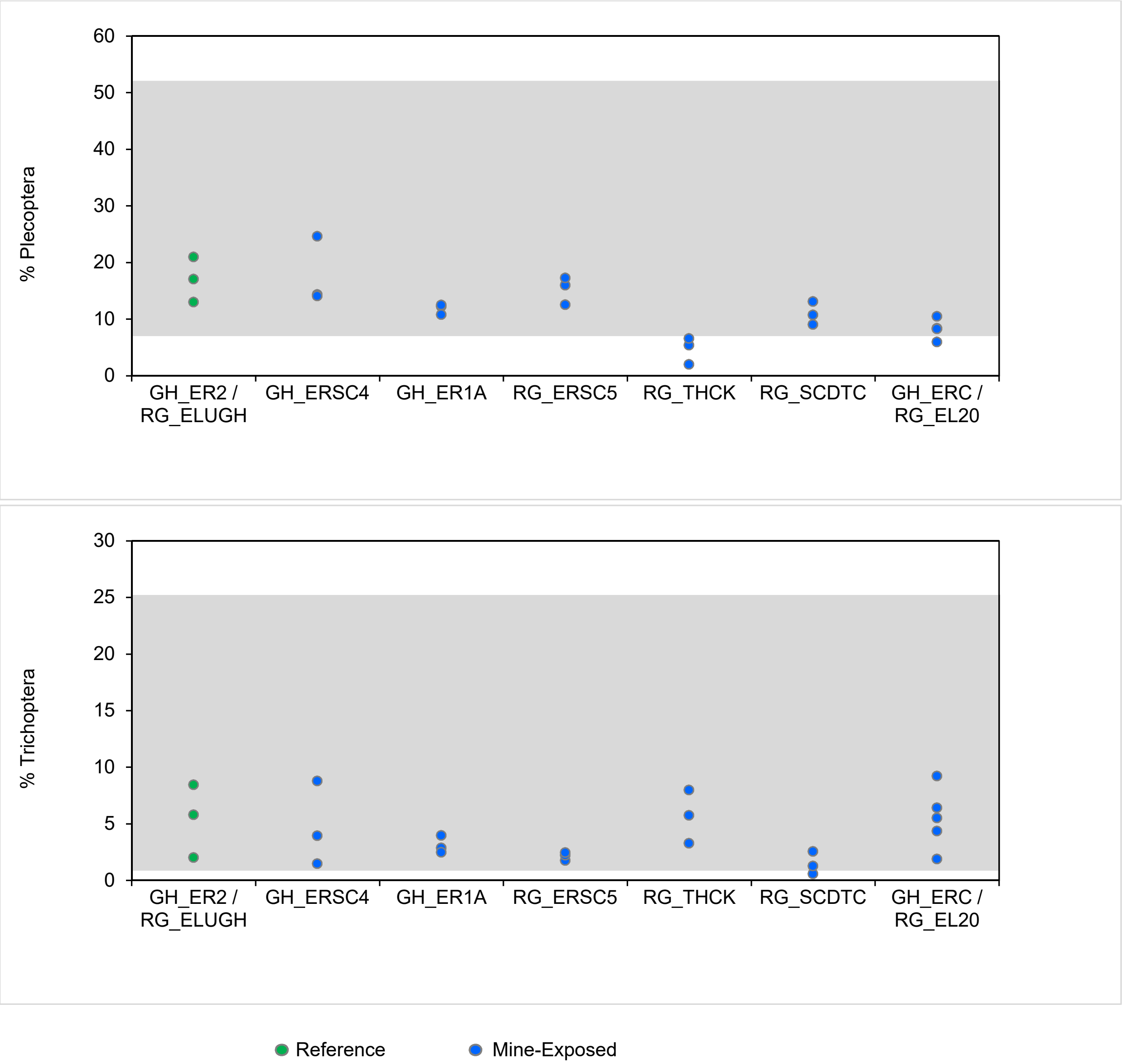

Figure 7.6: **Benthic Invertebrate Community % Plecoptera and % Trichoptera, GHO LAEMP, September 2019**

Note: Grey shading represent the upper and lower limits of the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP).

the range observed at the upstream main stem reference station (GH_ER2), except for one of three samples collected in 2019.

Overall, 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. The only temporal change observed was a possible decrease in % P at the downstream main stem Elk River station (GH_ERC).

7.3 Concentrations of Selenium in Benthic Invertebrate Tissue

Selenium concentrations in benthic invertebrate tissue samples collected in 2017, 2018, and 2019 from the main stem Elk River upstream (GH_ER2) and downstream (GH_ERC) of GHO, and from the most-upstream side channel station (GH_ERSC4) were below all EVWQP benchmarks (Figure 7.7, Table 7.1; Appendix Table F.1). In 2019, samples collected from GH_ER1A and RG_SCDTC were also below EVWQP benchmarks (Figure 7.7). Selenium concentrations in benthic invertebrate tissue collected in 2019 from RG_ERSC5 and GH_ERSC2 were higher than the EVWQP Level 1 dietary benchmark for fish in one of three replicates from each area, whereas all other 2019 samples from these two areas were below the Level 1 benchmarks (Figures 7.1 and 7.7). The highest selenium concentrations measured in 2019 were in the samples collected from Thompson Creek (RG_THCK) and from Reach 2 (RG_GH-SCW3), which receives direct inputs from Thompson Creek (Figure 7.7). The selenium concentrations in the three samples from Thompson Creek and one of three samples from Reach 2 were higher than EVWQP Level 3 benchmarks for benthic invertebrates, and dietary effects to fish and birds (Figure 7.7; Appendix Table F.1).

Concentrations of selenium in benthic invertebrate tissues were variable within stations, but generally similar between years, except for RG_ERSC5, GH_THCK, and RG_GH-SCW3 (Figure 7.7). One out of three samples from Reach 2 (RG_GH-SCW3) in 2019, all three samples from Thompson Creek (RG_THCK) in 2019, and two of three samples from RG_ERSC5 in 2017 had selenium concentrations that were elevated compared to other years or other samples collected within the same year. The higher concentrations may be due to the presence of annelids (segmented worms) in all of these selenium-elevated samples (Minnow 2016b, 2018a, Minnow and Lotic 2019). Annelids have previously been shown to exhibit higher concentrations of selenium compared to other benthic organisms, even at reference areas. Annelids were not present in the 2018 samples. When annelids are collected in samples, they typically contribute a large amount of biomass relative to the overall number of organisms present in the sample (i.e., one or two worms often provides sufficient biomass for a tissue sample). In addition, higher concentrations may result from aqueous selenium being present in more bioavailable forms (e.g., dimethylselenoxide, methylseleninic acid). Although no samples were collected in

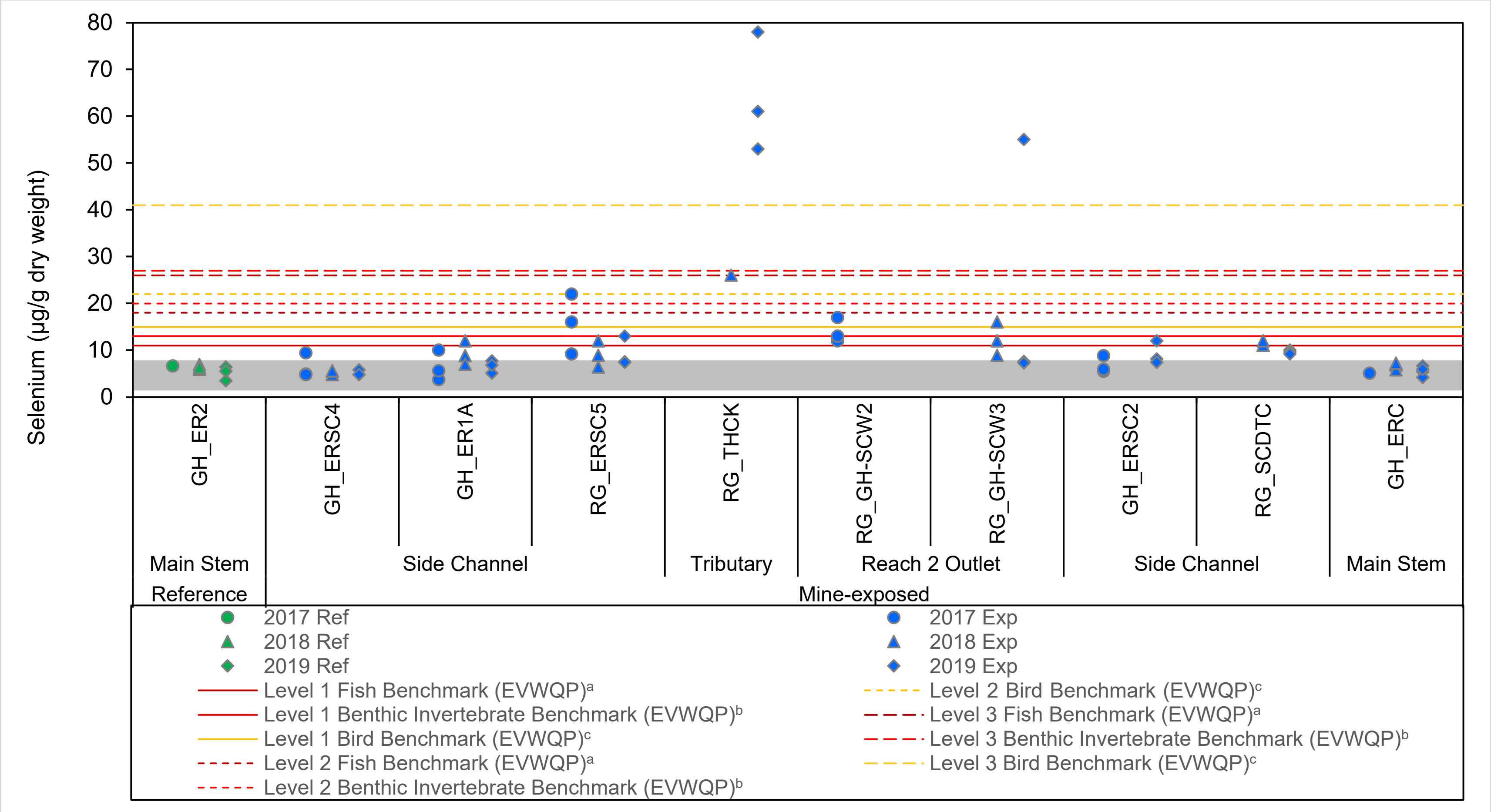

Figure 7.7: **Selenium Concentrations in Benthic Invertebrate Samples, 2017 to 2019**

Note: Gray shading represents the reference area normal range defined as the 2.5th to 97.5th percentiles of the distribution of reference area (pooled 1996 to 2015 data) reported in the RAEMP (Minnow 2018). The reference area normal range was calculated for community composite samples.

EVWQP - Elk Valley Water Quality Plan

[a] 11, 18, and 26 µg/g represent the Level 1, 2, and 3 EVWQP Benchmarks (Golder 2014a), respectively, for dietary effects to juvenile fish.

[b] 13, 20, and 27 µg/g represent the Level 1, 2, and 3 EVWQP Benchmarks (Golder 2014a), respectively, for growth, reproduction, and survival of benthic invertebrates.

[c] 15, 22, and 41 µg/g represent the Level 1, 2, and 3 EVWQP Benchmarks (Golder 2014a), respectively, for dietary effects to juvenile birds.

Table 7.1: Selenium Benchmarks for Benthic Invertebrates Tissue in the Elk Valley

Endpoint	Tissue Type	Benchmark			Source
		Selenium Value (µg/g dw)	Type	Description	
Benthic Invertebrates	Whole body	4 [a]	BC guideline	Interim guideline for aquatic dietary tissue based on weight of evidence of lowest published toxicity thresholds and no uncertainty factor applied	BCMOE (2014)
	Whole body	13	Site-specific benchmark	Level 1 (~10% effect) benchmark for growth, reproduction and survival of invertebrates	Golder (2014a)
	Whole body	20	Site-specific benchmark	Level 2 (~20% effect) benchmark for growth, reproduction and survival of invertebrates	Golder (2014a)
	Whole body	27	Site-specific benchmark	Level 3 (~50% effect) benchmark for growth, reproduction and survival of invertebrates	Golder (2014a)
	Whole body	11	Site-specific benchmark	Level 1 (~10% effect) benchmark for dietary effects to juvenile fish (growth)	Golder (2014a)
	Whole body	18 [b]	Site-specific benchmark	Level 2 (~20% effect) benchmark for dietary effects to juvenile fish (growth)	Golder (2014a)
	Whole body	26	Site-specific benchmark	Level 3 (~50% effect) benchmark for dietary effects to juvenile fish (growth)	Golder (2014a)
	Whole body	15	Site-specific benchmark	Level 1 (~10% effect) benchmark for dietary effects to juvenile birds	Golder (2014a)
	Whole body	22	Site-specific benchmark	Level 2 (~20% effect) benchmark for dietary effects to juvenile birds	Golder (2014a)
	Whole body	41	Site-specific benchmark	Level 3 (~50% effect) benchmark for dietary effects to juvenile birds	Golder (2014a)

[a] BC guidelines were not used in assessment of benthic invertebrate tissue selenium concentrations. Assessment was completed relative to site-specific benchmarks only.

[b] Site-specific benchmark not applicable to dietary effects to juvenile westslope cutthroat trout for reasons outlined in Golder 2014a.

September (when benthic tissue was collected), one selenium speciation sample was collected in May 2019 at Thompson Creek. The selenium speciation results for this sample indicate detectable concentrations of organoselenium species that could affect localized patterns of bioaccumulation within Thompson Creek, as well as downstream at Reach 2 (Appendix Table C.2).

Selenium concentrations were generally within the 95% prediction limits for the selenium bioaccumulation model (Figure 7.8; Teck 2014). Several samples with elevated selenium concentrations (noted above, collected at RG_ERSC5 in 2017, and at RG_THCK and RG_GH-SCW3 in 2019) were outside of the prediction limits, indicating higher concentrations of selenium in benthic invertebrate tissue relative to the predicted value based on the water chemistry at that station. As stated in previous reports and above (Minnow and Lotic 2018a, 2019), the higher concentrations were possibly due to the presence of annelids (segmented worms) in the samples. Elevated selenium concentrations in these benthic invertebrate tissue samples may also be due to the speciation of selenium at these stations. Most of data were above (rather than around) the model line (Figure 7.8), indicating that the model underpredicts bioaccumulation for benthic invertebrates in this area. Revisions to the selenium bioaccumulation model are currently under development and will separate evaluation of lentic versus lotic data in the future. In addition, Teck has developed and is undertaking updates to a speciation bioaccumulation tool to help predict and interpret bioaccumulation in areas with detectable organoselenium species (Golder 2018).

7.4 Supporting Information

7.4.1 Habitat

In situ water quality was similar among stations at the time of benthic invertebrate sampling (Appendix Table G.2), with all stations being well-oxygenated. Water in the side channel and main stem Elk River was cooler than water in Thompson Creek (Appendix Table G.2). Specific conductance was also highest in Thompson Creek. The mine-exposed and reference main stem Elk River stations were well matched, with similar sized channels and cobble-dominated substrates (Appendix Table G.7, Appendix Photos G.1 to G.13). Compared to the main stem stations, side channel stations had much narrower wetted widths and a greater proportion of sand and fines (Appendix Tables G.5 to G.7, Appendix Photos G.14 to G.47). Reach 2 and GH_ERSC2 were predominantly fines. Thompson Creek was steeper and narrower than main stem and side channel stations (Appendix Photos G.48 to G.50).

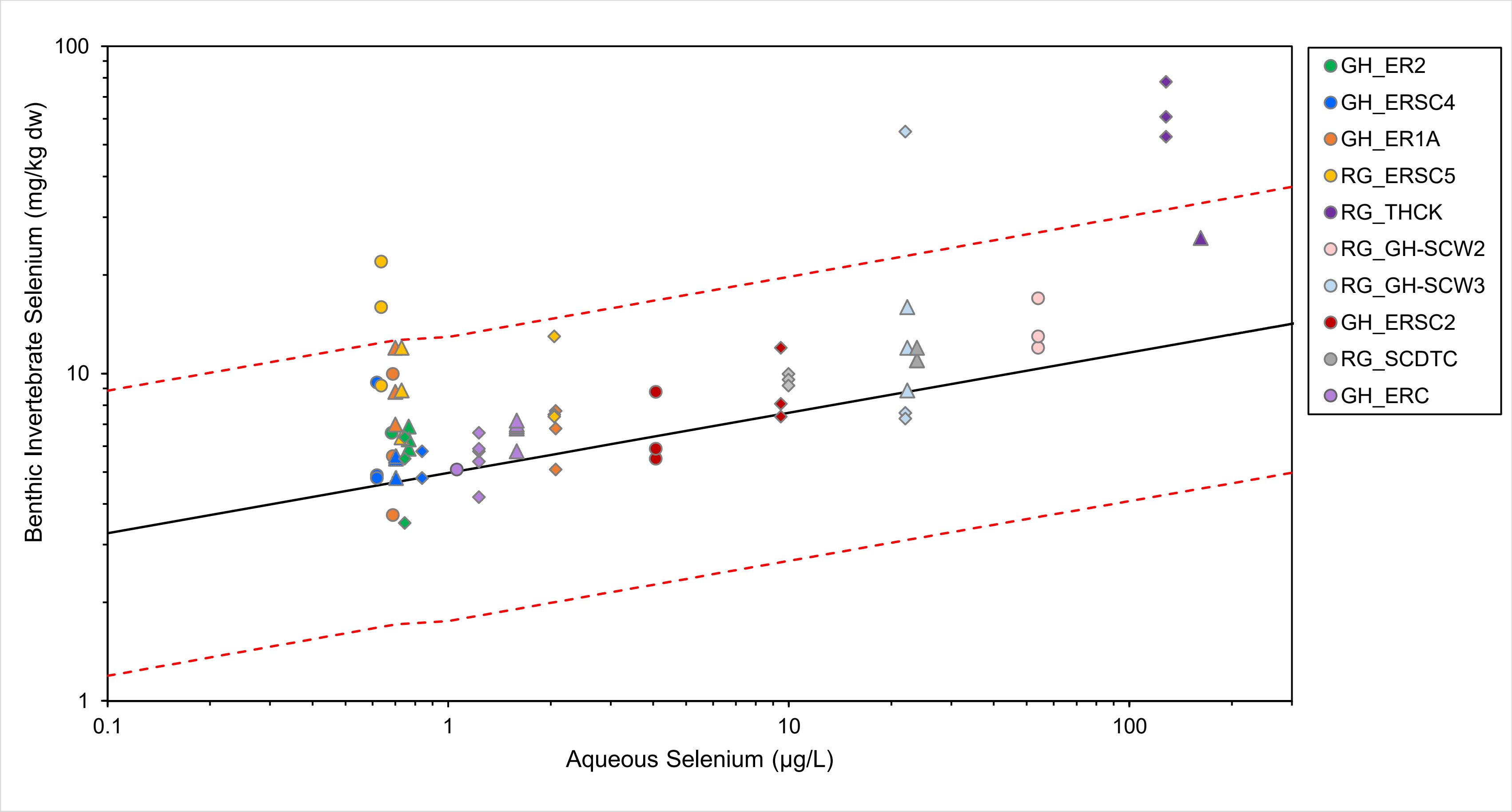

Figure 7.8: **Observed and Modelled[a] Selenium Concentrations in Benthic Invertebrate Composite Samples Relative to Aqueous Selenium Concentrations, September 2017 (circles), September 2018 (triangles), and September 2019 (diamonds)**

[a] Mean benthic invertebrate selenium concentrations (solid black line) were estimated using a one-step water to benthic invertebrate selenium accumulation model: log10[Se]benthicinvertebrate=0.696+0.184×log10$[Se]_{aq}$ (Teck 2014). The 95% prediction limits for a single value from the one-step water to benthic invertebrate selenium accumulation model are plotted as dashed red lines.

7.4.2 Calcite

Calcite indices measured in biological sampling areas at the downstream main stem Elk River station (GH_ERC) and Elk River side channel stations (GH_ERSC4, GH_ER1A, RG_ERSC5, RG_SCDTC) in September 2017, 2018, and 2019 ranged from 0 to 0.46 (Table 7.2, Appendix Table G.5), which is within the reference condition of less than 1.0 (Minnow 2018a). Calcite was present but not concreted in Thompson Creek (calcite index of 0.8 and 0.39 in 2018 and 2019, respectively; Table 7.2, Appendix Table G.5).

Table 7.2: Calcite Index at Benthic Invertebrate Monitoring Areas in Riffles, GHO LAEMP, September 2017 to 2019

Site Name	2017				2018				2019			
	Minimum	Maximum	n	Average Calcite Index	Minimum	Maximum	n	Average Calcite Index	Minimum	Maximum	n	Average Calcite Index
GH_ER2 / ELUGH	0	0	1	0	0	0	3	0	0	0	3	0
GH_ERSC4	0	0	1	0	0	0	3	0	0.10	0.63	3	0.34
GH_ER1A	0	0	1	0	0	0	3	0	0.33	0.48	3	0.43
RG_ERSC5	0	0	1	0	0	0	3	0	0	0	3	0
GH_TC2 / THCK[a]	-	-	-	-	-	-	1	0.80	0.30	0.50	3	0.39
RG_SCDTC[b]	-	-	-	-	0	0	1	0	0.40	0.57	3	0.46
GH_ERC / EL20	0	0	1	0	0	0	5	0	0.06	0.62	5	0.39

Note: "-" indicates no work conducted.
[a] THCK was not included in the 2017 GHO LAEMP study design.
[b] RG_SCDTC was dry in 2017.

7.4.3 Sediment Quality

Sediment quality samples were collected in the main stem Elk River upstream (GH_ER2) and downstream of the west side tributaries (GH_ERC), as well as Reach 2 (RG_GH-SCW3; Figure 7.1). Sediment TOC and particle size were generally similar among areas, and consistent with previous years (Figure 7.9).

In 2019, concentrations of parameters with SQGs were less than the upper SQG (Figure 7.10, Appendix Table G.3). Selenium concentrations in sediment samples from the main stem Elk River (GH_ER2 and GH_ERC) were below the only SQG, whereas one of five samples from

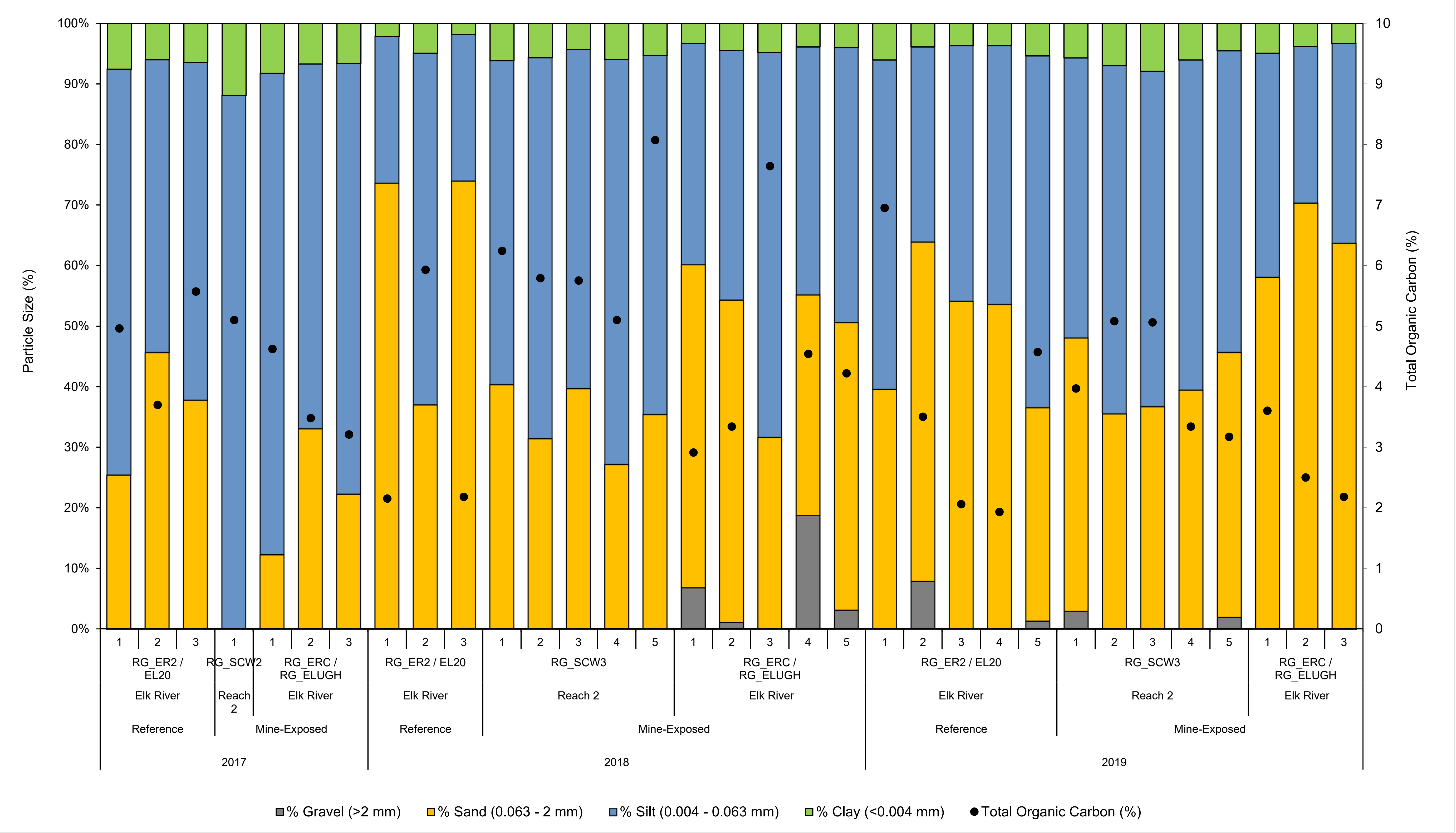

Figure 7.9: **Mean Particle Size (%) and Total Organic Carbon Content (%) in Sediments, September 2017, 2018, and 2019**

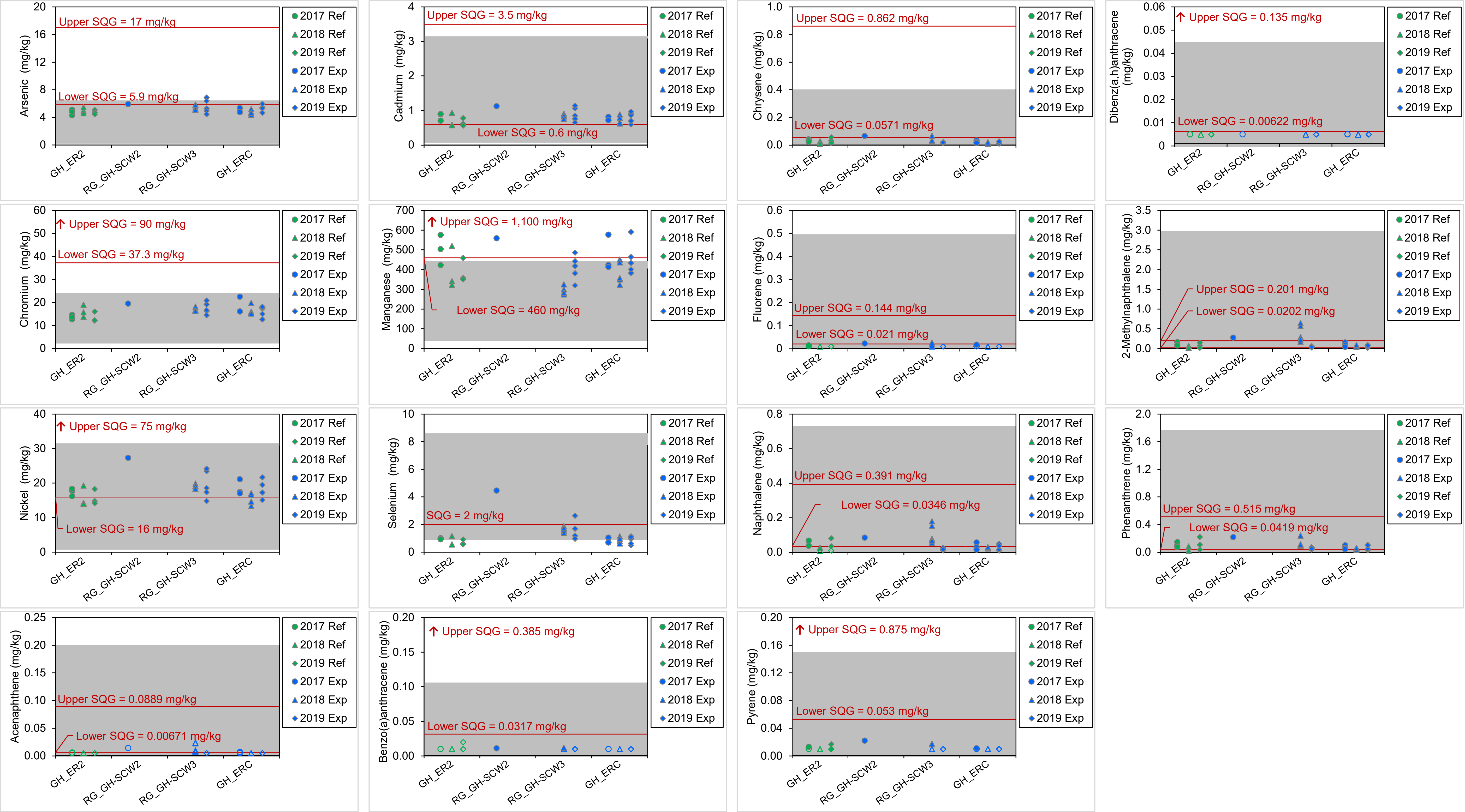

Figure 7.10: **Sediment Metal and Polycyclic Aromatic Hydrocarbons Concentrations Relative to BC Sediment Quality Guidelines (SQG) and Normal Ranges, 2017 to 2019**

Notes: Symbols differentiate year with circles representing 2017, triangles representing 2018 and diamonds representing 2019. Concentrations below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL value. Shading represents the normal range (2.5th to 97.5th percentiles of 2013 and 2015 reference area data collected in the RAEMP, Minnow 2018).

Reach 2 had concentrations higher than the SQG (Figure 7.10). Sediment quality was within the normal range, except for arsenic in one of five samples collected at Reach 2 and manganese concentrations in two of five samples each from Reach 2 and GH_ERC (Figure 7.10). Manganese concentrations also exceeded the normal range at the upstream reference area (GH_ER2) in 2017 and 2018, suggesting the elevated concentrations in 2019 may not be mine-related.

Sediment quality was similar in the main stem Elk River downstream (GH_ERC) and upstream (GH_ER2) of the west side tributaries (Figure 7.10). For parameters with SQG, sediment quality in Reach 2 (RG_GH-SCW3) was generally similar to the two main stem Elk River stations, but with higher concentrations of arsenic, chrysene, 2-methylnaphthalene, and selenium (Figure 7.10), likely as a result of inputs from Thompson Creek. Overall, sediment quality in the main stem Elk River downstream of the side channel (GH_ERC) was not adversely affected by mine-related discharges. However, sediment quality in Reach 2 exhibits influence from the west-side tributaries (particularly Thompson Creek), having higher concentrations of arsenic, selenium, and some PAHs relative to Elk River stations (though typically still within the normal range).

7.5 Summary

Data collected in 2017, 2018, and 2019 furthered the understanding of study question #5: What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?

Benthic invertebrate community endpoints did not differ greatly between perennially-wetted main stem stations (GH_ER2 and GH_ERC), and side channel stations (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC). Abundance, richness, % EPT, % E, % P, and % T were within or above the normal range for main stem Elk River and side channel stations, with the exception of % P at GH_ERC. The community of Thompson Creek was different than the main stem Elk River and Elk River side channel stations, likely due to a combination of habitat and water quality differences.

Selenium concentrations in benthic invertebrate tissue from side channel stations were higher than main stem stations. Concentrations increased from upstream to downstream, from GH_ERSC4 (upstream of Wolfram Creek) to GH_ER1A and GH_ERSC5 (both downstream of Wolfram Creek) to Reach 2 (RG_GH-SCW2 and RG_GH-SCW3, immediately downstream of Thompson Creek). Further downstream in the side channel at stations GH_ERSC2 and RG_SCDTC, concentrations were similar to GH_ER1A and RG_ERSC5.

Benthic invertebrate community structure and tissue chemistry were similar at the downstream main stem station (GH_ERC) and the upstream main stem reference station (GH_ER2), suggesting minimal influence of GHO and the west-side tributaries on benthic invertebrate community endpoints and tissue chemistry in the main stem Elk River.

8 STUDY QUESTION #6

8.1 Overview

Data evaluated in this section pertain to study question #6: Is the mine-related influence on Reach 2[11] having an effect on aquatic-dependent biota (benthic invertebrates, fish, amphibians, and aquatic-feeding birds)?

Within the 2017 GHO LAEMP report, the area at the confluence of Thompson Creek and the Elk River side channel (Figure 7.1; herein referred to as Reach 2, but previously referred to as “the side channel wetland”) was identified as an area of particular concern, as it was one of the few areas of the side channel that remained wetted all year, and was the location with the highest concentrations of selenium in benthic invertebrate tissue (Minnow and Lotic 2018a). A recommendation was made to complete an in-depth assessment of the area and, as work was just initiating on the Lentic Area Supporting Study (Minnow 2018b), Teck integrated some of the assessment into that study and results were used to support the GHO LAEMP. Additional assessment was completed as part of monthly GHO LAEMP surveys and September sampling. Habitat surveys conducted in 2018 determined that Reach 2 was swiftly flowing from freshet until early summer (lotic), and therefore should not be considered a lentic area. Consequently, Reach 2 was removed from the Lentic Area Supporting Study in the 2019 study design (Minnow 2019). Under the GHO LAEMP in 2019, Reach 2 continued to be monitored for habitat conditions and biota (monthly), water quality (monthly), sediment quality (September), and benthic invertebrate tissue chemistry (September).

8.2 Habitat and Biota

Field surveys conducted in 2019 confirmed the habitat availability and presence of aquatic-dependent biota that were documented in 2017 and 2018. In January to May 2019 and then again from October to December 2019, Reach 2 was wetted and receiving water from Thompson Creek, while the rest of the side channel was predominantly dry (Section 3.2). In June 2019, Reach 2 was swiftly flowing and inaccessible (i.e., lotic; Section 3.2). In late July to September, there was still flow in the area, but not as swift or deep (Section 3.2). Over three years of study, Reach 2 was being used by fish (longnose sucker, mountain whitefish; Table 8.1), amphibians (Columbia spotted frog, long-toed salamander, western toad; Table 8.2), and birds (American bittern, bank swallow, belted kingfisher, Canada goose, common yellowthroat, killdeer, mallard, northern waterthrush, spotted sandpiper, wood duck; Table 8.3).

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[11] The area that has previously been referred to as the “side channel wetland” is herein called Reach 2, as it is not a true wetland (Minnow and Lotic 2019).

Table 8.1: GHO LAEMP Fish Observations in Reach 2, January 2018 to December 2019

Species	Number	Life Stage	Year	Month	Location	Easting	Northing
unidentified	<10	fry	2018	June	Reach 2	648385	5550197
MW	~30	fry	2018	July	Reach 2	648284	5550122
MW	5	fry	2018	July	Reach 2 (1st finger)	648284	5550168
unidentified	~30	fry	2018	July	Reach 2	648380	5550206
LSU	4	unknown	2018	August	Reach 2	648371	5550219
MW	2	unknown	2018	August	Reach 2	648371	5550219
MW	3	unknown	2018	August	Reach 2	648324	5550233
MW	3	unknown	2018	August	Reach 2	648325	5550229
MW	2	unknown	2018	August	Reach 2	648333	5550225
MW	1	unknown	2018	August	Reach 2	648345	5550226
MW	~50	fry	2018	August	Reach 2 (1st finger)	648303	5550163
MW [a]	125	fry	2018	September	Reach 2 (2nd finger)	648090	5550244
MW	20	fry	2019	August	Reach 2	648285	5550117

Note: MW = mountain whitefish. LSU = longnose sucker.

[a] The 125 MW were deceased and were found in the naturally dewatering area off of Reach 2.

Table 8.2: GHO LAEMP Amphibian Observations in Reach 2, May 2017 to December 2019

Observation	Number	Year	Month	Location	Easting	Northing
western toad	1	2017	July	Reach 2	-	-
Columbia spotted frog	1	2018	June	Reach 2	648373	5550161
western toad	1	2018	July	Reach 2	648325	5550044
western toad	1	2018	July	Reach 2 (2nd finger)	648112	5550281
western toad	1	2018	July	Reach 2	648167	5550274
western toad	1	2018	August	Reach 2 (2nd finger)	647955	5550282
long-toed salamander[a]	10	2018	September	Reach 2 (2nd finger)	648090	5550244

[a] The 10 salamanders (larva life stage) were found deceased in the naturally dewatering area off of Reach 2.

Table 8.3: GHO LAEMP Aquatic-dependent Bird Observations in Reach 2, May 2017 to December 2019

Observation	Number	Year	Month	Easting	Northing
American bittern	1	2018	June	648345	5550229
bank swallow	8	2018	June	648345	5550229
belted kingfisher	1	2018	June	648345	5550229
Canada goose	8	2018	June	648345	5550229
common yellowthroat	3	2018	June	648345	5550229
northern waterthrush	8	2018	June	648345	5550229
killdeer	1	2018	June	648290	5550004
male mallard	1	2018	June	647958	5550266
female mallard	1	2018	June	647958	5550266
American bittern	1	2018	June	648345	5550229
bank swallow	8	2018	June	648345	5550229
Canada goose	8	2018	June	648345	5550229
common yellowthroat	2	2018	June	648345	5550229
northern waterthrush	5	2018	June	648345	5550229
belted kingfisher	1	2018	June	648345	5550229
common yellowthroat	1	2018	June	648345	5550229
northern waterthrush	3	2018	June	648345	5550229
mallard	2	2019	May	648341	5550064
Canada goose	2	2019	May	648334	5550169
snipe	1	2019	June	648162	5549988
wood duck	1	2019	June	648239	5550210
wood duck	2	2019	June	648126	5550240
sandpiper	1	2019	August	648239	5550198

8.3 Water Quality

In 2019 at the Reach 2 outlet (RG_GH-SCW3), aqueous concentrations of TDS and sulphate were frequently above the BCWQG and/or EVWQP Level 1 benchmarks, while aqueous concentrations of nitrate and total selenium were frequently above the EVWQP Level 2 benchmarks. However, most water constituents with EWT were always or typically below BCWQG and/or EVWQP Level 1 benchmarks (Appendix Table C.5, Appendix Figures C.20 to C.38). At the Reach 2 inlet (RG_GH-SCW1), constituents with EWT were below BCWQG and/or EVWQP Level 1 benchmarks, with the occasional exception of dissolved cadmium (Appendix Table C.5, Appendix Figures C.20 to C.38). Total nickel was higher in Reach 2 in 2019 compared to 2018 (Appendix Table C.8, Appendix Figure C.28). For most constituents, concentrations were typically higher at the outlet of Reach 2 (RG_GH-SCW3) compared to the lotic side channel stations located upstream (GH_ER1A) and downstream (GH_ERSC2), likely due to the influence of surface water flows from Thompson Creek, and possibly through groundwater (Appendix Table C.5, Appendix Figures C.20 to C.38). Similar to 2018, in 2019 specific conductance was an order of magnitude higher at the Reach 2 outlet compared to the inlet except during times of high flow (June to August 2019; Appendix Tables B.6 and B.7). Temperature, dissolved oxygen, and pH were comparable between the inlet and outlet (Appendix Tables B.6 and B.7).

8.4 Sediment Quality

Sediment quality samples (five replicates) were collected in Reach 2 in September 2019 (Appendix Table G.3). Sediment quality in Reach 2 (RG_GH-SCW3) in 2019 was generally similar to 2018, as well as to the two main stem Elk River stations (both reference and mine exposed), but with higher concentrations of arsenic, chrysene, 2-methylnaphthalene, and selenium (Figure 7.10), likely as a result of inputs from Thompson Creek. Concentrations of arsenic, cadmium, manganese, nickel, selenium, naphthalene, and phenanthrene each exceeded the lower (or only, in the case of selenium) SQG in at least one of the five samples (Figure 7.10, Appendix Table G.3). In 2019, concentrations of parameters with SQGs were less than the upper SQG. Concentrations of constituents were within the normal range, except for arsenic in one of five samples and manganese in two of five samples (Figure 7.10, Appendix Table G.3). Manganese concentrations also exceeded the normal range at the upstream reference area (GH_ER2) in 2017 and 2018, suggesting the elevated concentrations in 2019 may not be mine-related. There were no obvious changes in sediment quality over time.

8.5 Benthic Invertebrate Tissue Chemistry

Three benthic invertebrate tissue samples were collected from Reach 2 in September 2017, 2018, and 2019 (Table 8.4). Selenium concentrations in two of three tissue samples collected in 2019 were within the normal range and were lower than concentrations measured in 2017 and 2018 (Table 8.4). In contrast, one of the three samples from 2019 had a selenium concentration that was roughly four-times higher than the average from 2017 and 2018, and which exceeded all EVWQP Level 3 benchmarks for benthic invertebrates and dietary effects to birds and juvenile fish (Table 8.4). This one sample may have had much higher selenium concentrations due to the presence of annelids (see Section 7.2). A single selenium speciation sample was collected in May 2019 at Thompson Creek (which contributes water directly to Reach 2, and is the main source of water in Reach 2 in late fall through early winter). The selenium speciation results for this sample indicate detectable concentrations of organoselenium species that could affect localized patterns of bioaccumulation within Reach 2 (Appendix Table C.2). Based on this, as well as on comparison of selenium concentrations in benthic invertebrate tissue to the EVWQP benchmarks, there is potential for localized adverse effects to fish, benthic invertebrates, and aquatic-dependent birds.

Table 8.4: Selenium Concentrations in Benthic Invertebrate Tissue from Reach 2

Analyte	**Units**	**Year**	**Reach 2 (RG_GH_SCW3)**		
			Sample 1	**Sample 2**	**Sample 3**
Selenium	µg/g dw	2017	17	12	13
		2018	12	8.9	16
		2019	55	7.6	7.3

⬜ Value > upper limit of normal range of selenium (7.79 mg/kg dw; Minnow 2018).
🟦 Value > EVWQP level 1 benchmark of 11 mg/kg dw for dietary effects of selenium to fish.
■ Value > EVWQP level 2 benchmark of 18 mg/kg dw for dietary effects of selenium to fish.
🟩 Value > EVWQP level 3 benchmark of 26 mg/kg dw for dietary effects of selenium to fish.
(41 mg/kg dw is the level 3 benchmark for dietary effects of selenium to birds.).

Note: For each level, the lowest benchmark is shown (i.e, most conservative benchmark of effects to benthic invertebrates, dietary effects to fish, and dietary effects to birds).

8.6 Summary

Data collected from 2017 to 2019 were evaluated to address study question #6 (Is the mine-related influence on Reach 2 having an effect on aquatic dependent biota [benthic invertebrates, fish, amphibians, and aquatic-feeding birds?]). Data confirmed that Reach 2 of the side channel provides habitat for fish, adult amphibians, and aquatic-dependent birds, but is not expected to provide optimal habitat for breeding amphibians. Aqueous concentrations of TDS and sulphate were frequently above the BCWQG and/or EVWQP Level 1 benchmarks, while aqueous concentrations of nitrate and total selenium were frequently above the EVWQP Level 2 benchmarks. However, most water constituents with EWT were typically below BCWQG and/or EVWQP Level 1 benchmarks. In 2019, concentrations of metals and PAHs in sediment were below the upper SQG. However, selenium concentration in one of three samples was above the only SQG. Selenium concentrations in sediment were either similar to the upstream reference or were within the normal range. Benthic invertebrate tissue selenium concentrations varied greatly, with two samples below Level 1 benchmarks and within the normal range, and one sample that was higher than EVWQP Level 3 benchmarks for benthic invertebrates and dietary effects to birds and juvenile fish. Based on comparison of selenium concentrations in benthic invertebrate tissue to the EVWQP benchmarks, there is potential for localized adverse effects to fish, benthic invertebrates, and aquatic-dependent birds due to the mine related influence on Reach 2.

9 INTEGRATED SUMMARY AND RECOMMENDATIONS

9.1 Summary

The 2019 GHO LAEMP focused on six study questions designed to address localized concerns downstream of the west spoil development and Cougar Pit extension at GHO. The GHO LAEMP focused on the Elk River (upstream and downstream of GHO), tributaries on the west side of the Greenhills Ridge, as well as a side channel of the Elk River that receives flows, via surface water and/or groundwater, from the mine influenced west-side tributaries (e.g., Thompson, Wolfram, and Leask creeks). The study questions focused on characterization and understanding of hydrology, water quality, habitat quality/availability, and benthic invertebrate community structure and tissue chemistry.

Hydrology data collected from 2017 to 2019 answered study question #1 (What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?). The Elk River side channel was observed to undergo seasonal flooding and braiding, with variable flow throughout the year, which was generally consistent from 2017 to 2019. Flows in the main stem Elk River and flows in the Elk River side channel were strongly correlated, except for Reach 2, which remained wetted throughout the year predominantly due to overland flows from Thompson Creek. The side channel was fully wetted for three to four months of each study year. Water from the main stem Elk River flowed overland into the side channel from freshet until winter, during which time, stream flow decreased in the main stem Elk River. Stream flow was lowest in the main stem Elk River from winter until freshet after which the side channel became disconnected from the main stem Elk River and Reach 1 (the downstream end of the side channel) and Reach 3 (the upstream end of the side channel) slowly dried. Isolated pools were documented as drying occurred, but typically persisted for less than three months. Most pools were stagnant water that remained as the side channel dewatered, but two were identified as groundwater-fed and an additional two were identified as possibly groundwater fed.

Within the side channel and its floodplain complex, over thirty multi-day field visits were completed in all seasons from 2017 to 2019 to identify and document habitat and occurrences of aquatic-dependent biota. These data were used to answer study question #2 (What is the seasonal habitat availability for aquatic-dependent biota [i.e., fish, amphibians, and aquatic-feeding birds] in the Elk River side channel?). The results were generally consistent over the three years of study. Seasonal changes in flow (described above) affected habitat availability (e.g., lentic habitat was only observed in fall and winter, and only in Reach 2). The Elk River side channel had limited potential breeding habitat for amphibians, as much of the side channel and floodplain complex were flooded and swiftly flowing in the spring and early summer. However, breeding habitat may be present elsewhere in the areas, and several amphibians (Columbia spotted frog, western toad, long-toed salamander) were observed throughout the side channel in late spring and summer. Suitable habitat was available for all life stages of fish and aquatic-dependent birds in the side channel and floodplain complex from spring through fall, as well as in Reach 2 during winter. The side channel was being used by a variety of fish (bull trout, eastern brook trout, longnose sucker, mountain whitefish, and westslope cutthroat trout) and birds (American bittern, American dipper, bald eagle, bank swallow, belted kingfisher, blue heron, Canada goose, common yellowthroat, killdeer, northern waterthrush, spotted sandpiper, mallard).

Water quality data were assessed for stations in the west-side tributaries, the main stem Elk River, Elk River side channel, and isolated pools to address study question #3 (What is the influence of the GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?). Water quality at side channel stations GH_ER1A and GH_ERSC2 was influenced by Wolfram and Thompson creeks. Concentrations of constituents were typically lower at the side channel station GH_ERSC4, located upstream of Wolfram and Thompson creeks, compared to the two downstream stations. Within the side channel and main stem Elk River, the highest concentrations of constituents generally occurred in Reach 2 (RG_GH-SCW3), which receives flow directly from Thompson Creek. Water quality in isolated pools was highly dependent on location, with the highest concentrations of constituents generally occurring in pools downstream of Reach 2. Water quality indicated that most of the isolated pools were stagnant water that remained after the side channel dewatered, except at least two to four of the pools, which were identified as groundwater-fed. Discharges from the west-side tributaries contributed to higher concentrations of some mine-related constituents in the main stem Elk River (GH_ERC) downstream of GHO relative to the upstream reference; however, with the exception of selenium, concentrations measured at GH_ERC were typically below benchmarks, screening values, and/or BCWQG, or were comparable to the upstream reference. These general water quality results were consistent from 2017 to 2019. At the downstream main stem Elk River station (GH_ERC), total selenium concentrations increased in 2018 and 2019, and nitrate concentrations increased in 2019, as compared to previous years. At the Reach 2 outlet, total nickel concentrations were higher in 2019 compared to 2018. For the west-side tributaries, total selenium, sulphate, and TDS have been increasing in Leask and Wolfram creeks, while total nickel has been increasing in Leask Creek. In Thompson Creek, sulphate has increased in recent years, whereas total nickel has decreased.

To answer study question #4 (What is the interaction between surface water and groundwater in the Elk River side channel?), a hydrogeological review and analysis of available groundwater and surface water data was conducted by SNC Lavalin in 2020 using data from the west side of GHO along the Elk River side channel. The data review indicated that side channel surface water predominantly infiltrated to ground and recharged groundwater. Localized areas of groundwater discharge appeared to occur near the confluence with Wolfram Creek as well as downstream of Thompson Creek, creating at least two of the isolated pools that persisted when the side channel was otherwise dry. These discharge areas did not result in sustained flows within the side channel. Gaps and uncertainties were identified.

Benthic invertebrate community data collected in 2017, 2018, and 2019 furthered the understanding of study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?). Benthic invertebrate community endpoints did not differ greatly between perennially-wetted main stem stations (GH_ER2 and GH_ERC), and side channel stations (GH_ERSC4, GH_ER1A, RG_ERSC5, and RG_SCDTC). In 2019, benthic invertebrate community metrics that had normal ranges were within or above the normal range for main stem Elk River and side channel stations, except for % T at RG_SCDTC in one of three samples and % P at GH_ERC in one of three samples. Similarly low proportions of % T and % P were measured at reference station GH_ER2 in previous years. Overall, benthic invertebrate communities in the main stem Elk River and the Elk River side channel did not appear to be adversely affected by mine related discharges.

Benthic invertebrate tissue chemistry (selenium) data were collected in 2017, 2018, and 2019 and also furthered the understanding of study question #5. Selenium concentrations in benthic invertebrates at the downstream main stem Elk River station (GH_ERC) were similar to concentrations at the upstream reference station (GH_ER2). Within the side channel, selenium concentrations in benthic invertebrates increased from GH_ERSC4 (upstream of Wolfram Creek) and GH_ER1A (downstream of Wolfram Creek) to GH_ERSC5 (downstream of GH_ER1A) to Reach 2 (RG_GH-SCW3, immediately downstream of Thompson Creek). Further downstream in the side channel at stations GH_ERSC2 and RG_SCDTC, concentrations were similar to GH_ER1A. Some benthic invertebrate tissue samples collected in 2019 from RG_THCK (all three samples) and RG_GH-SCW3 (one out of three samples) were above the EVWQP Level 3 selenium benchmarks for either benthic invertebrates, dietary effects to juvenile fish, and/or dietary effects to birds. Selenium concentrations in benthic invertebrate tissue collected in 2019 from RG_ERSC5 and GH_ERSC2 were higher than the EVWQP Level 1 dietary benchmark for fish in one of three replicates from each area, whereas all other 2019 samples were below the Level 1 benchmarks. Elevated concentrations of selenium in benthic invertebrate tissue may have resulted from the presence of annelids in samples, and/or due to aqueous selenium being present in more bioavailable forms.

In support of study question #5 to better understand potential mine-related effects on benthic invertebrate communities and tissue chemistry, sediment quality was assessed in the main stem Elk River upstream and downstream of the side channel, and in Reach 2 of the side channel. Except for arsenic in one of five samples collected at Reach 2 and manganese in two of five samples each from Reach 2 and GH_ERC, concentrations of constituents were within the normal range. Concentrations of constituents were below the upper (or only in the case of selenium) SQG in all samples from 2019, except for selenium in Reach 2. In general, sediment quality data indicated limited influence of mine-related discharges on sediment chemistry in the main stem Elk River downstream of the side channel.

Habitat characterization, biota observations, water quality, sediment quality, and benthic invertebrate tissue chemistry data collected from Reach 2 in 2017 to 2019 for the GHO LAEMP addressed study question #6 (Is the mine-related influence on Reach 2 having an effect on aquatic dependent biota [benthic invertebrates, fish, amphibians, and aquatic-feeding birds]?). An FHAP survey and monthly surveys confirmed that Reach 2 provides some habitat for fish, adult amphibians, and aquatic-dependent birds, but does it is not expected to provide optimal habitat for breeding amphibians (due to swiftly flowing water during the breeding season). Most water quality constituents were below BCWQG, EVWQP Level 1 benchmarks, and/or interim screening values. Aqueous concentrations of TDS and sulphate were frequently above the BCWQG and/or EVWQP Level 1 benchmarks, while concentrations of nitrate and total selenium were frequently above the EVWQP Level 2 benchmarks. In sediment at Reach 2, concentrations of constituents were below the upper SQG (or only for selenium), except for selenium. Concentrations were either similar to the upstream reference or were within the normal range. Benthic invertebrate tissue selenium concentrations varied greatly, with two samples below all EVWQP Level 1 benchmarks, and one sample higher than the EVWQP Level 3 benchmarks for benthic invertebrates and dietary effects to birds and juvenile fish. The data for Reach 2 indicate potential for localized exposure to elevated dietary selenium to fish, amphibians, and aquatic feeding birds.

9.2 Recommendations

Based on findings of the GHO LAEMP to 2019, the following amendments are recommended for the 2018 to 2020 GHO LAEMP study design.

Study question #1: What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?

Recommendation: do no further work on study question #1 (What is the relationship between flows in the main stem Elk River and flows [including connectivity, intermittence, and pools] in the Elk River side channel?).

Rationale: the seasonality of wet and dry areas and the formation of isolated pools in the Elk River side channel, as well as the relationship between flows in the side channel and the main stem Elk River have been documented monthly over three years. The data have answered the study question; the side channel flow is predominantly influenced by the Elk River itself, rather than the tributaries, except for Reach 2 at the mouth of Thompson Creek.

Study question #2: What is the seasonal habitat availability for aquatic dependent biota (i.e., fish, amphibians, and aquatic feeding birds) in the Elk River side channel?

Recommendation: re-word study question #2 and cease monthly documentation of habitat and biota observations. Suggested rewording to "What is the seasonal habitat availability for amphibians in Reach 2 of the Elk River side channel?".

Rationale: The habitat of the Elk River side channel and observations of biota in the side channel were documented over three years, during over 30 field visits that occurred in all seasons. The seasonal habitat availability and use by aquatic-dependent biota has been demonstrated. Surveys of aquatic-dependent biota from 2017 to 2019 determined that the side channel was being used by a variety of fish, amphibians, and birds. Additional years of surveys would not further the understanding of how mine-related discharges might affect seasonal habitat availability for aquatic-dependent biota. Uncertainties regarding amphibian use of Reach 2 have been identified, as larval long-toed salamanders were found in a dry 'finger' of the side channel in this area in 2018, suggesting the area may have amphibian breeding habitat that has been previously undiscovered, perhaps due to accessibility issues. To reflect these findings and uncertainties, it is recommended that study question #2 is reworded to: "What is the seasonal habitat availability for amphibians in Reach 2 of the Elk River side channel?". Additional amphibian surveys will be conducted in 2020, consistent with the methods used in the amphibian distribution and occurrence study, timed to target three life stages from May through August to document egg, larval, and adult life stages for species found in the Elk Valley.

Study question #3: What is the influence of the GHO discharges from the west-side tributaries on water quality in the Elk River and Elk River side channel?

Recommendation: continue to monitor water quality in the west-side tributaries, Elk River side channel (including Reach 2), and the main stem Elk River, in support of study question #3a, #3b, and #3c, but do no further work on study question #3d (water quality of isolated pools of the Elk River side channel).

Rationale: Three years of study have determined that isolated pools provide relatively limited habitat, as pools typically persisted for less than a month, had small surface areas, and were shallow. The water quality of most isolated pools was determined by side channel water quality because isolated pools were formed by water that persisted as the side channel dried. Side channel water quality will continue to be monitored under study question #3b. Water quality indicated that a few of the isolated pools were localized areas of groundwater discharge, occurring near the confluence with Wolfram Creek (SC3-P13) and downstream of Thompson Creek (SC2-P3, SC2-P1 and SC2-P2). Groundwater quality will continue to be monitored under groundwater programs outside of the GHO LAEMP.

Recommendation: collect selenium speciation water quality samples concurrent with September benthic invertebrate tissues samples at Elk River side channel and Thompson Creek stations.

Rationale: The concentrations of selenium in benthic invertebrate tissue was higher than EVWQP benchmarks at some stations, and concentrations were typically above the concentrations predicted by the selenium bioaccumulation model based on total aqueous selenium concentrations. Selenium speciation water quality samples will support the interpretation of selenium bioavailability and assist in understanding possible causes of these elevated concentrations.

Study question #4: What is the interaction between surface water and groundwater in the Elk River side channel?

Recommendation: continue to assess the interaction between surface water and groundwater to address study question #4.

Rationale: The current data have provided a high-level characterization of surface water-groundwater interactions in the side channel: the side channel surface water predominantly infiltrated to ground and recharged groundwater. Localized areas of groundwater discharge appeared to occur near the confluence with Wolfram Creek as well as downstream of Thompson Creek, creating four of the isolated pools that persisted when the side channel was otherwise dry. These pools were shallow, and either typically covered small surface areas or only persisted for two months. The objective of study question #4 was to address data gaps and uncertainties associated with groundwater–surface water interaction along the Elk River side channel. The interaction has been generally characterized. Remaining gaps that were identified will be addressed by improving the monitoring well network with new well installations in 2020 and collection of additional groundwater data. This will occur as part of other on-going programs, such as the SSGMP, the RGMP, the CPX2, and the MBI Program. Data from these projects will continue to be pulled together to address study question #4 in an annually updated hydrogeological review and analysis of available groundwater and surface water data.

Study question #5: What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?

Recommendation: continue to monitor benthic invertebrate community, benthic invertebrate tissue chemistry, and supporting data (i.e., habitat data, calcite index, and, for some areas, sediment quality) to address study question #5.

Rationale: Similar to rationale for inclusion in the RAEMP, evaluation of benthic invertebrate community characteristics and tissue chemistry are important components for assessing potential mine-related effects on the aquatic ecosystem.

Study question #6: Is the mine-related influence on Reach 2[12] having an effect on aquatic dependent biota (benthic invertebrates, fish, amphibians, and aquatic-feeding birds)?

Recommendation: remove study question #6 to reduce redundancy in reporting, while continuing to monitor Reach 2 water quality (monthly), Reach 2 sediment quality (September), and Reach 2 benthic invertebrate tissue chemistry (September).

Rationale: within the 2018 GHO LAEMP and this current 2019 GHO LAEMP, reporting of Reach 2 data has been repetitive, with results first presented under study questions #2, #3, and #5, and then the same results summarized again under study question #6. To reduce the redundancy, it is recommended that study question #6 is removed, and Reach 2 data are assessed within the context of the rest of the side channel, as follows:

- Water quality will continue to be assessed under study question #3b (What is the water quality at monitoring stations in the Elk River side channel, is it changing over time, and how does it compare to water quality in the main stem Elk River?) and study question #4 (What is the interaction between surface water and groundwater in the Elk River side channel?).
- Sediment quality and benthic invertebrate tissue chemistry will continue to be assessed under study question #5 (What are the benthic invertebrate community structures and tissue chemistry in the Elk River side channel and the main stem Elk River upstream and downstream of the side channel, and are they changing over time?).

Amendment

An amendment request to the 2020 study design will be provided to ENV by June 1, 2020, including EMC input and Teck responses. Field monitoring is currently being conducted in

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[12] The area that has previously been referred to as the “side channel wetland” is herein called Reach 2, as it is not a true wetland (see Section 8 and Minnow and Lotic 2019).

accordance with the 2018 to 2020 study design, and changes recommended above will not be implemented until written confirmation has been received from ENV. The GHO LAEMP 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 or other existing monitoring programs, as appropriate.

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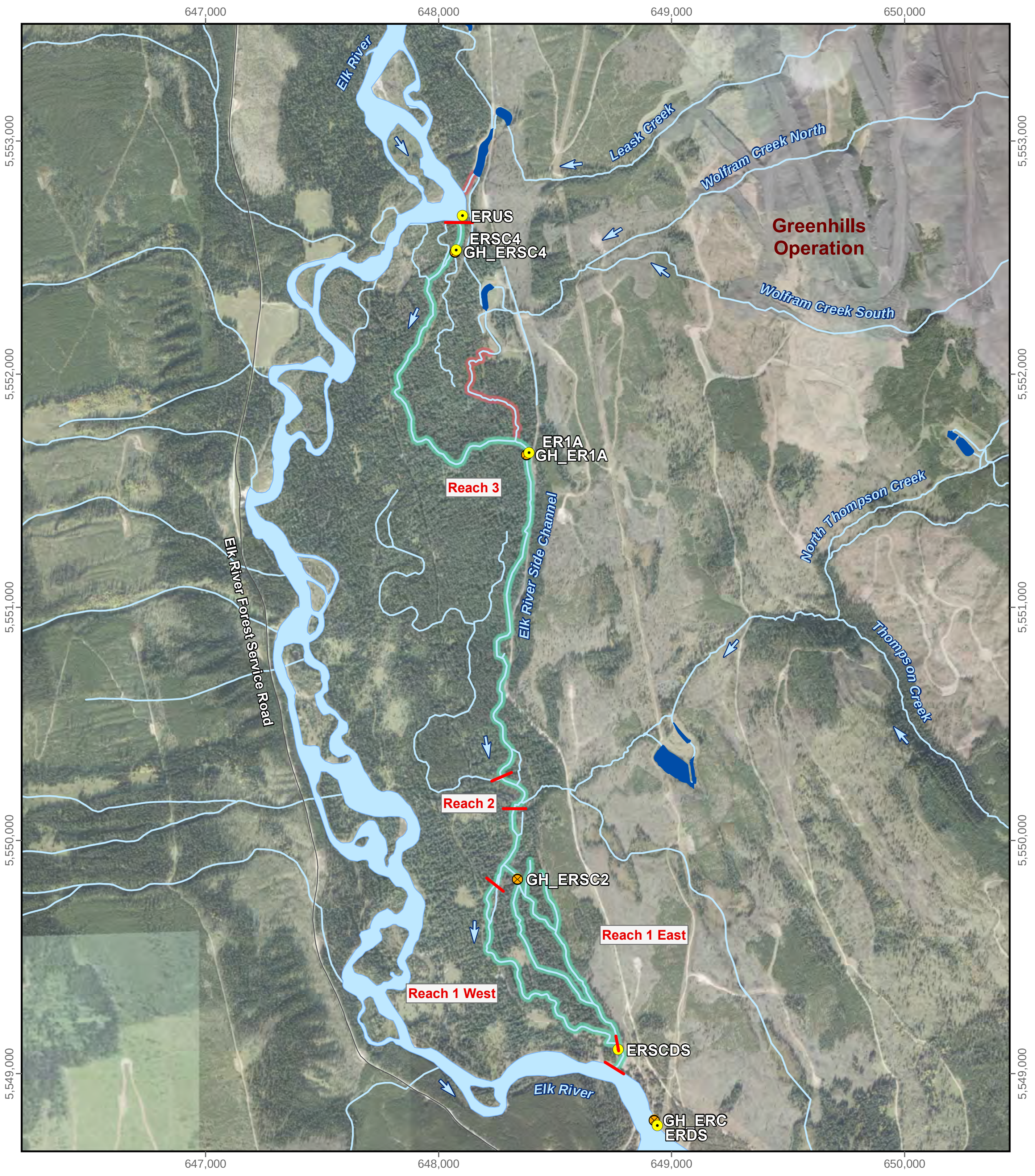
APPENDIX A
HYDROLOGY



LEGEND

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

Elk River Side Channel Wet and Dry Locations, May to July 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

Datum: NAD 83 Map Projection: UTM Zone 11N
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N W E S

Date: May 2020
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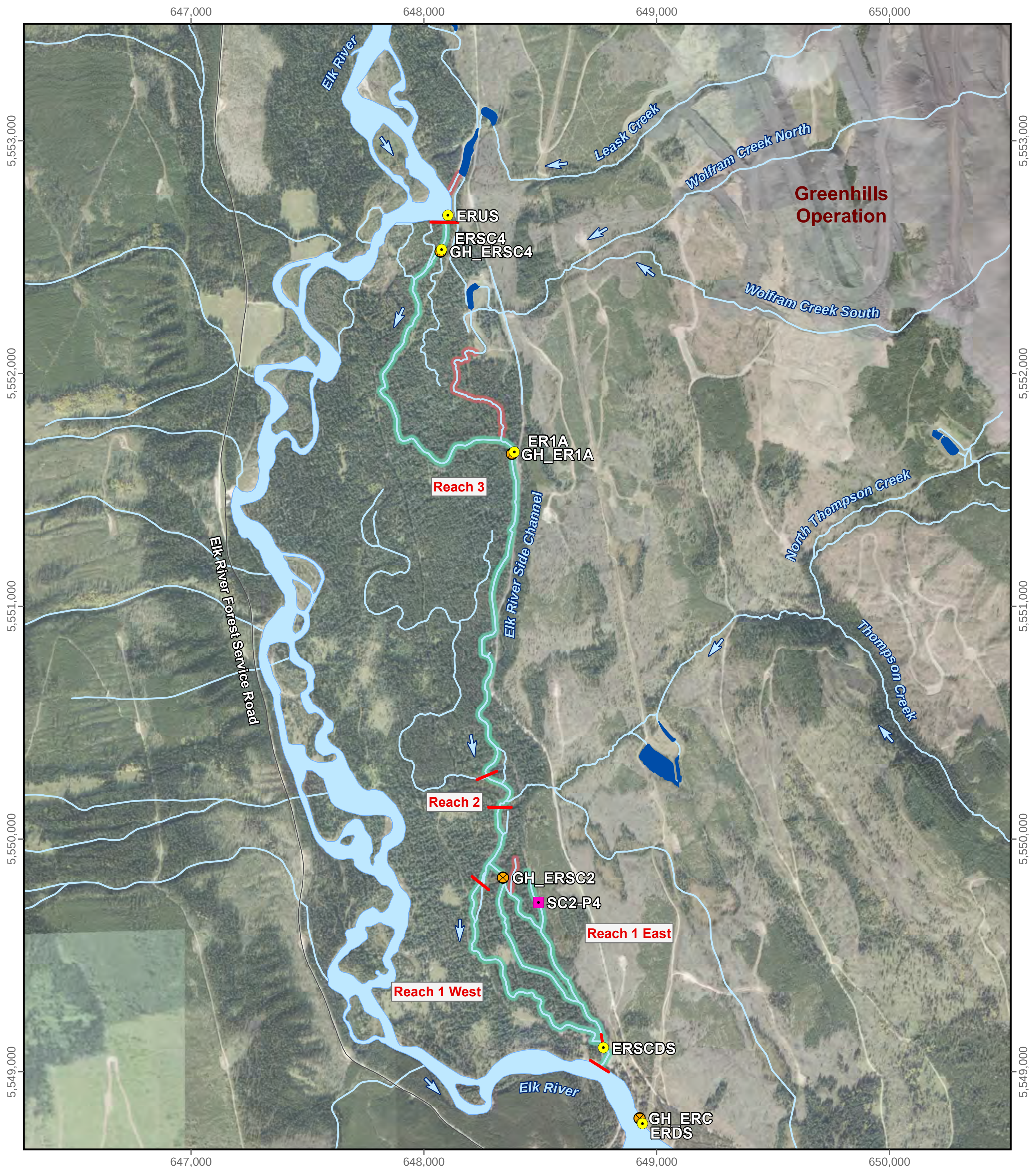
Figure A.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, August 2017 (Minnow and Lotic 2018a)

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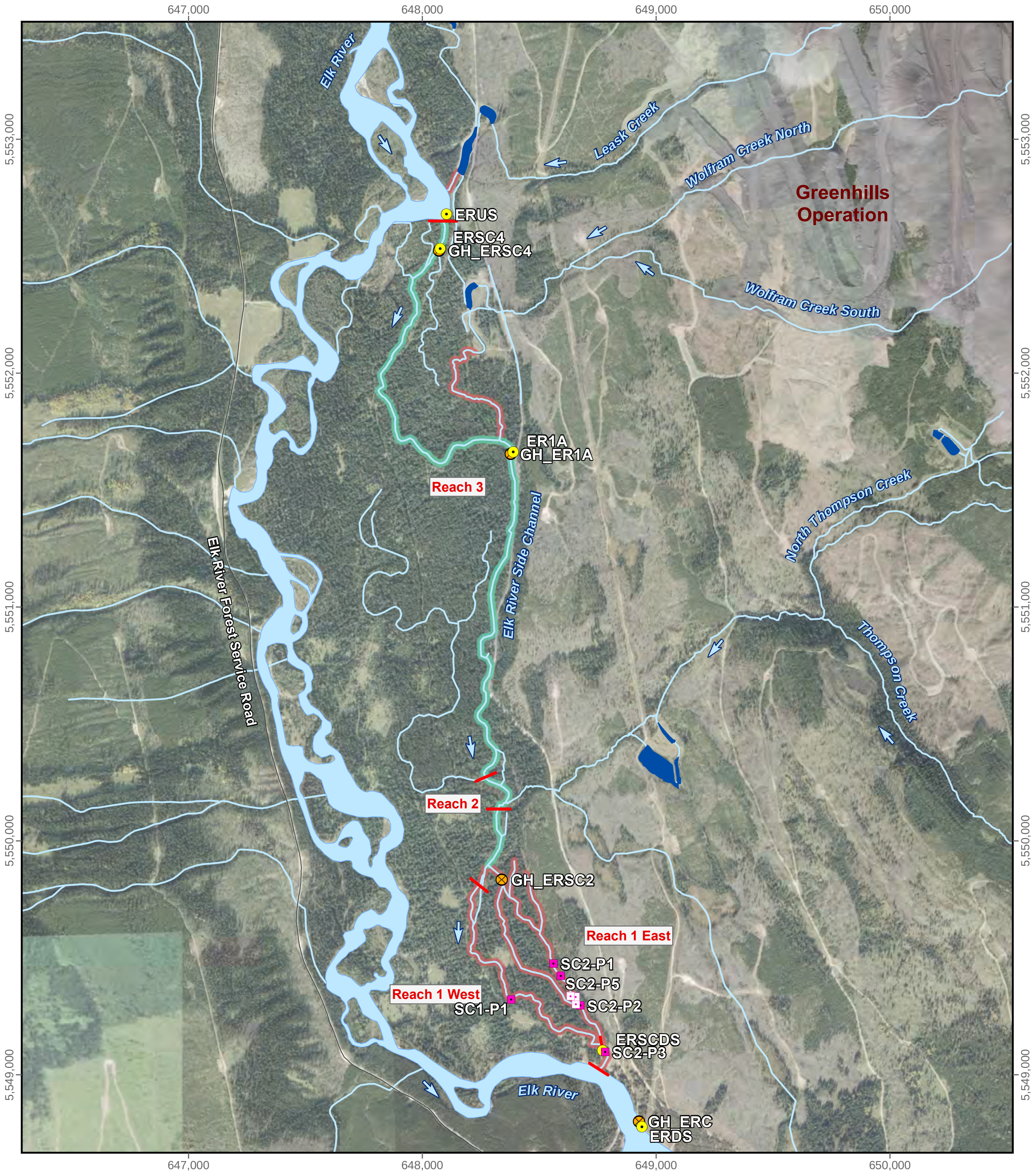
Figure A.2

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- ▬ Dry channel
- ▬ Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, September 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N
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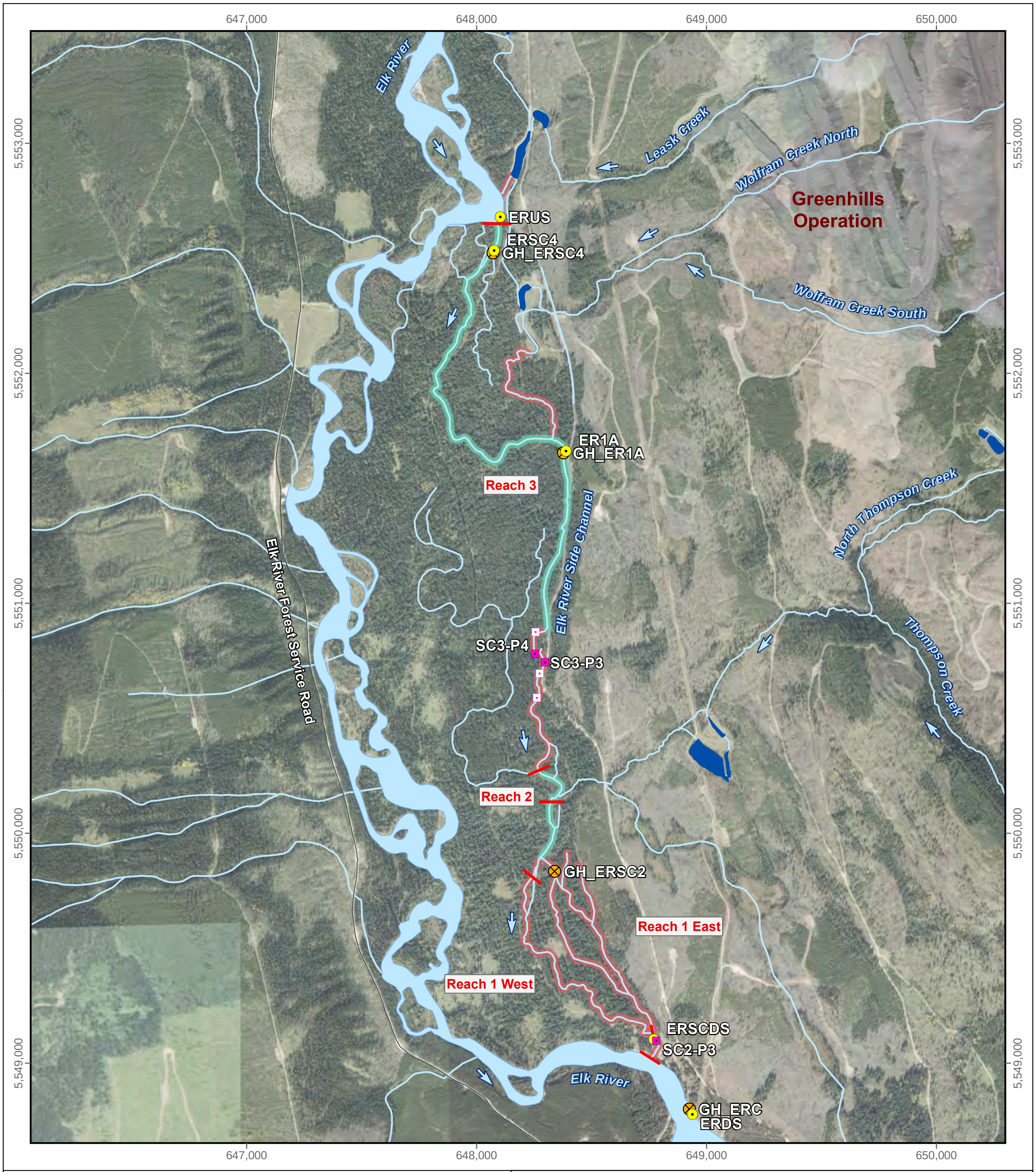
Figure A.3

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, October 2017 (Minnow and Lotic 2018a)

0 0.4 0.8 1.6 km

Datum: NAD 83 Map Projection: UTM Zone 11N
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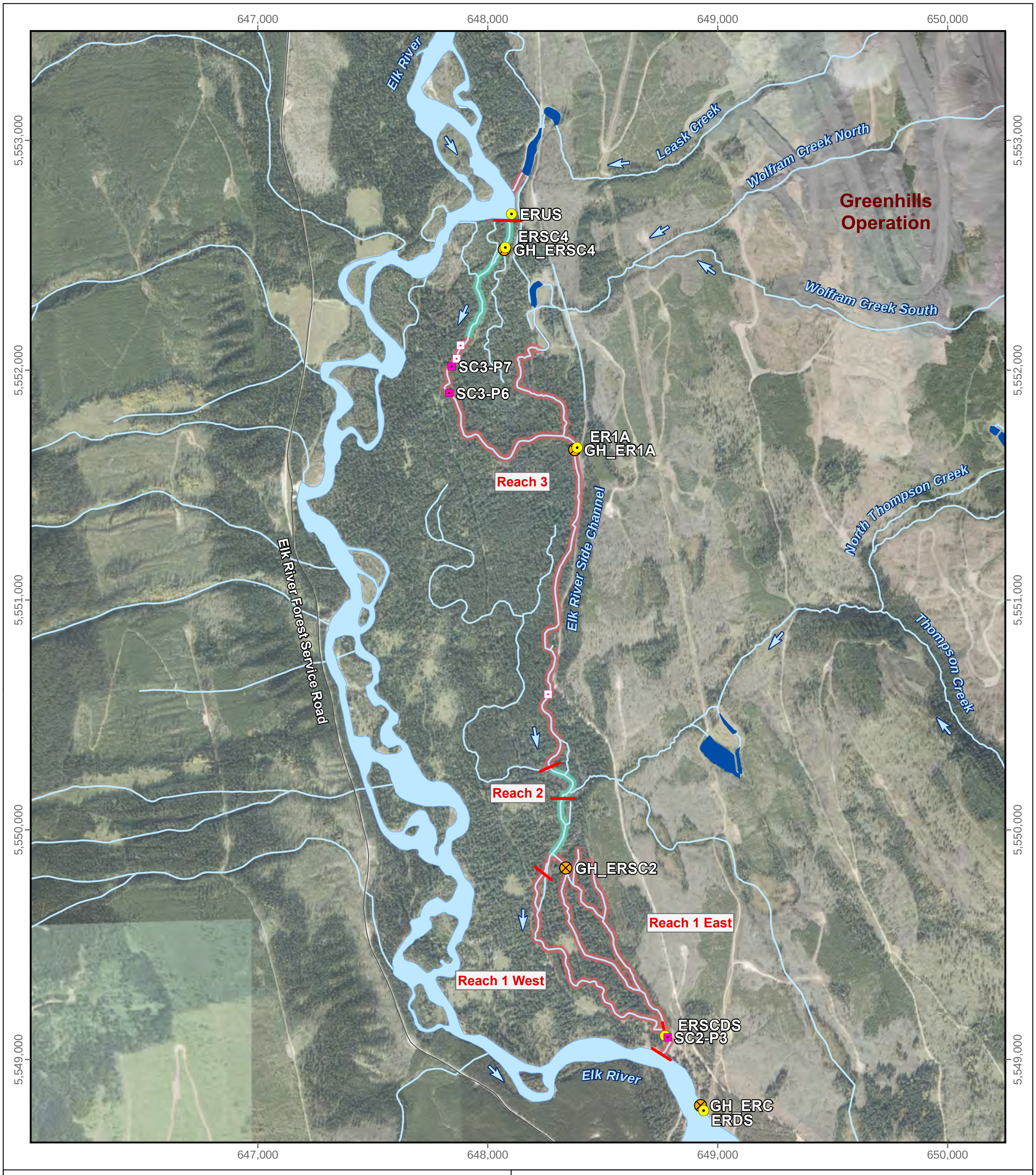
Figure A.4

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- 🟥 Dry channel
- 🟩 Wetted channel
- 🟦 Settling pond

Elk River Side Channel Wet and Dry Locations, November 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N
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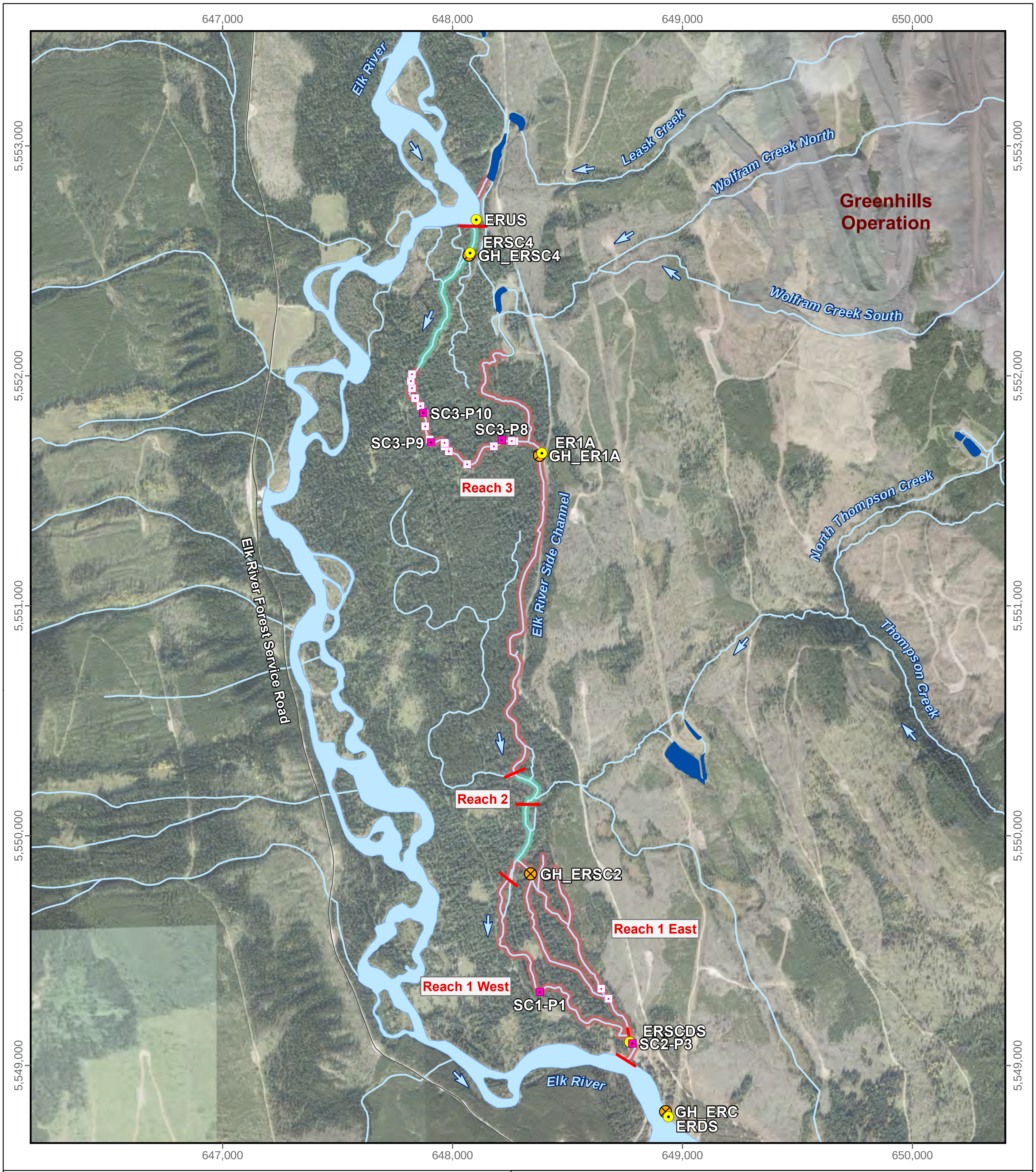
Figure A.5

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.5 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, December 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N E S W

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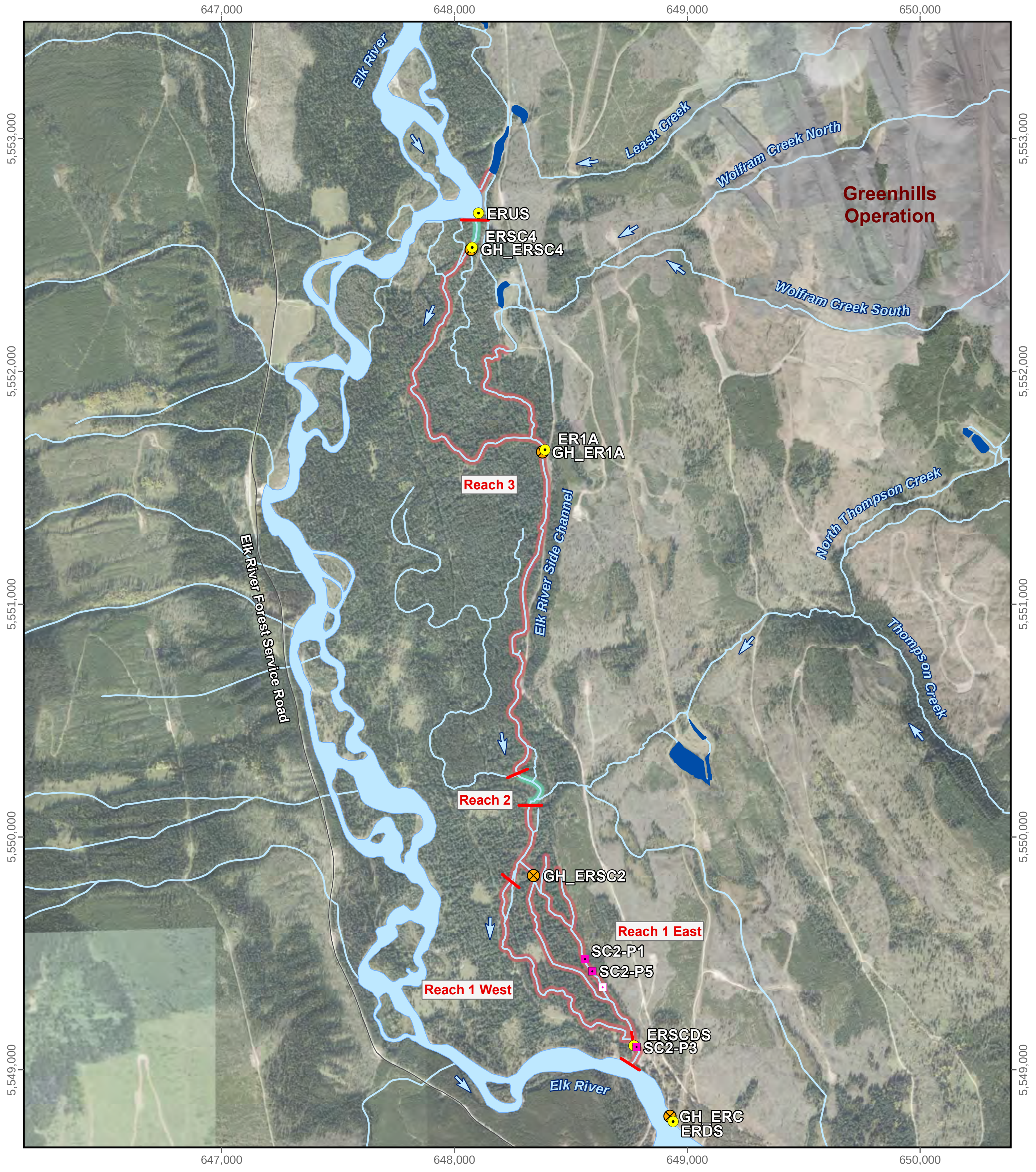
Figure A.6

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, January 2018 (Minnow and Lotic 2018a)

0 0.4 0.8 1.6 km

N E S W

Datum: NAD 83 Map Projection: UTM Zone 11N
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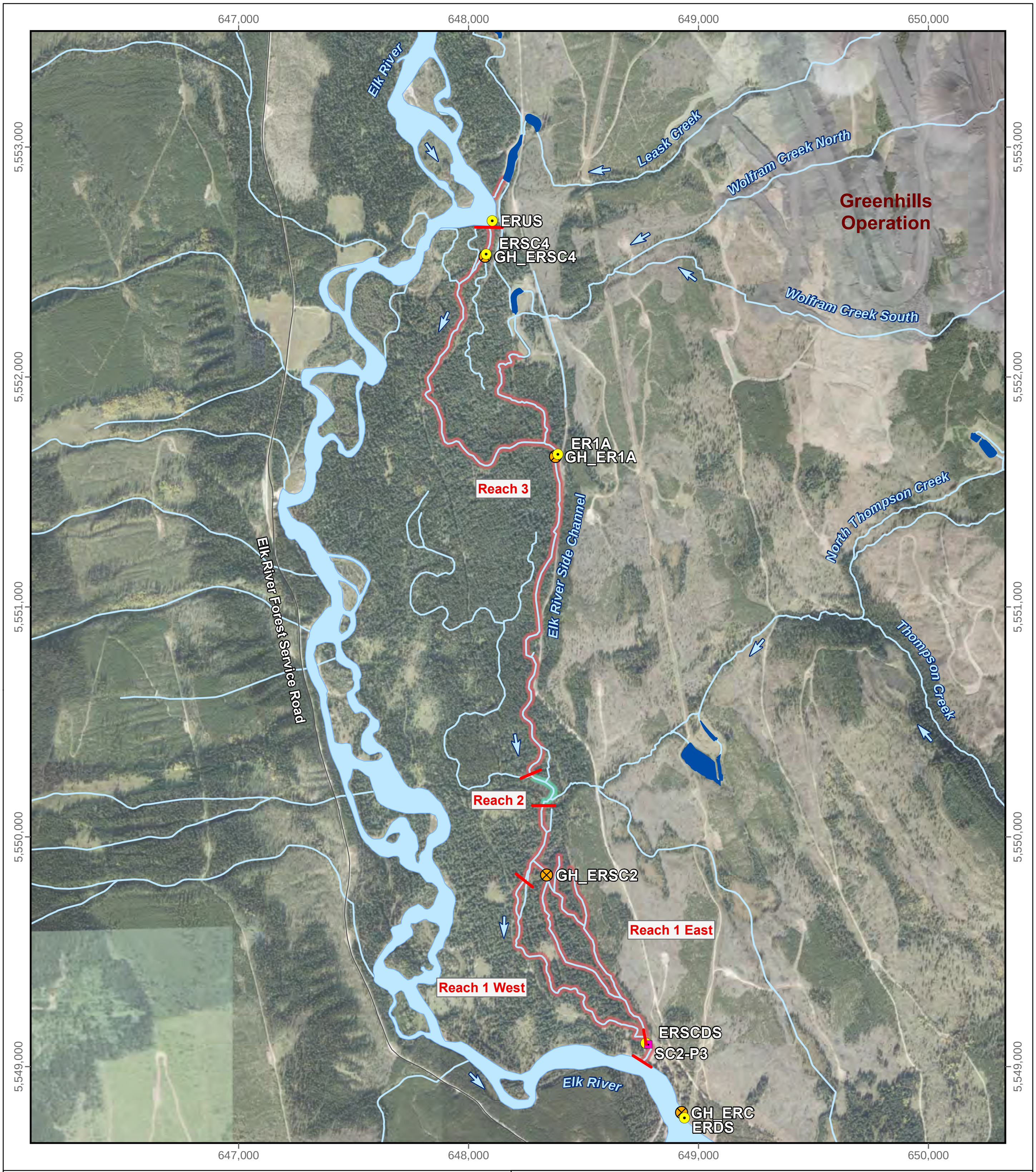
Figure A.7

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.7 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
- ━ Dry channel
- ━ Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, February to March 2018 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

Datum: NAD 83 Map Projection: UTM Zone 11N
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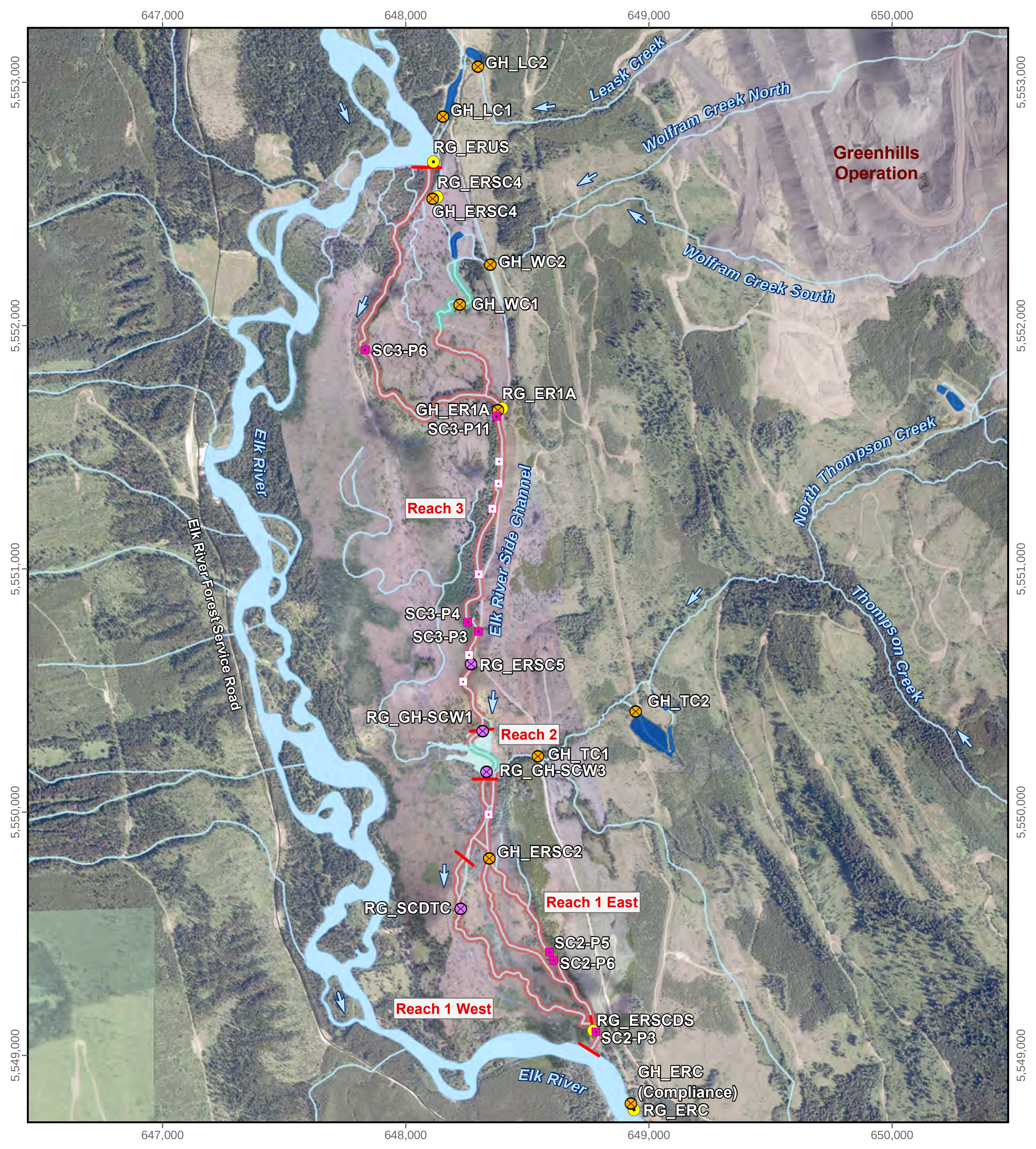
Figure A.8



LEGEND

■ Pool, Water Quality Sampling

□ Pool

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

● Staff Gauge Location

— Reach Break

— Dry Channel

— Wetted Channel

▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, April 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.9

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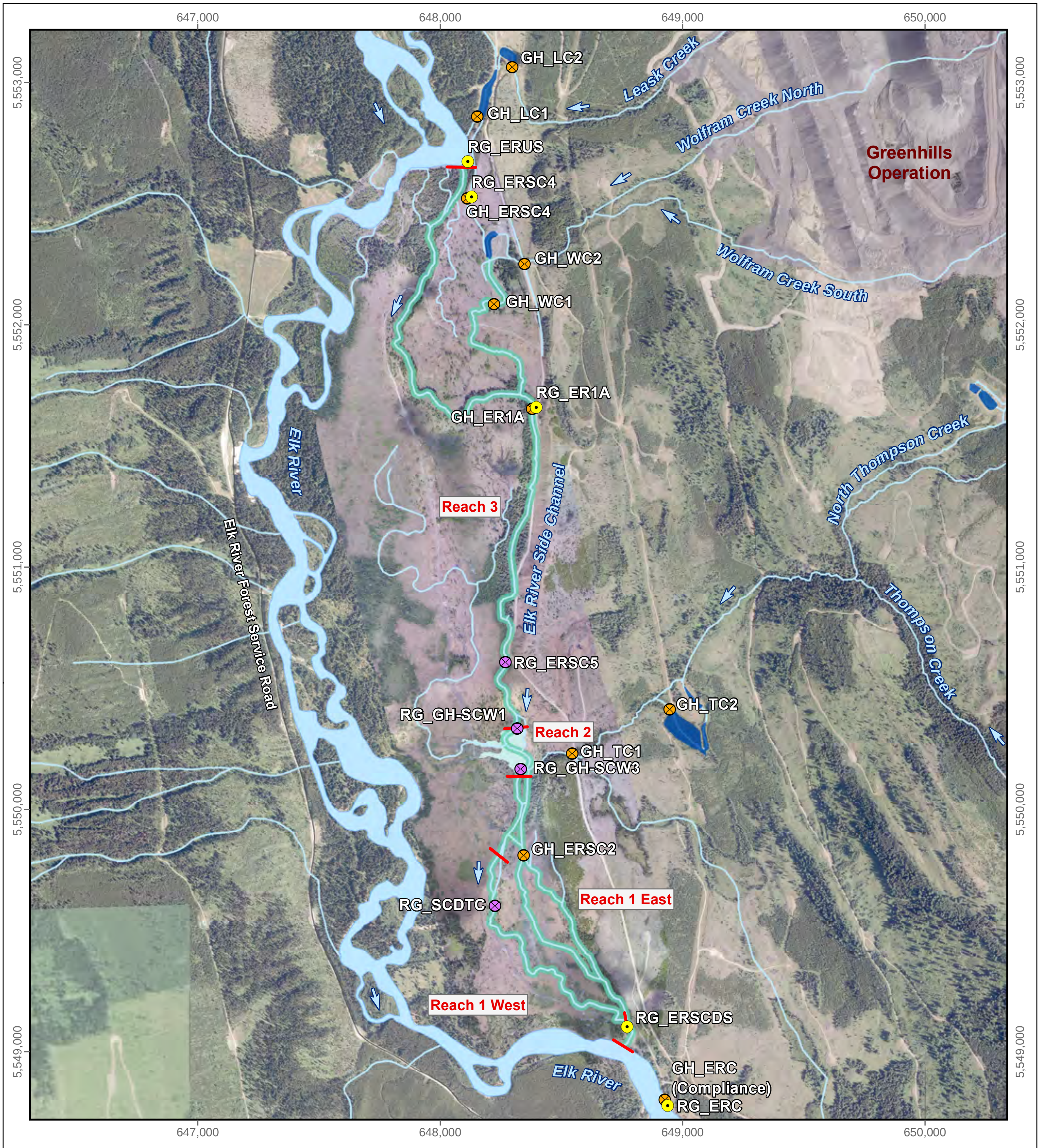

LEGEND

⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
⊙	Staff Gauge Location
🟥	Reach Break
▬	Dry Channel
▬	Wetted Channel
🟦	Settling Pond

Elk River Side Channel Wet and Dry Locations, May 2018 (Minnow and Lotic 2019)

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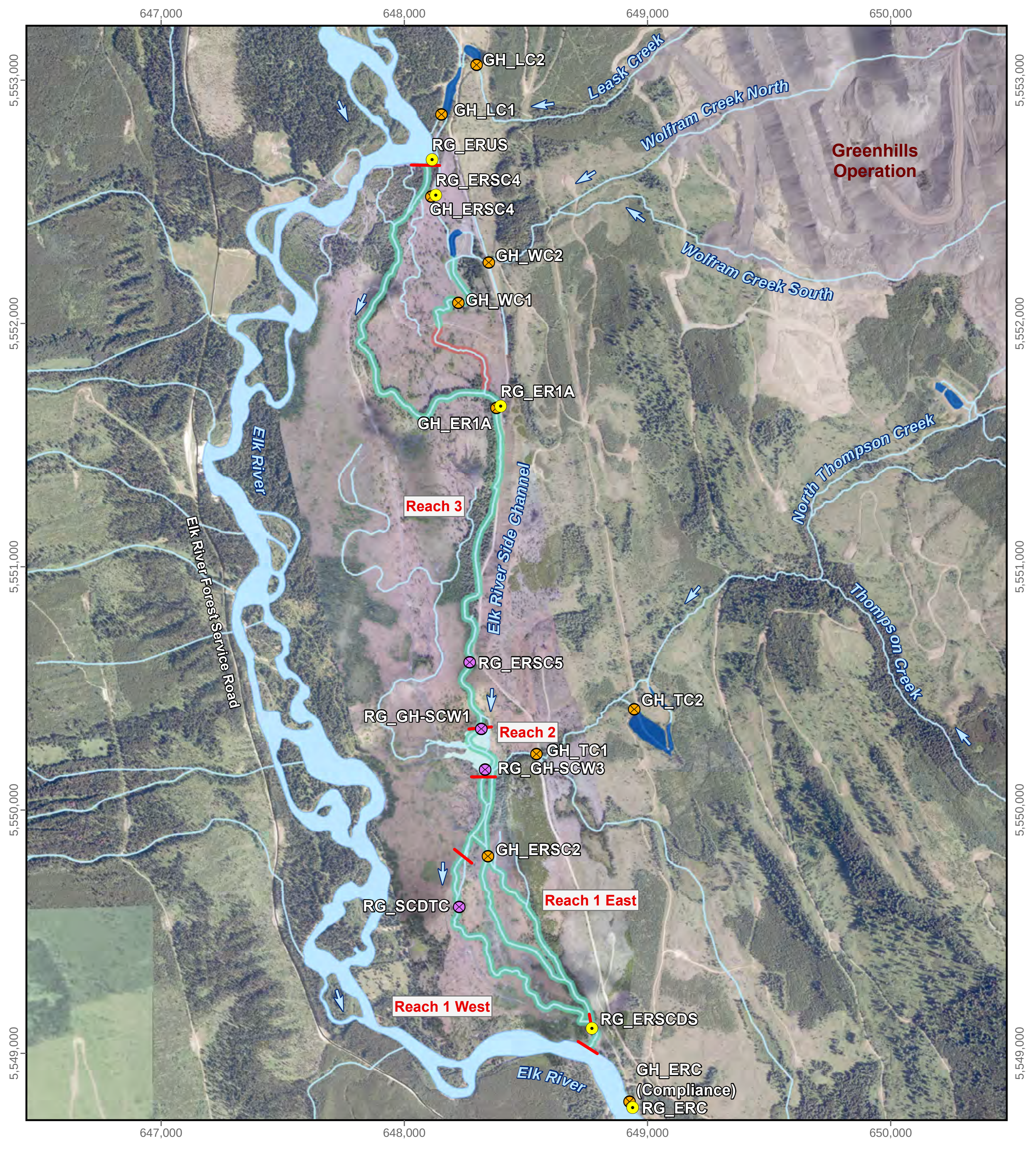
Figure A.10



LEGEND

- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ▬ Reach Break
- ▬ Dry Channel
- ▬ Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, June 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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Figure A.11

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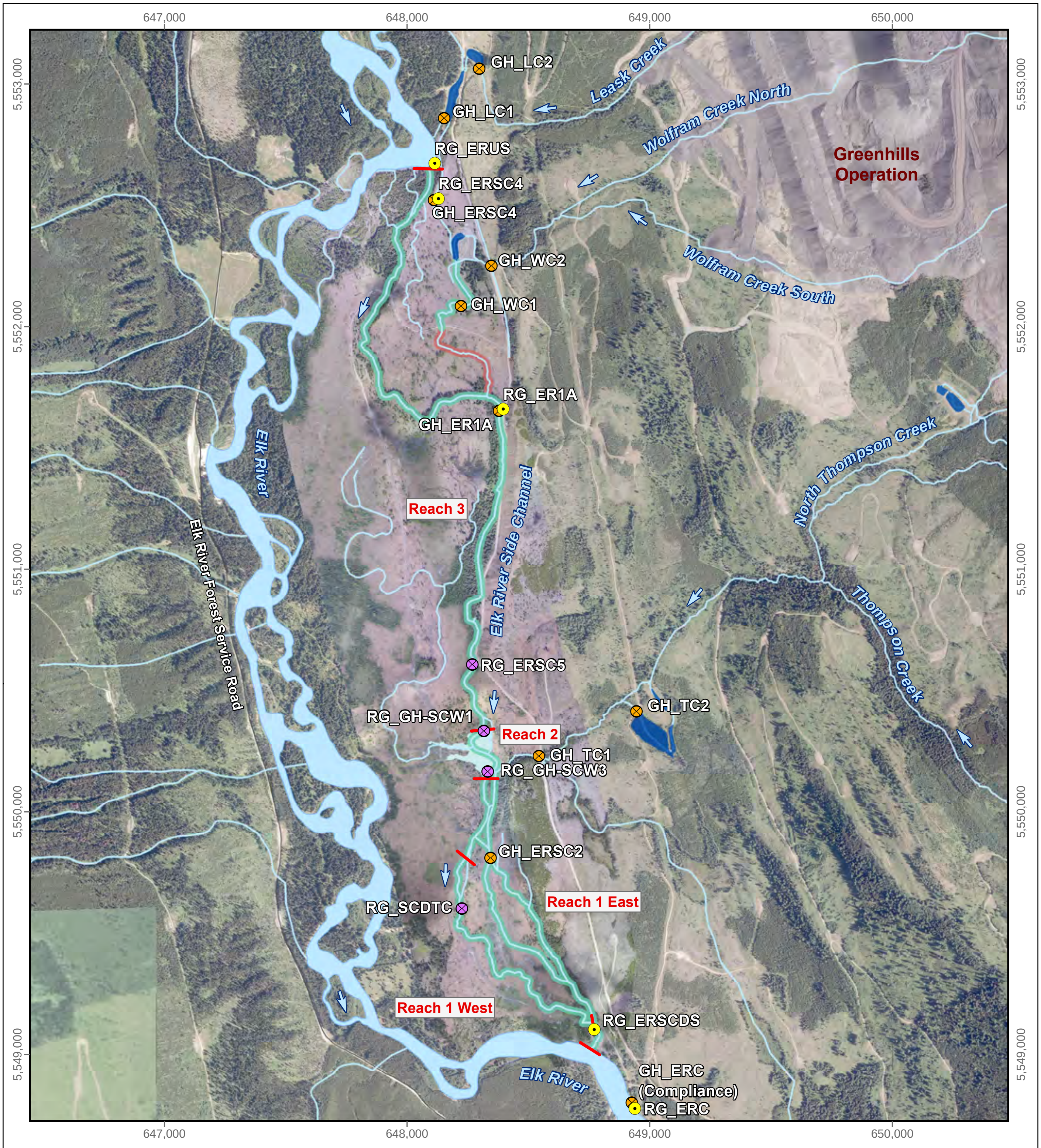

LEGEND

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

⊙ Staff Gauge Location

— Reach Break

— Dry Channel

— Wetted Channel

🟦 Settling Pond

Elk River Side Channel Wet and Dry Locations, July 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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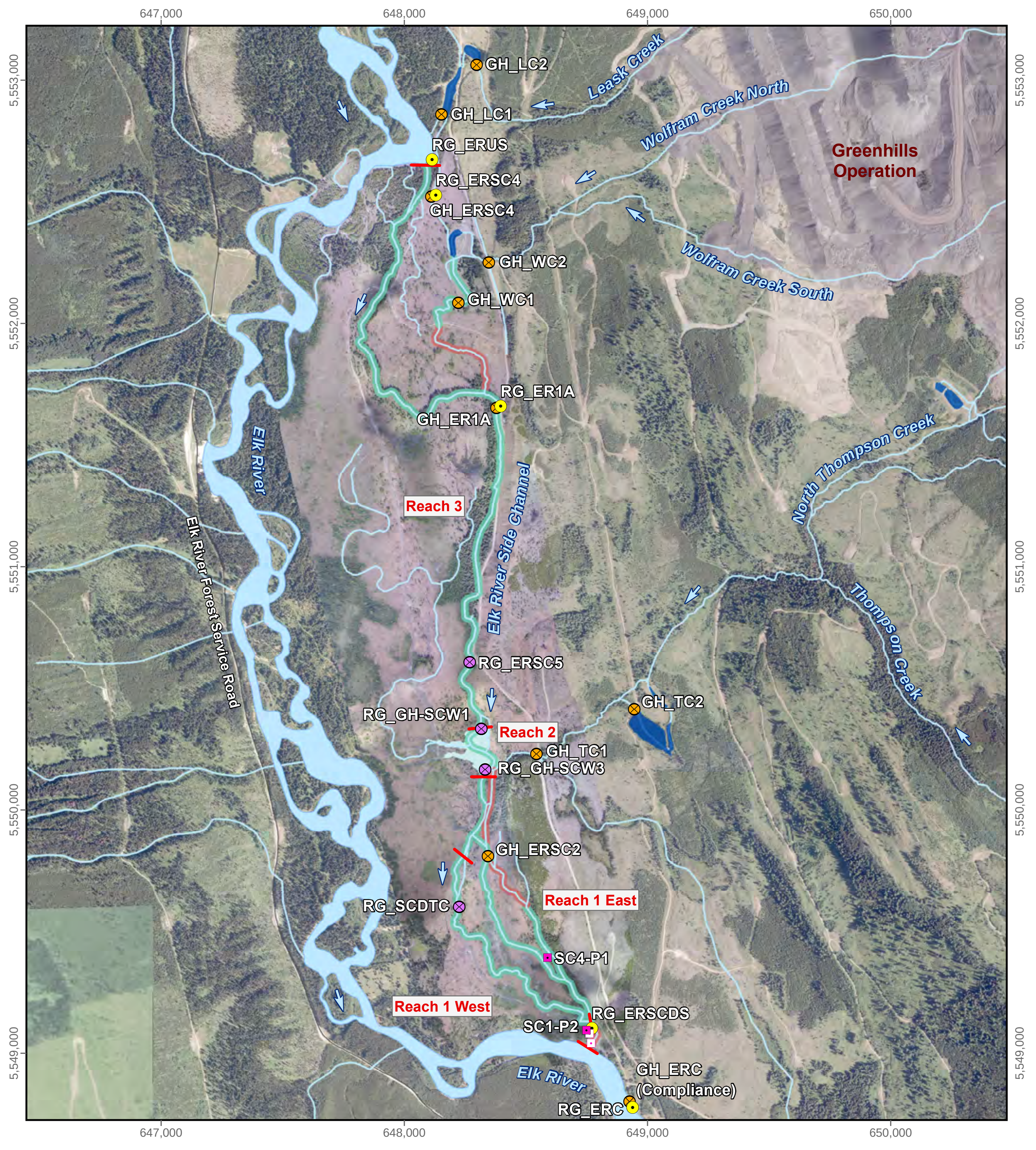
Figure A.12



LEGEND

■	Pool, Water Quality Sampling
□	Pool
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
⊙	Staff Gauge Location
—	Reach Break
—	Dry Channel
—	Wetted Channel
■	Settling Pond

Elk River Side Channel Wet and Dry Locations, August 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.13

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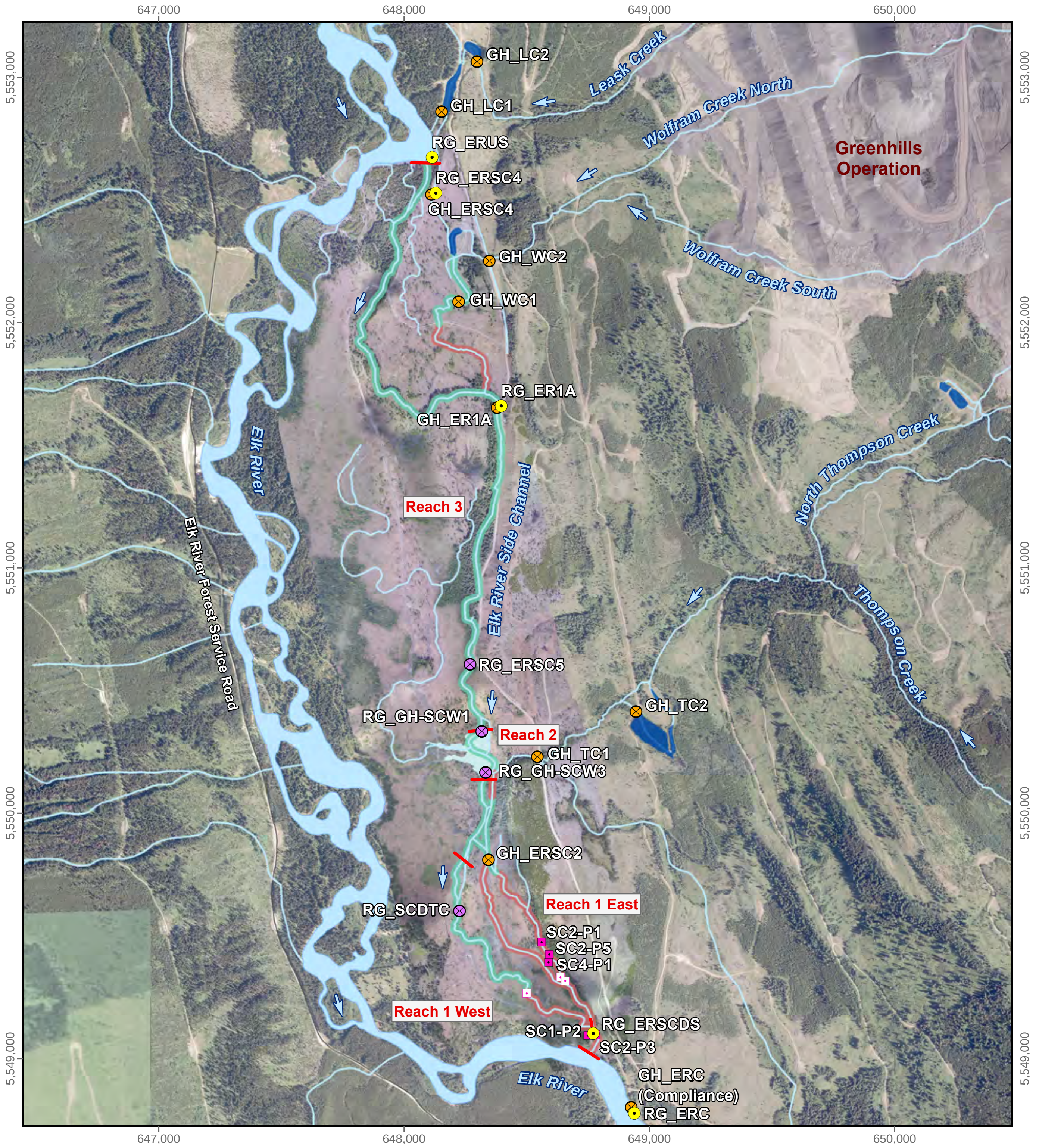

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- ▬ Reach Break
- ▬ Dry Channel
- ▬ Wetted Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, September 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.14

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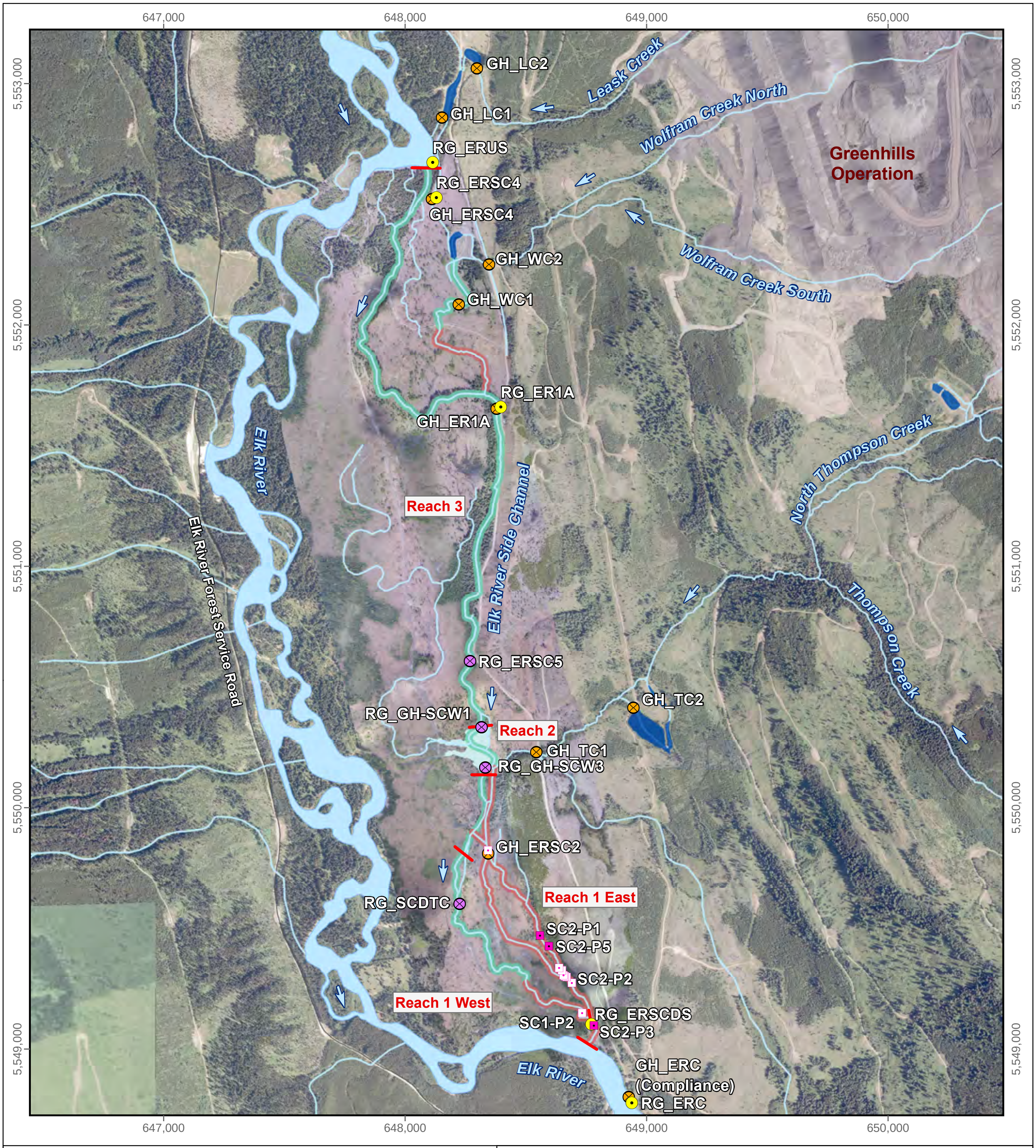

LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- — Reach Break
- — Dry Channel
- — Wetted Channel
- ▬ Setting Pond

Elk River Side Channel Wet and Dry Locations, October 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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Figure A.15

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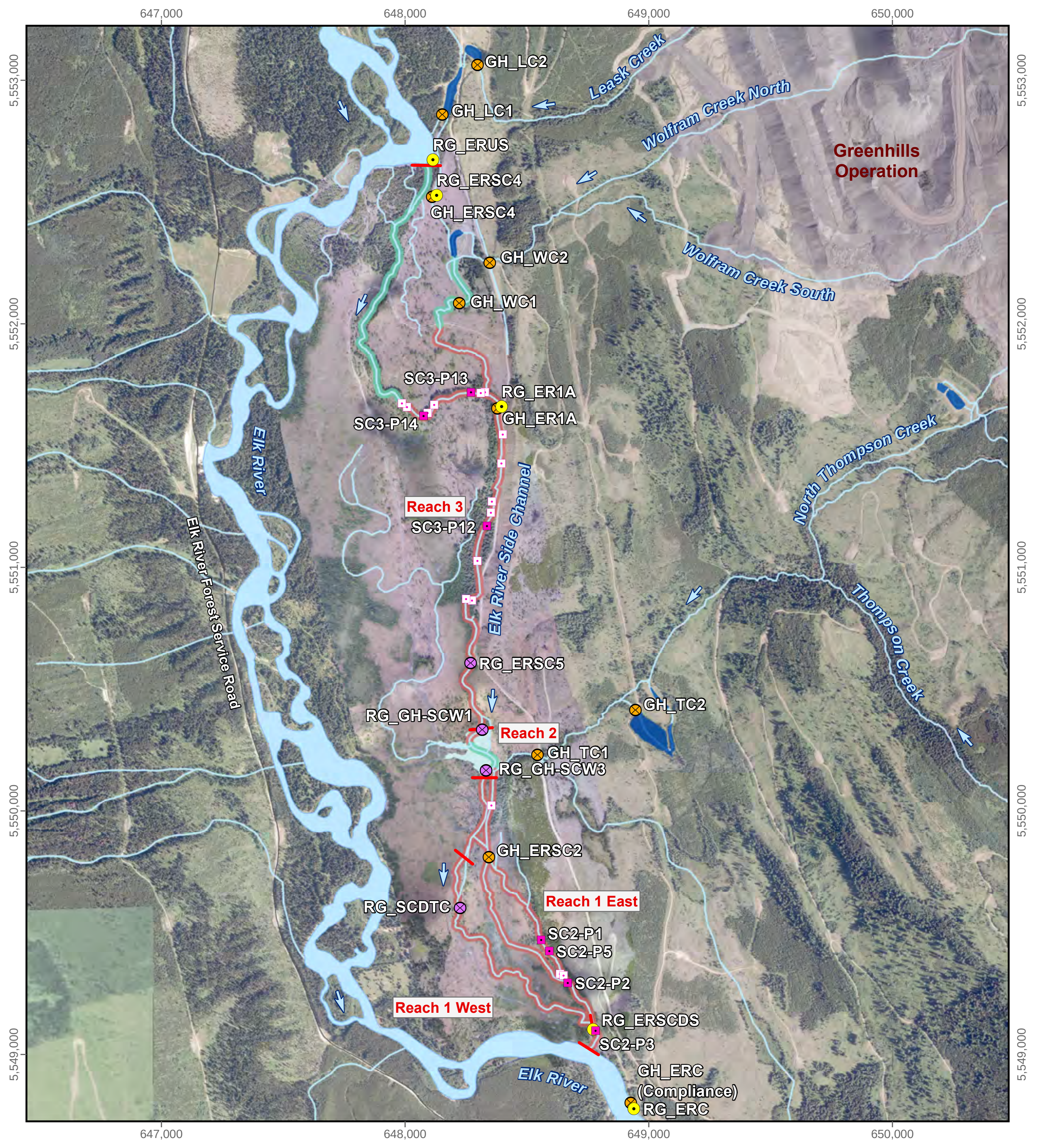

LEGEND

- ▪ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- — Dry Channel
- — Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, November 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.16

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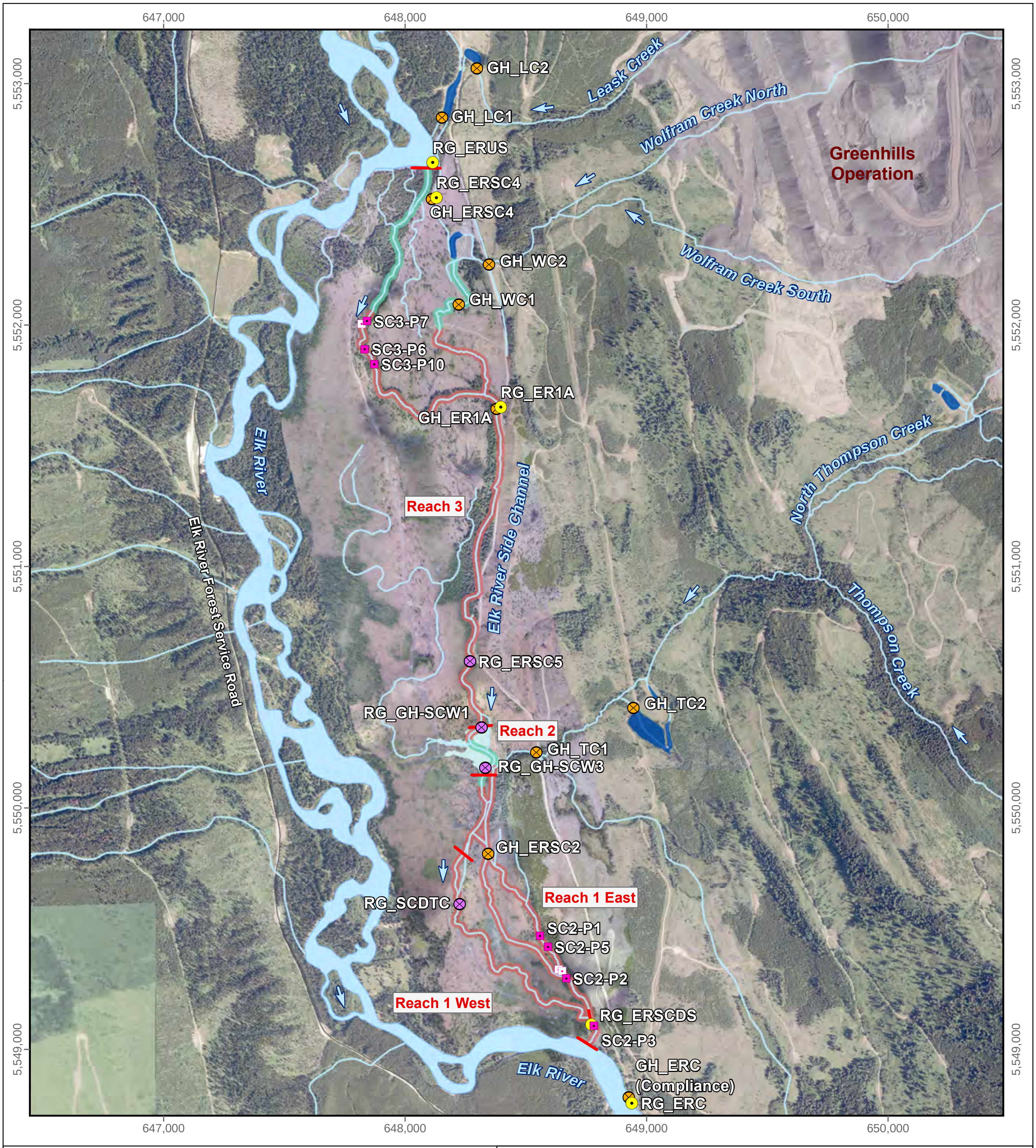

LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ━ Reach Break
- ━ Dry Channel
- ━ Wetted Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, December 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.17

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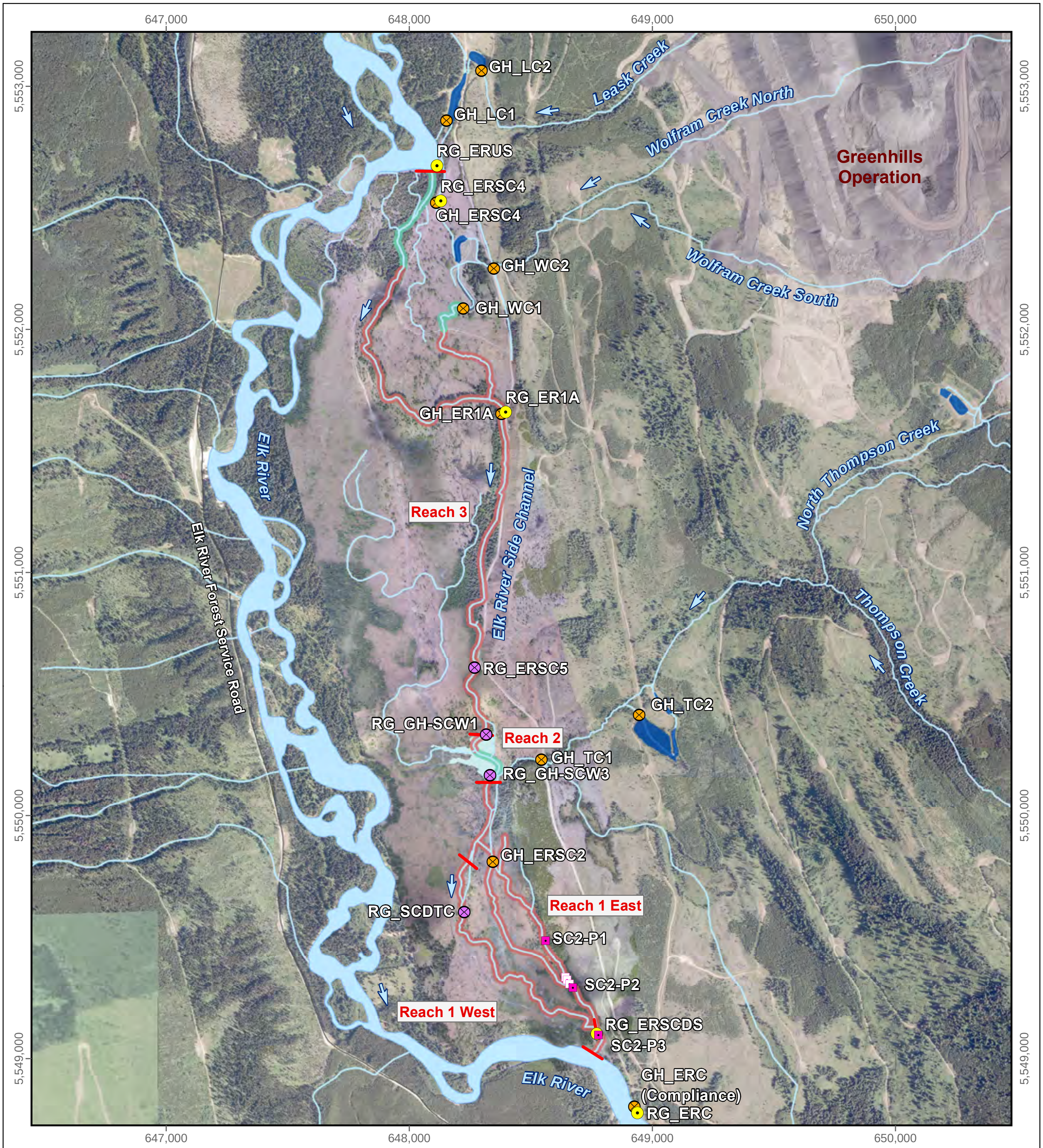

LEGEND

▪ Pool, Water Quality Sampling

▫ Pool

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

⊙ Staff Gauge Location

— Reach Break

— Wetted Channel

— Dry Channel

▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, January 2019

0 250 500 1,000 Meters

N W E S

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Figure A.18

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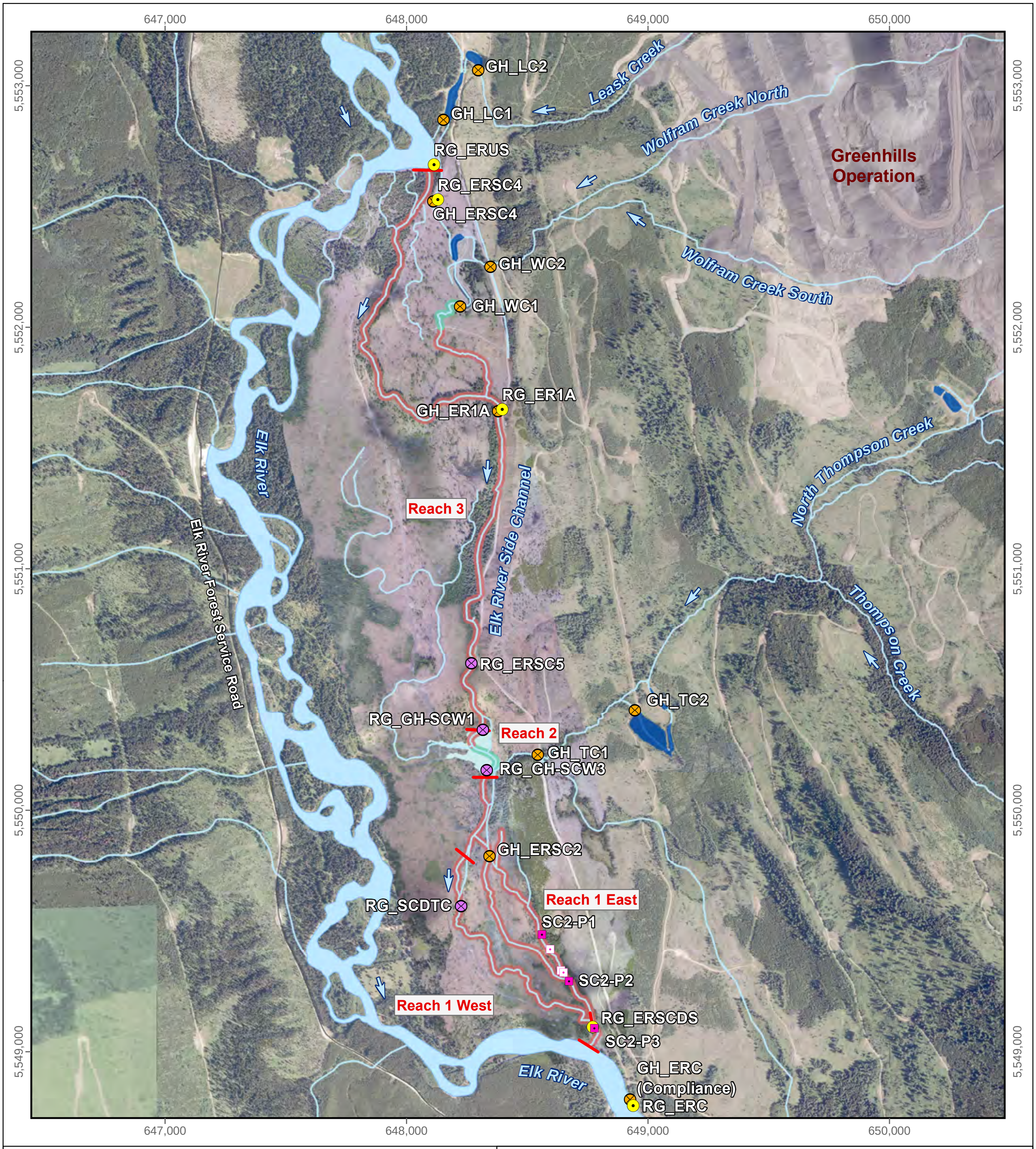

LEGEND

- ■ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- — Wetted Channel
- — Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, February 2019

0 250 500 1,000 Meters

N E S W

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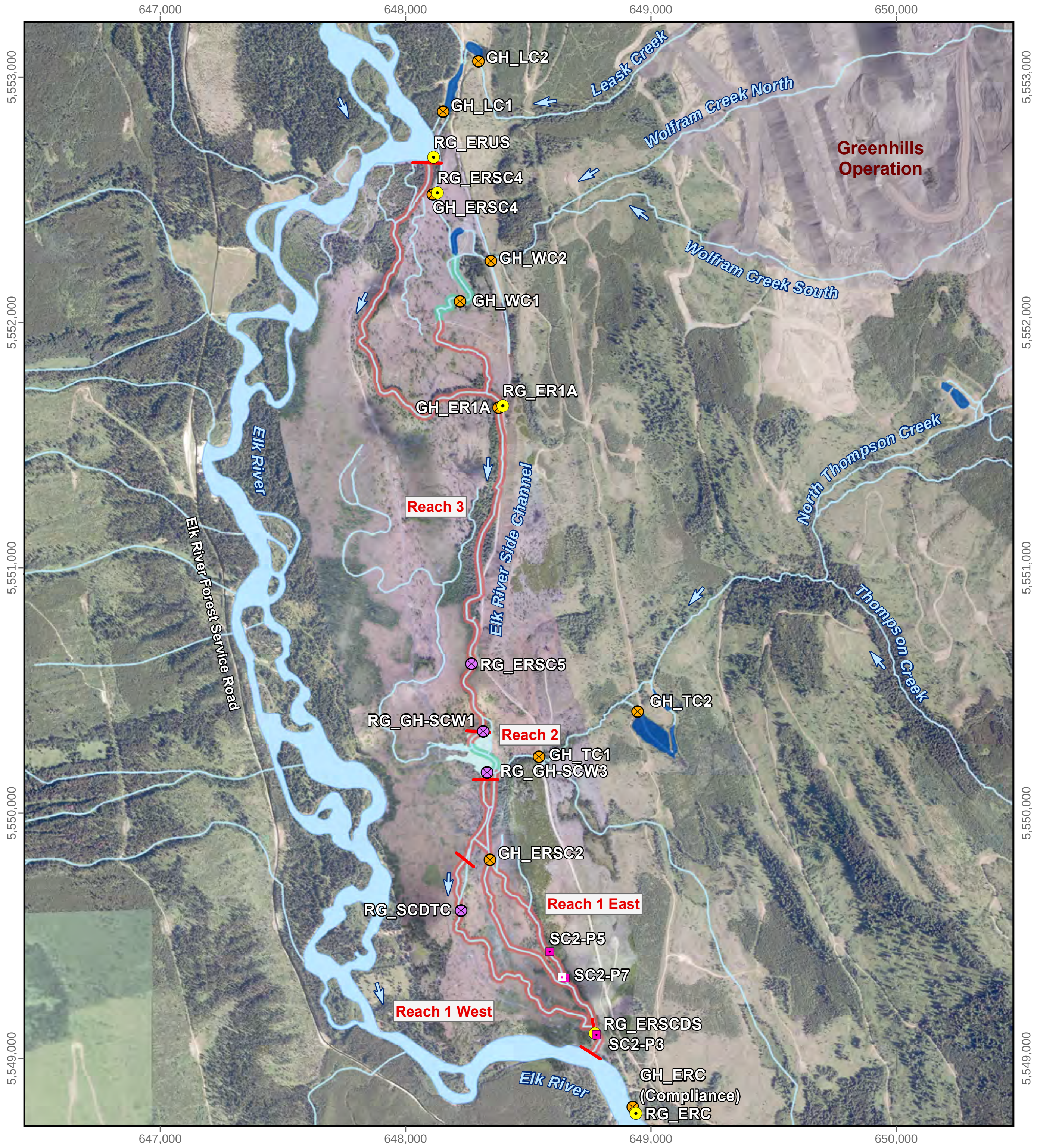
Figure A.19



LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- ▬ Reach Break
- ▬ Wetted Channel
- ▬ Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, March 2019

0 250 500 1,000
Meters

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Figure A.20

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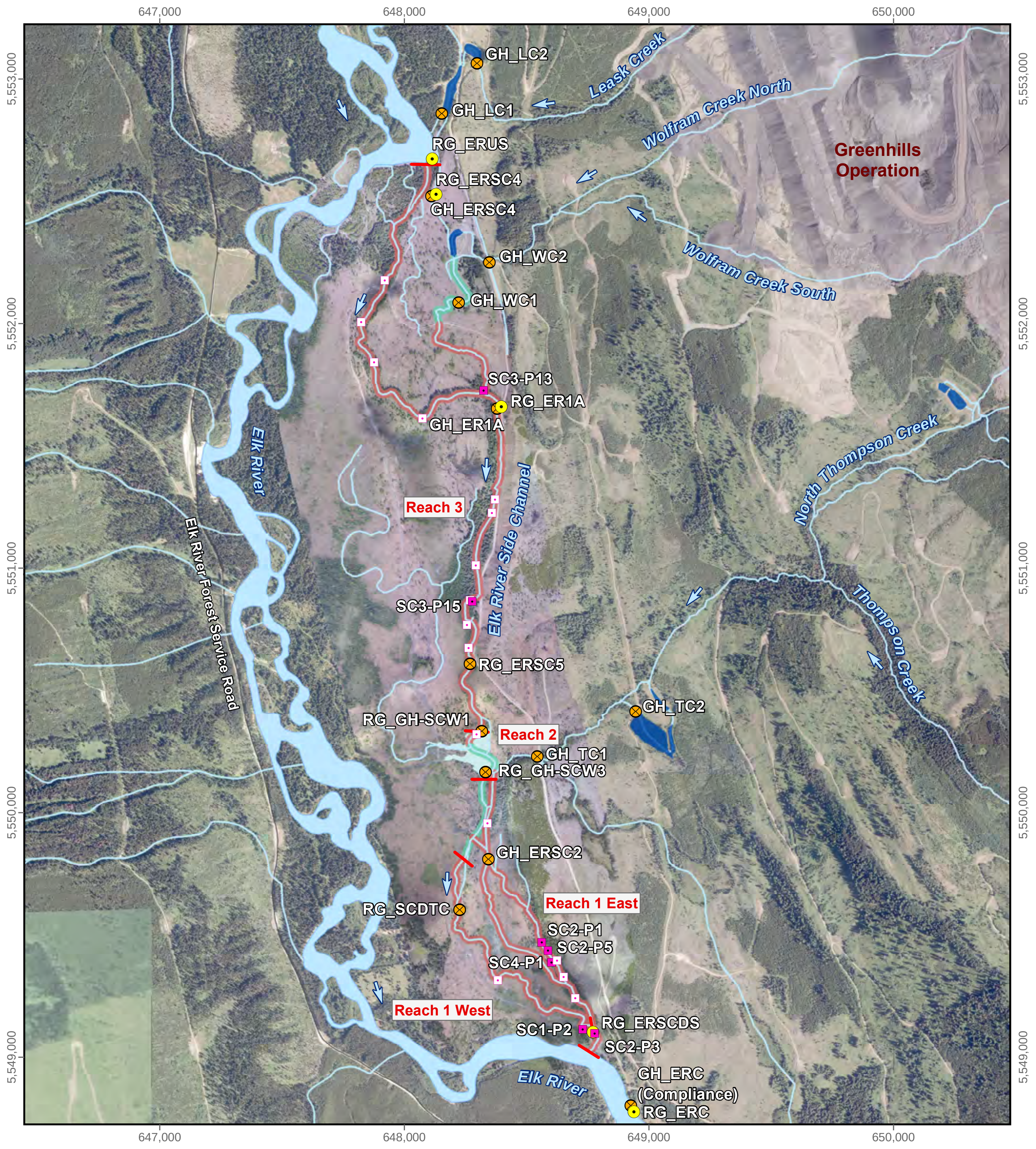

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- ▬ Reach Break
- ▬ Wetted Channel
- ▬ Dry Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, April 2019

0 250 500 1,000 Meters

N W E S

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Figure A.21

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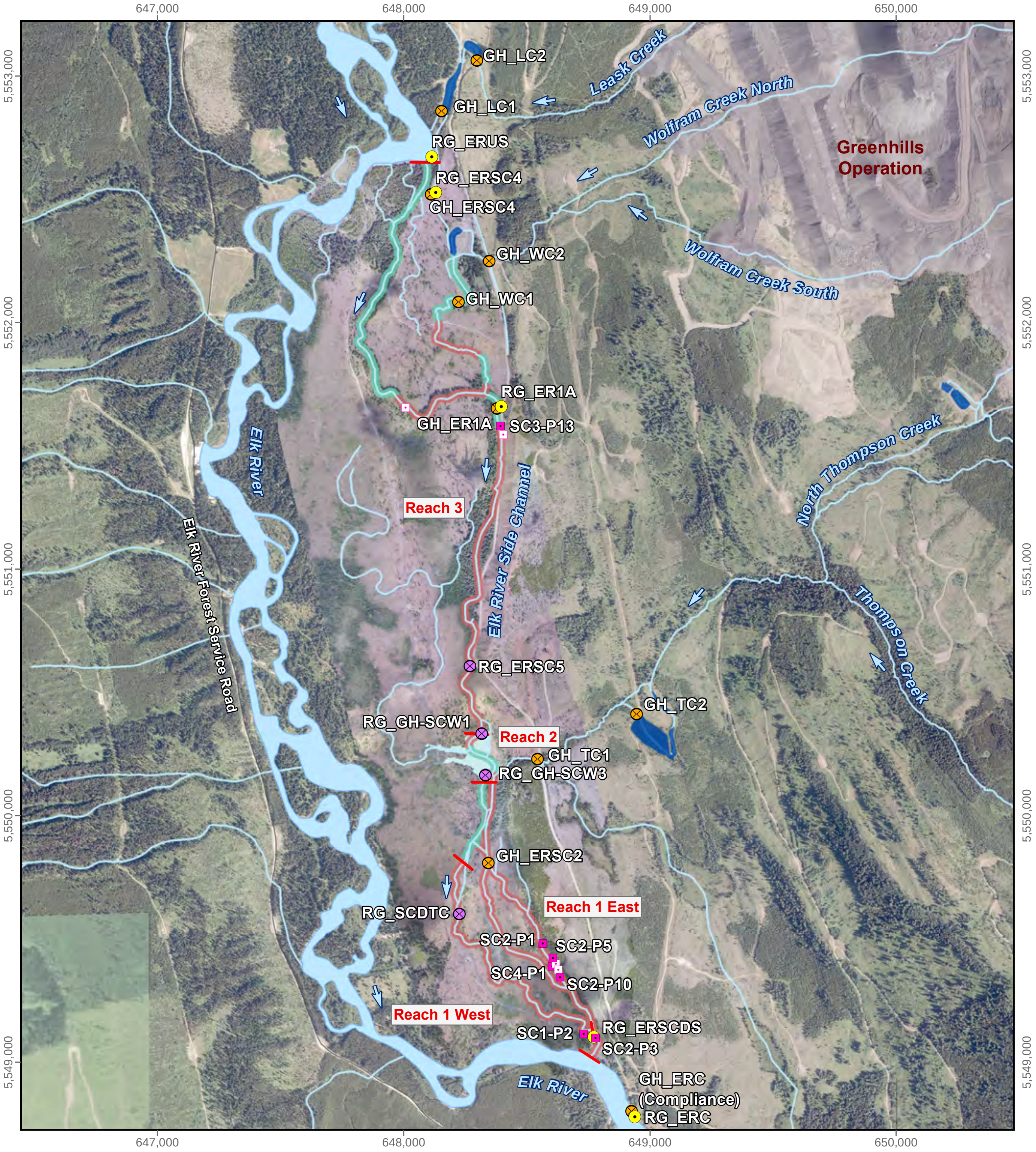

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- — Wetter Channel
- — Dry Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, May 2019

0 250 500 1,000 Meters

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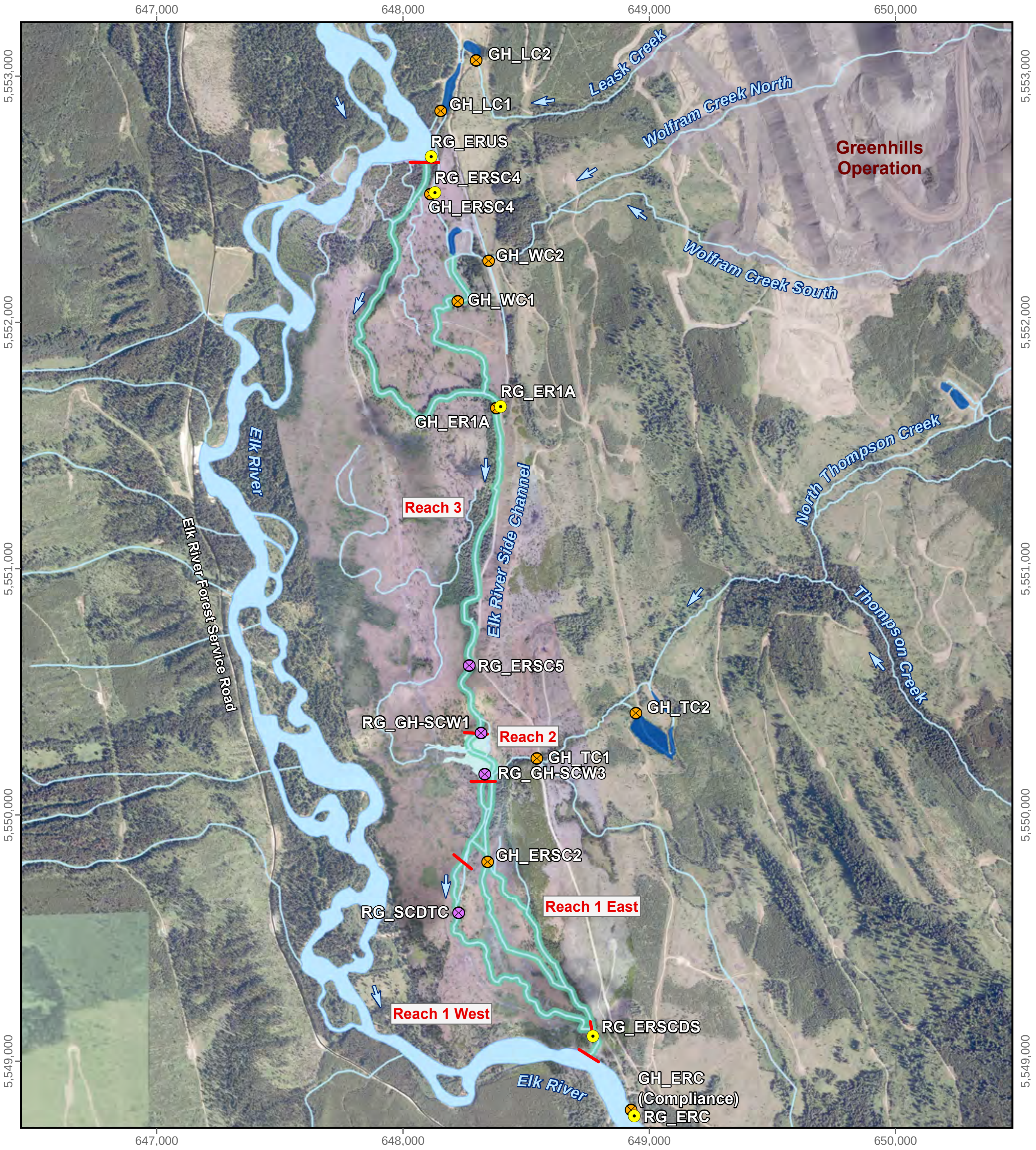
Figure A.22

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.22 Elk River Side Channel - May.mxd



LEGEND

- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ― Reach Break
- ― Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, June and July 2019

0 250 500 1,000 Meters

N W E S

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Figure A.23

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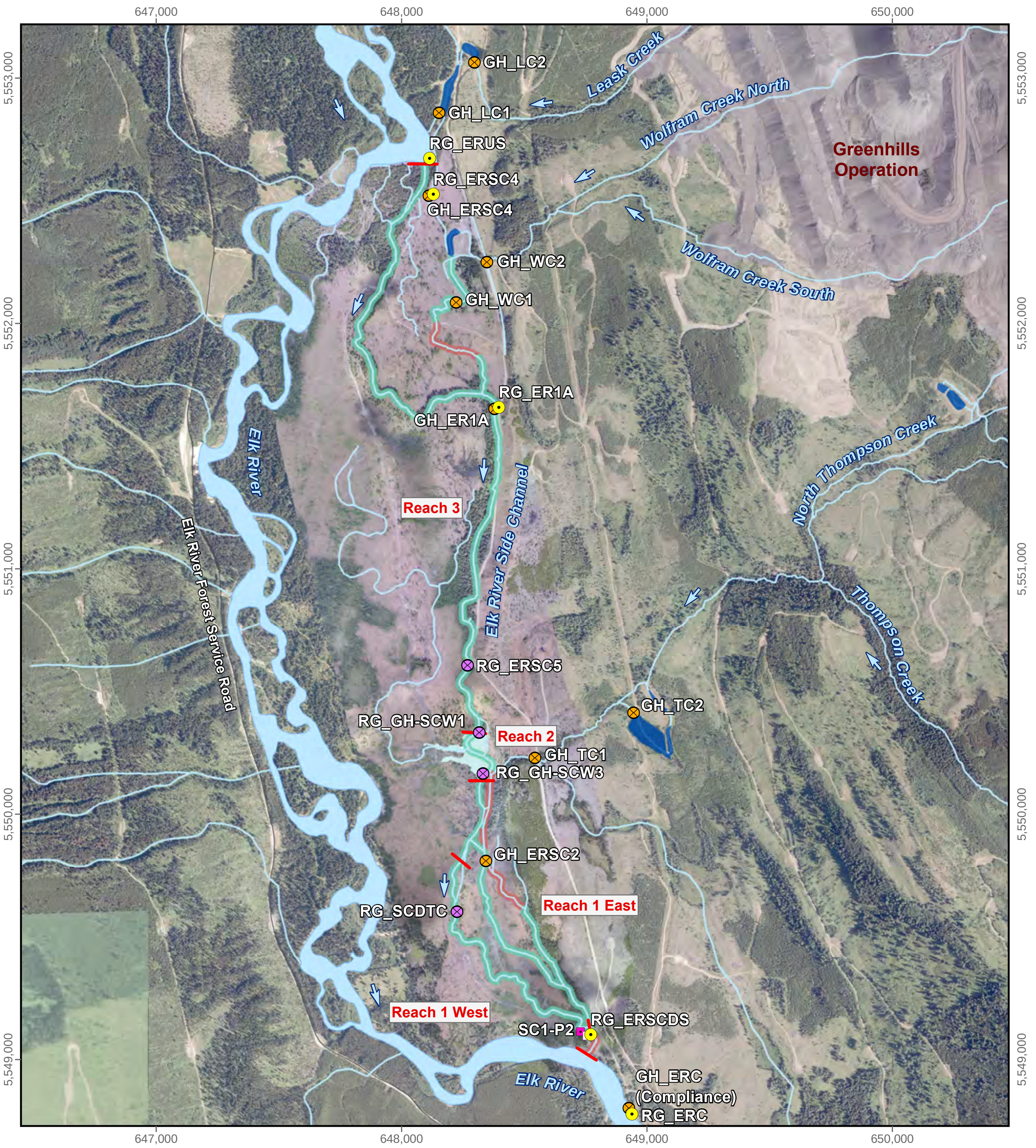

LEGEND

- ■ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- — Wetter Channel
- — Dry Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, August 2019

0 250 500 1,000 Meters

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Figure A.24

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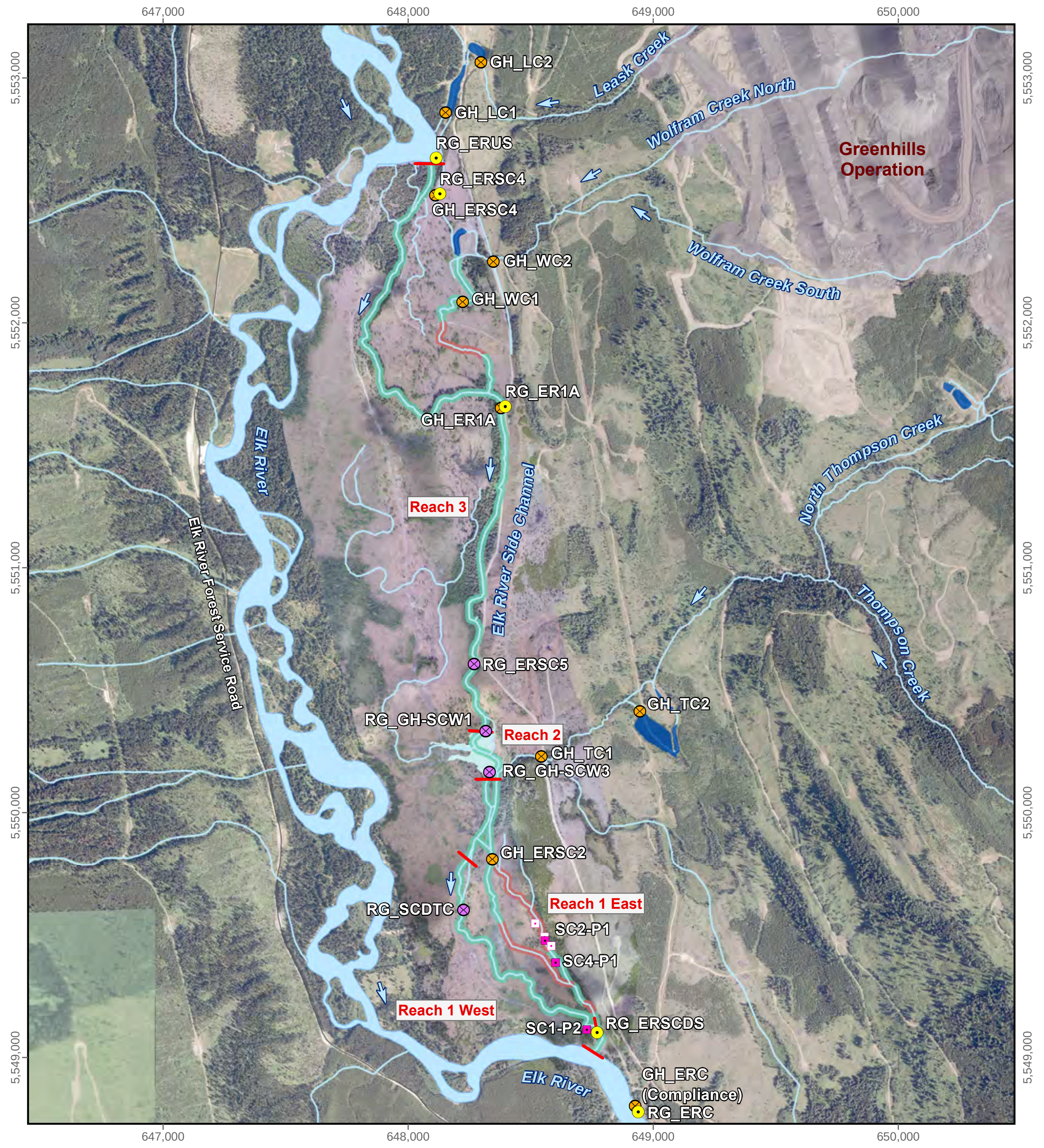

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- ▬ Wetted Channel
- ▬ Dry Channel
- █ Settling Pond

Elk River Side Channel Wet and Dry Locations, September 2019

0 250 500 1,000 Meters

N W E S

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Figure A.25

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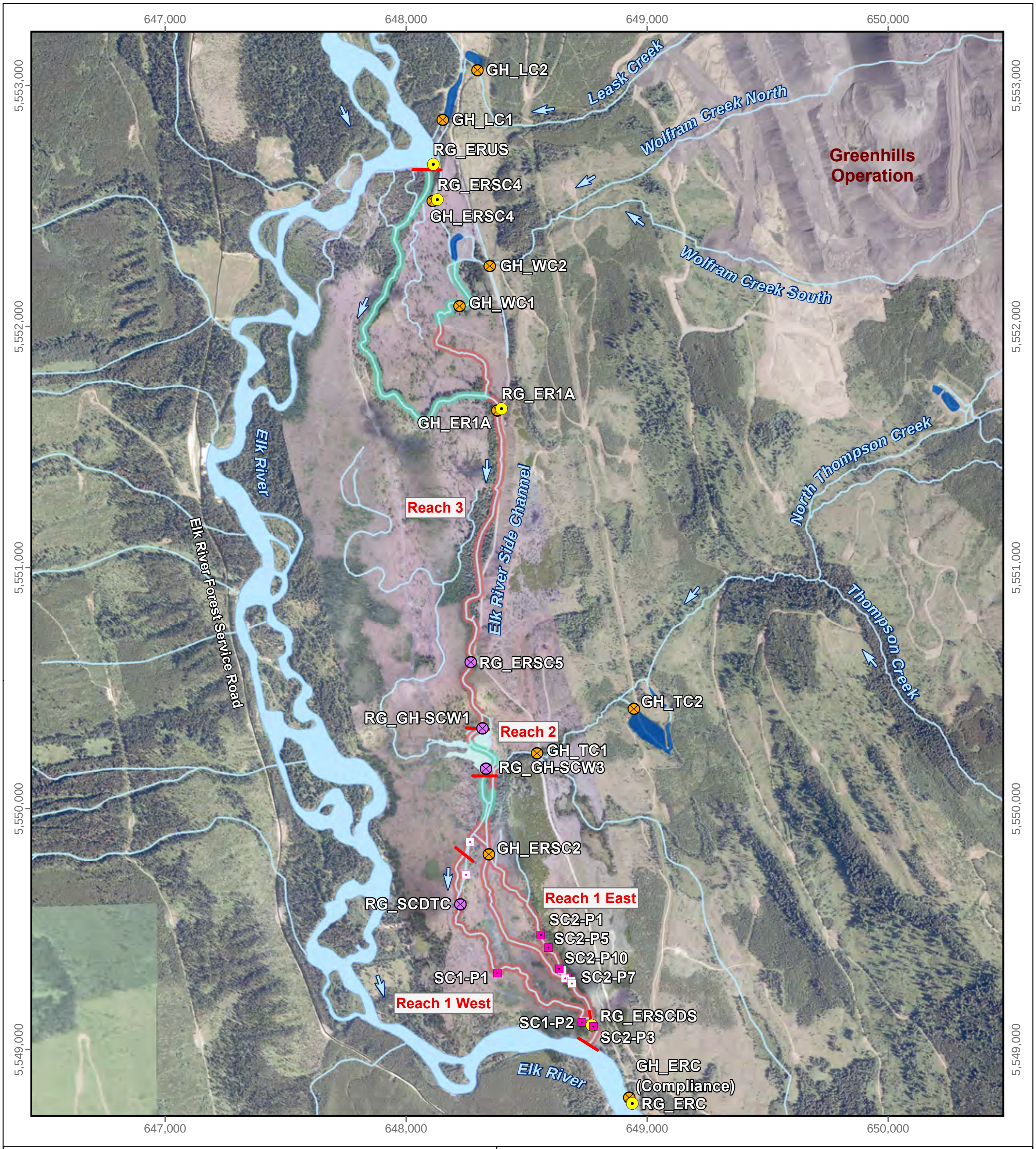

LEGEND

▪	Pool, Water Quality Sampling	▬	Reach Break
▫	Pool	▬	Wetted Channel
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed	▬	Dry Channel
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing	■	Settling Pond
⊙	Staff Gauge Location		

Elk River Side Channel Wet and Dry Locations, October 2019

0 250 500 1,000 Meters

N W E S

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Figure A.26

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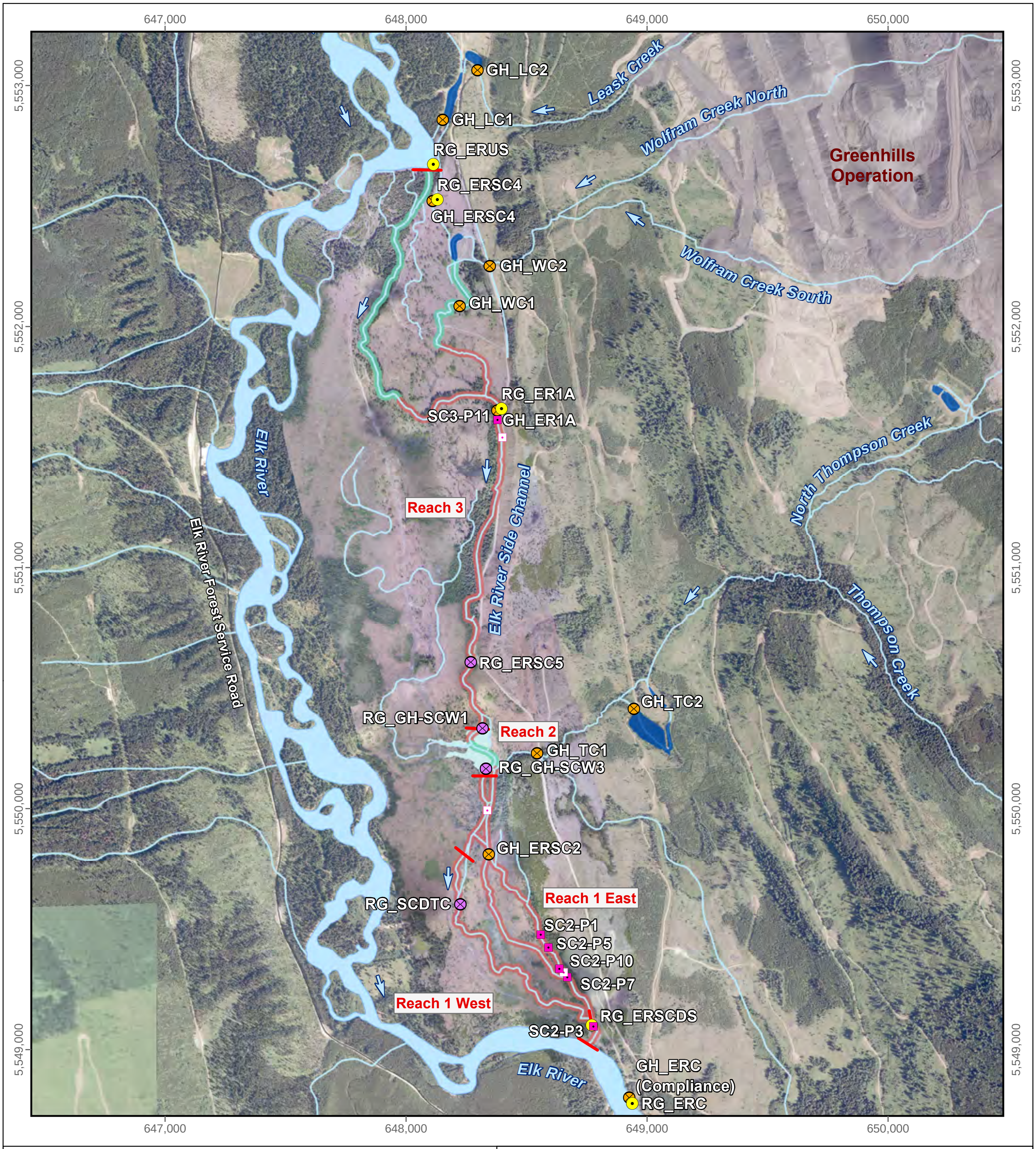

LEGEND

▪	Pool, Water Quality Sampling
▫	Pool
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
⊙	Staff Gauge Location
—	Reach Break
—	Wetted Channel
—	Dry Channel
▬	Settling Pond

Elk River Side Channel Wet and Dry Locations, November 2019

0 250 500 1,000 Meters

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Figure A.27

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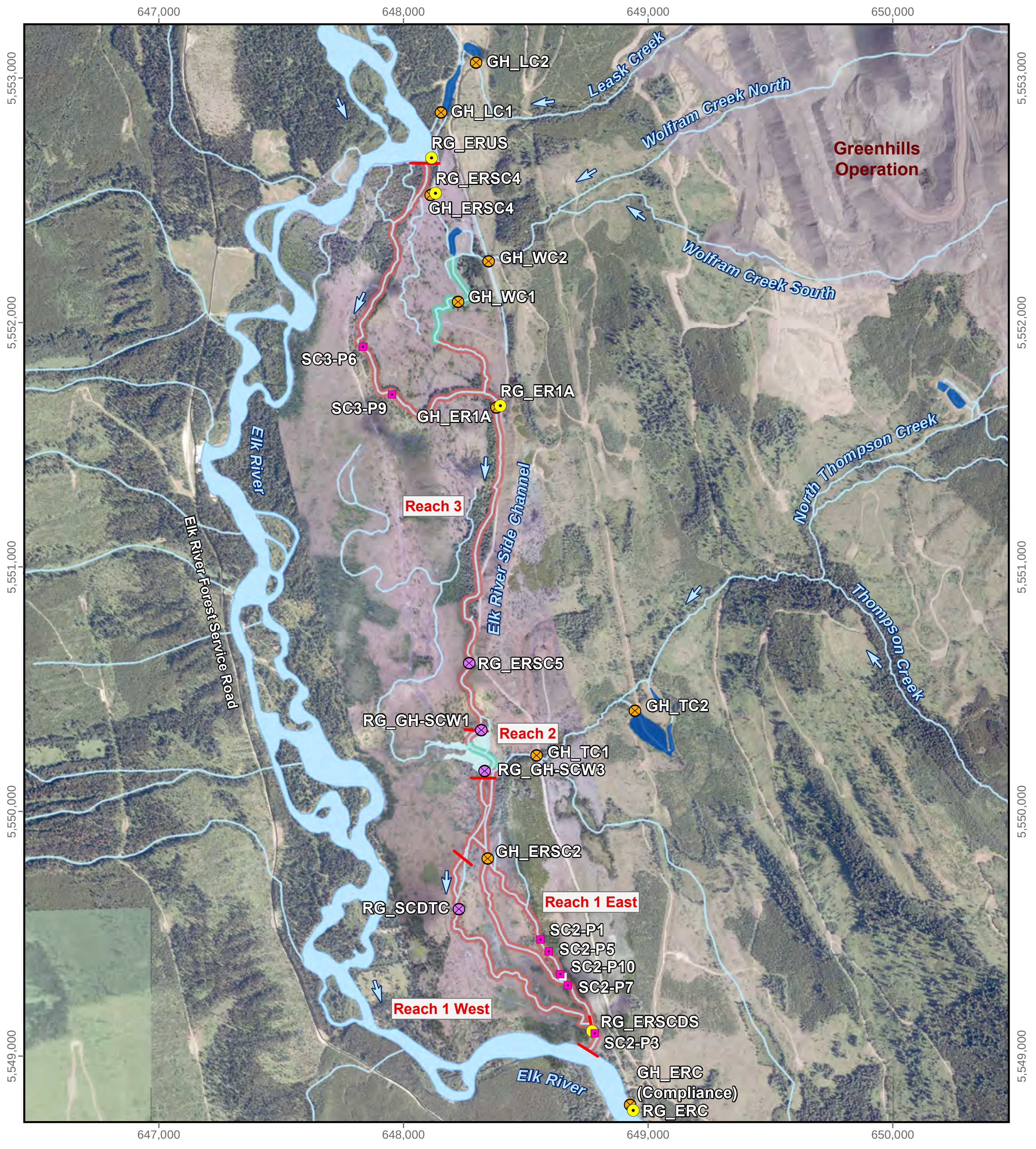

LEGEND

- ■ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- 🟥 Reach Break
- 🟩 Wetted Channel
- 🟥 Dry Channel
- 🟦 Settling Pond

Elk River Side Channel Wet and Dry Locations, December 2019

0 250 500 1,000 Meters

N W E S

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Figure A.28

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.28 Elk River Side Channel-Dec.mxd

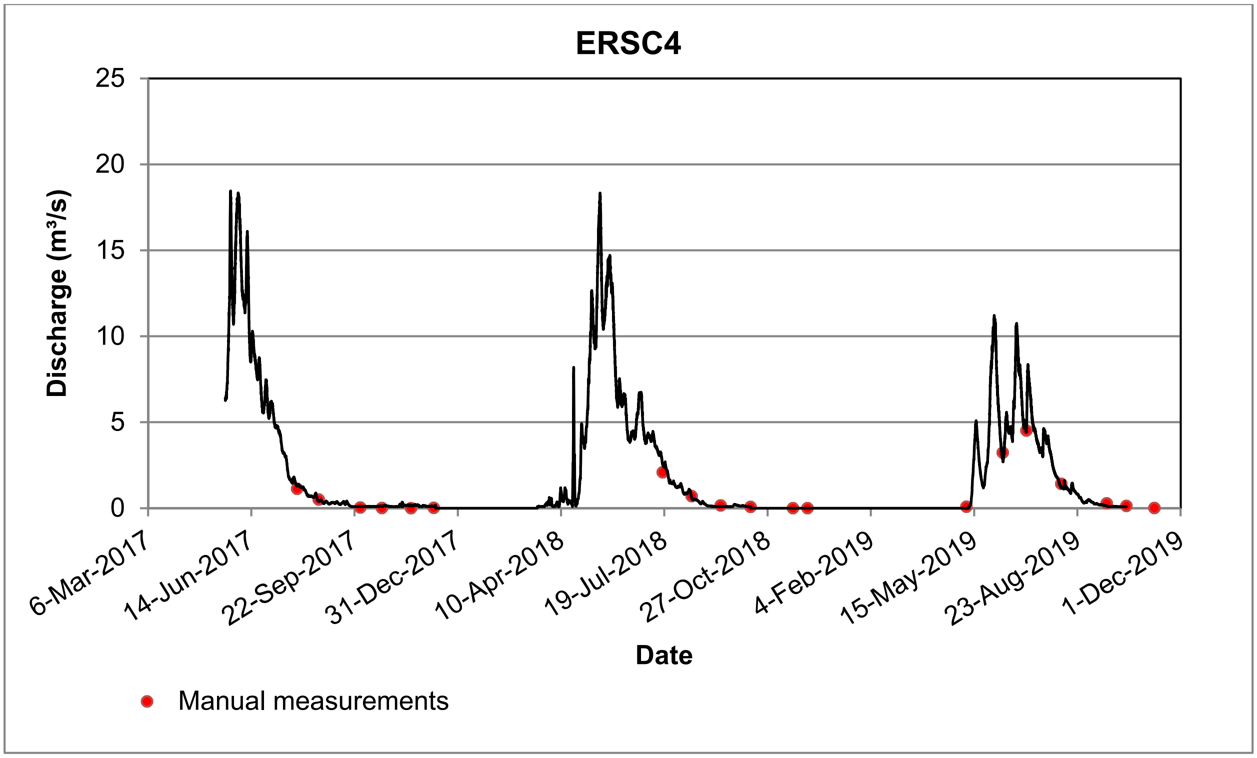


Figure A.29: **Discharge at ERSC4, 2017 to 2019**

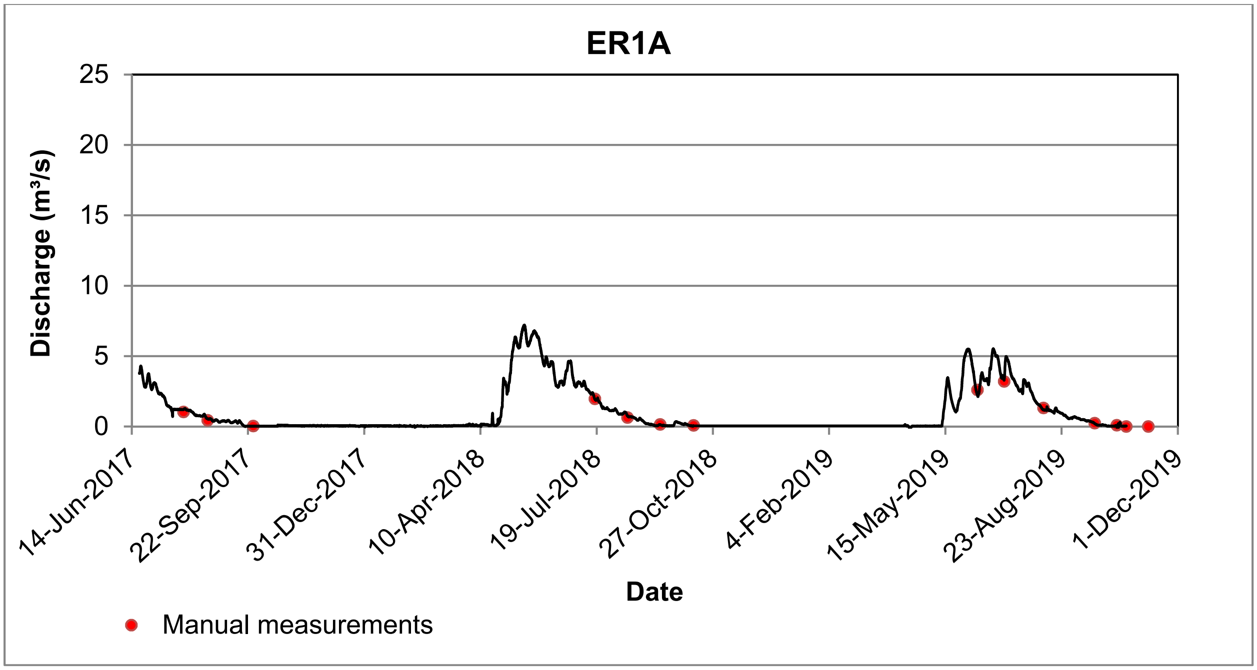


Figure A.30: **Discharge at ER1A, 2017 to 2019**

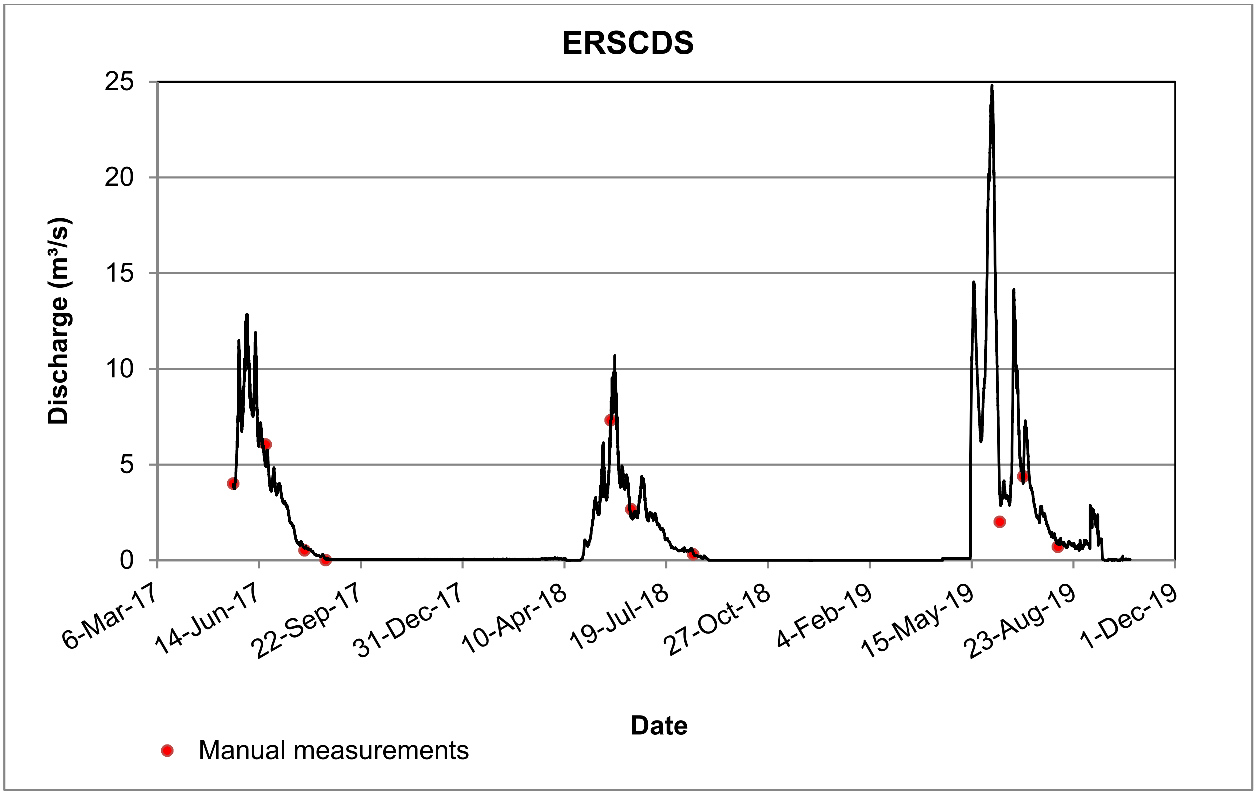


Figure A.31: Discharge at ERSCDS, 2017 to 2019

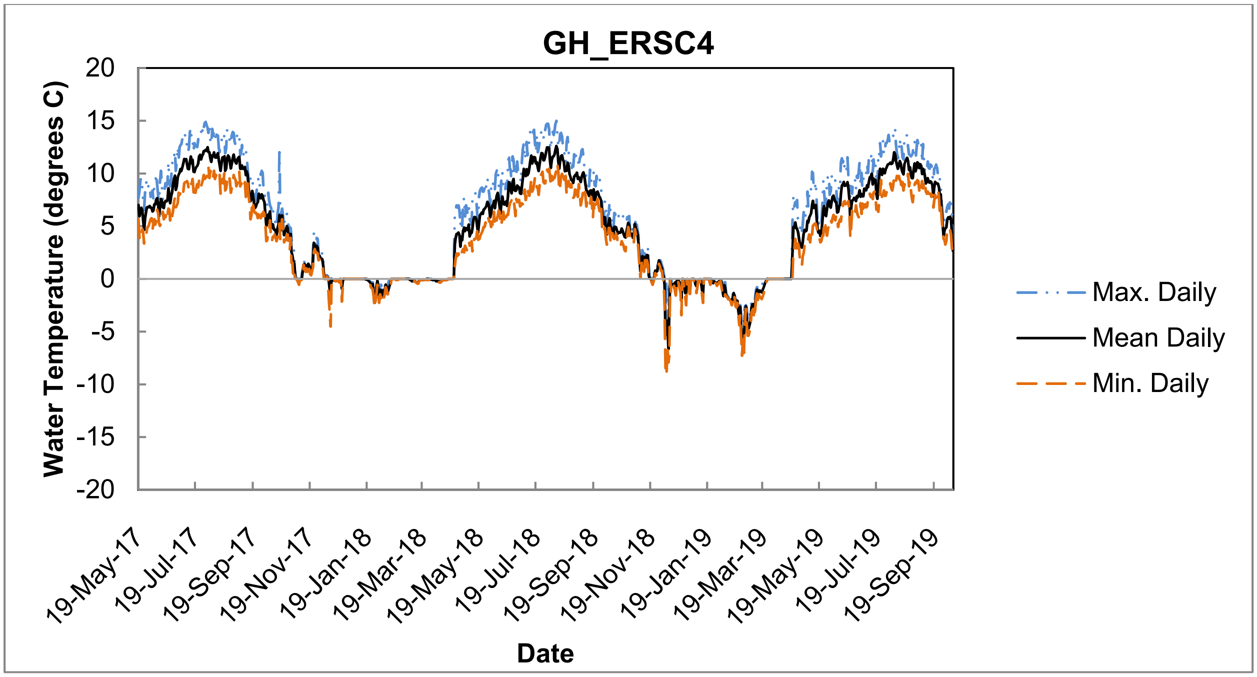


Figure A.32: Temperature Logger Data for GH_ERSC4

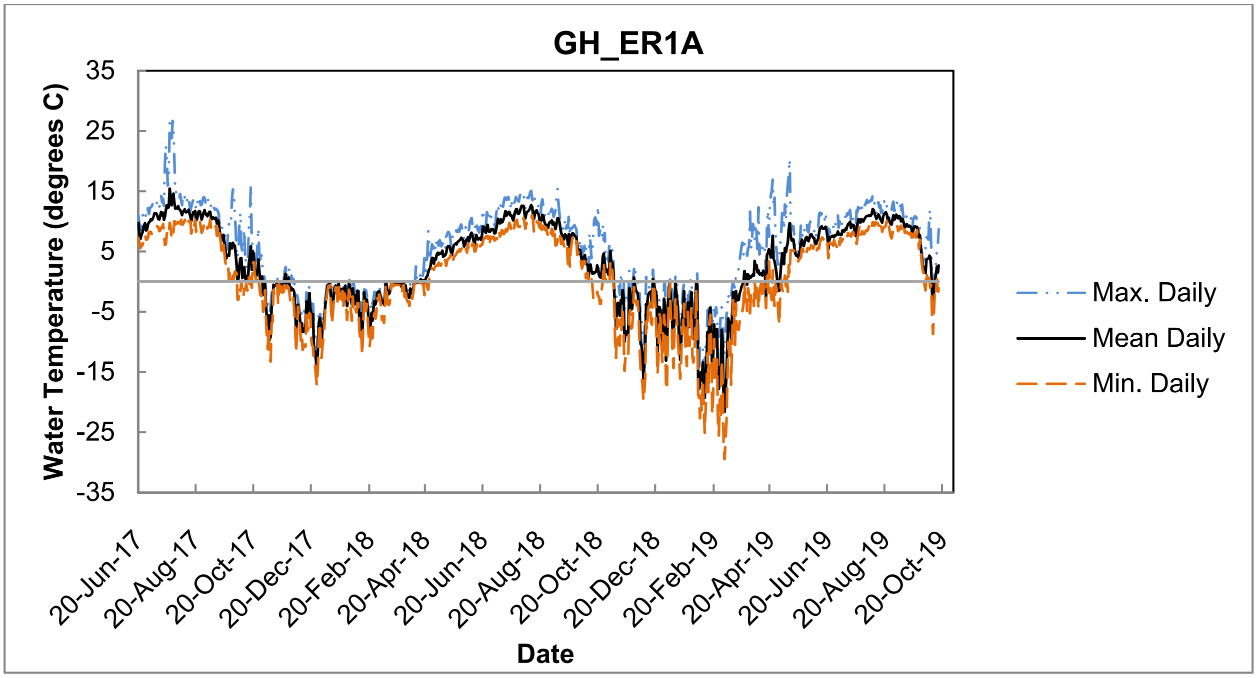


Figure A.33: Temperature Logger Data for GH_ER1A

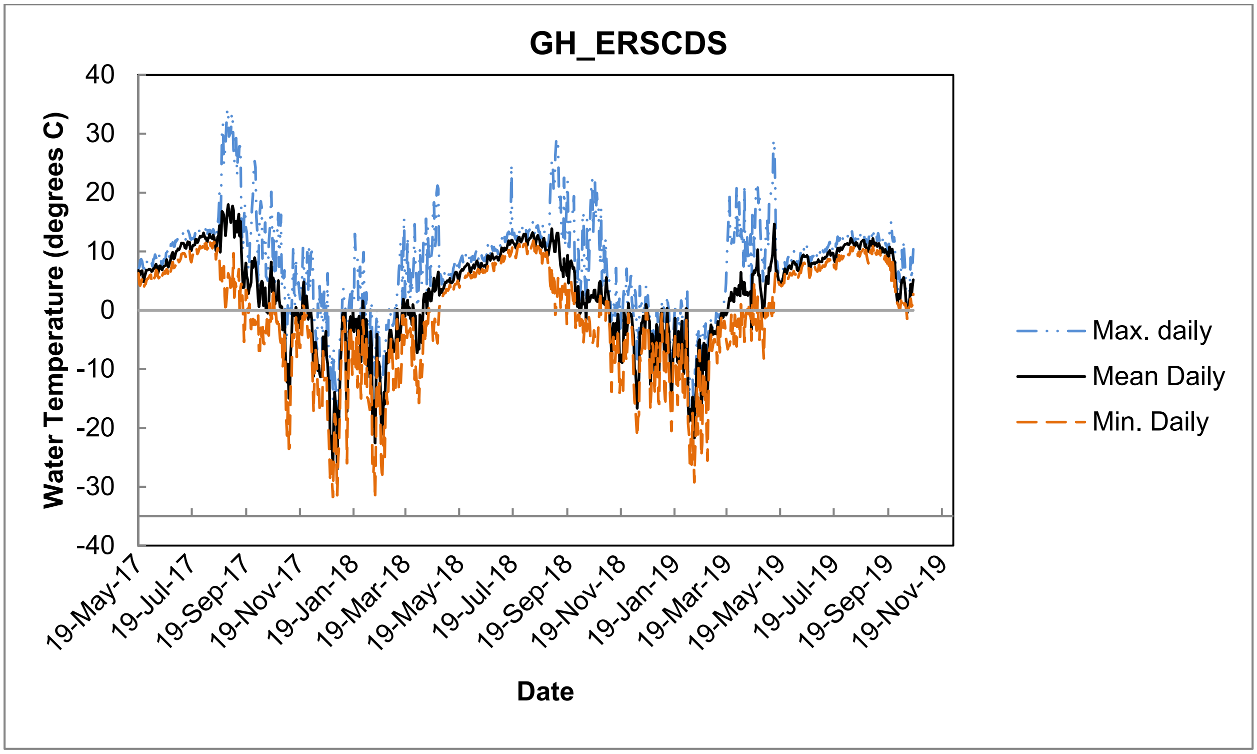


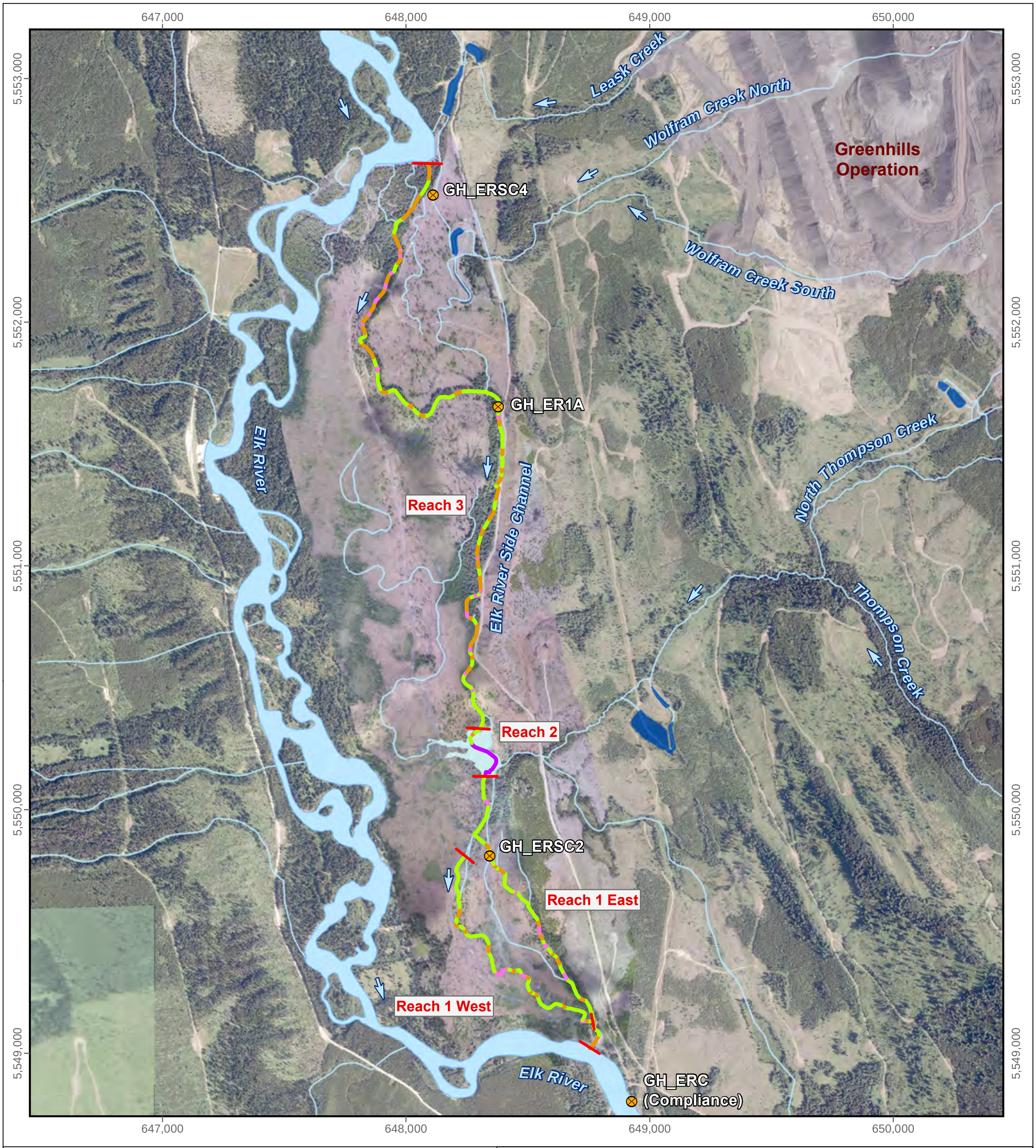
Figure A.34: Temperature Logger Data for GH_ERSDCDS

Table A.1: Hydrological Data, Data Quality Grades

Station	ERSC4	ER1A	ERSCDS
Instrumentation			
Meter calibration	A	A	A
Meter field verification	A	A	A
Water level gauge type	A	A	A
Water level gauge sensor accuracy	B	B	B
Stream Channel Condition			
Erosion, stability, vegetation	B	B	C
Field Procedures			
# Bench marks	A	A	A
# Manual flow measurement panels	C	C	C
# Manual flow measurements per year	A	A	A
# Level checks per year	B	B	B
Data Calculation and Assessment			
Discharge rating accuracy	B	B	C/E
Reviewed for anomalies	A	A	A
Stations/years compared as check	A	A	A

APPENDIX B

HABITAT AND BIOTA



LEGEND

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

— Reach Break

■ Settling Pond

Habitat Type

— Glide

— Other: Semi-lotic Side Channel / Beaver Impoundment

— Pool

— Riffle

Habitat of the Elk River Side Channel (Original FHAP Survey Completed July 2017, Minnow and Lotic 2018a)

0 250 500 1,000 Meters

N W E S

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 2020
Project 197202.0011

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Figure B.1

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig B.1 Elk River Side Channel Habitat.mxd

Photo B.1: Isolated Pool SC1-P1, September 2017

Photo B.2: Isolated Pool SC2-P1, September 2017

Photo B.3: Isolated Pool SC2-P1, November 2018

Photo B.4: Isolated Pool SC2-P1, February 2020

Photo B.5: Isolated Pool SC2-P5, October 2019

Photo B.6: Isolated Pool SC2-P5, February 2020

Photo B.7: Isolated Pool SC2-P2, September 2017

Photo B.8: Isolated Pool SC2-P2, September 2017

Photo B.9: **Isolated Pool SC2-P2, September 2017**

Photo B.10: **Isolated Pool SC2-P10, October 2018**

Photo B.11: Isolated Pool SC2-P10, October 2019

Photo B.12: Isolated Pool SC2-P10, February 2020

Photo B.13: Isolated Pool SC2-P2, September 2017

Photo B.14: Isolated Pool SC2-P2, September 2017

Photo B.15: Isolated Pool SC2-P3, September 2017

Photo B.16: Isolated Pool SC2-P3, November 2019

Photo B.17: Isolated Pool SC2-P3, February 2020

Table B.1: *In Situ* Water Quality Measurements for Staff Gauge Location RG_ERUS, Collected during Monthly Surveys, 2019

Date	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
15-Jan-19	0.0	99.6	14.01	345.3	8.00
20-Feb-19	0.0	92.2	13.30	316.9	7.03
14-Mar-19	0.2	99.7	14.45	327.8	8.03
18-Apr-19	2.8	77.0	10.40	329.4	7.20
7-May-19	6.2	87.9	10.88	297.0	7.96
12-Jun-19	6.9	89.0	10.81	255.2	8.12
4-Jul-19	7.5	80.2	9.58	233.0	7.86
7-Aug-19	9.7	81.7	9.30	267.5	7.91
20-Sep-19	8.0	79.8	9.44	386.1	7.69
9-Oct-19	2.9	89.7	12.09	503.1	7.42
5-Nov-19	3.7	98.5	13.00	275.7	7.93
3-Dec-19	1.5	74.0	10.36	210.6	7.14

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.2: *In Situ* Water Quality Measurements for Staff Gauge Location RG_ERSC4, Collected during Monthly Surveys, 2019

Date [a]	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
7-May-19	6.0	84.4	10.42	305.9	7.97
11-Jun-19	10.1	93.1	10.45	255.7	8.10
4-Jul-19	7.6	85.8	10.27	232.9	7.86
7-Aug-19	9.8	83.0	9.43	264.5	8.09
20-Sep-19	8.1	79.3	9.38	382.9	7.86
9-Oct-19	2.4	90.1	12.30	502.3	7.30
5-Nov-19	3.3	93.3	12.42	279.3	7.55
3-Dec-19	0.0	69.1	10.11	212.7	6.97

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] From January 2019 to April 2019, station RG_ERSC4 was dry.

Table B.3: ***In Situ*** **Water Quality Measurements for Staff Gauge Location RG_ER1A, Collected during Monthly Surveys, 2019**

Date [a]	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
12-Jun-19	7.0	88.5	10.74	265.8	8.13
4-Jul-19	7.9	86.8	10.30	238.5	7.87
7-Aug-19	10.0	85.3	9.64	271.4	8.07
20-Sep-19	8.2	80.6	9.47	383.0	7.93
9-Oct-19	1.4	84.8	11.94	503.6	7.24

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] From January 2019 to May 2019 and from November to December 2019, station RG_ER1A was dry.

Table B.4: *In Situ* Water Quality Measurements for Staff Gauge Location RG_ERSCDS, Collected during Monthly Surveys, 2019

Date [ab]	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
12-Jun-19	7.3	85.3	10.29	303.0	7.77
4-Jul-19	8.3	78.8	9.12	267.7	7.76
7-Aug-19	12.3	76.8	8.27	325.2	8.05
20-Sep-19	10.1	77.6	8.70	693.8	7.19

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] From January 2019 to May 2019, station RG_ERSCDS was dry.

[b] From October 2019 to December 2019, station RG_ERSCDS was dry.

Table B.5: *In Situ* Water Quality Measurements for Staff Gauge Location RG_ERC, Collected during Monthly Surveys, 2019

Date	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
15-Jan-19	3.2	42.1	12.25	363.9	7.84
20-Feb-19	4.0	82.6	10.83	345.8	7.78
14-Mar-19	2.7	86.0	11.61	391.5	6.64
18-Apr-19	3.0	79.7	10.76	343.9	7.84
7-May-19	5.5	83.6	10.45	324.3	7.72
12-Jun-19	8.5	90.0	10.49	275.0	7.94
5-Jul-19	6.8	82.2	10.00	241.3	7.73
7-Aug-19	12.0	80.2	8.62	277.1	8.07
20-Sep-19	9.3	71.6	8.21	416.6	7.78
9-Oct-19	5.7	82.3	10.29	557.4	7.62
5-Nov-19	5.3	88.1	11.13	306.7	7.71
4-Dec-19	5.2	63.0	8.00	302.0	6.62

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.
Note: " - " indicates no value.

Table B.6: *In Situ* Water Quality Measurements for the Reach 2 Inlet (RG_GH-SCW1), Collected during Monthly Surveys, 2019

Date [ab]	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
12-Jun-19	7.4	90.7	10.91	262.7	8.10
5-Jul-19	7.0	85.9	10.36	230.0	7.87
7-Aug-19	10.9	86.8	9.58	270.4	8.18
20-Sep-19	8.8	81.9	9.52	381.4	8.09
9-Oct-19	0.7	90.7	12.97	375.1	7.54

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] From January 2019 to May 2019, station SCW1 was dry.

[b] From November 2019 to December 2019, station SCW1 was dry.

Table B.7: *In Situ* Water Quality Measurements for the Reach 2 Outlet (RG_GH-SCW3), Collected during Monthly Surveys, 2019

Date [a]	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (μs/cm)	pH
BC WQG Minimum	-	-	5	-	6.5
BC WQG Maximum	19.0	-	-	-	9
15-Jan-19	0.0	96.2	13.96	1,936	8.11
17-Apr-19	6.3	82.6	10.25	1,233	8.81
8-May-19	8.4	83.2	9.72	1,130	8.40
12-Jun-19	7.9	92.8	11.00	259.5	8.15
5-Jul-19	7.2	86.1	10.40	230.0	7.93
7-Aug-19	11.0	87.8	9.69	272.1	7.92
20-Sep-19	9.1	84.5	9.72	558.2	8.17
9-Oct-19	1.4	92.4	12.92	1,943	8.00
6-Nov-19	0.0	92.7	13.45	1,468	7.52
4-Dec-19	0.1	62.2	9.04	1,589	8.17

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] From February 2019 to March 2019, station SCW3 was frozen.

Table B.8: *In Situ* Water Quality Measurements for Isolated Pools Observed in January 2019

Pool Name	**UTM**		**Date**	**Water Quality Sample Collected (yes/no)**	**Temperature (°C)**	**DO (%)**	**DO (mg/L)**	**Specific Conductivity (µs/cm)**	**pH**	**Observed Fish Presence (yes/no)**	**Length (m)[a]**	**Width (m)[a]**	**Surface Area (m^2)**	**Deepest Depth (m)[a]**
	Easting	**Northing**												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P1	648561	5549486	15-Jan-19	Yes	1.8	30.8	4.26	1,392	7.01	No	-	-	-	-
Jan-1E-P2	648643	5549335	14-Jan-19	No	1.9	31.3	4.35	1,474	7.12	No	-	-	-	-
Jan-1E-P3	648650	5549324	14-Jan-19	No	3.1	53.3	7.15	1,453	7.19	No	-	-	-	-
Jan-1E-P4	648659	5549308	14-Jan-19	No	3.1	31.6	4.25	1,468	7.20	No	-	-	-	-
SC2-P2	648673	5549292	15-Jan-19	Yes	1.5	49.5	6.93	1,354	7.20	No	-	-	-	-
SC2-P3	648778	5549097	15-Jan-19	Yes	2.1	58.7	8.04	1,480	7.27	No	-	-	-	-

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] Length, width, and depth could not be determined due to snow cover.

Table B.9: *In Situ* Water Quality Measurements for Isolated Pools Observed in February 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)[a]	Width (m)[a]	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
Feb-1E-P1	648595	5549424	19-Feb-18	No	0.0	68.2	9.98	1,493	7.60	No	-	-	-	0.08
Feb-1E-P2	648640	5549336	19-Feb-18	No	1.2	54.0	7.59	1,409	7.49	No	-	-	-	0.08
Feb-1E-P3	648651	5549328	19-Feb-18	No	0.0	39.8	5.80	1,236	7.51	No	-	-	-	0.08
SC2-P2	648673	5549292	21-Feb-18	Yes	0.3	51.1	7.37	1,348	7.51	No	-	-	-	0.13
SC2-P3	648778	5549097	21-Feb-18	Yes	0.3	55.8	8.07	1,423	7.06	No	-	-	-	0.10
SC2-P1	648561	5549486	21-Feb-18	Yes	0.0	69.7	10.11	1,483	7.72	No	-	-	-	0.08

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] Length and width could not be determined due to snow cover.

Table B.10: *In Situ* Water Quality Measurements for Isolated Pools Observed in March 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P3	648778	5549097	14-Mar-19	Yes	0.1	53.2	7.76	1,462	6.83	No	3.5	2	7	0.20
SC2-P5	648587	5549436	14-Mar-19	Yes	0.8	23.8	3.45	1,174	7.10	No	4.0	2.0	8	0.15
SC2-P7	648652	5549329	14-Mar-19	Yes	1.2	70.5	9.90	1,526	7.04	No	2.5	0.5	1.3	0.10
Mar-1E-P1	648638	5549332	13-Mar-19	No	0.5	68.0	9.72	1,488	6.76	No	2.0	1.0	2	0.05

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.11: *In Situ* Water Quality Measurements for Isolated Pools Observed in April 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)[a]	DO (mg/L)[a]	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P3	648778	5549097	17-Apr-19	Yes	4.9	-	-	1,175	7.34	Yes	10	2.5	25	0.40
SC1-P2	648730	5549114	16-Apr-19	No	5.2	-	-	1,217	6.74	No	3	1	3	0.10
SC1-P1	648383	5549315	16-Apr-19	No	4.7	-	-	878	7.74	No	3	2	6	0.10
Apr-1E-P1	648340	5549956	16-Apr-19	No	2.4	-	-	475.4	6.41	No	10	1.5	15	0.15
SC4-P1	648602	5549388	17-Apr-19	Yes	5.0	-	-	1,256	7.22	No	4	2	8	0.20
SC2-P5	648587	5549436	17-Apr-19	Yes	4.5	-	-	524.6	7.76	No	23	3	69	0.35
SC2-P1	648562	5549469	16-Apr-19	No	3.4	-	-	1,200	6.49	No	10	3	30	0.20
Apr-1E-P4	648624	5549395	16-Apr-19	No	3.6	-	-	493.8	7.15	No	4	2	8	0.15
Apr-1E-P5	648652	5549328	16-Apr-19	No	4.2	-	-	686.4	7.10	No	75	2	150	0.25
Apr-1E-P6	648699	5549241	16-Apr-19	No	5.2	-	-	1,121	6.84	No	5	1	5	0.10
Apr-3-P1	648295	5550320	17-Apr-19	No	0.3	-	-	39.8	5.36	No	5	2	10	0.05
Apr-3-P2	648263	5550674	17-Apr-19	No	0.6	-	-	183.3	6.41	No	4	2	8	0.20
Apr-3-P3	648256	5550768	17-Apr-19	No	0.6	-	-	206.8	6.03	No	15	1.5	22.5	0.20
Apr-3-P4	648269	5550868	17-Apr-19	No	0.2	-	-	225.0	5.88	No	2	1	2	0.10
SC3-P15	648278	5550864	17-Apr-19	Yes	0.9	-	-	86.3	6.44	No	10	3	30	0.30
Apr-3-P6	648292	5551012	17-Apr-19	No	0.7	-	-	191.1	6.37	No	5	1.5	7.5	0.20
Apr-3-P7	648359	5551226	17-Apr-19	No	0.2	-	-	217.7	6.27	No	5	1	5	0.20
Apr-3-P8	648371	5551280	17-Apr-19	No	0.4	-	-	202.4	6.10	No	12	2	24	0.10
SC3-P13	648325	5551726	17-Apr-19	Yes	4.6	-	-	886.0	7.83	No	10	2.5	25	0.20
Apr-3-P10	648074	5551612	17-Apr-19	No	1.3	-	-	305.2	6.87	No	2	1	2	0.10
Apr-3-P11	647877	5551841	17-Apr-19	No	0.7	-	-	236.3	6.75	No	7	1	7	0.10
Apr-3-P12	647824	5552006	17-Apr-19	No	1.5	-	-	263.4	6.70	No	5	1	5	0.15
Apr-3-P13	647920	5552177	17-Apr-19	No	0.4	-	-	238.0	6.96	No	5	2	10	0.5

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] DO probe was malfunctioning.

Table B.12: *In Situ* Water Quality Measurements for Isolated Pools Observed in May 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P3	648778	5549097	8-May-19	Yes	4.2	57.4	7.42	1,068	7.24	No	12	3	36	0.30
SC1-P2	648730	5549114	6-May-19	No	5.4	66.0	8.24	1,111	6.99	No	4	1	4	0.20
SC4-P1	648602	5549388	8-May-19	Yes	3.9	53.2	6.94	1,107	7.20	No	6	2	12	0.15
May-1E-P1	648617	5549398	6-May-19	No	8.0	72.3	8.52	479.2	7.16	No	15	2	30	0.15
SC2-P5	648606	5549422	8-May-19	Yes	4.8	63.5	8.11	843	7.33	No	36	3	108	0.30
SC2-P1	648565	5549480	6-May-19	No	7.0	79.0	9.50	981	7.25	No	15	2.5	37.5	0.40
May-1E-P4	648628	5549374	6-May-19	No	7.3	63.3	7.54	501.1	7.08	No	10	2	20	0.10
SC2-P10	648635	5549343	8-May-19	Yes	3.1	50.8	6.79	1,016	7.26	No	142	3	426	0.25
May-3-P1[a]	648405	5551545	7-May-19	No	-	-	-	-	-	No	10	1	10	0.05
SC3-P13	648393	5551580	8-May-19	Yes	6.5	76.6	9.35	1,306	7.54	No	175	5	875	0.20
May-3-P3	648007	5551656	7-May-19	No	8.7	75.9	8.81	357.3	7.38	No	5	3	15	0.10

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] Pool May-3-P1 too shallow for YSI.

Table B.13: *In Situ* Water Quality Measurements for Isolated Pools Observed in August 2019

Pool Name	**UTM**		**Date**	**Water Quality Sample Collected (yes/no)**	**Temperature (°C)**	**DO (%)**	**DO (mg/L)**	**Specific Conductivity (µs/cm)**	**pH**	**Observed Fish Presence (yes/no)**	**Length (m)**	**Width (m)**	**Surface Area (m^2)**	**Deepest Depth (m)**
	Easting	**Northing**												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC1-P2	648730	5549114	7-Aug-19	Yes	10.7	41.6	▨ 4.56	360.2	7.40	No	20	2	40	0.25
Aug-1-P1[a]	648756	5549098	14-Aug-18	No	-	-	-	-	-	No	7	2	14	0.05

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

[a] Pool Aug-1-P1 too shallow for YSI.

Table B.14: ***In Situ* Water Quality Measurements for Isolated Pools Observed in September 2019**

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC1-P2	648730	5549114	20-Sep-19	Yes	10.2	52.7	5.87	722	6.85	No	3	1.5	4.5	0.20
SC4-P1	648602	5549388	20-Sep-19	Yes	9.6	42.9	4.84	864	7.01	No	4	2	8	0.20
Sep-1E-P1	648557	5549493	19-Sep-19	No	9.2	49.8	5.69	1,131	6.54	No	5	1	5	0.10
Sep-1E-P2	648519	5549548	19-Sep-19	No	10.0	46.2	5.17	1,190	6.53	No	15	2	30	0.10
SC2-P1	648559	5549477	20-Sep-19	Yes	9.7	49.7	5.62	925	7.00	Yes	25	3	75	0.30
Sep-1E-P3	648585	5549456	19-Sep-19	No	10.2	69.8	7.80	941	6.86	Yes	290	3	870	0.30

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.15: *In Situ* Water Quality Measurements for Isolated Pools Observed in October 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (μs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P3	648778	5549097	9-Oct-19	Yes	4.2	51.6	6.69	1,209	6.76	Yes	7	3	21	0.30
SC1-P2	648730	5549114	7-Oct-19	No	6.0	43.3	5.35	913	6.37	No	2	1	2	0.10
SC1-P1	648380	5549318	9-Oct-19	Yes	3.7	79.8	10.52	989	6.62	No	7	5.5	38.5	0.40
Oct-1W-P2	648249	5549726	7-Oct-19	No	1.2	58.8	8.24	1,307	6.95	Yes	5	1	5	0.20
Oct-1W-P3	648266	5549862	7-Oct-19	No	3.1	69.7	9.33	1,516	6.88	Yes	5	1	5	0.30
Oct-1W-P4	648300	5599931	7-Oct-19	No	4.1	64.5	8.36	1,601	6.73	No	2	1	2.0	0.20
SC2-P7	648670	5549301	9-Oct-19	Yes	4.4	54.7	7.03	1,191	6.67	Yes	7	5	35	0.30
Oct-1E-P3	648661	5549296	7-Oct-19	No	4.3	66.9	8.47	957	7.21	Yes	9	2	18	0.20
Oct-1E-P4	648647	5549329	7-Oct-19	No	5.5	54.9	6.87	962	6.66	Yes	6	2	12	0.25
SC2-P10	648636	5549336	7-Oct-19	No	5.4	52.7	6.64	986	6.97	Yes	7	4	28	0.25
SC2-P5	648592	5549424	7-Oct-19	No	5.7	73.0	9.06	781	6.52	Yes	9	3	27	0.60
SC2-P1	648559	5549477	9-Oct-19	Yes	3.5	60.8	8.04	1,315	6.34	Yes	4	2	8	0.20
Oct-1E-P8	648686	5549285	7-Oct-19	No	6.4	79.9	9.79	850	7.32	Yes	12	2	24	0.15
Oct-1E-P9	648689	5549275	7-Oct-19	No	6.1	53.5	6.60	894	7.34	Yes	4	1.5	6	0.15

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.16: *In Situ* Water Quality Measurements for Isolated Pools Observed in November 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (µs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
Nov-1W-P1	648338	5549994	4-Nov-19	No	0.0	82.1	11.95	1,752	7.32	No	8	2	16	0.15
SC2-P3	648778	5549097	6-Nov-19	Yes	1.3	33.4	4.64	844	6.35	No	3.5	2	7	0.30
SC2-P7	648670	5549301	6-Nov-19	Yes	0.9	29.1	4.15	713.1	6.62	No	5	3	15	0.10
Nov-1E-P1	648655	5549321	4-Nov-19	No	3.5	65.5	8.66	970	7.31	No	5	1	5	0.10
SC2-P10	648636	5549336	4-Nov-19	No	1.1	37.9	5.35	950	6.78	No	3	1	3	0.15
SC2-P5	648592	5549424	4-Nov-19	No	1.1	40.0	5.40	619.9	6.68	No	8	2	16	0.40
SC2-P1	648559	5549477	6-Nov-19	Yes	0.1	35.7	5.17	357.1	6.35	No	2	1	2	0.20
Nov-3-P1	648400	5551541	4-Nov-19	No	0.5	91.2	13.09	288.6	7.14	No	60	3	180	0.30
SC3-P11	648380	5551613	6-Nov-19	Yes	0.0	90.3	13.15	282.8	6.73	No	6	1	6	0.15

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.17: *In Situ* Water Quality Measurements for Isolated Pools Observed in December 2019

Pool Name	UTM		Date	Water Quality Sample Collected (yes/no)	Temperature (°C)	DO (%)	DO (mg/L)	Specific Conductivity (μs/cm)	pH	Observed Fish Presence (yes/no)	Length (m)	Width (m)	Surface Area (m^2)	Deepest Depth (m)
	Easting	Northing												
BC WQG Minimum	-	-	-	-	-	-	5	-	6.5	-	-	-	-	-
BC WQG Maximum	-	-	-	-	19.0	-	-	-	9	-	-	-	-	-
SC2-P3	648782	5549093	4-Dec-19	Yes	2.2	34.1	4.67	1,006	6.93	No	5.0	2.0	10	0.30
SC2-P7	648671	5549288	2-Dec-19	No	0.8	25.5	3.64	755	6.46	No	1.0	0.5	0.5	0.05
Dec-1E-P1	648651	5549325	2-Dec-19	No	0.3	40.3	5.84	836	6.83	No	3	0.5	1.5	0.10
SC2-P10	648640	5549335	4-Dec-19	Yes	0.1	43.6	6.35	1,054	7.01	Yes	2.5	1	3	0.20
SC2-P5	648593	5549427	2-Dec-19	No	0.0	4.0	0.58	485.6	6.13	No	8	2	16	0.30
SC2-P1	648559	5549475	4-Dec-19	Yes	0.3	44.5	6.44	1,058	7.13	Yes	1.5	1	1.5	0.20
SC3-P9	647953	5551705	4-Dec-19	Yes	0.0	70.0	10.21	335.6	7.11	No	20	3	60	0.20
SC3-P6	647834	5551900	3-Dec-19	No	0.3	58.1	8.40	269.1	6.91	No	6	2	12	0.10

▨ Value less than the BCWQG minimum or greater than the BCWQG maximum.

Note: " - " indicates no value.

Table B.18: GHO LAEMP Fish Observations, January 2018 to December 2019

Species	Number	Life Stage	Year	Month	Location	Easting	Northing
unidentified	<10	fry	2018	June	Reach 2	648385	5550197
MW	~30	fry	2018	July	Reach 2	648284	5550122
MW	5	fry	2018	July	Reach 2 (1st finger)	648284	5550168
unidentified	~30	fry	2018	July	Reach 2	648380	5550206
LSU	4	unknown	2018	August	Reach 2	648371	5550219
MW	2	unknown	2018	August	Reach 2	648371	5550219
MW	3	unknown	2018	August	Reach 2	648324	5550233
MW	3	unknown	2018	August	Reach 2	648325	5550229
MW	2	unknown	2018	August	Reach 2	648333	5550225
MW	1	unknown	2018	August	Reach 2	648345	5550226
WCT	15 - 20	juvenile / adult	2018	August	Reach 1	648782	5549097
MW	5	fry	2018	August	Reach 1 (west channel)	648511	5549241
MW	~50	fry	2018	August	Reach 2 (1st finger)	648303	5550163
unidentified	<10	fry	2018	August	Reach 1	648363	5549777
5 MW fry	5	fry	2018	August	Reach 1 (east channel)	648719	5549228
unidentified	1	adult	2018	August	Reach 3 (near ERSC4)	648111	5552523
MW	~40	fry	2018	September	Reach 1 (SC2-P3)	648777	5549096
MW	~20	fry	2018	September	Reach 1 (west channel)	648741	5549139
WCT	1	juvenile	2018	September	Reach 1 (west channel)	648741	5549139
MW [a]	125	fry	2018	September	Reach 2 (2nd finger)	648090	5550244
MW	5	fry	2018	September	Reach 1 (pool SC2-P5)	648598	5549419
unidentified	1	juvenile	2018	September	Reach 1 (pool SC2-P5)	648598	5549419
MW	~40	fry	2018	September	Reach 1 (pool SC2-P1)	648561	5549473
unidentified	1	juvenile	2018	September	Reach 1 (pool SC2-P1)	648561	5549473
MW	20	fry	2018	September	Reach 1 (pool SC2-P7)	648638	5549332
MW	~25	fry	2018	September	Reach 1 (east channel)	648658	5549316
unidentified	1	juvenile	2018	September	Reach 3	648254	5550573
MW	2	fry	2018	September	Reach 3	648050	5551618
MW	~30	fry	2018	October	Reach 1 (SC2-P3)	648777	5549096
MW	~25	fry	2018	October	Reach 1 (east channel pool)	648691	5549275
WCT	5	juvenile	2018	October	Reach 1 (east channel pool)	648691	5549275
MW	~30	fry	2018	October	Reach 1 (east channel pool)	648685	5549293
MW	15	fry	2018	October	Reach 1 (east channel pool)	648669	5549299
MW	2	fry	2018	October	Reach 1 (east channel pool)	648657	5549306
MW	~50	fry	2018	October	Reach 1 (east channel pool)	648650	5549326
MW	23	fry	2018	October	Reach 1 (SC2-P2)	648638	5549336
WCT	7	juvenile	2018	October	Reach 1 (SC2-P2)	648638	5549336
MW fry	~30	fry	2018	October	Reach 1 (east channel pool)	648596	5549426
MW (most abundant), WCT and EB (present)	~200	fry / juvenile	2018	October	Reach 1 (pool SC2-P1)	648559	5549470
MW	~20	fry	2018	October	Reach 1 (west channel pool)	648733	5549150
MW	~10	fry	2018	November	Reach 1 (SC2-P1)	648561	5549477
unidentified	2	juvenile	2018	November	Reach 3	647861	5551860
unidentified	~20 - 30	fry / juvenile	2018	December	Reach 1 (pool SC2-P1)	648559	5549470
WCT	4	fry / juvenile	2018	December	Reach 1 (east channel pool)	648645	5549336
WCT	5	fry / juvenile	2018	December	Reach 1 (east channel pool)	648552	5549328
MW	1	fry	2019	April	Reach 1 SC2-P3	648782	5549093
MW	~10	fry	2019	August	Reach 1 SC1-P2	648733	5549113
MW	20	fry	2019	August	Reach 2	648285	5550117
MW	~10	fry	2019	September	Reach 1 SC2-P1	648561	5549479
EB	2	juvenile	2019	September	Reach 1 SC2-P1	648561	5549479
WCT	6	juvenile	2019	September	Reach 1 SC2-P1	648561	5549479
MW	1	fry	2019	September	Reach 1 (middle channel)	648368	5549776
MW	12	fry	2019	September	Reach 1 (middle channel)	648351	5549761
MW	1	fry	2019	September	Reach 3	648327	5551715
MW	~30	fry	2019	October	Reach 1 (pool Oct-1E-P4)	648647	5549329
MW and WCT	~20	fry	2019	October	Reach 1 SC2-P10	648636	5549336
WCT	4	juvenile	2019	October	Reach 1 SC2-P5	648593	5549427
WCT	3	juvenile	2019	October	Reach 1 SC2-P1	648559	5549475
EB	1	juvenile	2019	October	Reach 1 SC2-P1	648559	5549475
MW and WCT	~15	fry	2019	October	Reach 1 (pool Oct-1E-P8)	648686	5549285
MW	~10	fry	2019	October	Reach 1 (pool Oct-1E-P10)	648689	5549275
MW and WCT	~40	fry	2019	October	Reach 1 SC2-P3	648782	5549093
MW and WCT	~60	fry	2019	October	Reach 1 (pool Oct-1W-P2)	648249	5549726
BT	3	juvenile	2019	October	Reach 1 (pool Oct-1W-P3)	648266	5549862
MW	~20	fry	2019	October	Reach 1 (middle channel)	648340	5549891
MW	6	fry	2019	October	Reach 1 (middle channel)	648344	5549817
MW	~30	fry	2019	October	Reach 1 SC2-P7	648670	5549301
MW	~20	fry	2019	October	Reach 1 (pool Oct-1E-P3)	648661	5549296
MW	~40	fry	2019	December	Reach 1 SC2-P3	648782	5549093
WCT	~10	fry	2019	December	Reach 1 SC2-P10	648640	5549335
WCT	1	juvenile	2019	December	Reach 1 SC2-P1	648559	5549475

Note: MW = mountain whitefish. WCT = westslope cutthroat trout. EB = eastern brook trout. BT = bull trout. LSU = longnose sucker.

[a] The 125 MW were deceased and were found in the naturally dewatering area off of Reach 2.

Table B.19: GHO LAEMP Amphibian Observations, May 2017 to December 2019

Observation	Number	Year	Month	Location	Easting	Northing
western toad	1	2017	June	Reach 1	-	-
Columbia spotted frog	1	2017	July	Reach 1	-	-
western toad	1	2017	July	Reach 2	-	-
Columbia spotted frog	1	2017	August	Reach 1	-	-
Columbia spotted frog	1	2017	August	Reach 3	-	-
unidentified frog/toad	1	2017	August	Elk River	-	-
Columbia spotted frog	1	2018	June	Reach 2	648373	5550161
western toad	1	2018	July	Reach 1/2 break	648257	5549933
western toad	1	2018	July	Reach 2	648325	5550044
western toad	1	2018	July	Reach 2 (2nd finger)	648112	5550281
western toad	1	2018	July	Reach 2	648167	5550274
western toad	1	2018	August	Reach 1 (west channel)	648476	5549317
western toad	1	2018	August	Reach 2 (2nd finger)	647955	5550282
western toad	1	2018	August	Reach 1 (east channel)	648597	5549374
long-toed salamander[a]	10	2018	September	Reach 2 (2nd finger)	648090	5550244
western toad	1	2019	July	Reach 1 (west channel)	648268	5549847

Note: "-" indicates UTM not recorded.

[a] The 10 salamanders (larva life stage) were found deceased in the naturally dewatering area off of Reach 2.

Table B.20: GHO LAEMP Aquatic-dependent Bird Observations, May 2017 to December 2019

Observation	Number	Year	Month	Location	Easting	Northing
mallard	multiple	2017	August	Reach 1	-	-
killdeer	1	2018	May	Reach 3 near Wolfram	648146	5551918
American bittern	1	2018	June	Reach 2	648345	5550229
bank swallow	8	2018	June	Reach 2	648345	5550229
belted kingfisher	1	2018	June	Reach 2	648345	5550229
Canada goose	8	2018	June	Reach 2	648345	5550229
common yellowthroat	3	2018	June	Reach 2	648345	5550229
northern waterthrush	8	2018	June	Reach 2	648345	5550229
killdeer	1	2018	June	Reach 1 (east channel)	648436	5549673
female mallard	2	2018	June	Reach 1 (east channel)	648384	5549941
killdeer	2	2018	June	Reach 1 (middle channel)	648346	5549588
killdeer	1	2018	June	Reach 1 (west channel)	648764	5549055
killdeer	1	2018	June	Reach 2	648290	5550004
male mallard	1	2018	June	Reach 2	647958	5550266
female mallard	1	2018	June	Reach 2	647958	5550266
killdeer	1	2018	June	Wolfram Pond	648137	5552003
Canada goose	8	2018	June	Reach 2	-	-
blue heron	1	2018	July	Reach 1	648661	5549156
killdeer	2	2018	July	Reach 1	648343	5549859
mallard	1	2018	July	Reach 1	648416	5549822
killdeer	2	2018	July	Reach 3 near Wolfram	648210	5552101
mallard	1	2018	August	Reach 1 (east channel)	648497	5549663
killdeer	1	2018	August	Reach 1	648482	5549449
Canada goose	1	2018	August	Reach 3 near Wolfram	648197	5552099
killdeer	1	2019	April	Reach 1 (east channel)	648507	5549561
killdeer	2	2019	May	Reach 1 (east channel)	648639	5549343
mallard	2	2019	May	Reach 2	648341	5550064
Canada goose	2	2019	May	Reach 2	648334	5550169
snipe	1	2019	June	Reach 2	648162	5549988
wood duck	1	2019	June	Reach 2	648239	5550210
wood duck	2	2019	June	Reach 2	648126	5550240
great blue heron	1	2019	August	Reach 1 (west channel)	648220	5549506
sandpiper	1	2019	August	Reach 2	648239	5550198

Note: "-" indicates UTM not recorded.

APPENDIX C

WATER QUALITY

WATER QUALITY

West-side Tributary Water Quality Figures

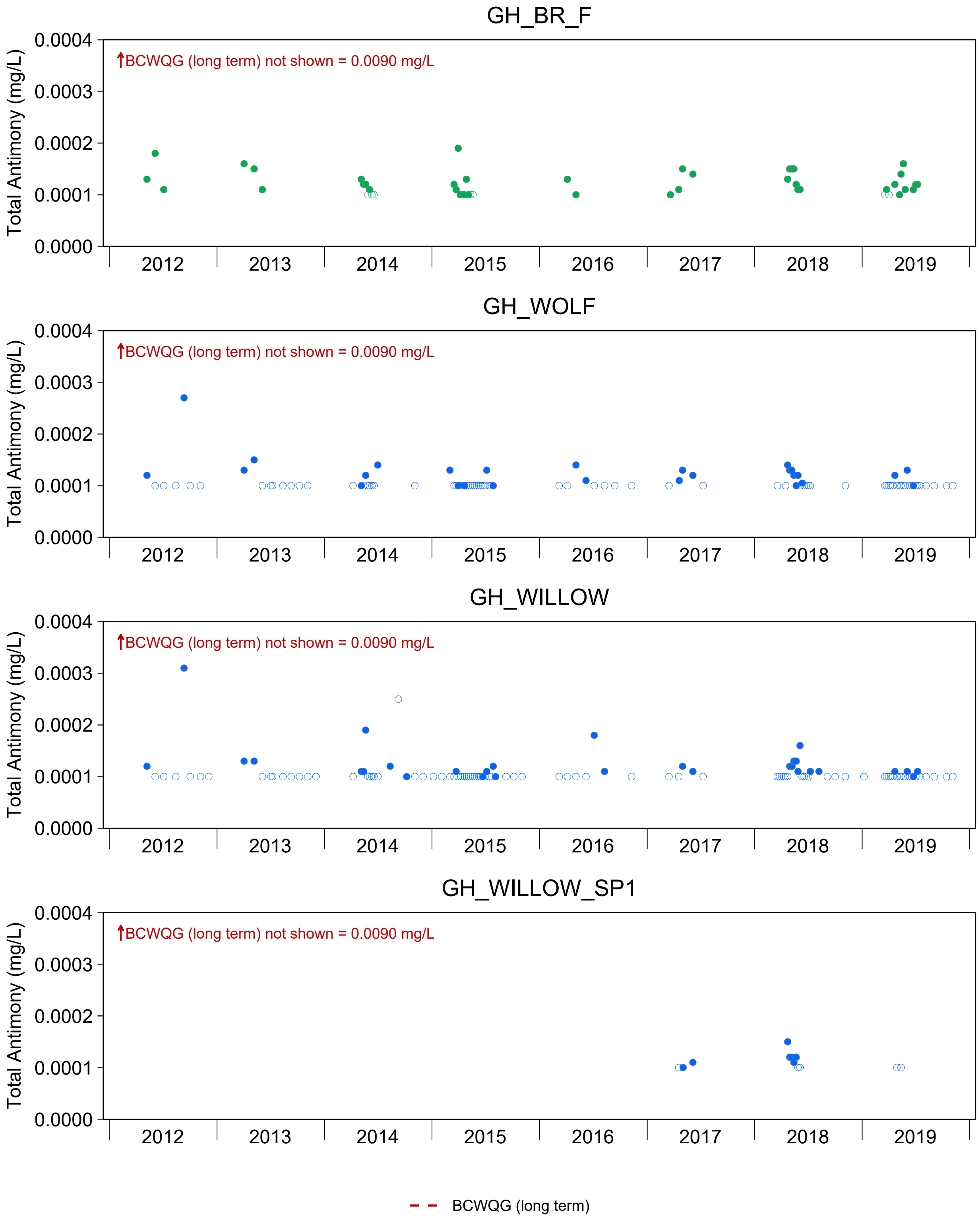


Figure C.1: **Time Series Plots for Total Antimony Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

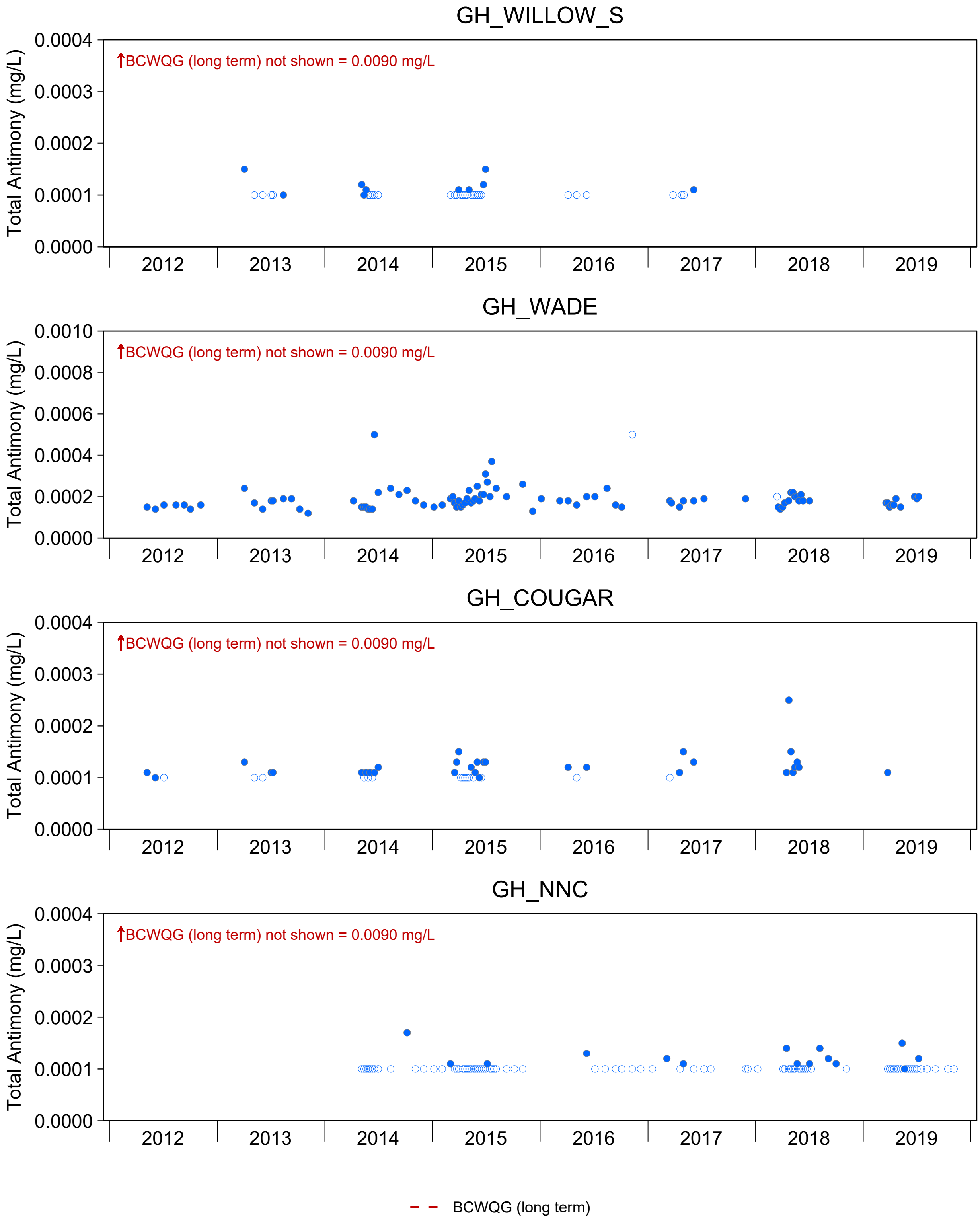


Figure C.1: Time Series Plots for Total Antimony Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

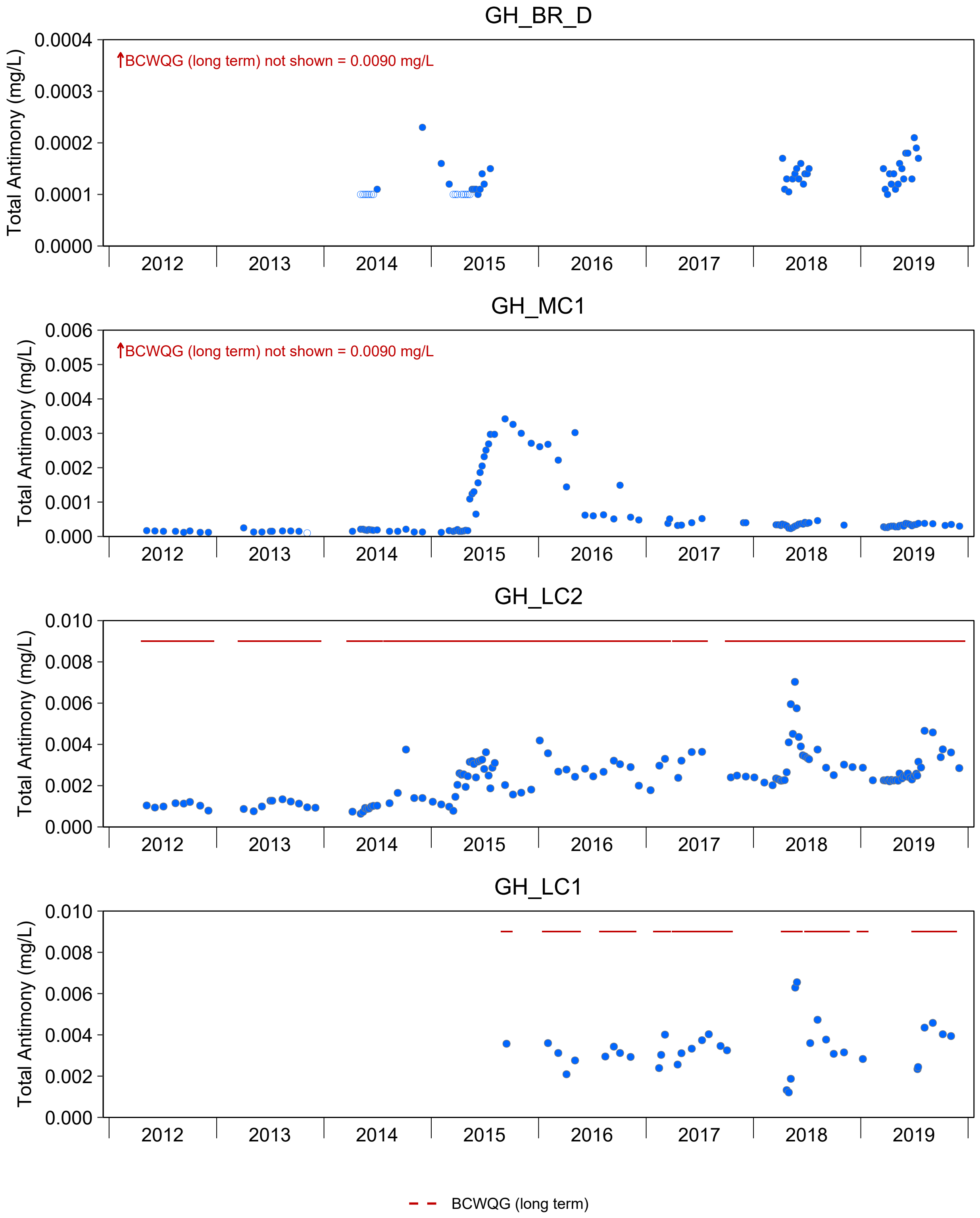


Figure C.1: **Time Series Plots for Total Antimony Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

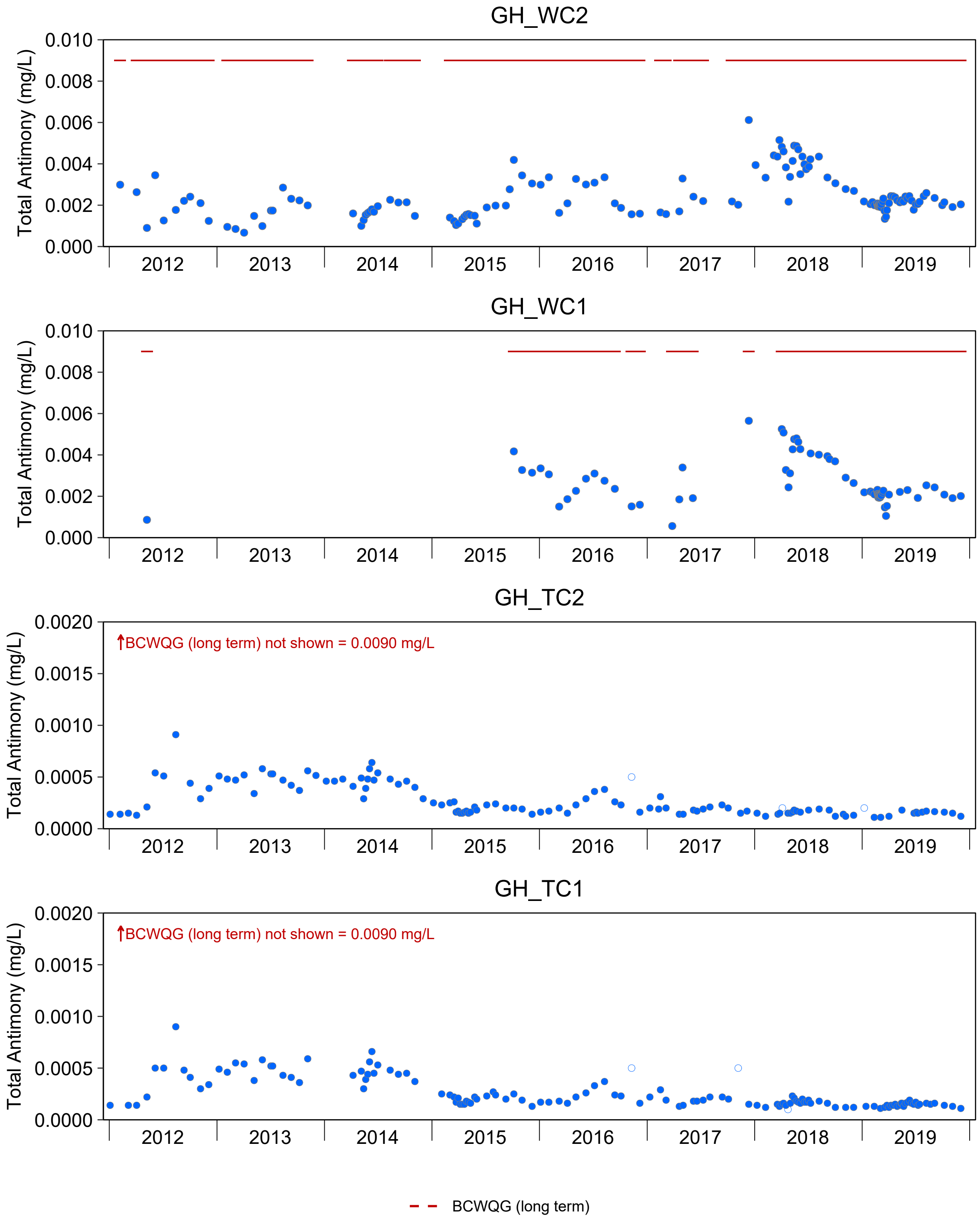


Figure C.1: **Time Series Plots for Total Antimony Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

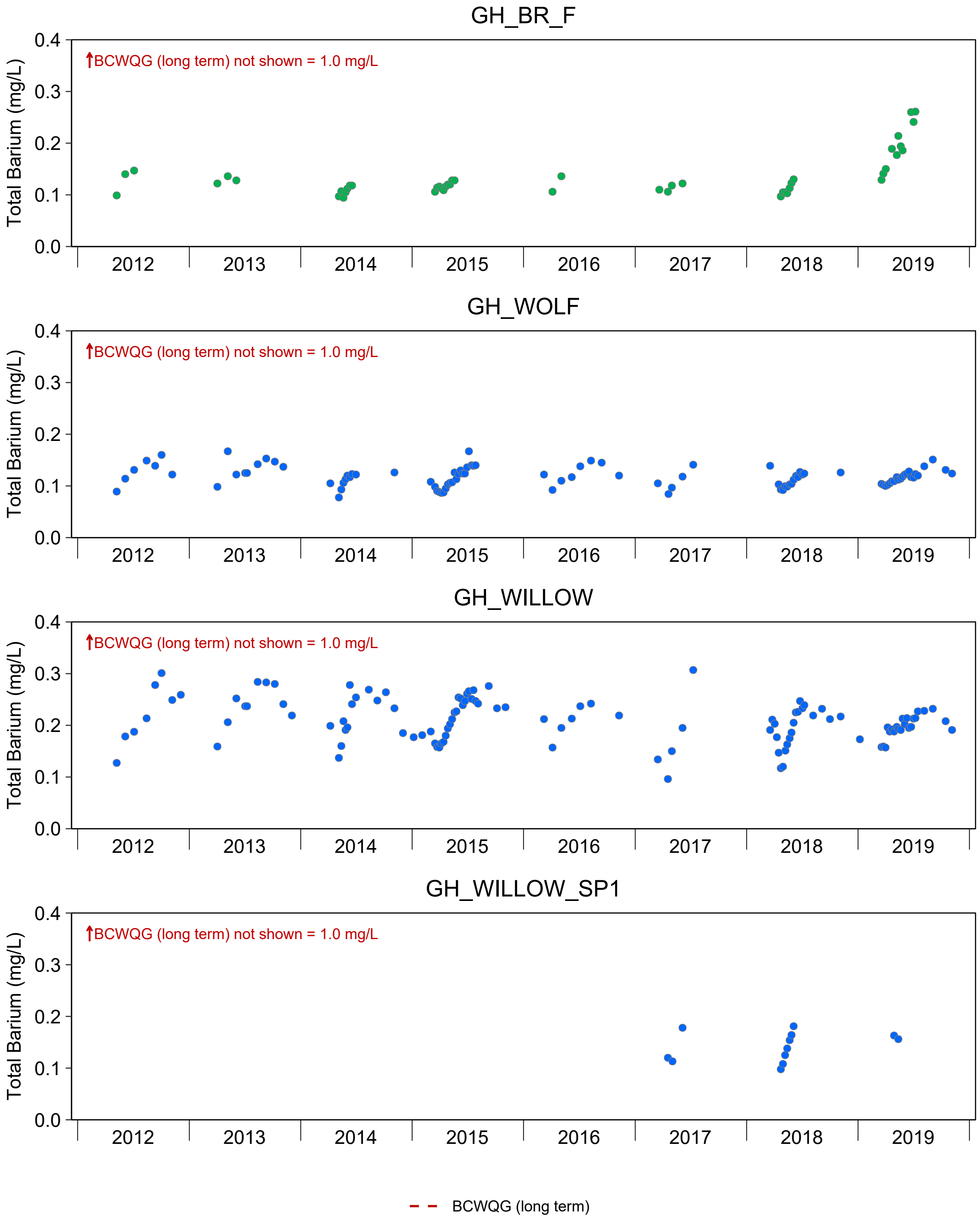


Figure C.2: **Time Series Plots for Total Barium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

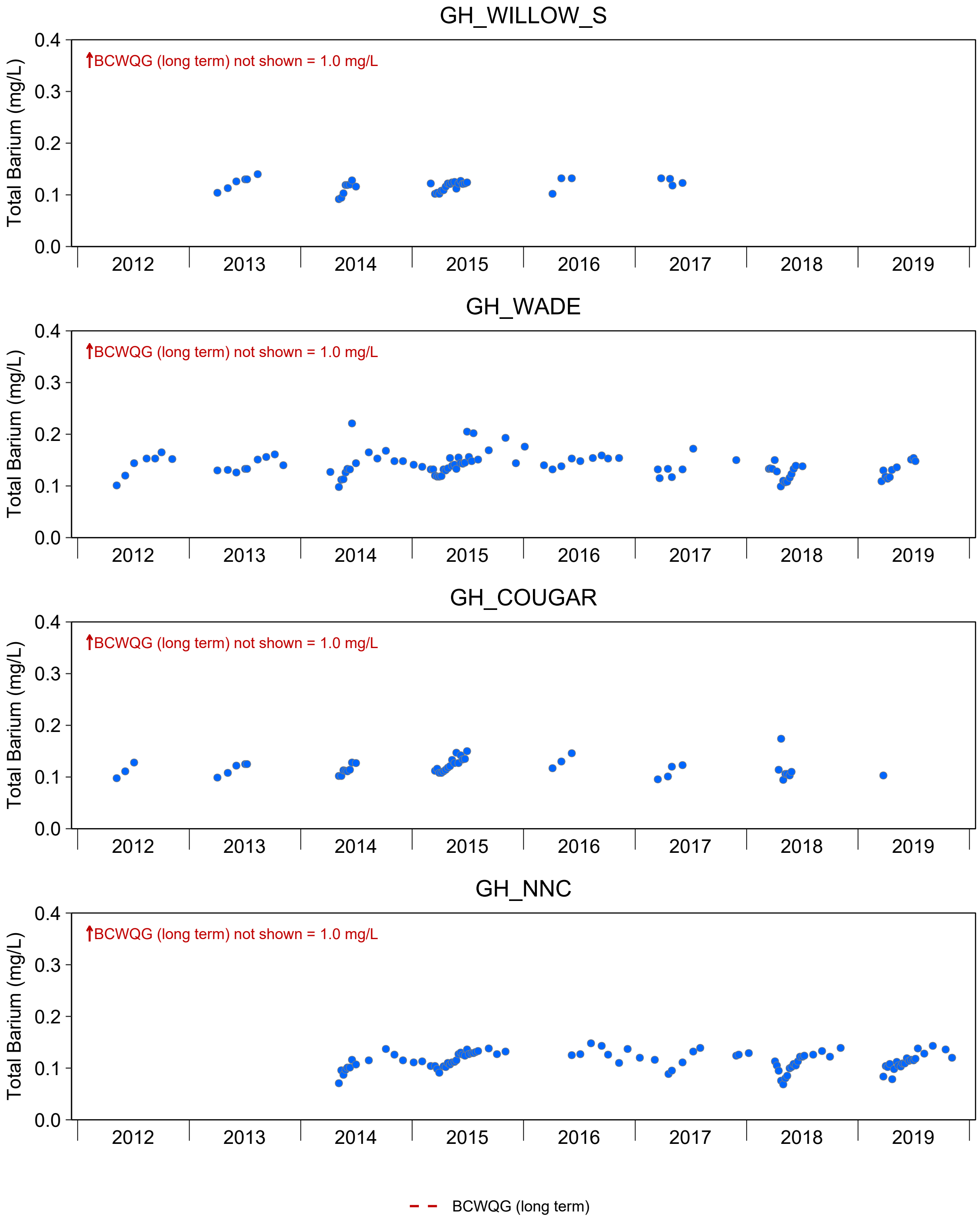


Figure C.2: Time Series Plots for Total Barium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

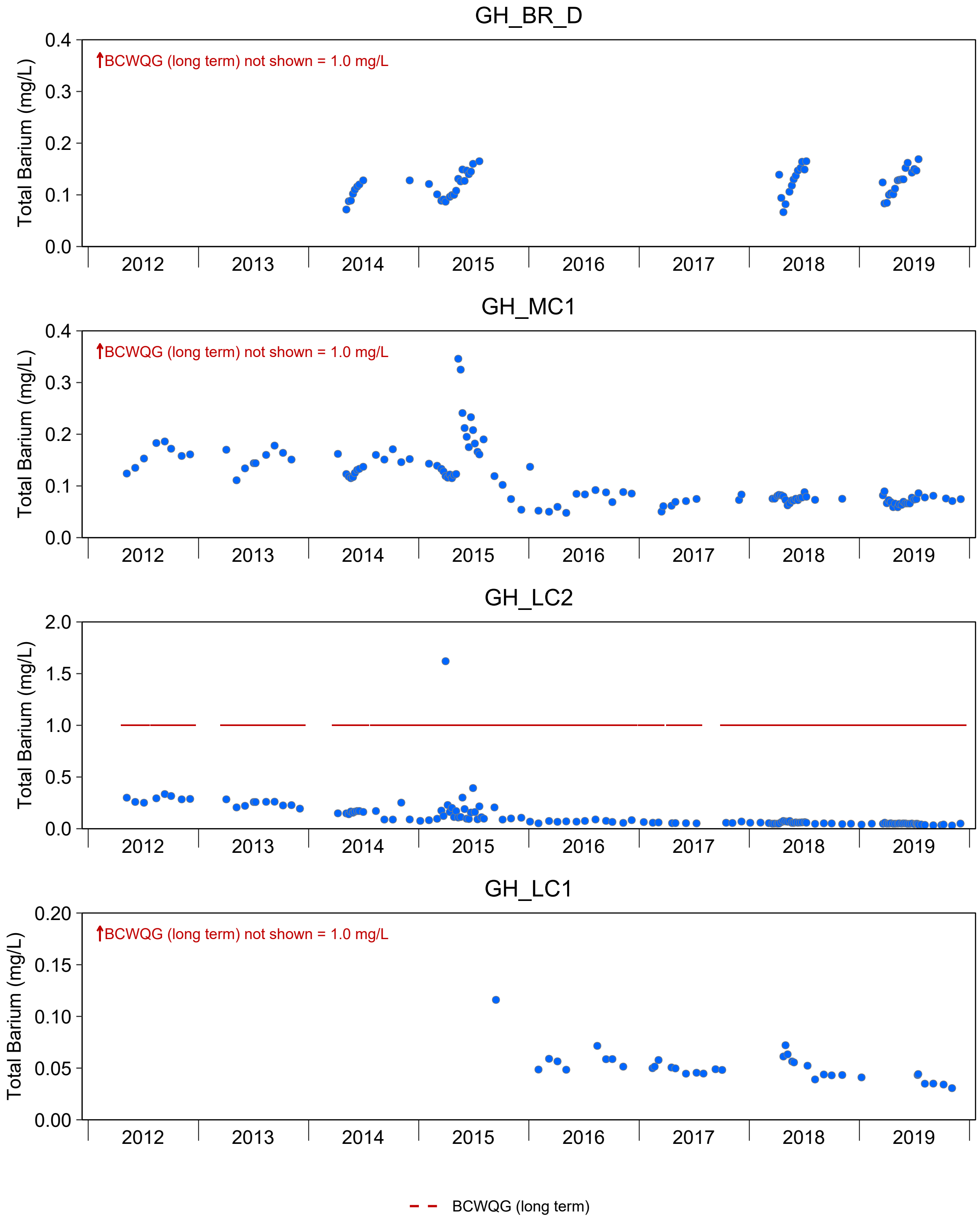


Figure C.2: **Time Series Plots for Total Barium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

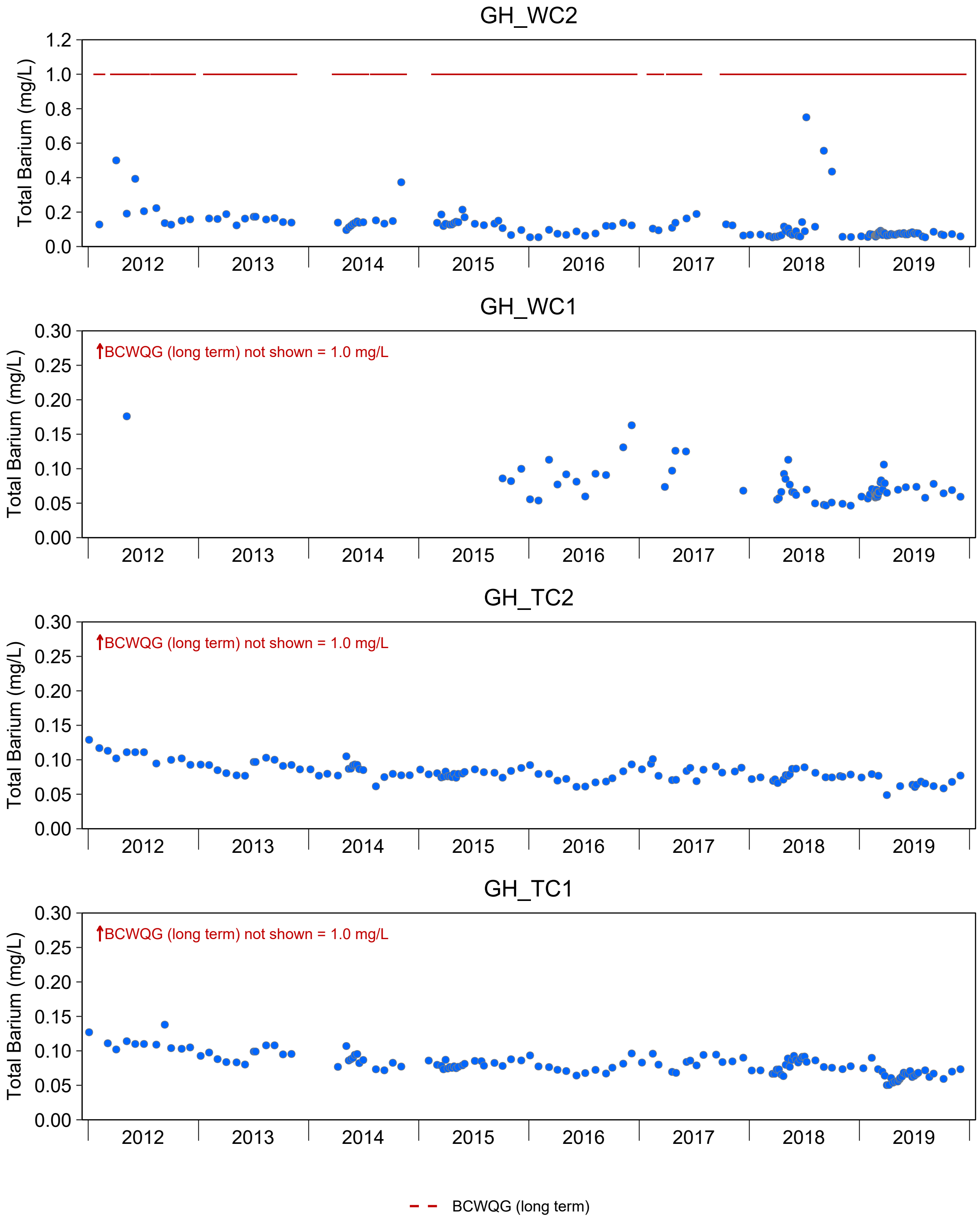


Figure C.2: **Time Series Plots for Total Barium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

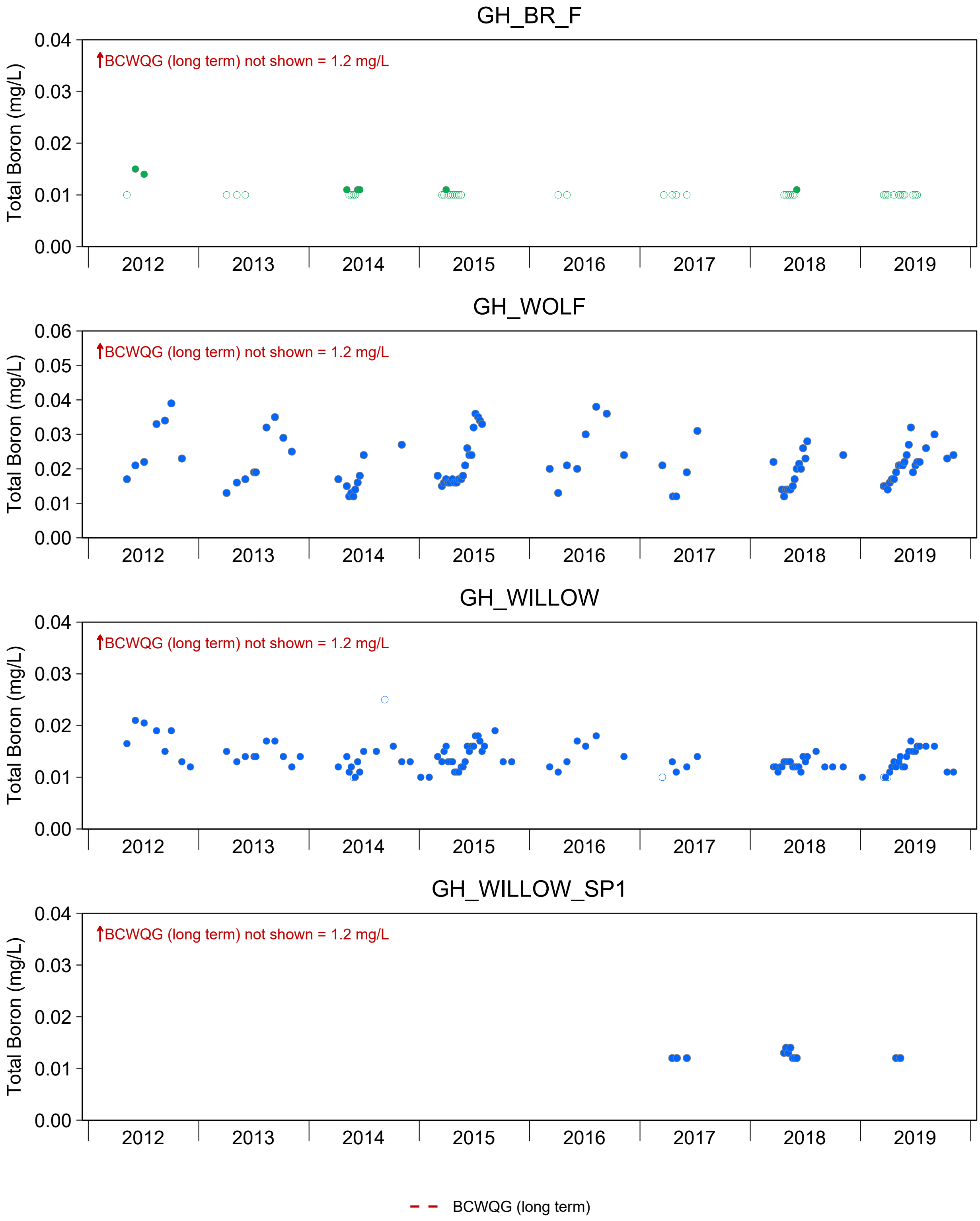


Figure C.3: **Time Series Plots for Total Boron Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

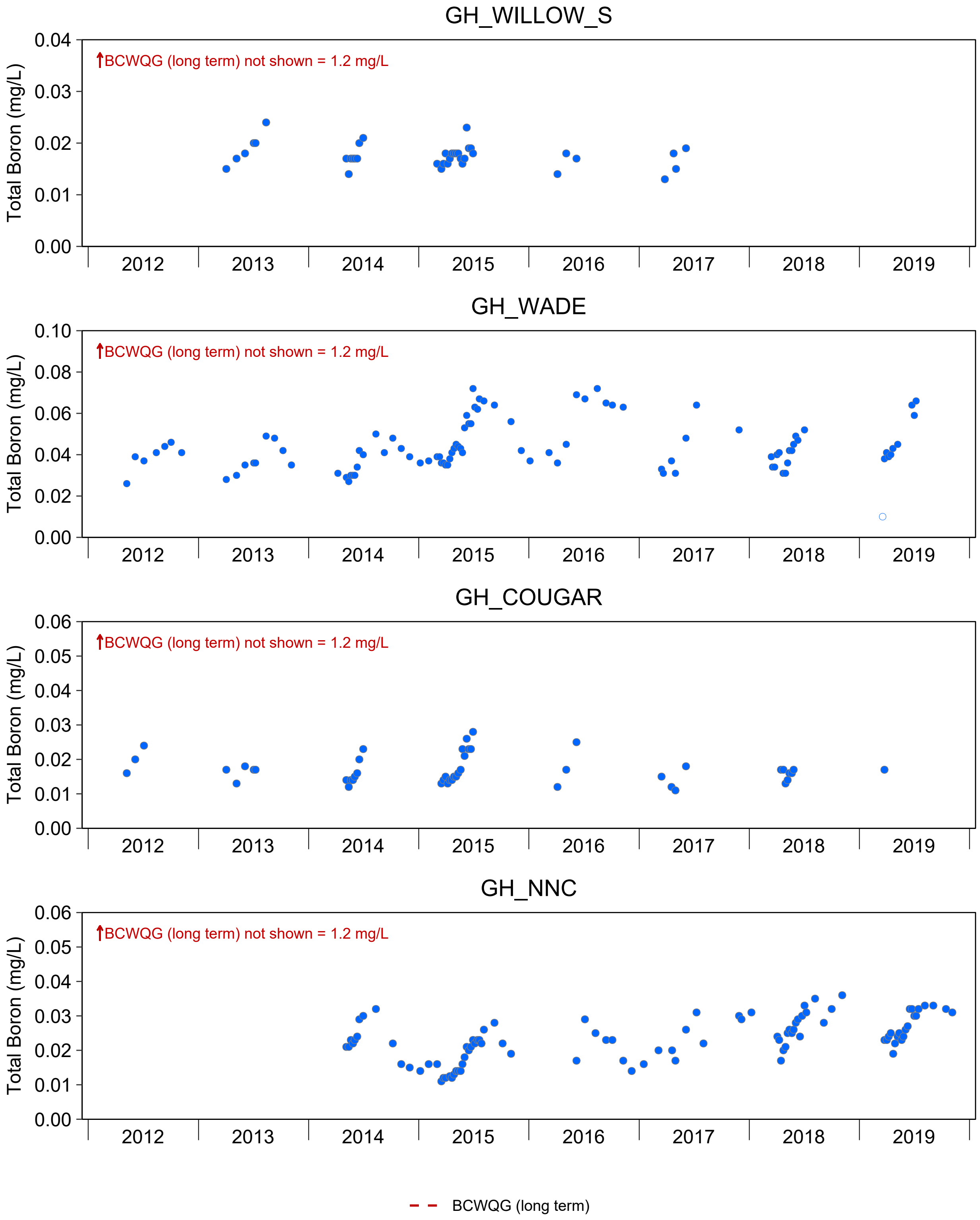


Figure C.3: **Time Series Plots for Total Boron Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

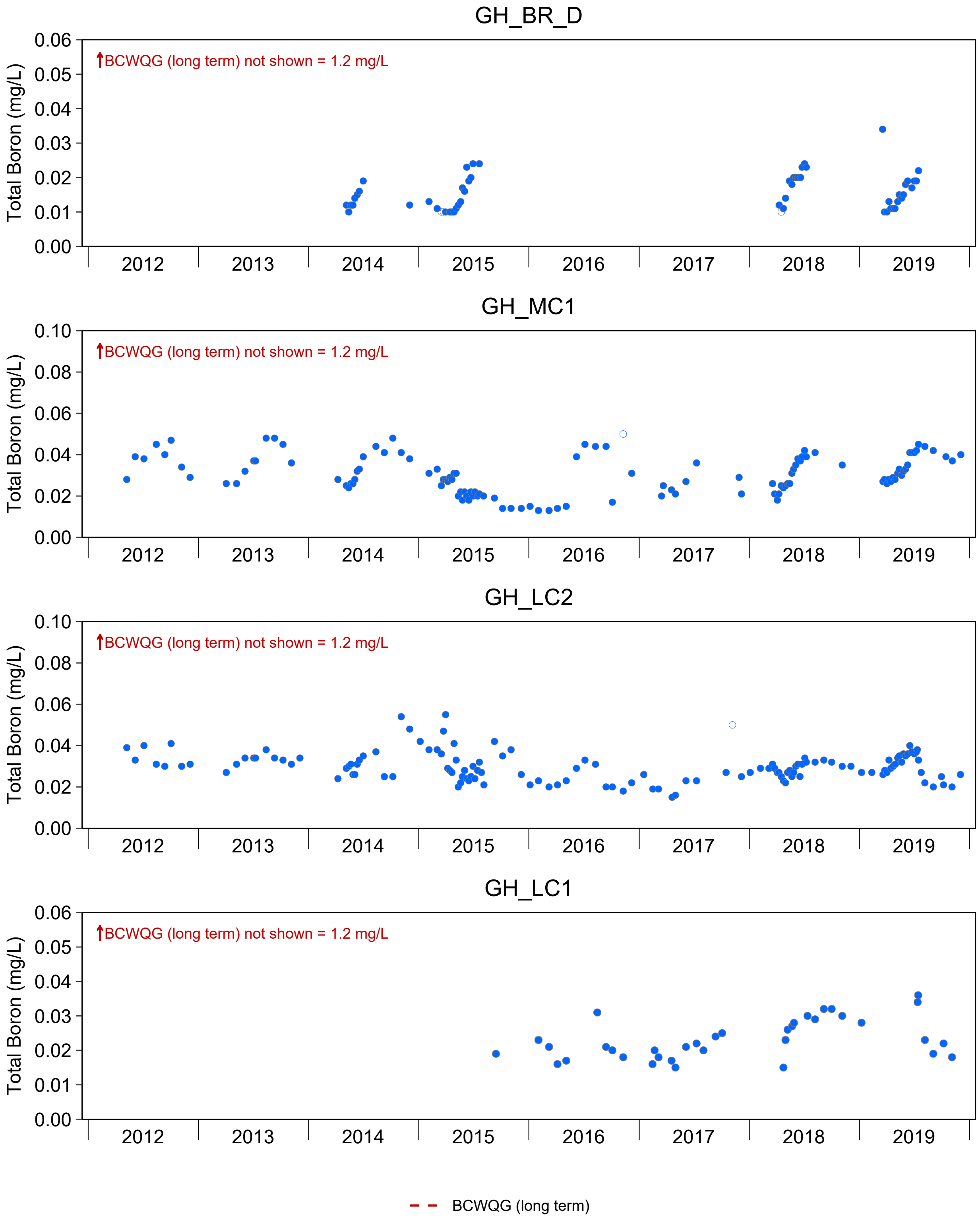


Figure C.3: **Time Series Plots for Total Boron Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

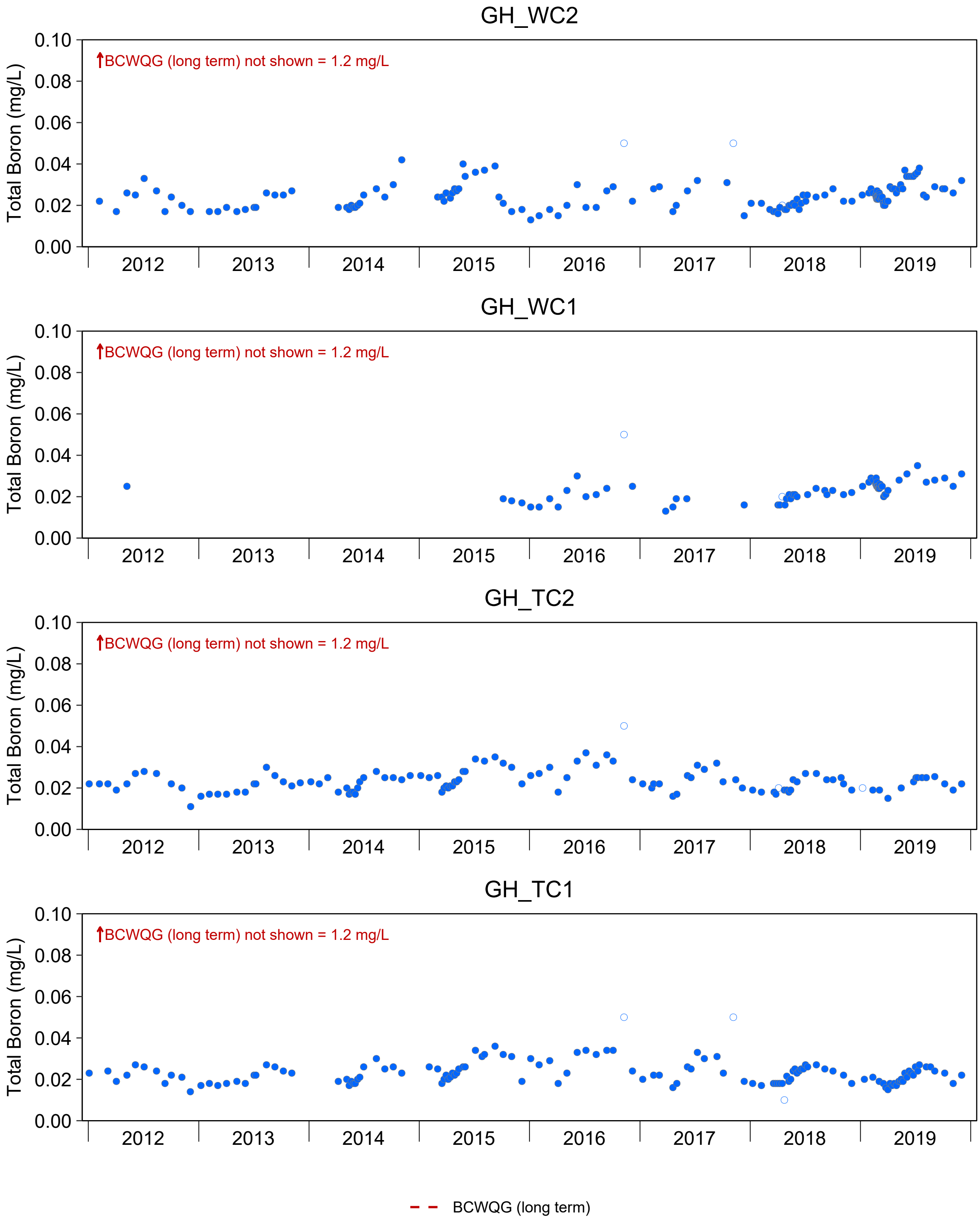


Figure C.3: Time Series Plots for Total Boron Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

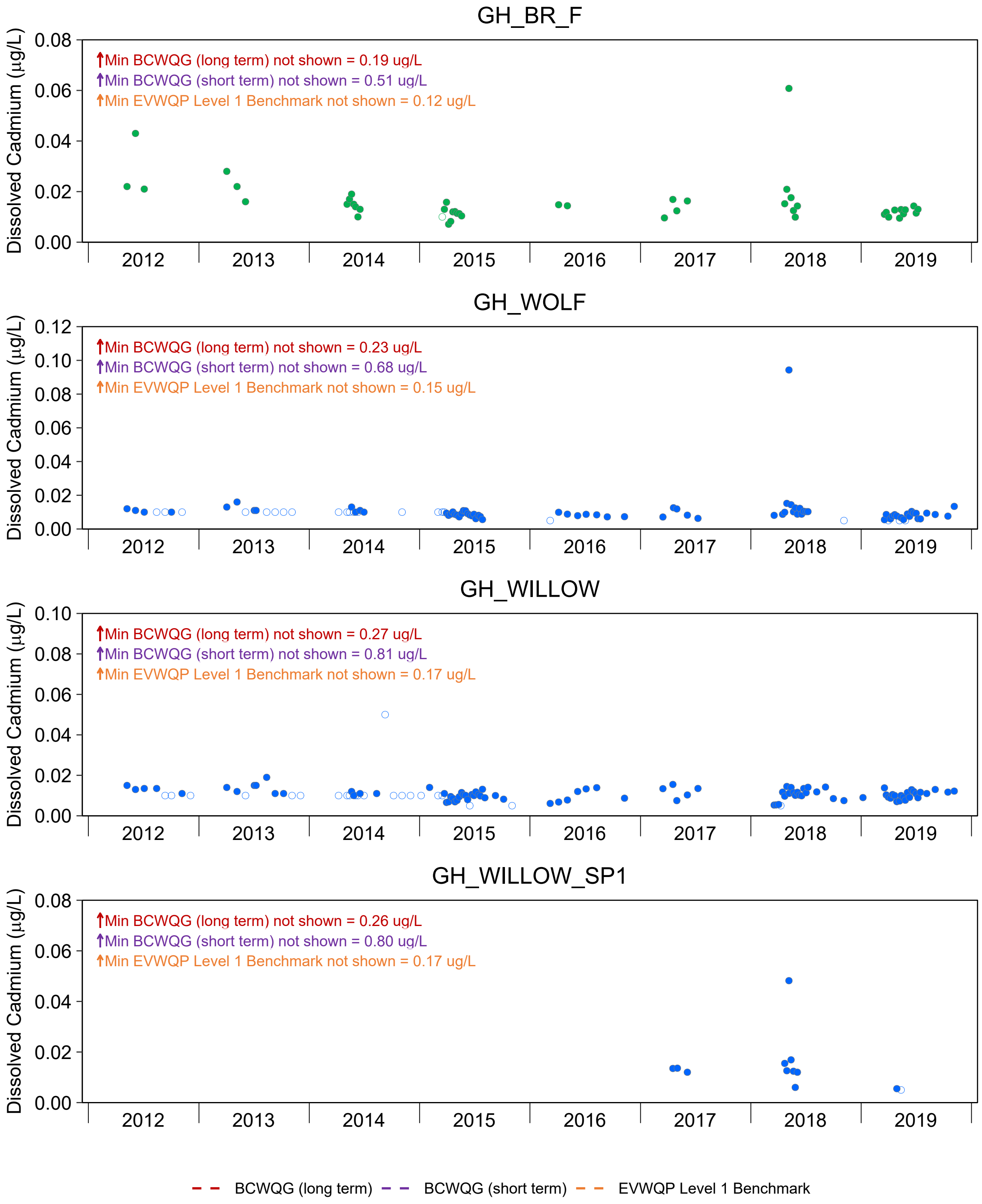


Figure C.4: Time Series Plots for Dissolved Cadmium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

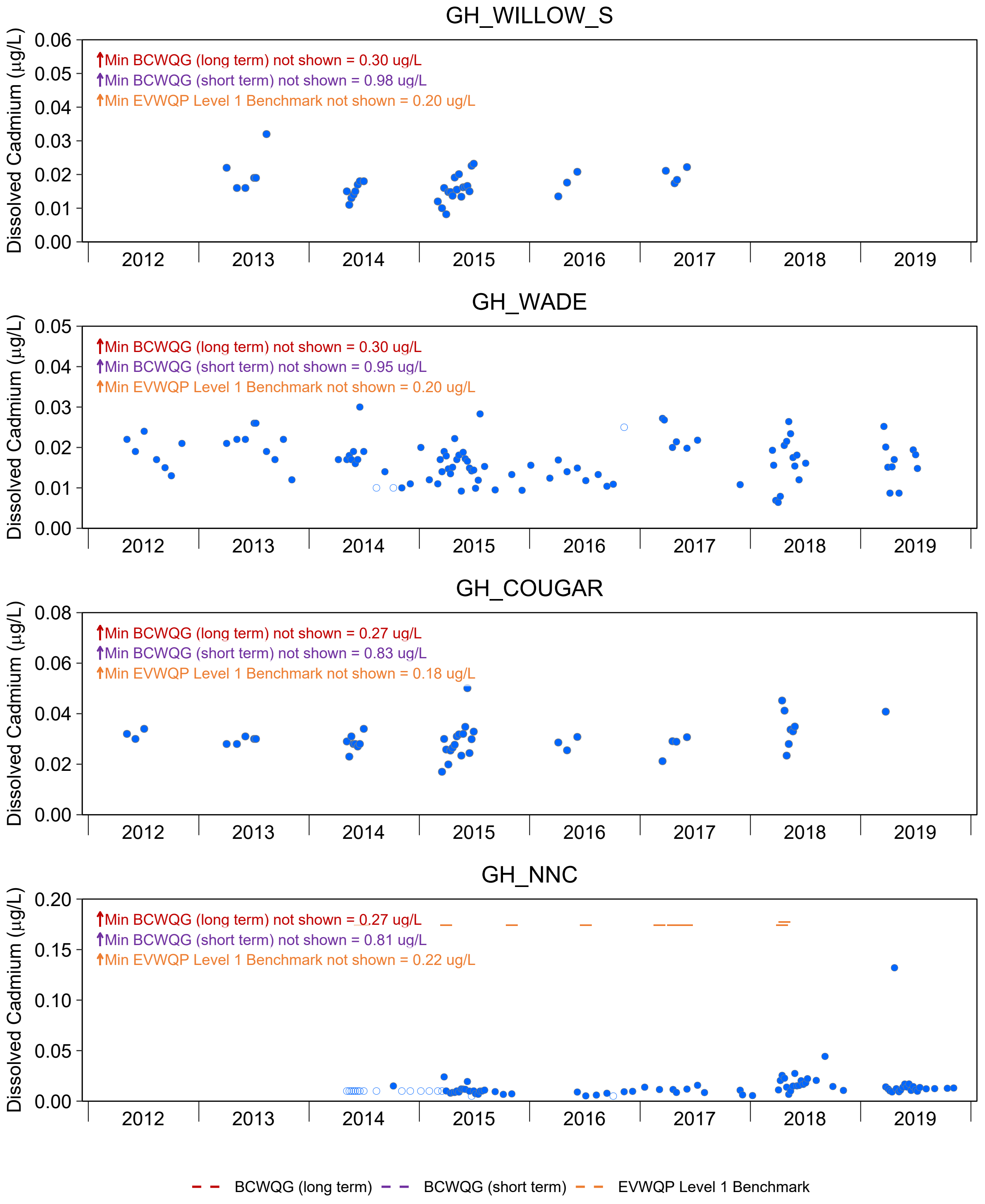


Figure C.4: **Time Series Plots for Dissolved Cadmium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

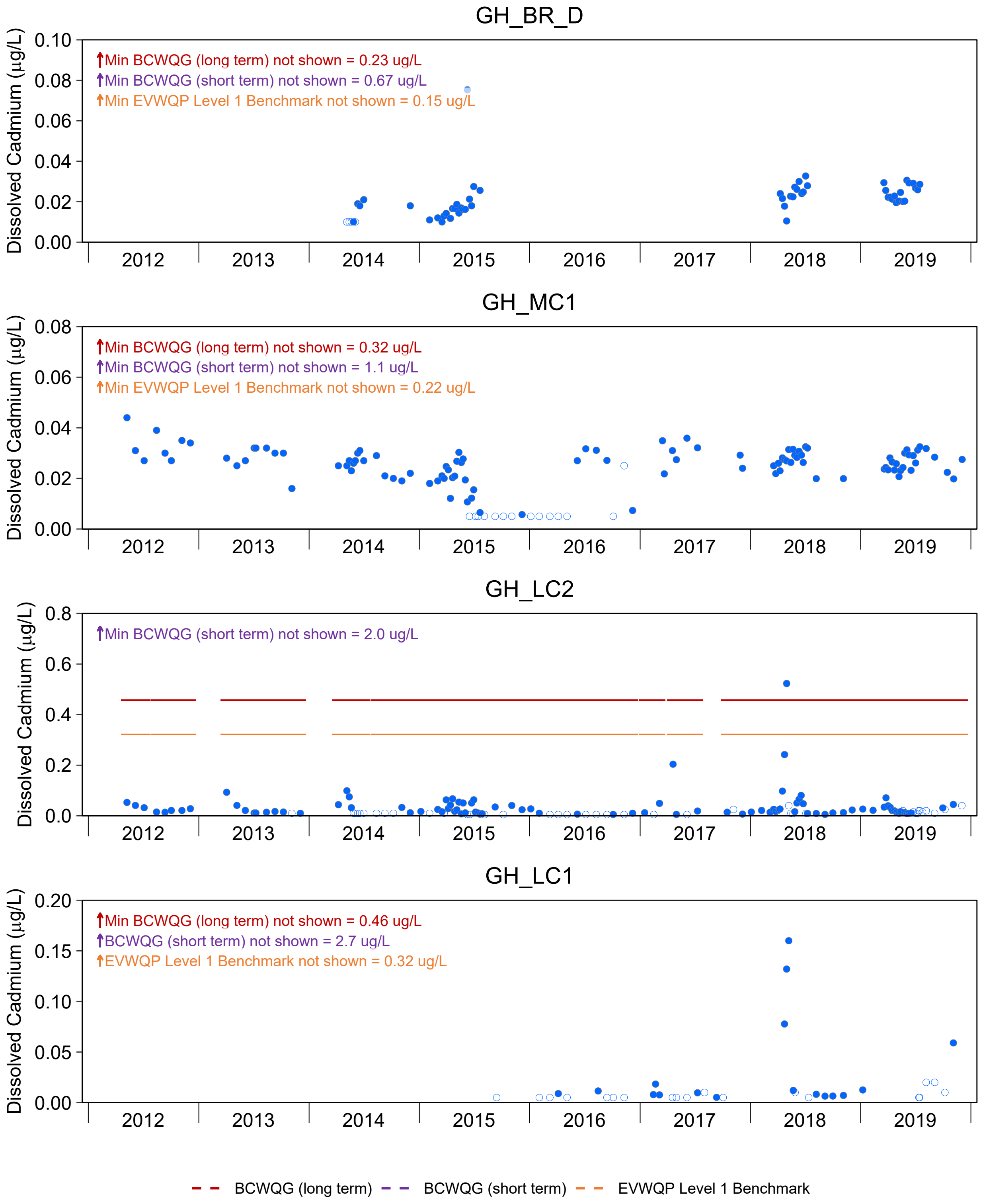


Figure C.4: Time Series Plots for Dissolved Cadmium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

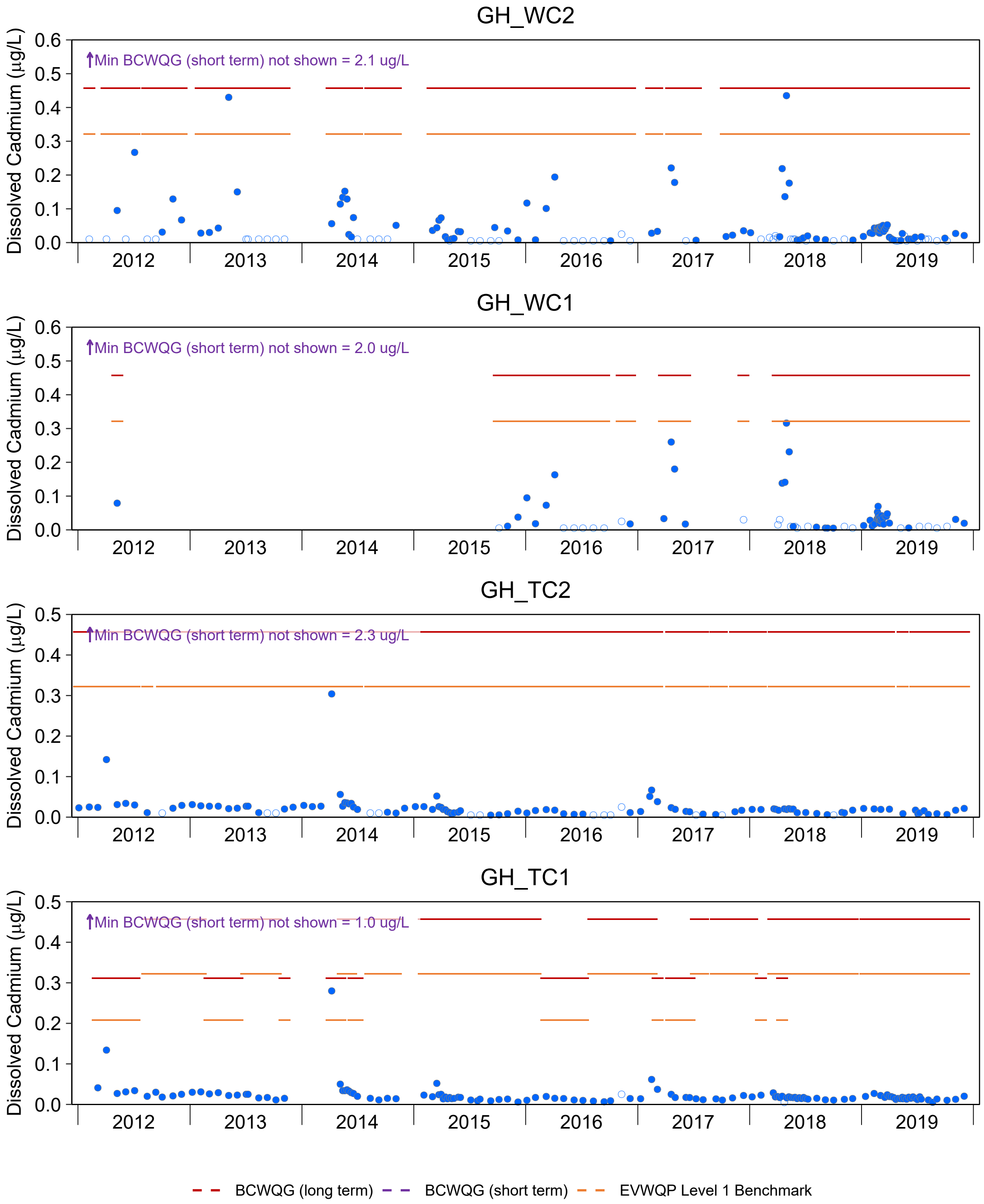


Figure C.4: **Time Series Plots for Dissolved Cadmium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

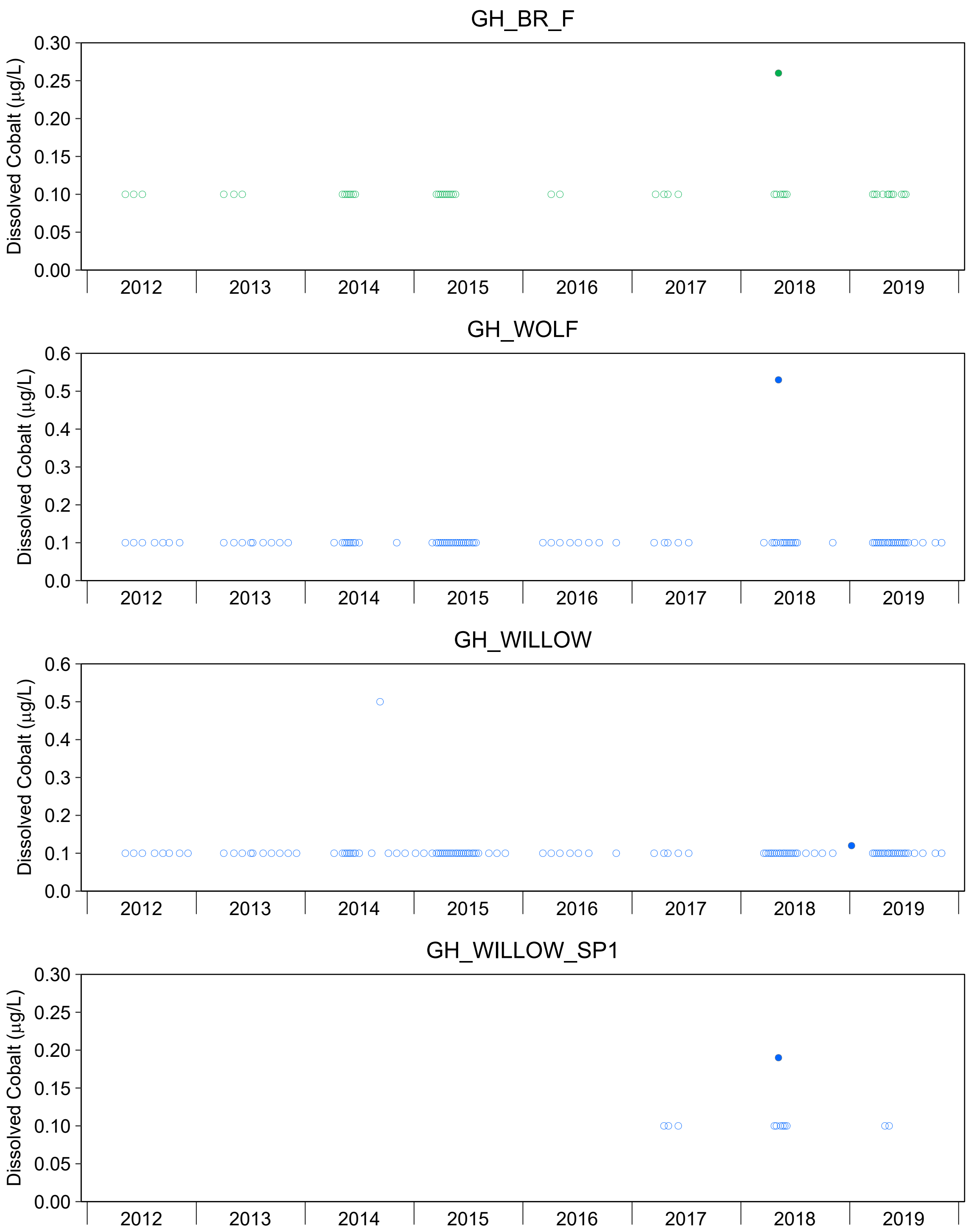


Figure C.5: Time Series Plots for Dissolved Cobalt Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

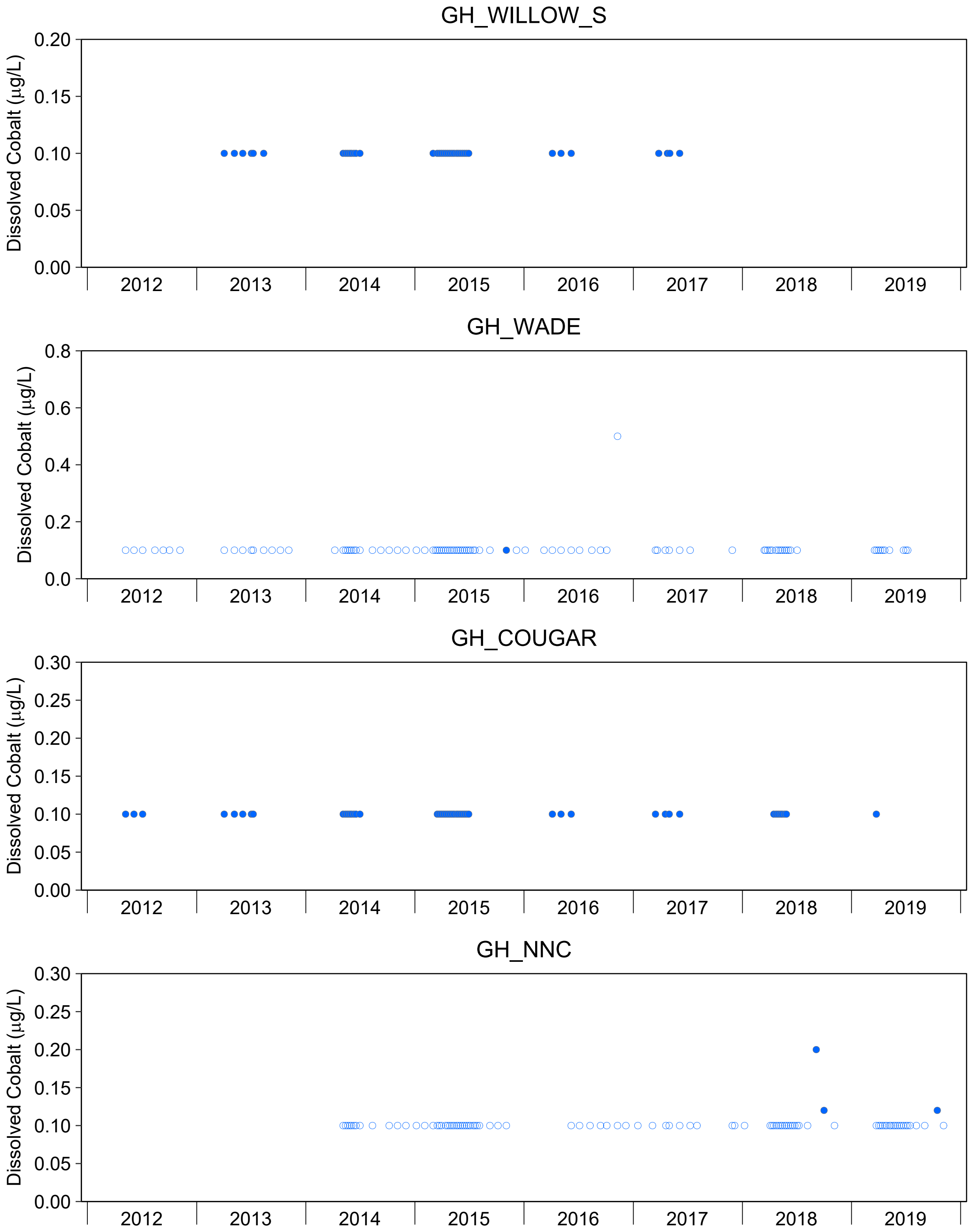
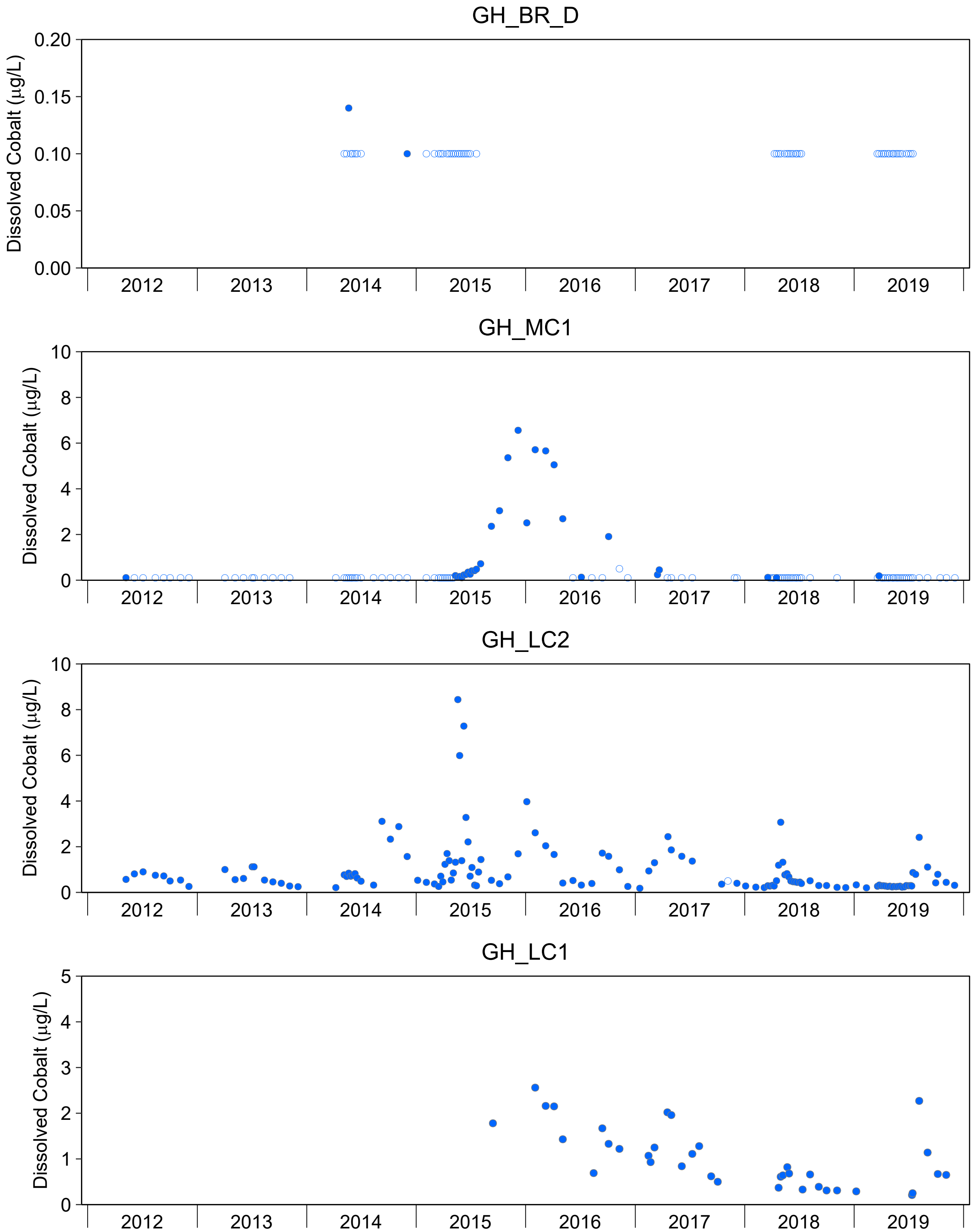


Figure C.5: Time Series Plots for Dissolved Cobalt Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.


GH_BR_D

GH_MC1

GH_LC2

GH_LC1

Figure C.5: Time Series Plots for Dissolved Cobalt Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

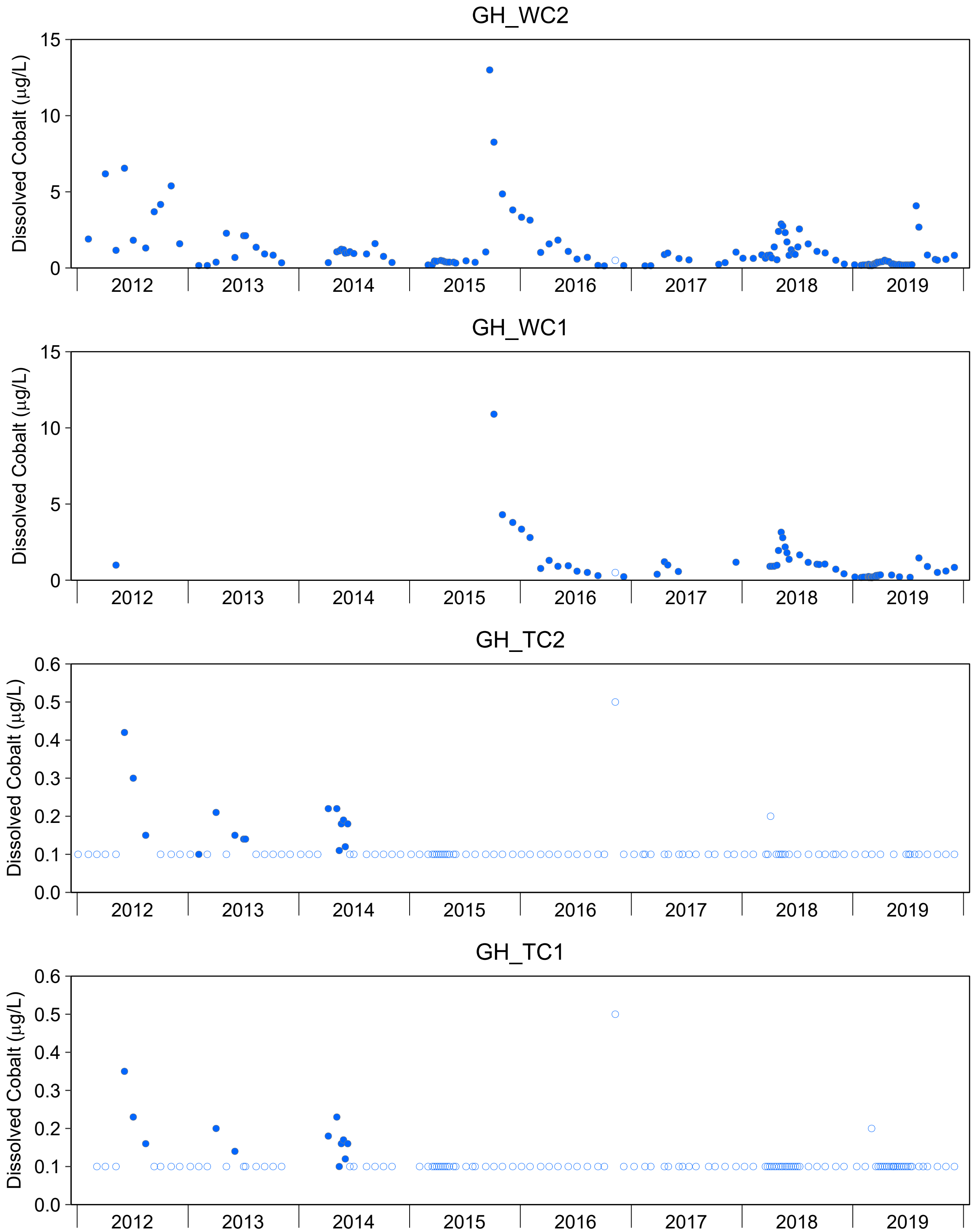


Figure C.5: **Time Series Plots for Dissolved Cobalt Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

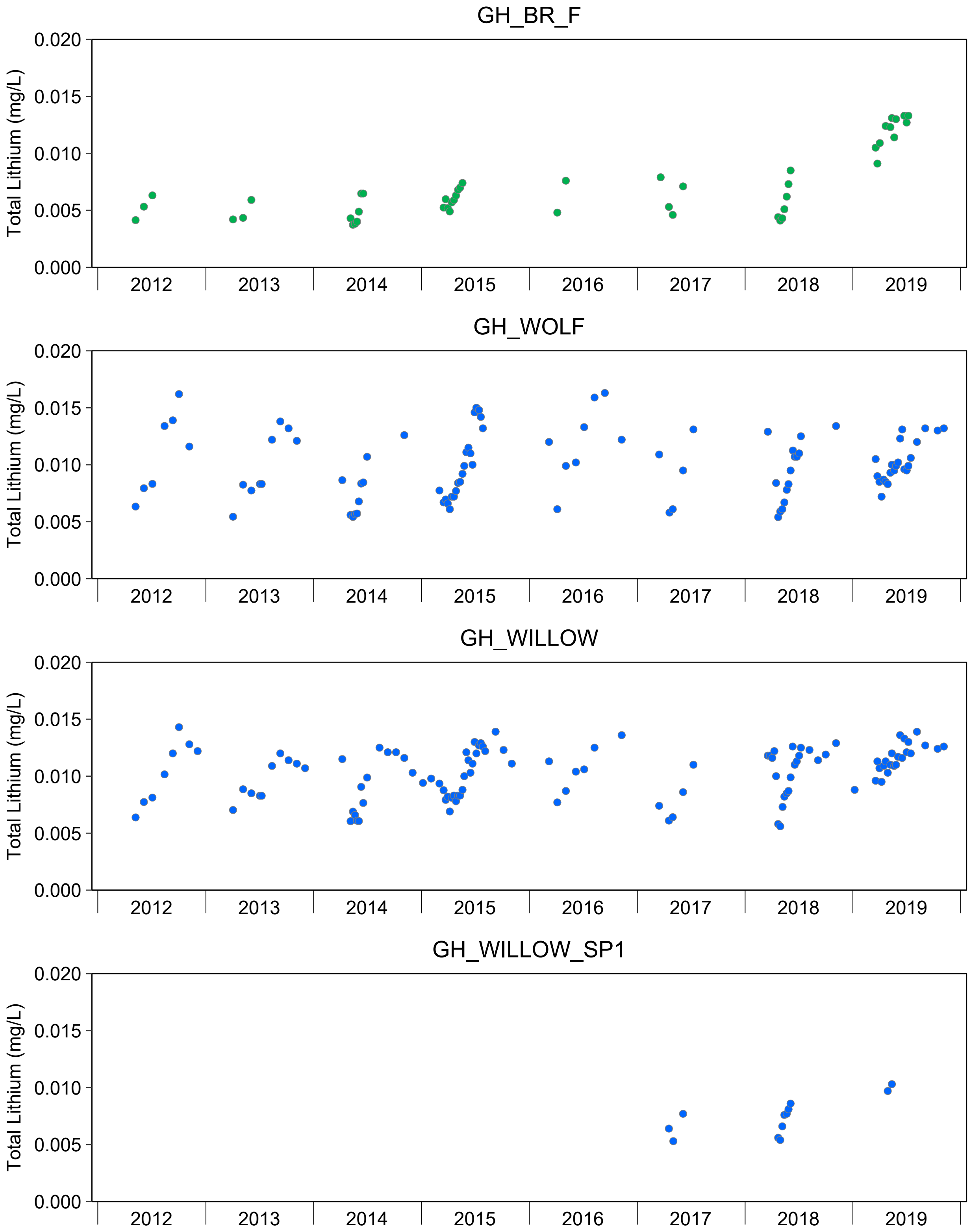


Figure C.6: Time Series Plots for Total Lithium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

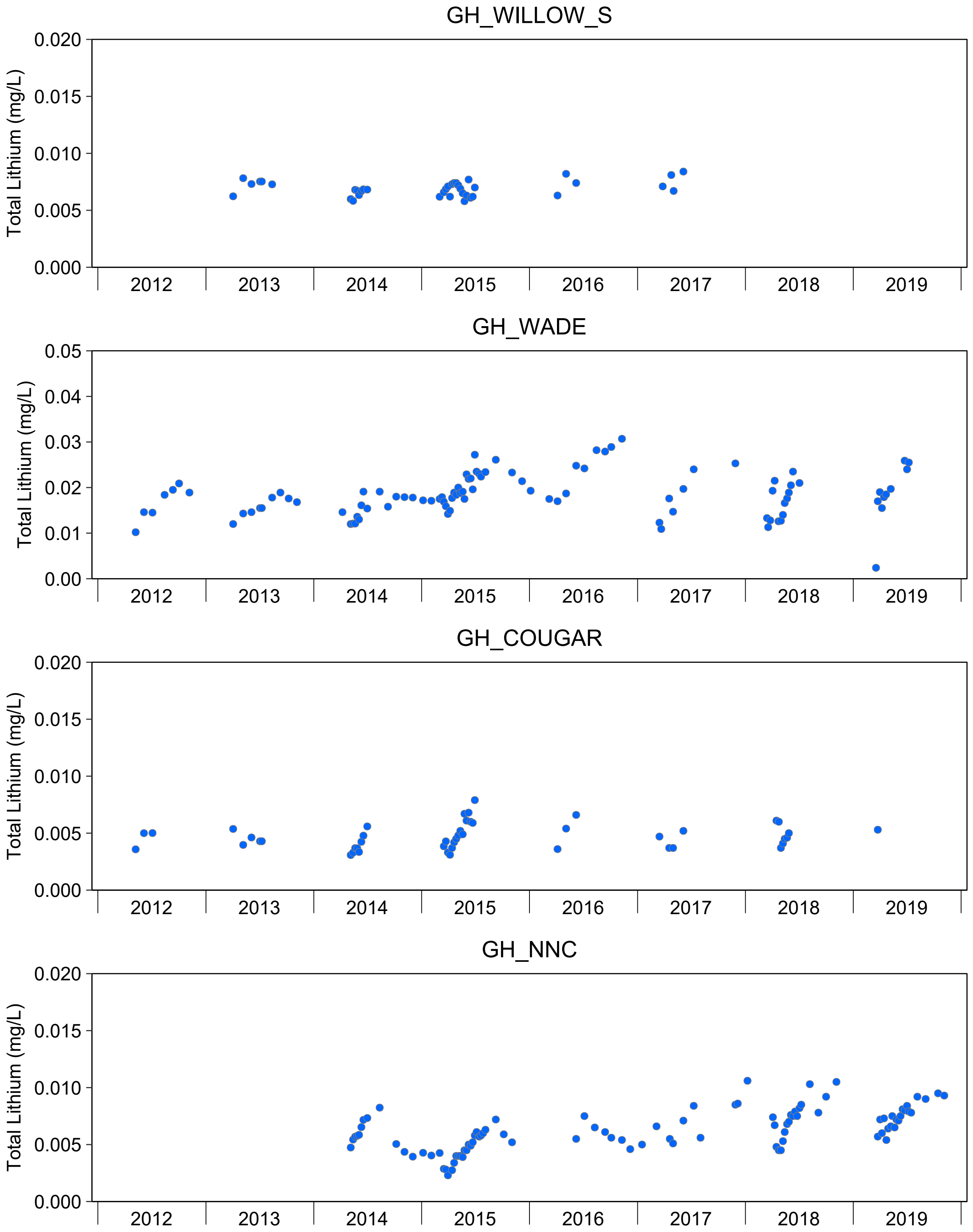


Figure C.6: Time Series Plots for Total Lithium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

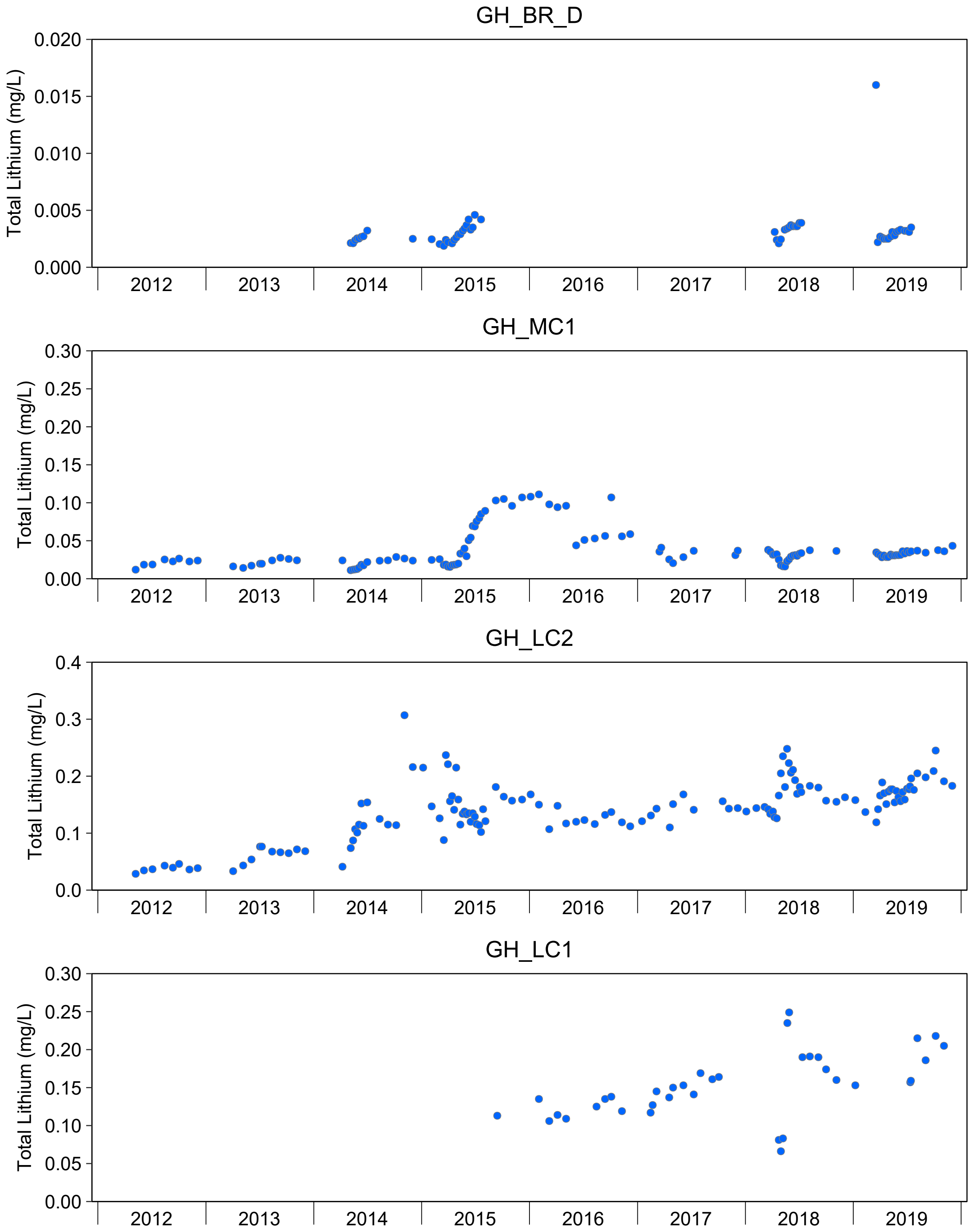


Figure C.6: **Time Series Plots for Total Lithium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

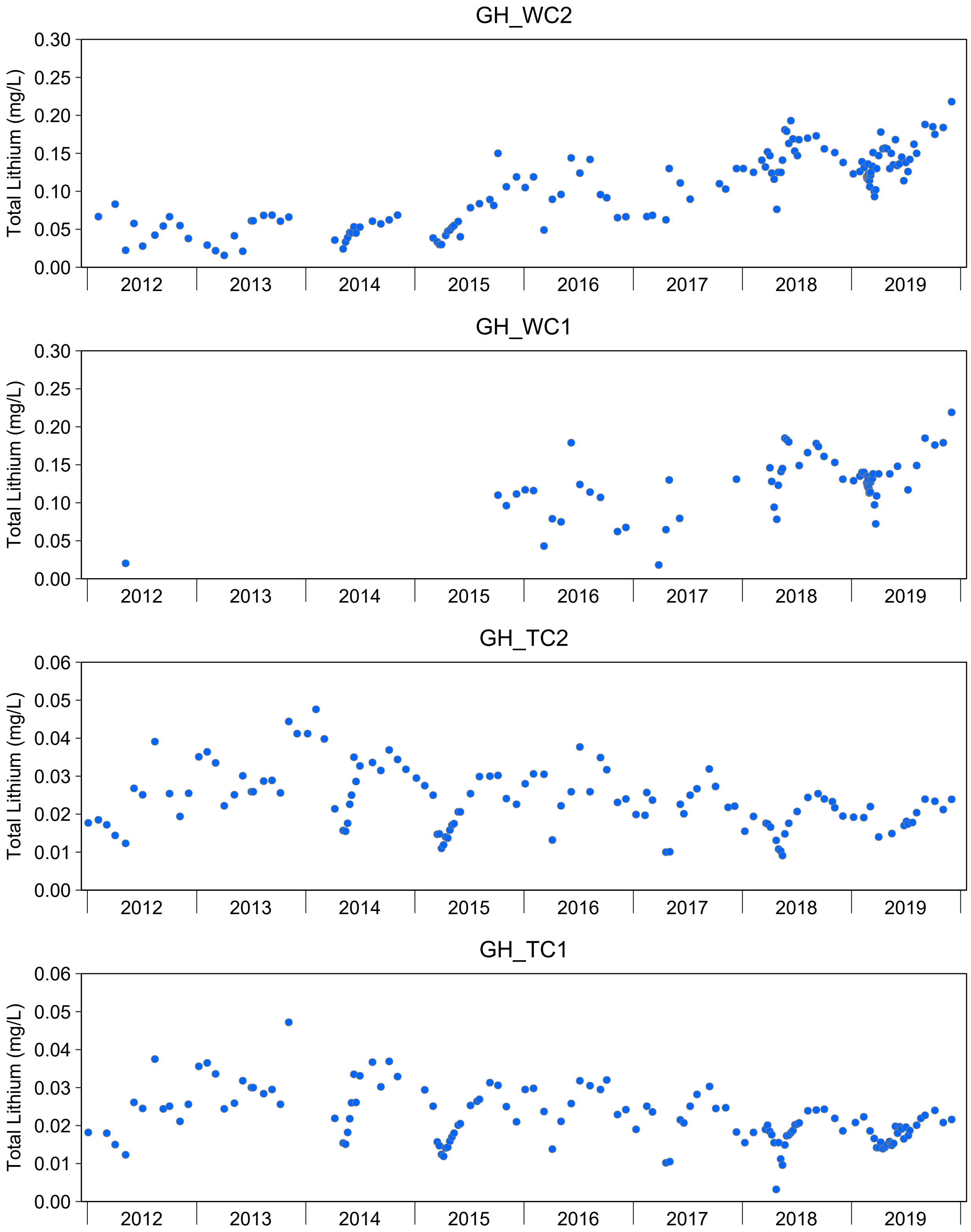
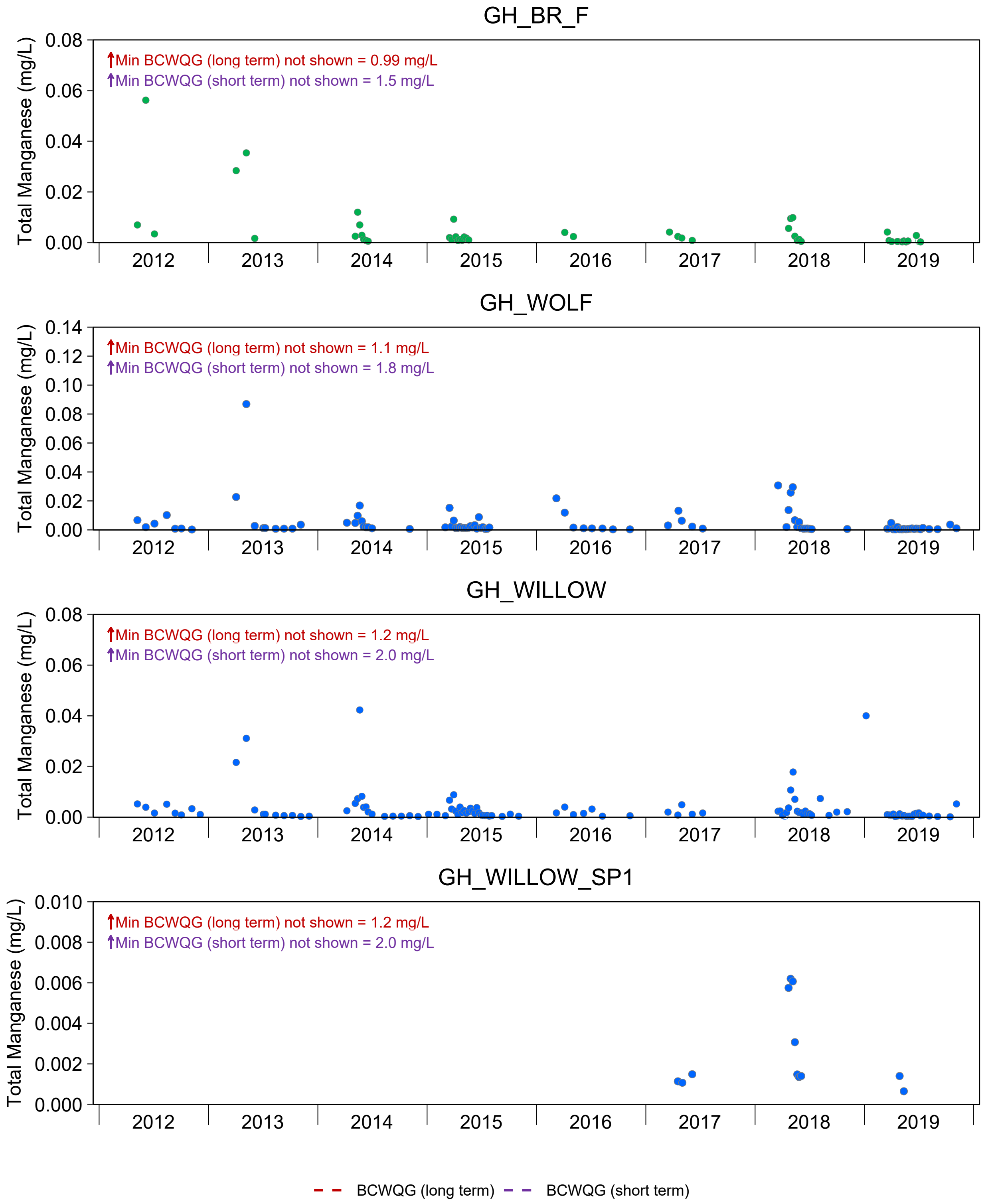


Figure C.6: Time Series Plots for Total Lithium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).


GH_BR_F

↑Min BCWQG (long term) not shown = 0.99 mg/L
↑Min BCWQG (short term) not shown = 1.5 mg/L

GH_WOLF

↑Min BCWQG (long term) not shown = 1.1 mg/L
↑Min BCWQG (short term) not shown = 1.8 mg/L

GH_WILLOW

↑Min BCWQG (long term) not shown = 1.2 mg/L
↑Min BCWQG (short term) not shown = 2.0 mg/L

GH_WILLOW_SP1

↑Min BCWQG (long term) not shown = 1.2 mg/L
↑Min BCWQG (short term) not shown = 2.0 mg/L

Figure C.7: Time Series Plots for Total Manganese Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

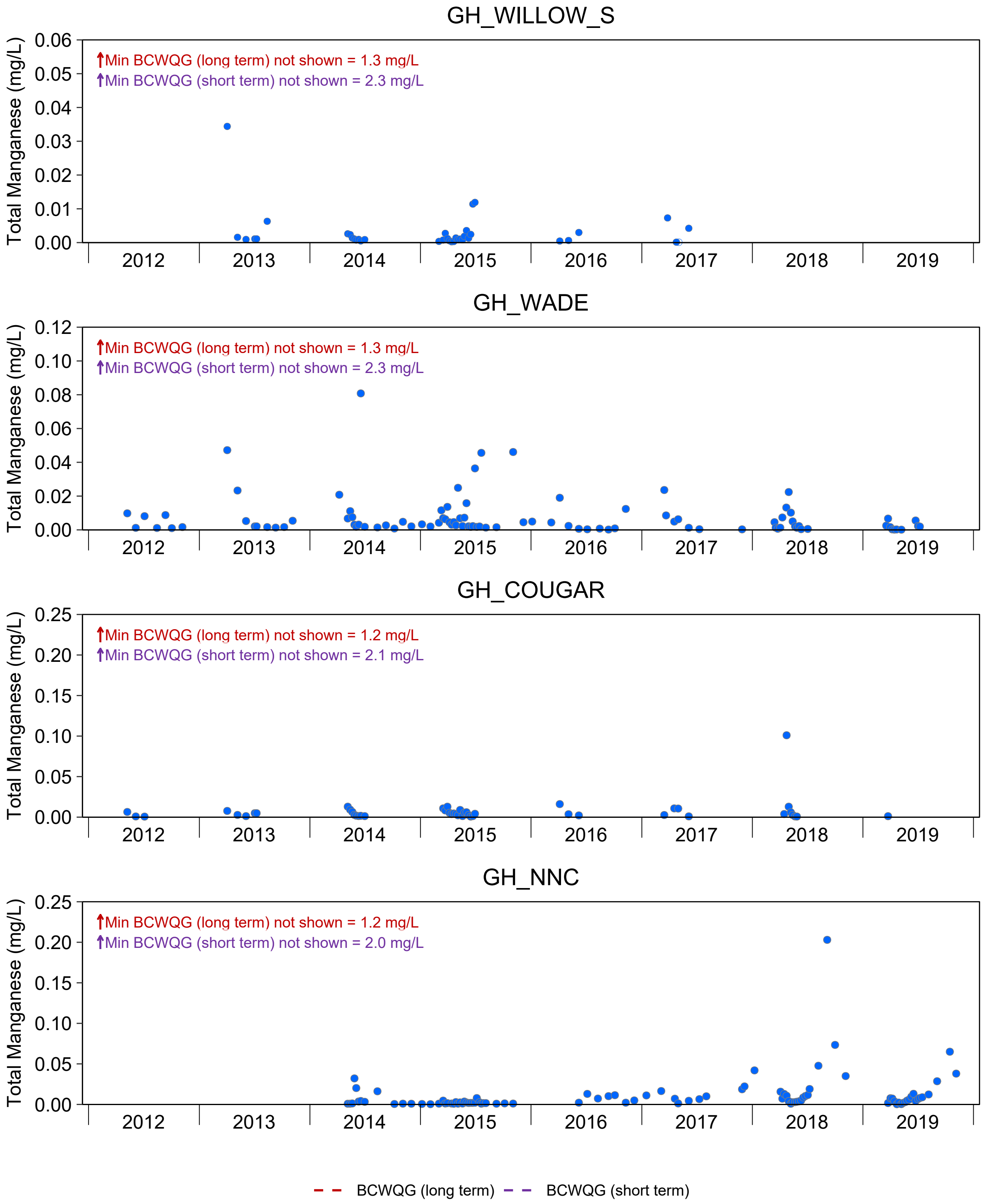


Figure C.7: Time Series Plots for Total Manganese Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

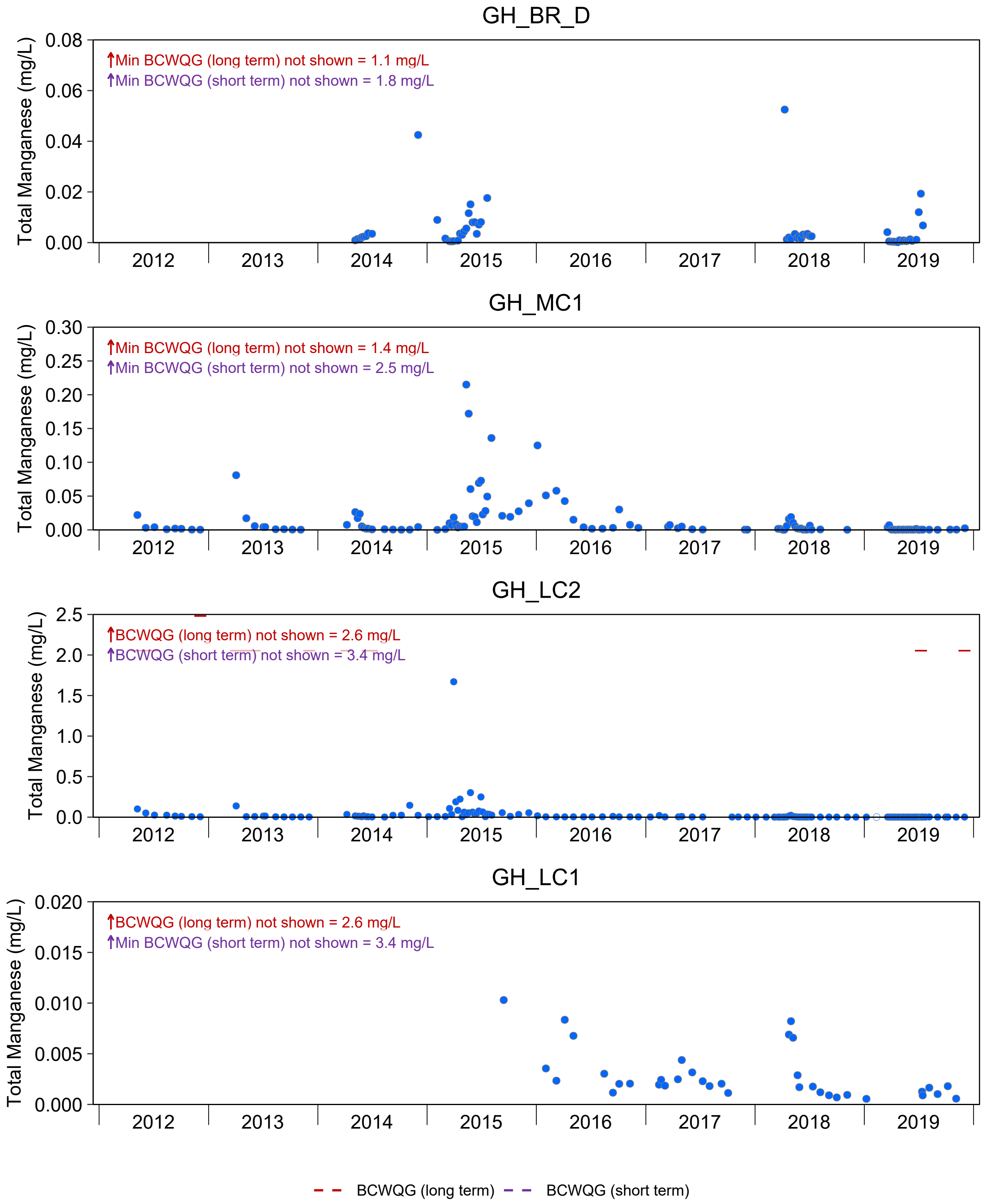


Figure C.7: Time Series Plots for Total Manganese Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

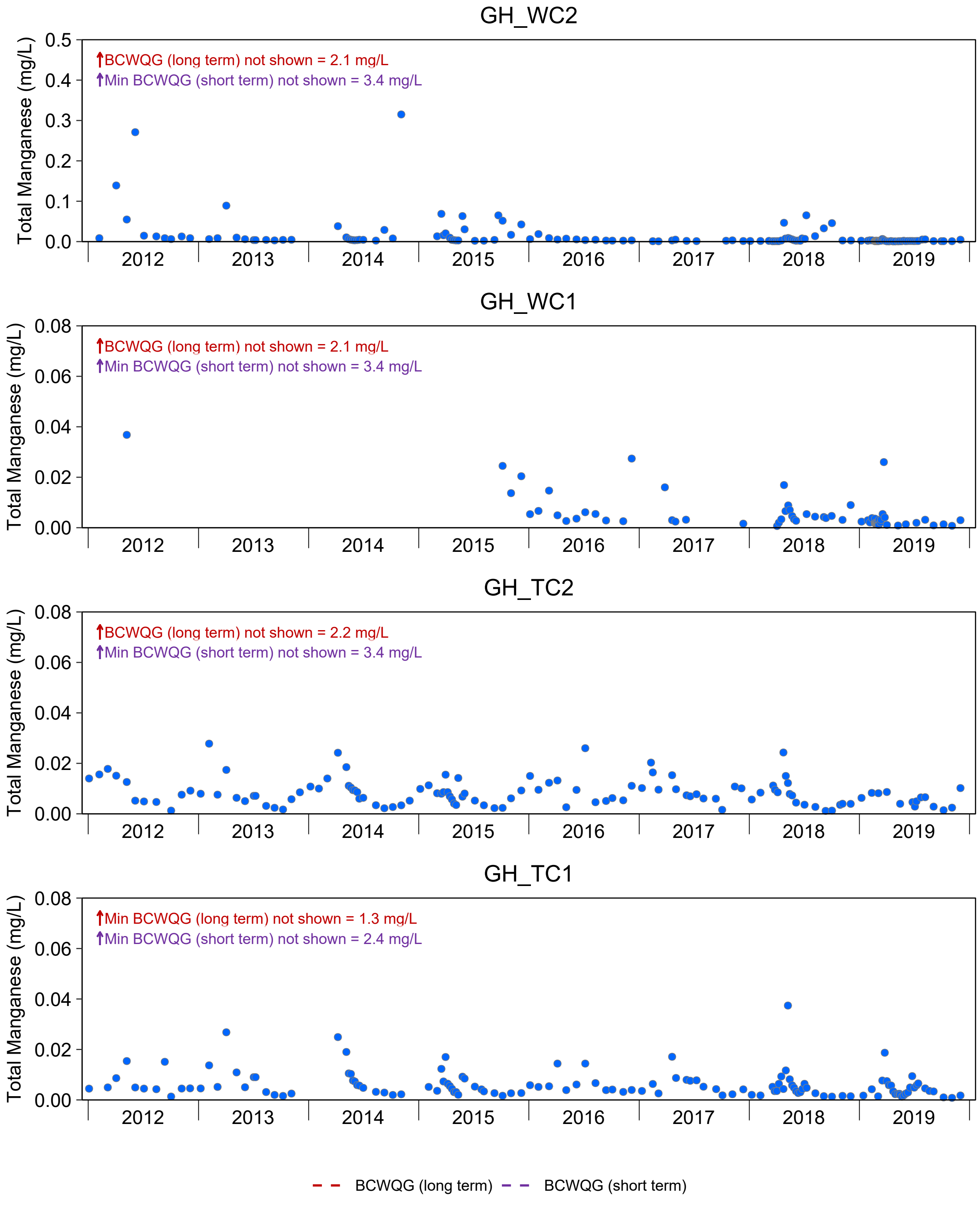


Figure C.7: Time Series Plots for Total Manganese Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

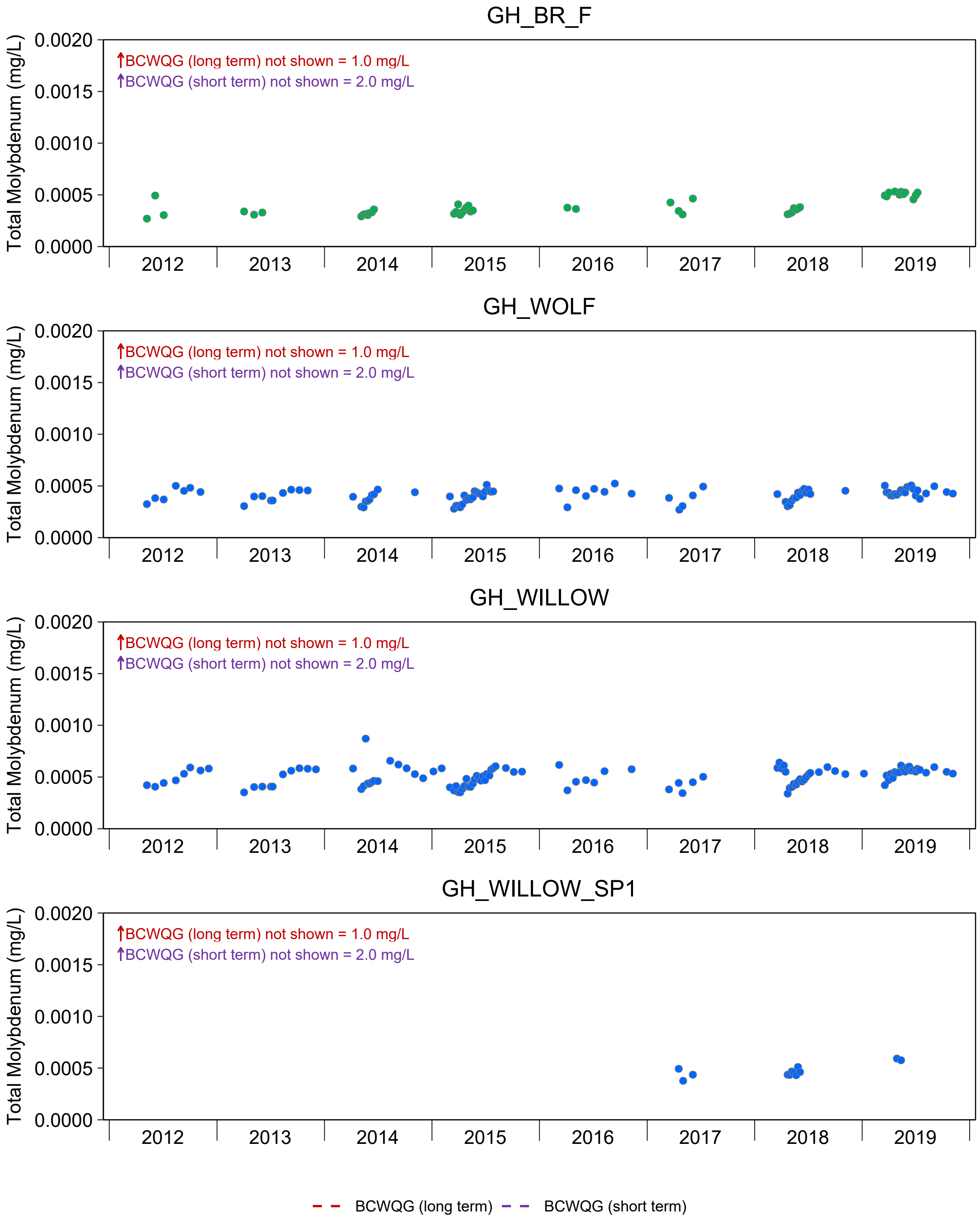


Figure C.8: **Time Series Plots for Total Molybdenum Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

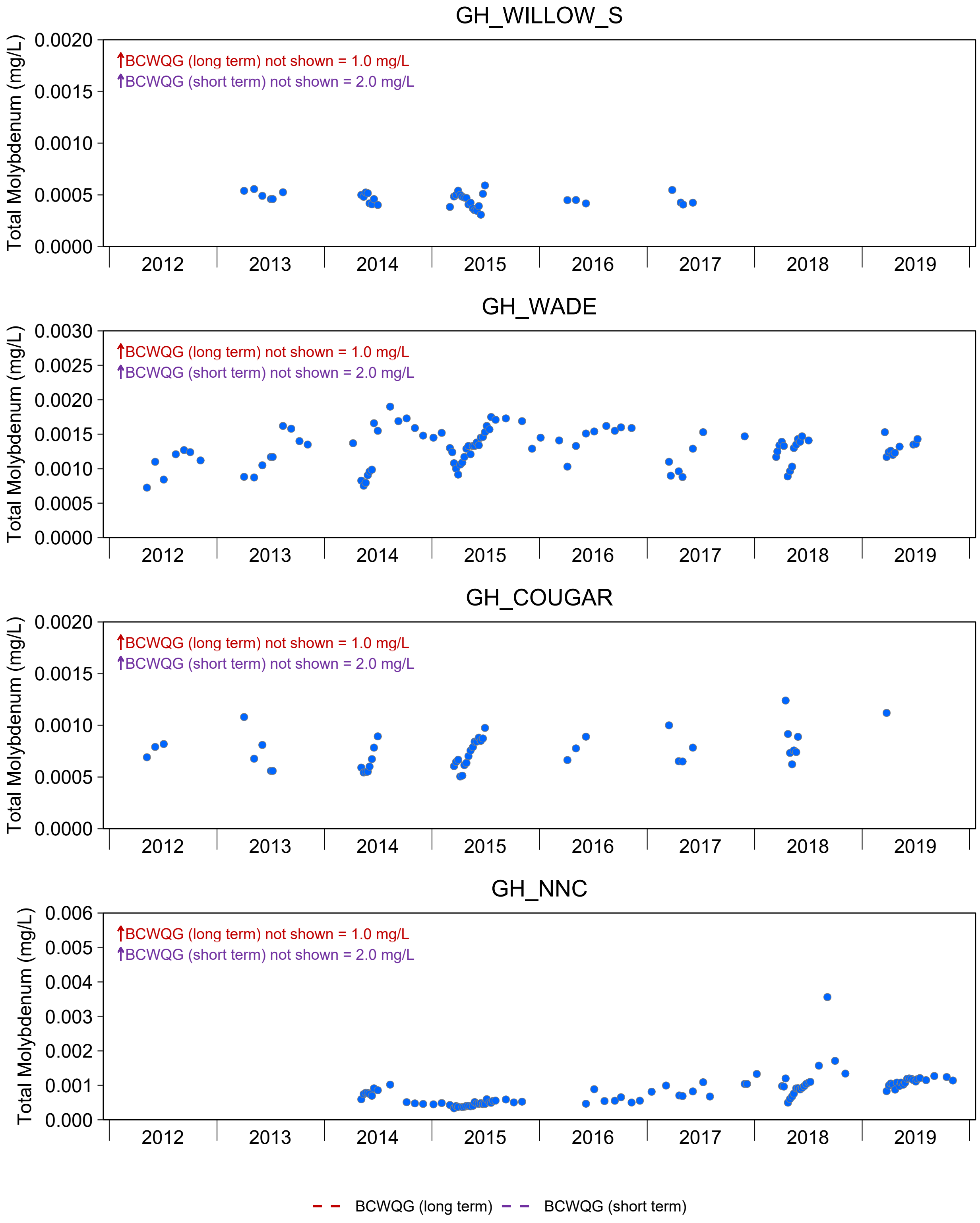


Figure C.8: **Time Series Plots for Total Molybdenum Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

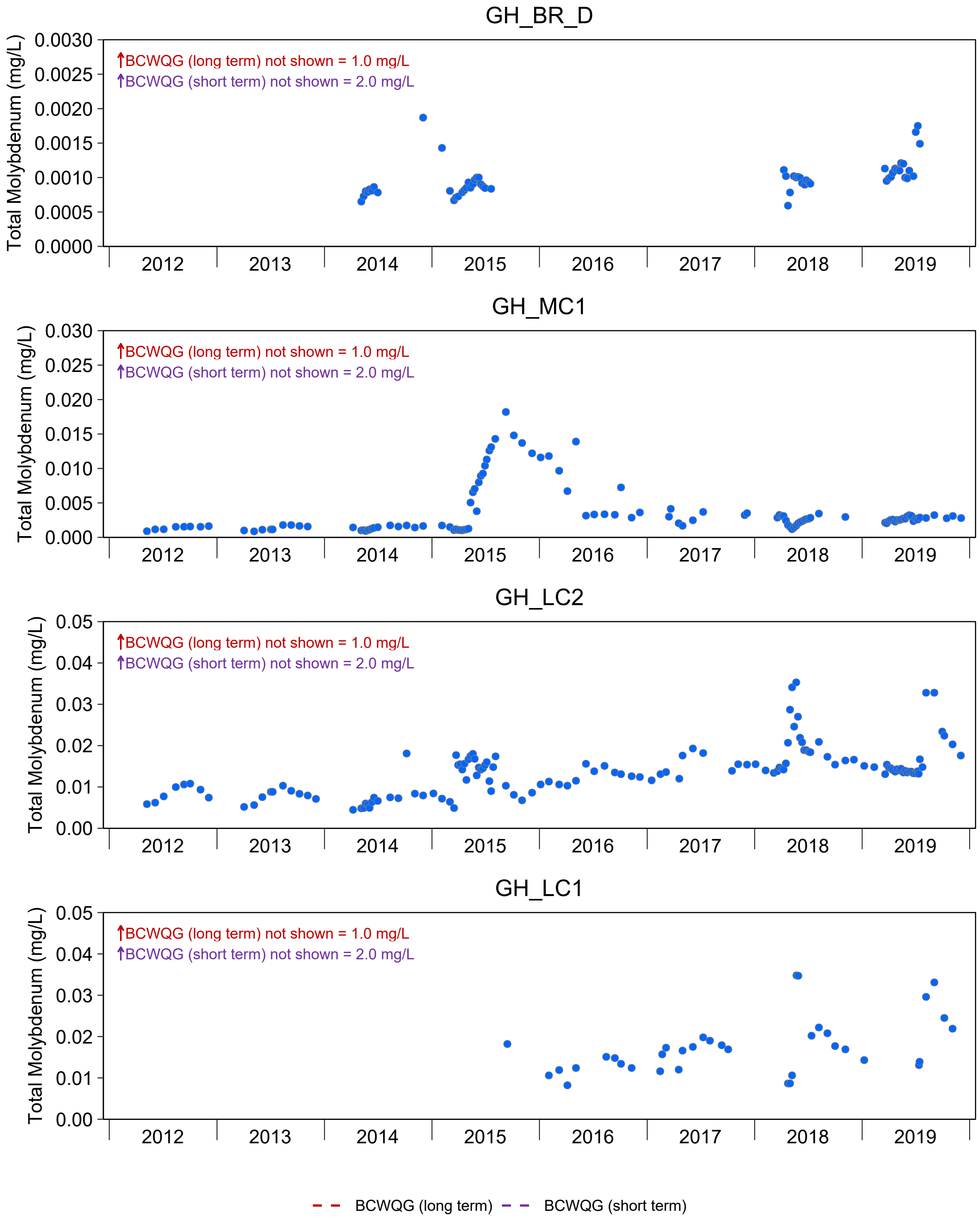


Figure C.8: **Time Series Plots for Total Molybdenum Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

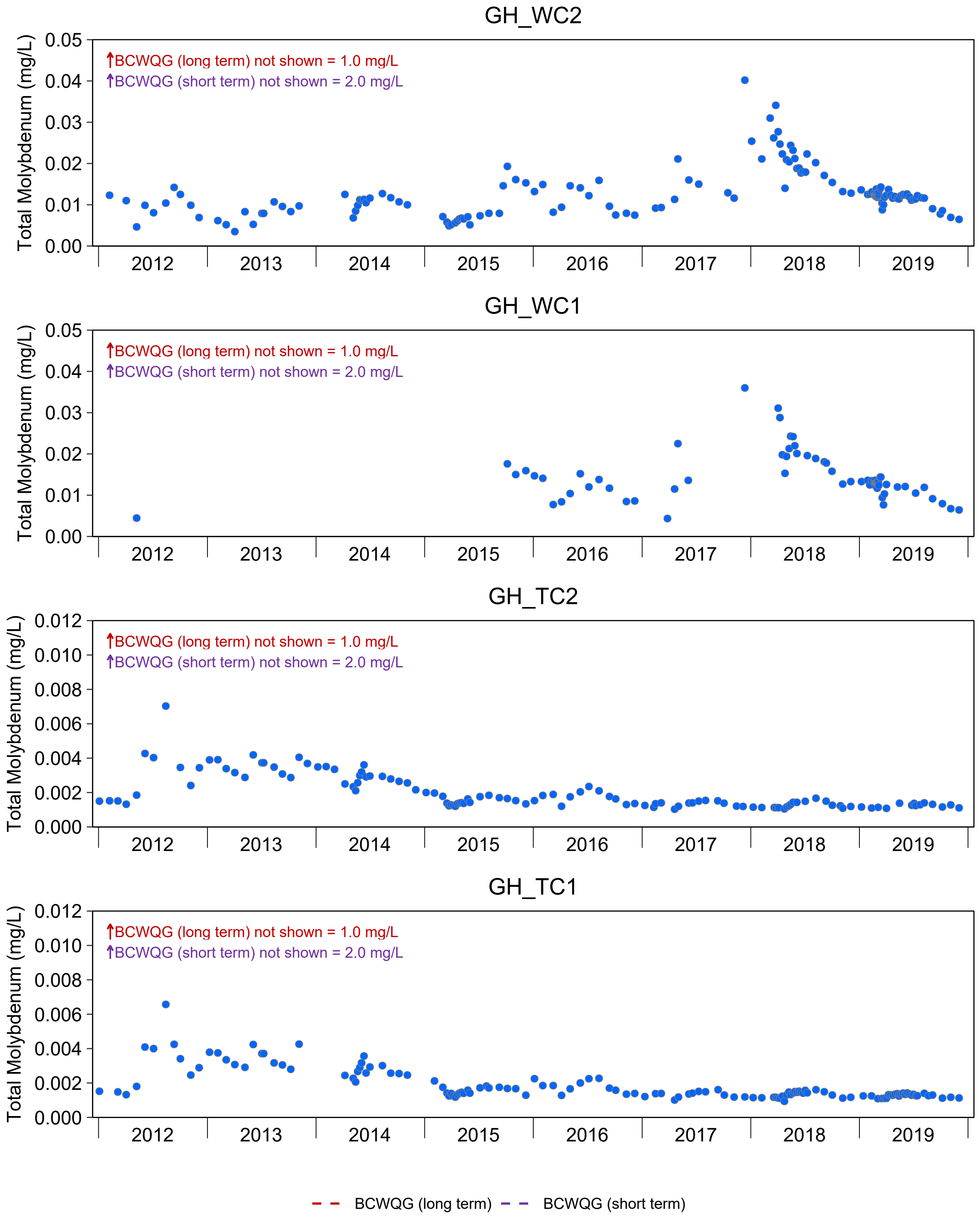


Figure C.8: **Time Series Plots for Total Molybdenum Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

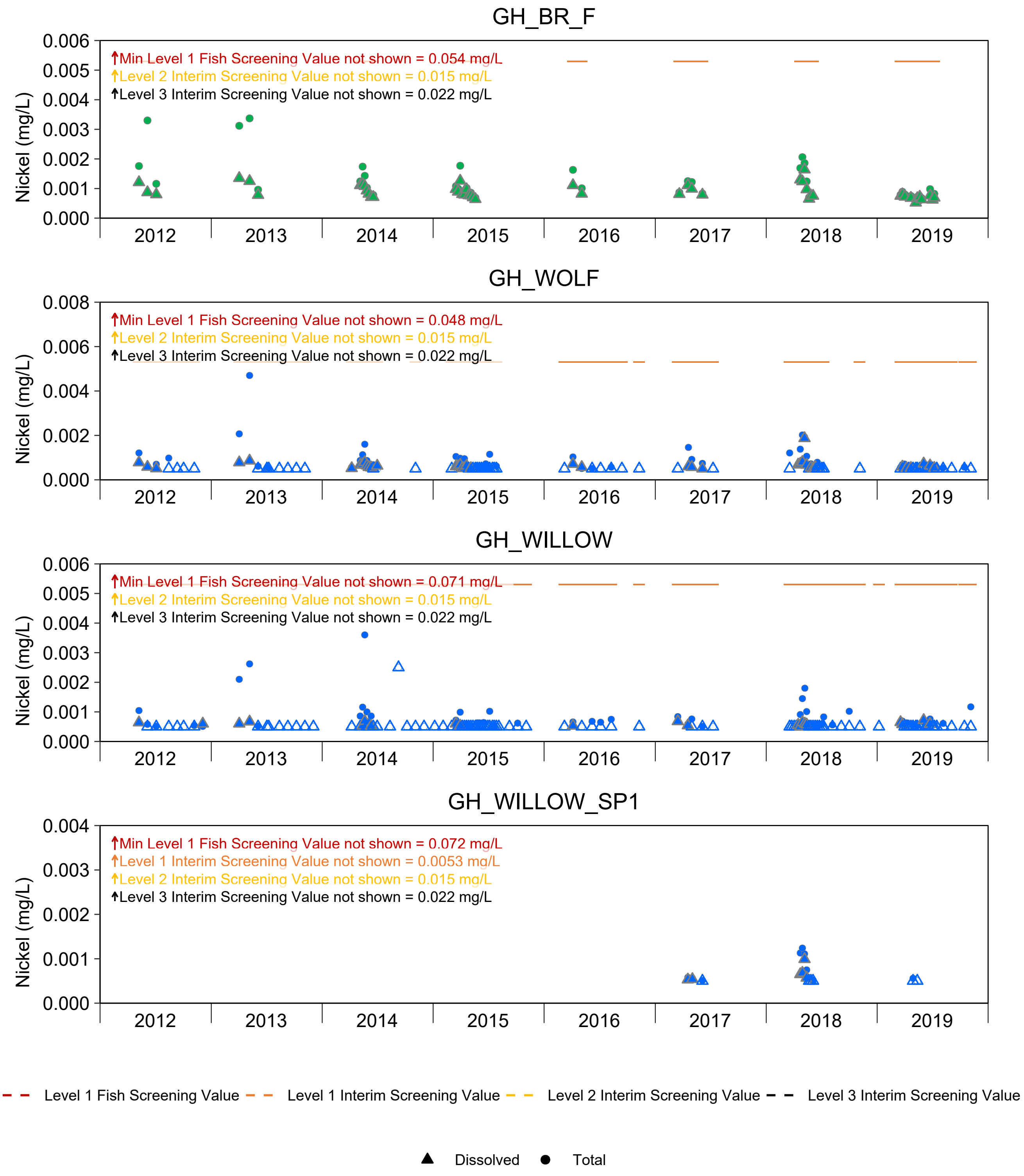


Figure C.9: **Time Series Plots for Total and Dissolved Nickel Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

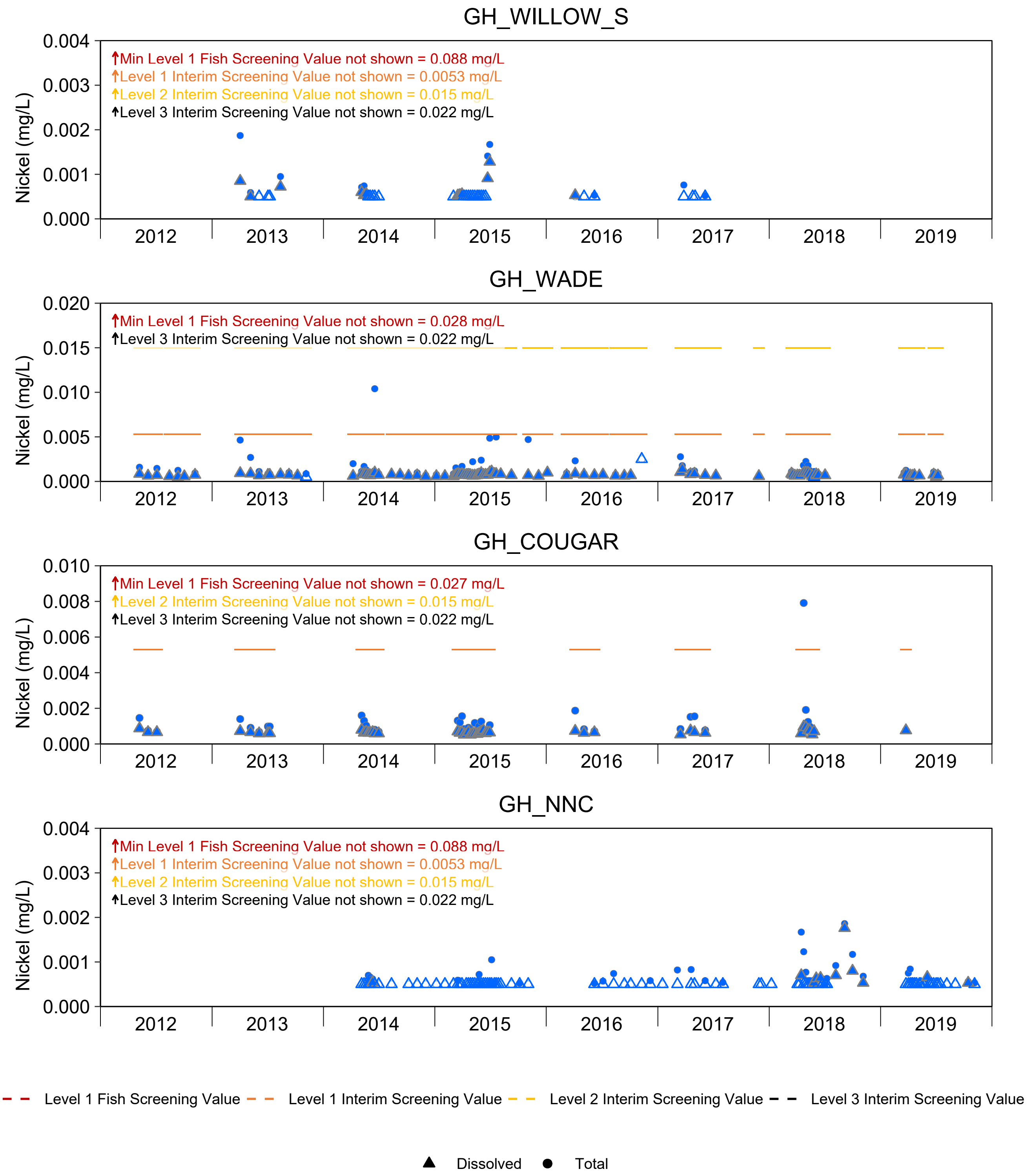


Figure C.9: Time Series Plots for Total and Dissolved Nickel Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

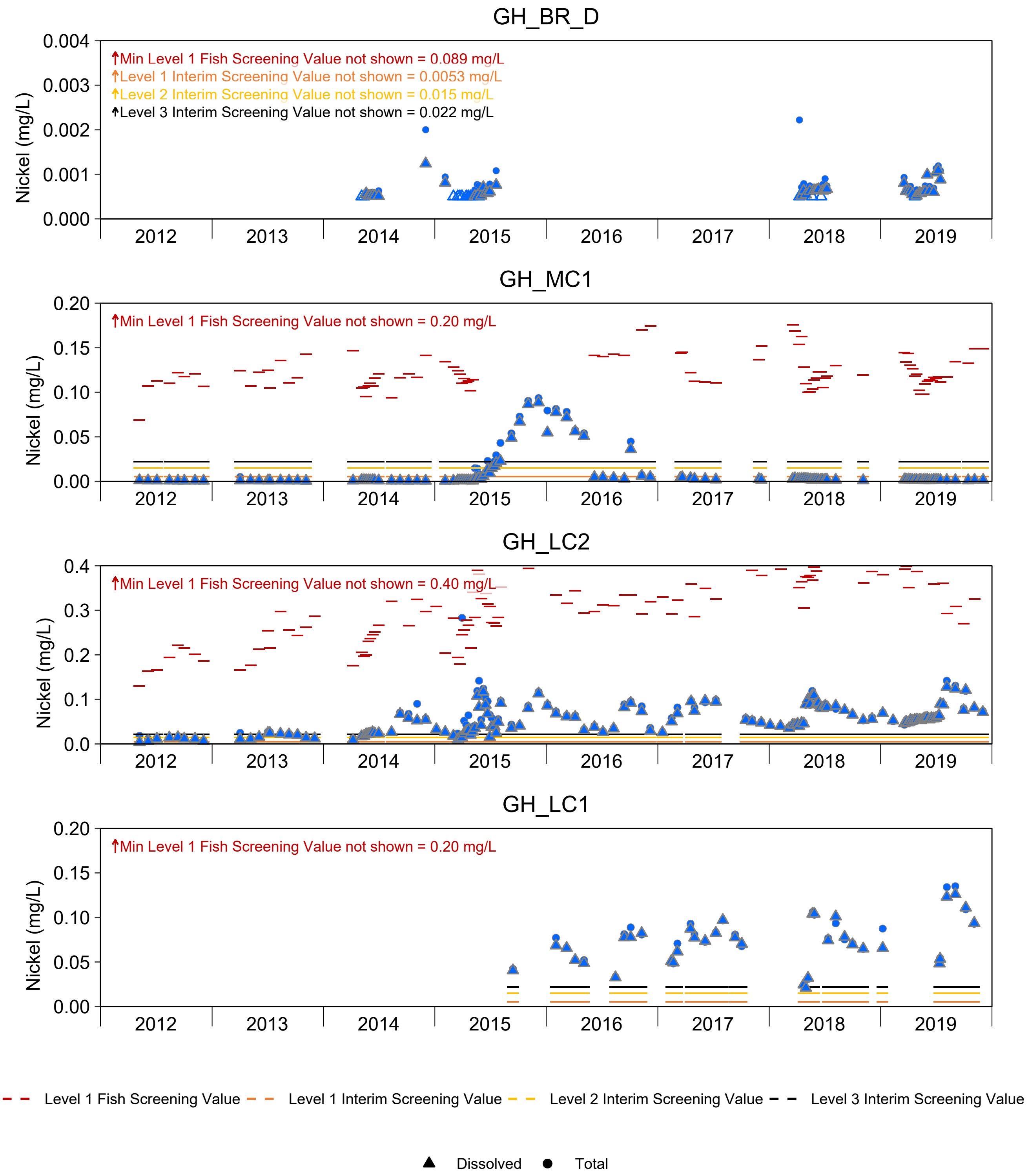


Figure C.9: Time Series Plots for Total and Dissolved Nickel Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

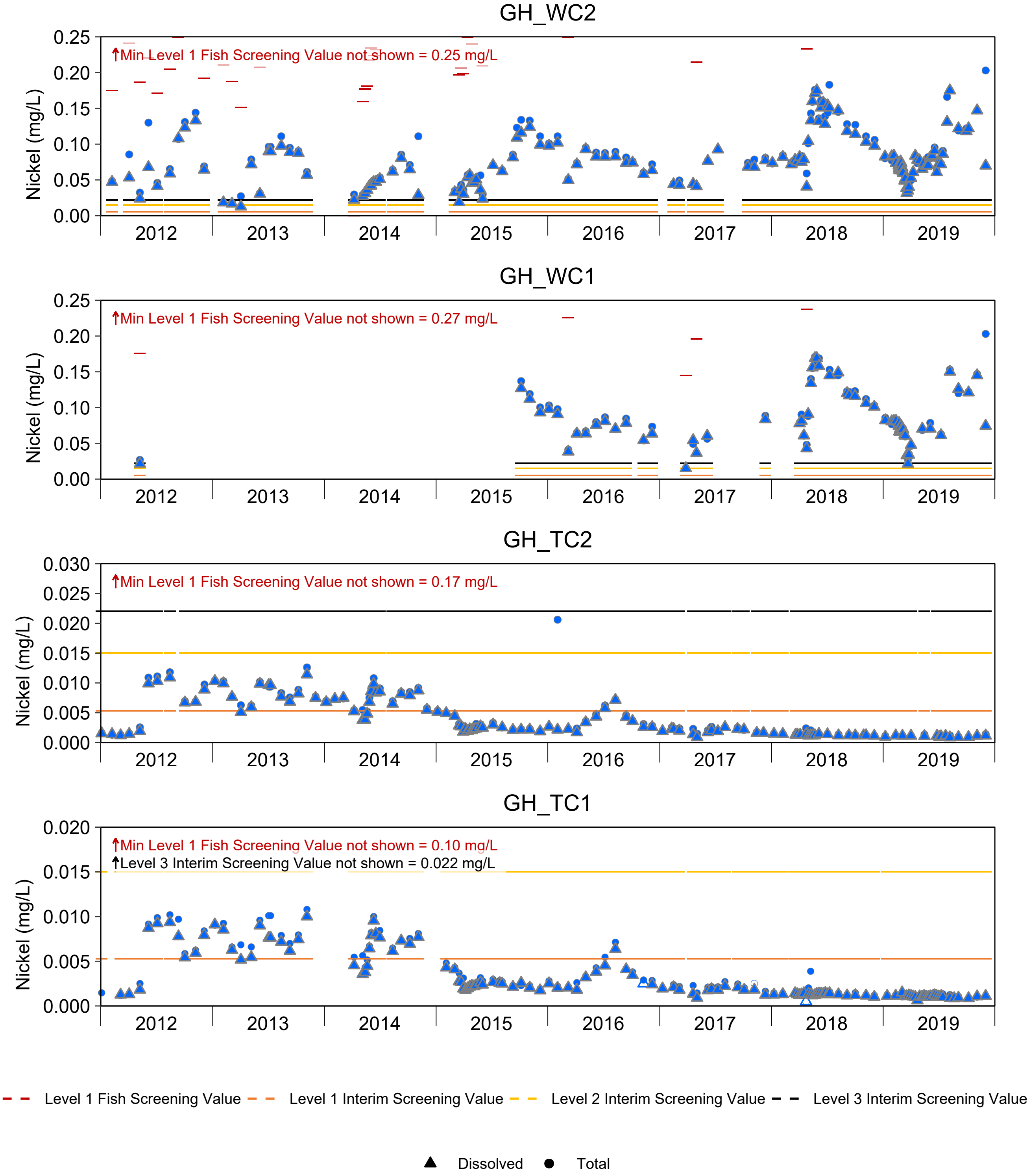


Figure C.9: **Time Series Plots for Total and Dissolved Nickel Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

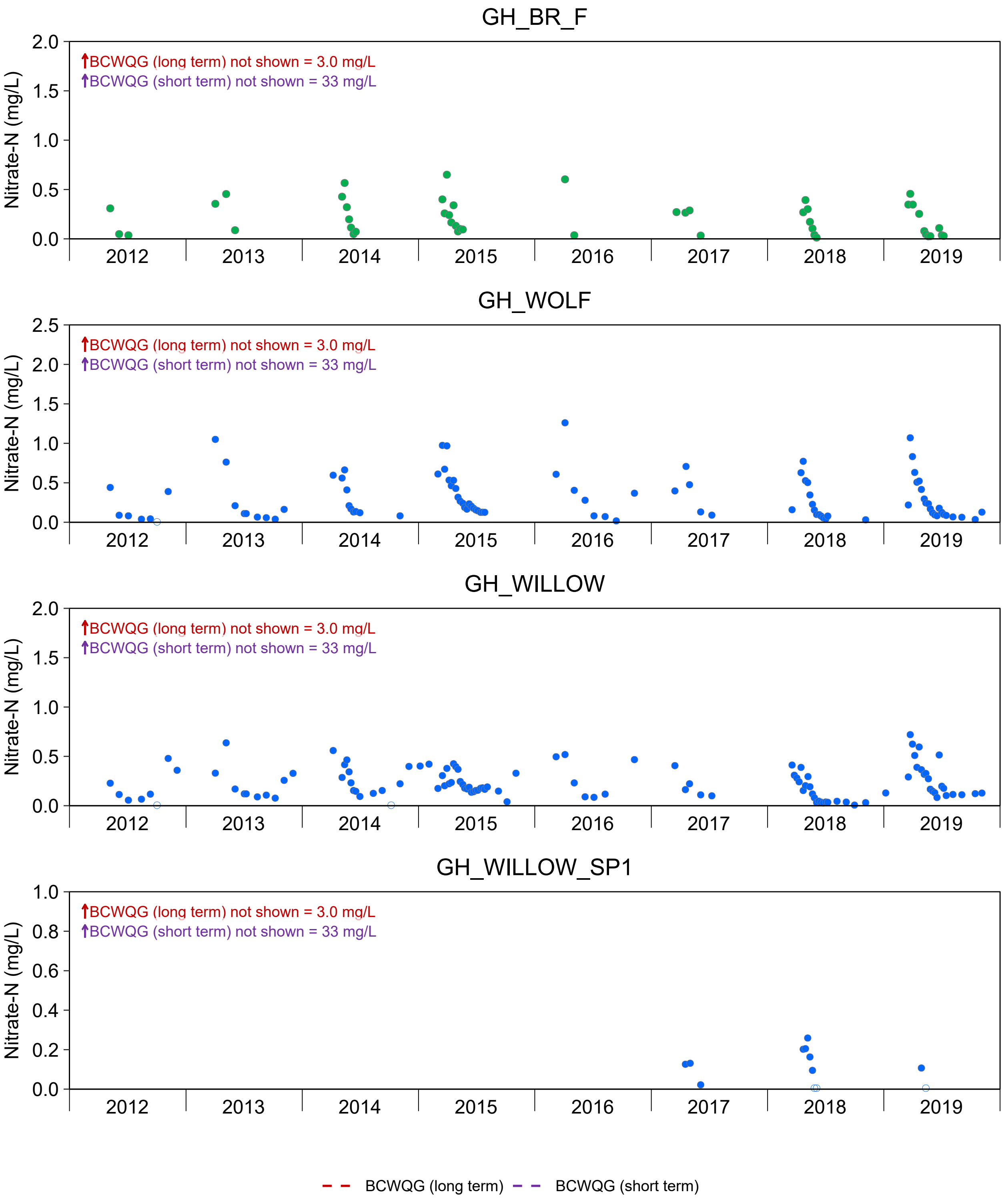


Figure C.10: **Time Series Plots for Nitrate-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

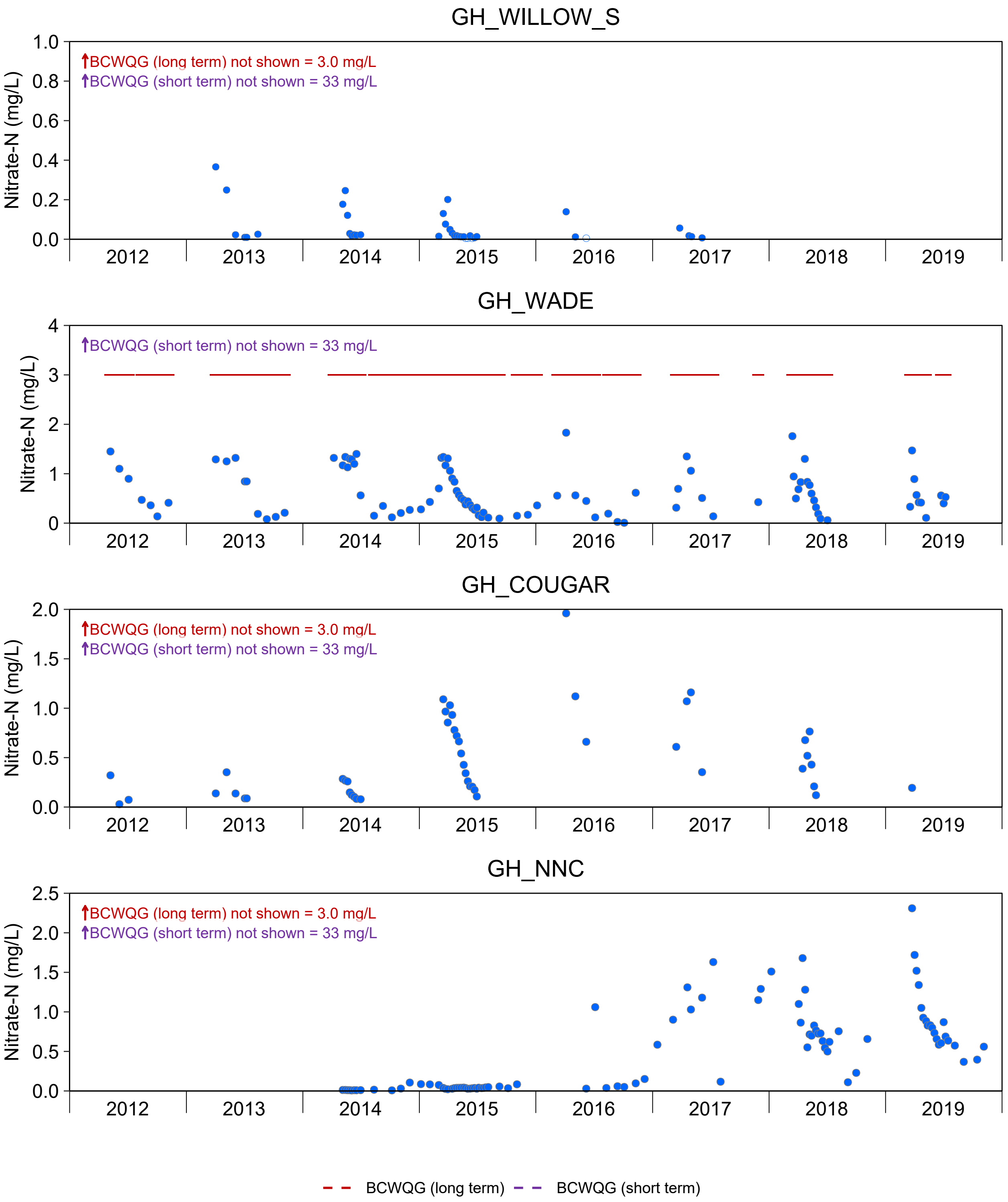


Figure C.10: Time Series Plots for Nitrate-N Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

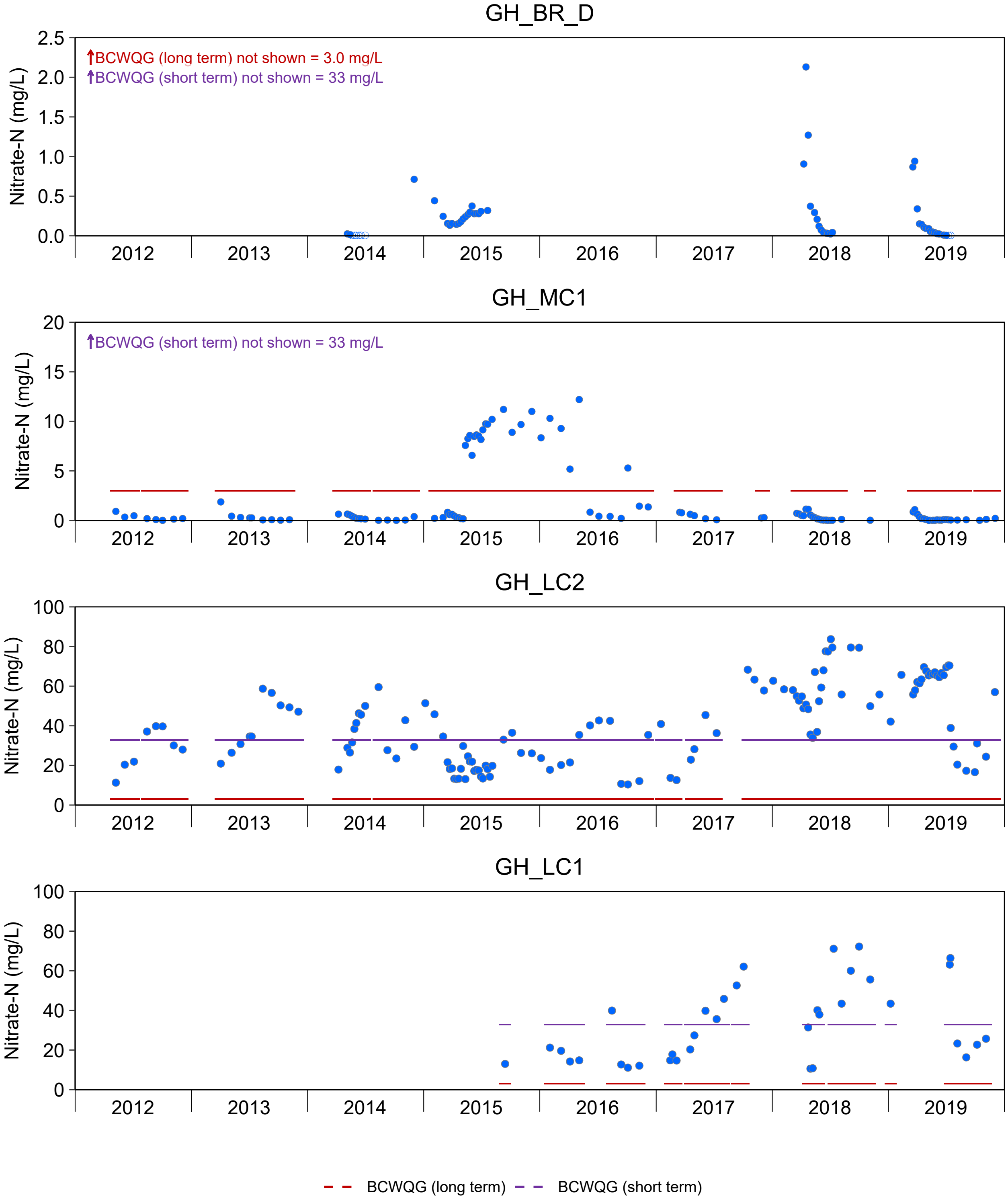


Figure C.10: **Time Series Plots for Nitrate-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

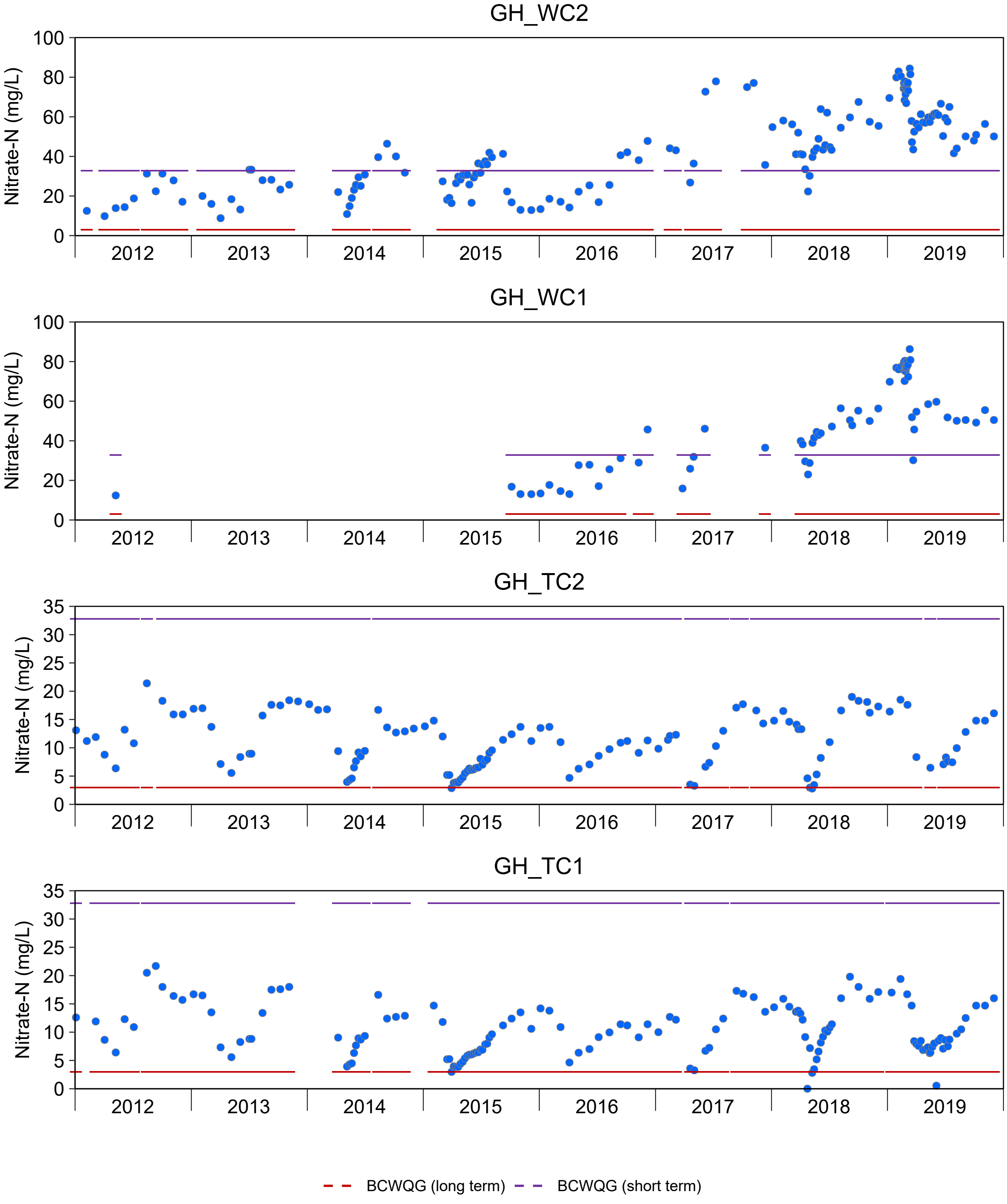


Figure C.10: **Time Series Plots for Nitrate-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

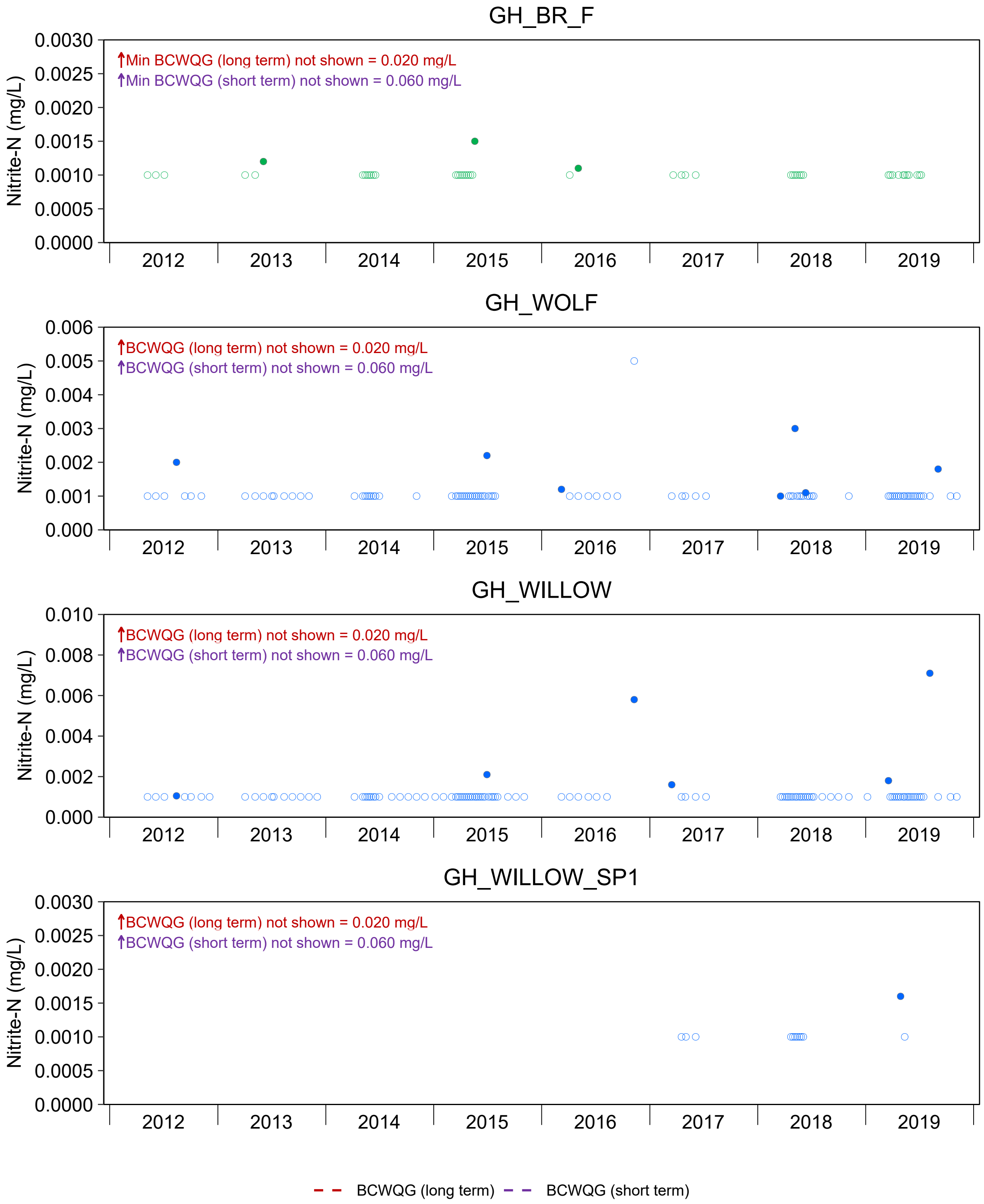


Figure C.11: **Time Series Plots for Nitrite-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

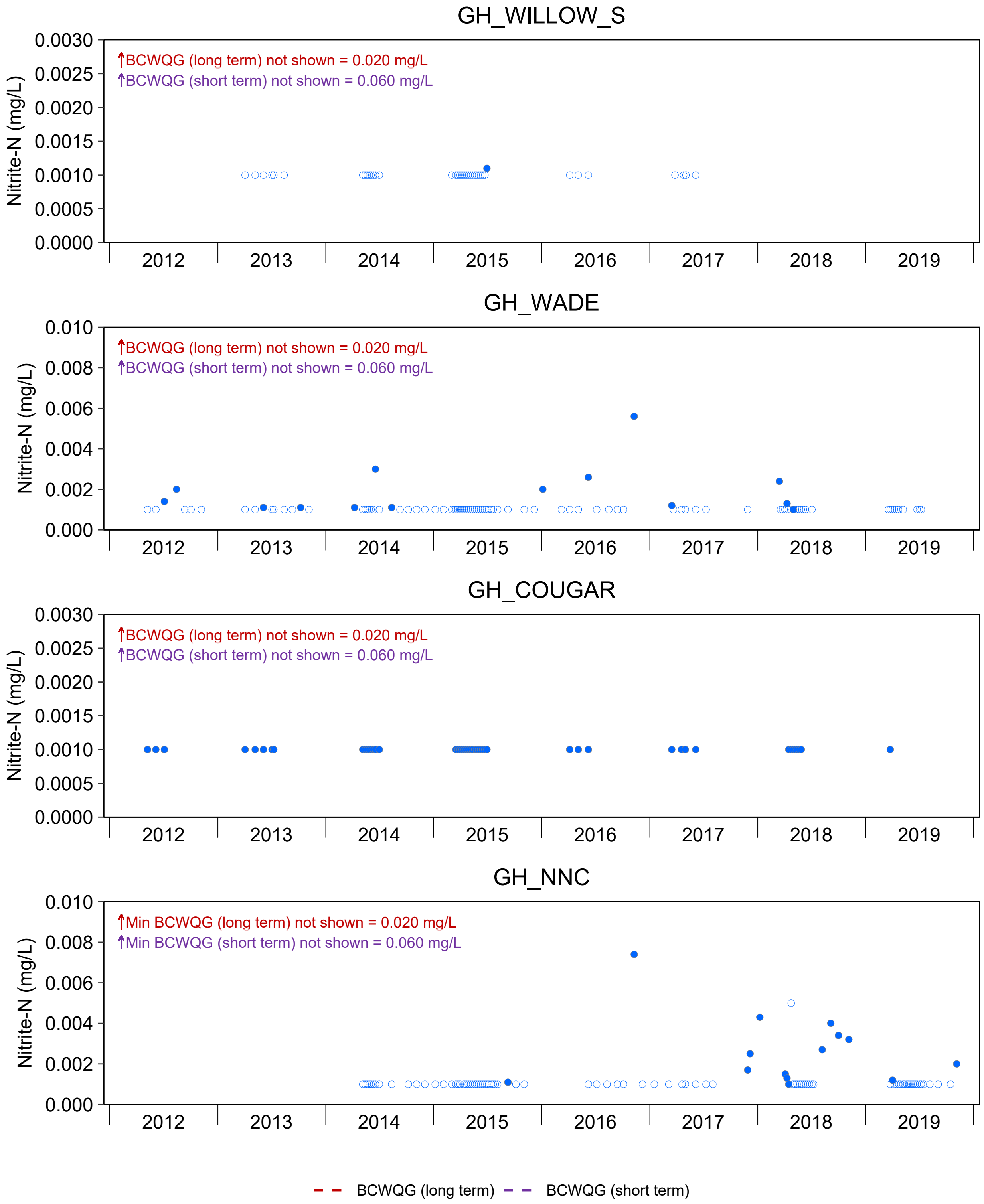


Figure C.11: **Time Series Plots for Nitrite-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

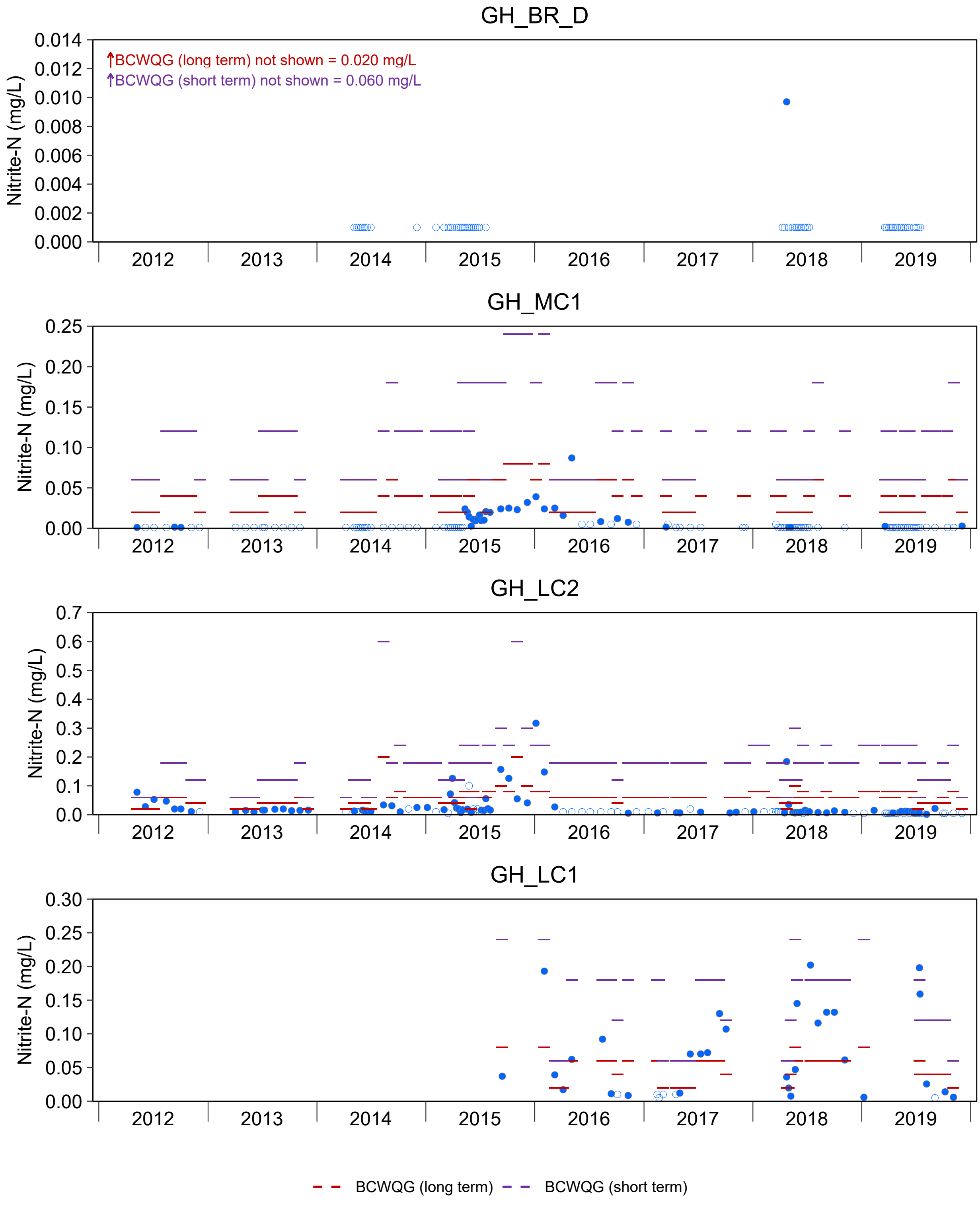


Figure C.11: **Time Series Plots for Nitrite-N Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

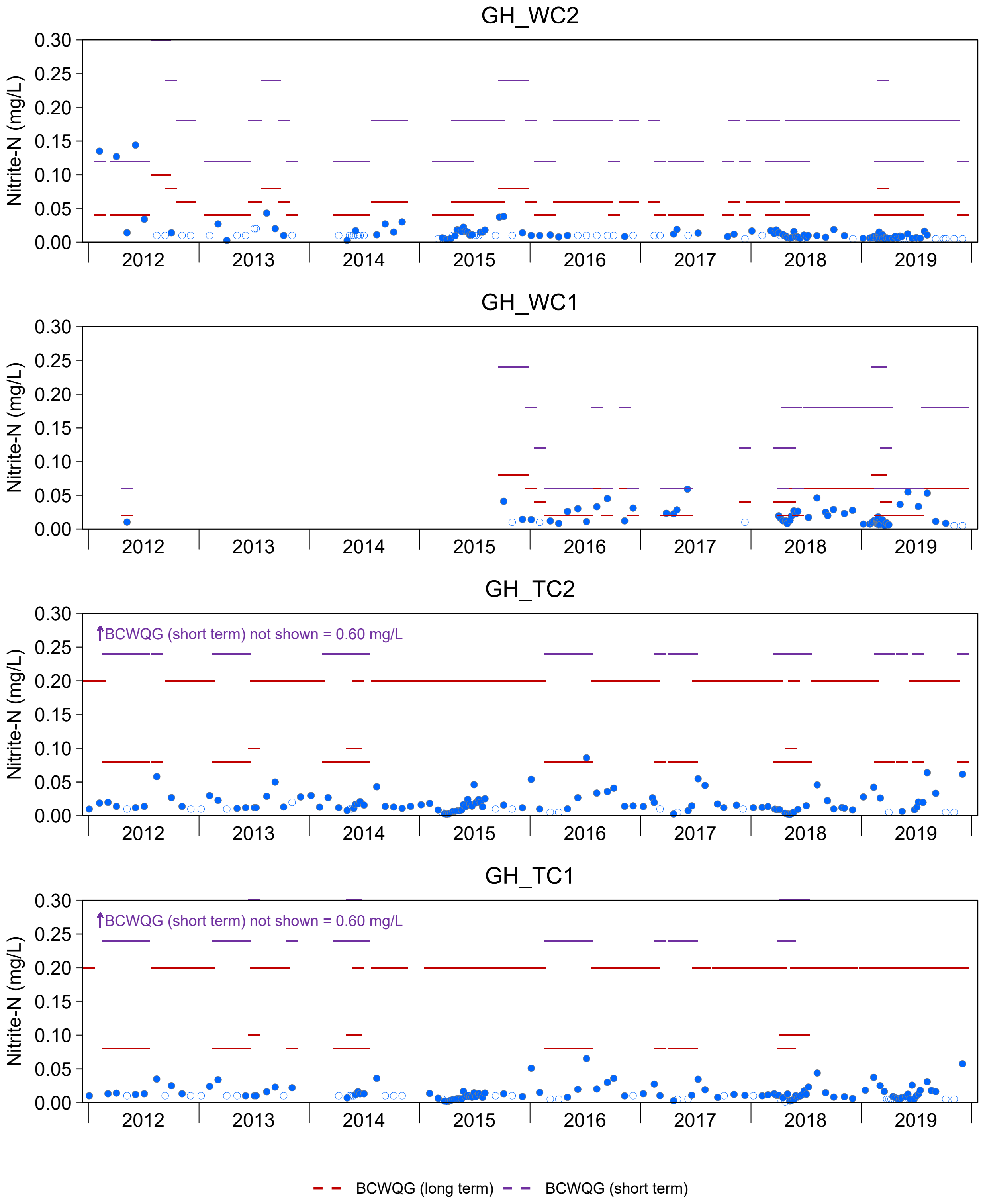


Figure C.11: Time Series Plots for Nitrite-N Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

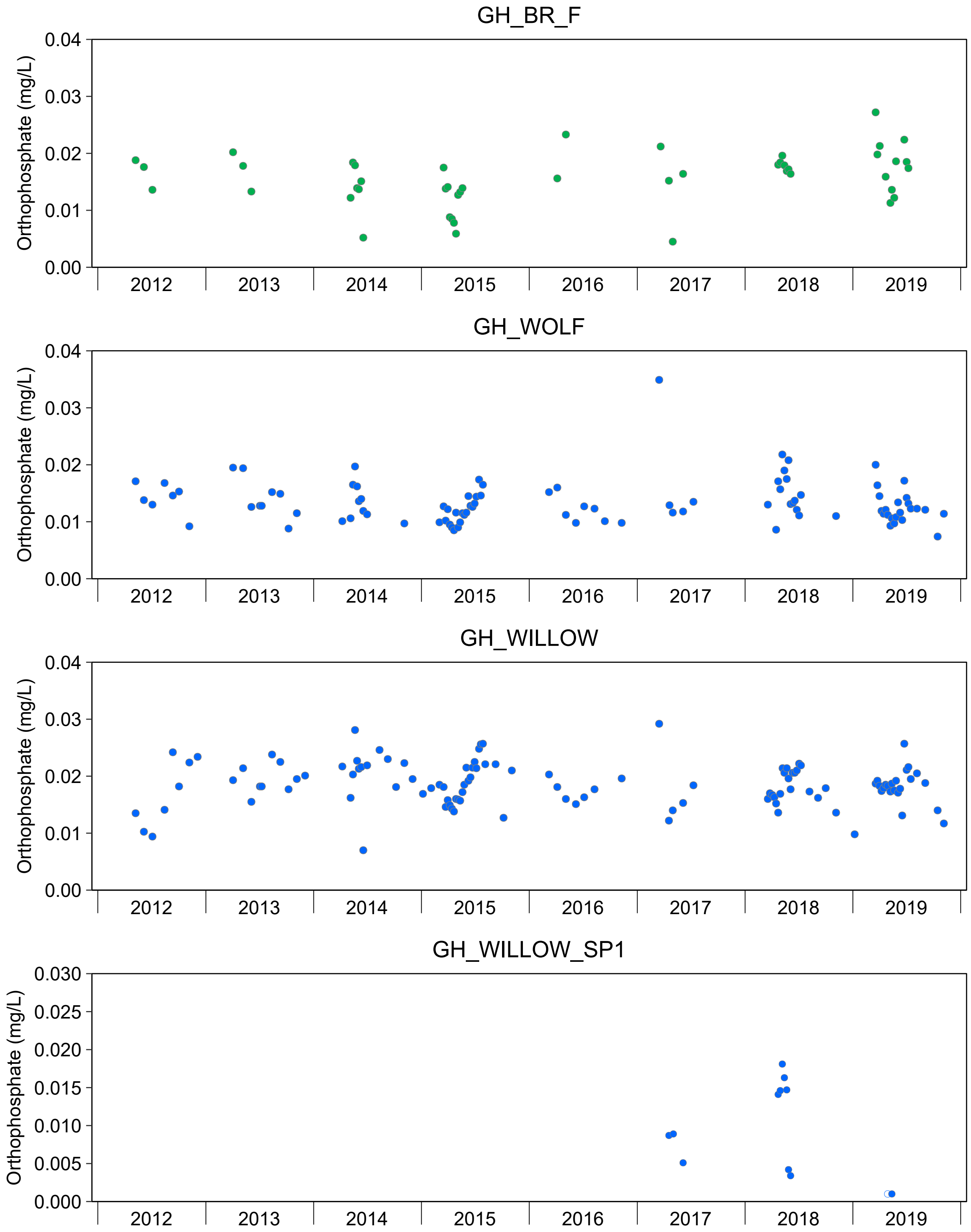


Figure C.12: **Time Series Plots for Orthophosphate Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

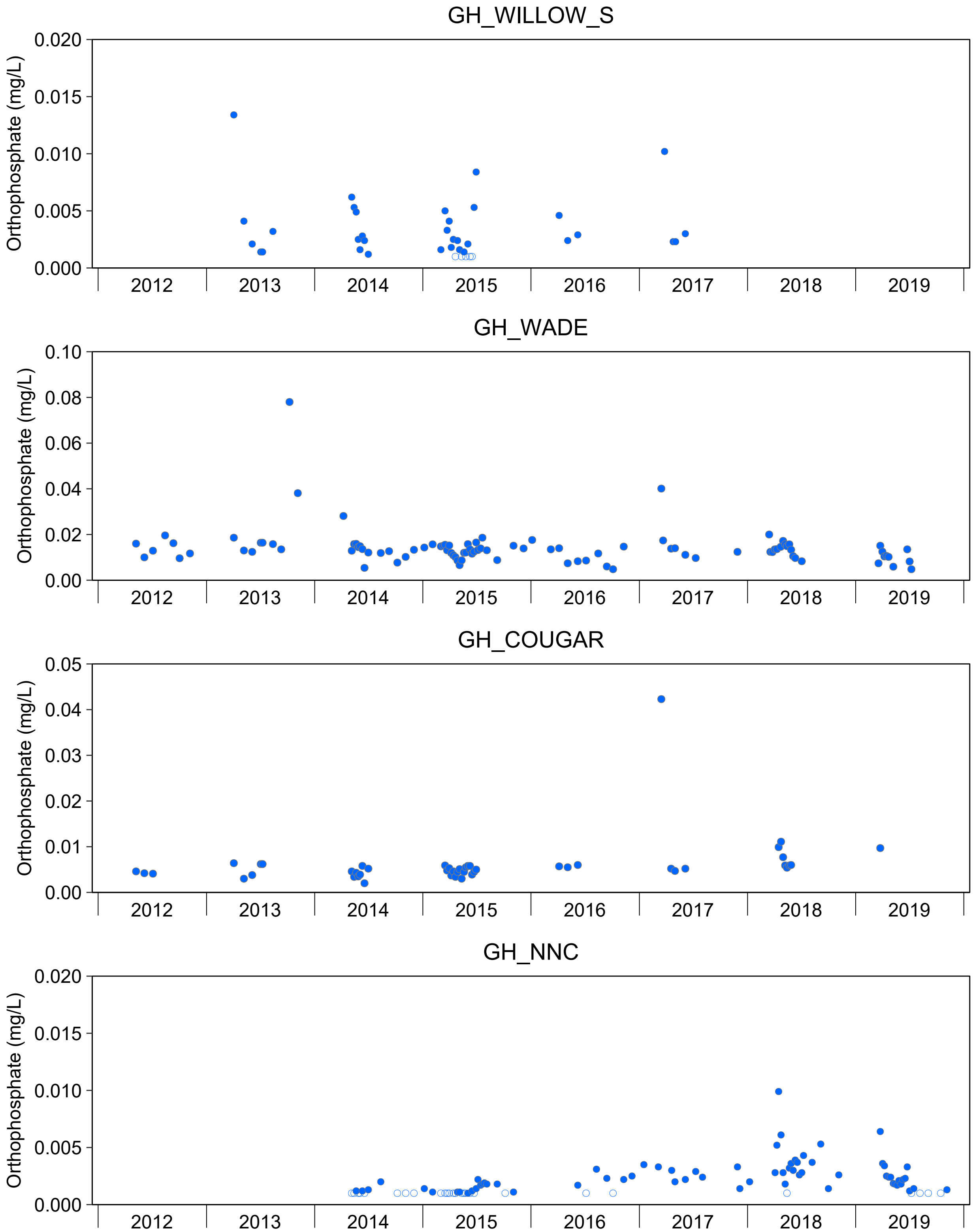


Figure C.12: Time Series Plots for Orthophosphate Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

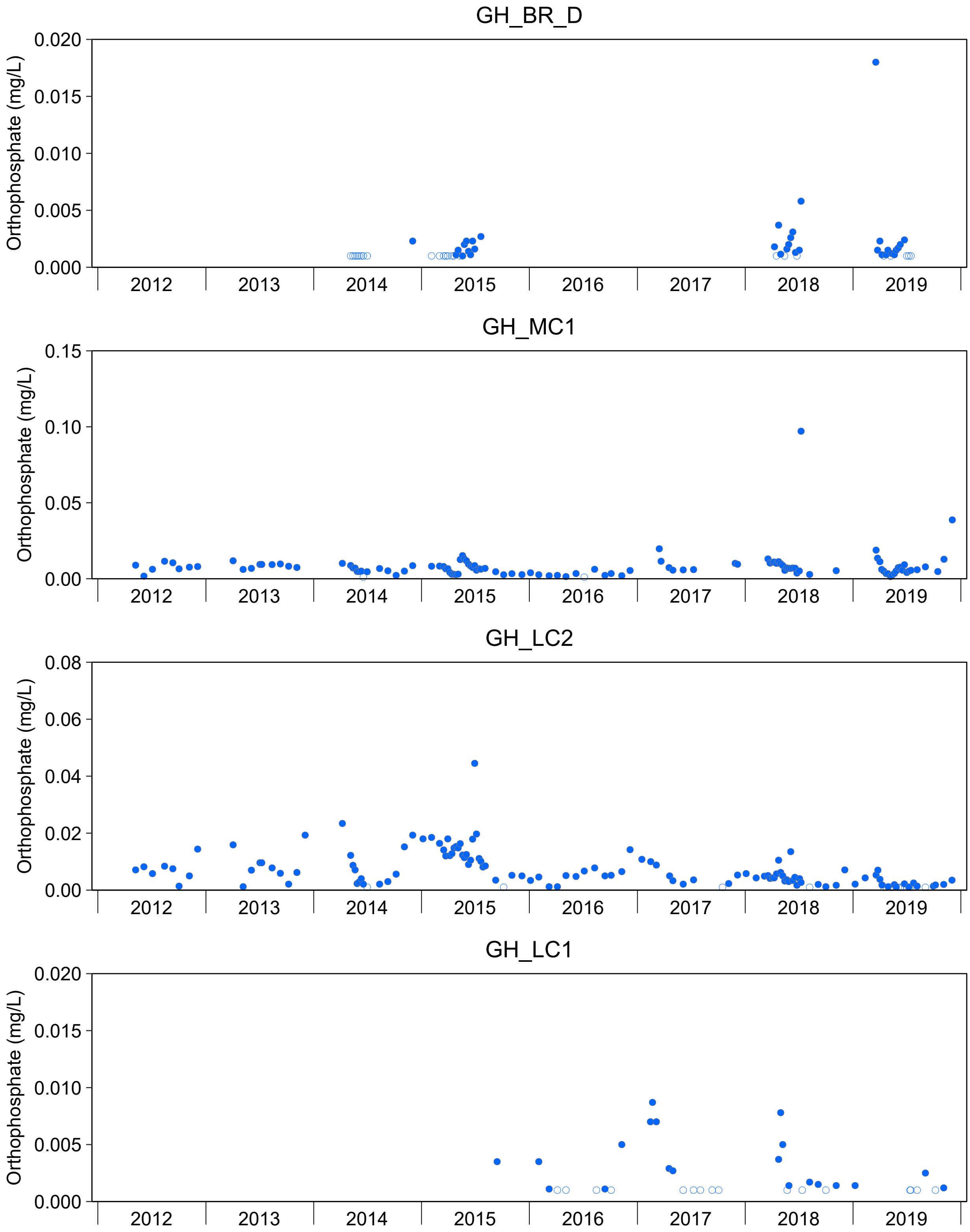


Figure C.12: **Time Series Plots for Orthophosphate Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

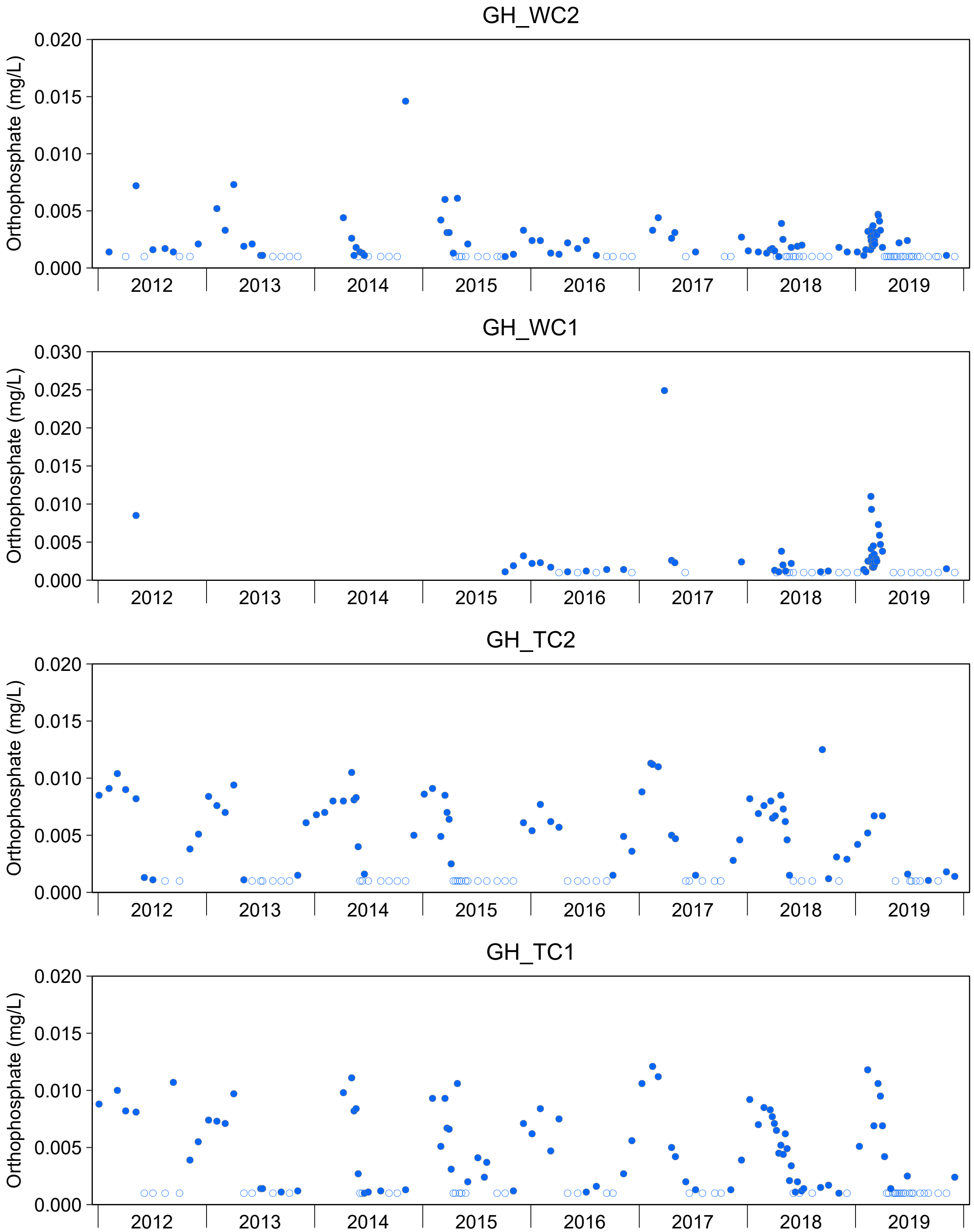


Figure C.12: Time Series Plots for Orthophosphate Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

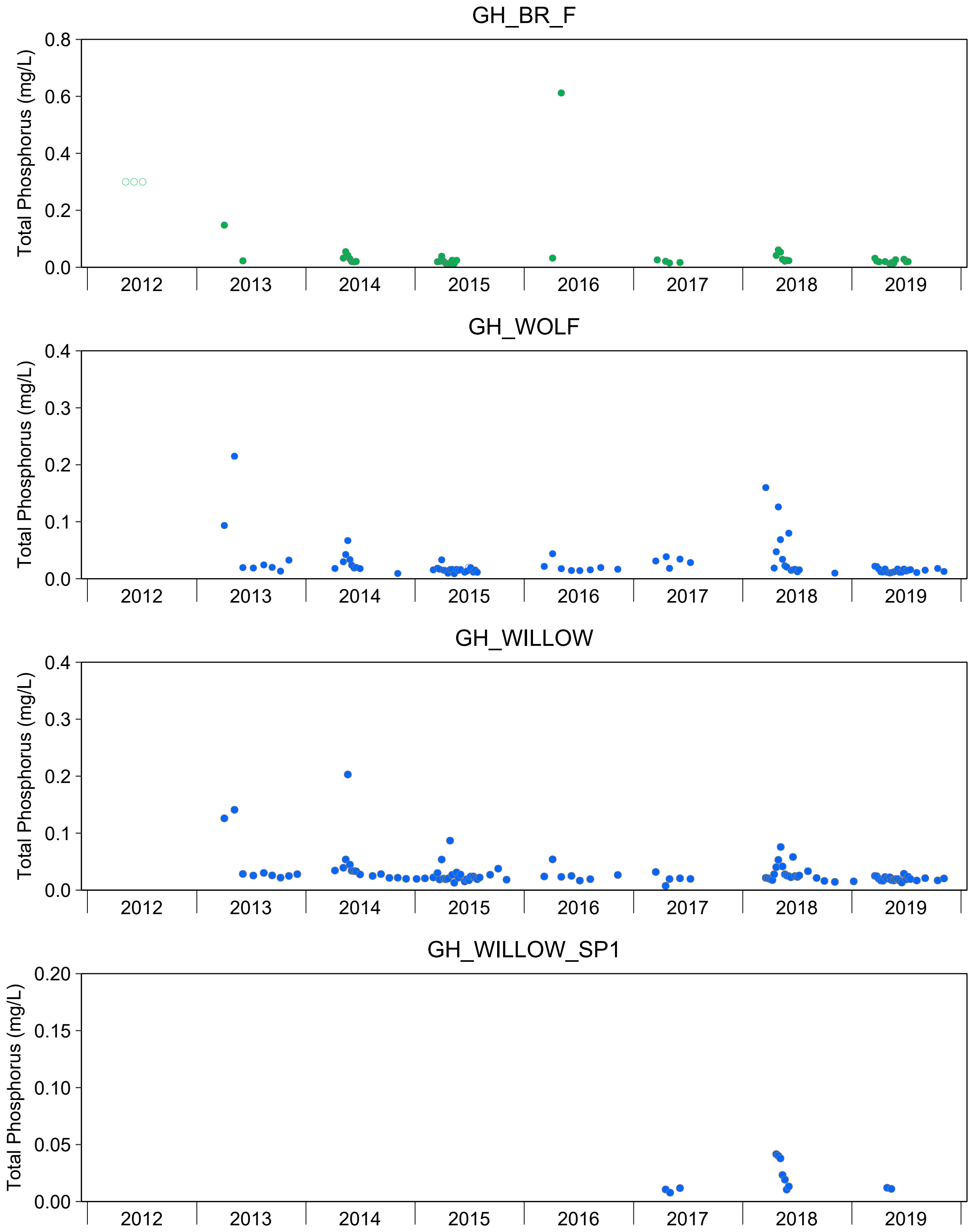


Figure C.13: **Time Series Plots for Total Phosphorus Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

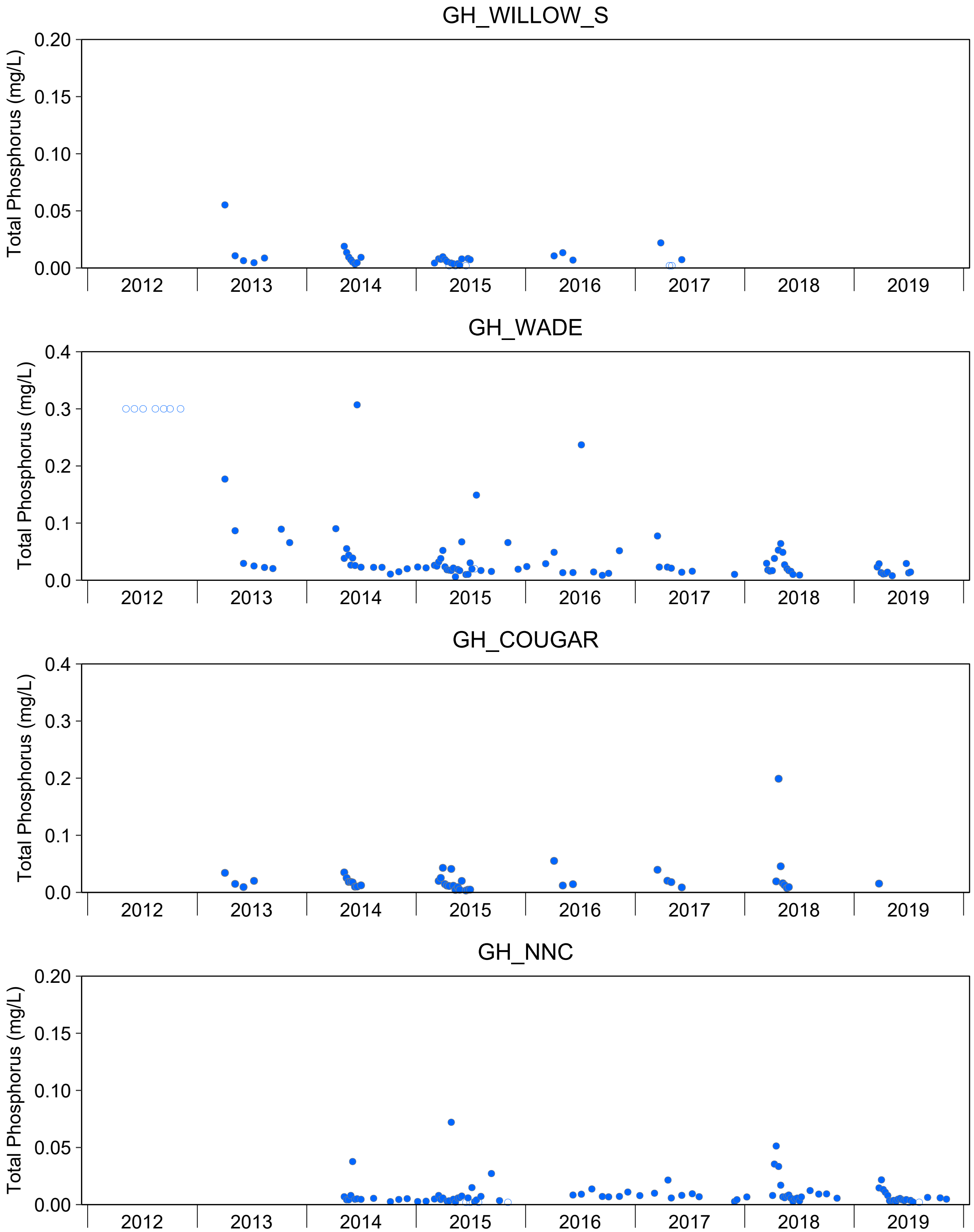


Figure C.13: **Time Series Plots for Total Phosphorus Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

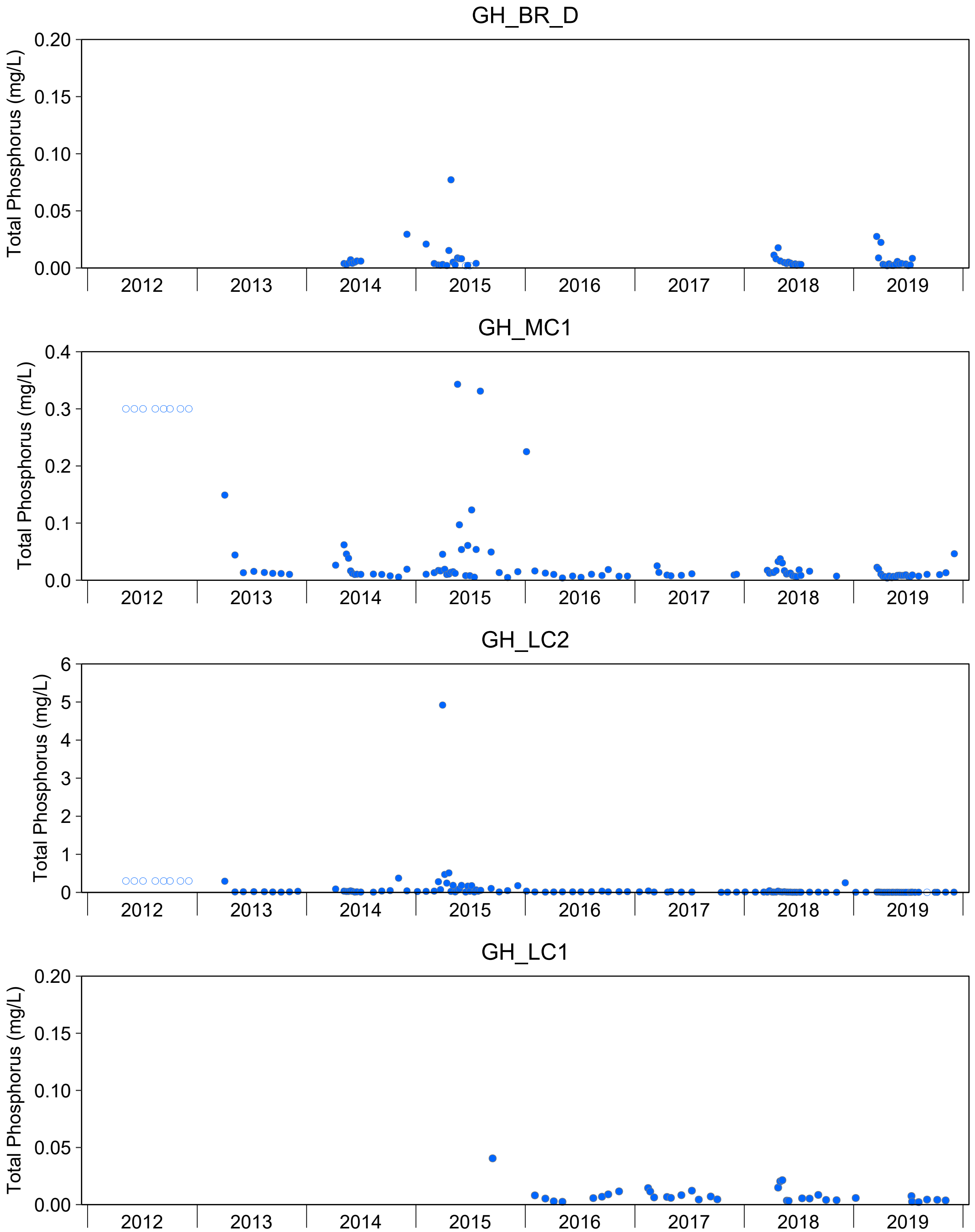


Figure C.13: Time Series Plots for Total Phosphorus Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

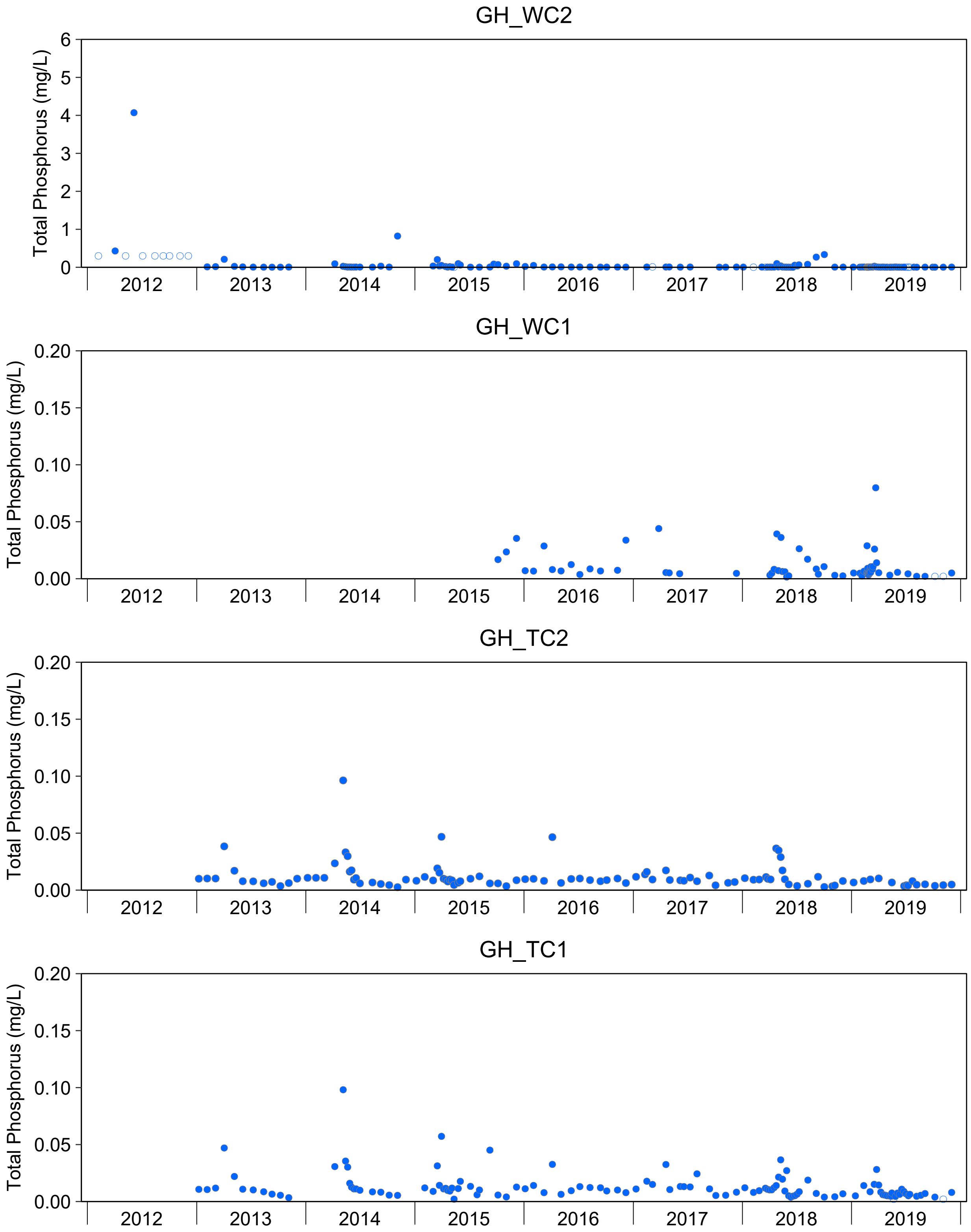


Figure C.13: Time Series Plots for Total Phosphorus Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

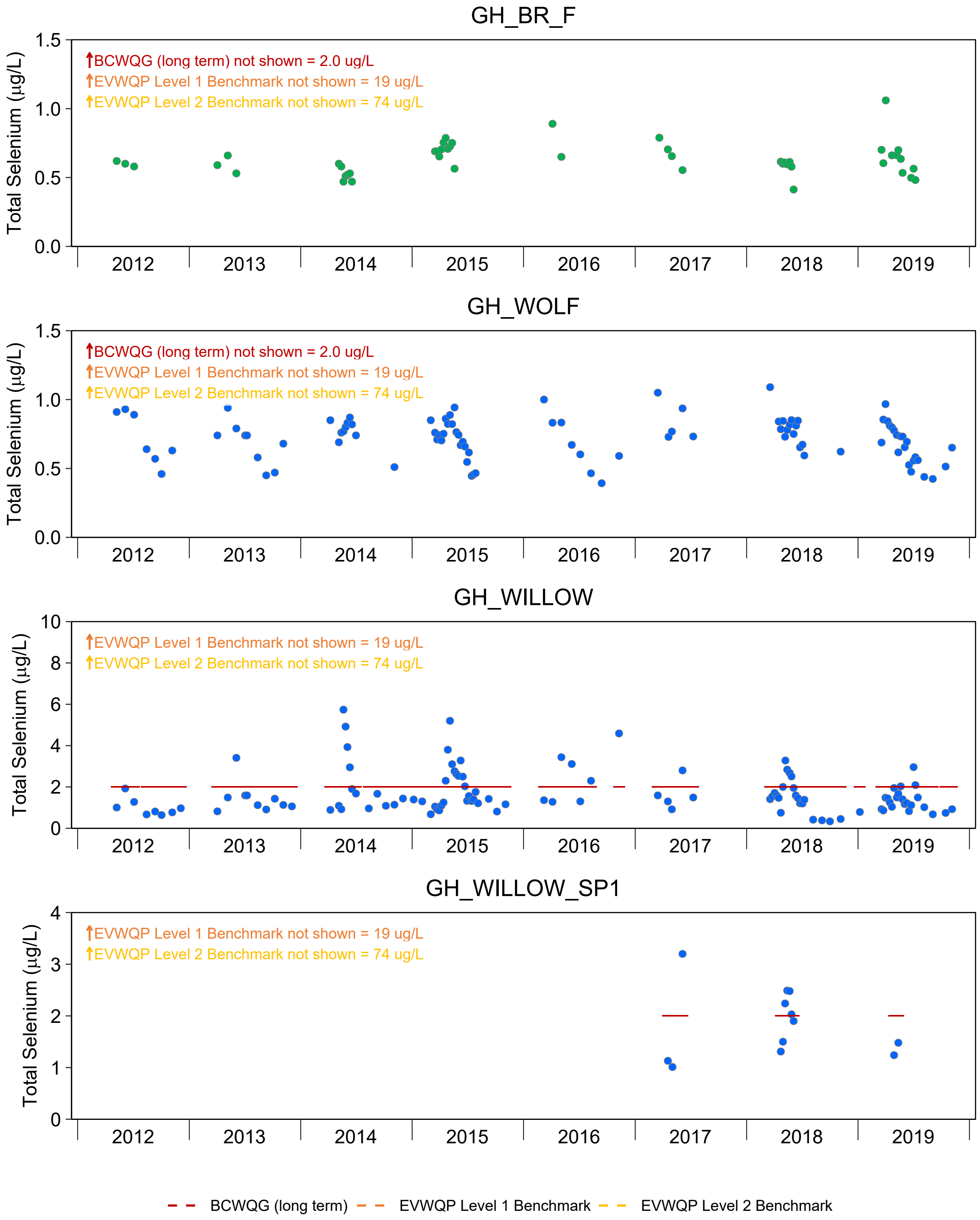


Figure C.14: **Time Series Plots for Total Selenium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

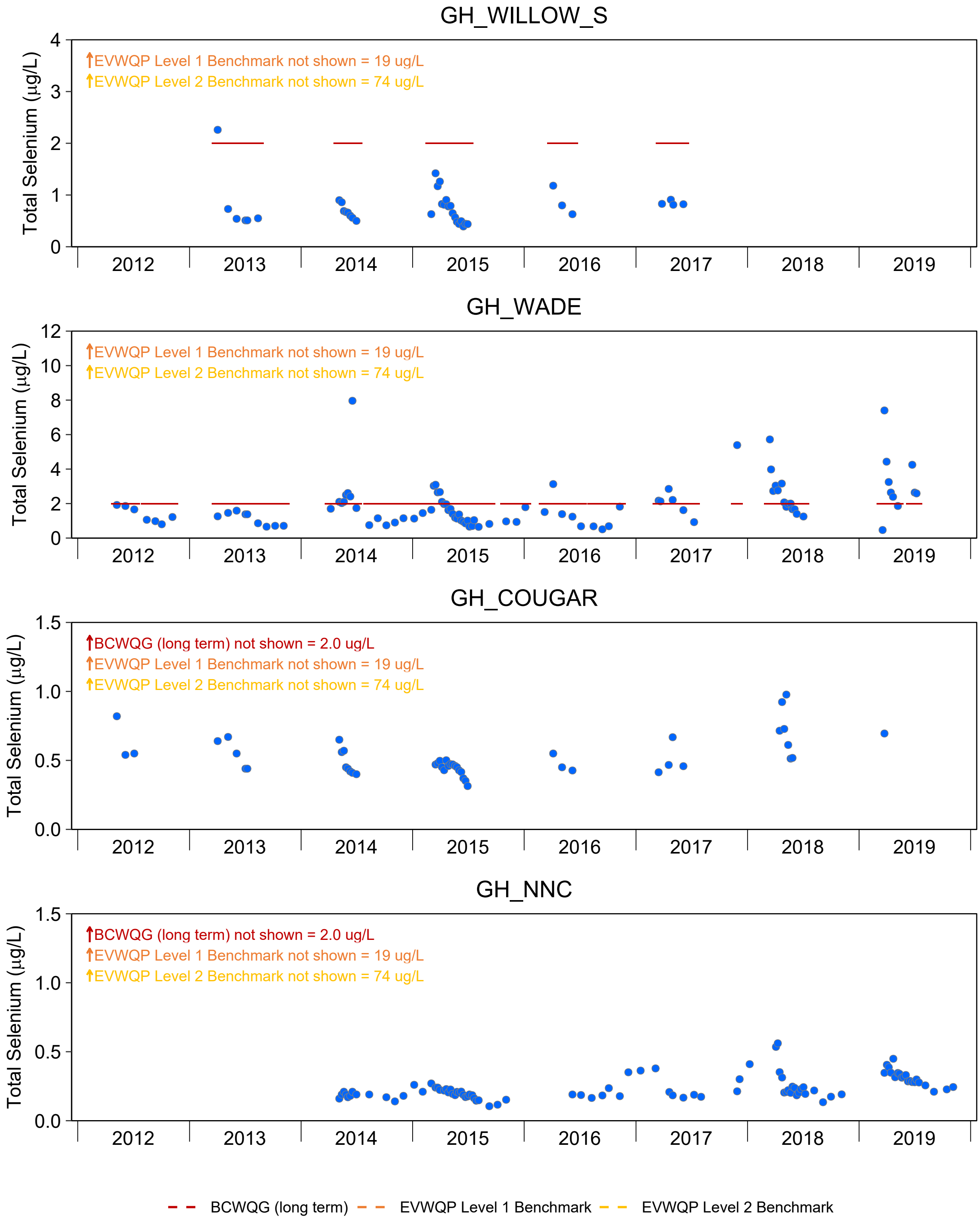


Figure C.14: **Time Series Plots for Total Selenium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

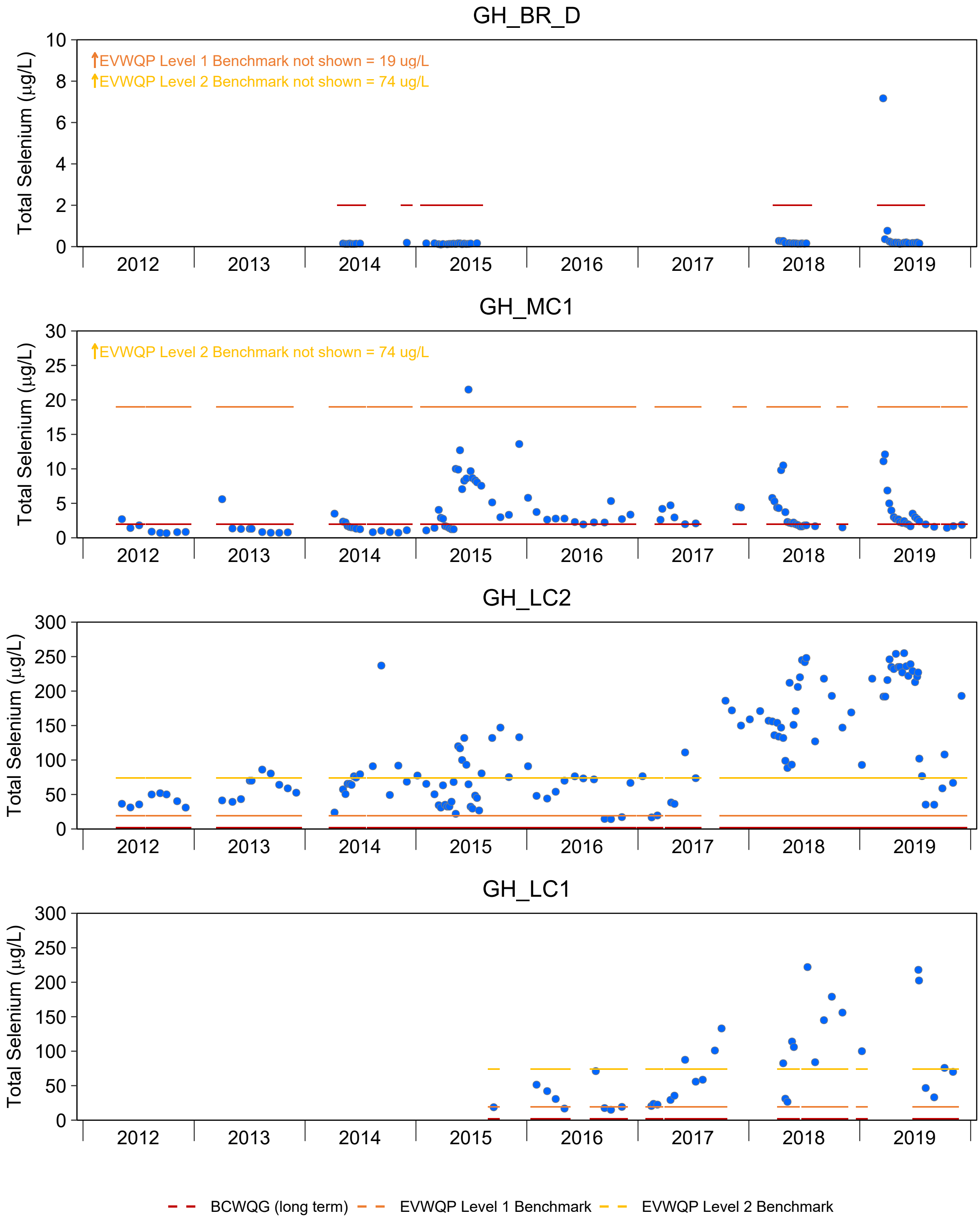


Figure C.14: **Time Series Plots for Total Selenium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

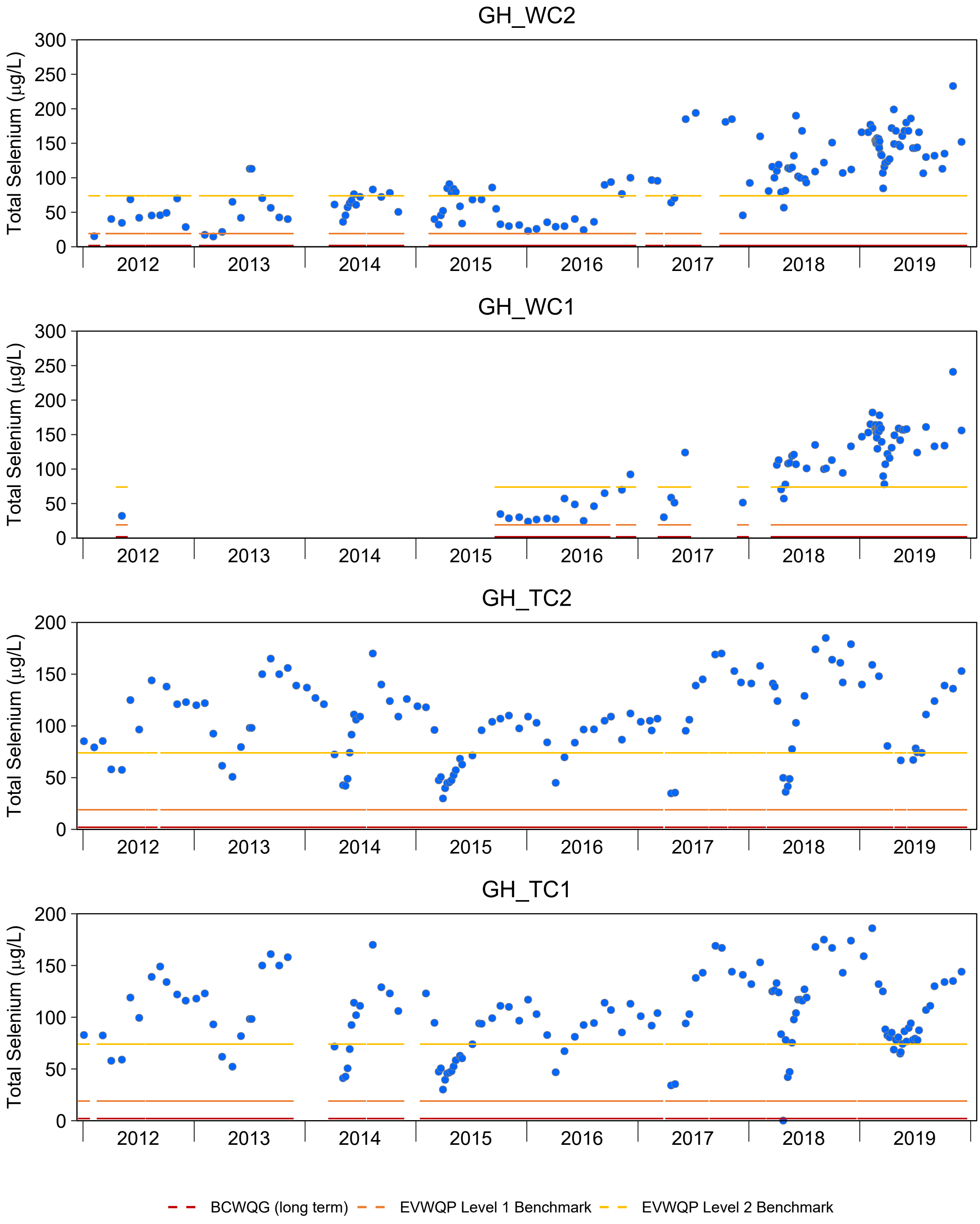


Figure C.14: **Time Series Plots for Total Selenium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

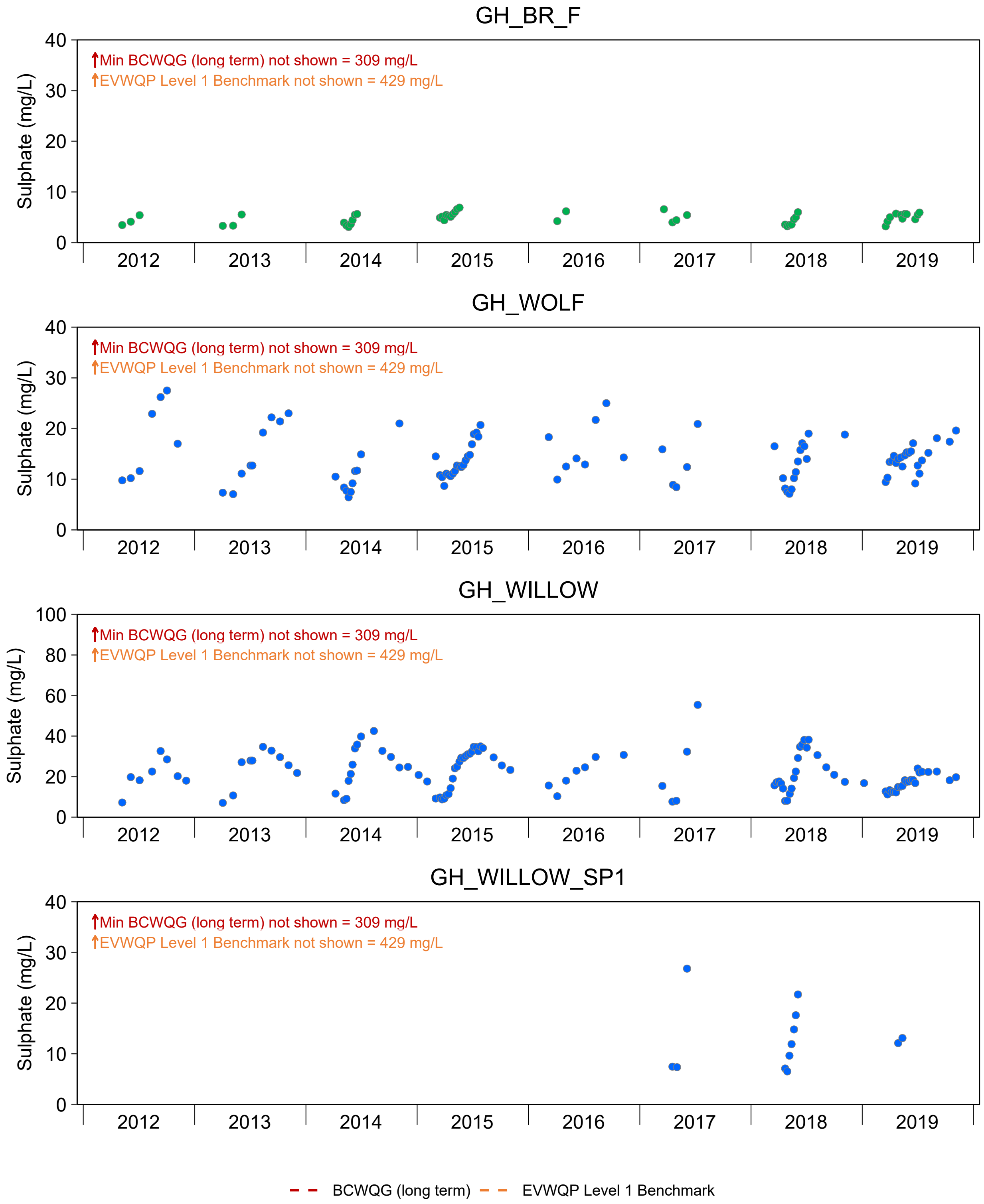


Figure C.15: **Time Series Plots for Sulphate Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

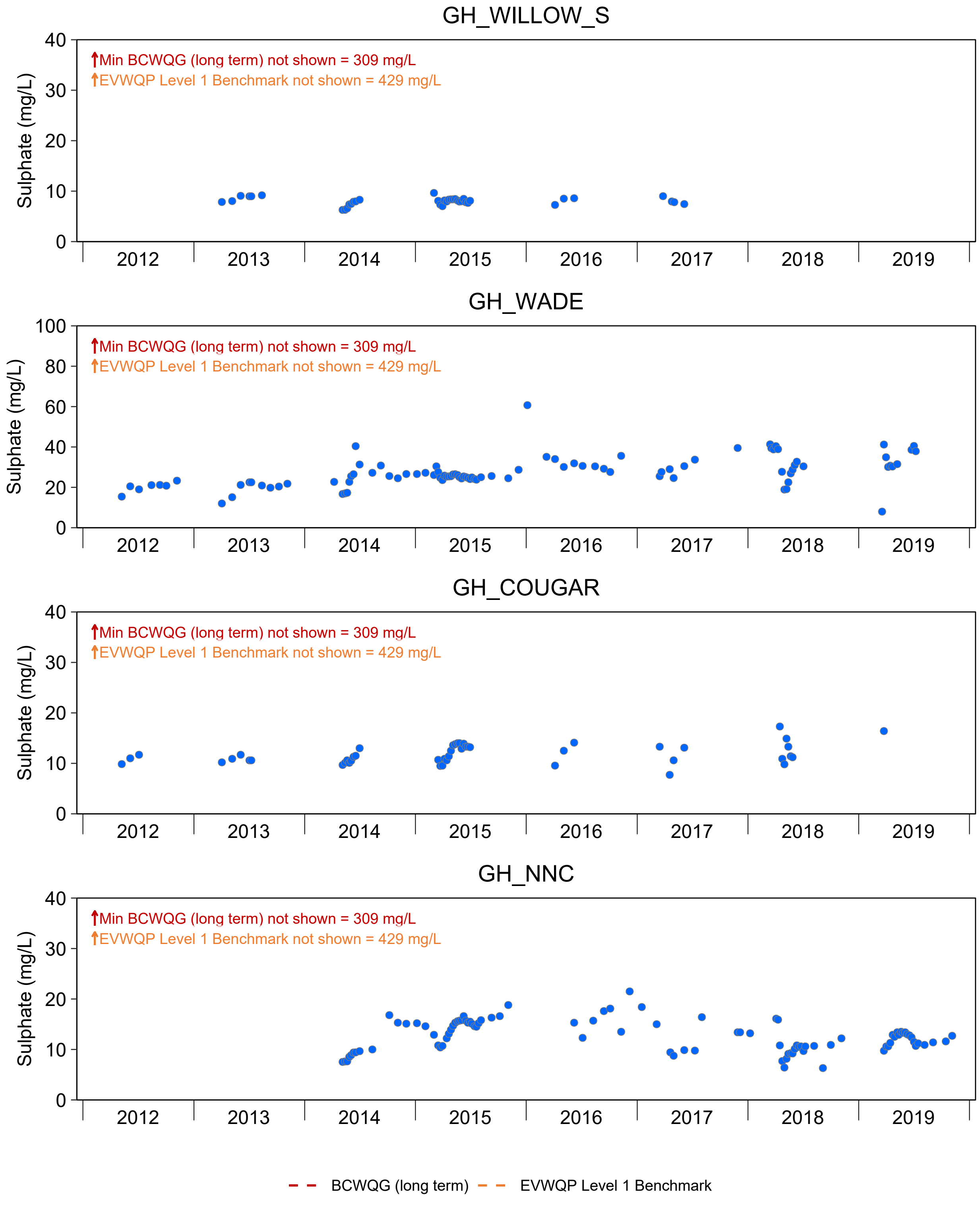


Figure C.15: Time Series Plots for Sulphate Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

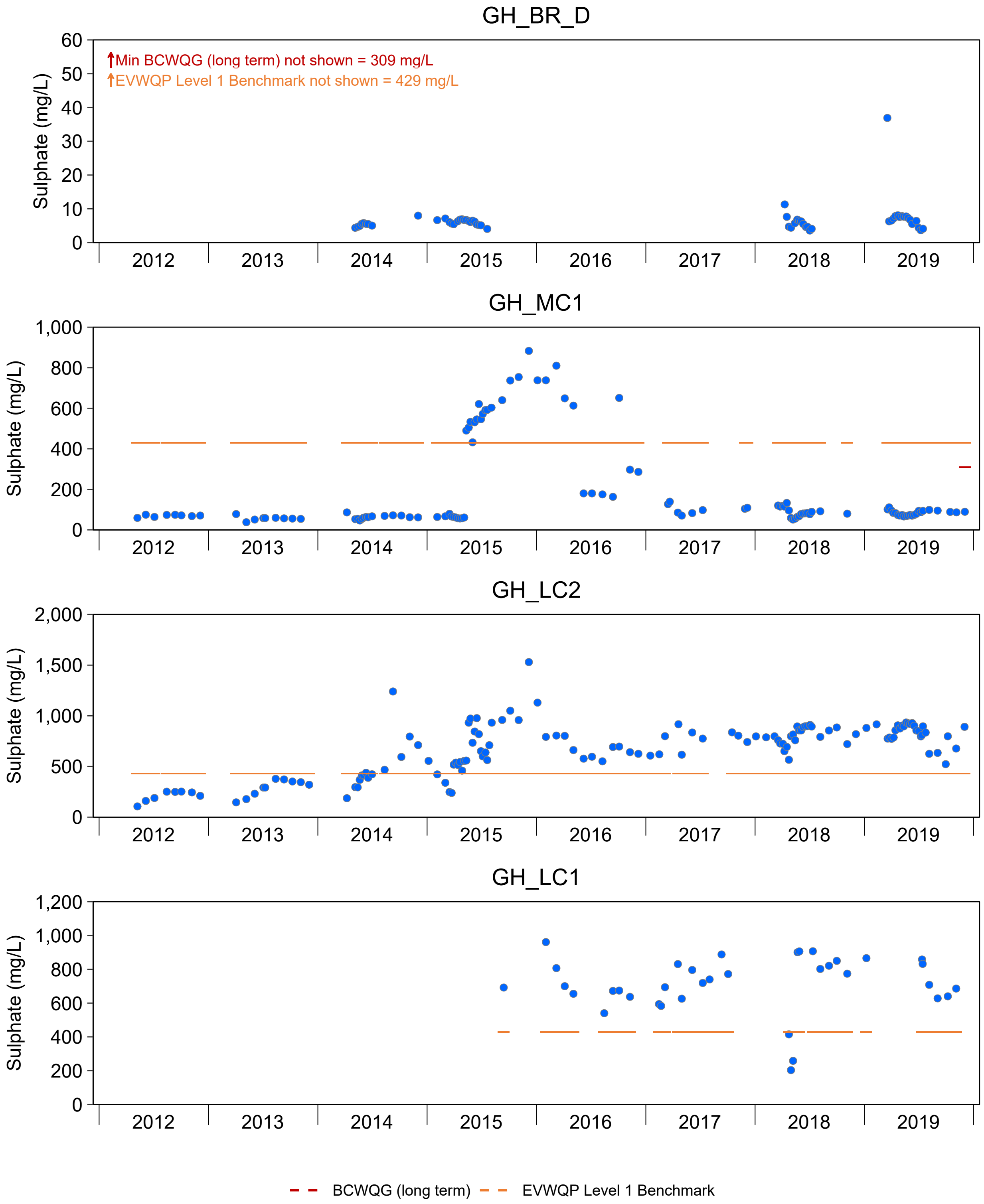


Figure C.15: **Time Series Plots for Sulphate Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

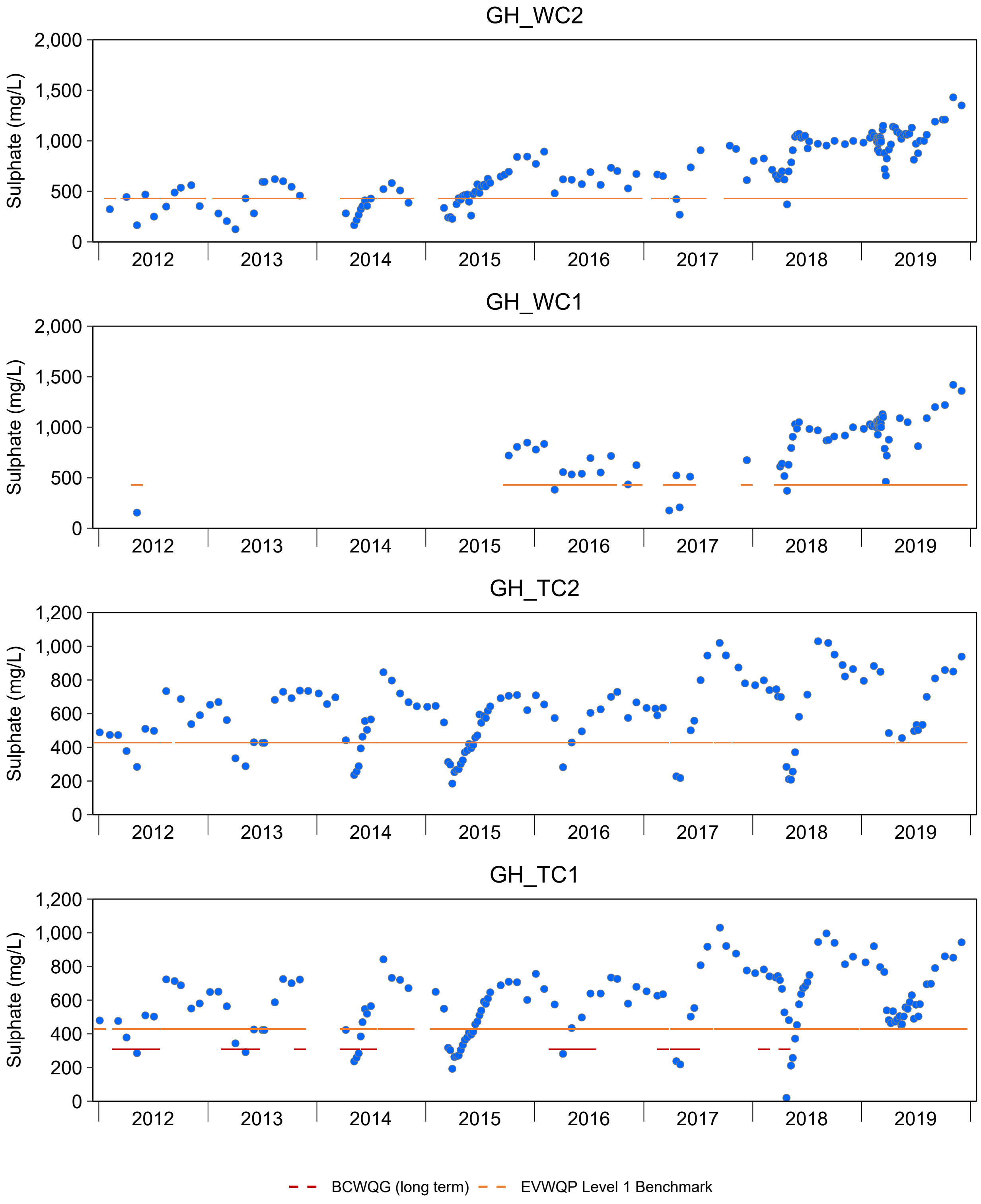


Figure C.15: **Time Series Plots for Sulphate Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

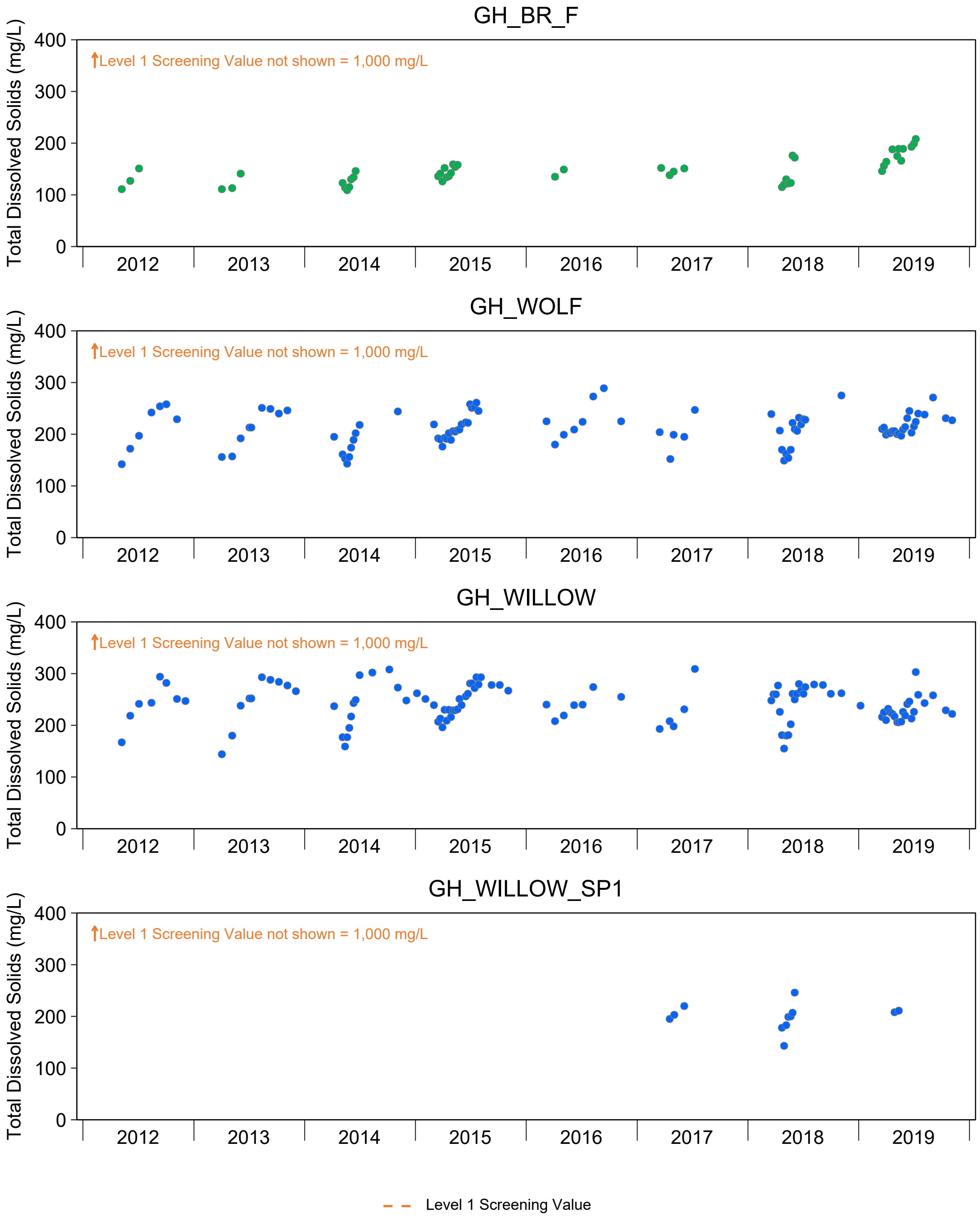


Figure C.16: **Time Series Plots for Total Dissolved Solids Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

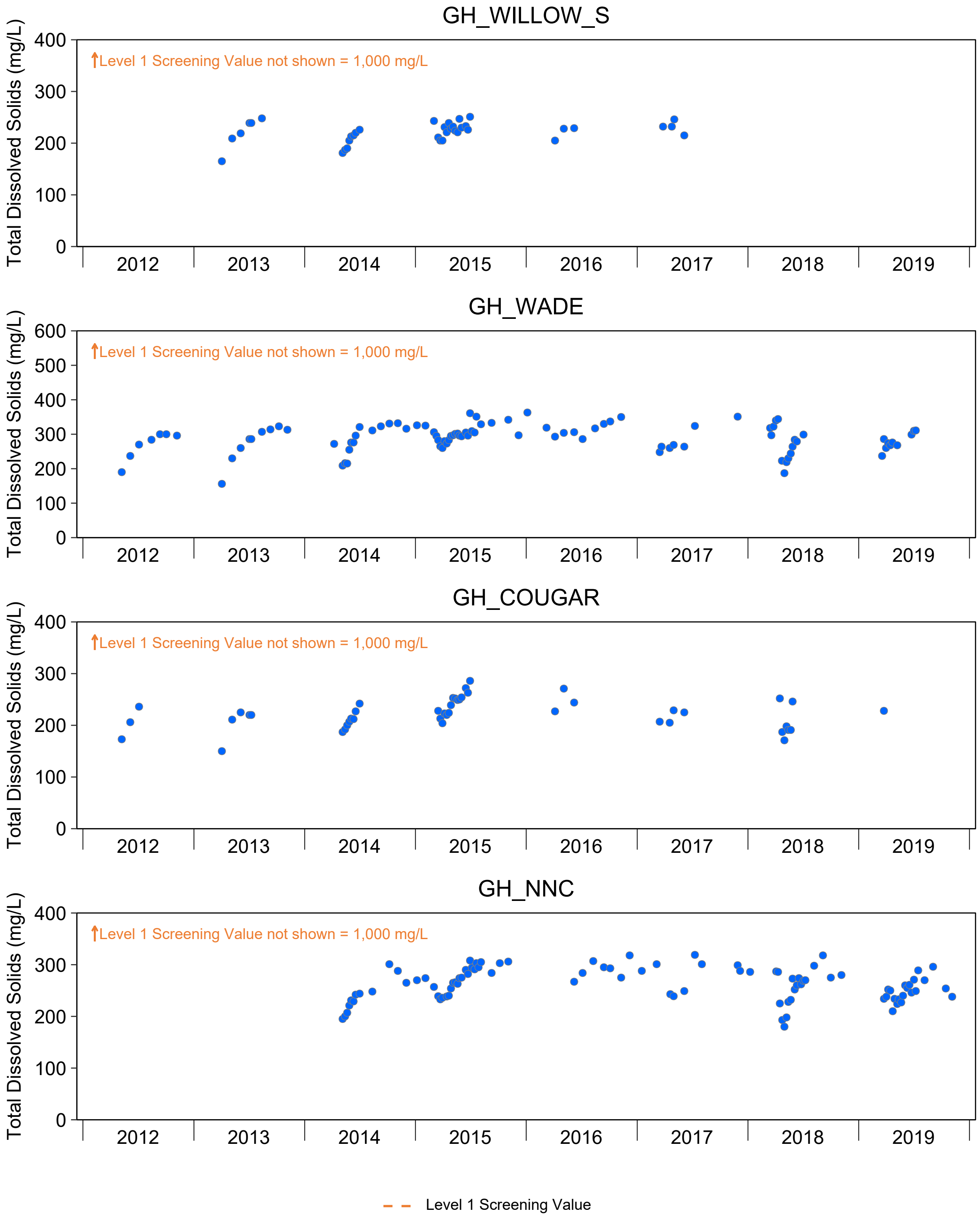


Figure C.16: **Time Series Plots for Total Dissolved Solids Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

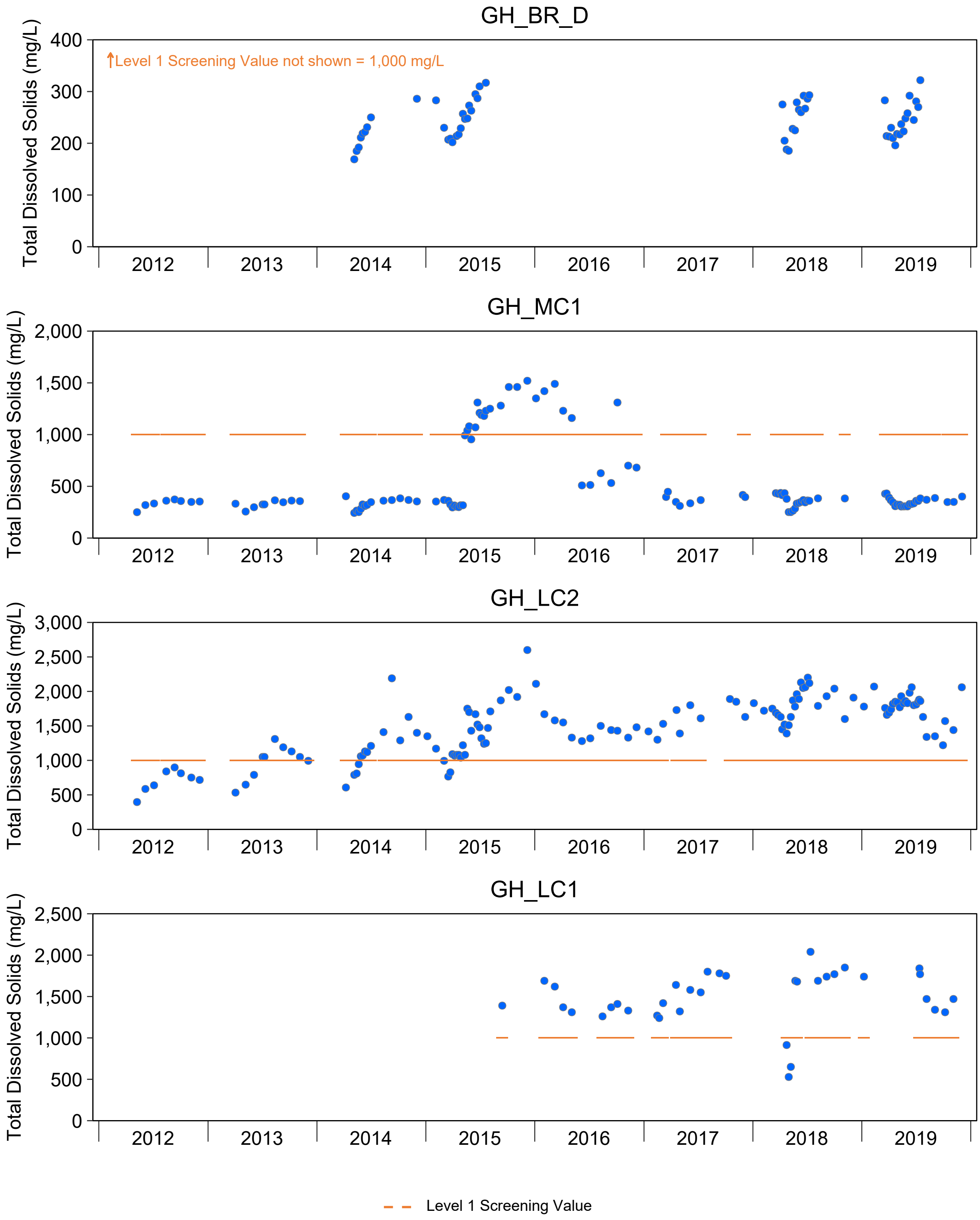


Figure C.16: **Time Series Plots for Total Dissolved Solids Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

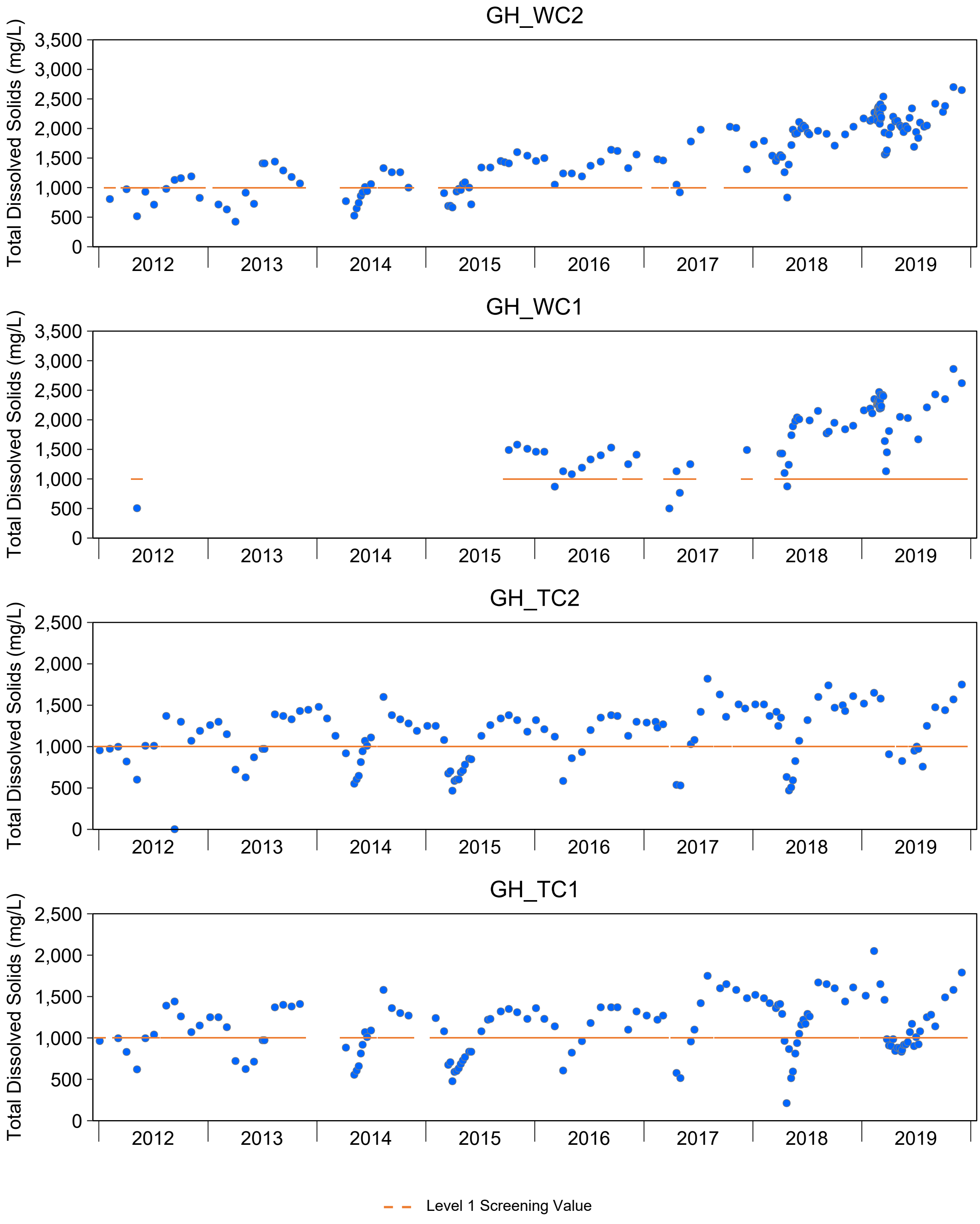


Figure C.16: **Time Series Plots for Total Dissolved Solids Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

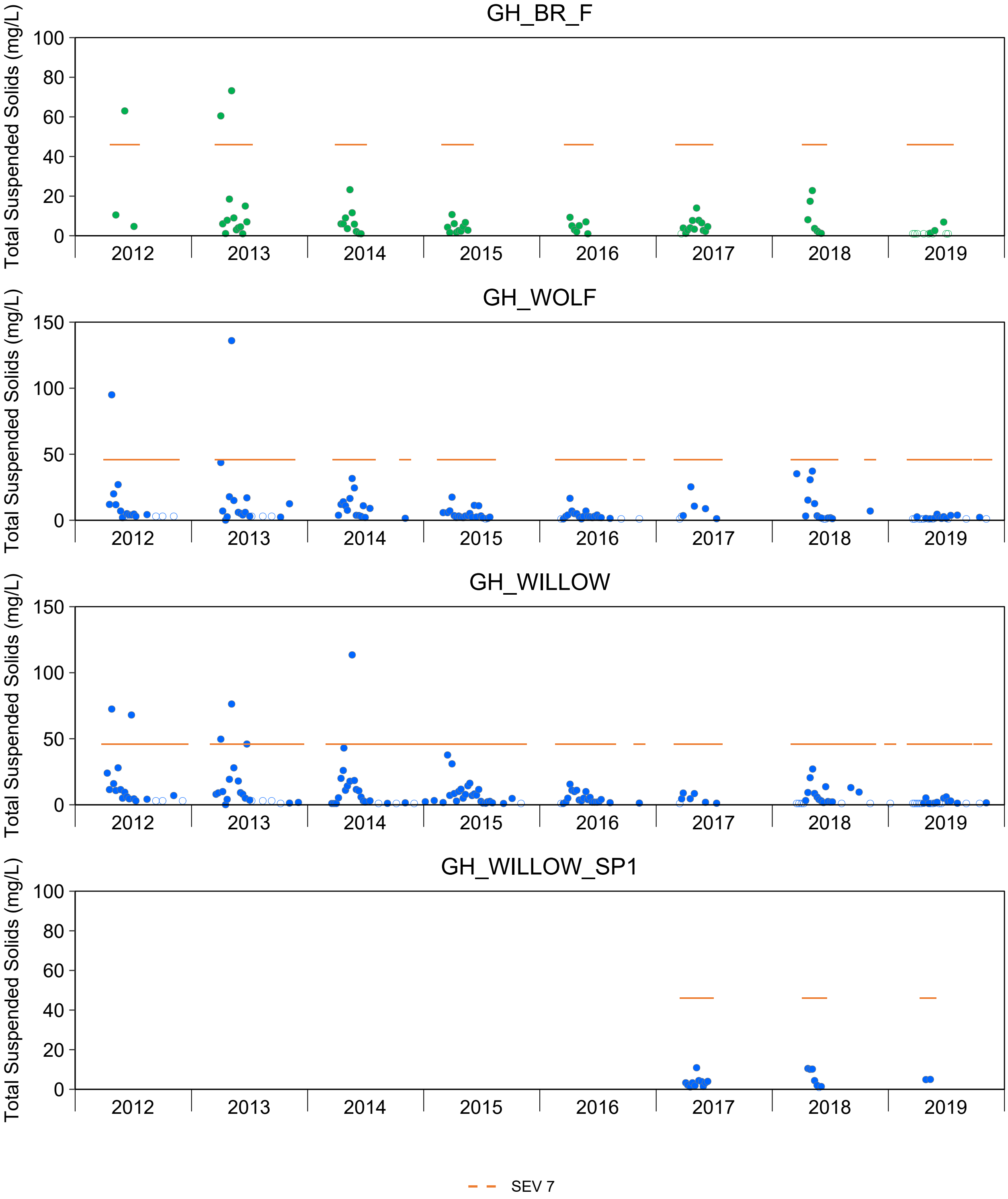


Figure C.17: Time Series Plots for TSS Concentrations from the West-side Tributaries, 2012 to 2019

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Notes: Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 μm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

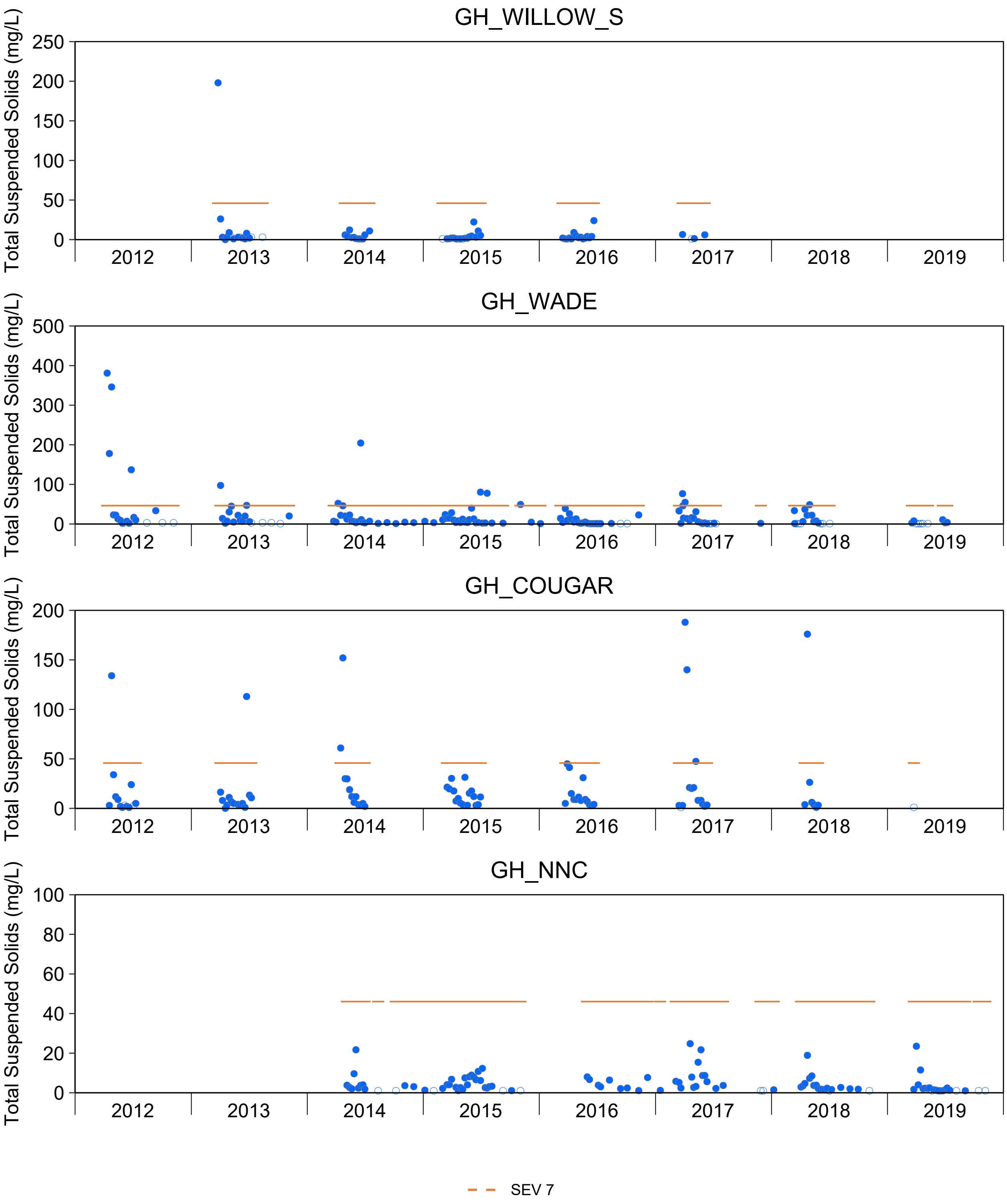


Figure C.17: Time Series Plots for TSS Concentrations from the West-side Tributaries, 2012 to 2019

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Notes: Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

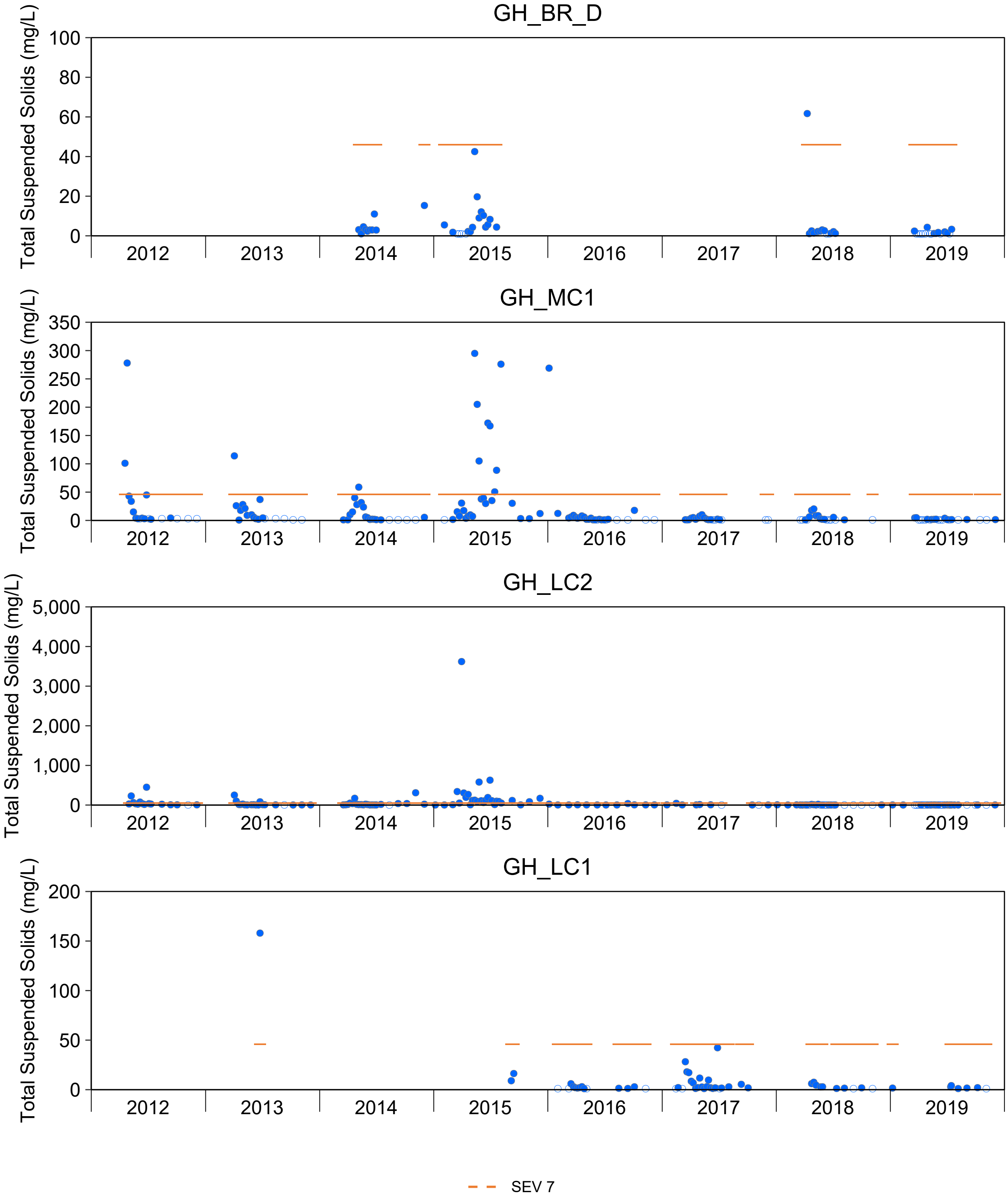


Figure C.17: **Time Series Plots for TSS Concentrations from the West-side Tributaries, 2012 to 2019**

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Notes: Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

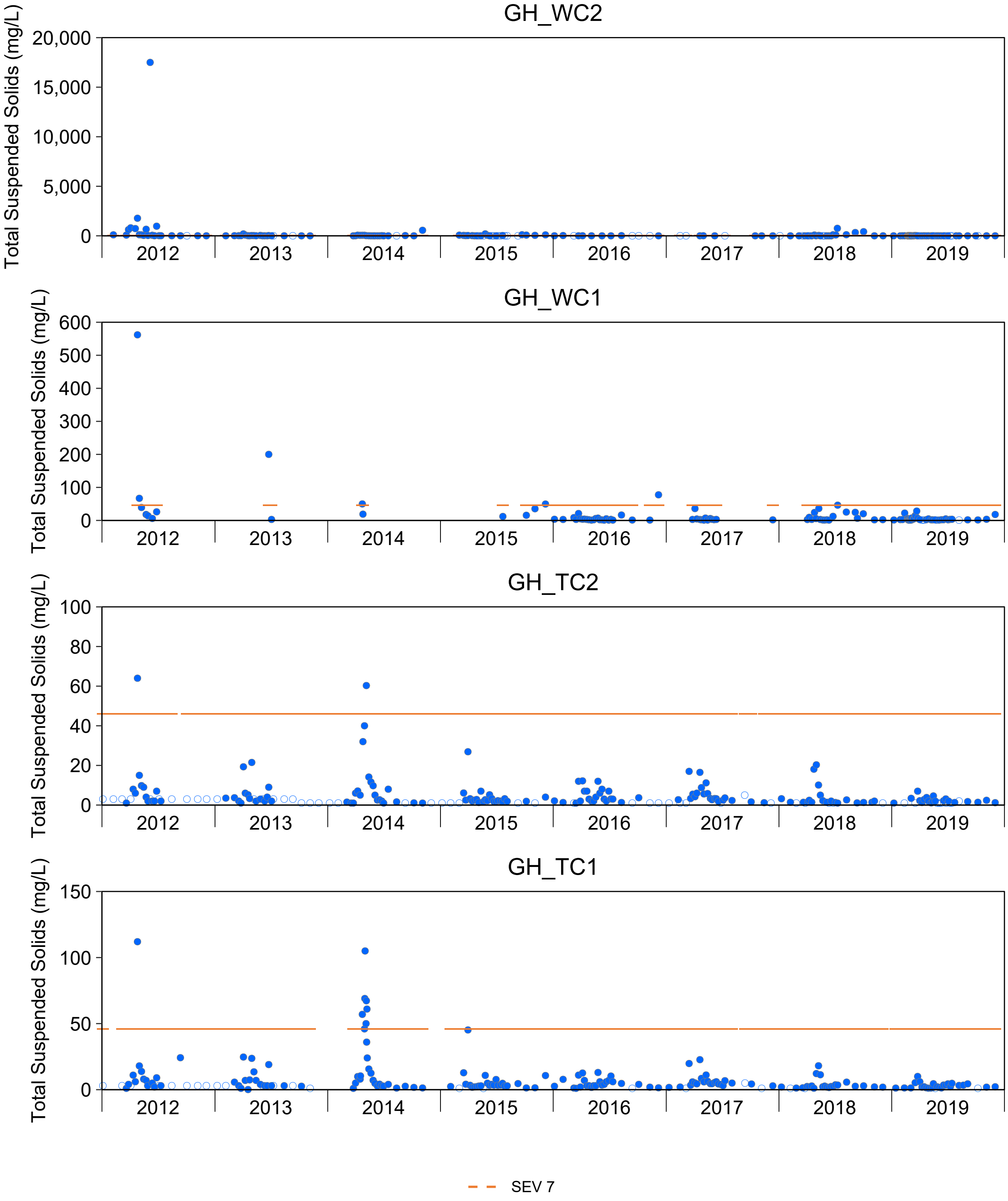


Figure C.17: **Time Series Plots for TSS Concentrations from the West-side Tributaries, 2012 to 2019**

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Notes: Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

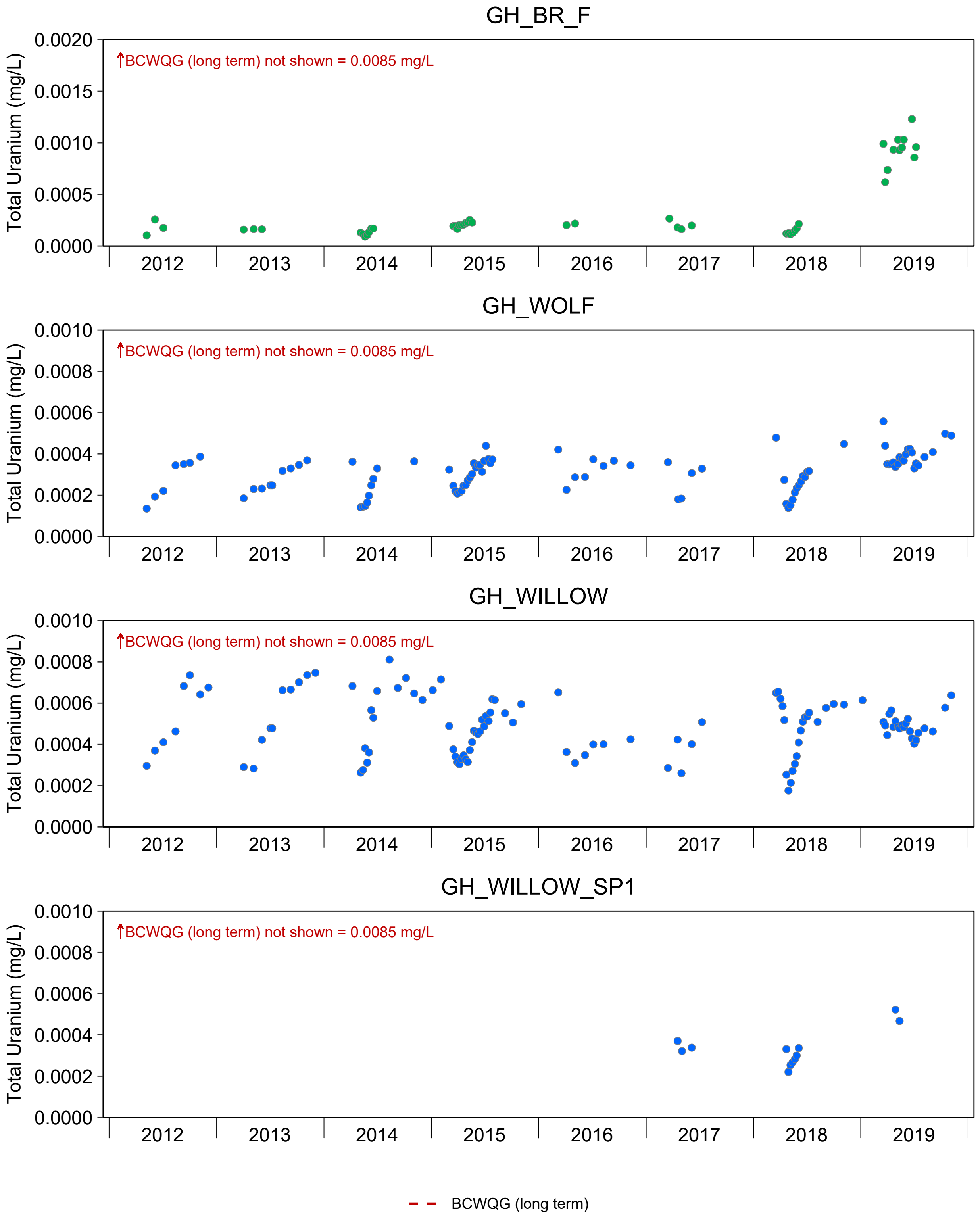


Figure C.18: **Time Series Plots for Total Uranium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

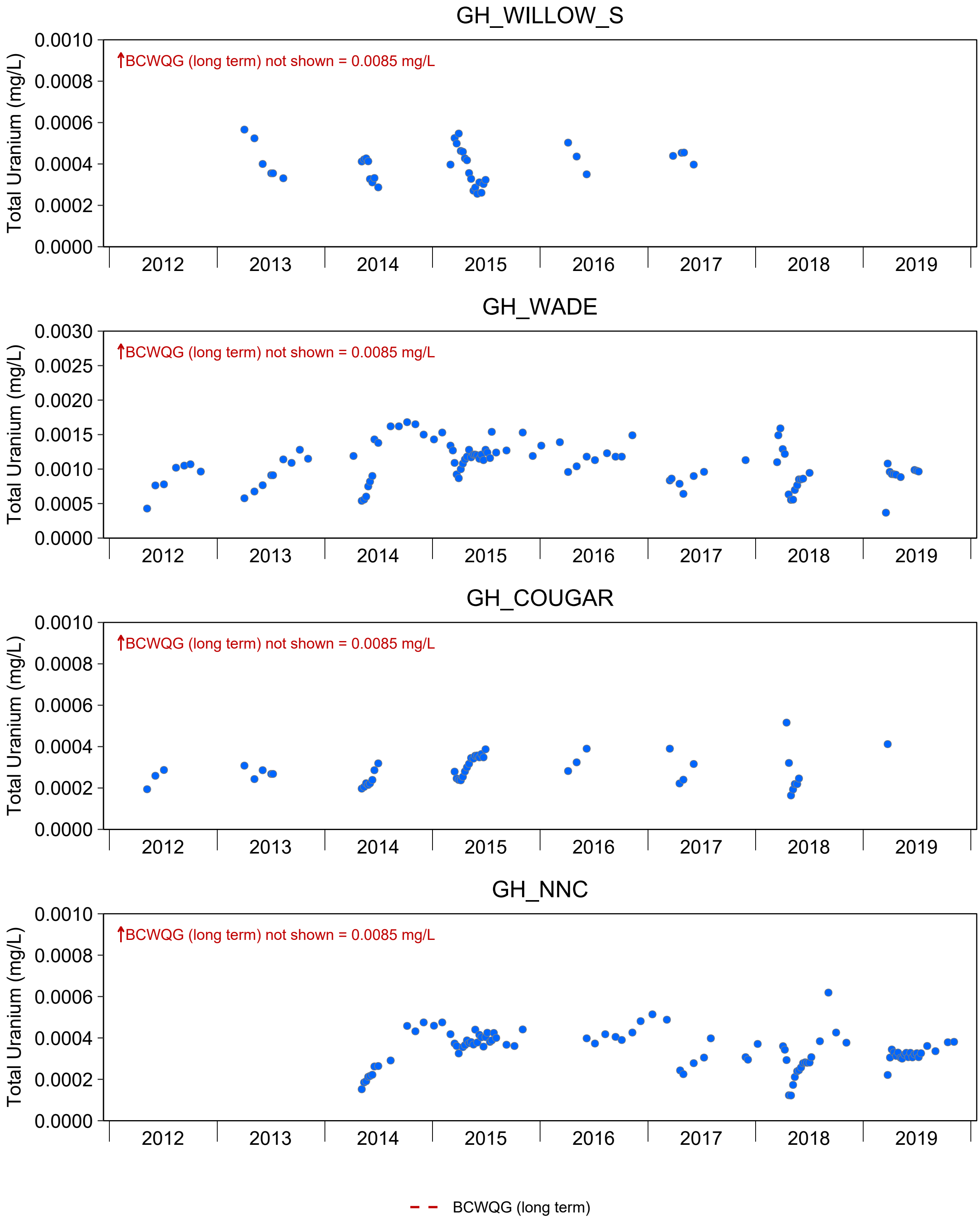


Figure C.18: **Time Series Plots for Total Uranium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

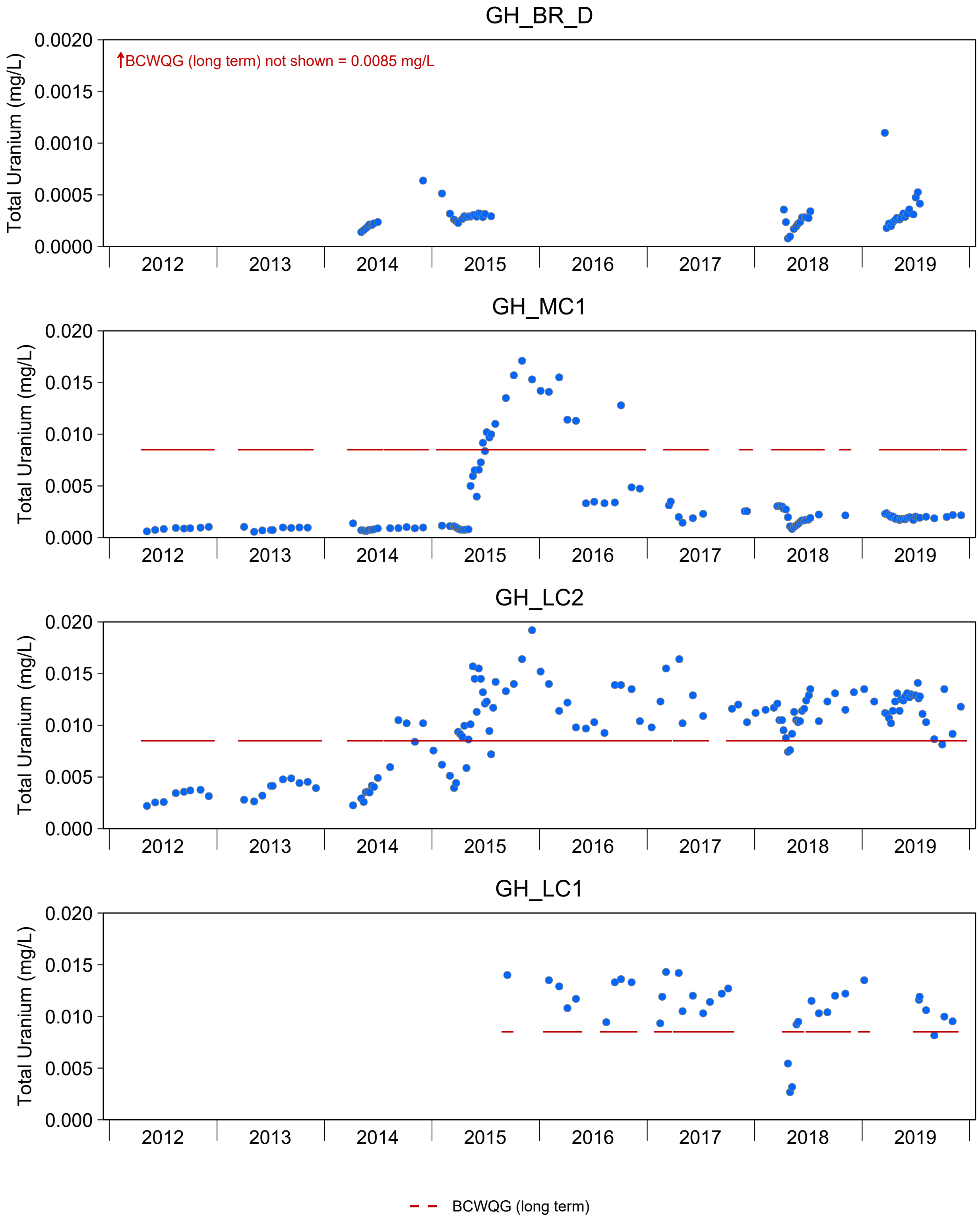


Figure C.18: **Time Series Plots for Total Uranium Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

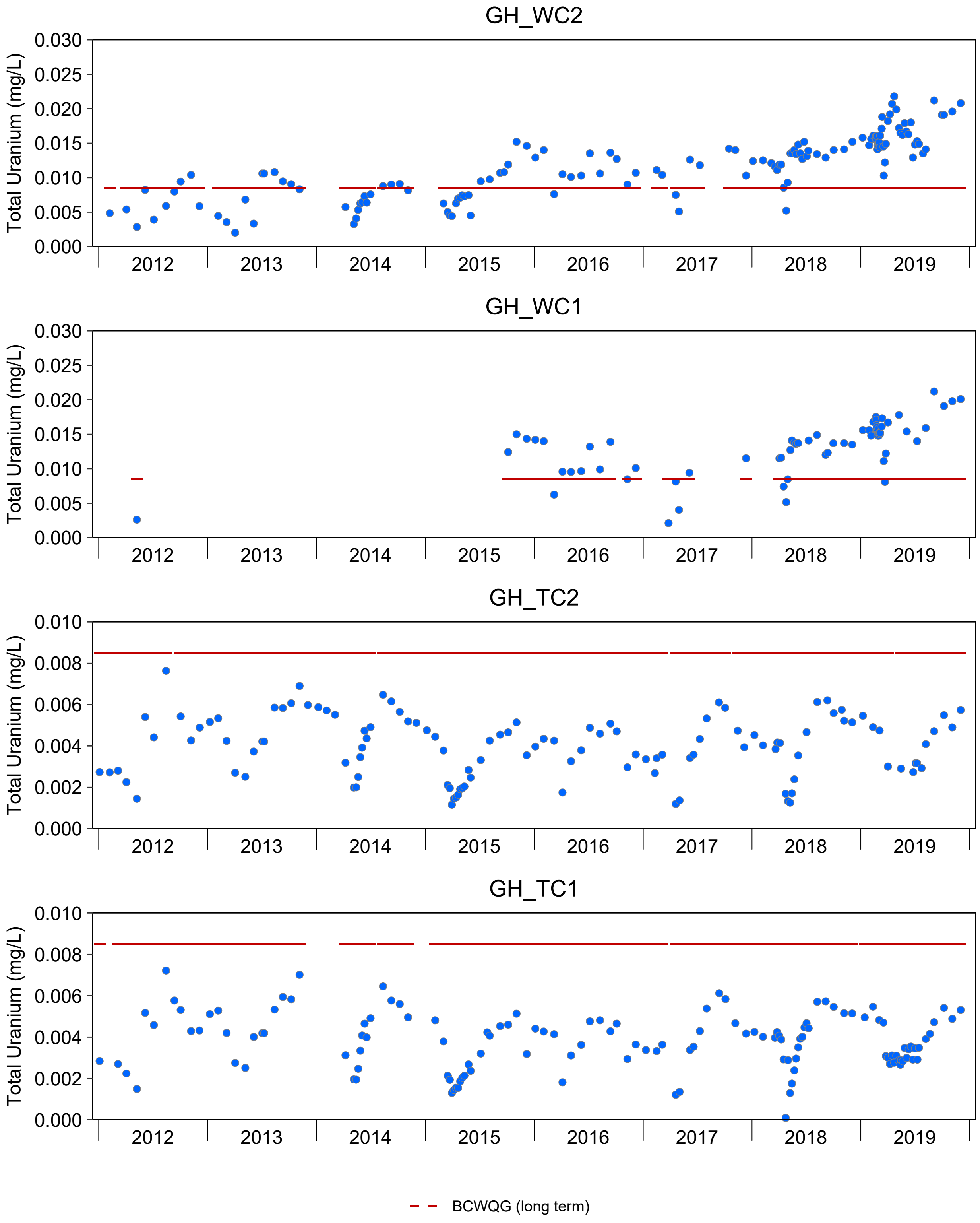


Figure C.18: Time Series Plots for Total Uranium Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

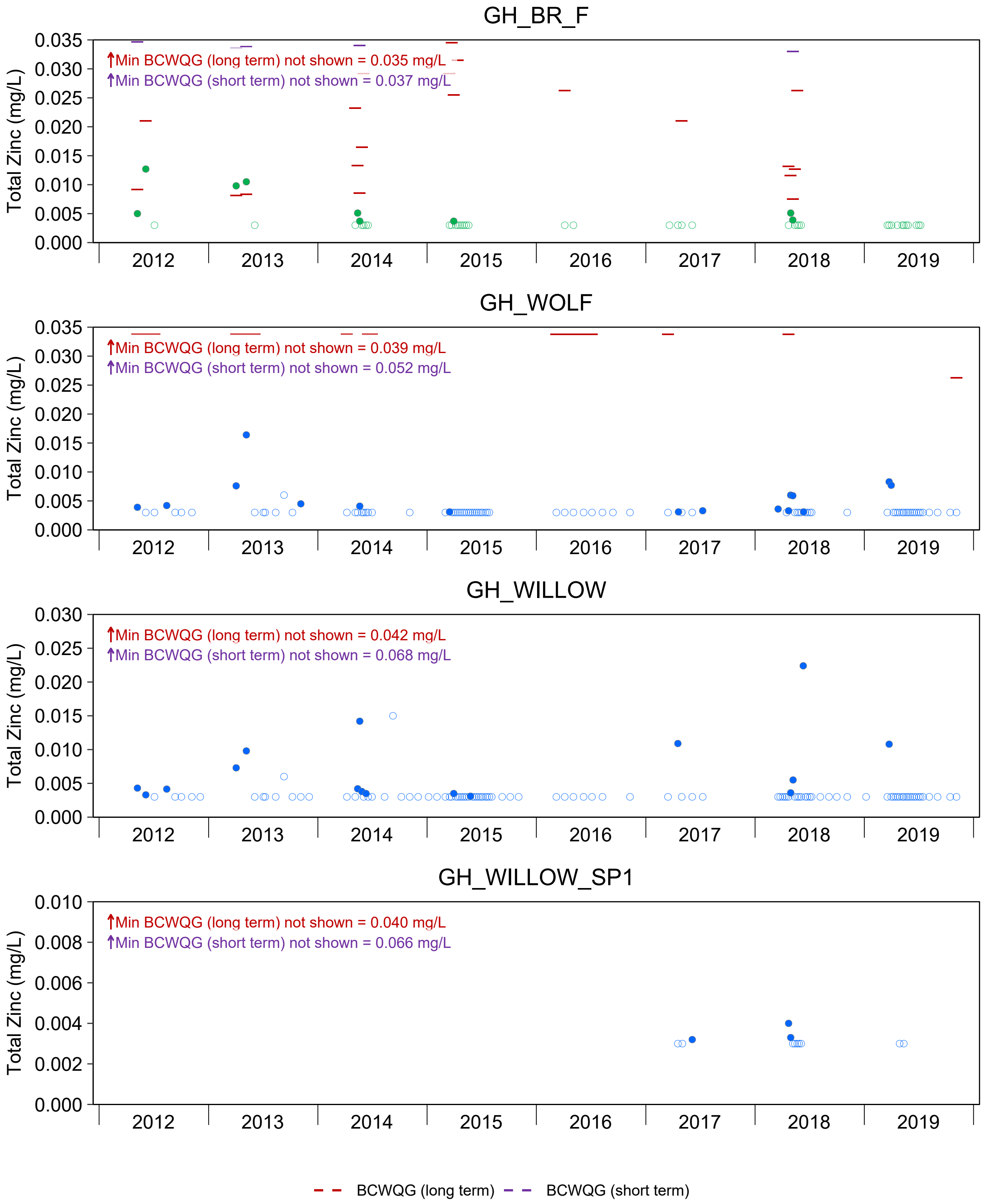


Figure C.19: **Time Series Plots for Total Zinc Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

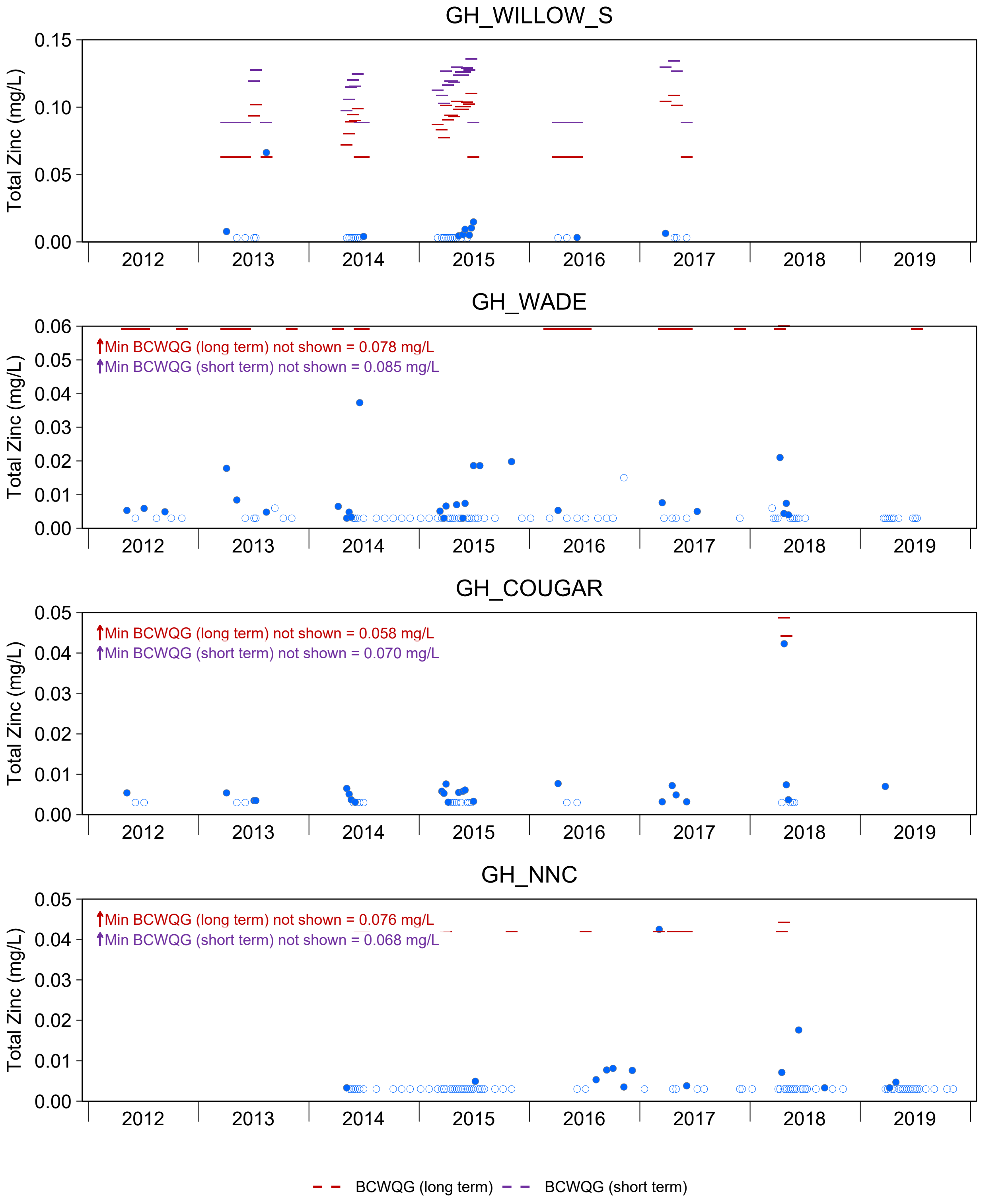


Figure C.19: **Time Series Plots for Total Zinc Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

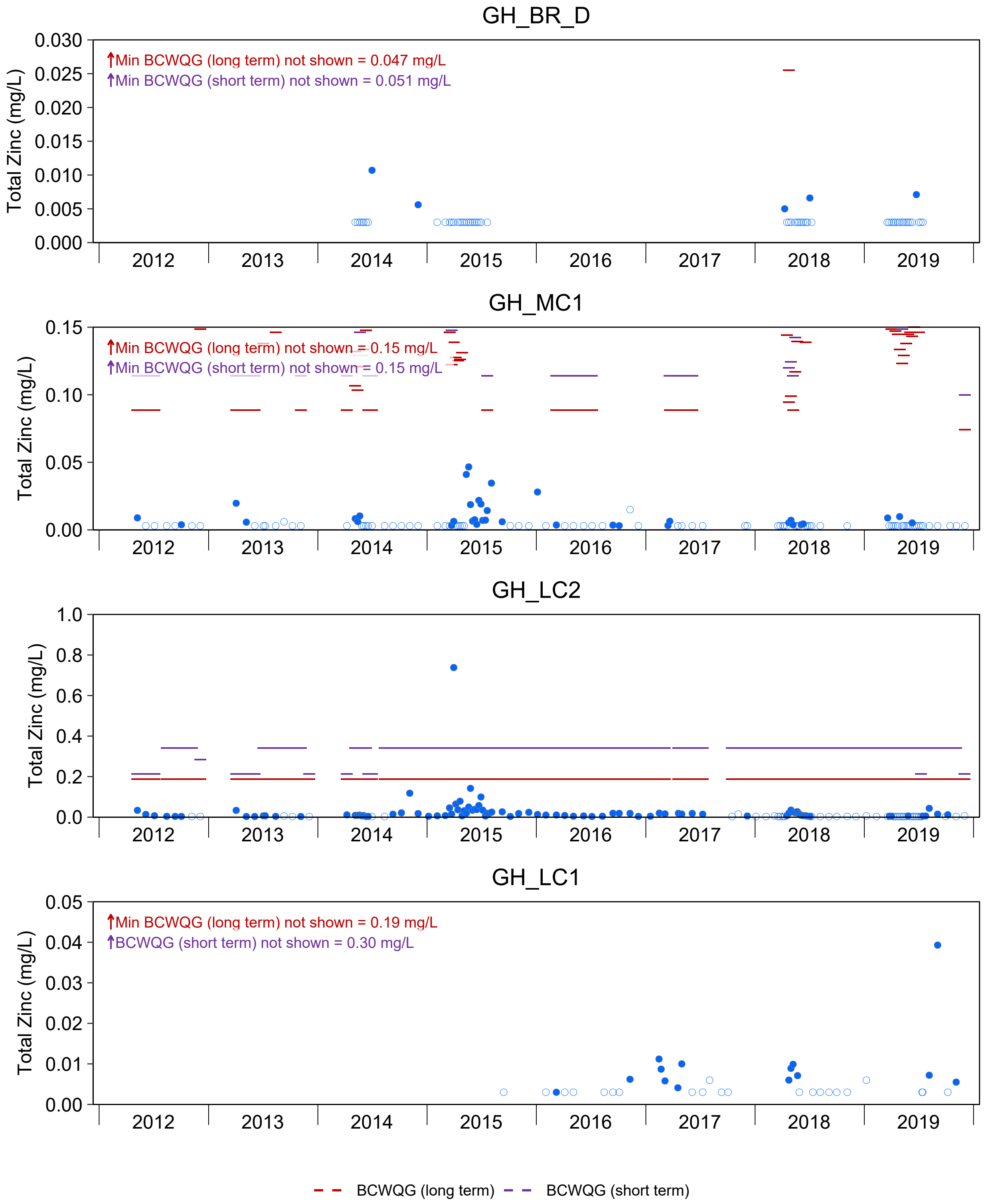


Figure C.19: **Time Series Plots for Total Zinc Concentrations from the West-side Tributaries, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

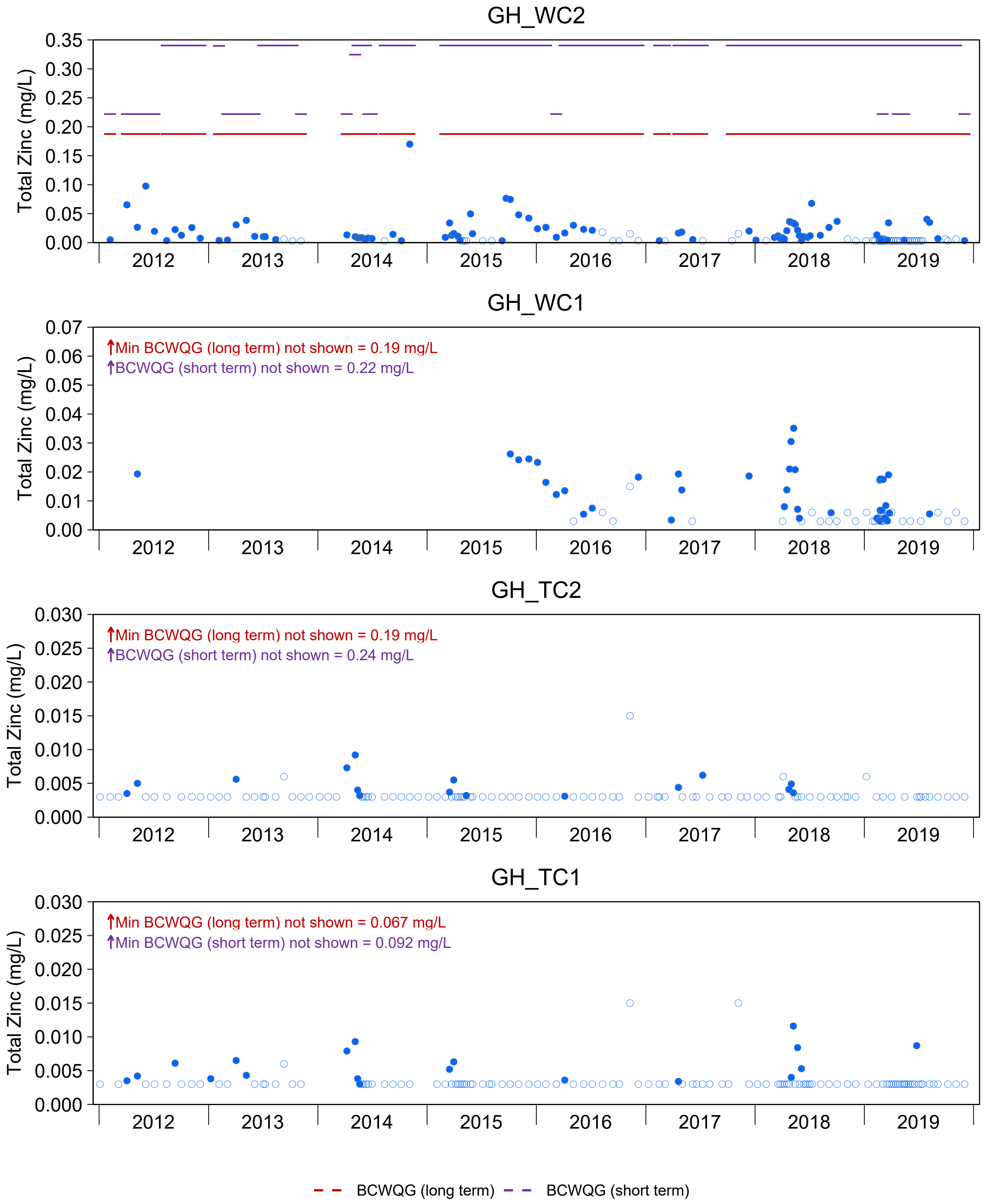


Figure C.19: Time Series Plots for Total Zinc Concentrations from the West-side Tributaries, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

WATER QUALITY

Elk River Side Channel Water Quality Figures

Figure C.20: Time Series Plots for Total Antimony Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

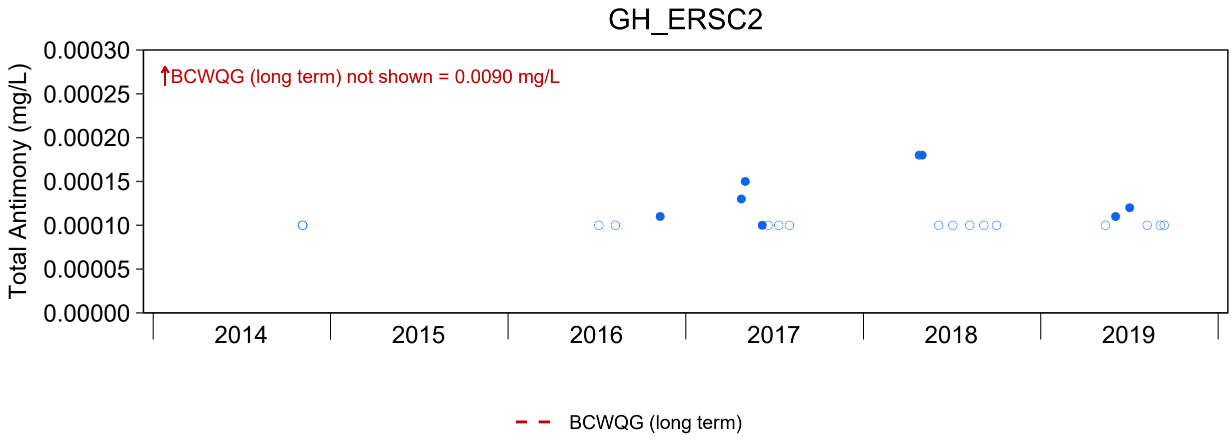


Figure C.20: **Time Series Plots for Total Antimony Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

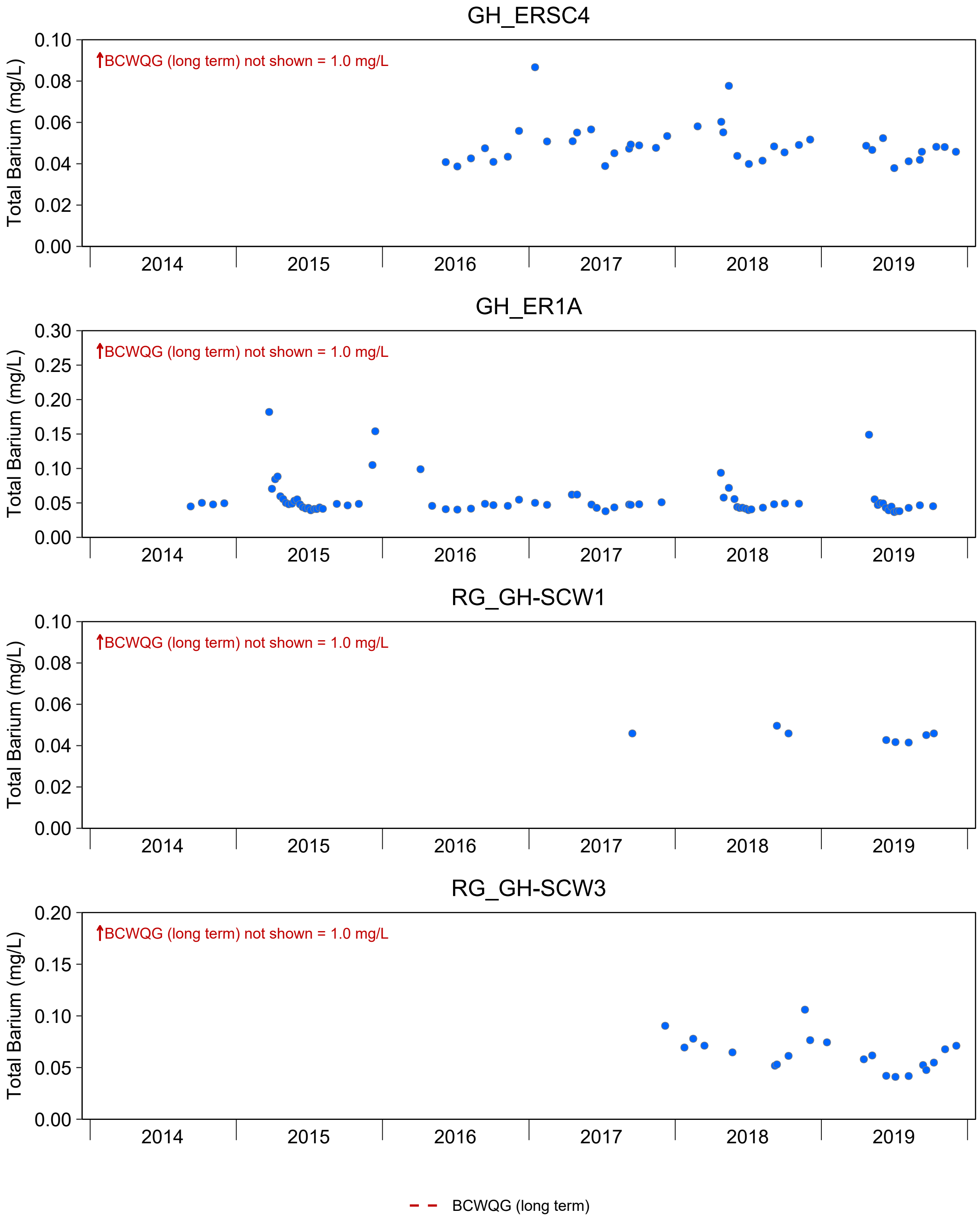


Figure C.21: **Time Series Plots for Total Barium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

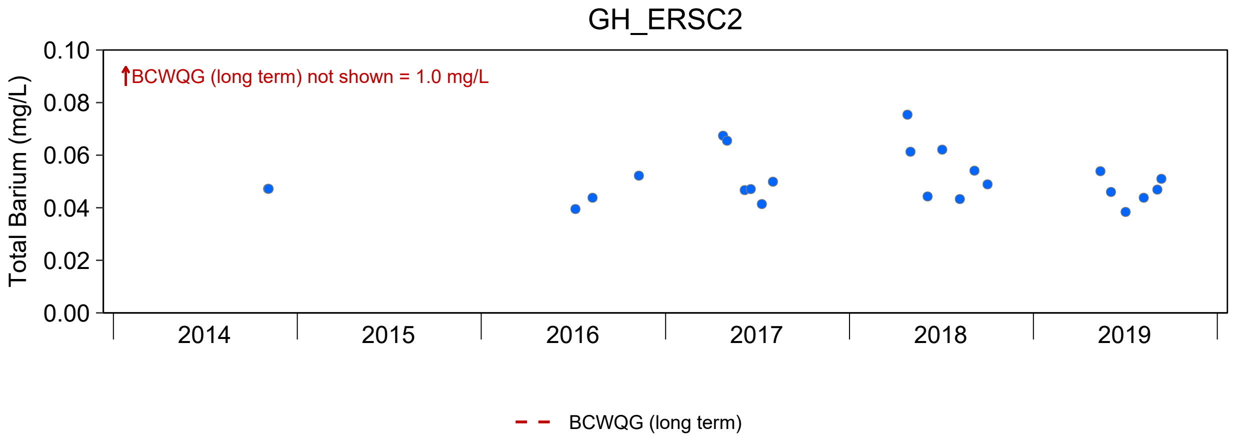


Figure C.21: **Time Series Plots for Total Barium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

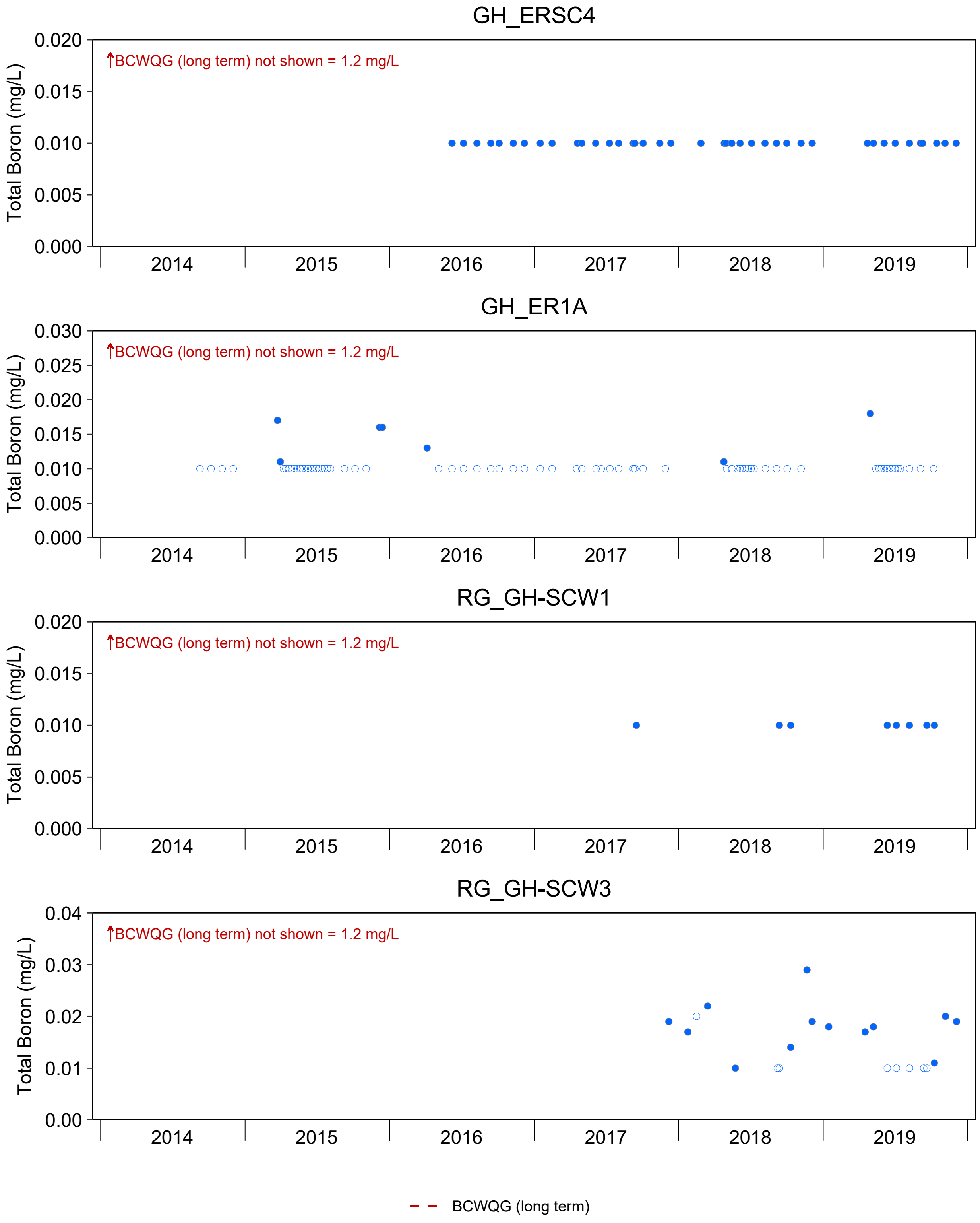


Figure C.22: **Time Series Plots for Total Boron Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

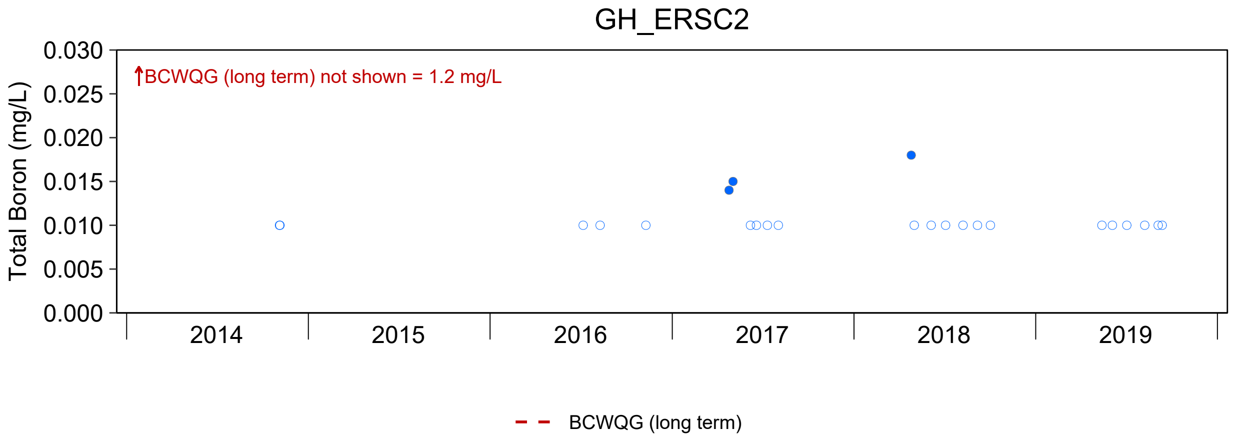


Figure C.22: **Time Series Plots for Total Boron Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

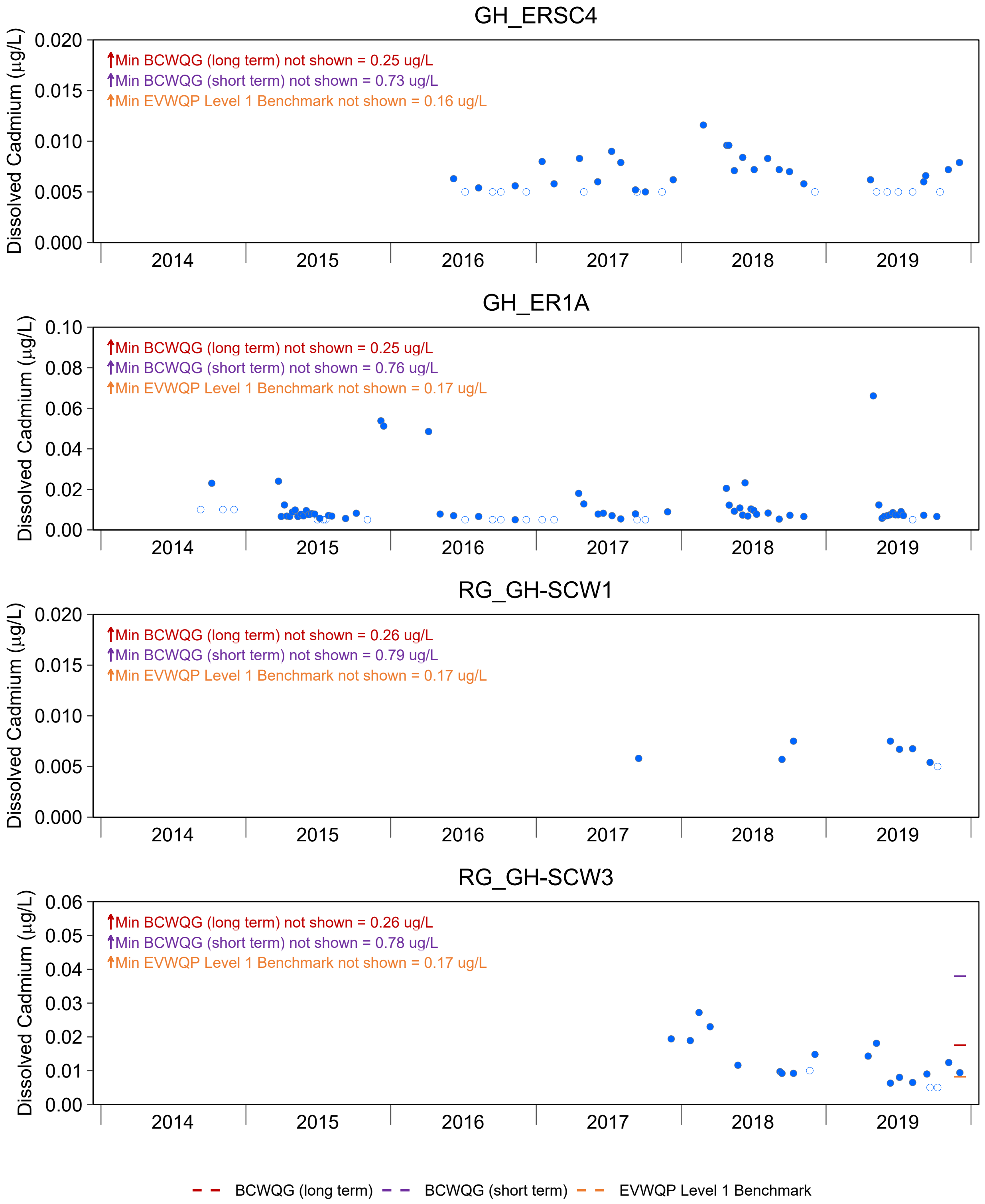


Figure C.23: **Time Series Plots for Dissolved Cadmium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

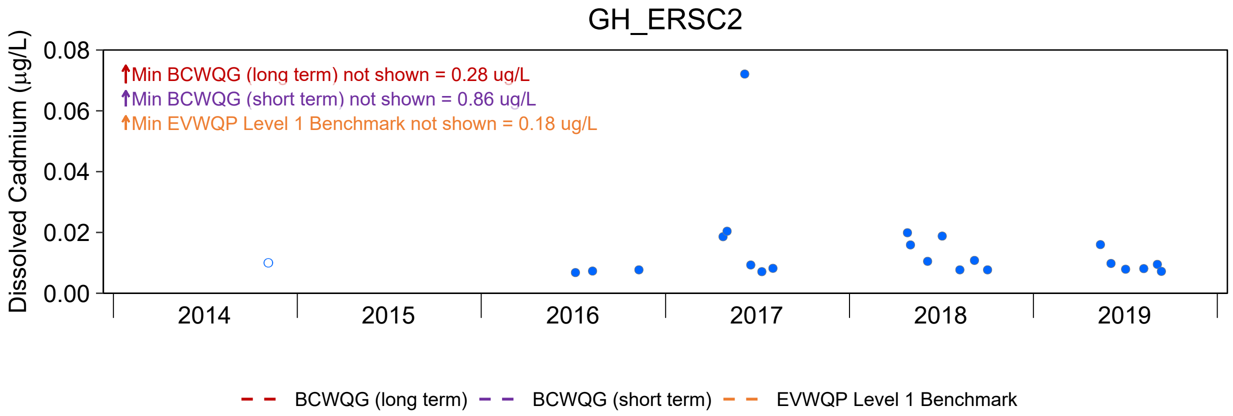


Figure C.23: **Time Series Plots for Dissolved Cadmium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

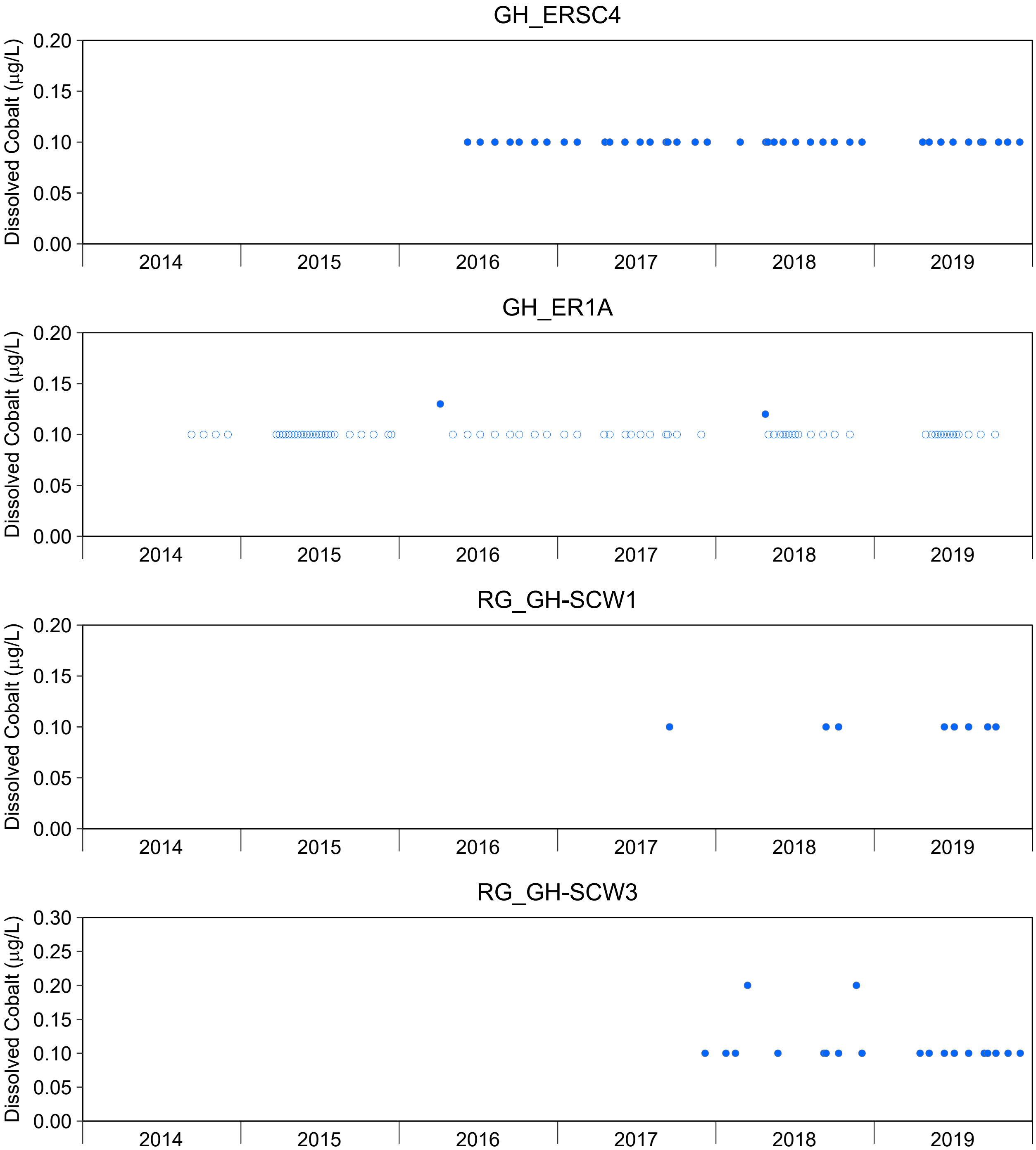


Figure C.24: **Time Series Plots for Dissolved Cobalt Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

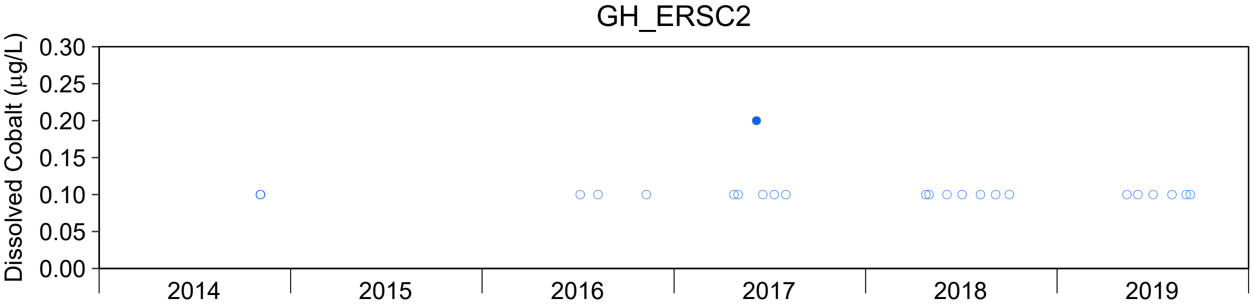


Figure C.24: **Time Series Plots for Dissolved Cobalt Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

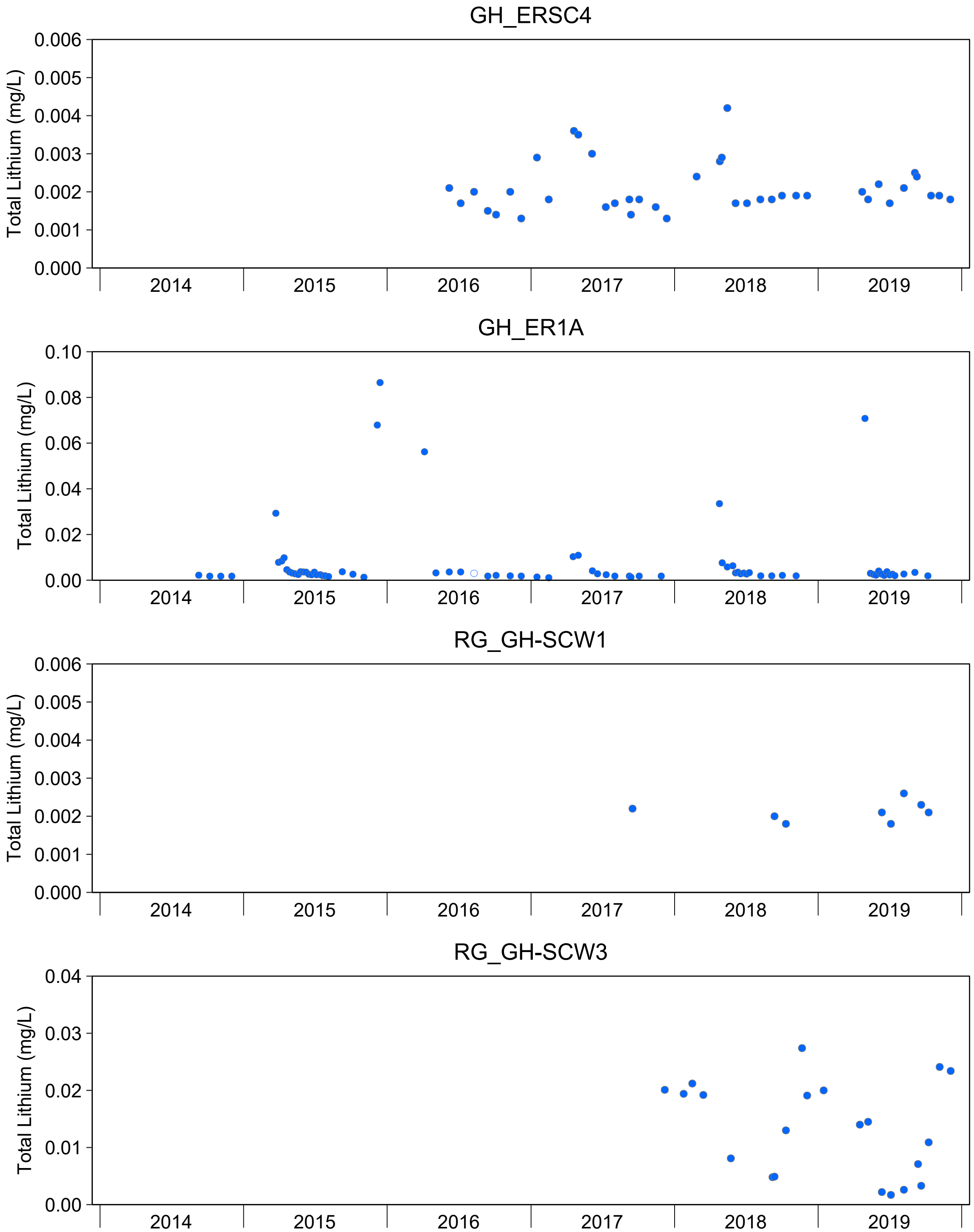


Figure C.25: **Time Series Plots for Total Lithium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

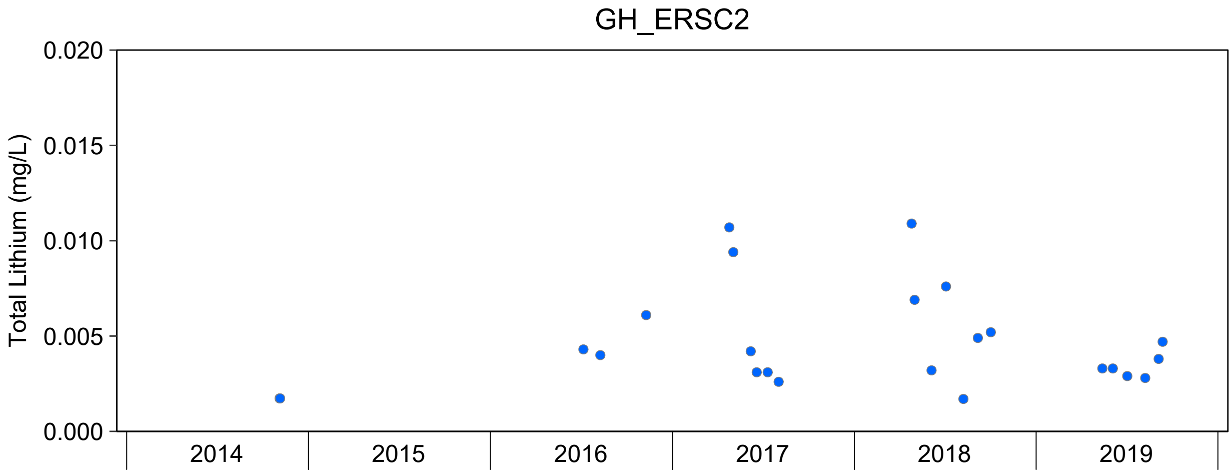


Figure C.25: Time Series Plots for Total Lithium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

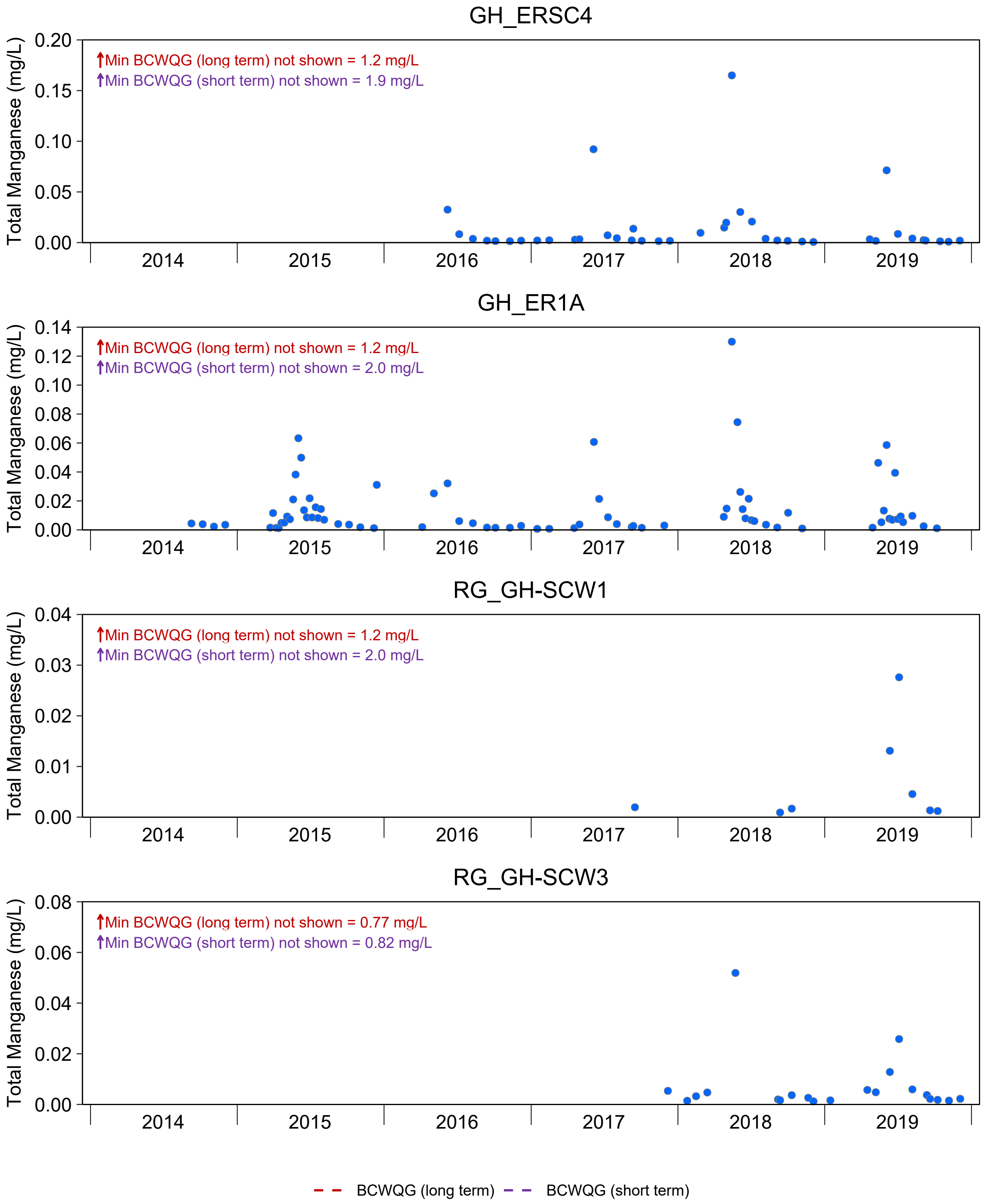


Figure C.26: **Time Series Plots for Total Manganese Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

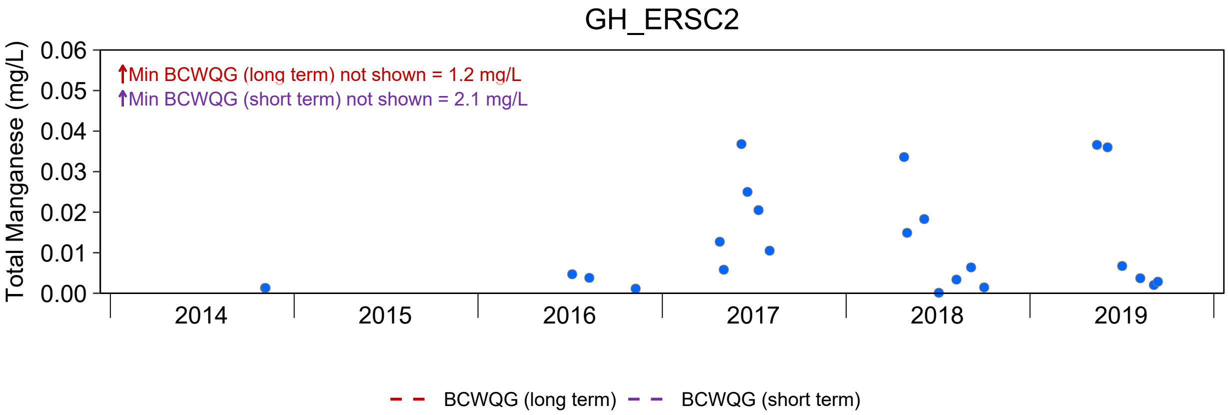


Figure C.26: **Time Series Plots for Total Manganese Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

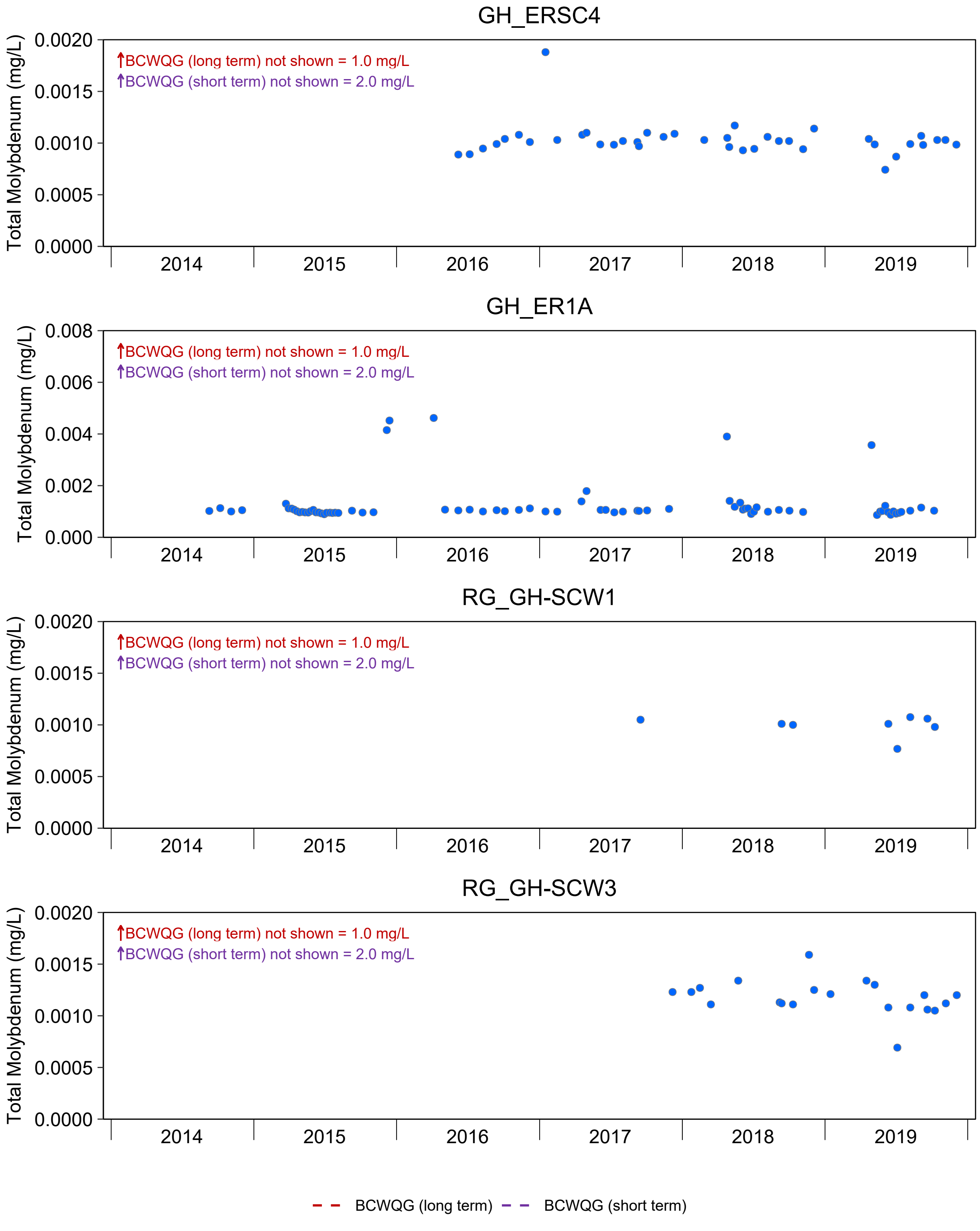


Figure C.27: **Time Series Plots for Total Molybdenum Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

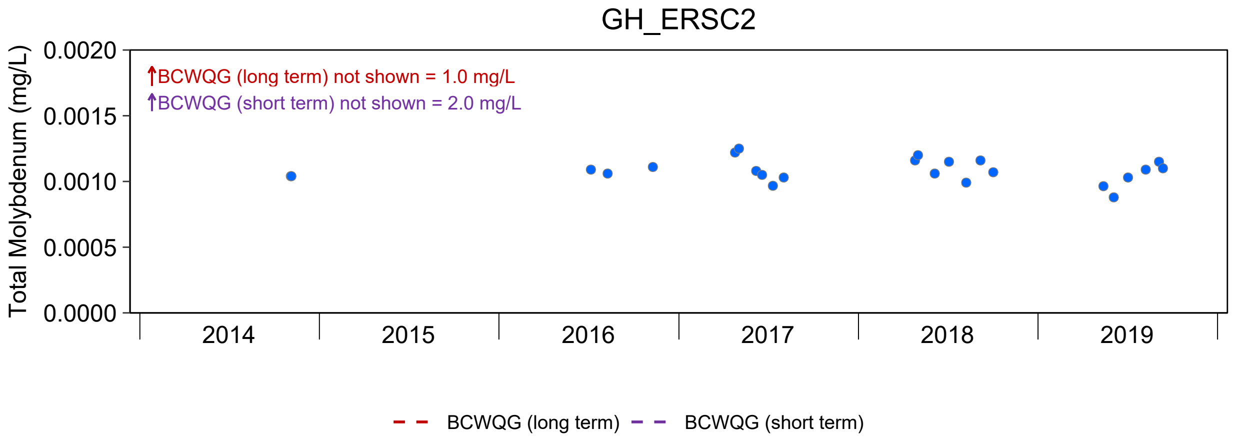


Figure C.27: **Time Series Plots for Total Molybdenum Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

Figure C.28: Time Series Plots for Total and Dissolved Nickel Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

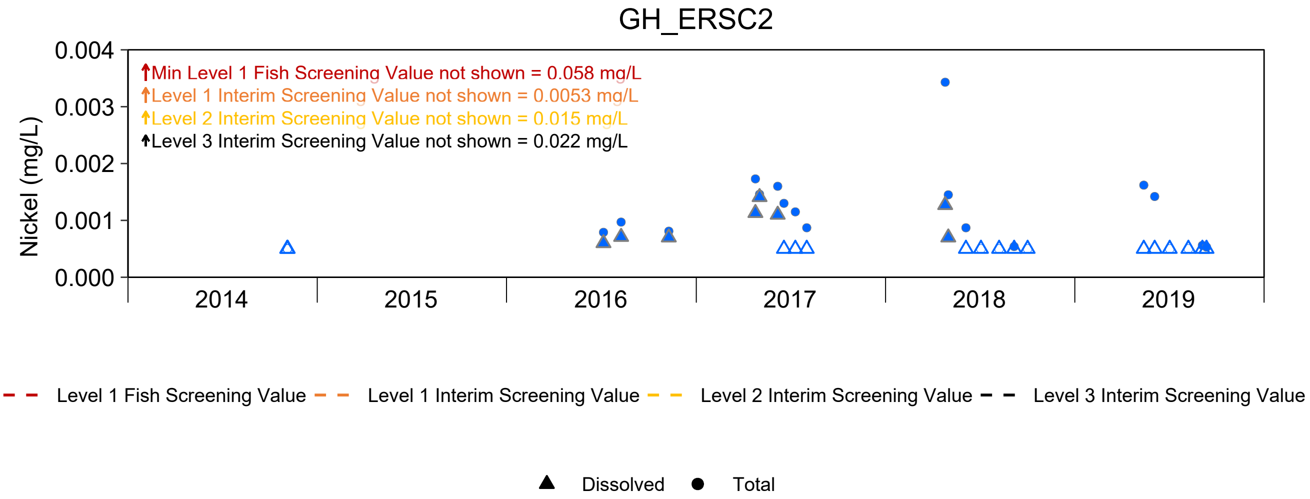


Figure C.28: **Time Series Plots for Total and Dissolved Nickel Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is also provided for context on bioavailability. The nickel guidelines presented apply to total nickel only.

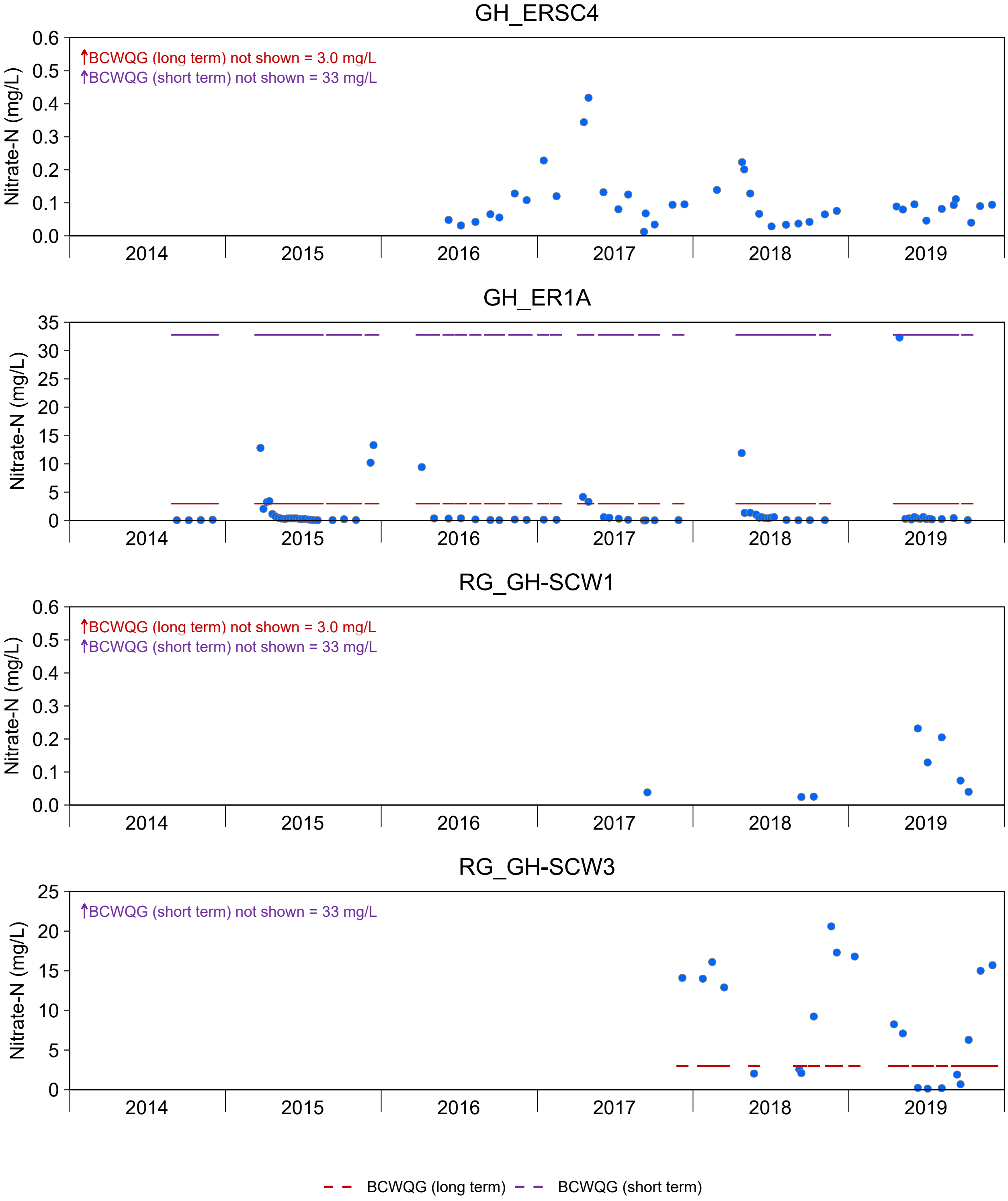


Figure C.29: Time Series Plots for Nitrate-N Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

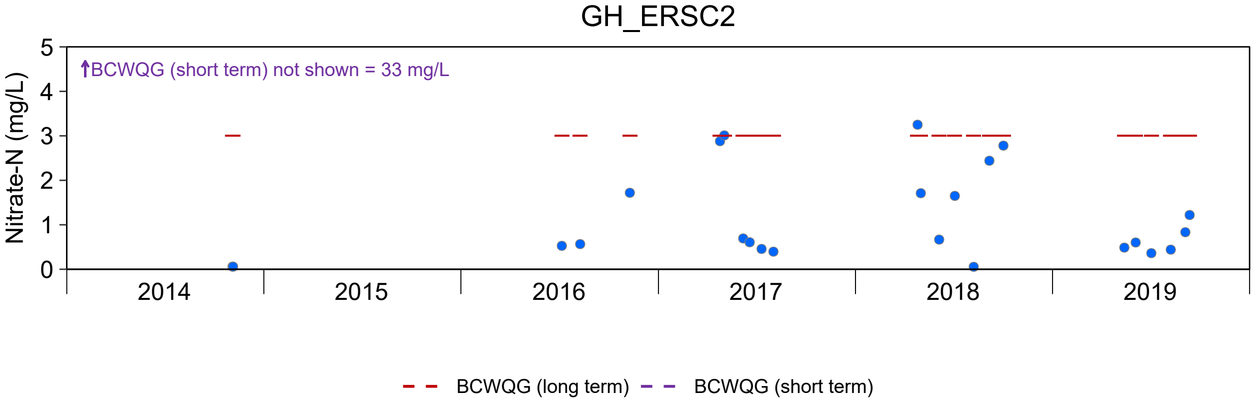


Figure C.29: **Time Series Plots for Nitrate-N Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

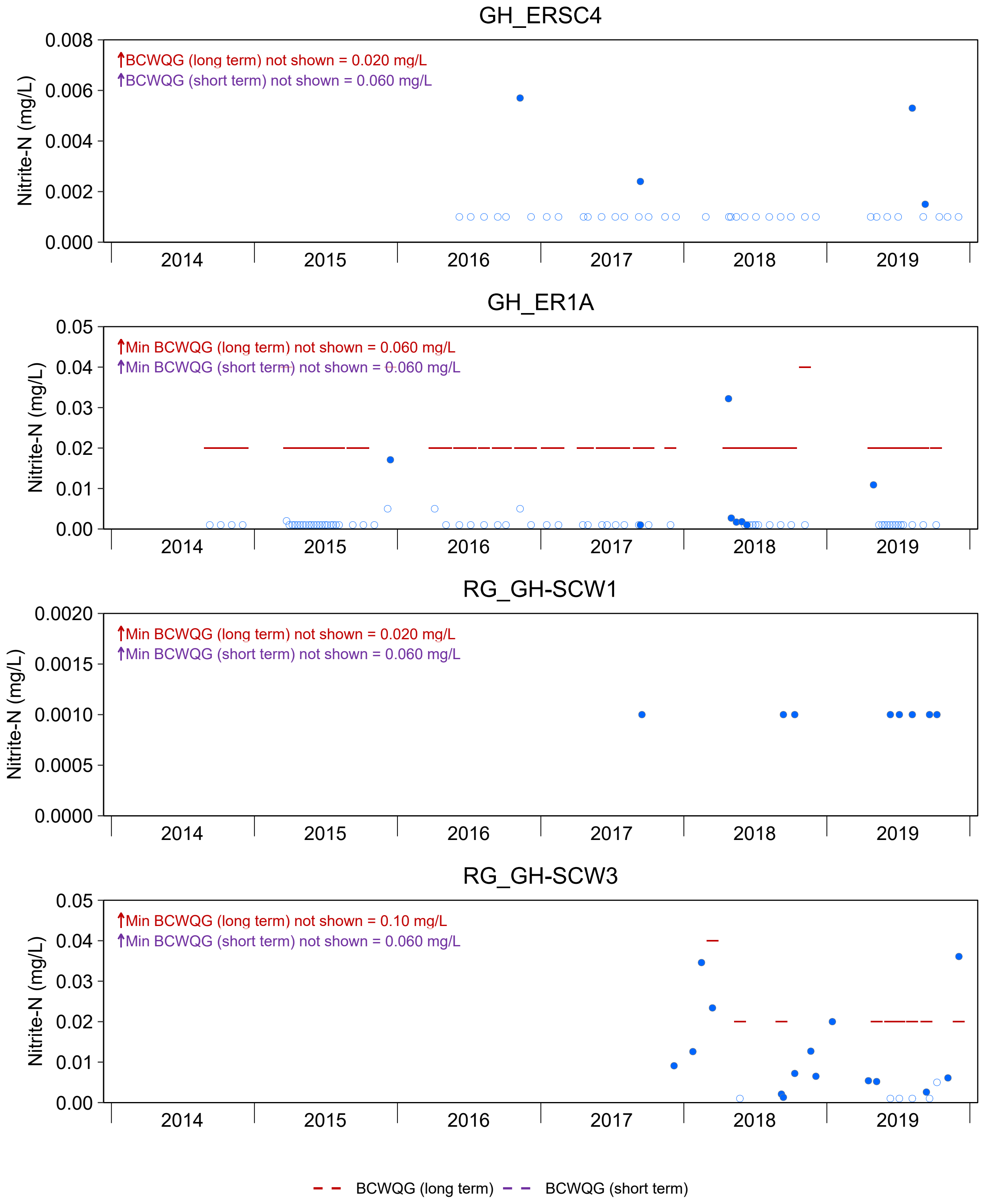


Figure C.30: **Time Series Plots for Nitrite-N Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

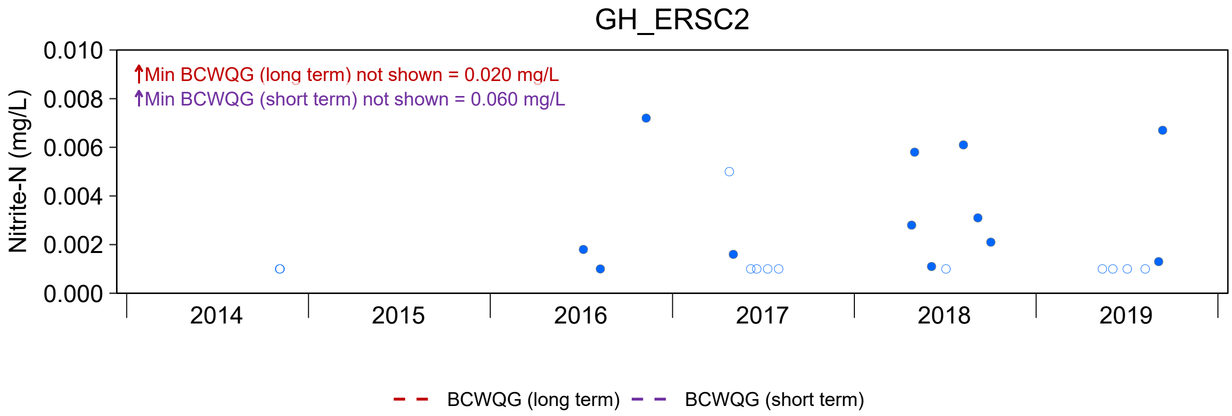


Figure C.30: Time Series Plots for Nitrite-N Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water chloride concentrations. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

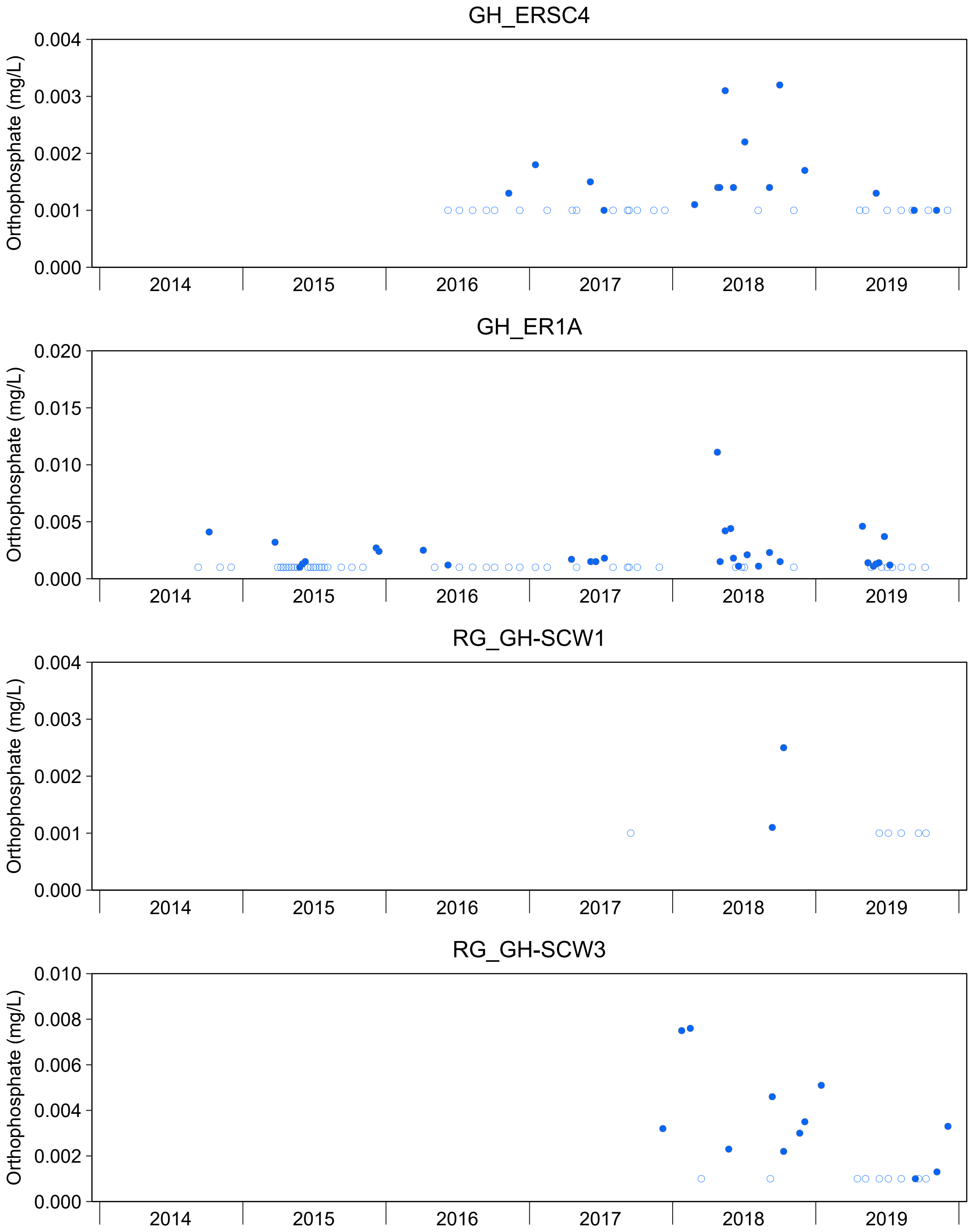


Figure C.31: Time Series Plots for Orthophosphate Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

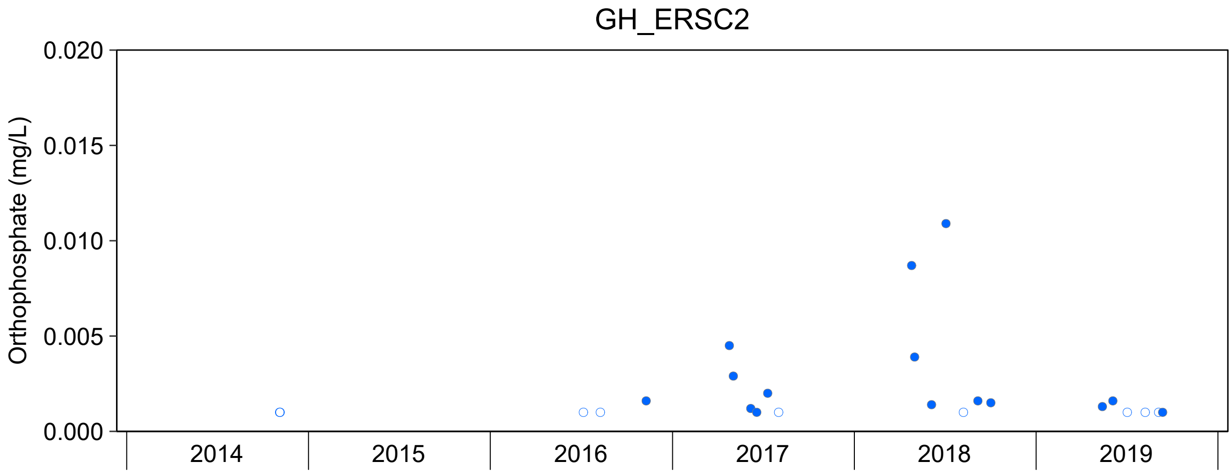


Figure C.31: **Time Series Plots for Orthophosphate Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

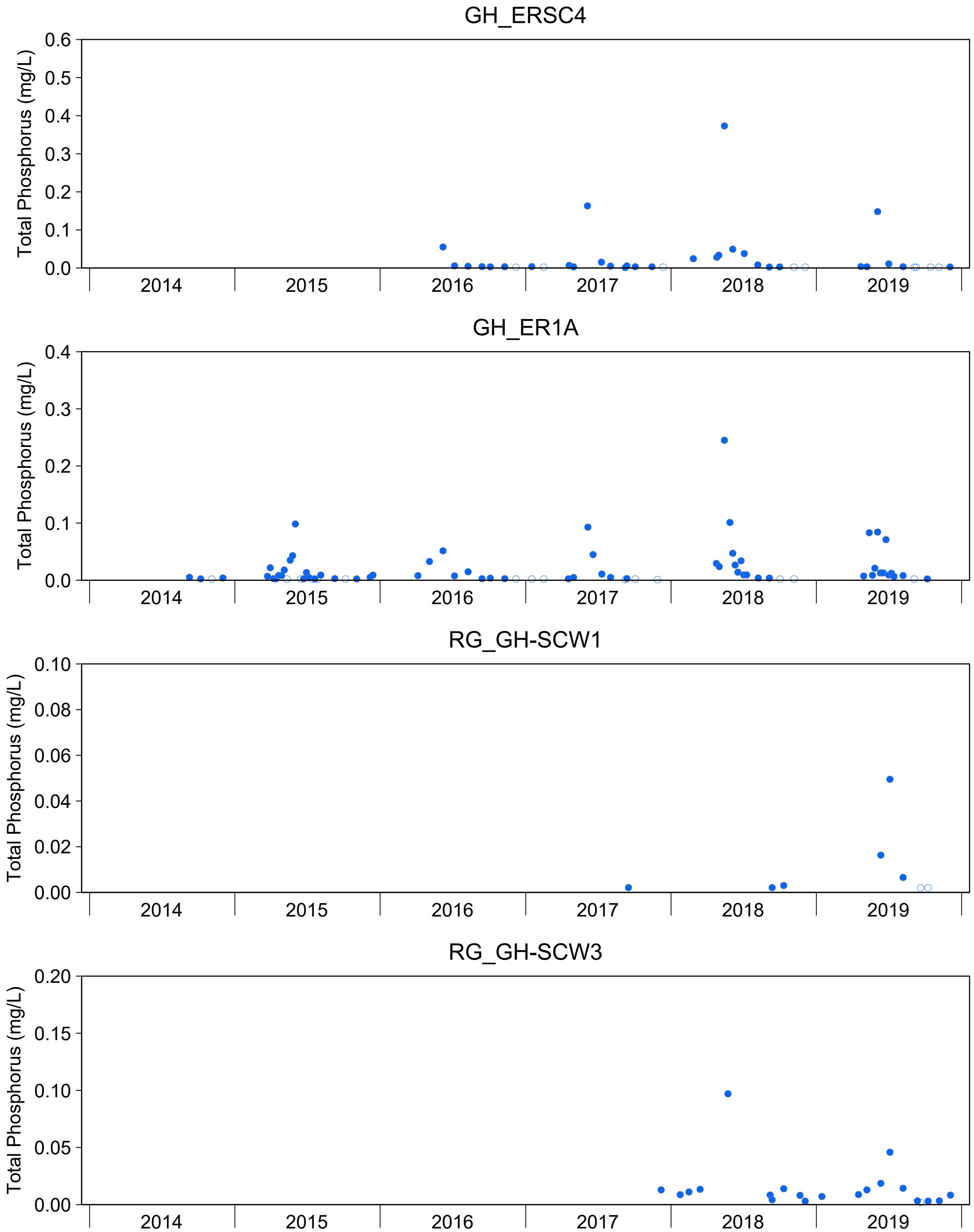


Figure C.32: **Time Series Plots for Total Phosphorus Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

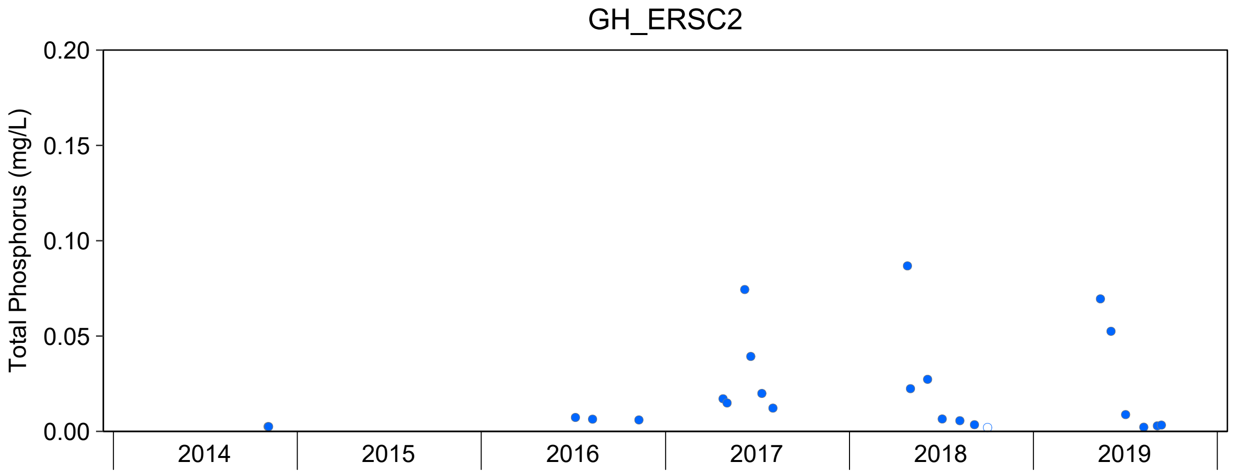


Figure C.32: **Time Series Plots for Total Phosphorus Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

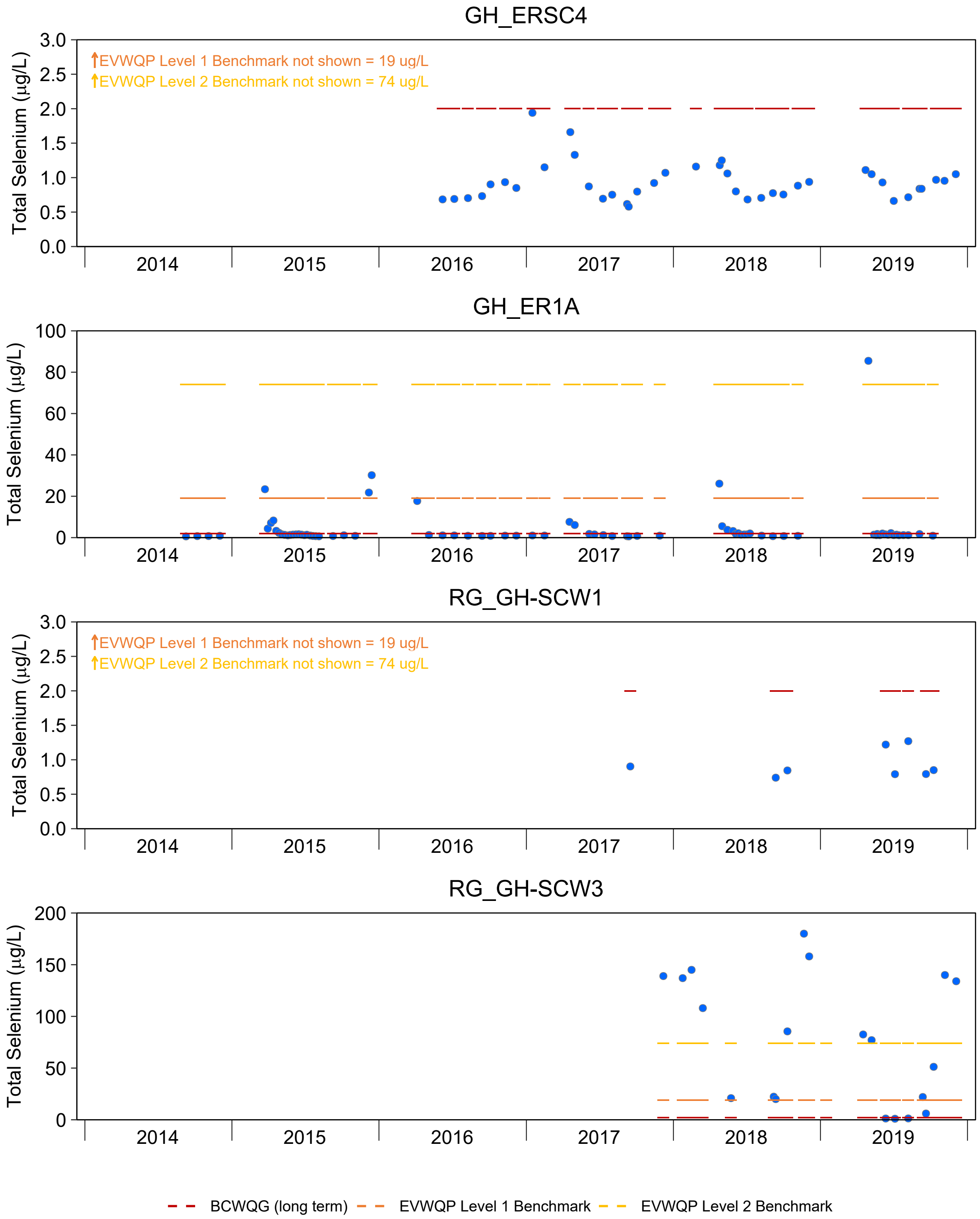


Figure C.33: **Time Series Plots for Total Selenium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

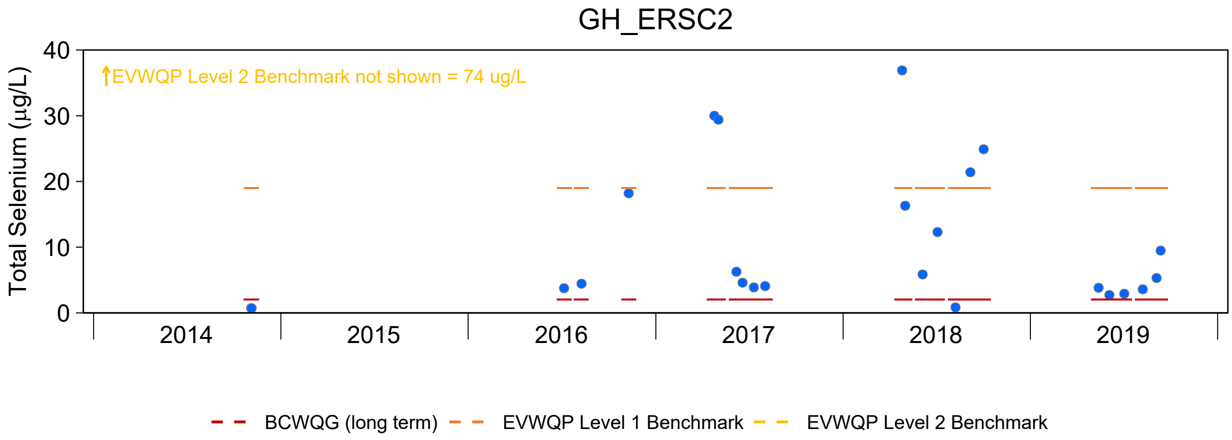


Figure C.33: **Time Series Plots for Total Selenium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

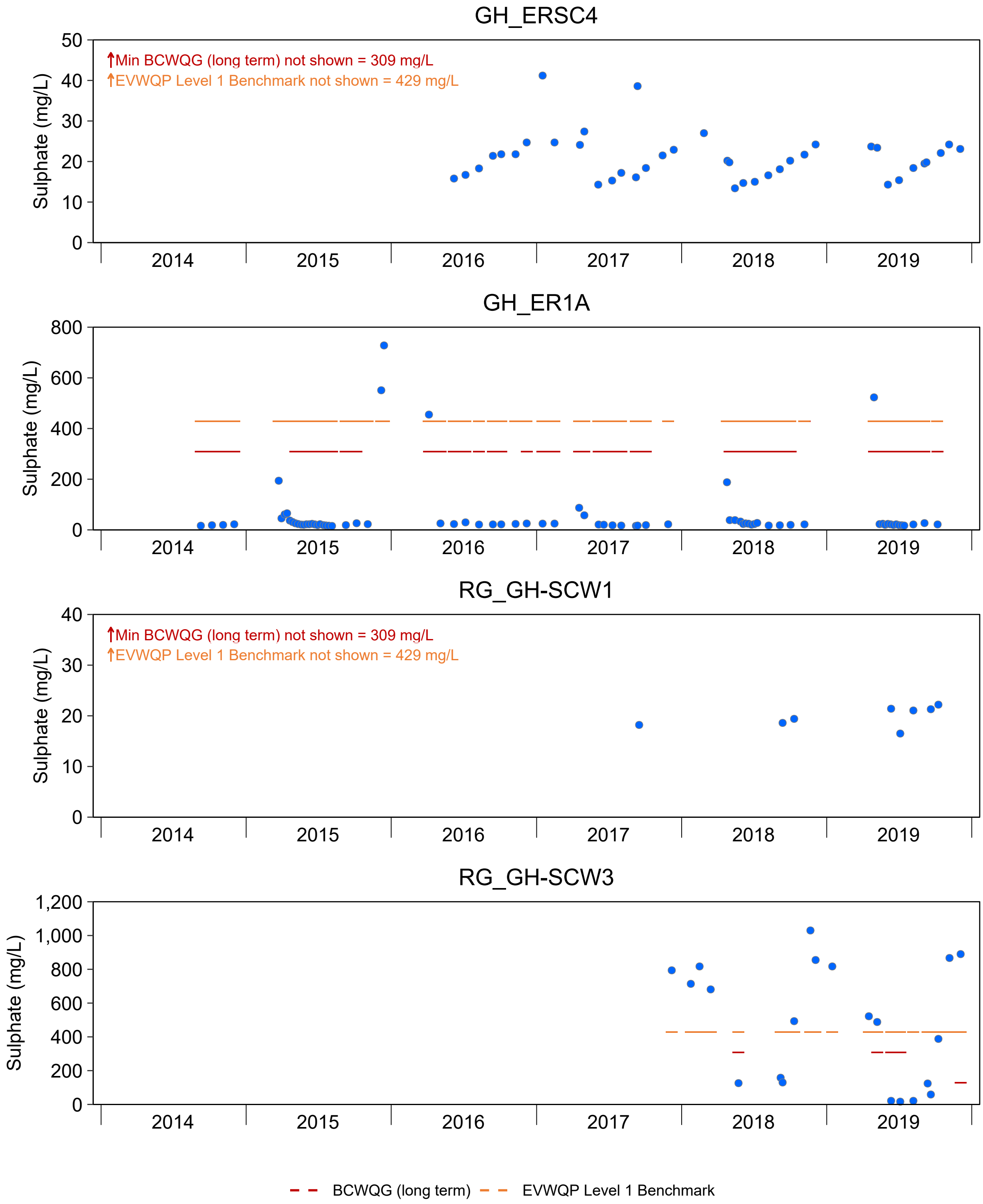


Figure C.34: Time Series Plots for Sulphate Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

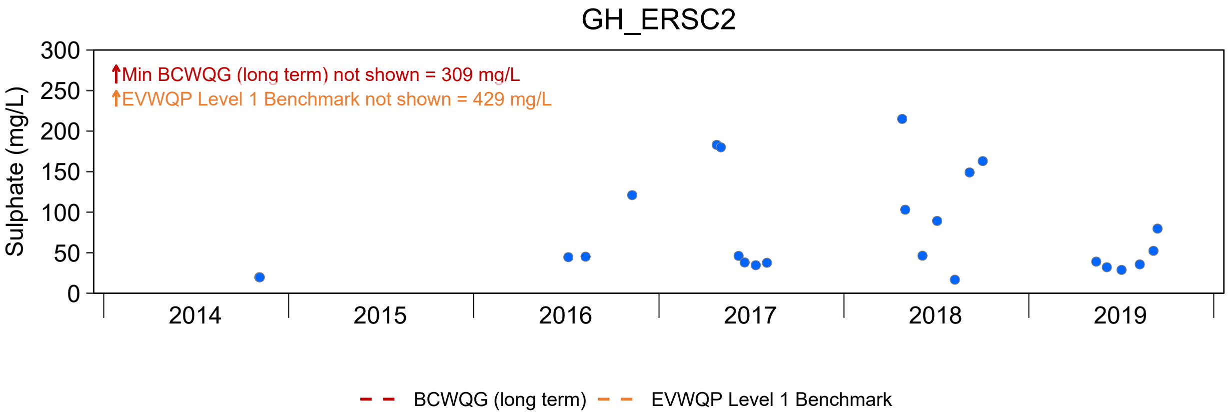


Figure C.34: **Time Series Plots for Sulphate Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

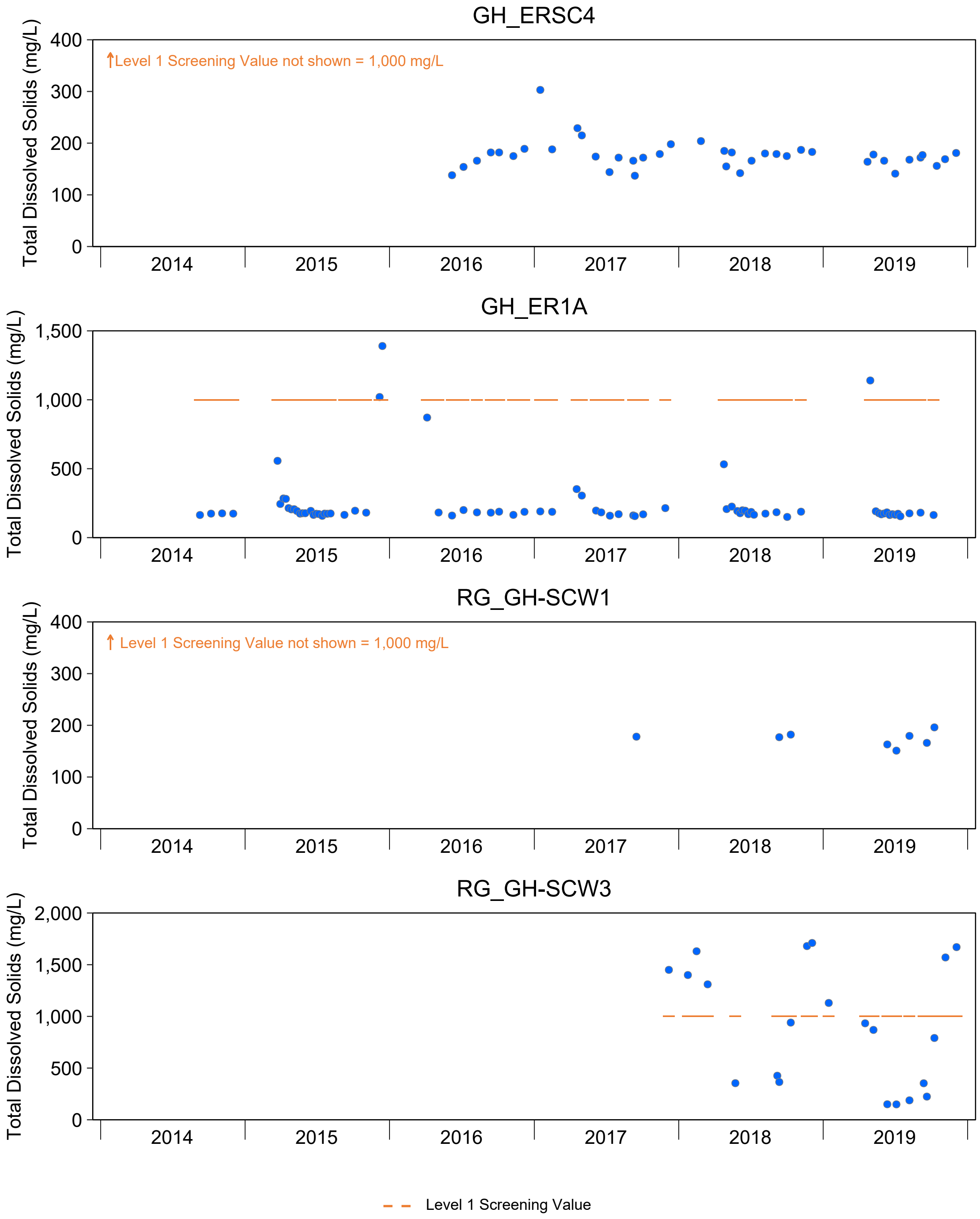


Figure C.35: Time Series Plots for Total Dissolved Solids Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

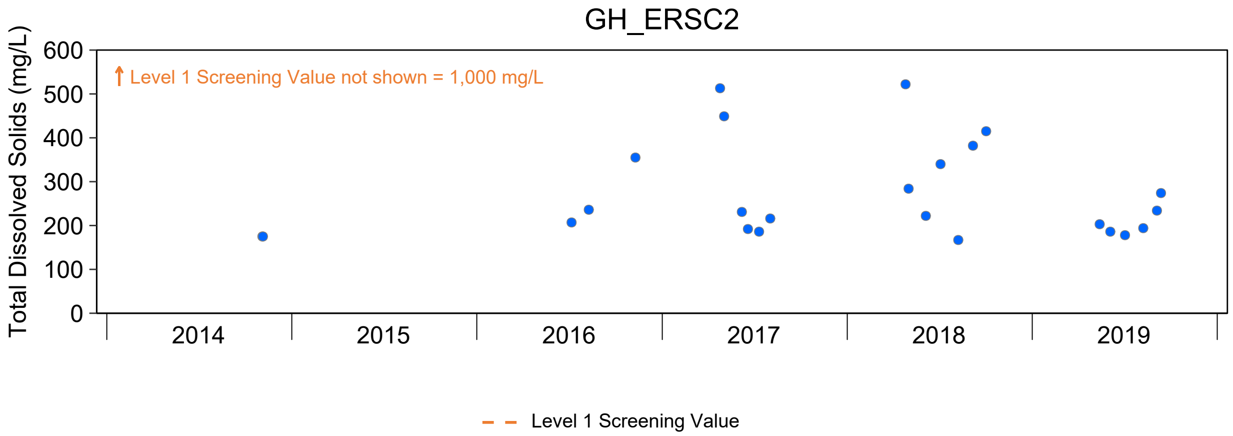


Figure C.35: **Time Series Plots for Total Dissolved Solids Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

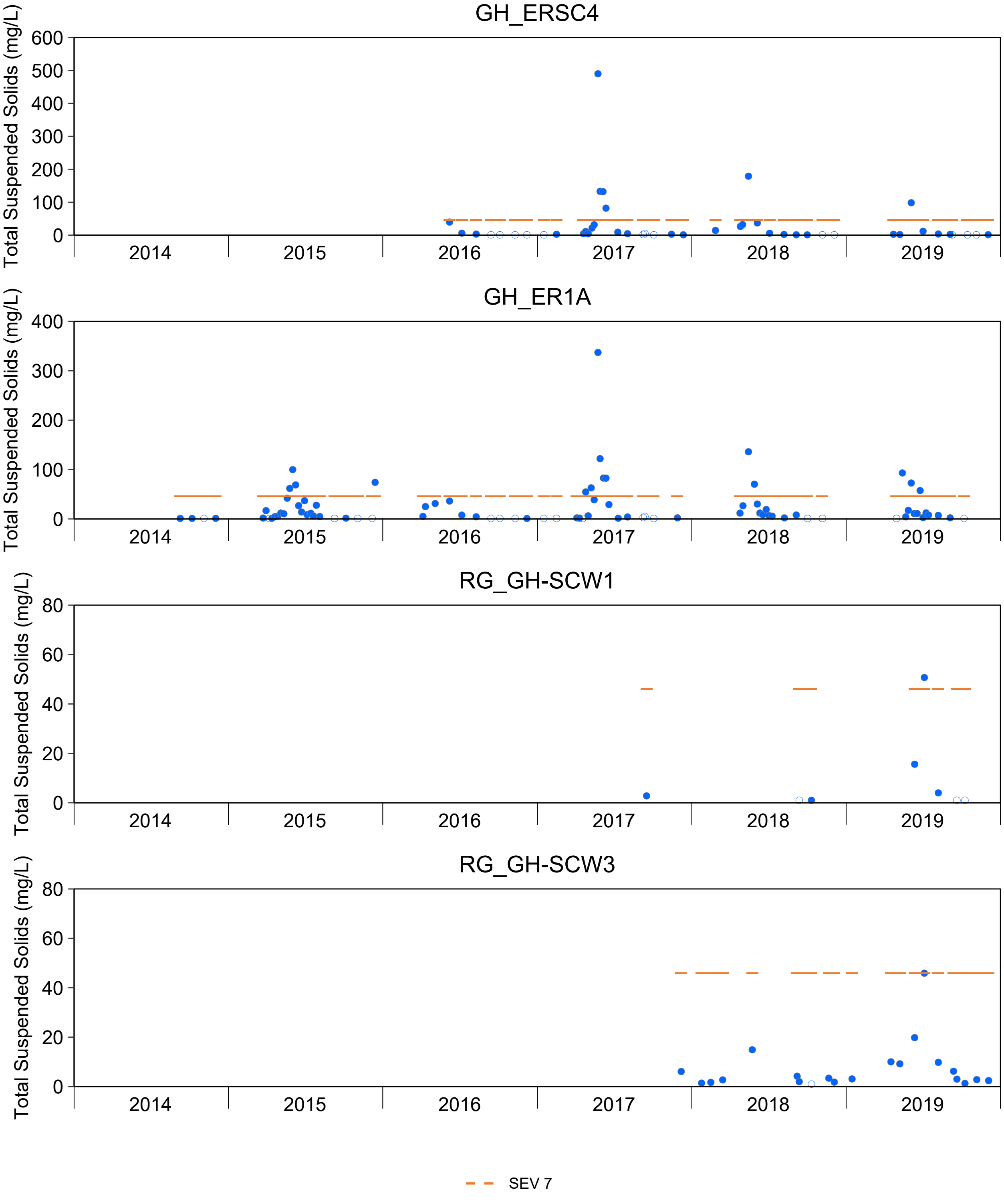


Figure C.36: Time Series Plots for Total Suspended Solids Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 μm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

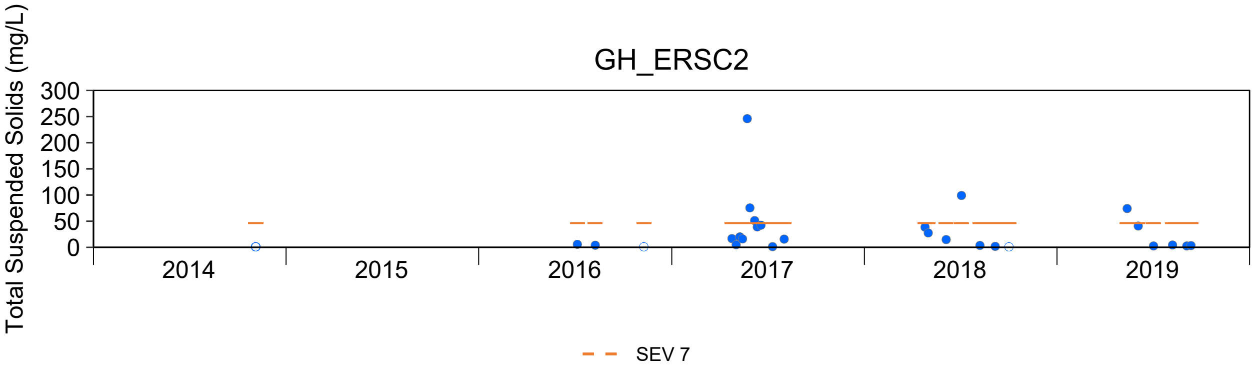


Figure C.36: **Time Series Plots for Total Suspended Solids Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

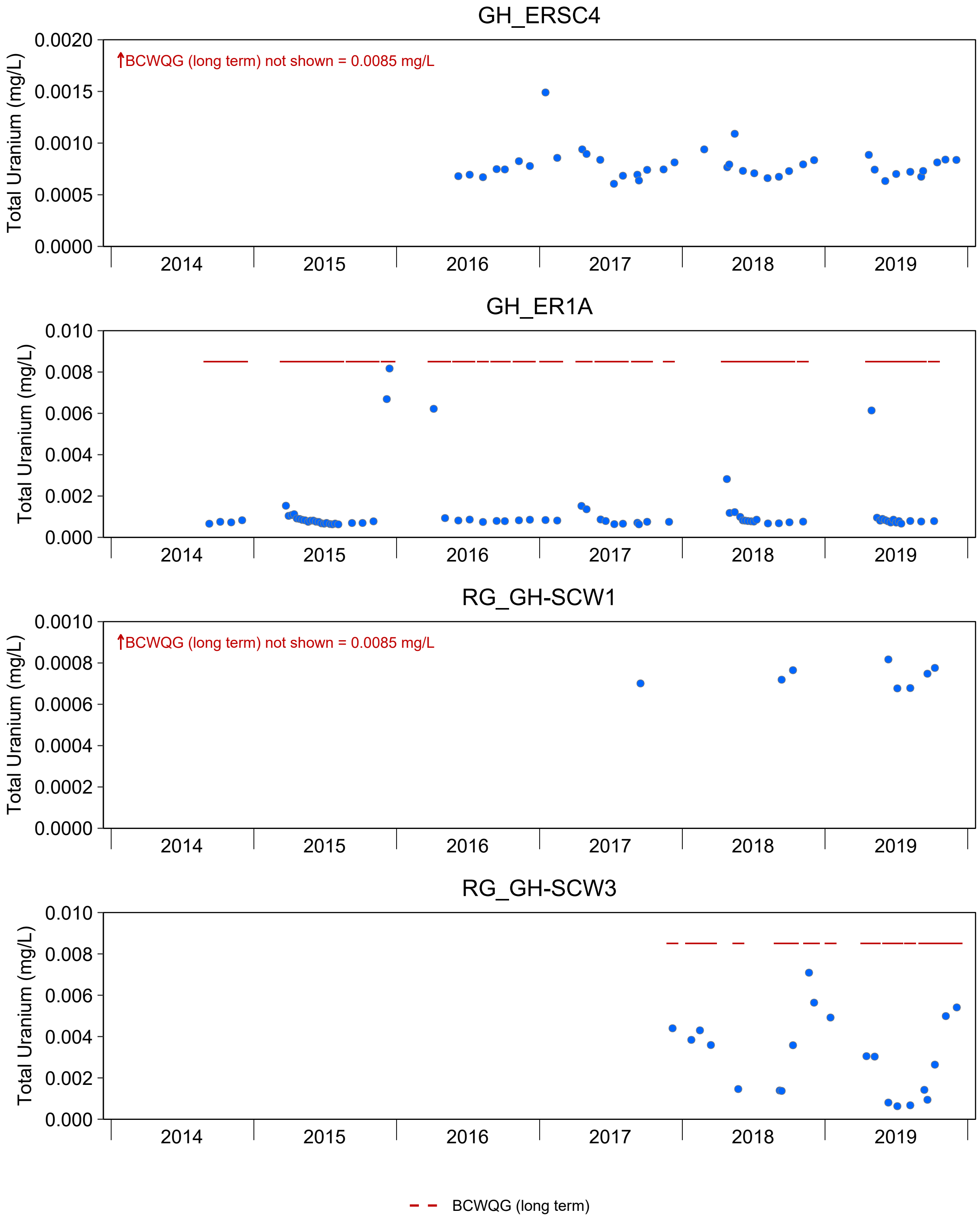


Figure C.37: **Time Series Plots for Total Uranium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

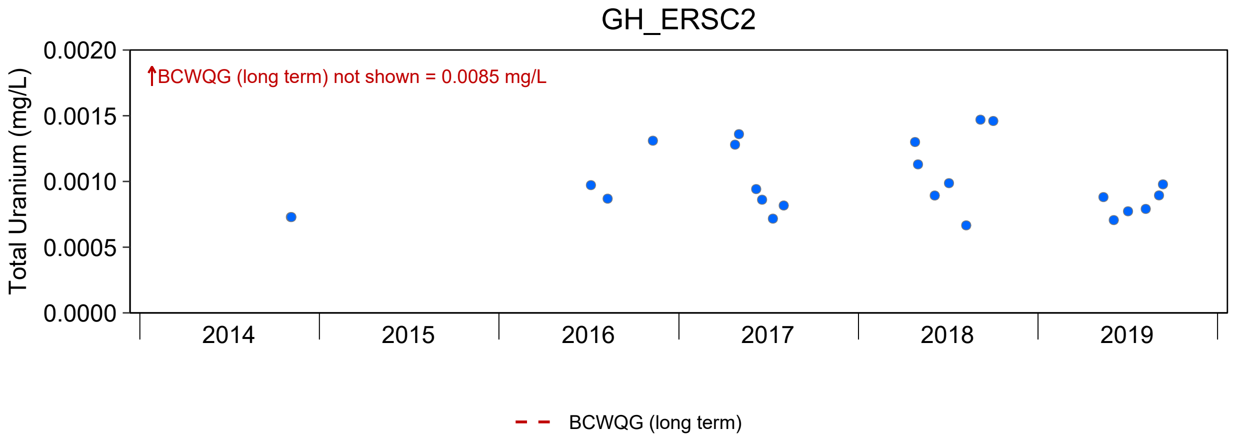


Figure C.37: **Time Series Plots for Total Uranium Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

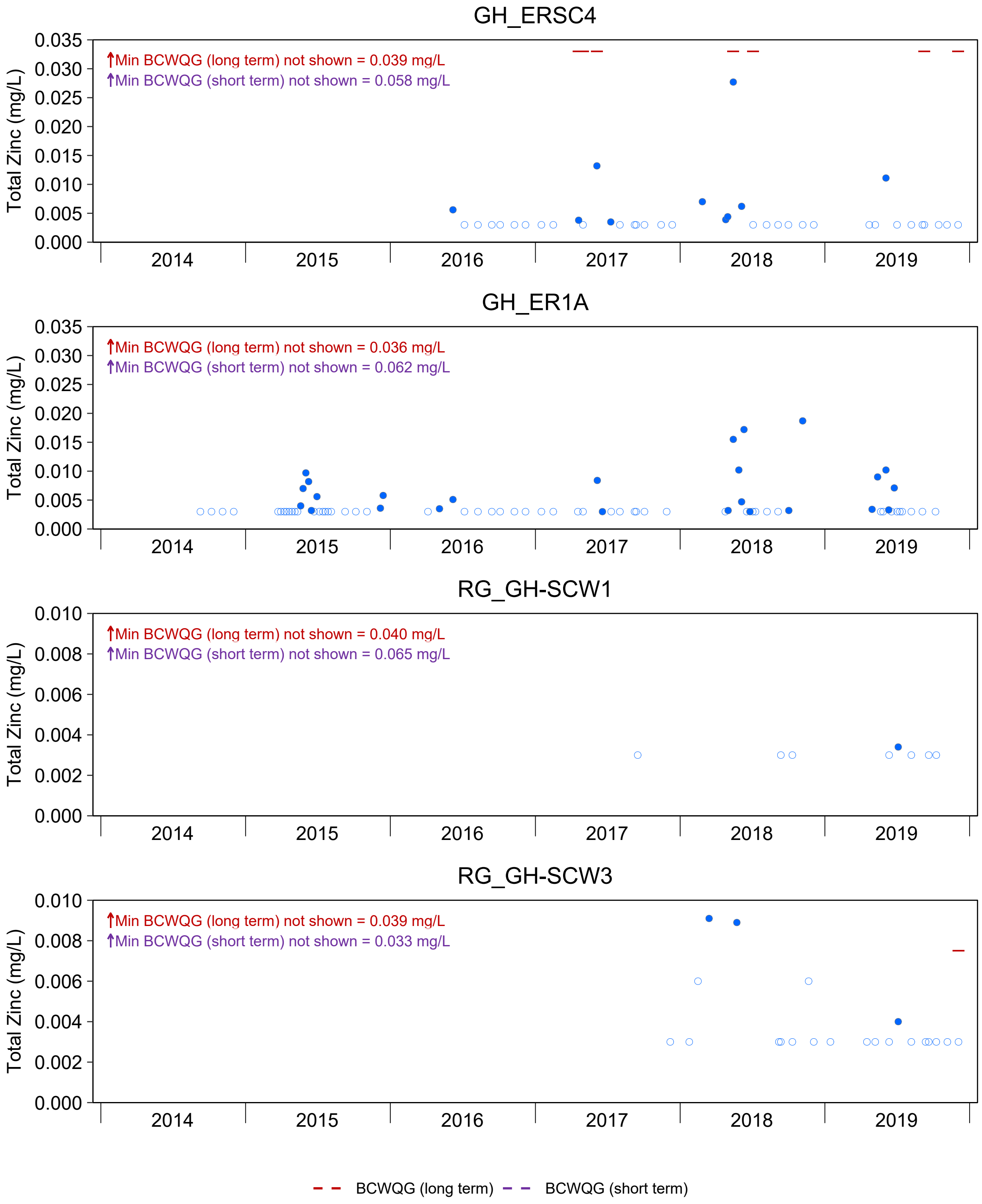


Figure C.38: **Time Series Plots for Total Zinc Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

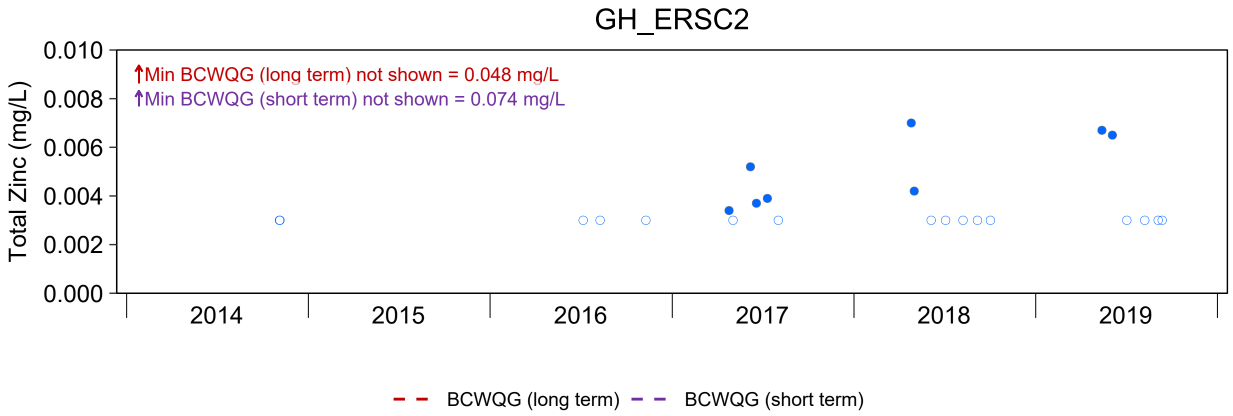


Figure C.38: Time Series Plots for Total Zinc Concentrations from the from the Elk River Side Channel Monitoring Stations, 2014 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Guidelines are dependent on water hardness. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

WATER QUALITY

West-side Tributary Elk and River Side Channel Comparison Water Quality Figures

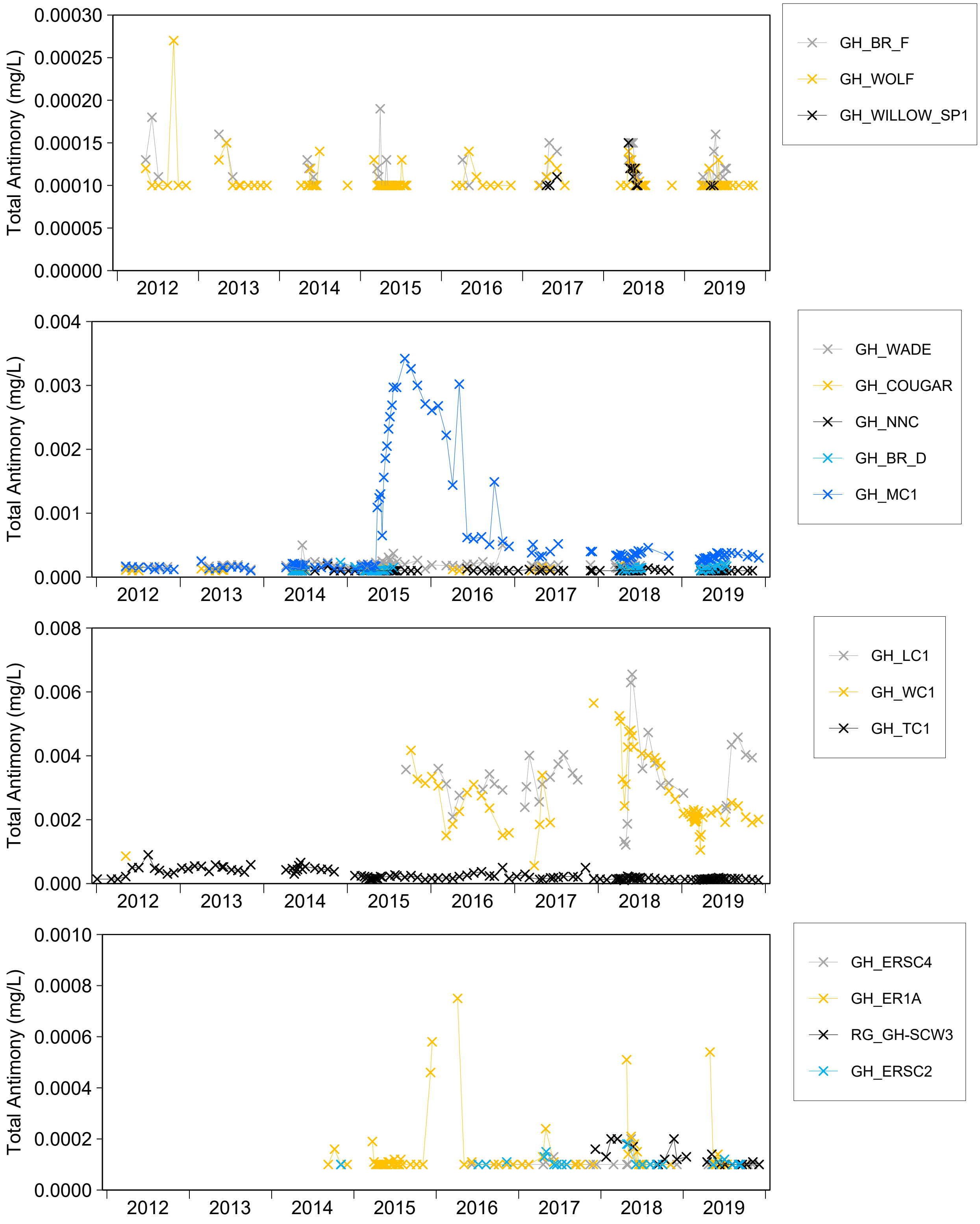


Figure C.39: **Time Series Plots for Total Antimony Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.00010 and 0.00050 mg/L). Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

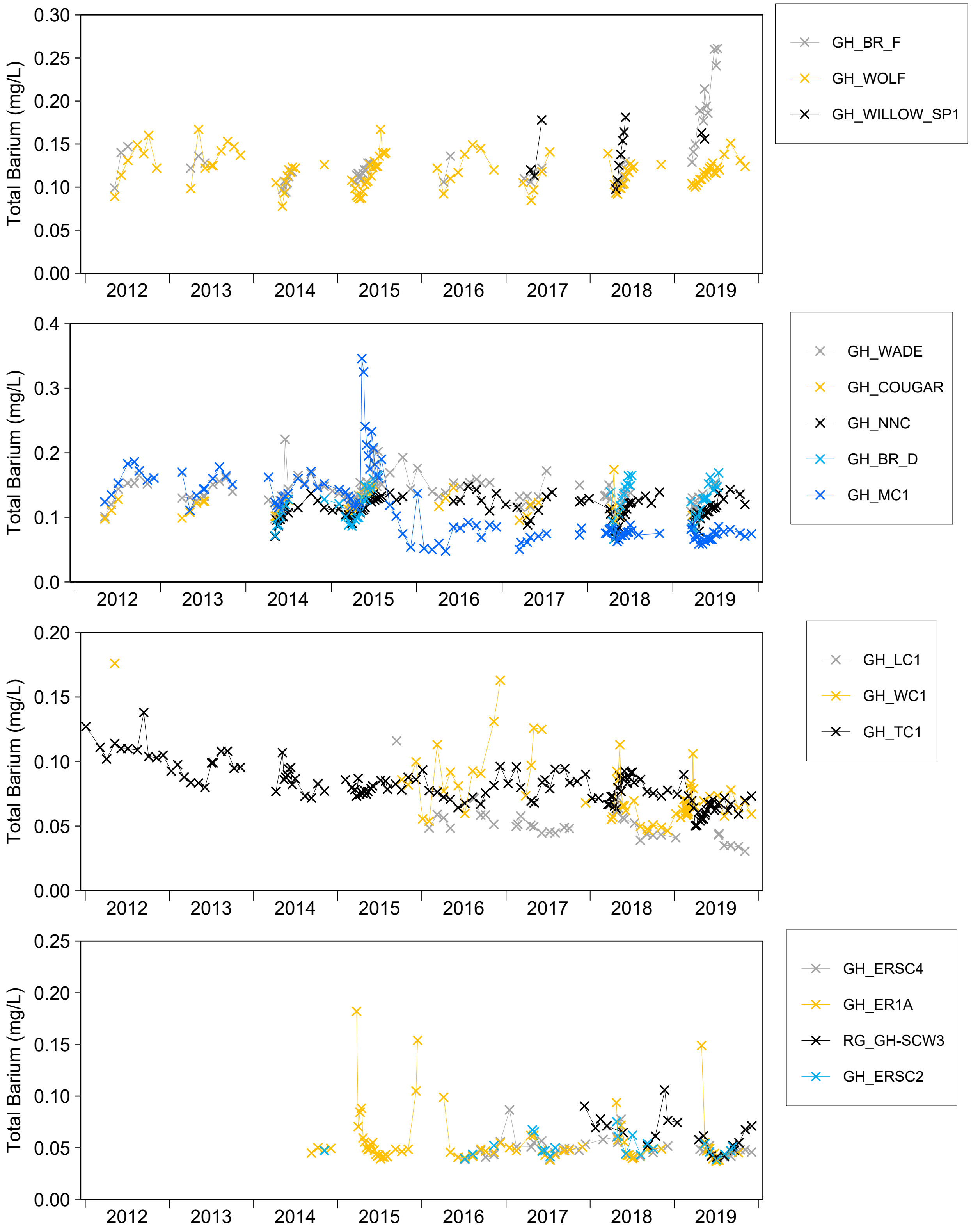


Figure C.40: **Time Series Plots for Total Barium Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: No values below the LRL. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

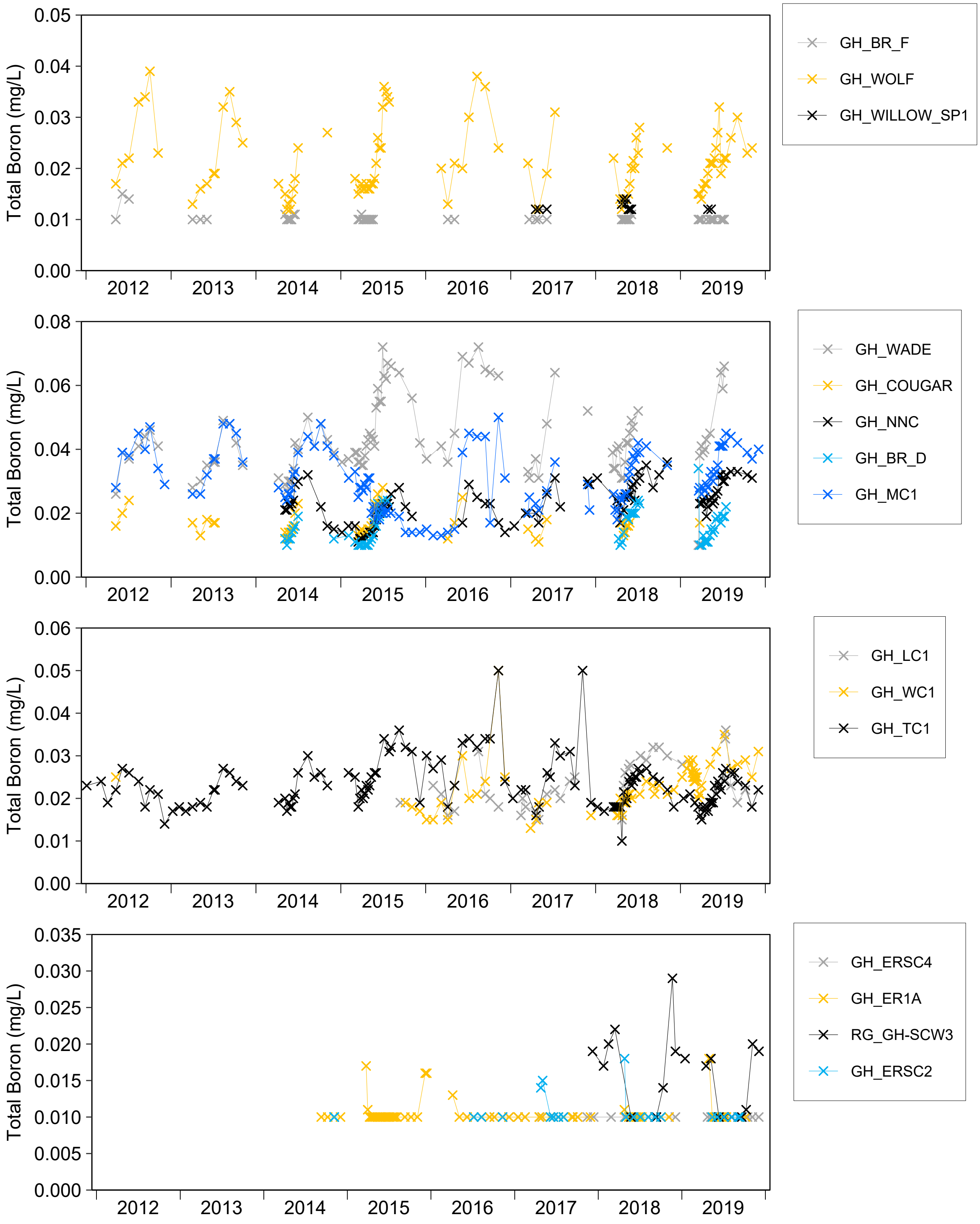


Figure C.41: **Time Series Plots for Total Boron Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.010 and 0.050 mg/L). Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

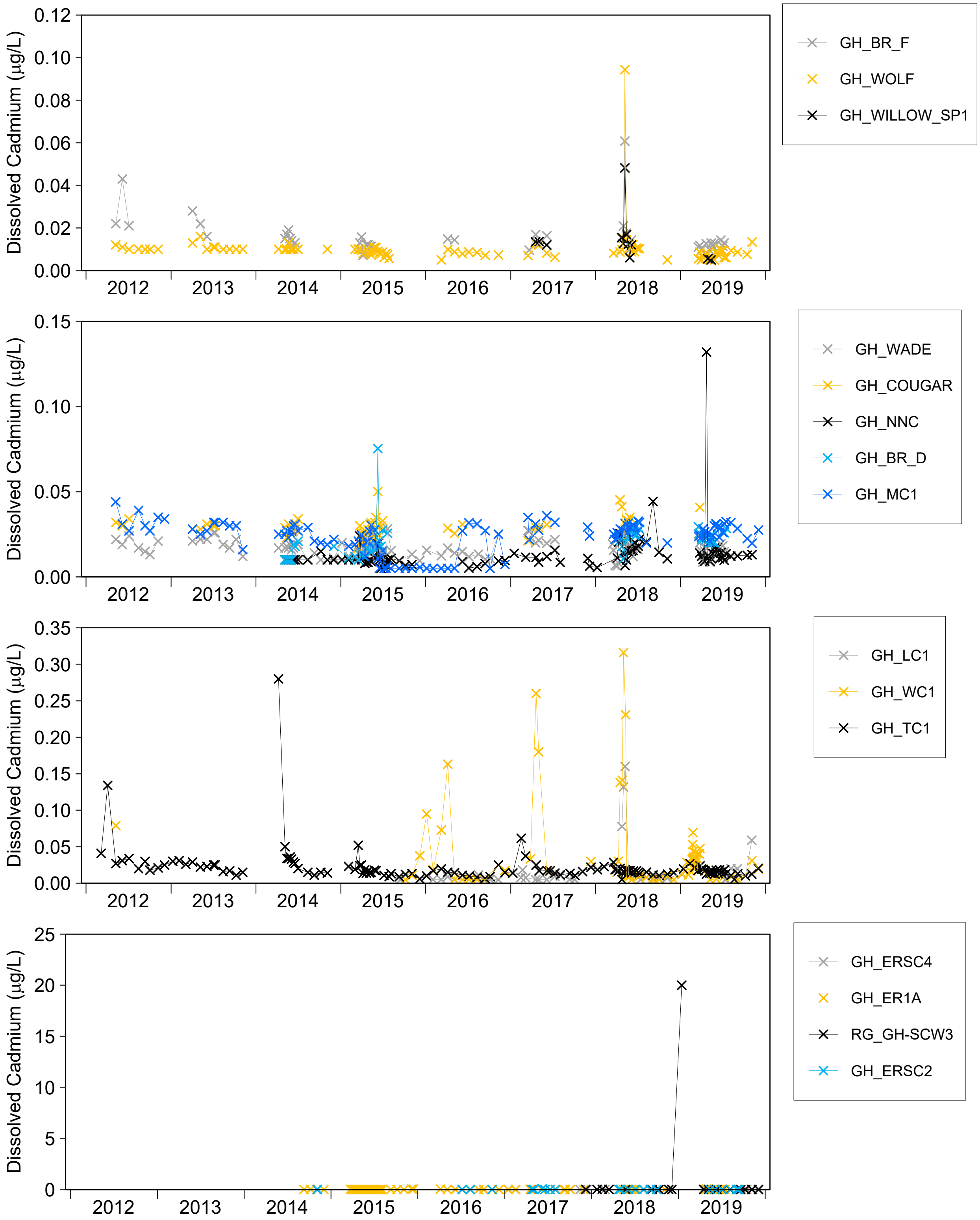


Figure C.42: **Time Series Plots for Dissolved Cadmium Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0050 and 0.030 mg/L). Dissolved Cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

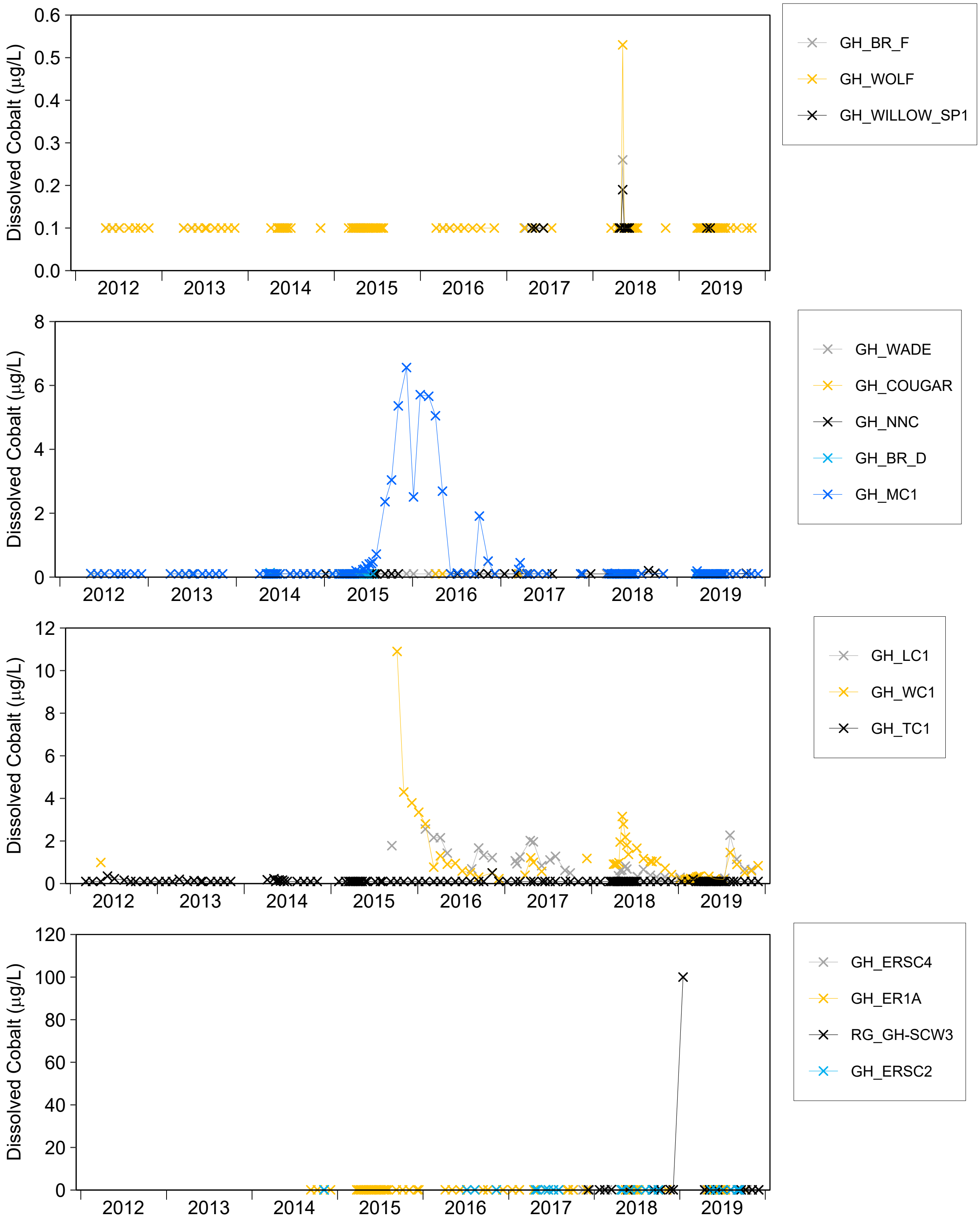


Figure C.43: Time Series Plots for Dissolved Cobalt Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.10 and 100 mg/L). Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

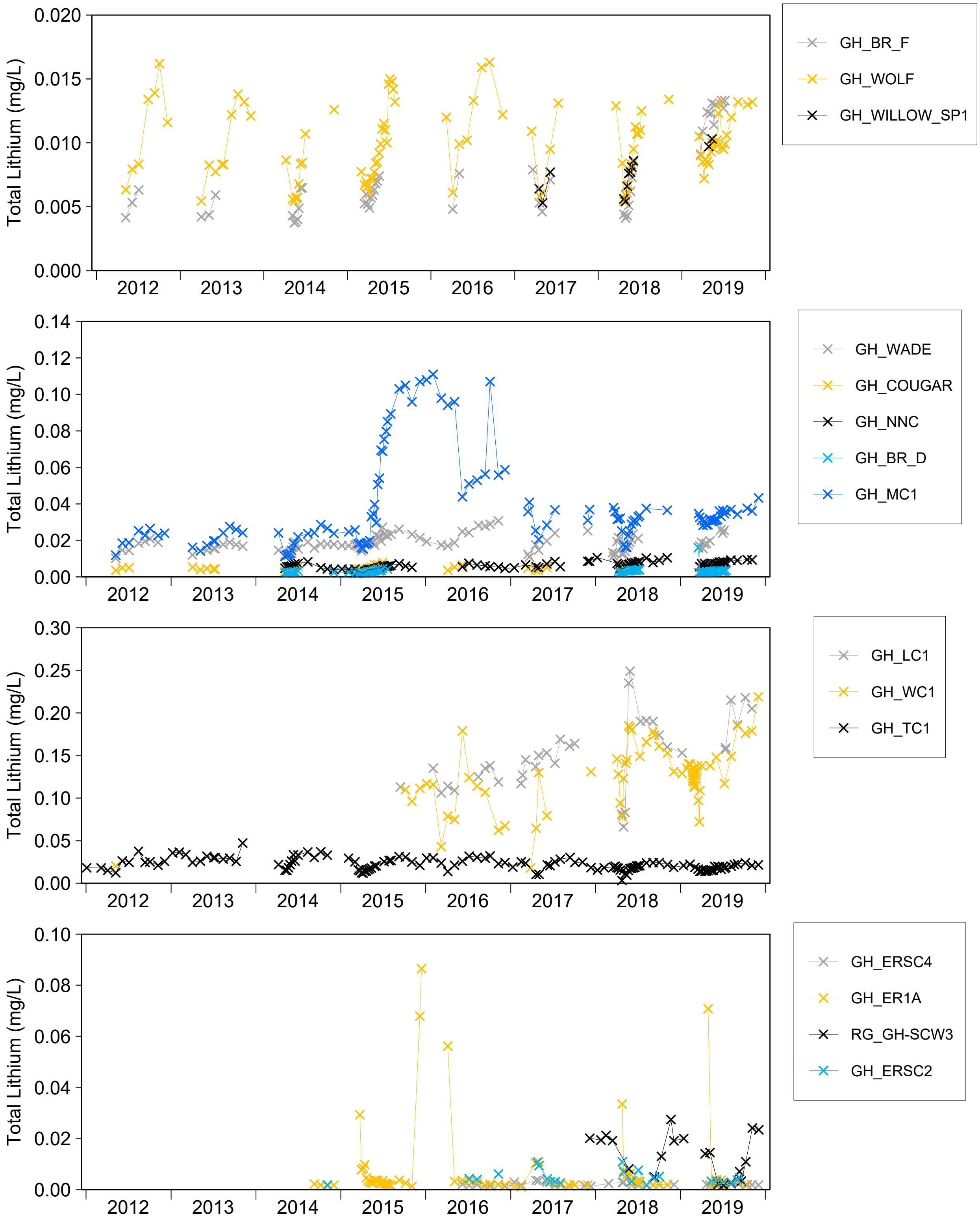


Figure C.44: Time Series Plots for Total Lithium Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0030 and 0.0030 mg/L). Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

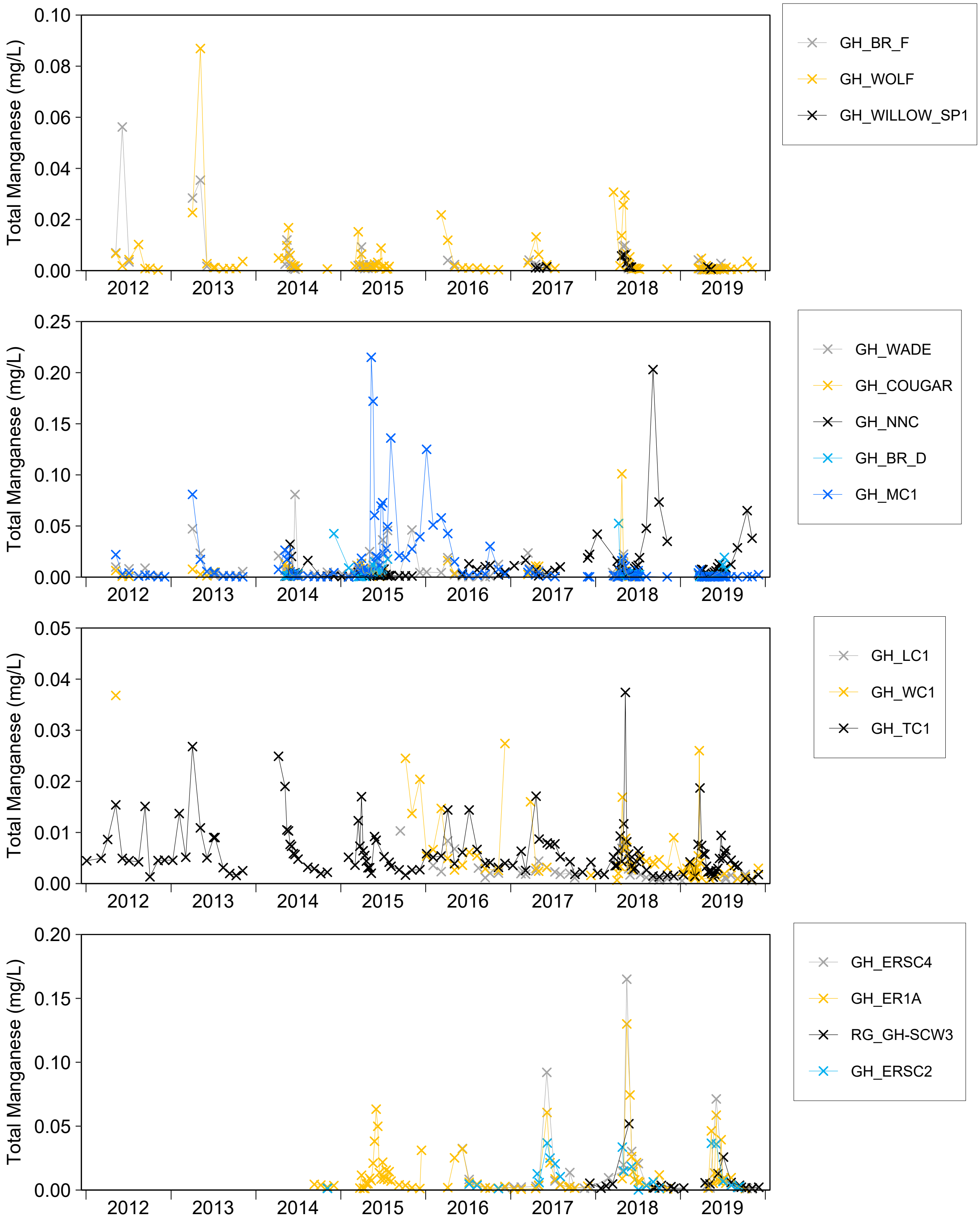


Figure C.45: **Time Series Plots for Total Manganese Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.00050 and 0.00050 mg/L). Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

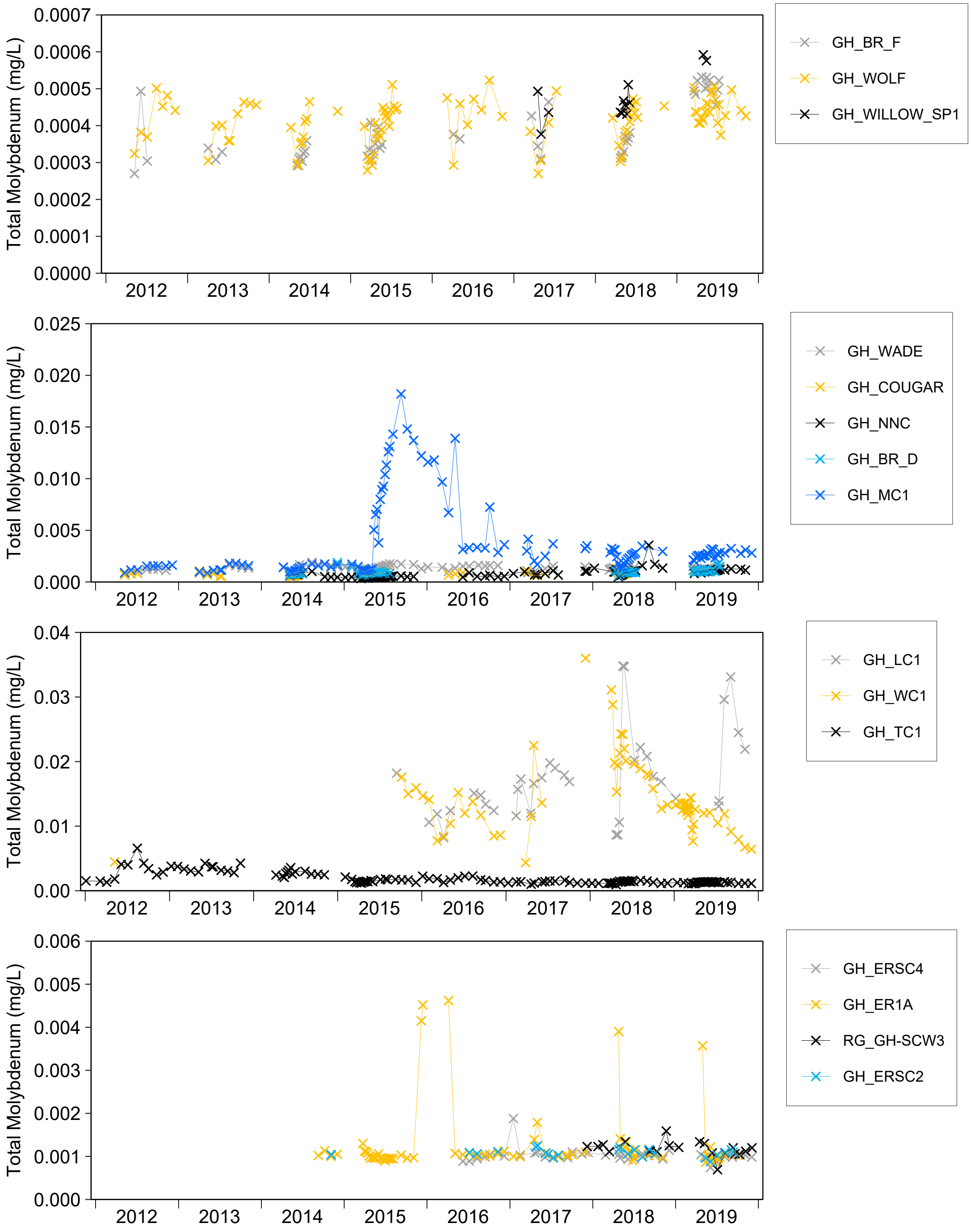


Figure C.46: **Time Series Plots for Total Molybdenum Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: No values below the LRL. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

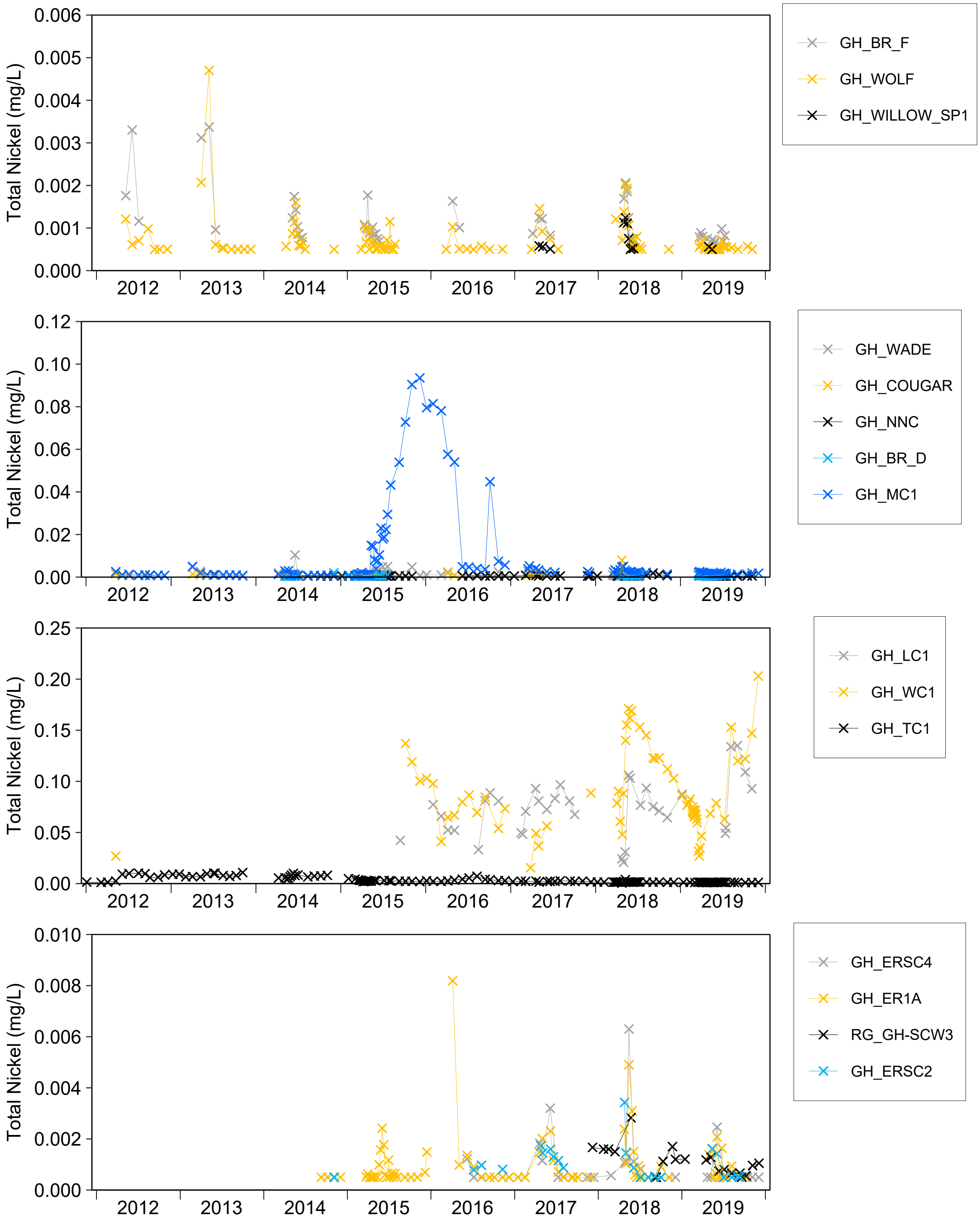


Figure C.47: **Time Series Plots for Total Nickel Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.00050 and 0.0025 mg/L). Total Nickel was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

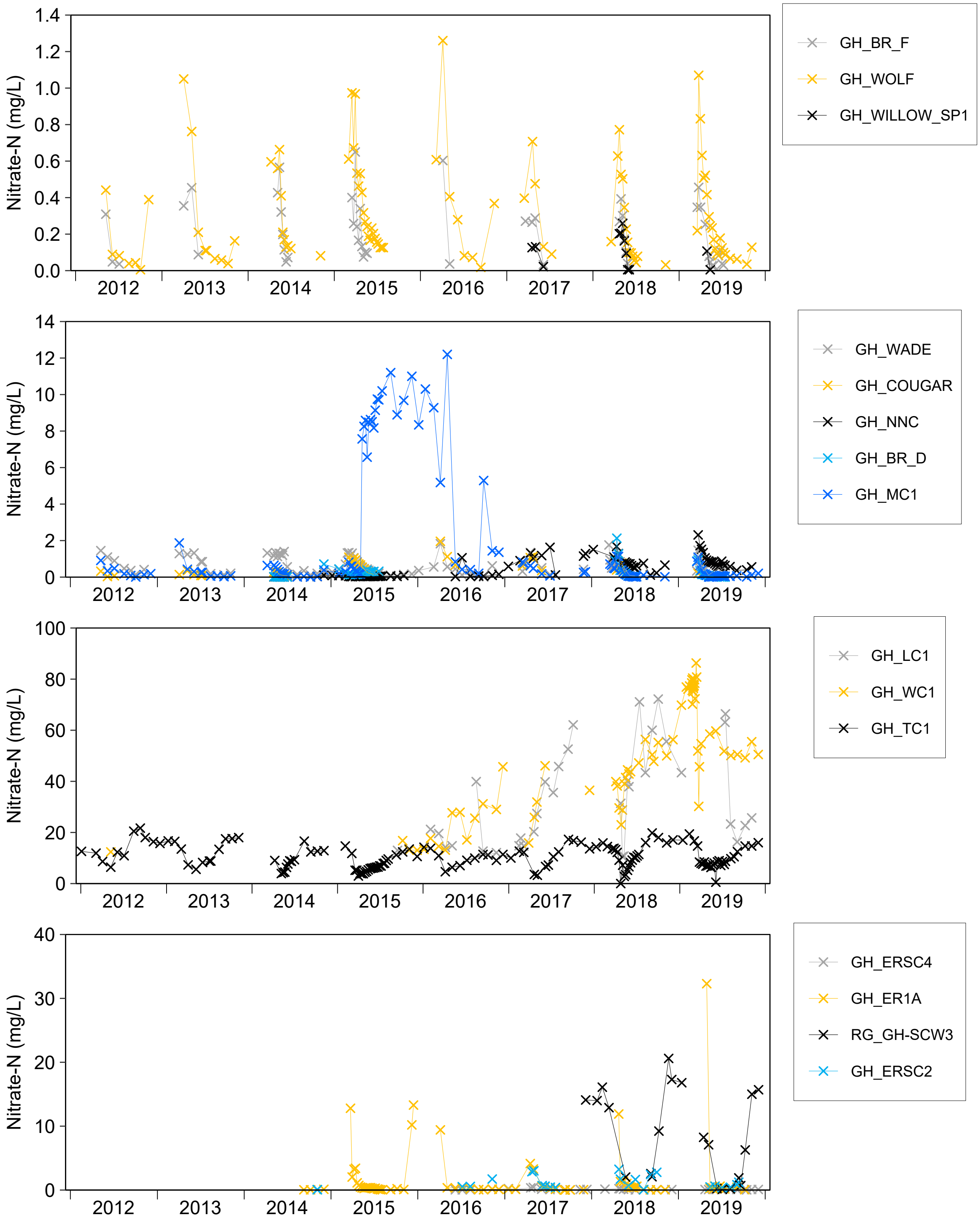


Figure C.48: Time Series Plots for Nitrate-N Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0050 and 0.0050 mg/L). Nitrate-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

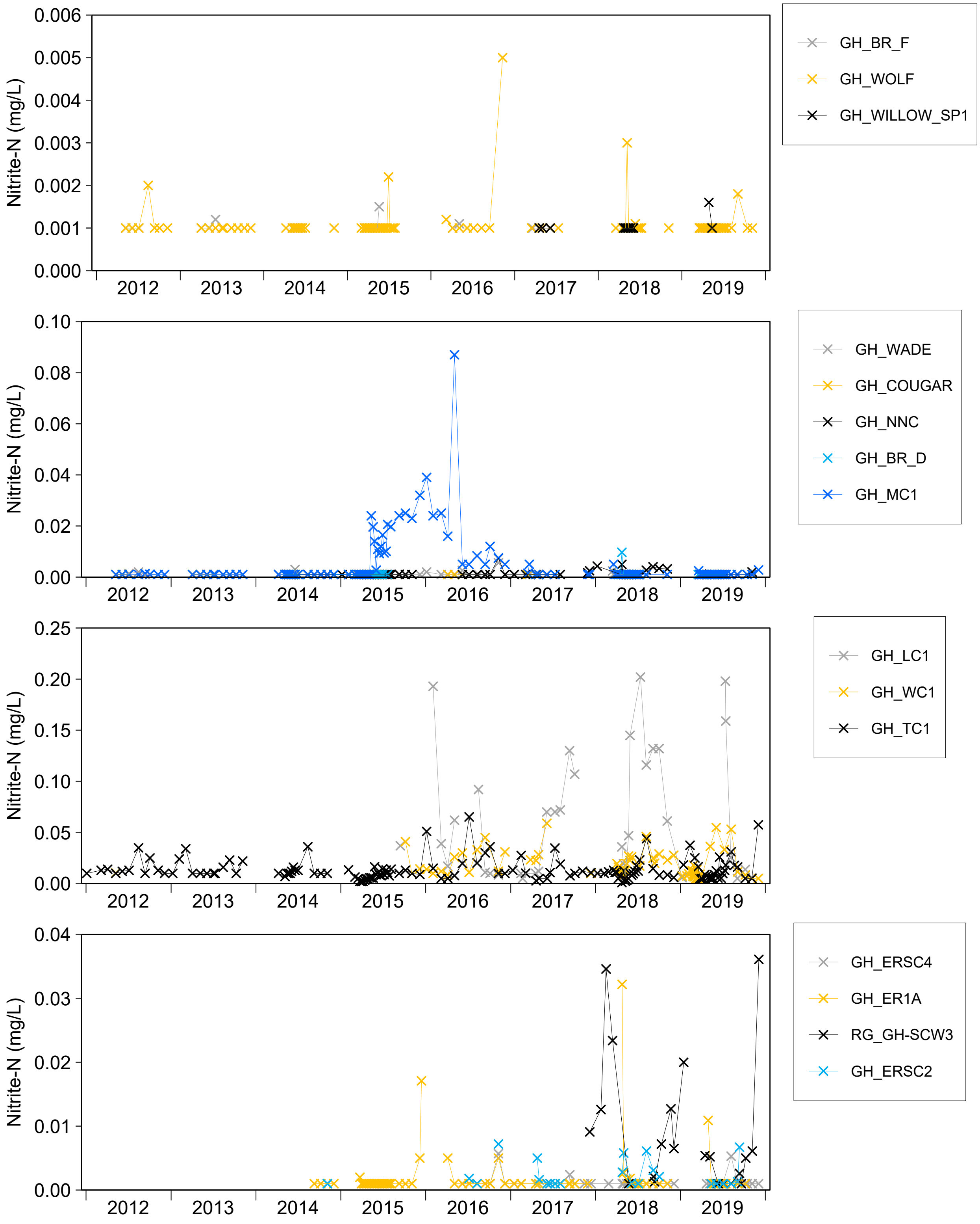


Figure C.49: **Time Series Plots for Nitrite-N Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0010 and 0.010 mg/L). Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

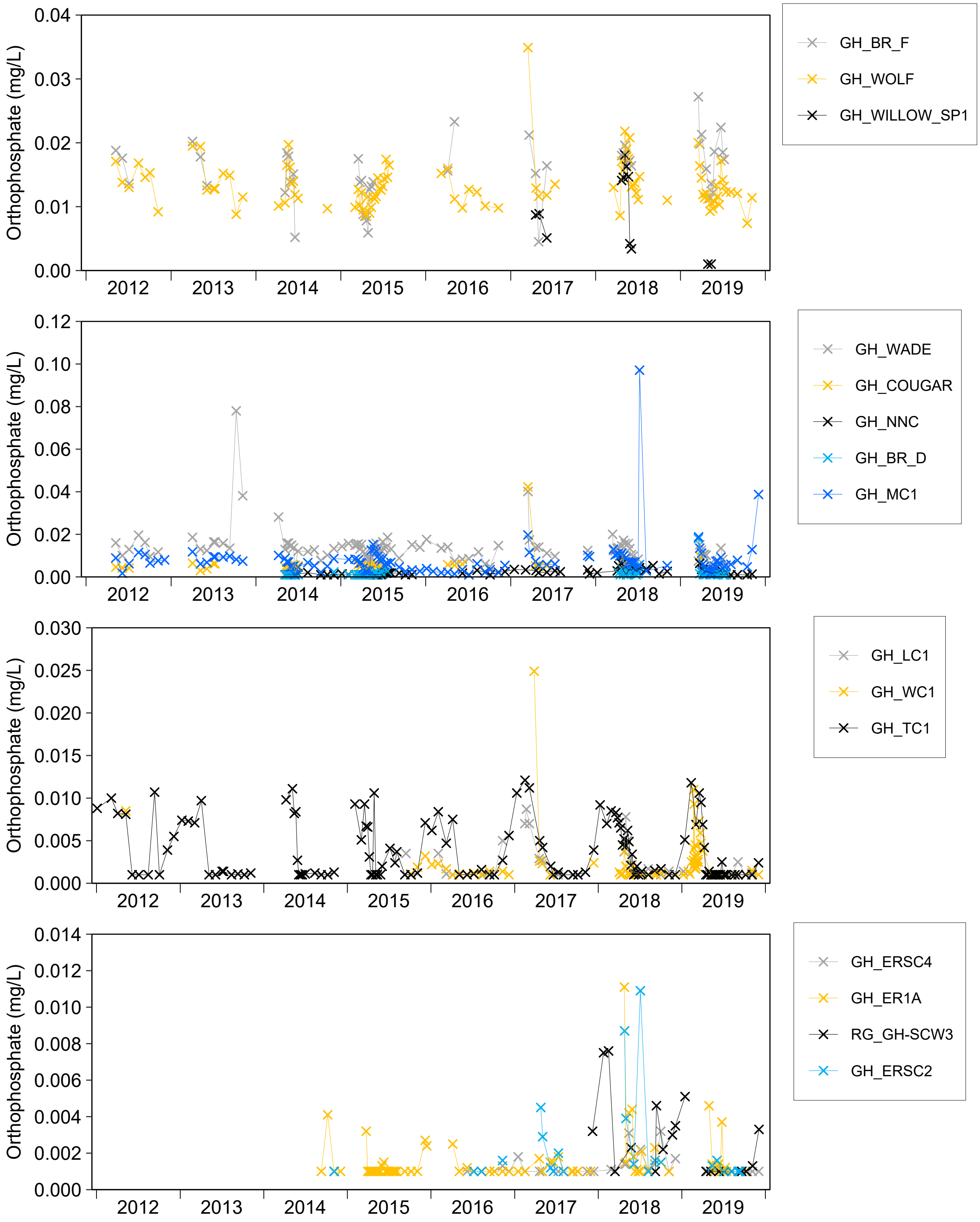


Figure C.50: **Time Series Plots for Orthophosphate Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0010 and 0.0010 mg/L). Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

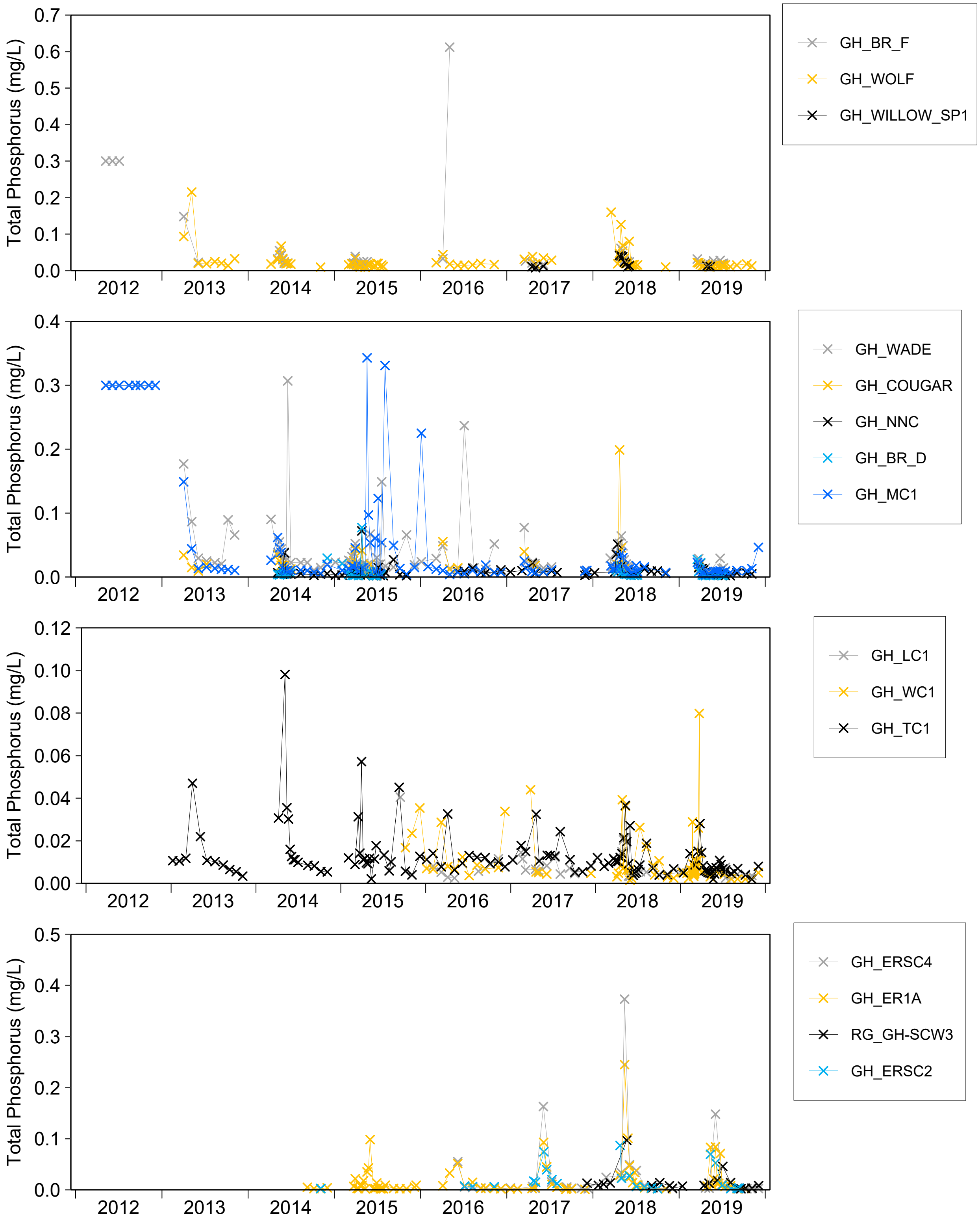


Figure C.51: **Time Series Plots for Total Phosphorus Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0010 and 0.30 mg/L). Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

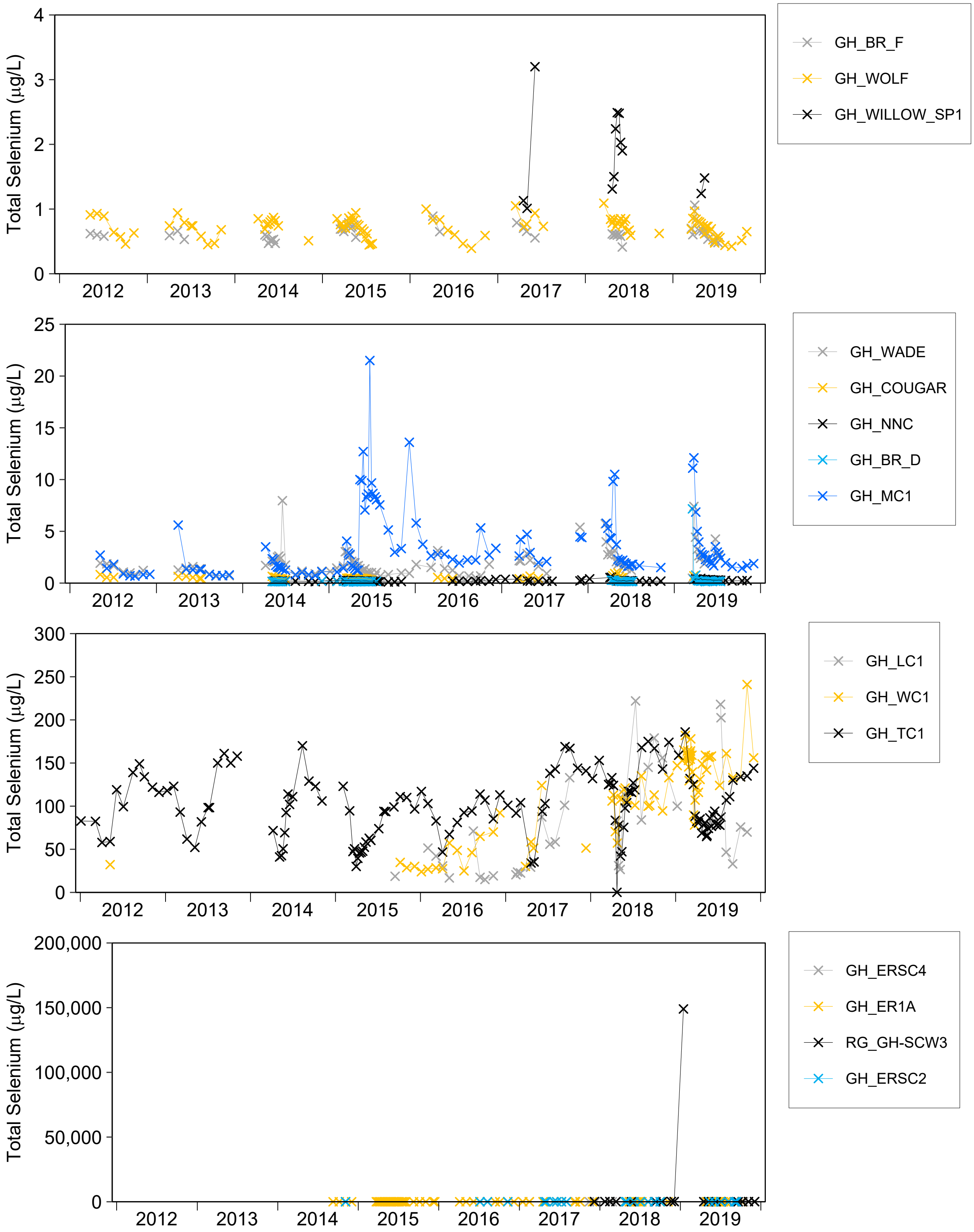


Figure C.52: Time Series Plots for Total Selenium Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: No values below the LRL. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

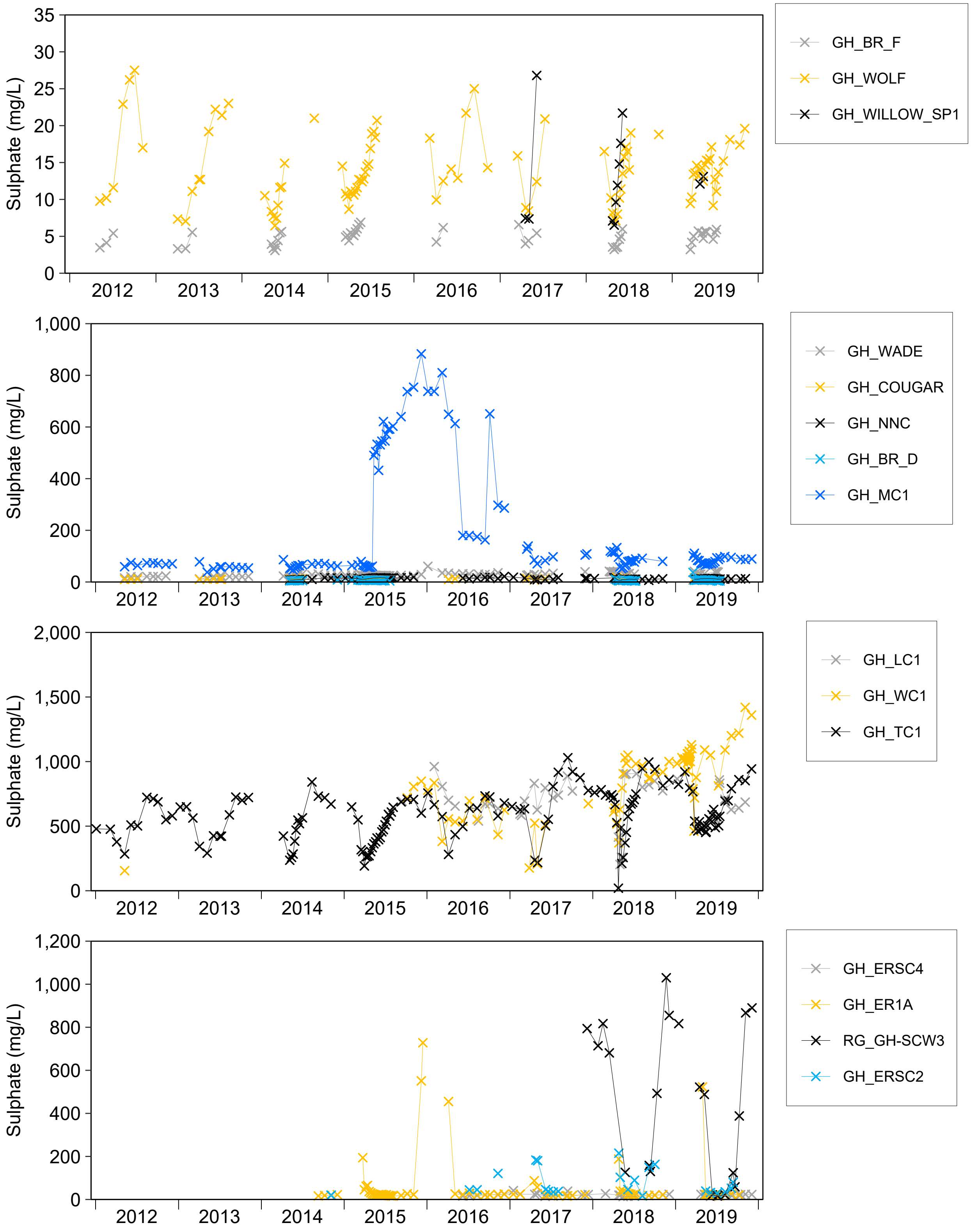


Figure C.53: Time Series Plots for Sulphate Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: No values below the LRL. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

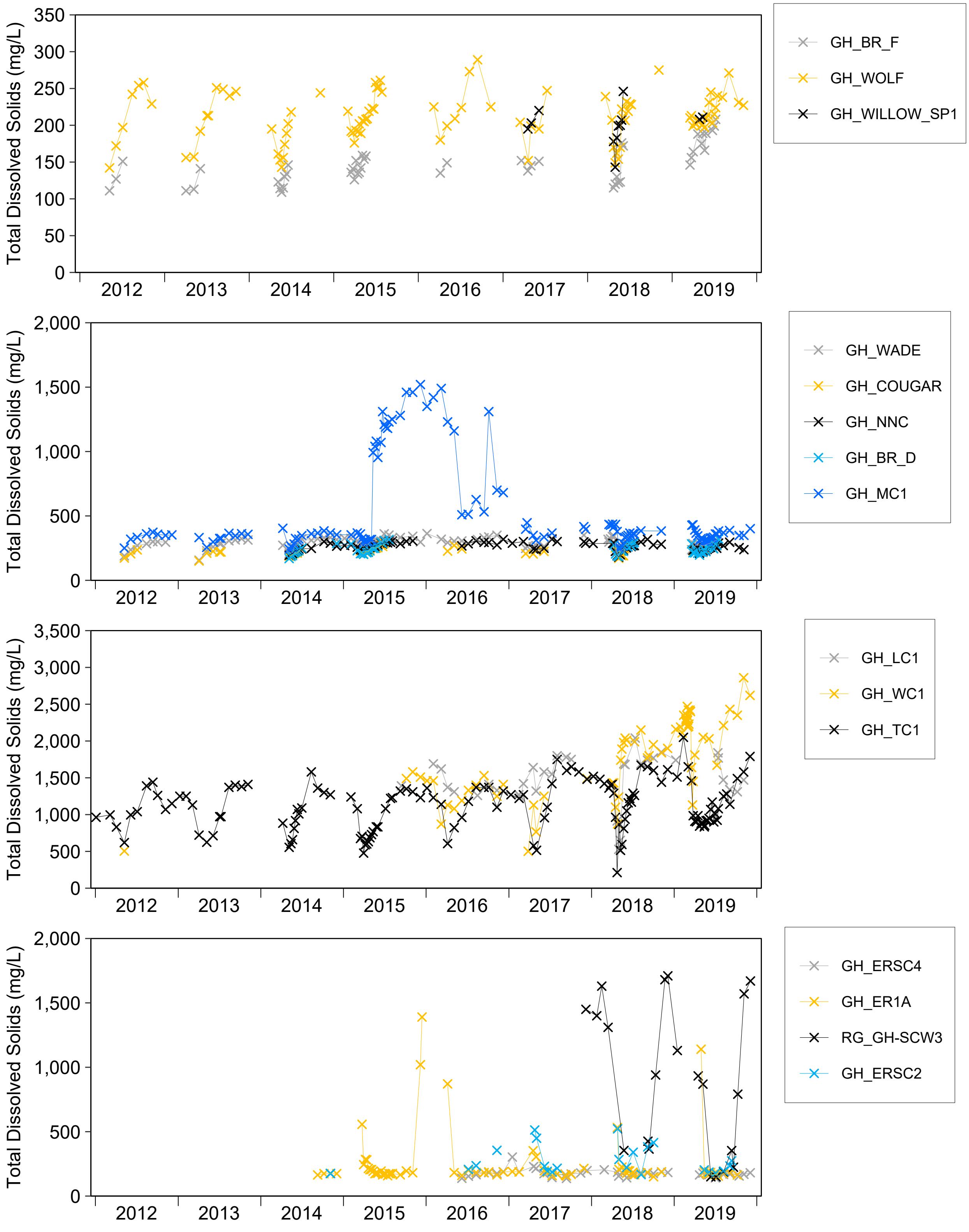


Figure C.54: Time Series Plots for Total Dissolved Solids Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: No values below the LRL. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

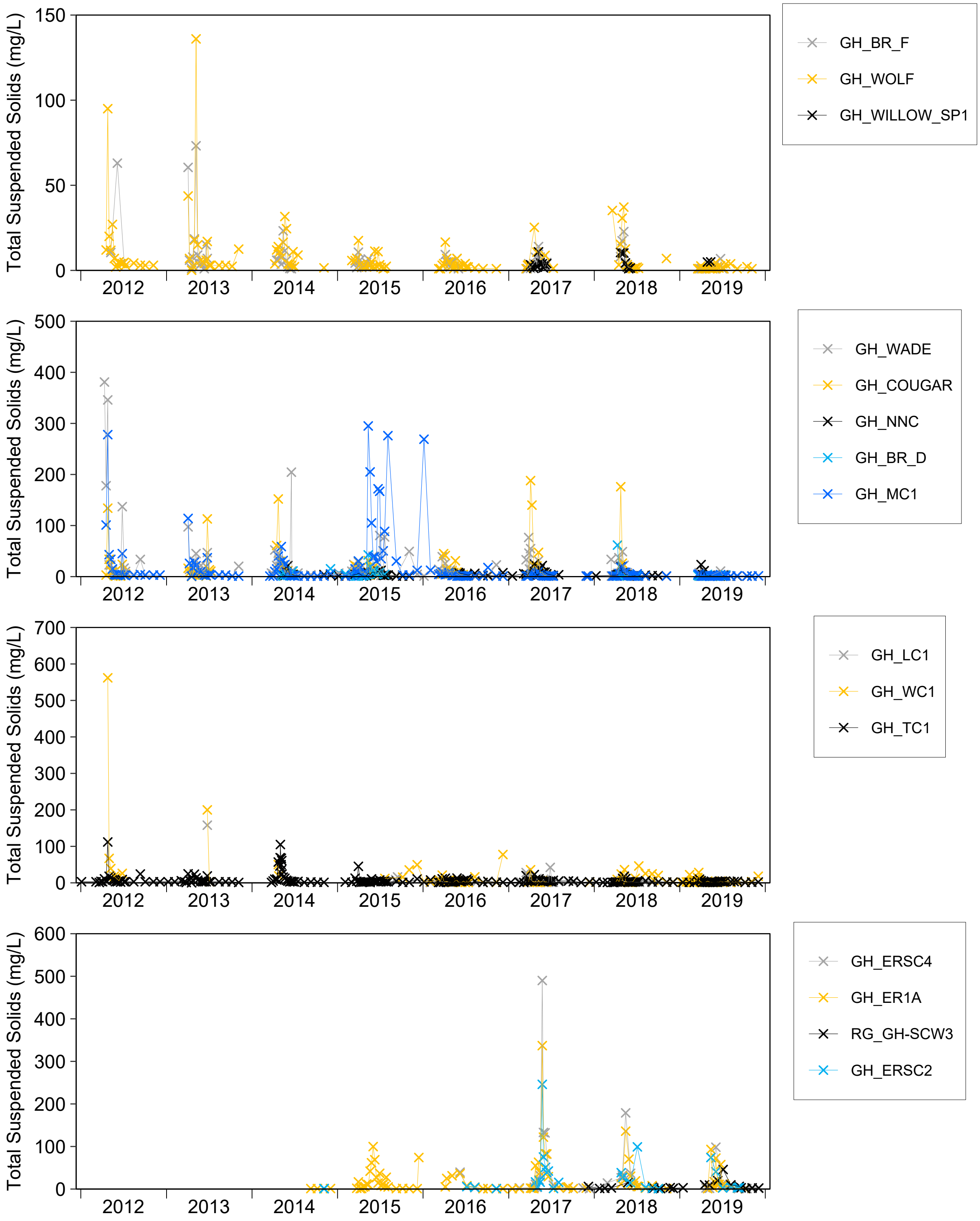


Figure C.55: Time Series Plots for Total Suspended Solids Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 1.0 and 5.0 mg/L). Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 μm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4).

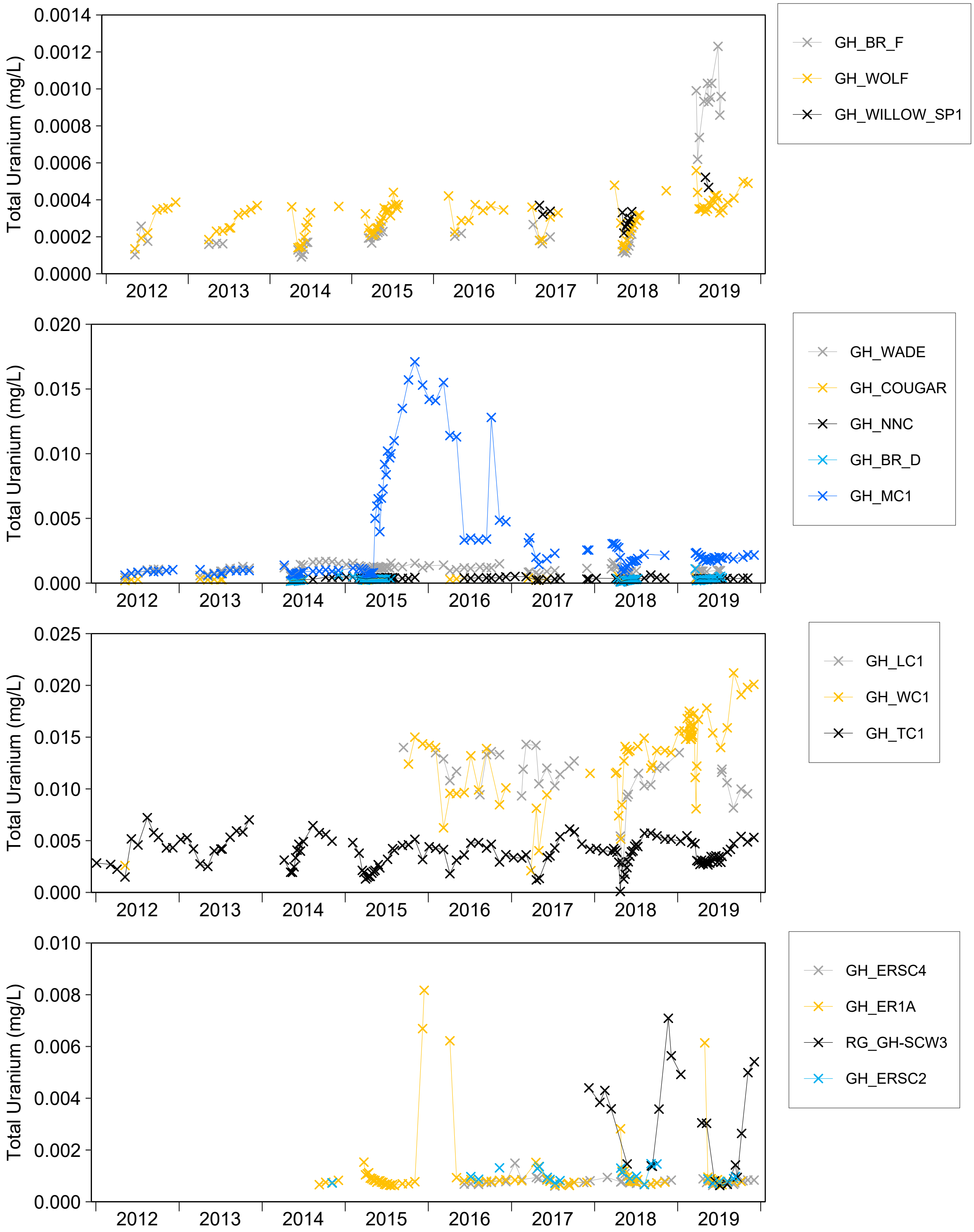


Figure C.56: **Time Series Plots for Total Uranium Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: No values below the LRL. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

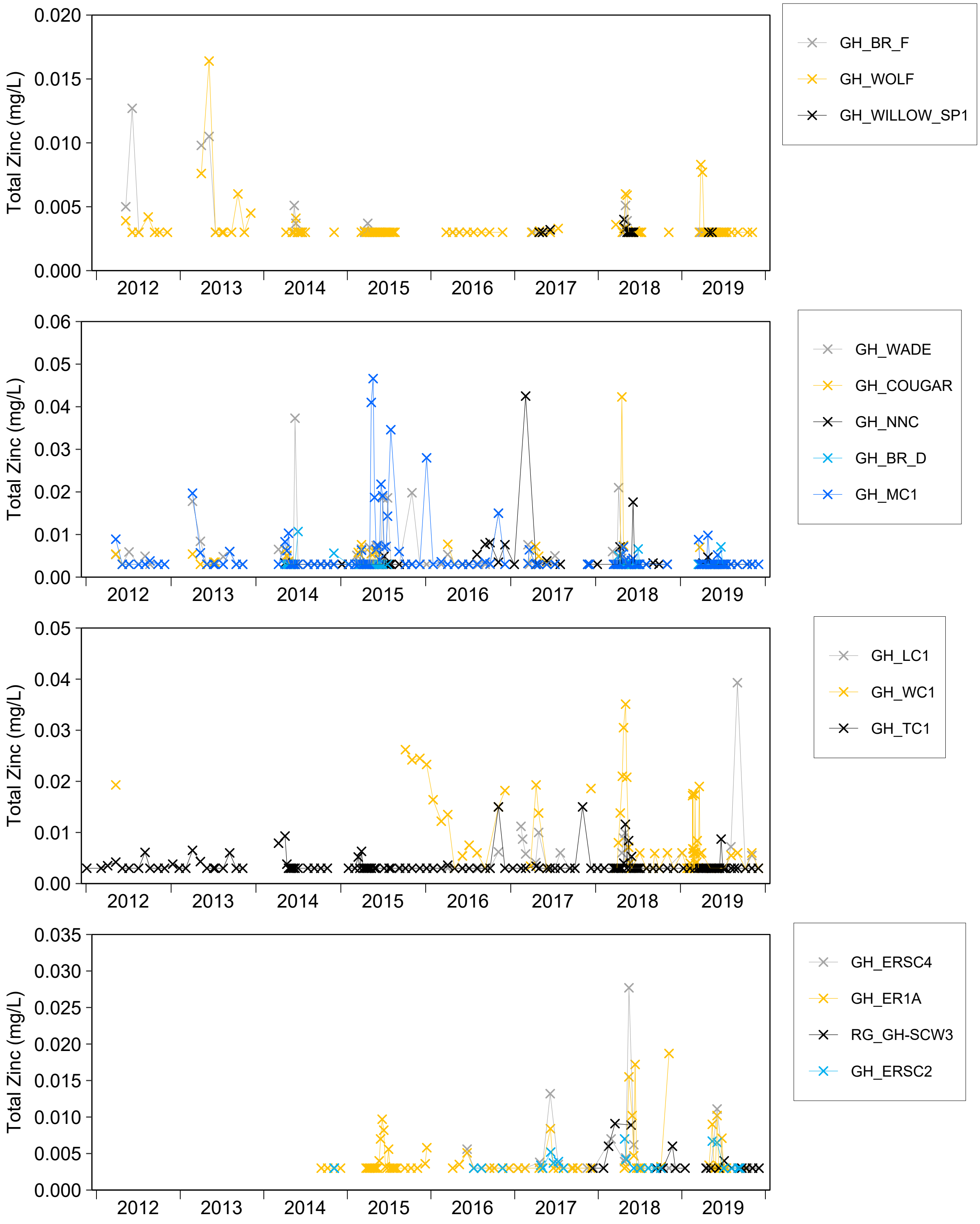


Figure C.57: **Time Series Plots for Total Zinc Concentrations from West-side Tributaries and Side Channel Monitoring Stations, 2012 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted at the LRL (LRLs between 0.0030 and 0.015 mg/L). Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

WATER QUALITY

Main Stem Elk River Water Quality Figures

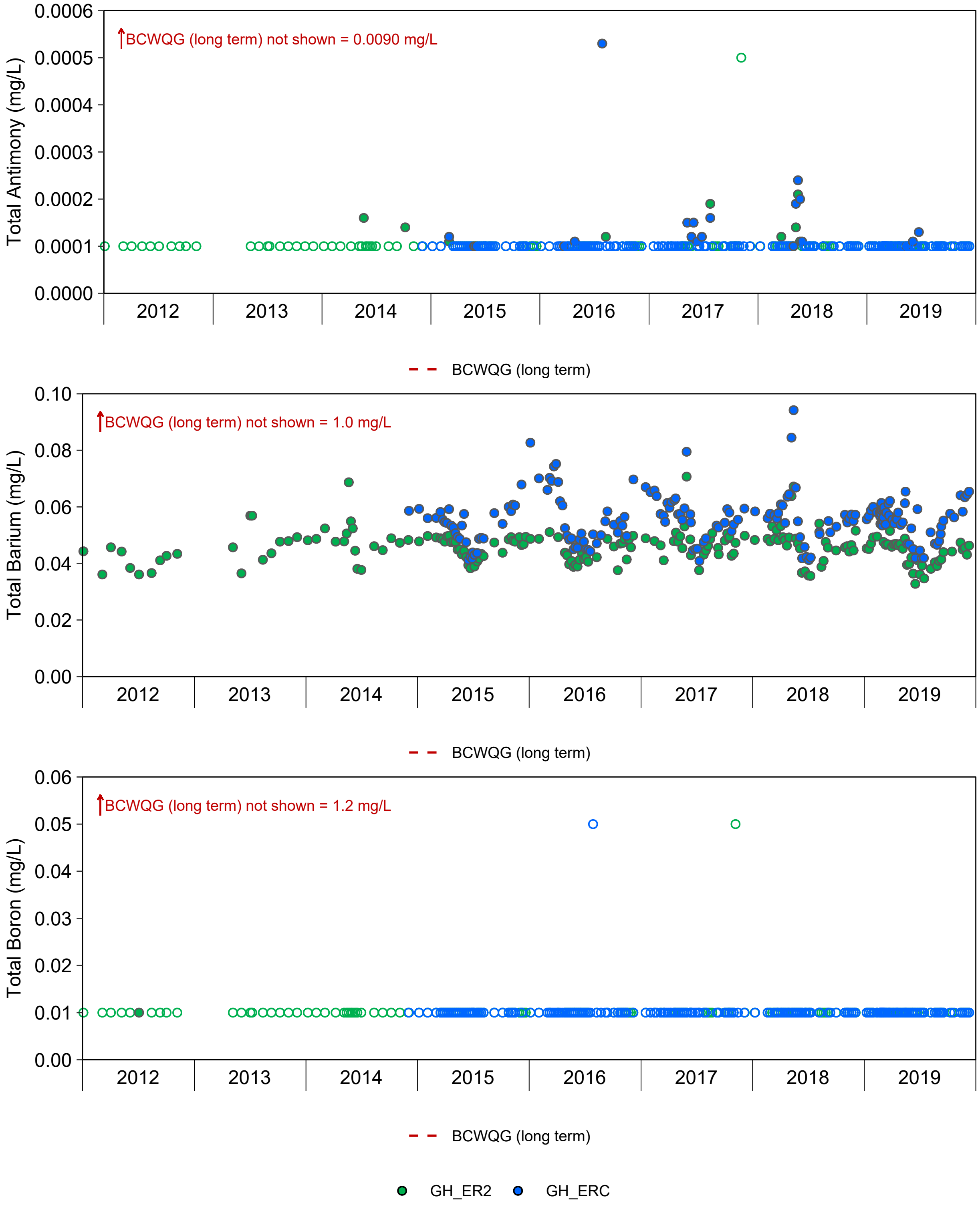


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

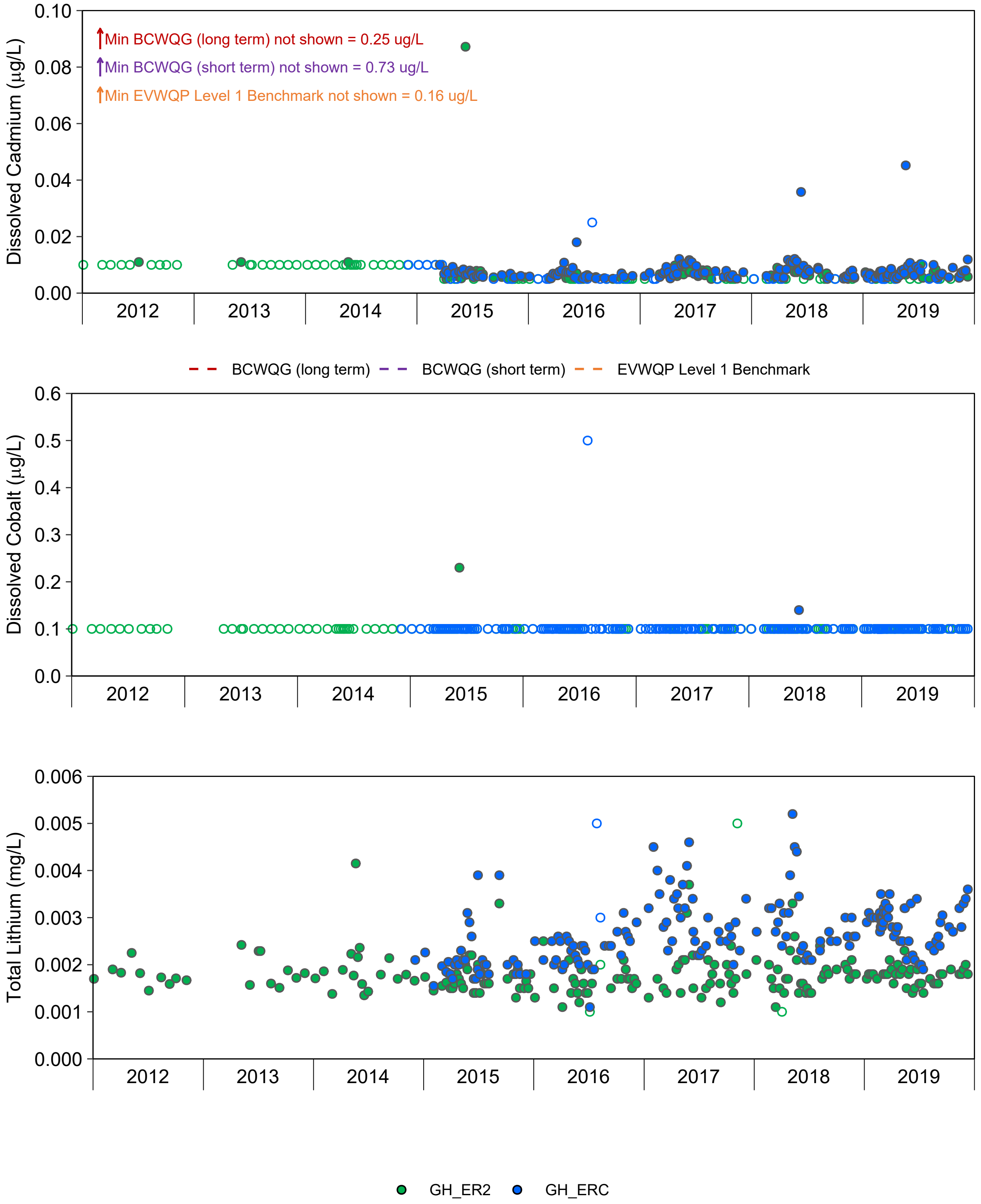


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.

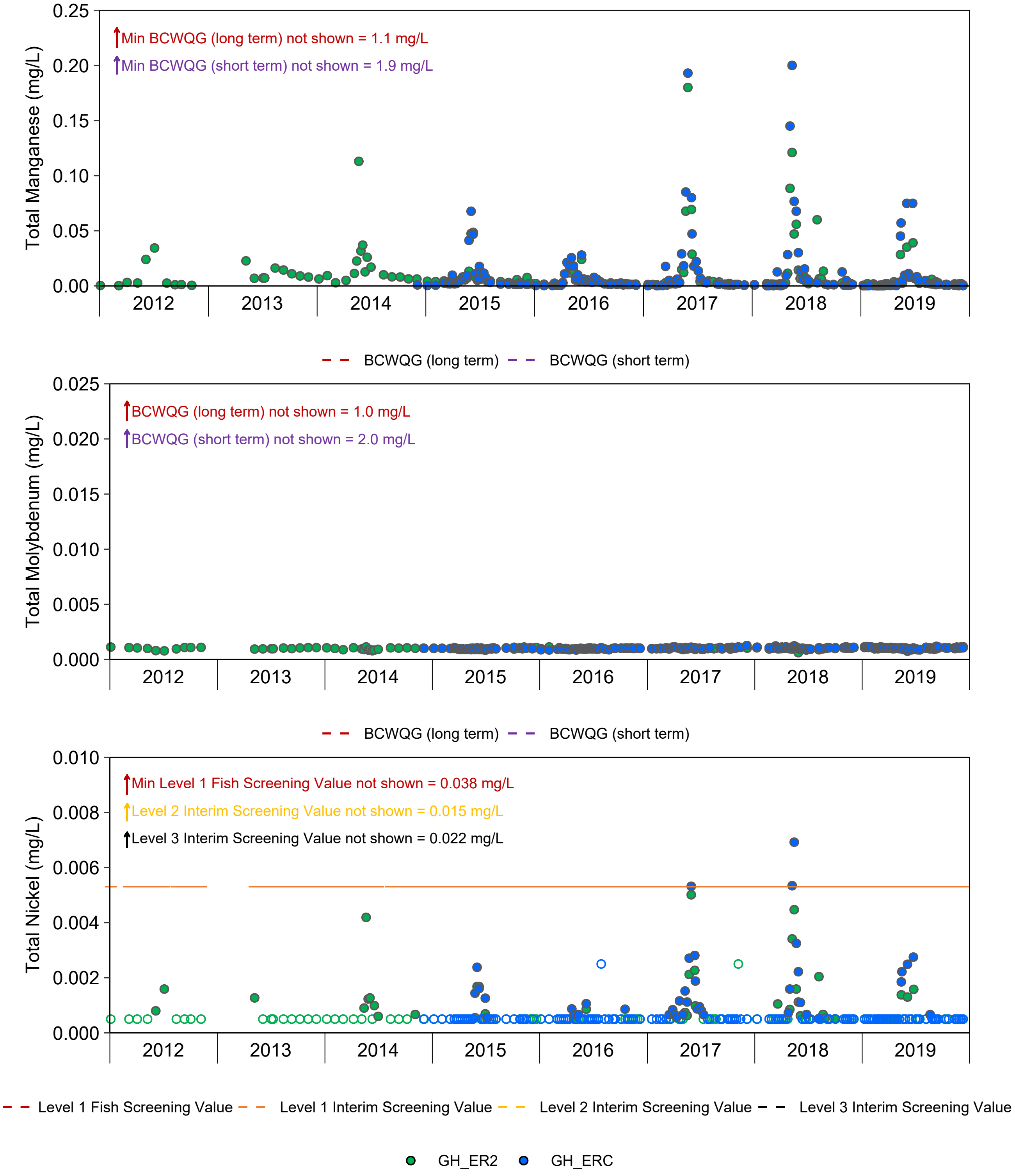


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

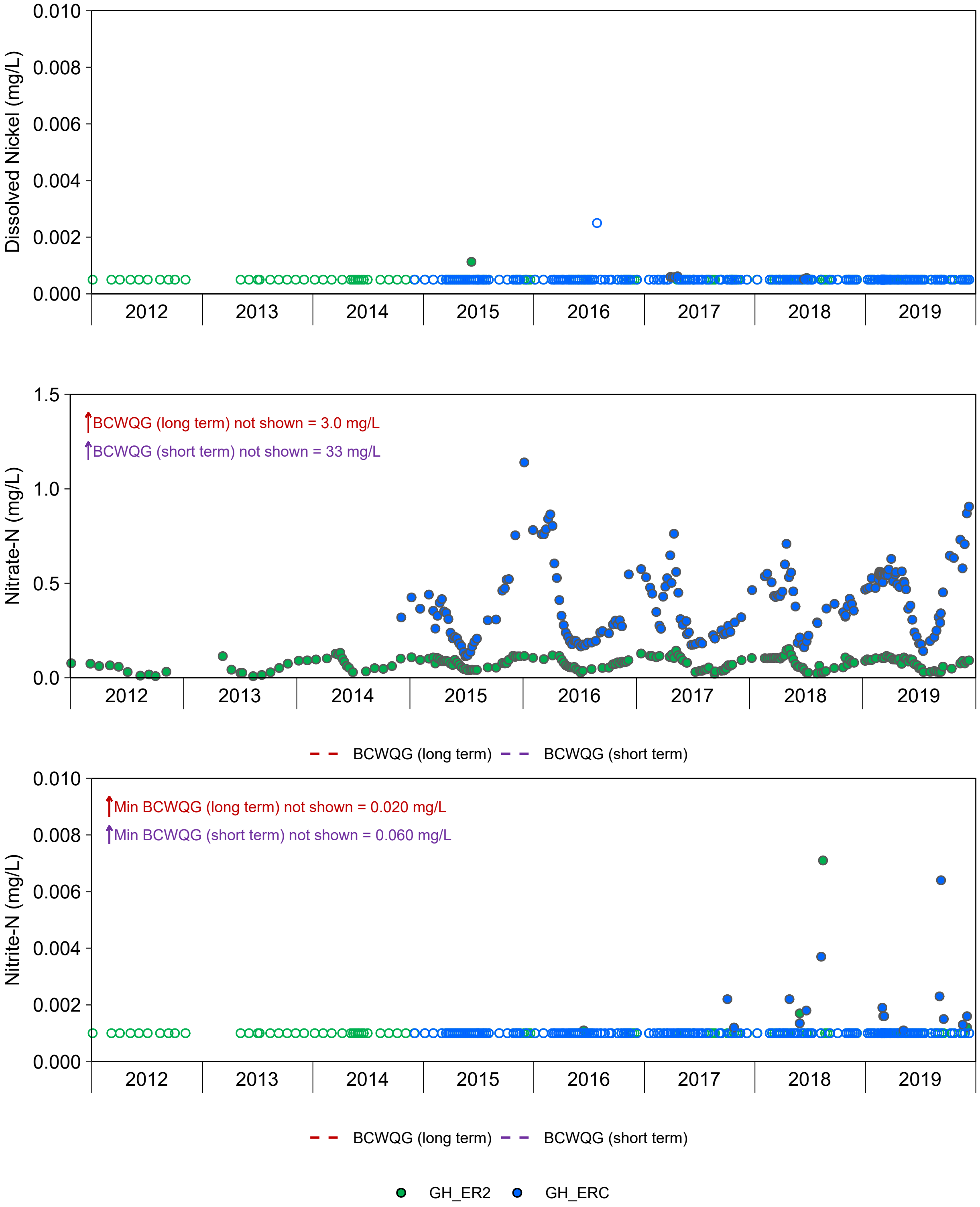


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

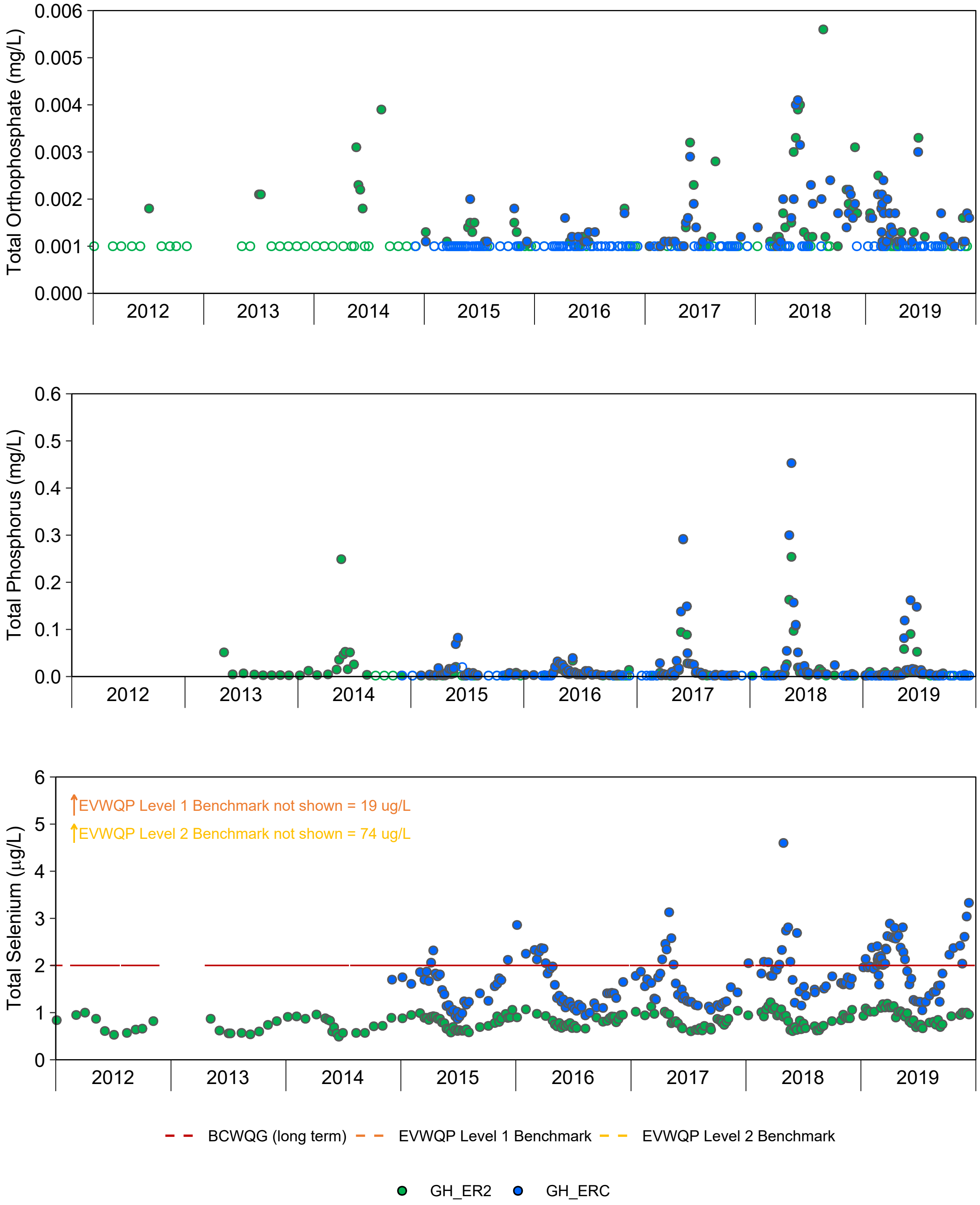


Figure C.58: Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

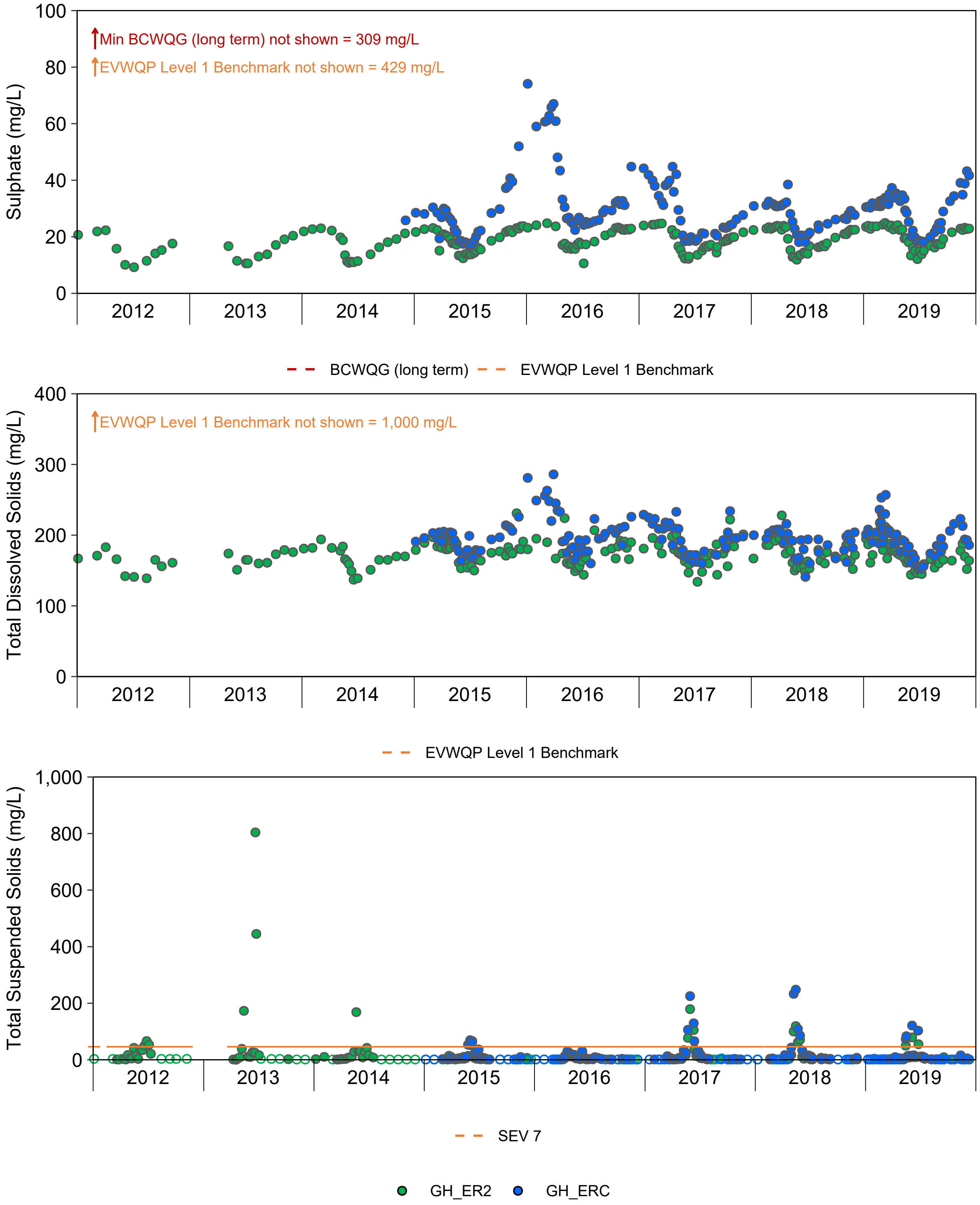


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Appendix Table C.4)

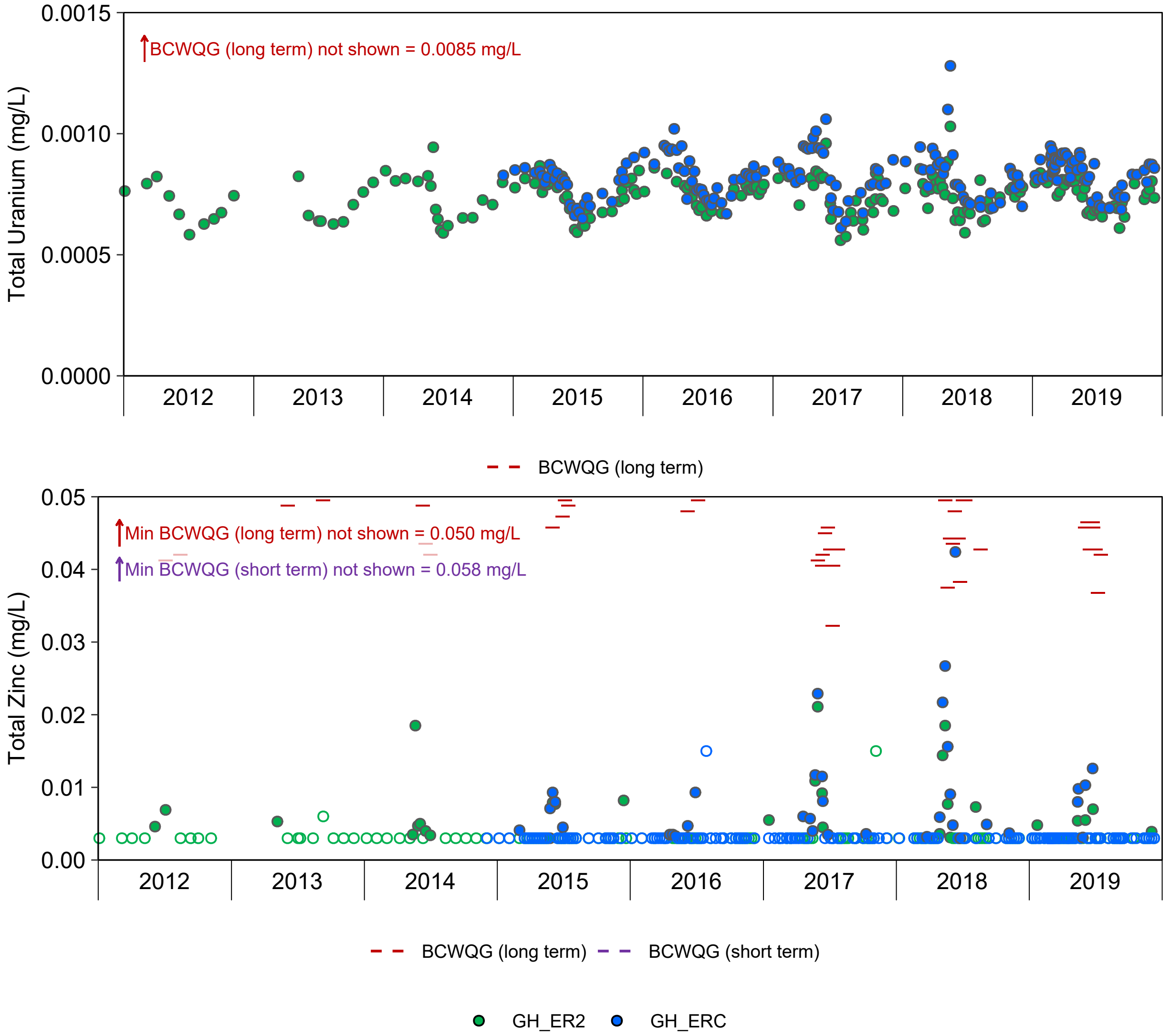


Figure C.58: **Time Series Plots for Constituents from Main Stem Elk River Stations Upstream (Reference, GH_ER2) and Downstream (Mine-Exposed, GH_ERC) of the Elk River Side Channel, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. Orthophosphate and phosphorus were also plotted based on EMC input, because these constituents were assessed in the GHO Cougar Pit Extension Joint Application. Dissolved nickel is provided for bioavailability context. All other constituents were plotted because they was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

WATER QUALITY

Isolated Pool Water Quality Figures

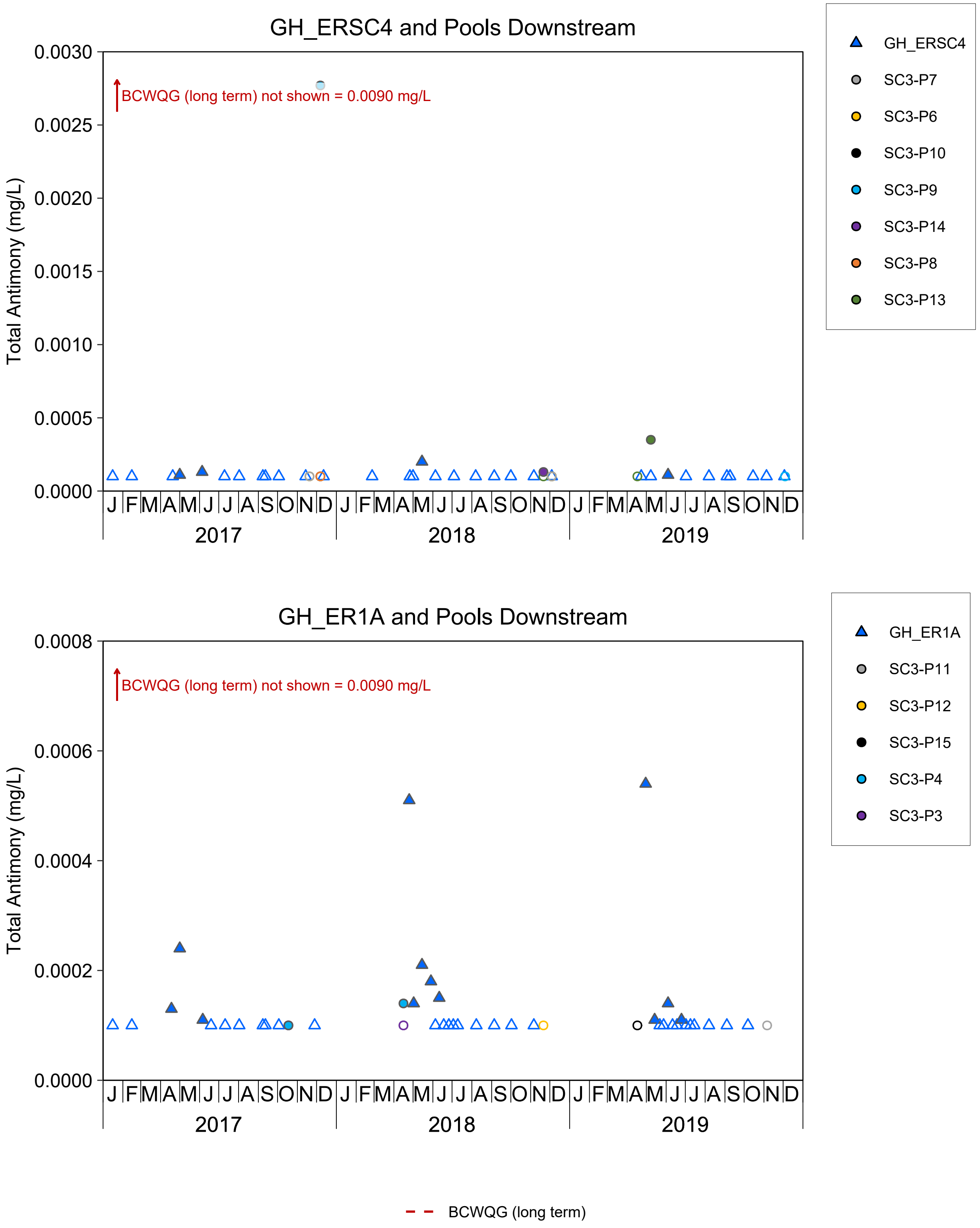


Figure C.59: **Time Series Plots for Total Antimony Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

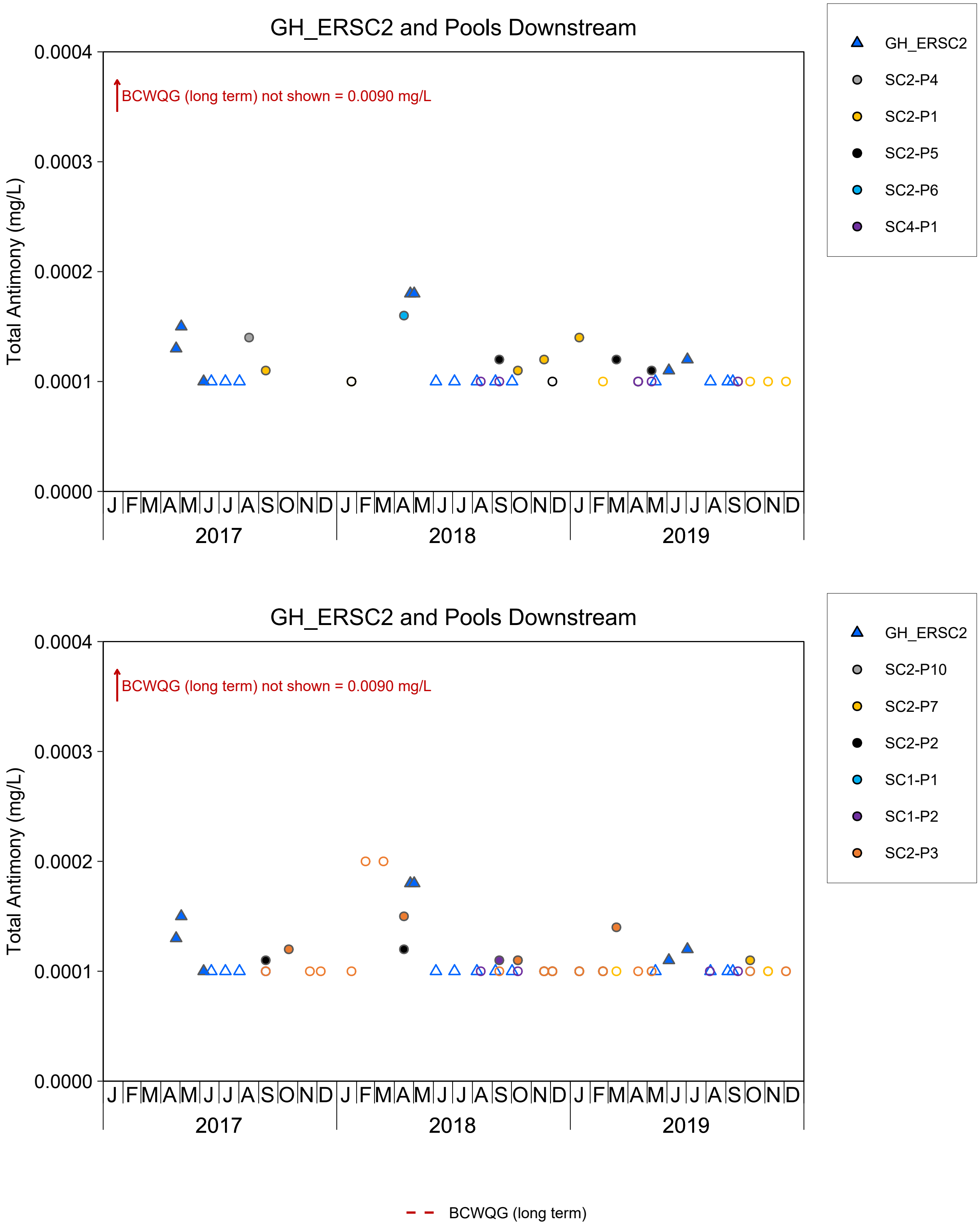


Figure C.59: **Time Series Plots for Total Antimony Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total antimony was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

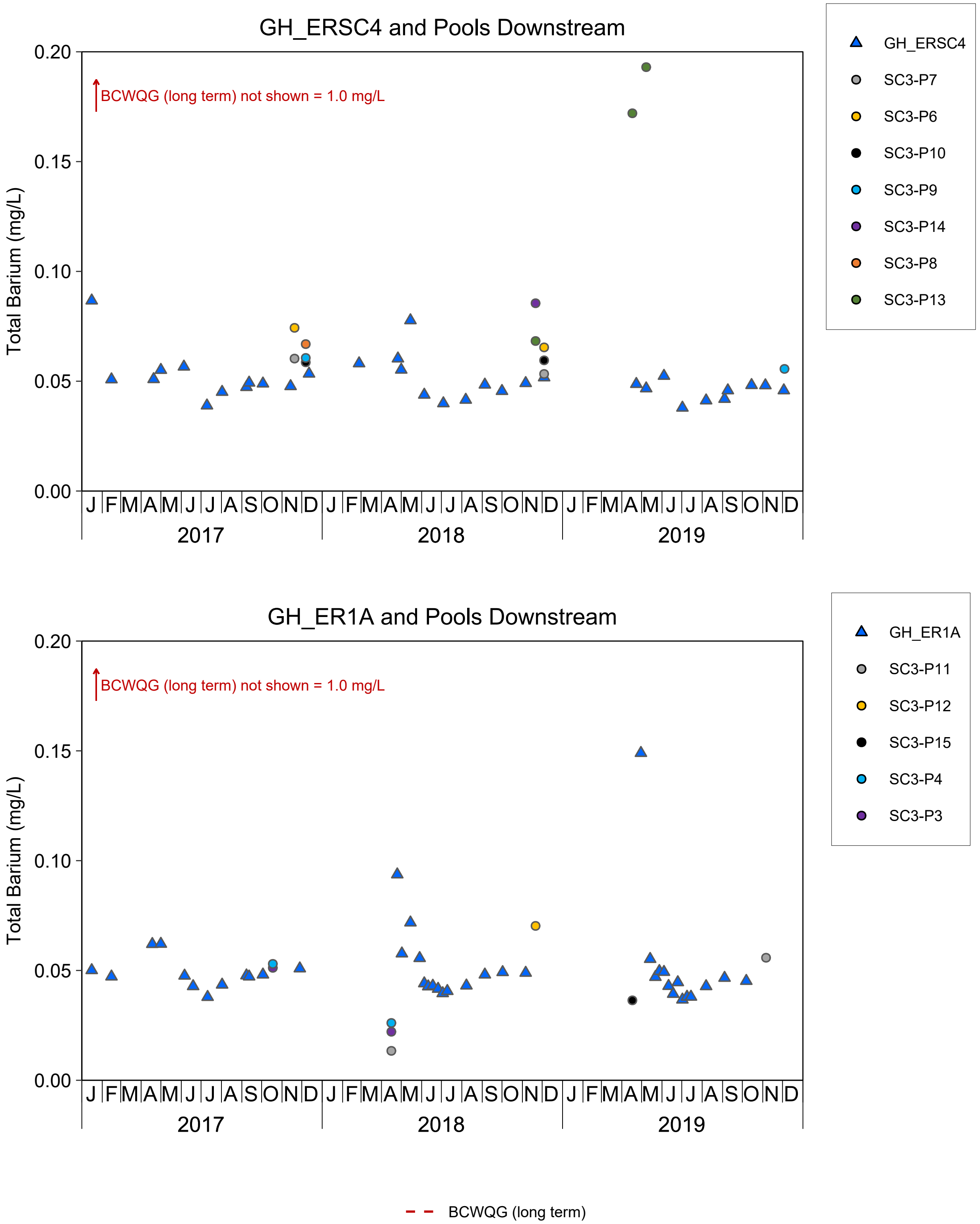


Figure C.60: **Time Series Plots for Total Barium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

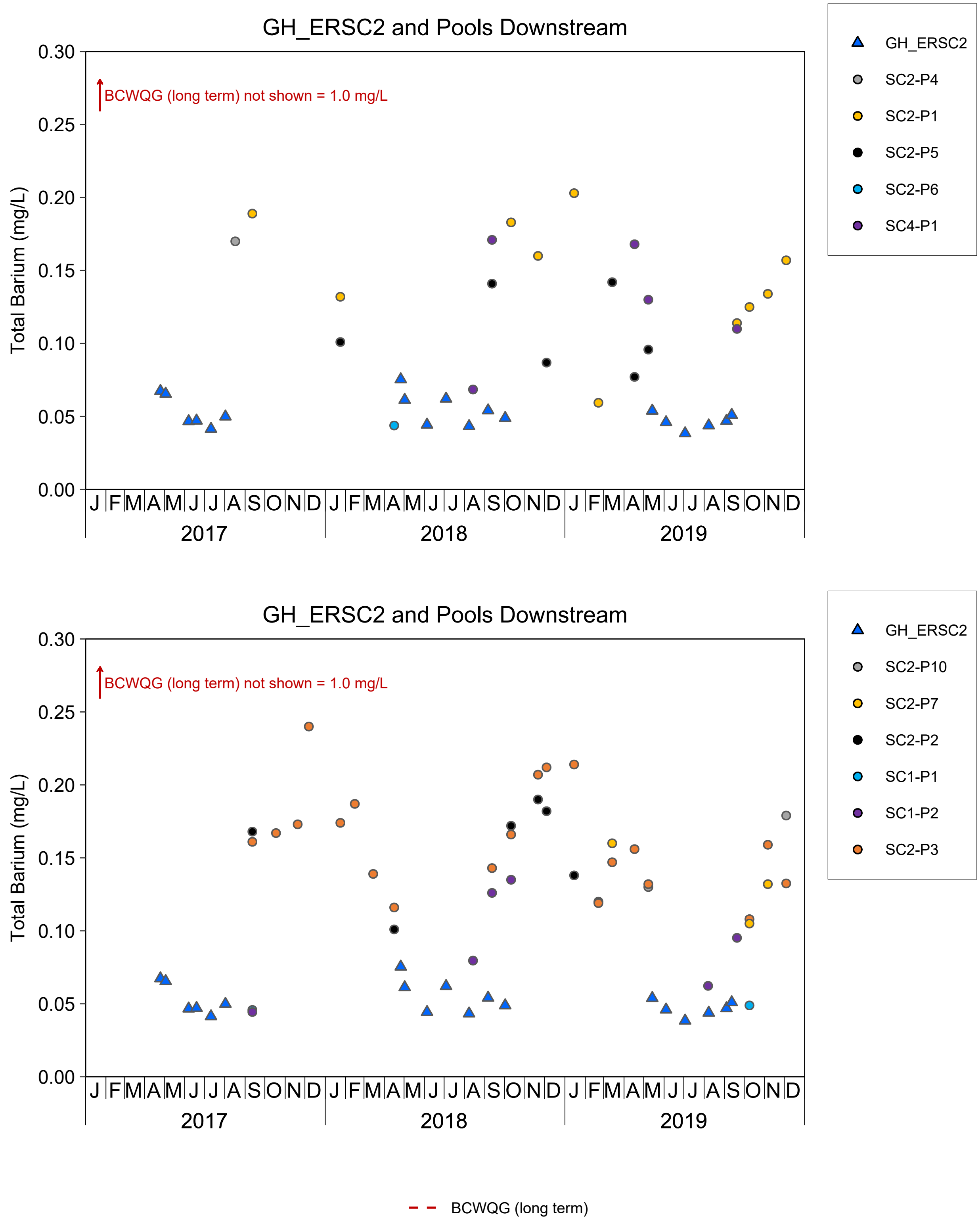


Figure C.60: **Time Series Plots for Total Barium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total barium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

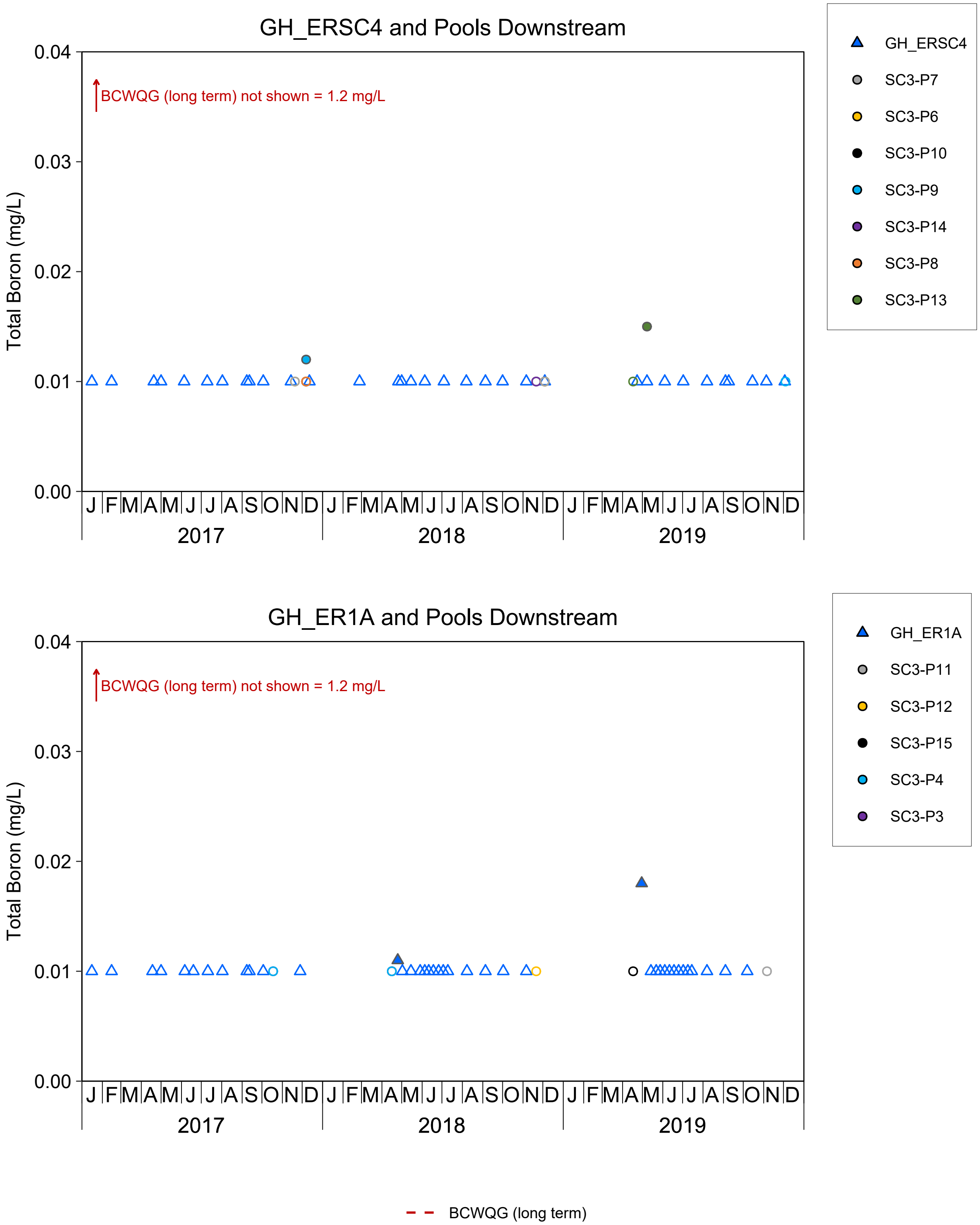
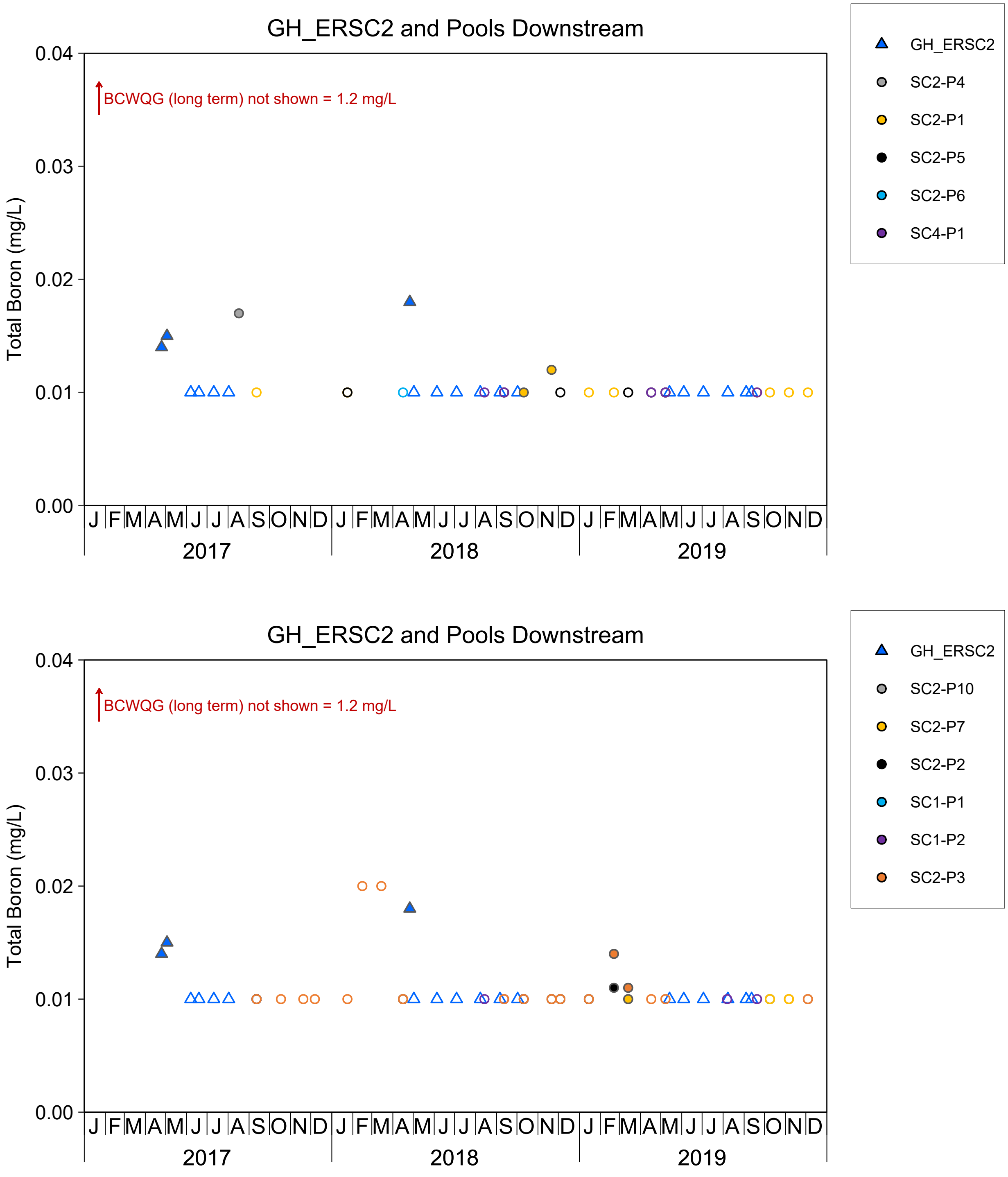


Figure C.61: **Time Series Plots for Total Boron Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).



– – BCWQG (long term)

Figure C.61: **Time Series Plots for Total Boron Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total boron was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

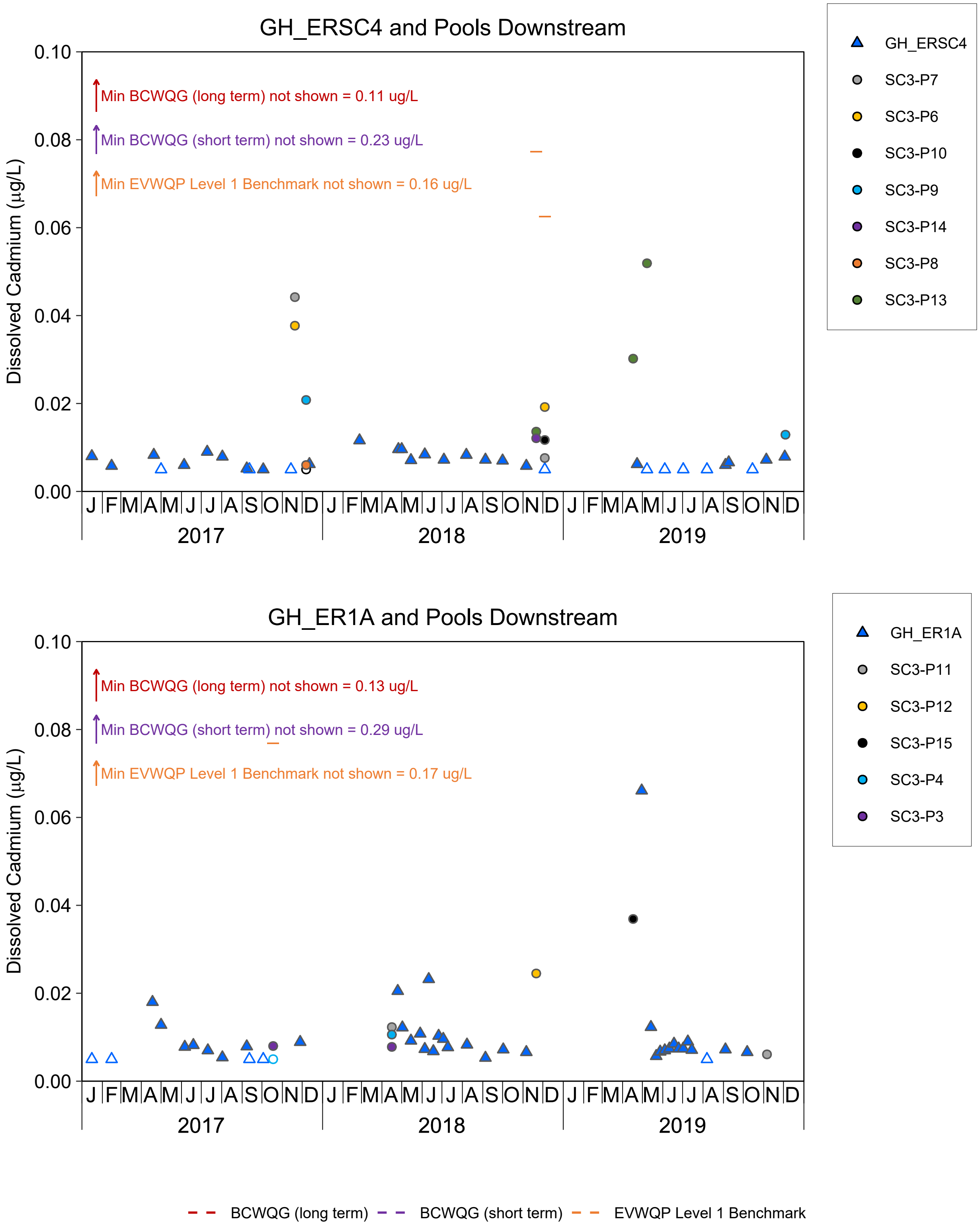


Figure C.62: **Time Series Plots for Dissolved Cadmium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

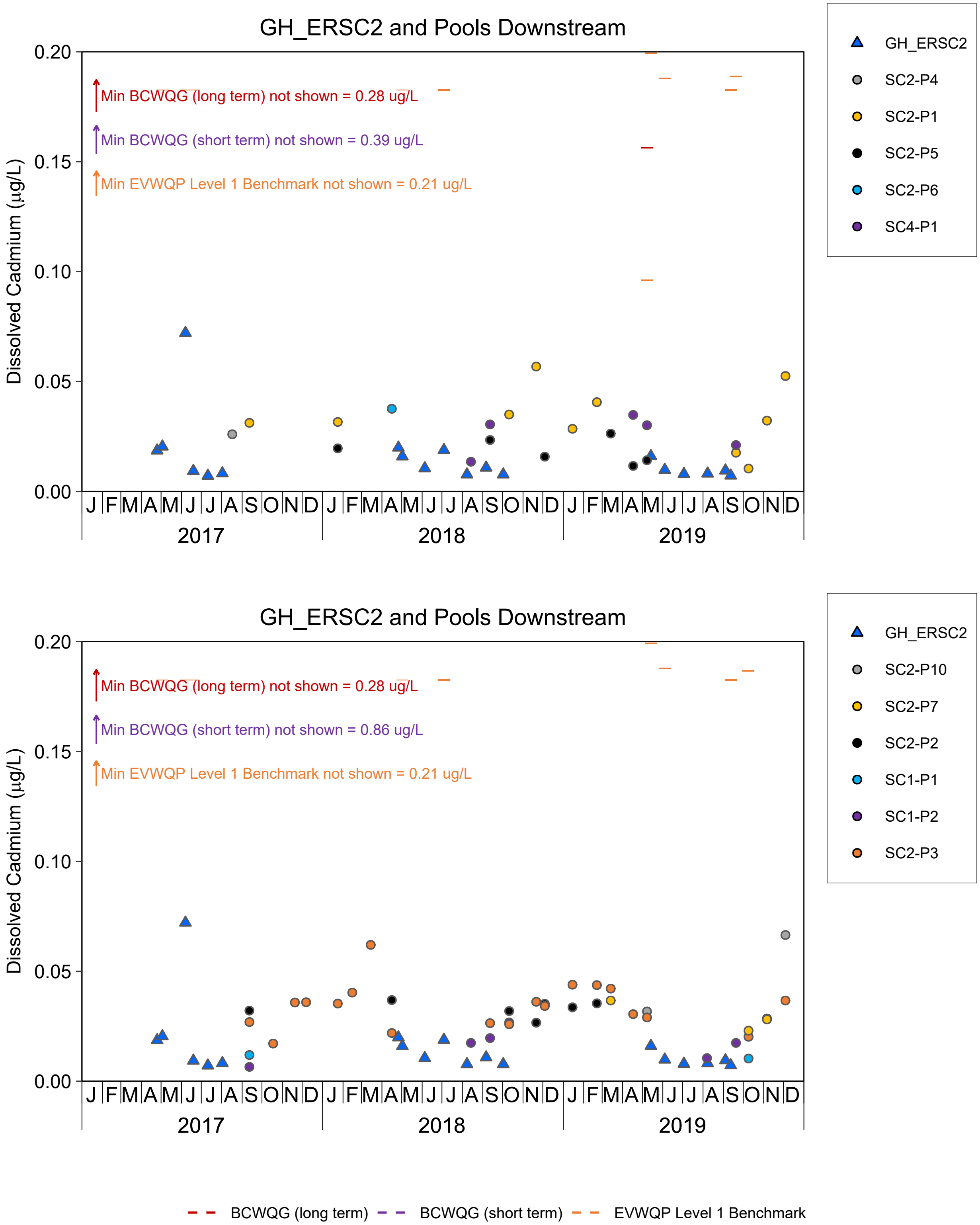
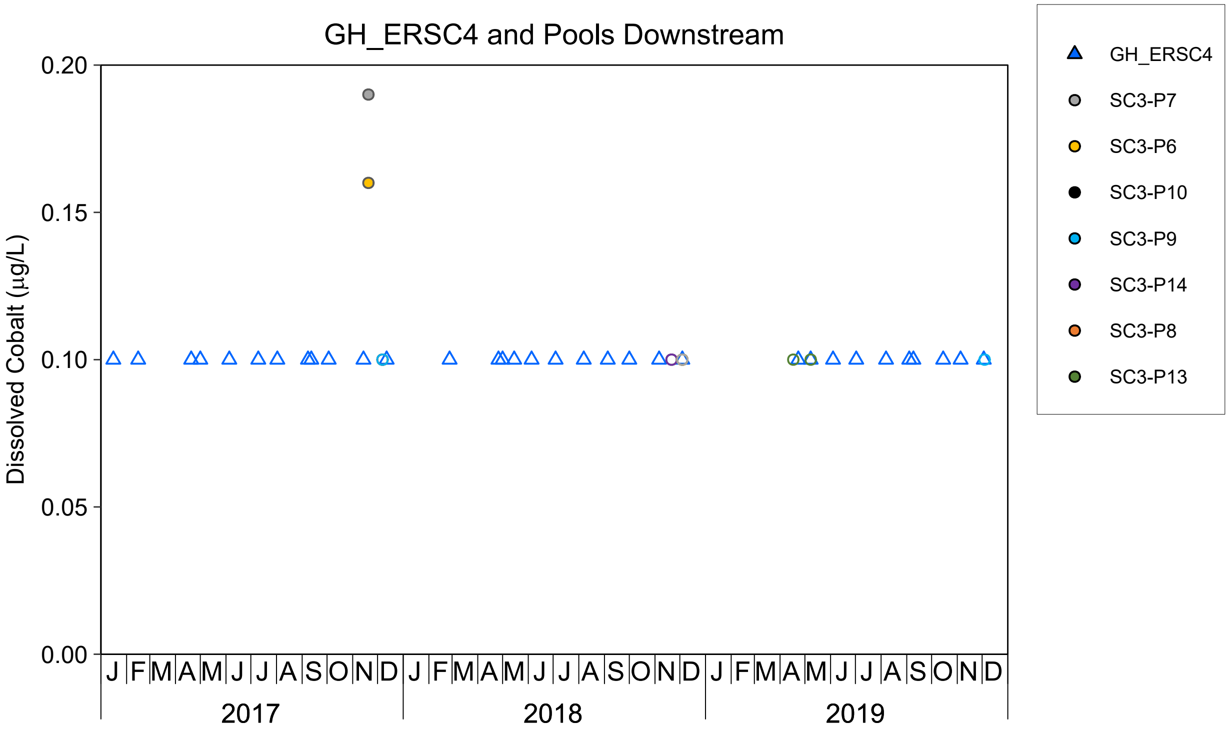


Figure C.62: **Time Series Plots for Dissolved Cadmium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Dissolved cadmium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).



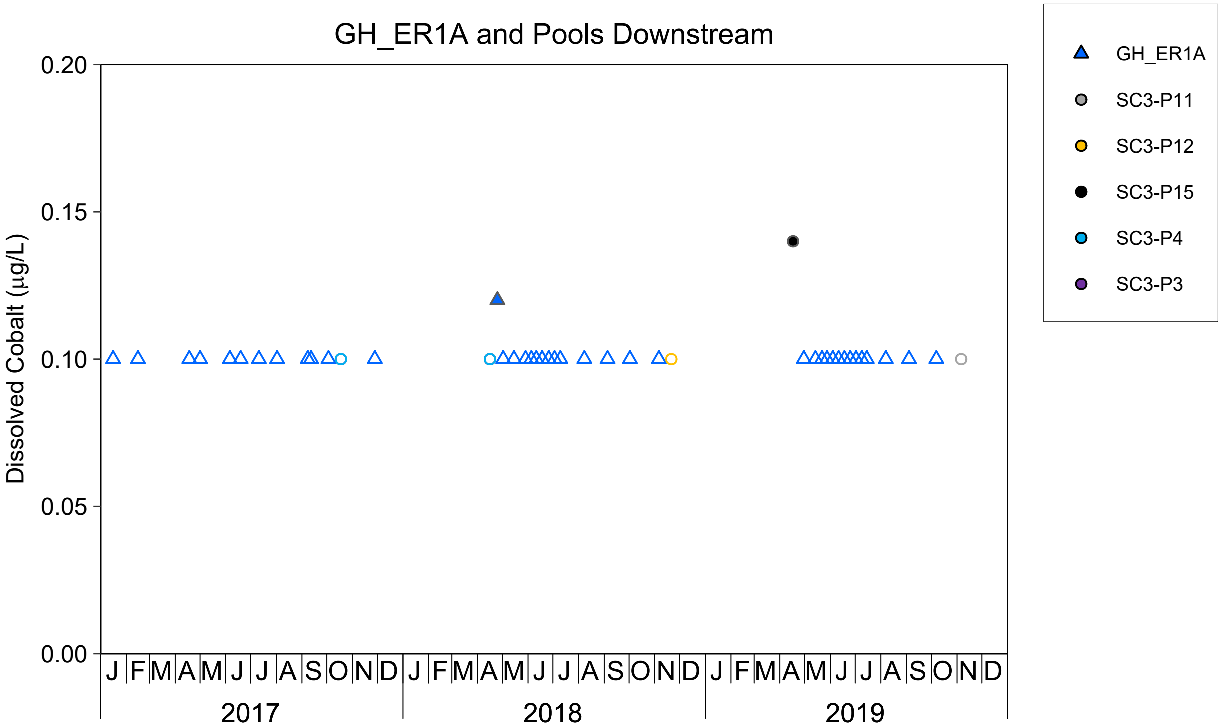
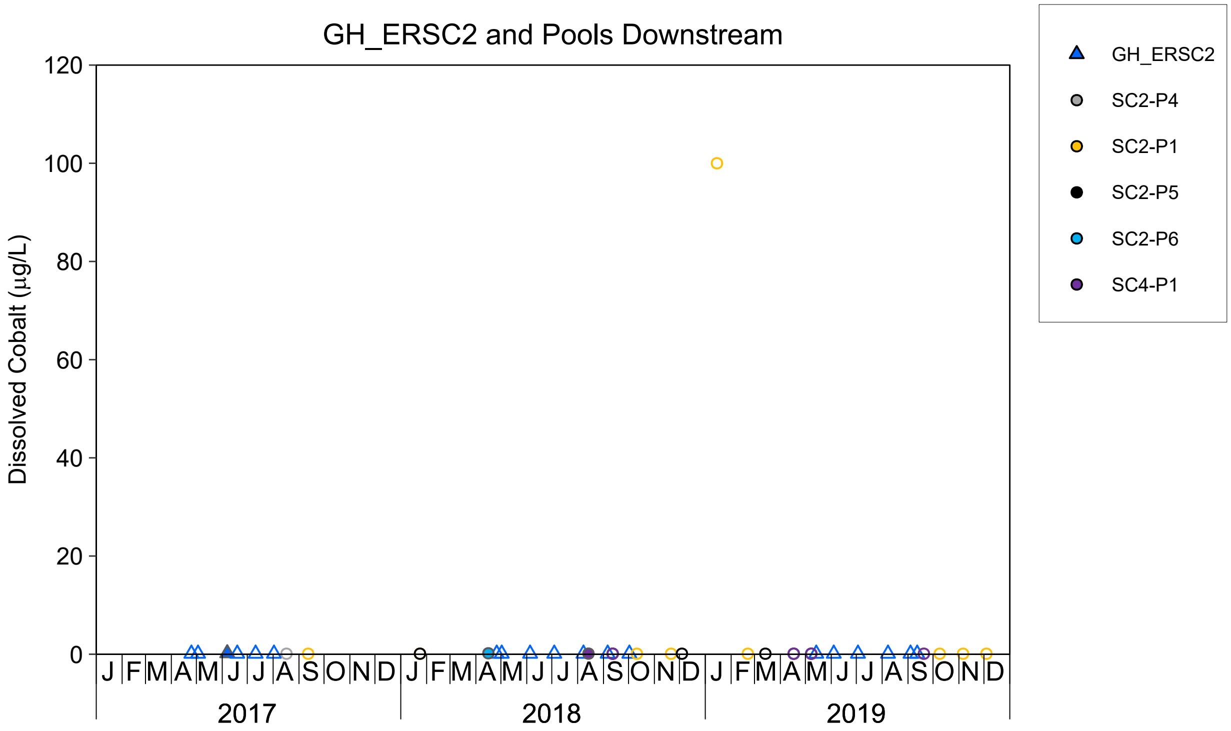


Figure C.63: Time Series Plots for Dissolved Cobalt Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.



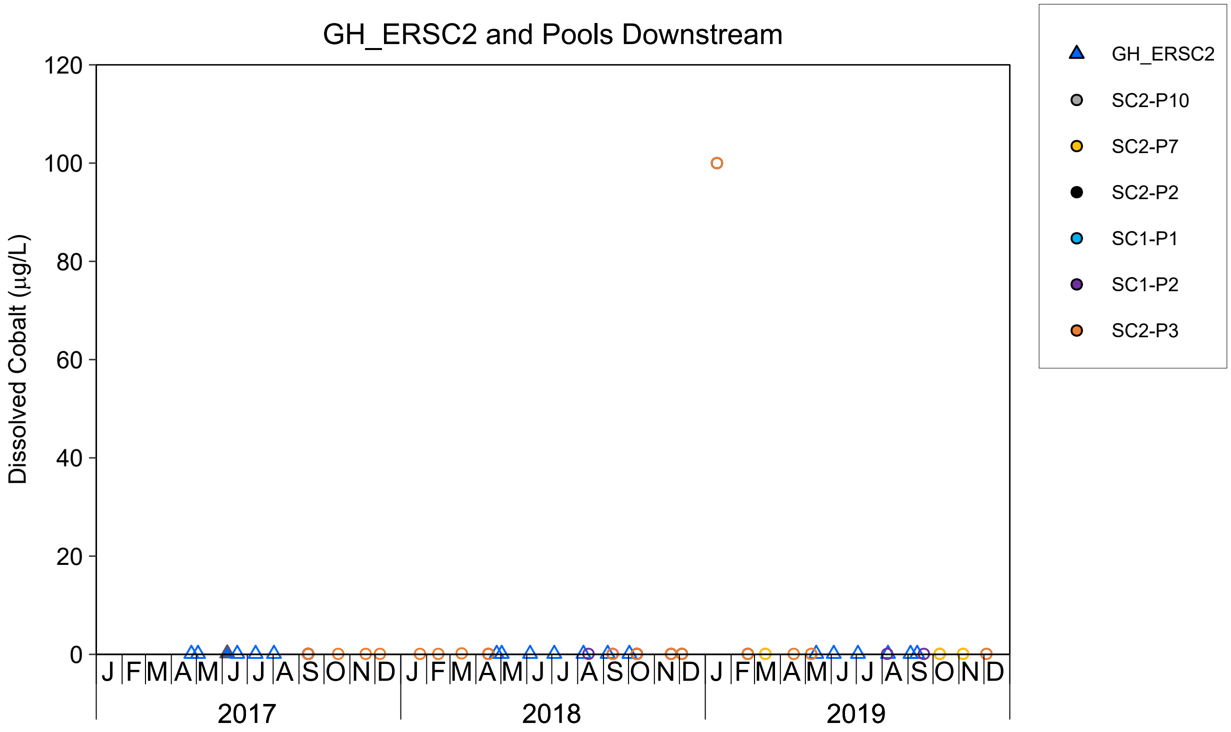
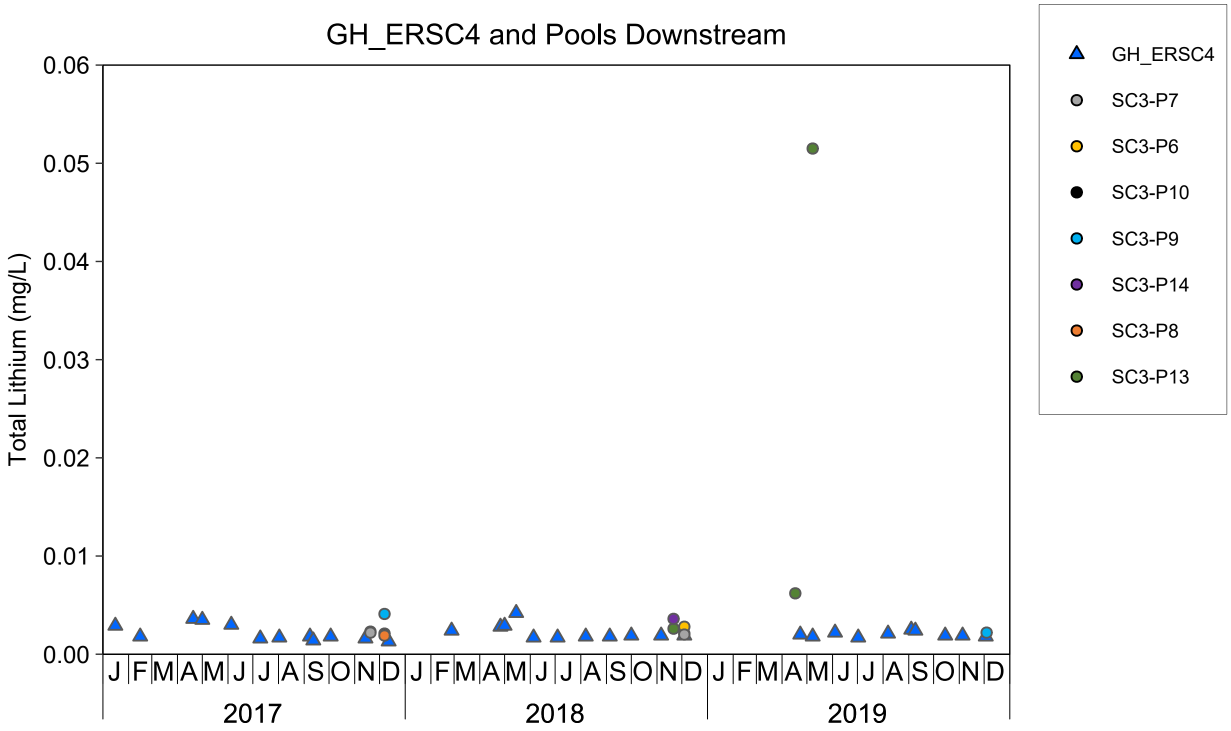


Figure C.63: Time Series Plots for Dissolved Cobalt Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Dissolved cobalt was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). No BCWQG or EVWQP benchmarks exist for dissolved cobalt. Long-term average BCWQG for total cobalt is 4 µg/L.



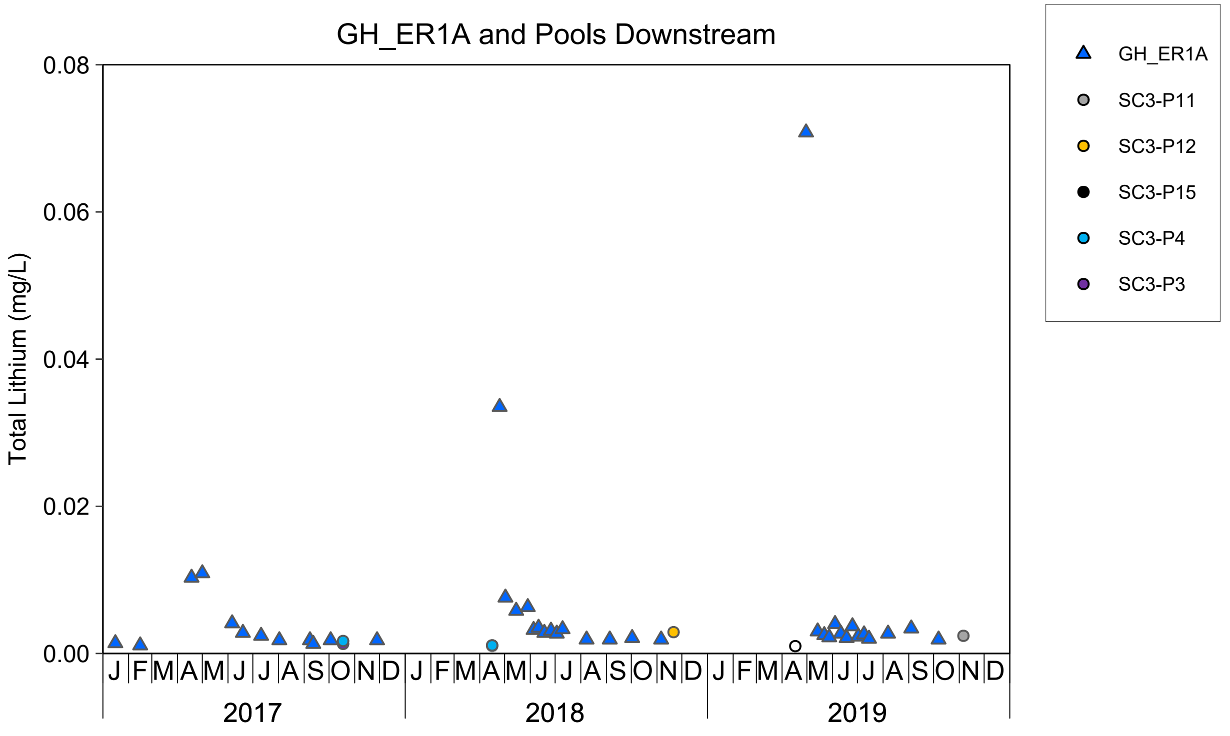
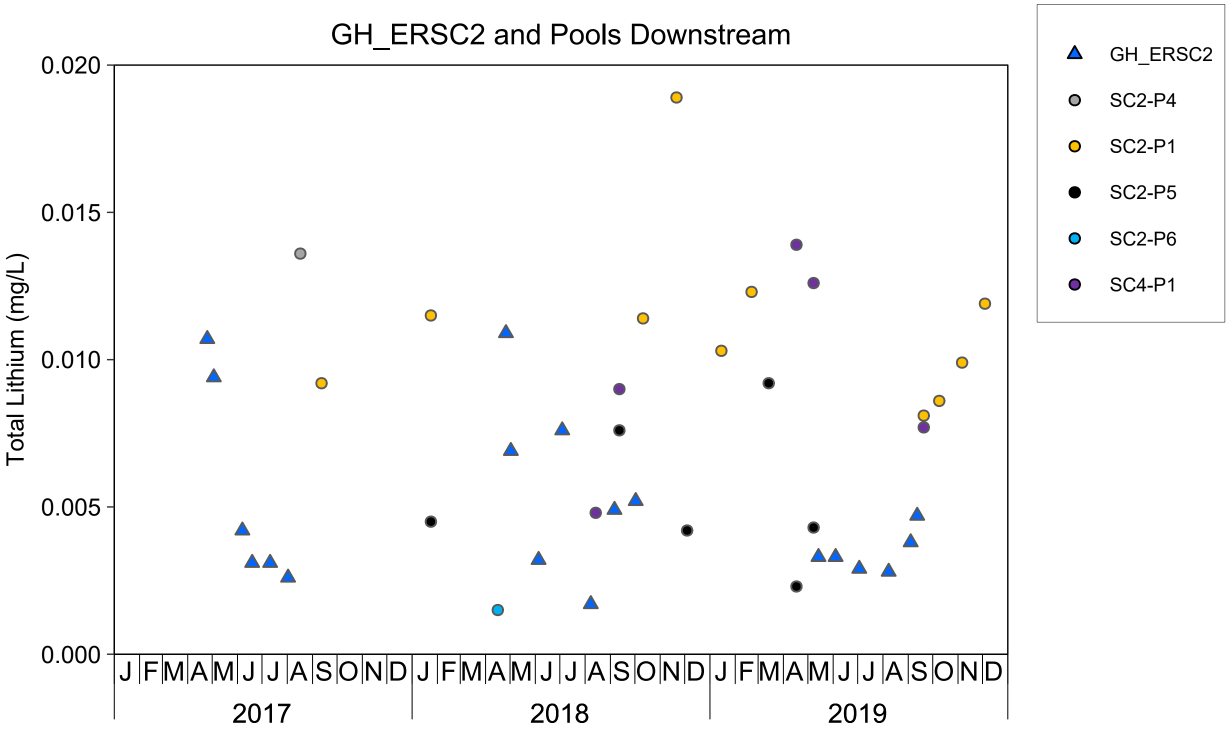


Figure C.64: Time Series Plots for Total Lithium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).



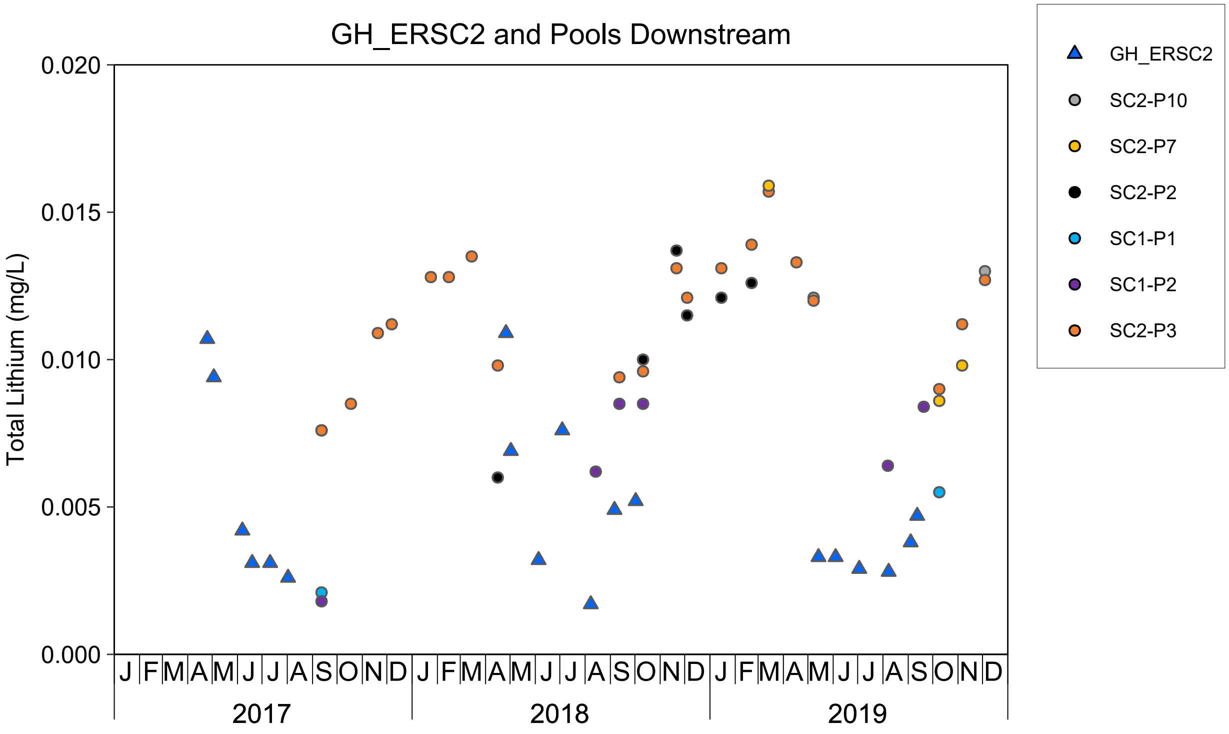


Figure C.64: Time Series Plots for Total Lithium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total lithium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

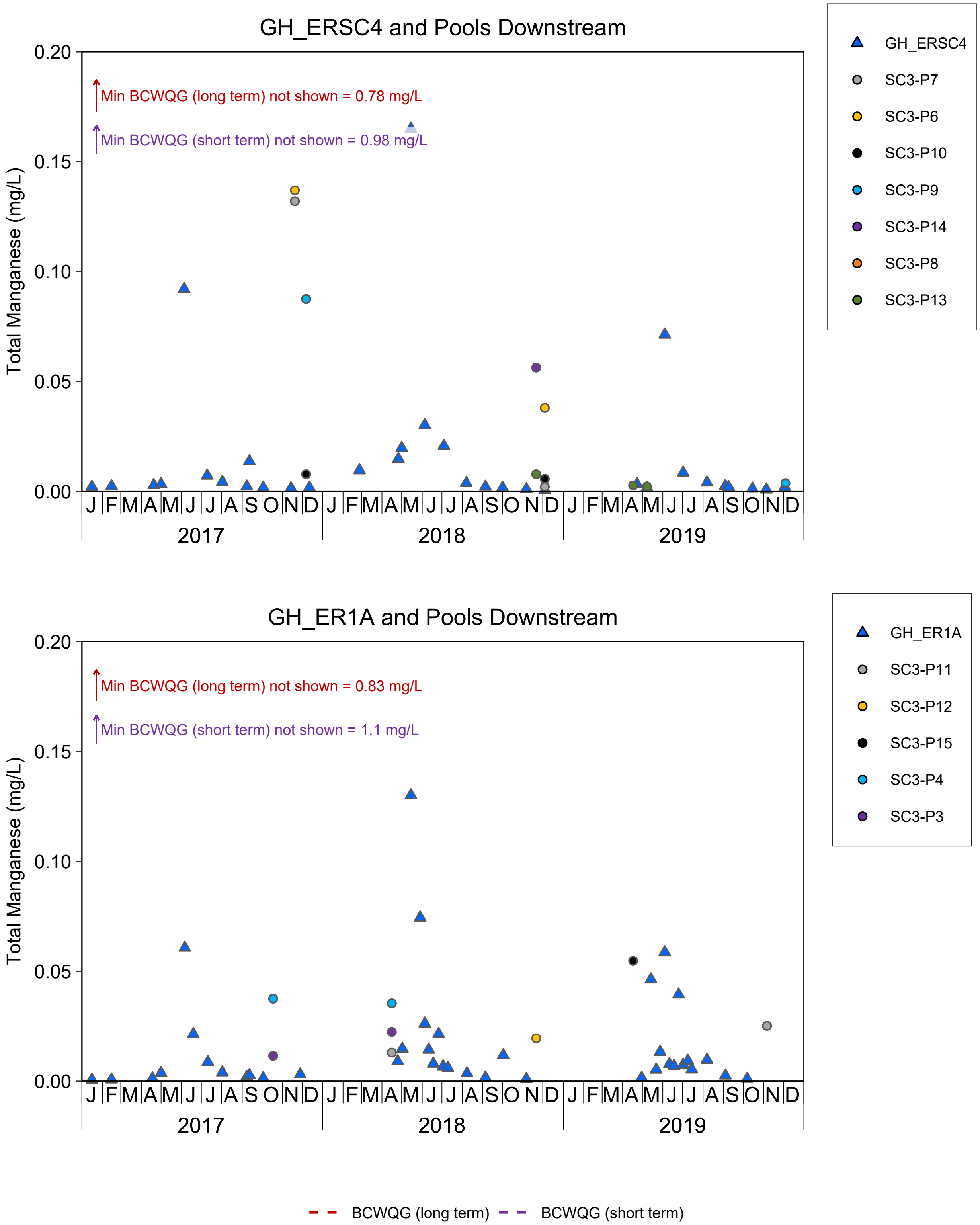


Figure C.65: Time Series Plots for Total Manganese Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

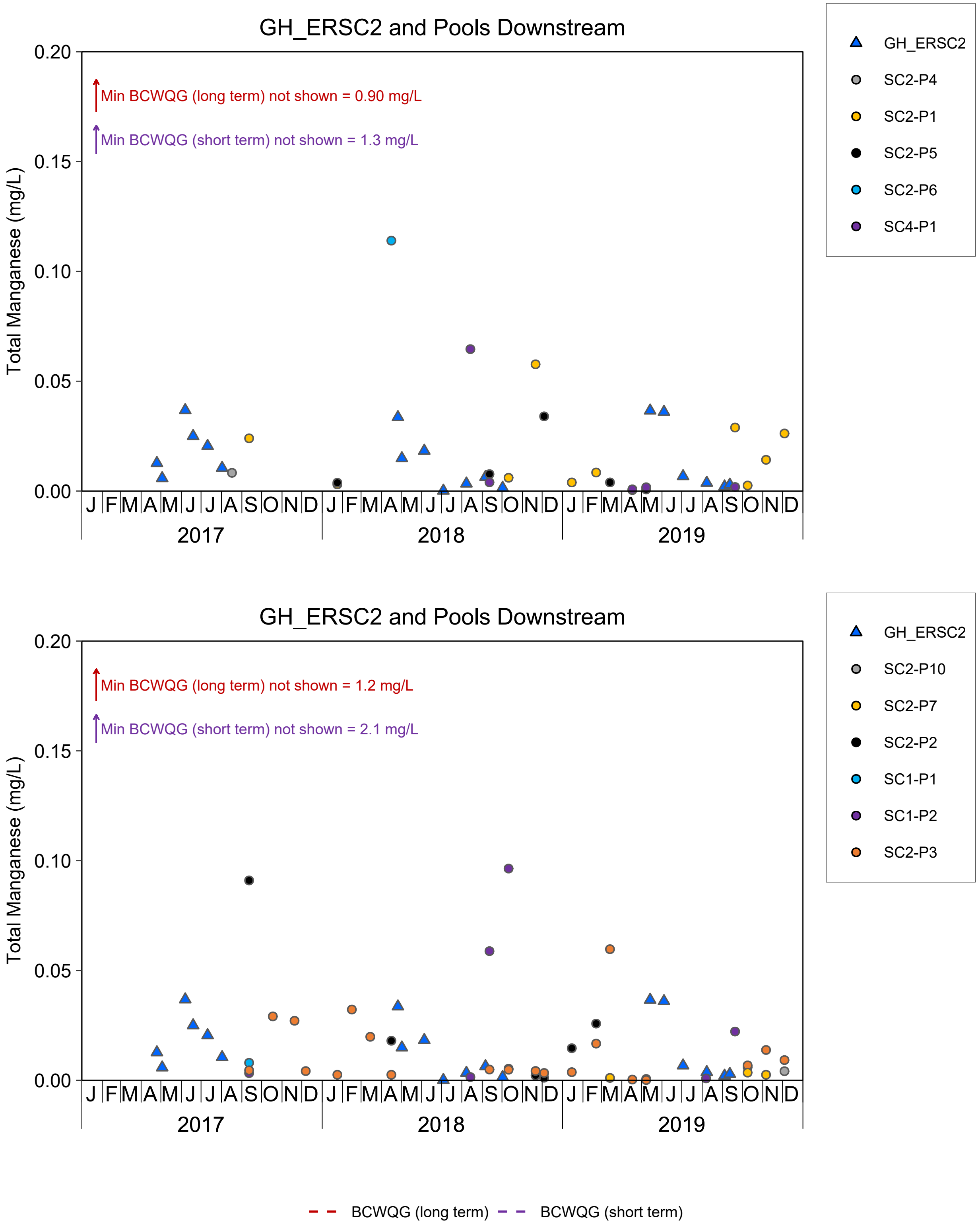


Figure C.65: **Time Series Plots for Total Manganese Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total manganese was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

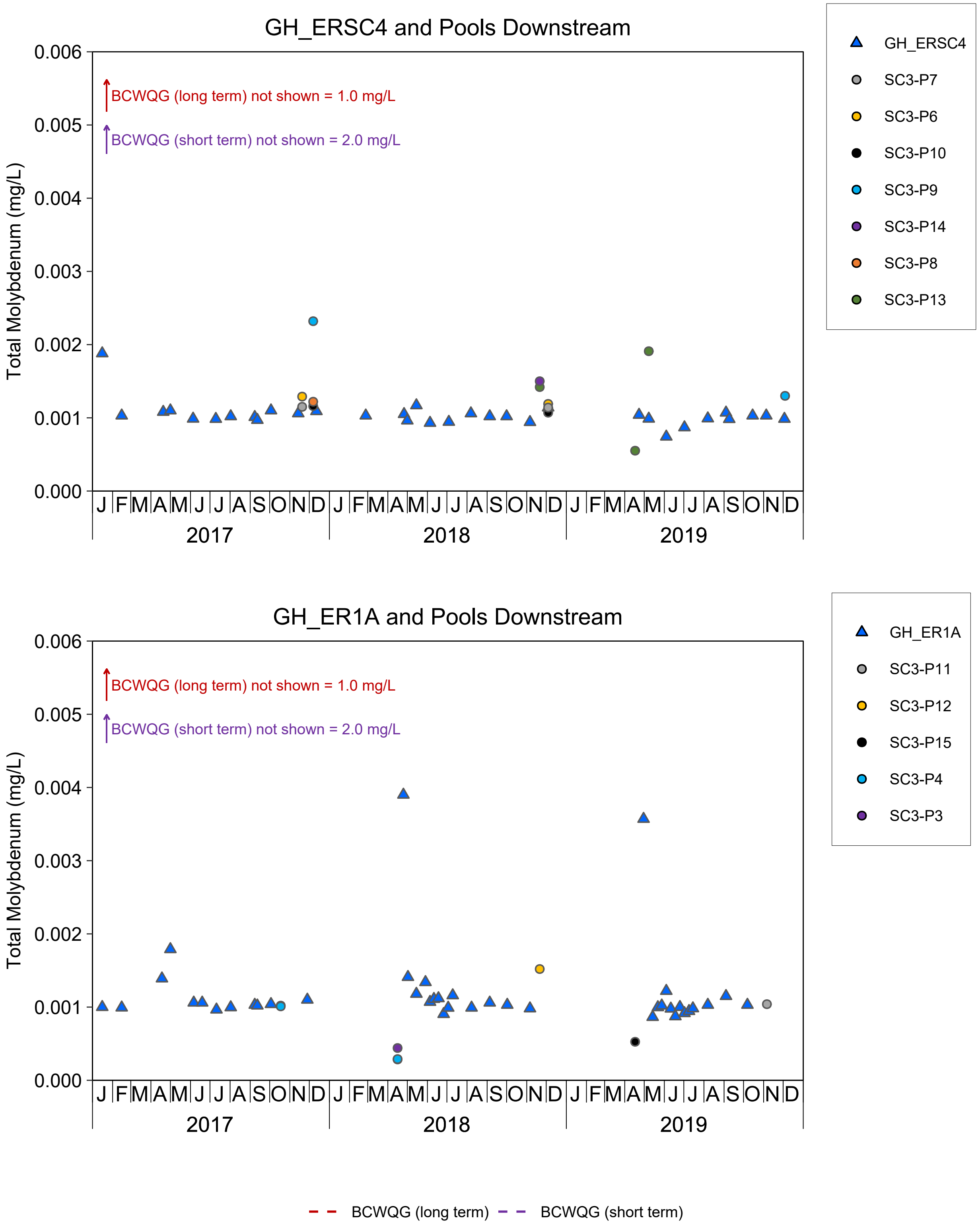


Figure C.66: **Time Series Plots for Total Molybdenum Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

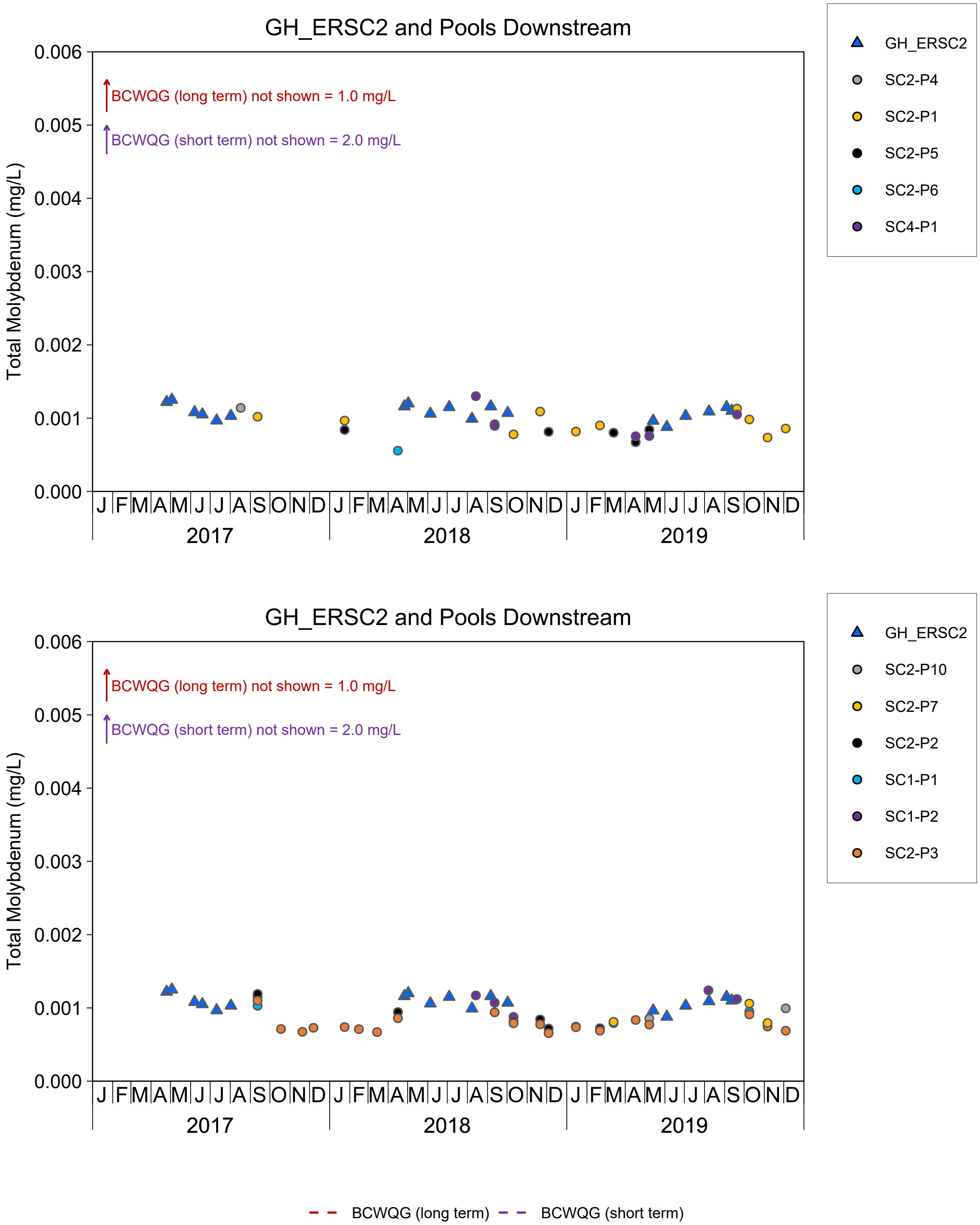


Figure C.66: **Time Series Plots for Total Molybdenum Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total molybdenum was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

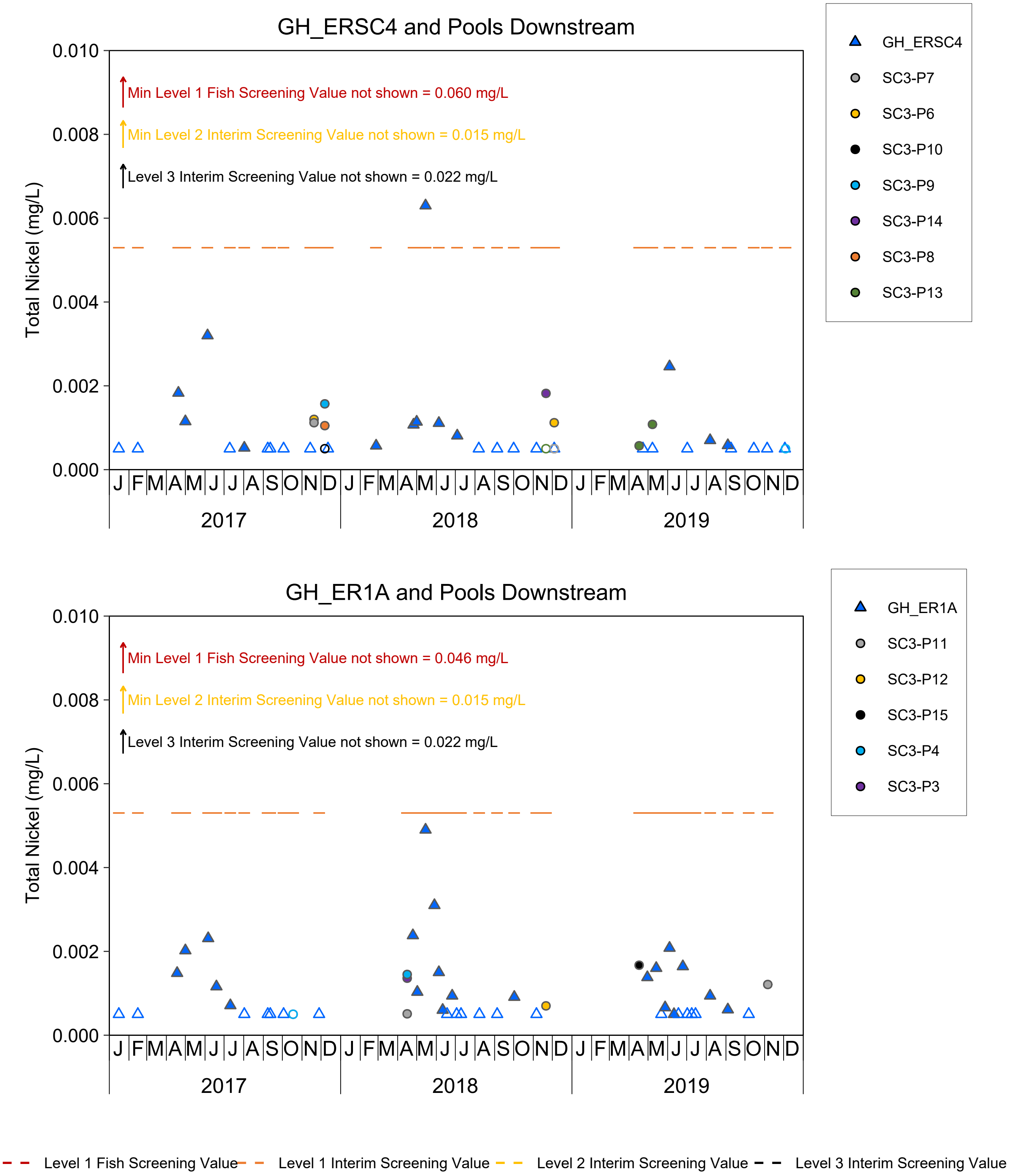


Figure C.67: **Time Series Plots for Total Nickel Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total Nickel was was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

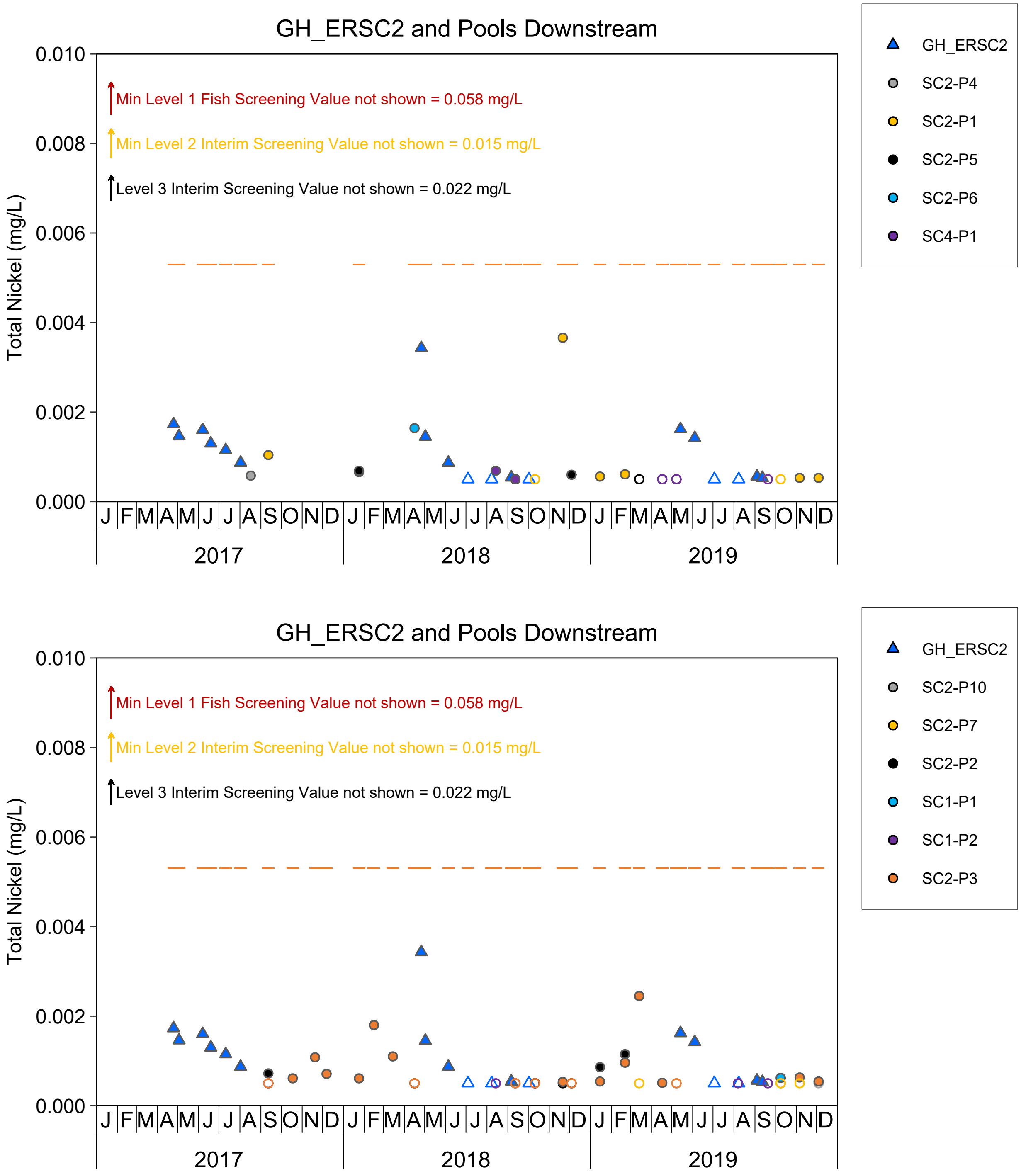


Figure C.67: **Time Series Plots for Total Nickel Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total Nickel was was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

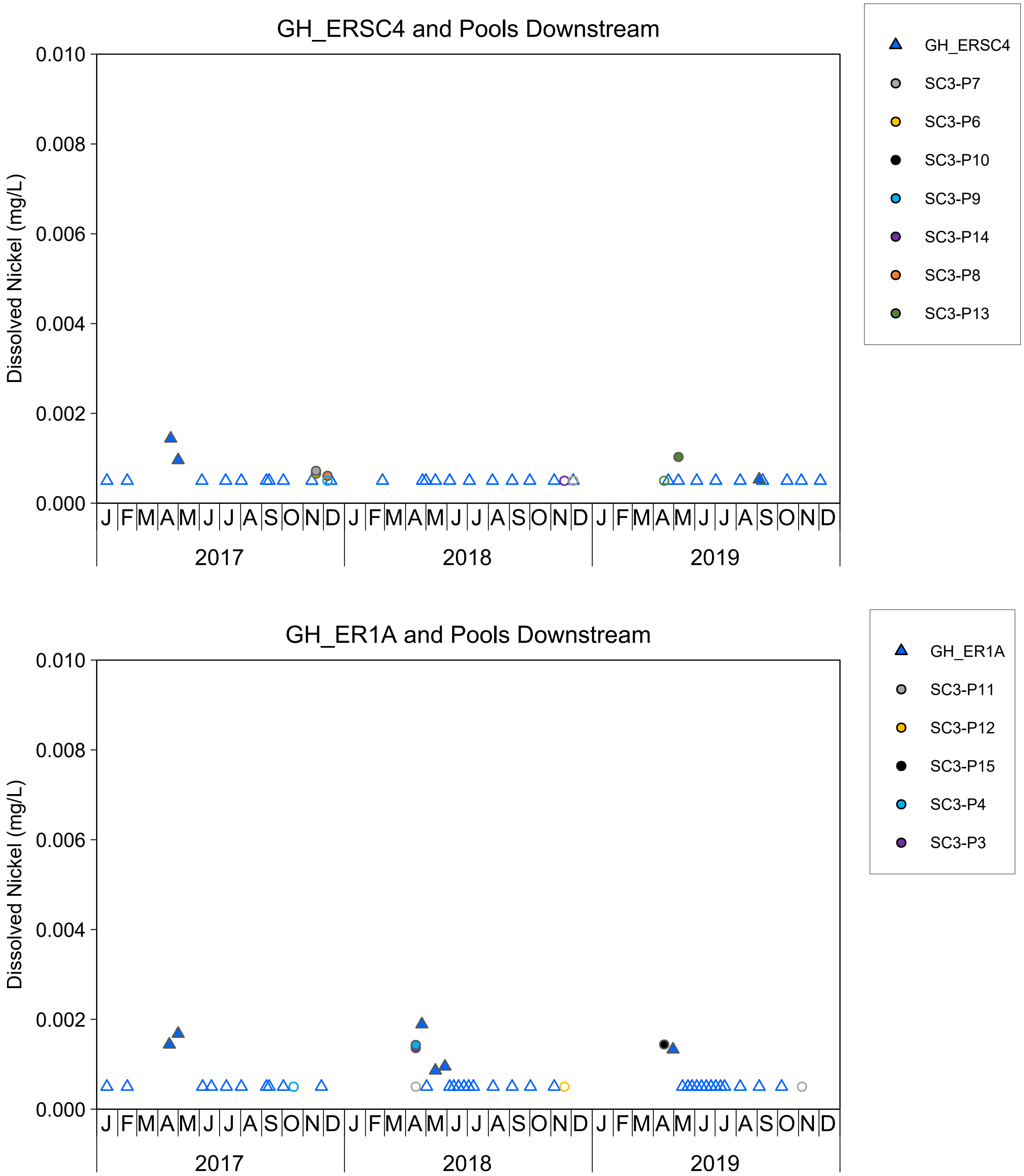


Figure C.68: Time Series Plots for Dissolved Nickel Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total nickel was plotted (see Figure C.67) because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is provided here for context on bioavailability. No BCWQG or EVWQP benchmarks exist for dissolved nickel. The level 1 interim screening value for total nickel is .0053 mg/L.

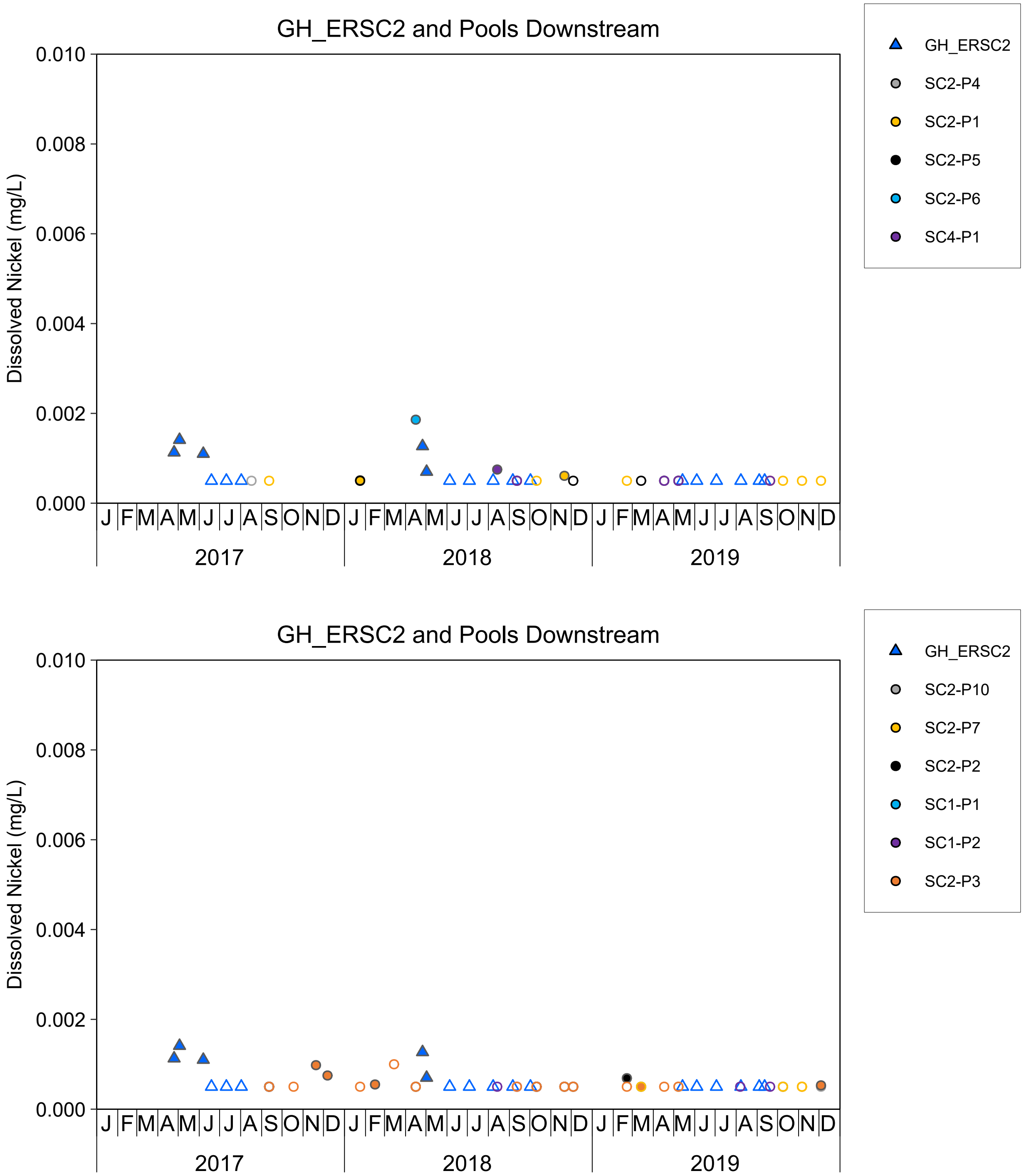


Figure C.68: Time Series Plots for Dissolved Nickel Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Total nickel was plotted (see Figure C.67) because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019). Dissolved nickel is provided here for context on bioavailability. No BCWQG or EVWQP benchmarks exist for dissolved nickel. The level 1 interim screening value for total nickel is .0053 mg/L.

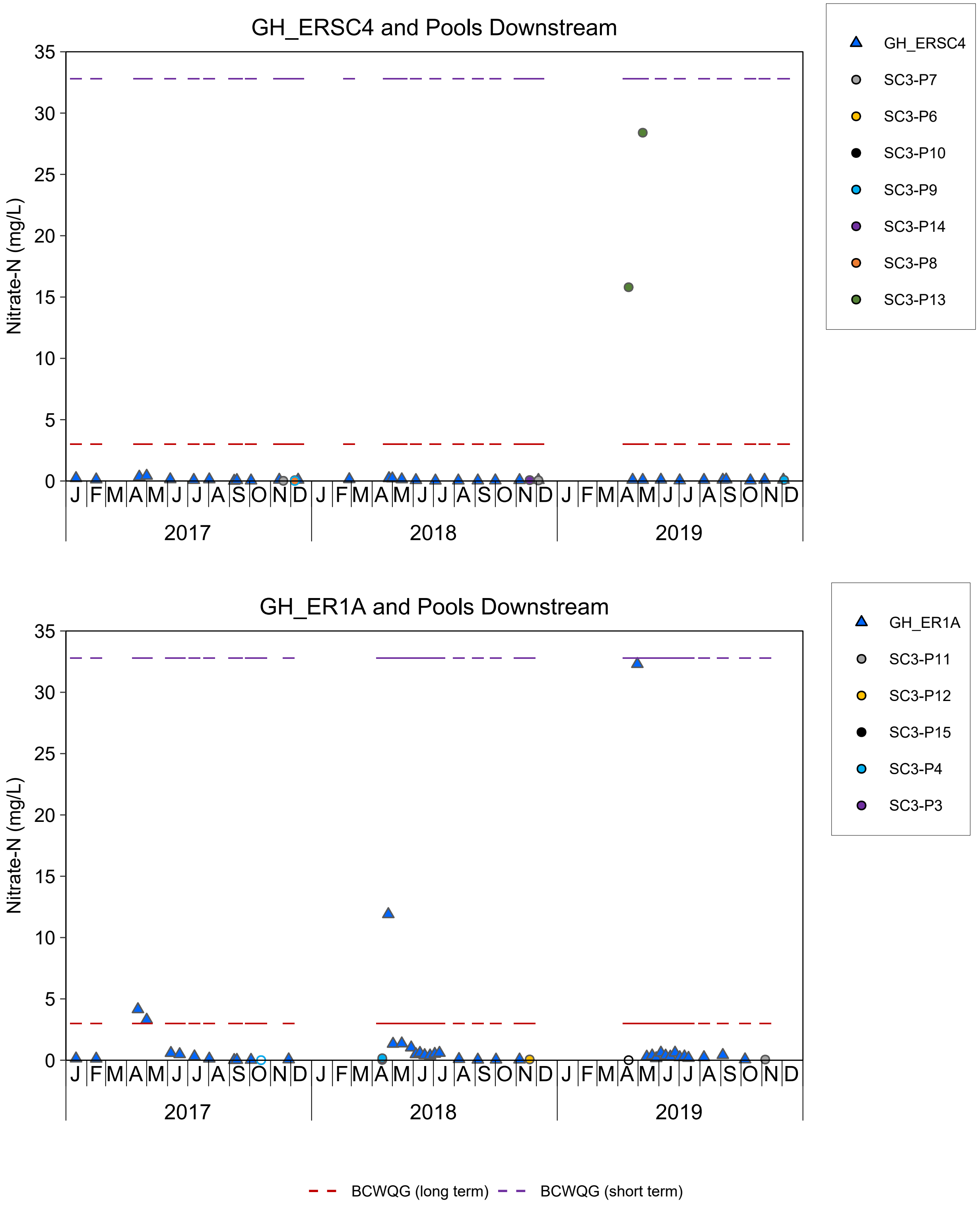


Figure C.69: **Time Series Plots for Nitrate-N Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Nitrate-N was was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

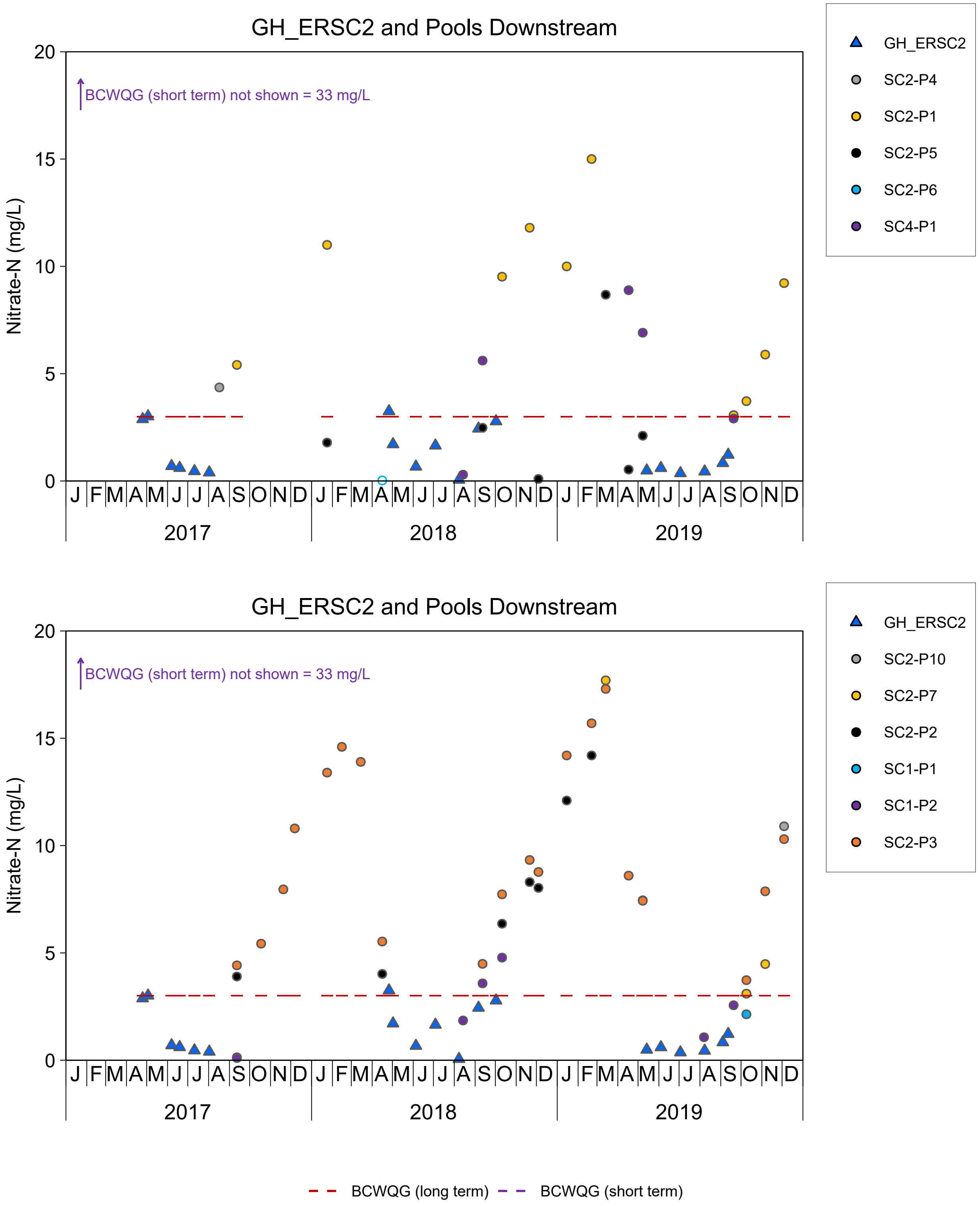


Figure C.69: Time Series Plots for Nitrate-N Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Nitrate-N was was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

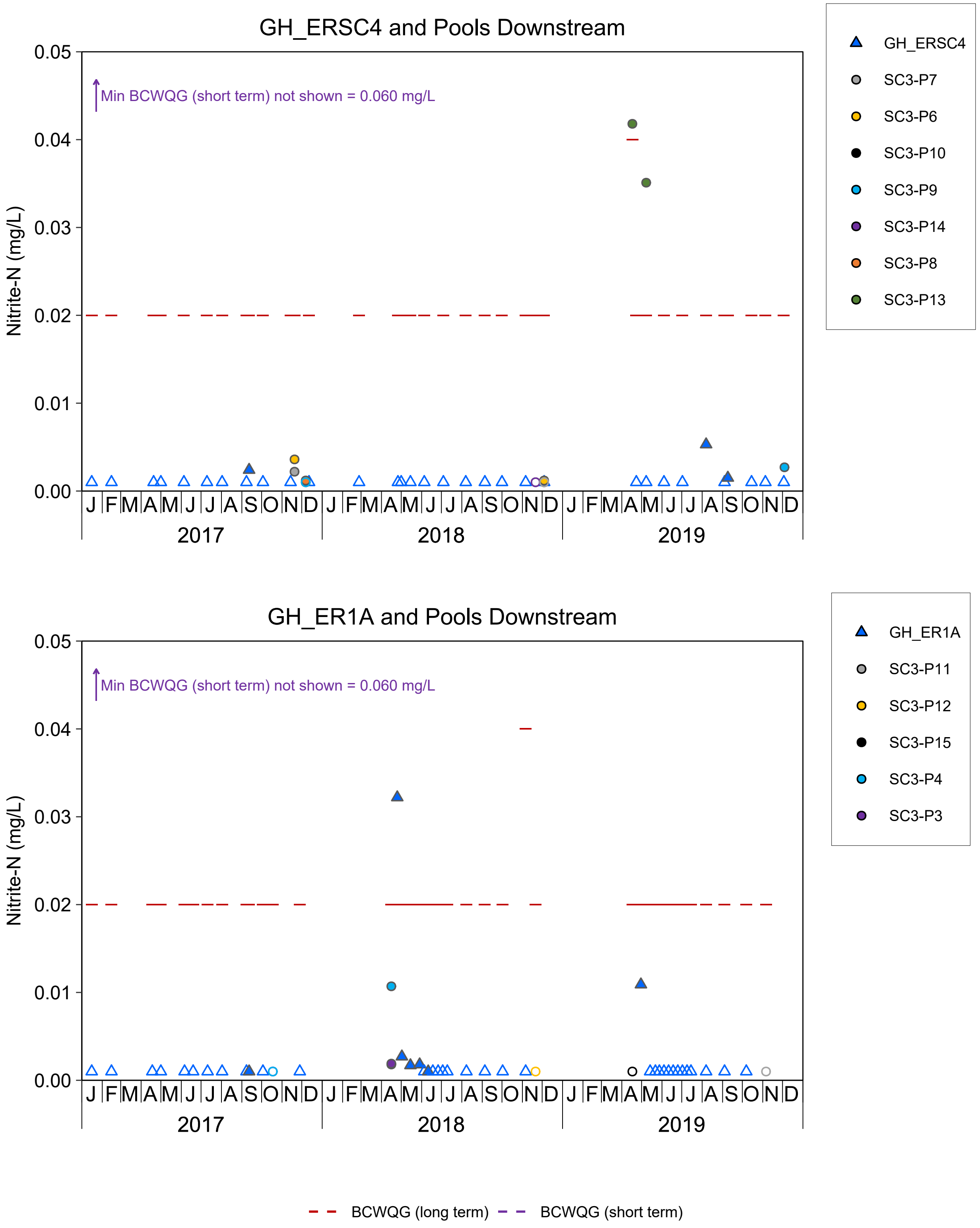


Figure C.70: **Time Series Plots for Nitrite-N Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019)

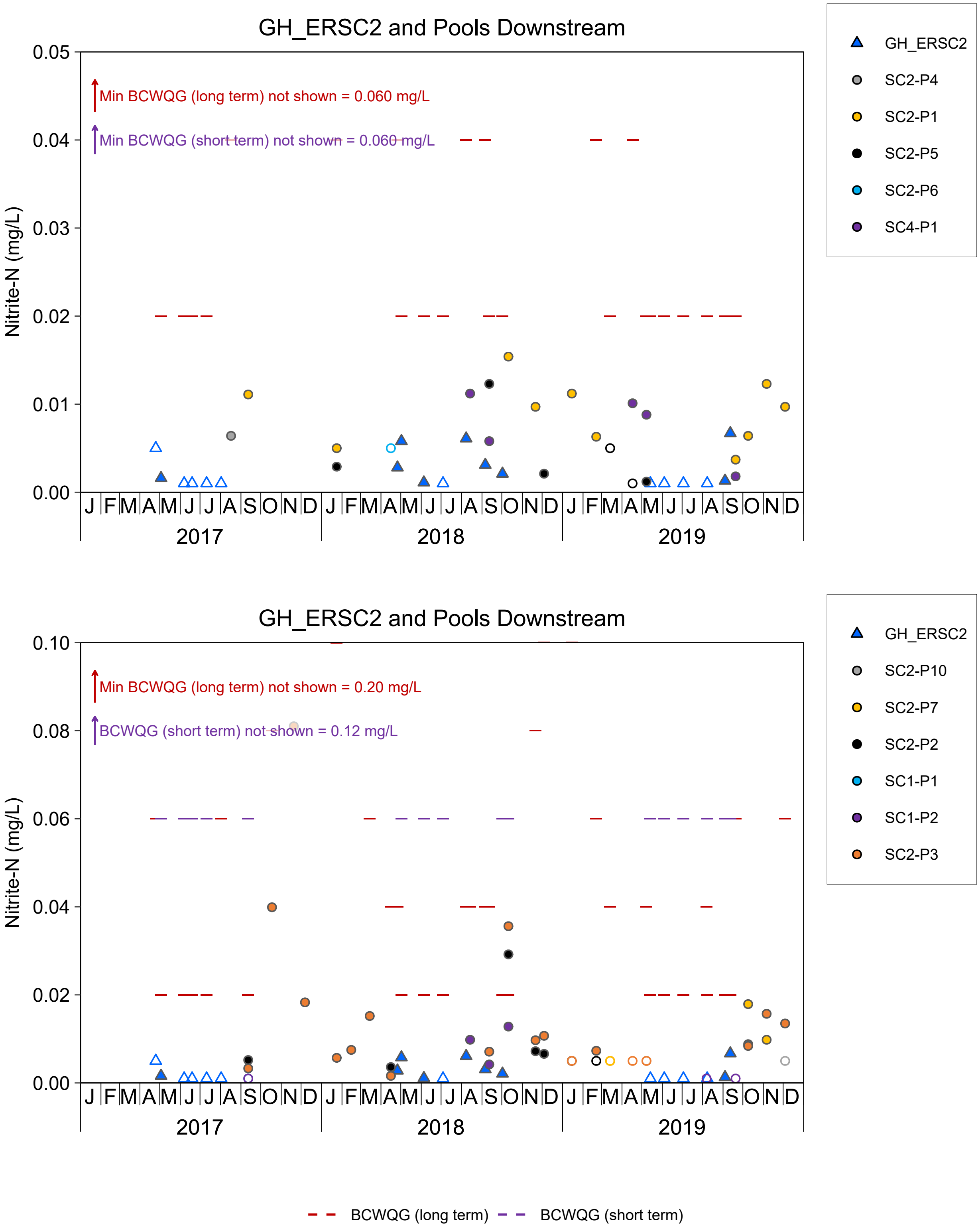
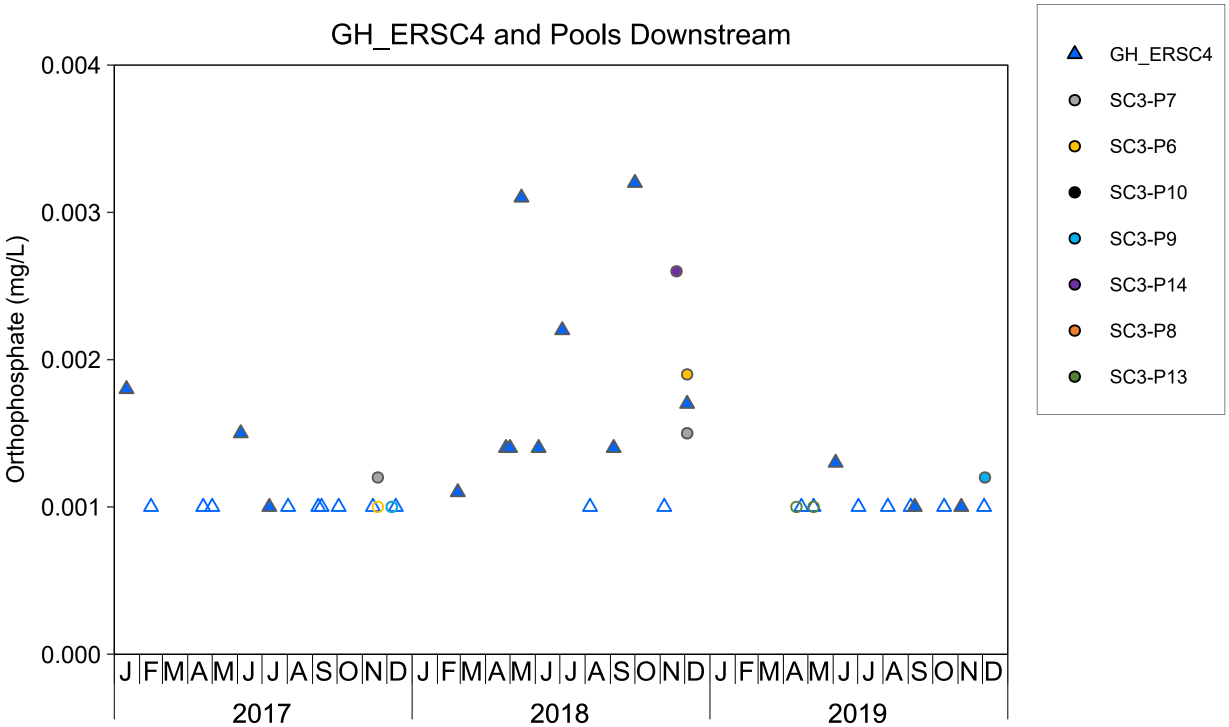


Figure C.70: **Time Series Plots for Nitrite-N Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Nitrite-N was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019)



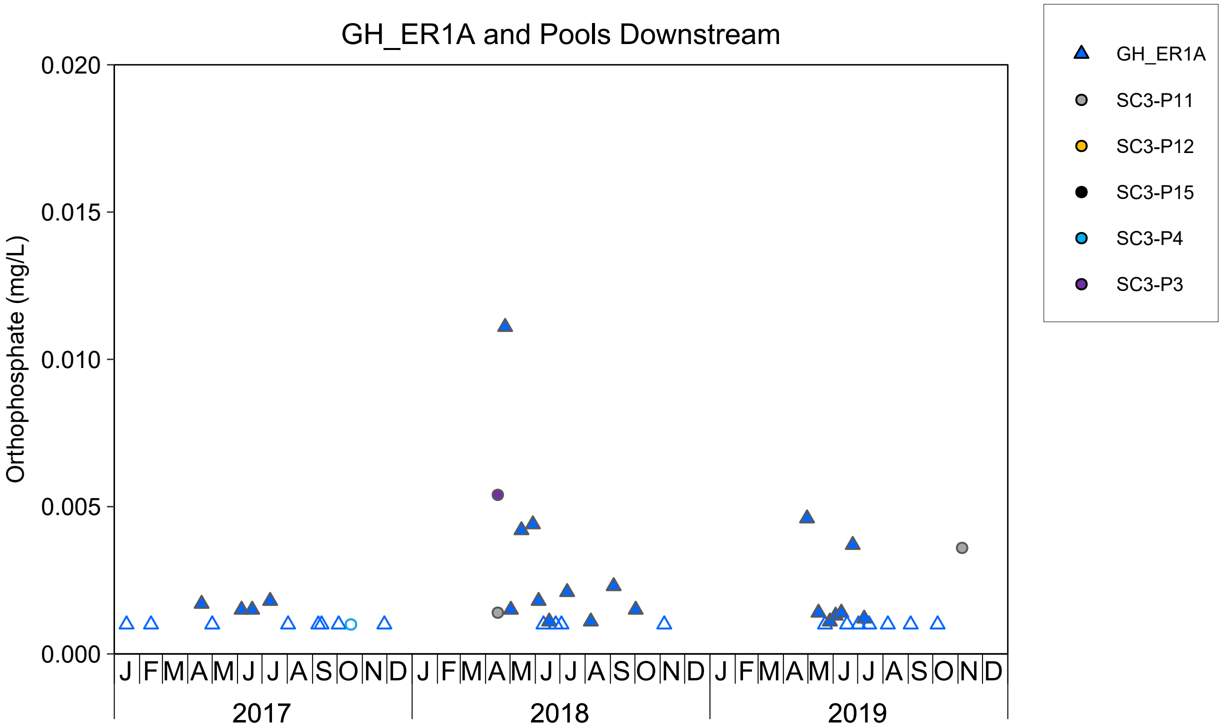
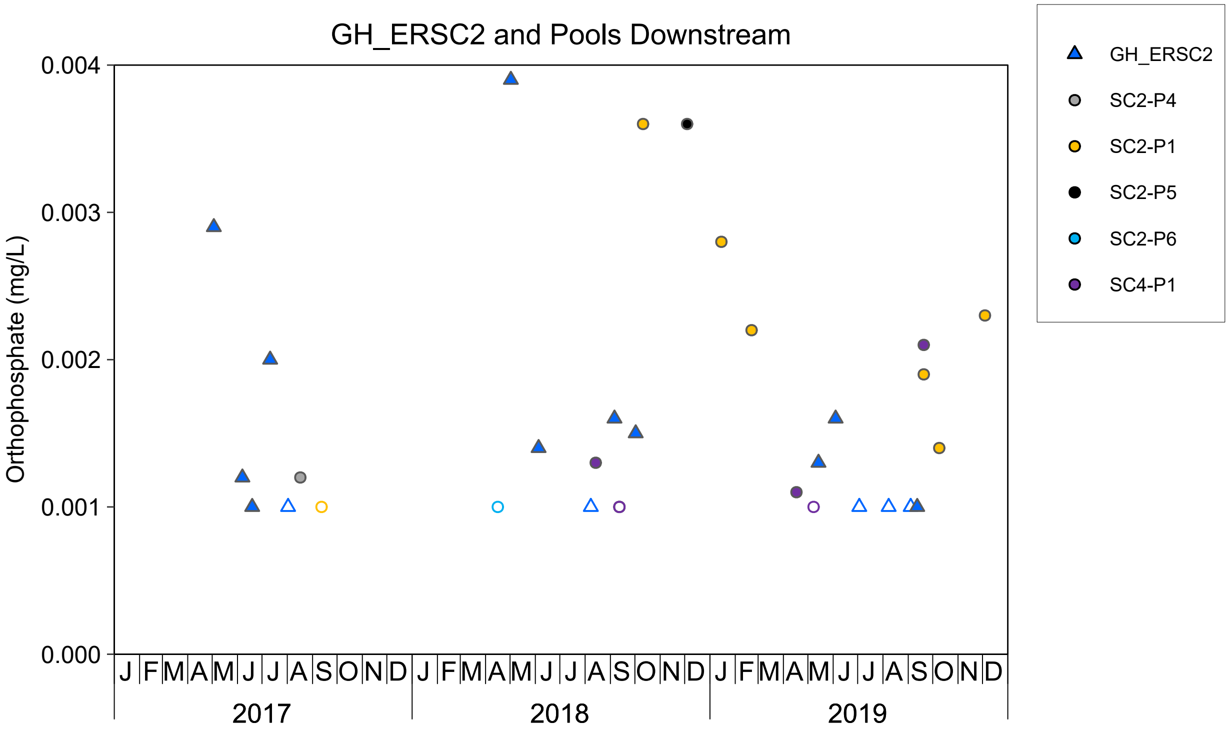


Figure C.71: Time Series Plots for Orthophosphate Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.



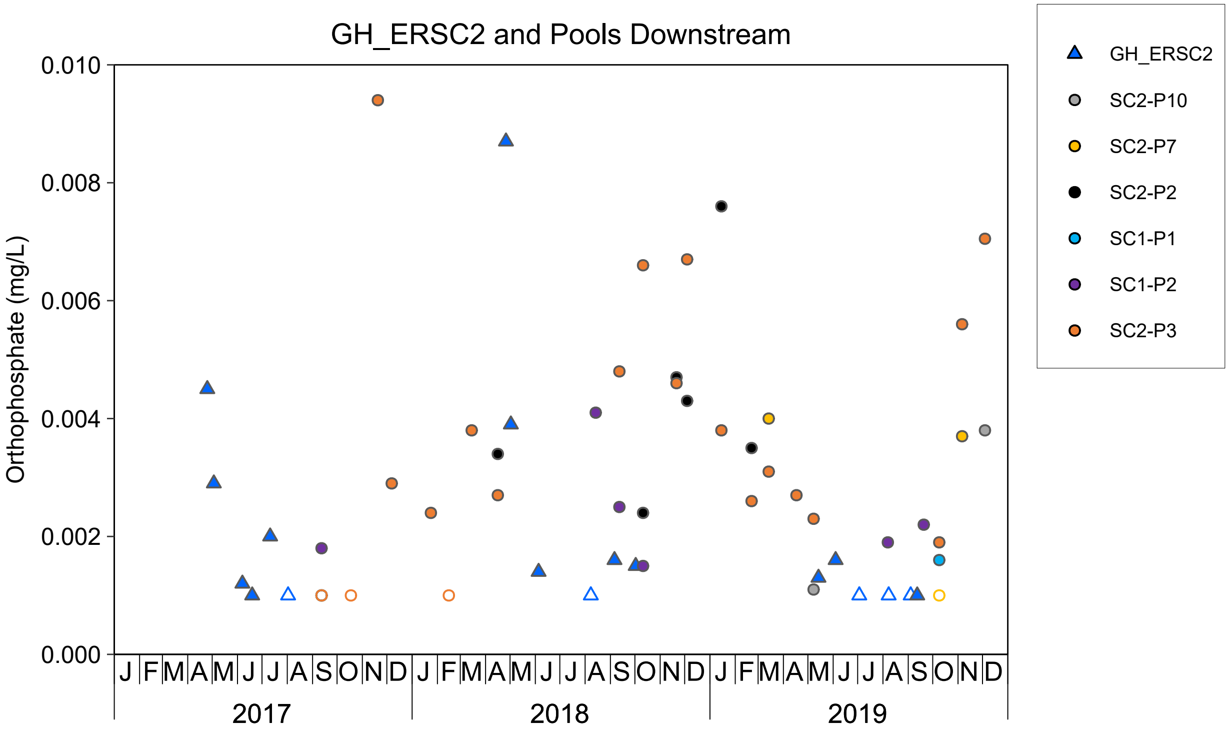
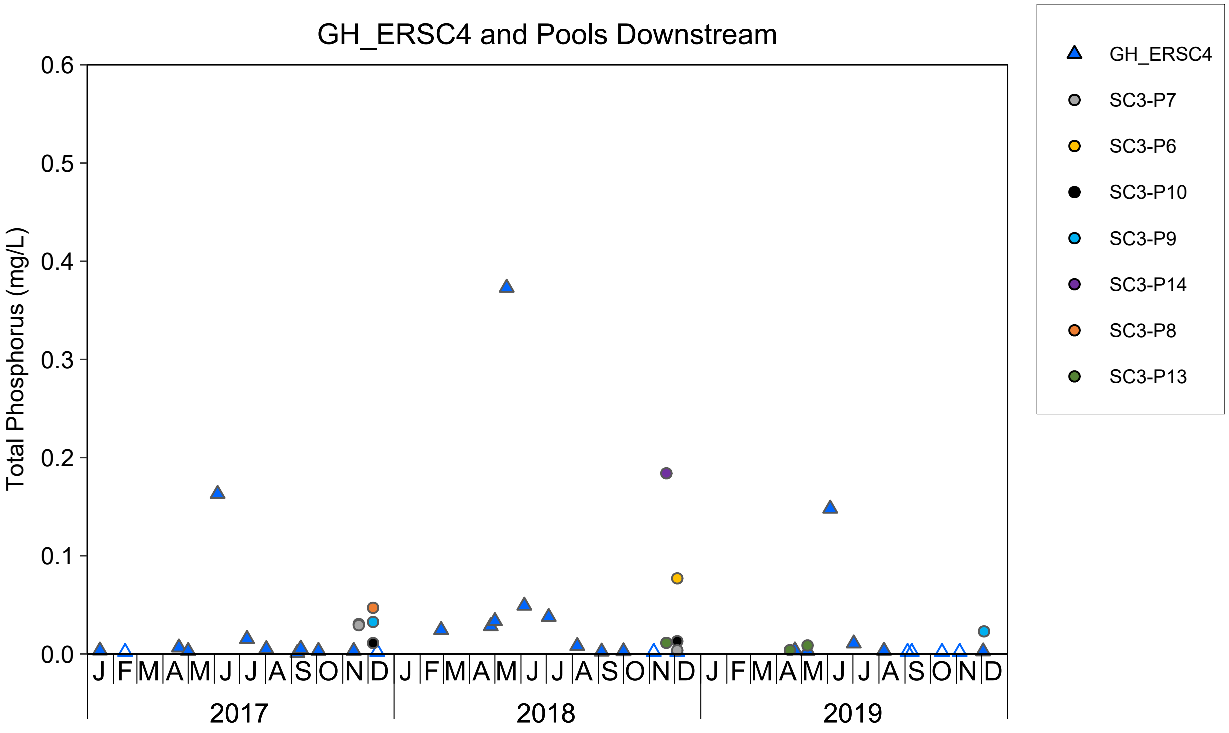


Figure C.71: Time Series Plots for Orthophosphate Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Orthophosphate was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.



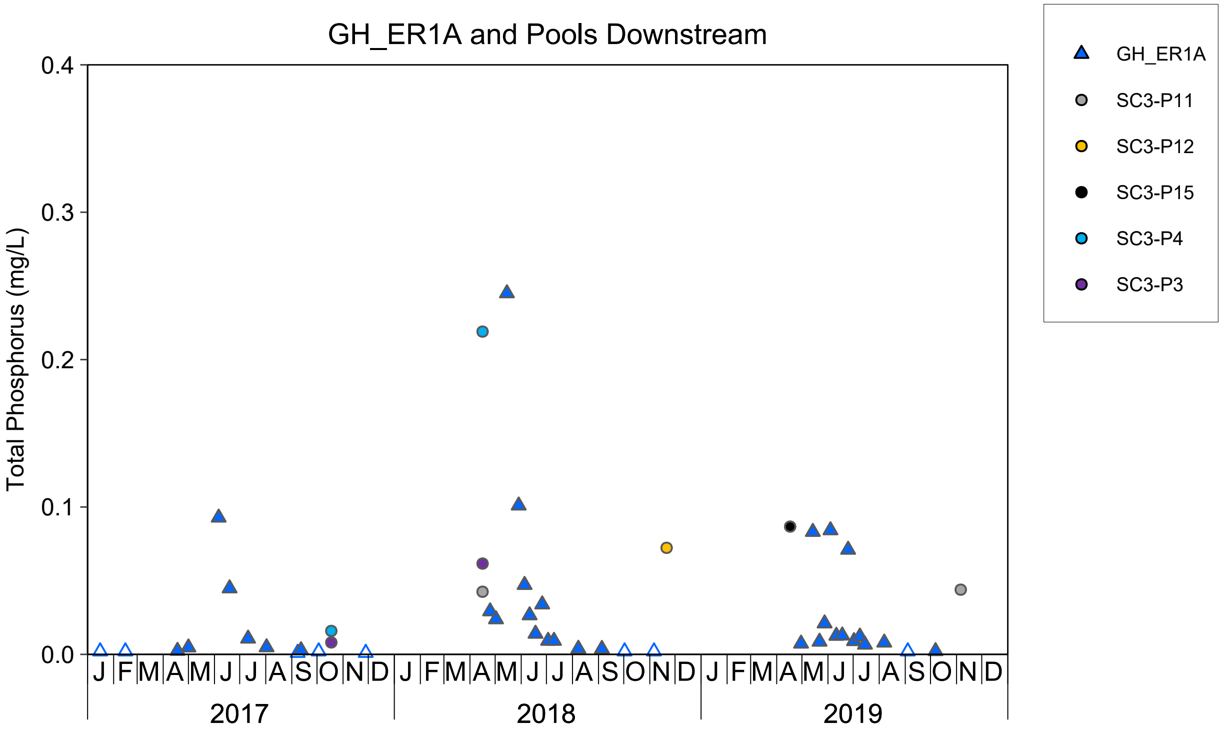
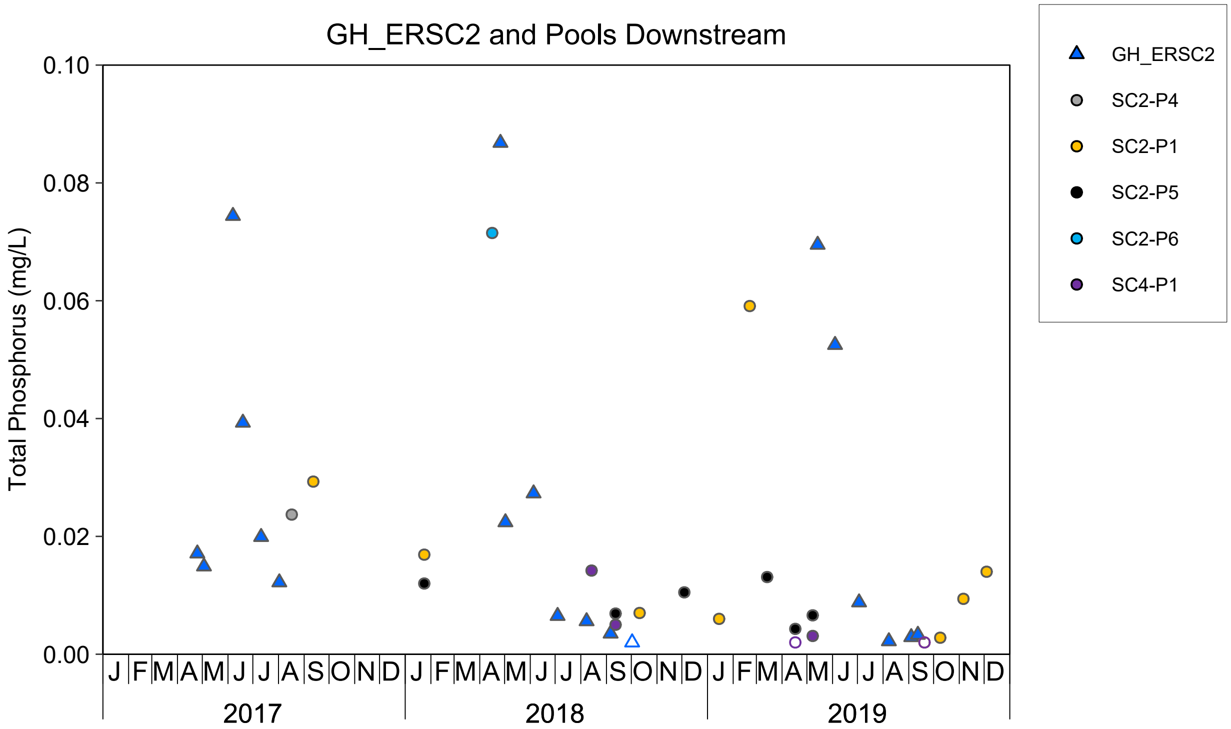


Figure C.72: **Time Series Plots for Total Phosphorus Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.



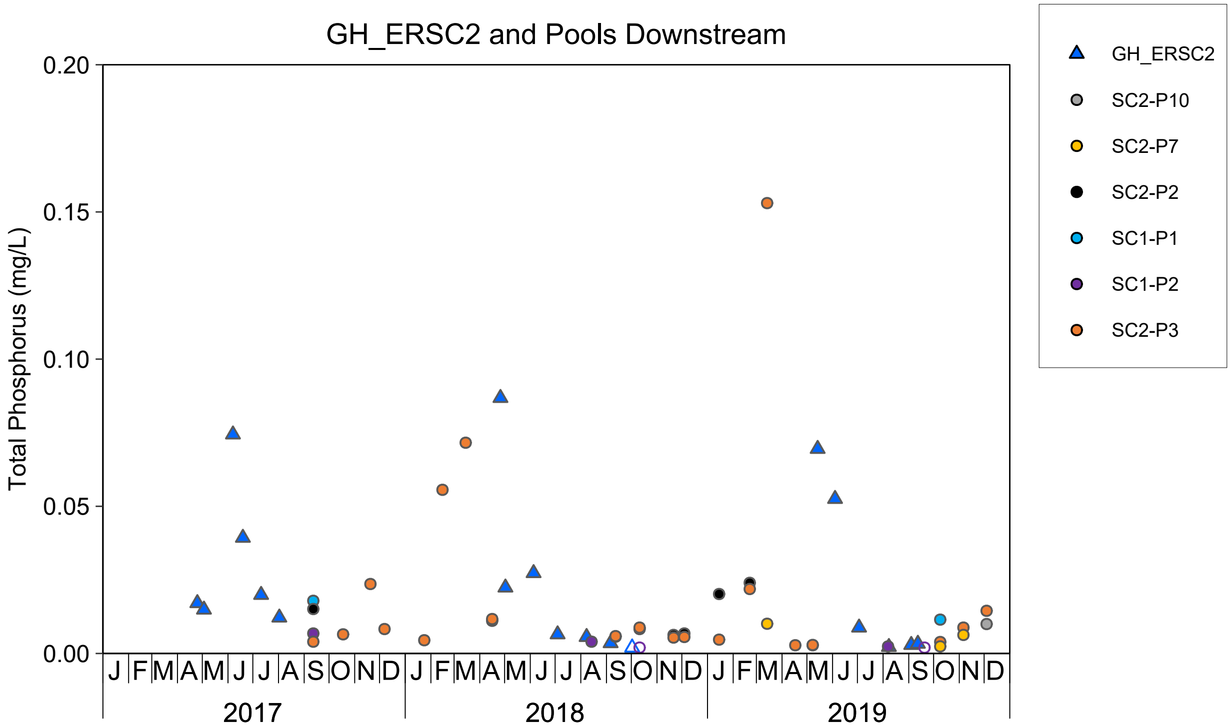


Figure C.72: Time Series Plots for Total Phosphorus Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Phosphorus was plotted based on EMC input, because this constituent was assessed in the GHO Cougar Pit Extension Joint Application.

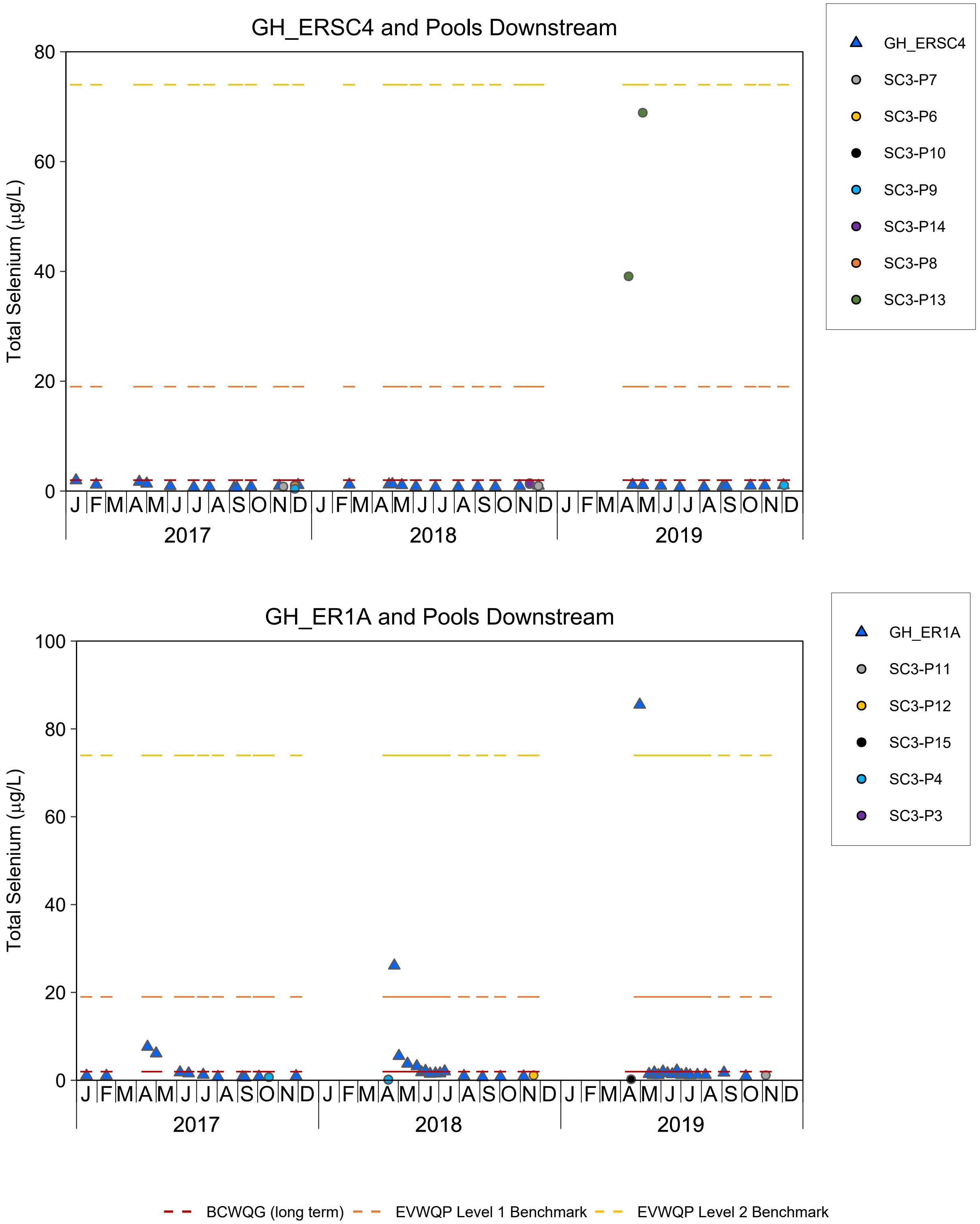


Figure C.73: **Time Series Plots for Total Selenium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

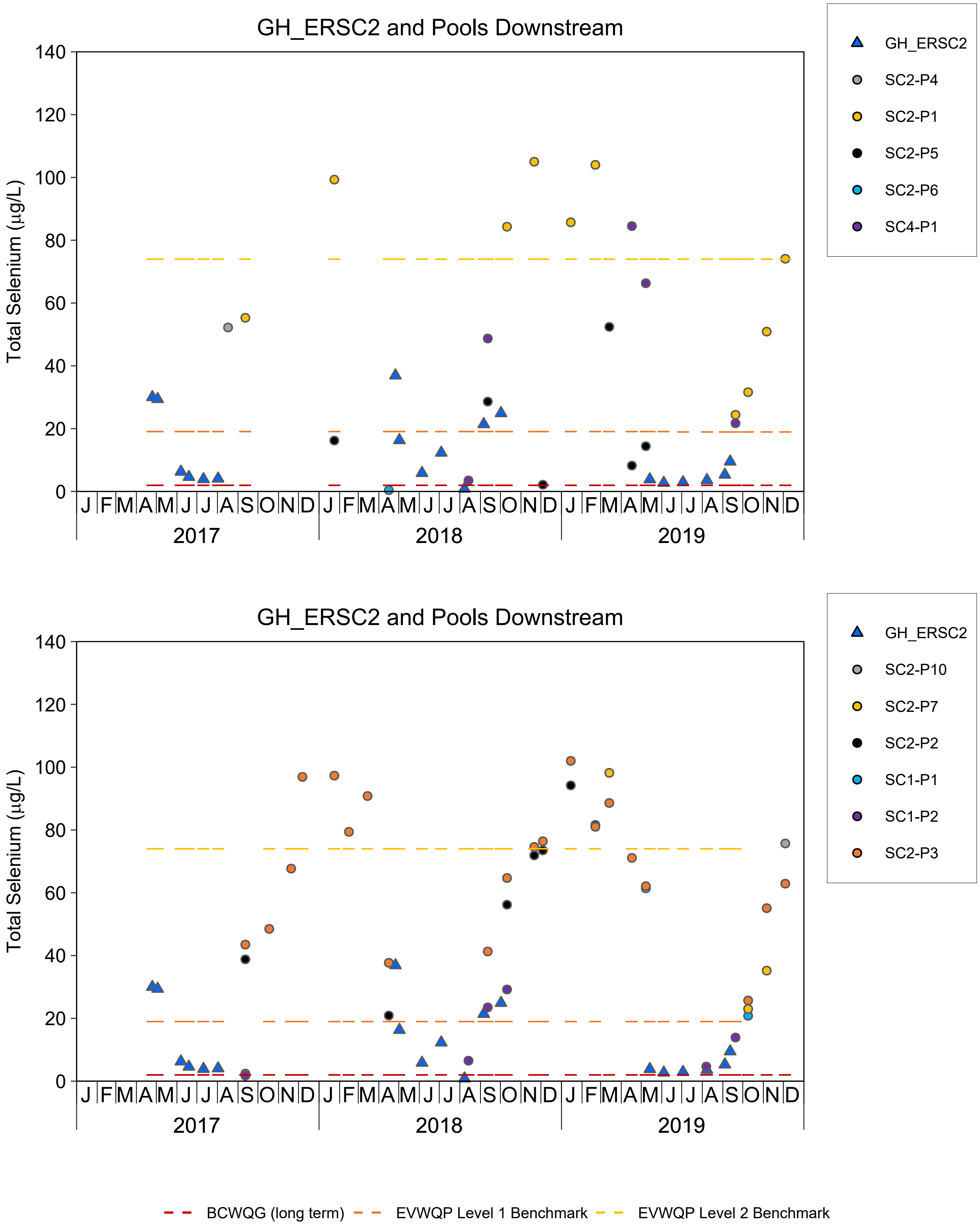


Figure C.73: **Time Series Plots for Total Selenium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total selenium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

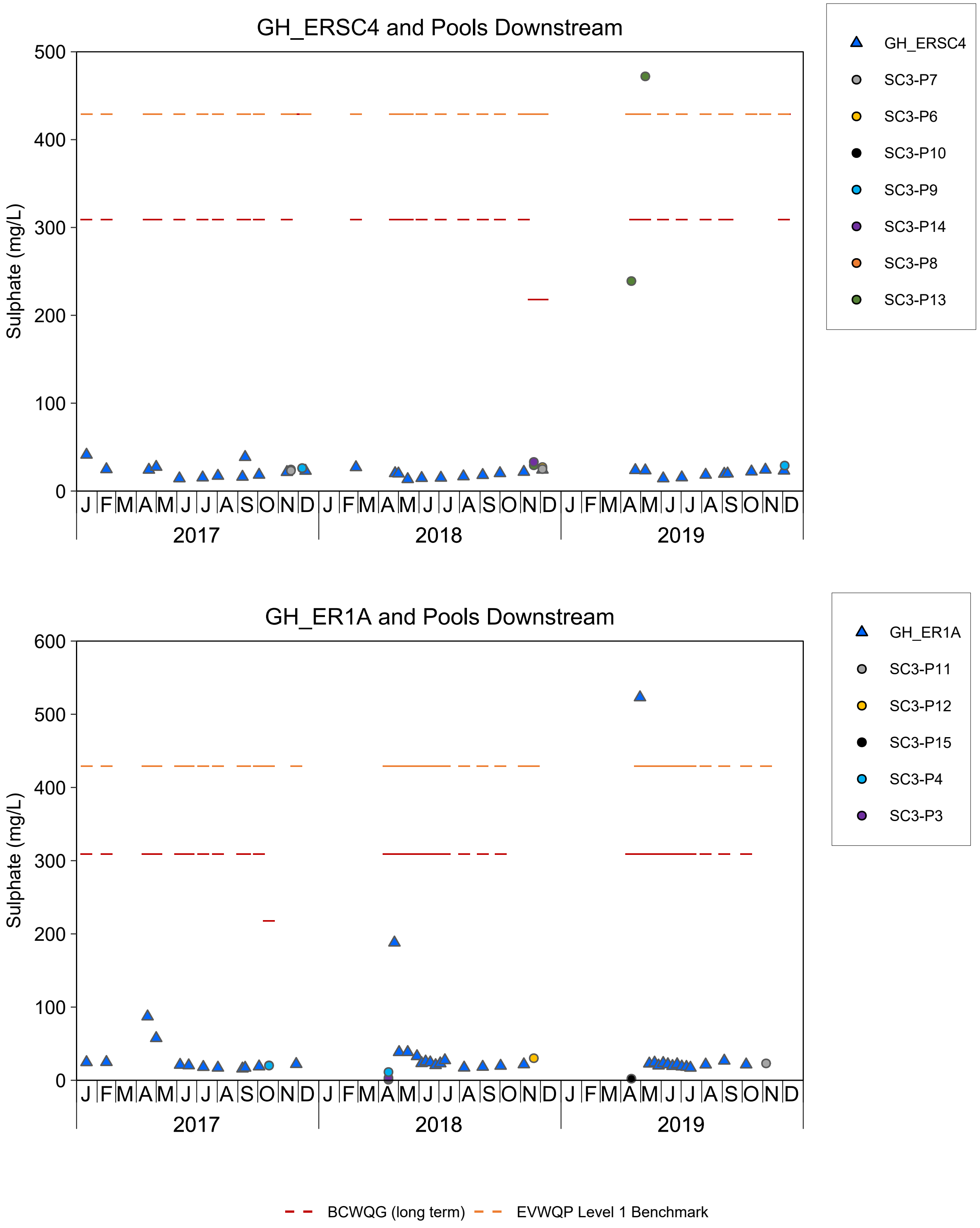


Figure C.74: **Time Series Plots for Sulphate Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

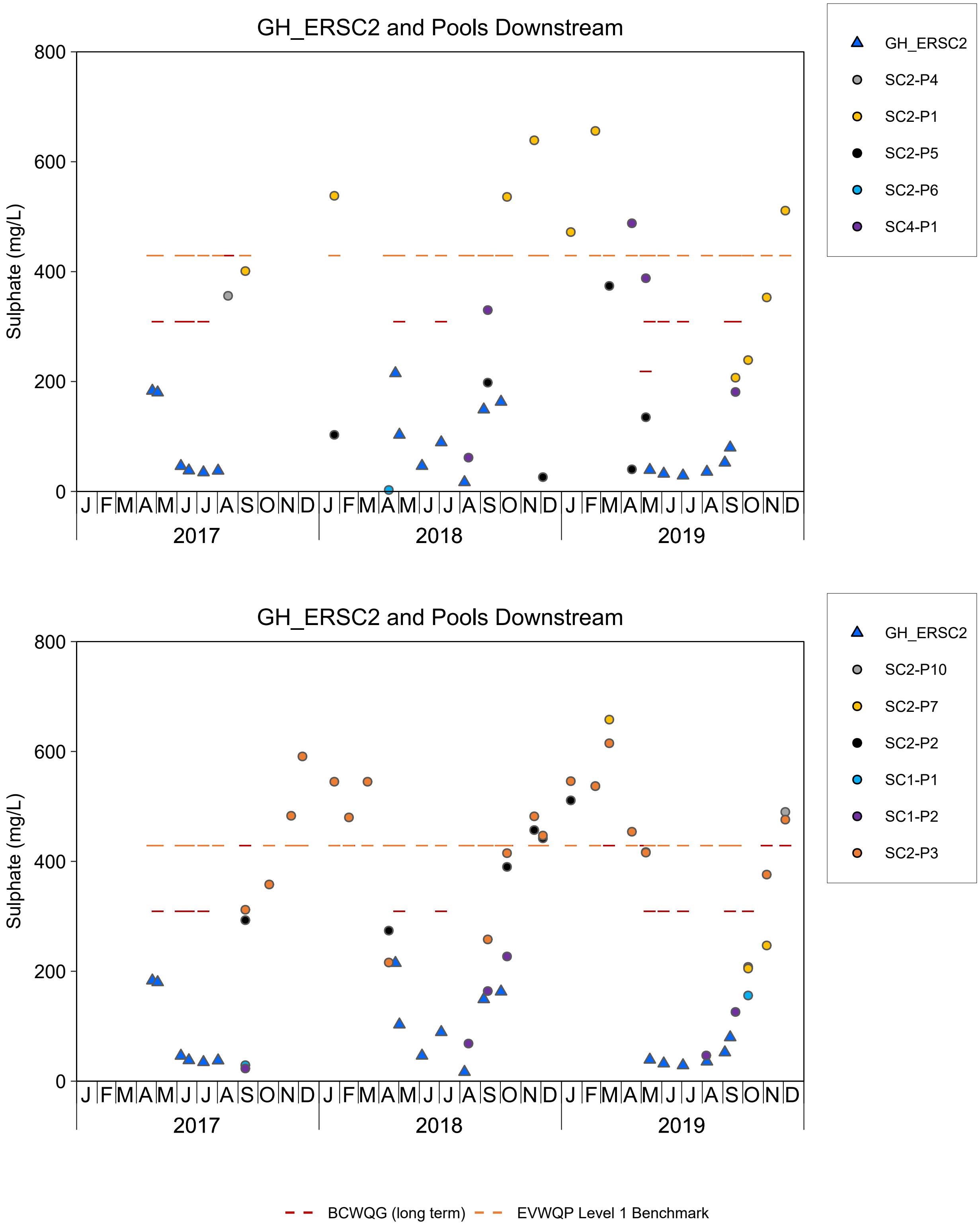


Figure C.74: **Time Series Plots for Sulphate Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Sulphate was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

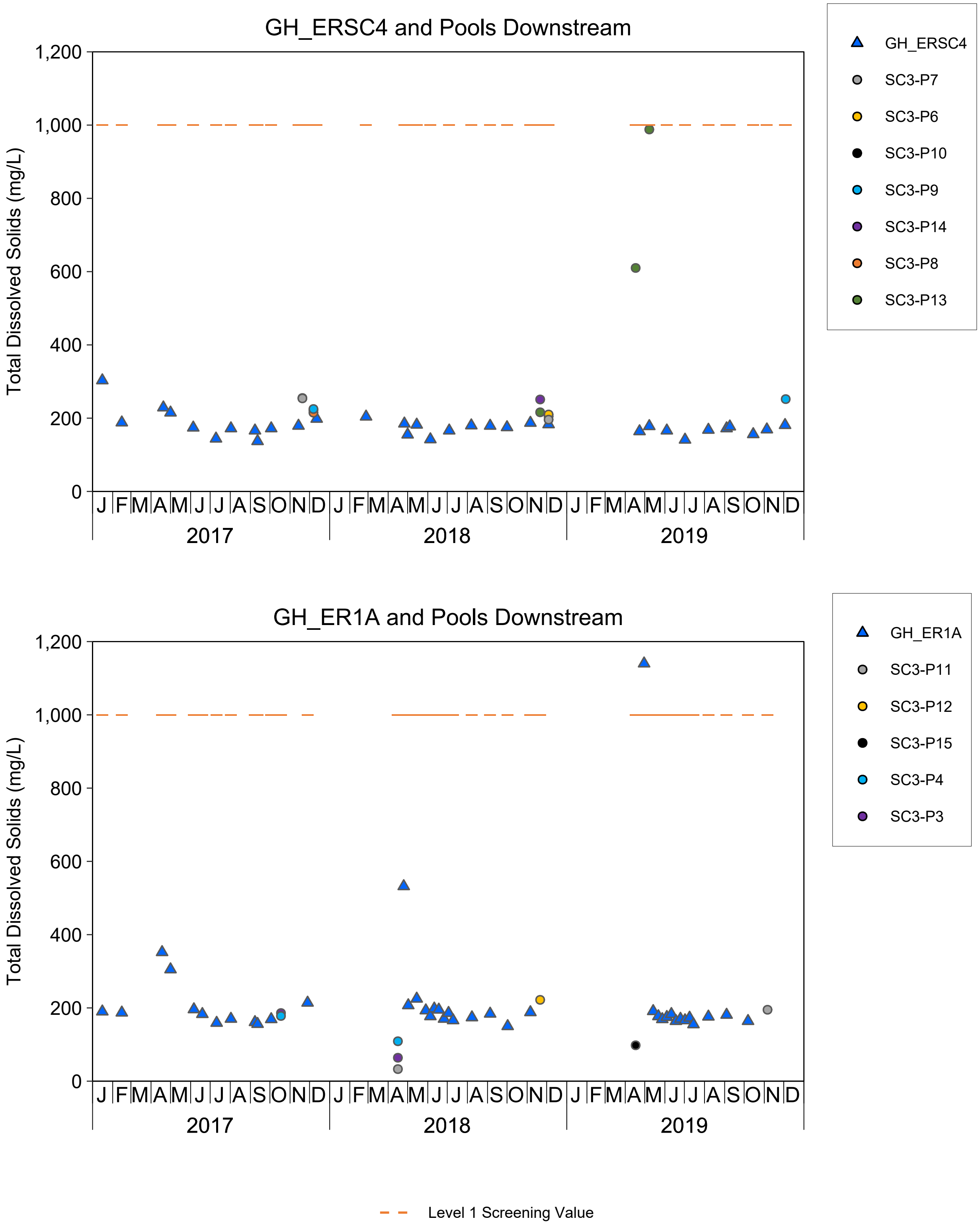


Figure C.75: **Time Series Plots for Total Dissolved Solids Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

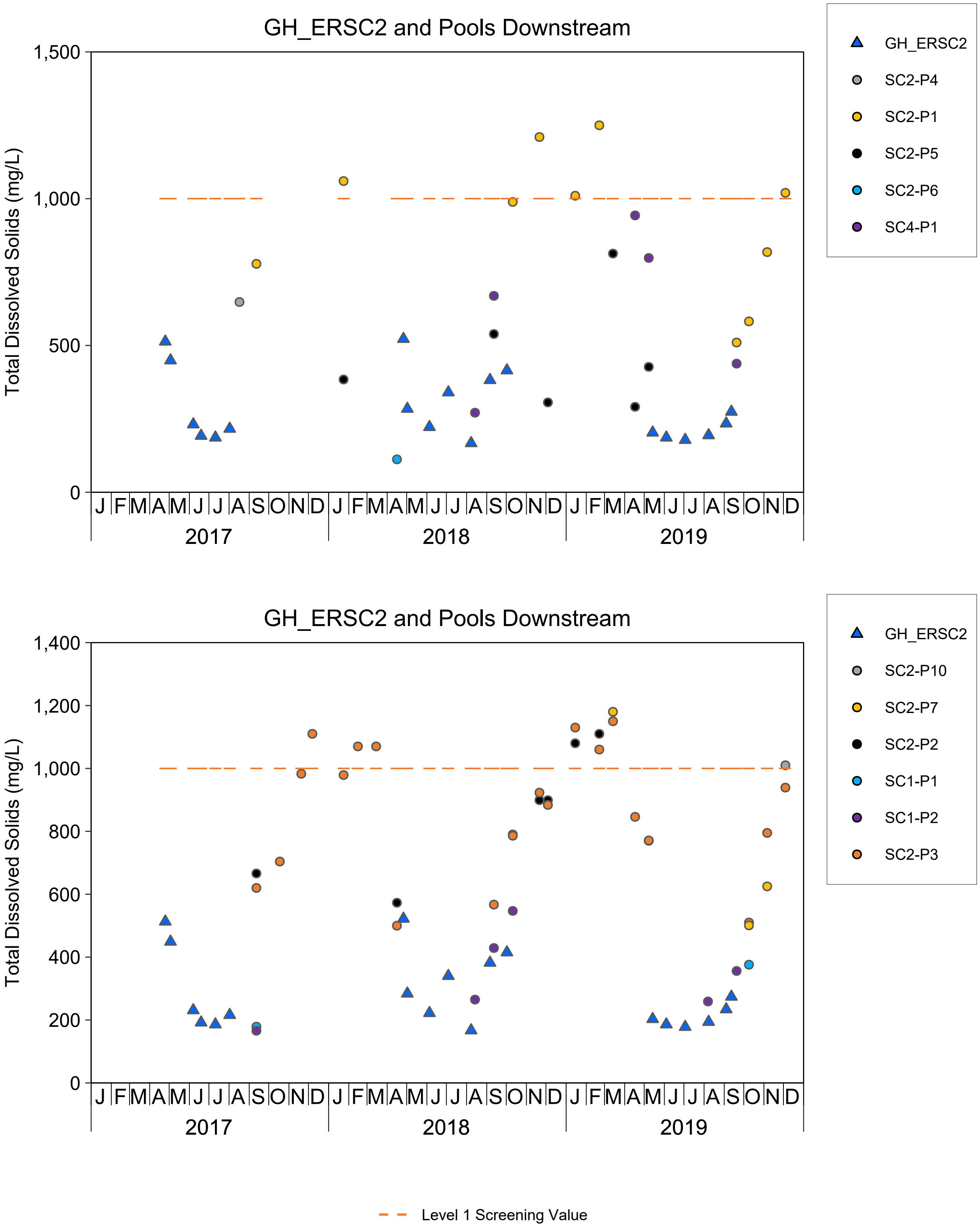


Figure C.75: **Time Series Plots for Total Dissolved Solids Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total dissolved solids was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

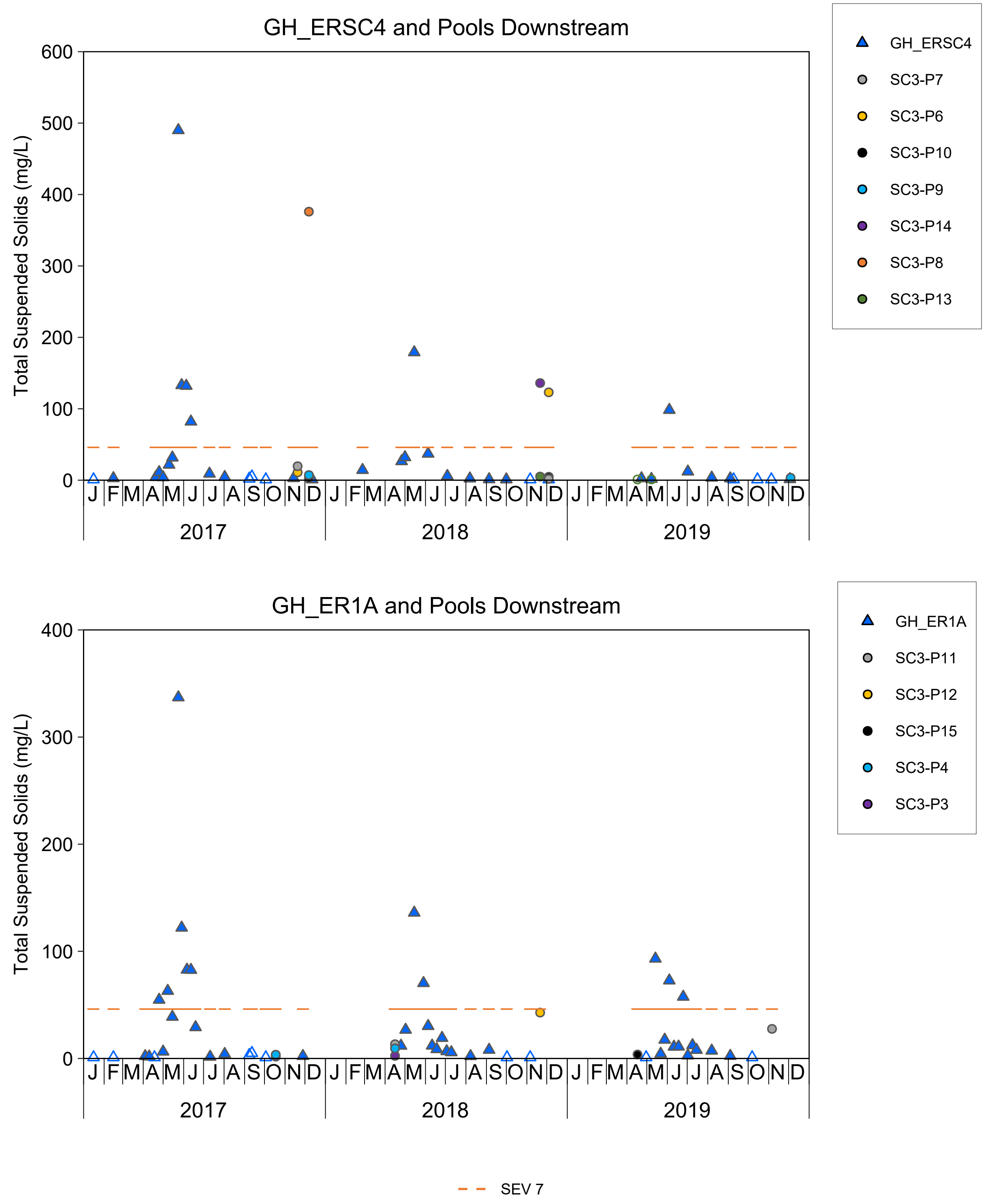


Figure C.76: **Time Series Plots for Total Suspended Solids Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 µm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Table C.7).

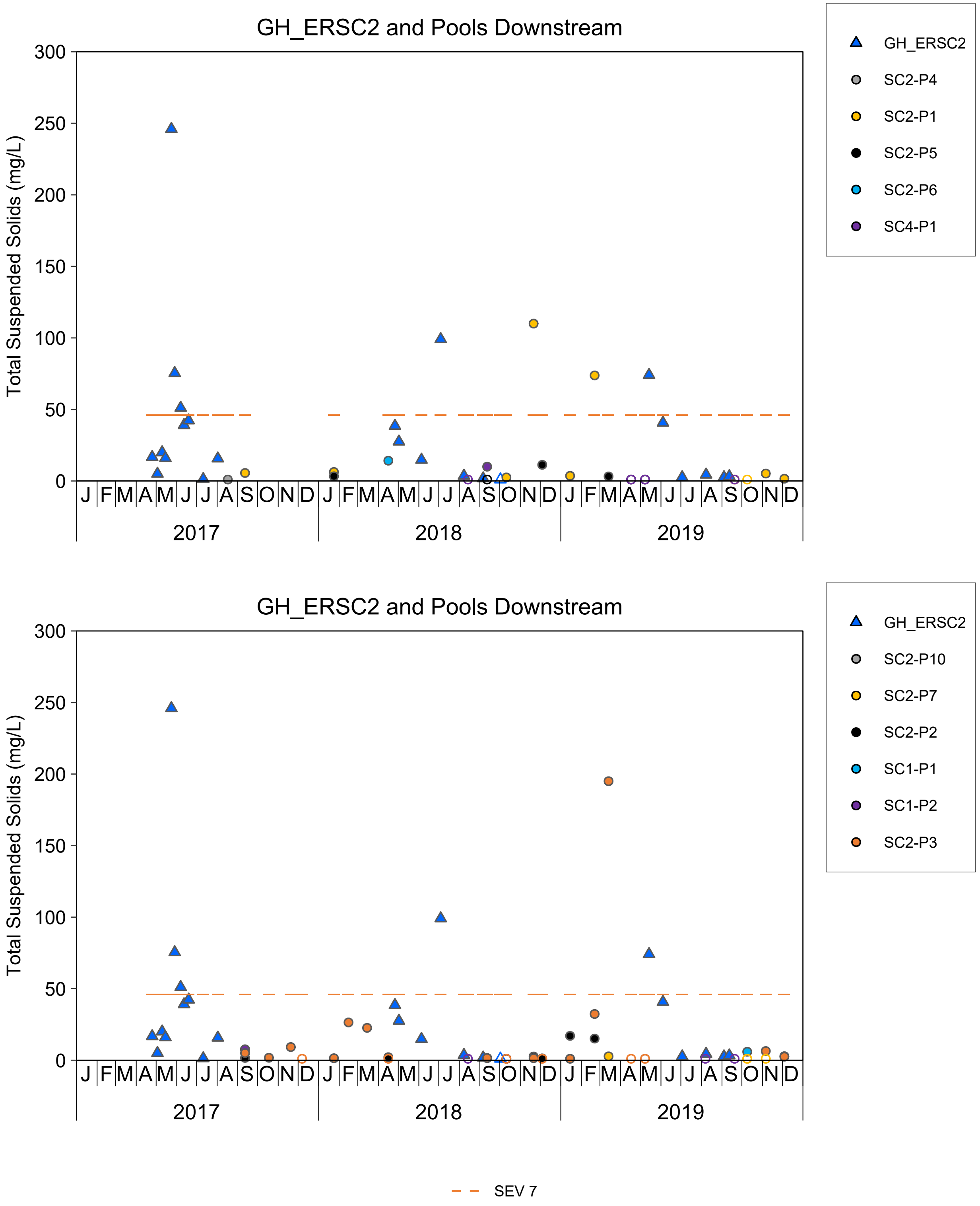


Figure C.76: Time Series Plots for Total Suspended Solids Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Note: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL.
Total suspended solids (TSS) was plotted based on EMC input, aiming to assess the potential effects of total suspended solids on fish use and habitat availability. TSS effect level benchmarks based on modeling by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5-250 μm (Group 1 from Newcombe and Jensen 1996). Severity of ill effect (SEV) level 7 (TSS = 46 mg/L) is associated with moderate habitat degradation and impaired homing (see Table C.7).

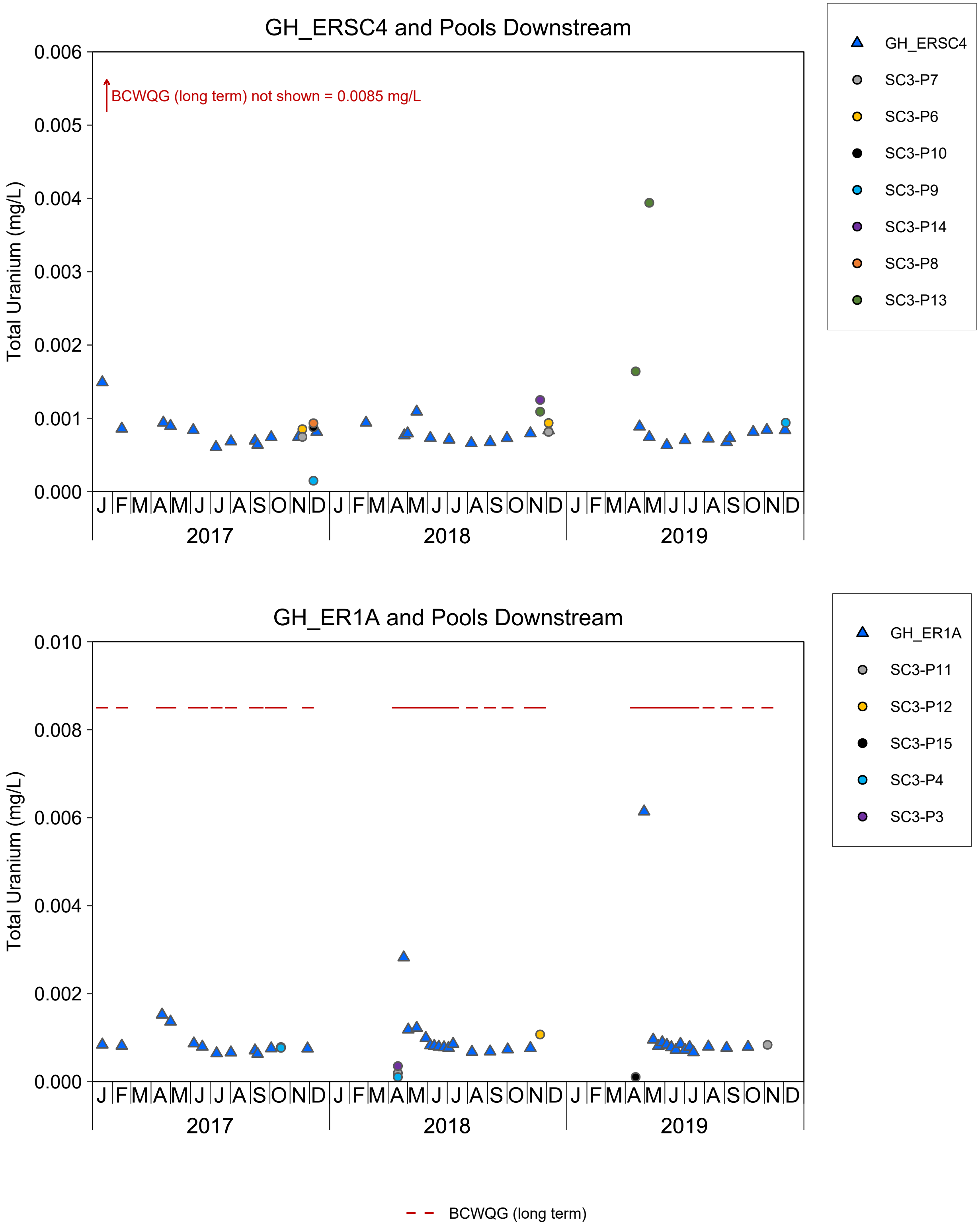


Figure C.77: **Time Series Plots for Total Uranium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

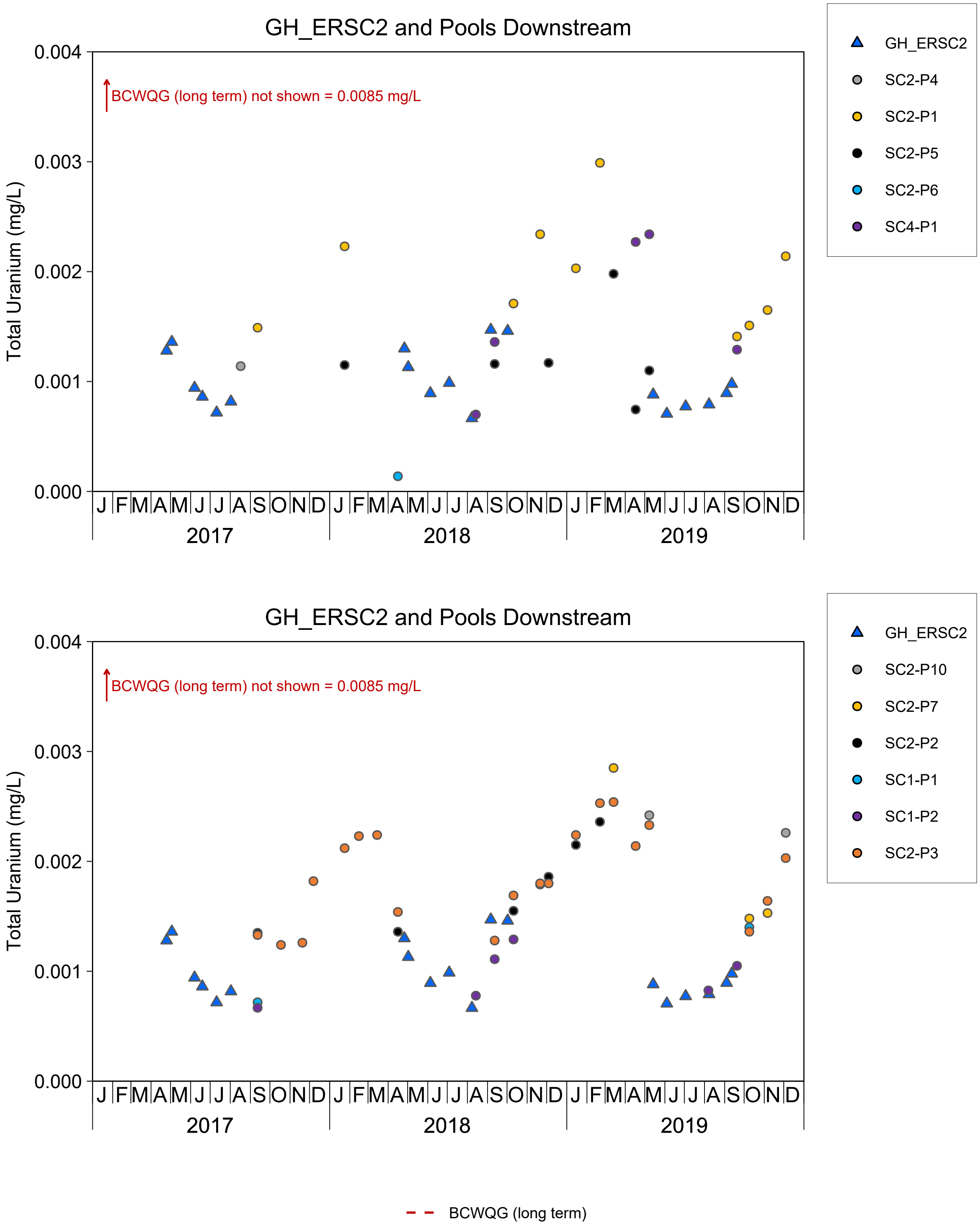


Figure C.77: **Time Series Plots for Total Uranium Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total uranium was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

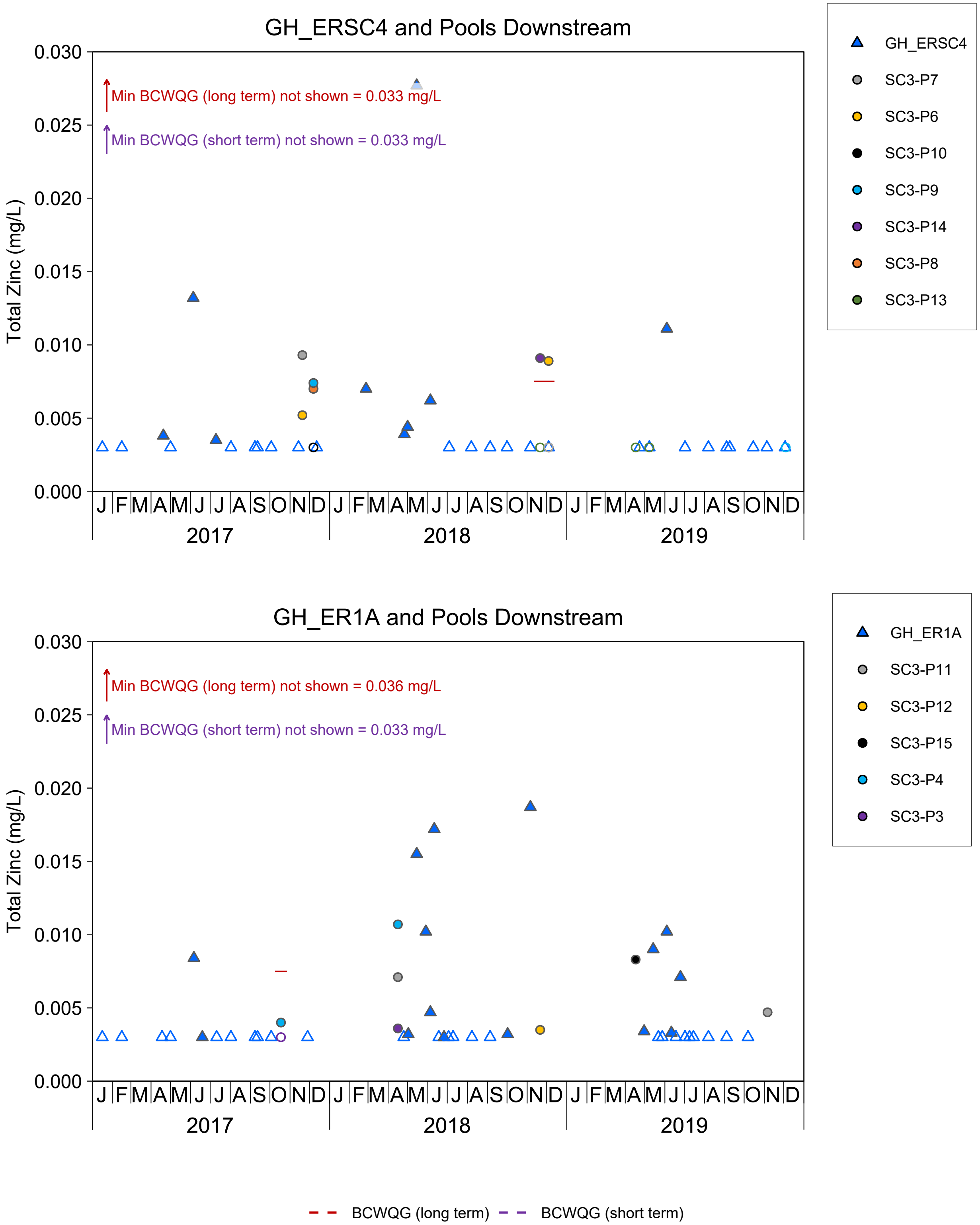


Figure C.78: **Time Series Plots for Total Zinc Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019**

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

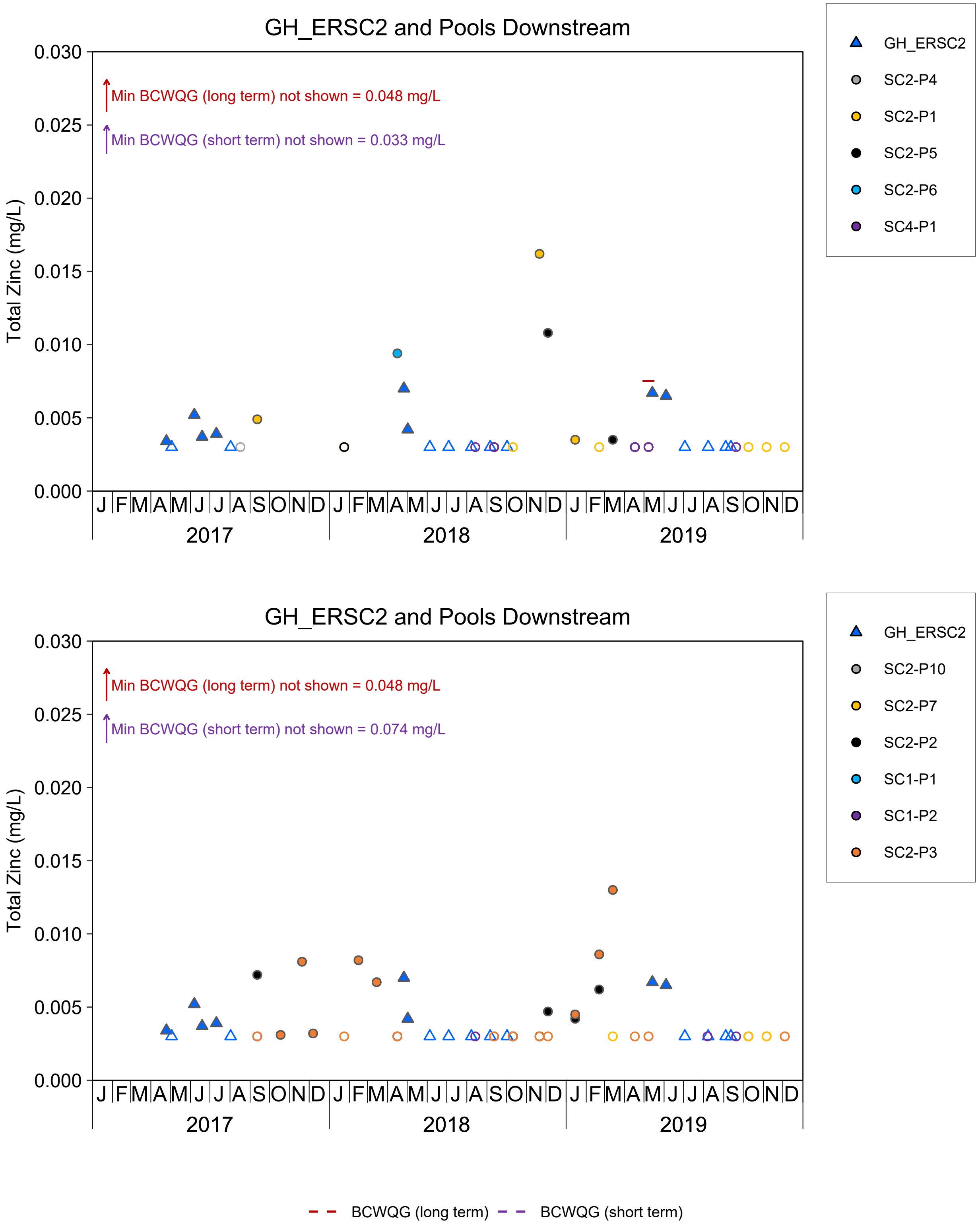


Figure C.78: Time Series Plots for Total Zinc Concentrations from Side Channel Monitoring Stations (GH_ERSC4, GH_ER1A, GH_ERSC2) and Isolated Pools, 2017 to 2019

Notes: Concentrations reported below the laboratory reporting limit (LRL) are plotted as open symbols at the LRL. Pools are listed in the legend from upstream to downstream. Total zinc was plotted because it was identified as a mine-related constituent in the Adaptive Management Plan and an early warning trigger was defined (Azimuth 2019).

WATER QUALITY

Water Quality Tables

Table C.1: Monthly Average Pit Pumping Volumes Discharged to Leask and Wolfram Creeks, 2018 and 2019

Year [a]	Month	Monthly Average Pit Pumping Volumes [b]	
		Discharged to Leask Creek (m^3/day)	Discharged to Wolfram Creek (m^3/day)
2018	January	0	4,360
	February	0	4,360
	March	2,000	4,360
	April	4,360	6,768
	May	10,378	6,864
	June	8,000	6,800
	July	0	4,728
	August	0	2,894
	September	0	937
	October	0	971
	November	25	537
	December	0	793
2019	January	0	0
	February	0	0
	March	0	0
	April	0	0
	May	0	0
	June	5,451	0
	July	5,177	5,219
	August	6,488	1,589
	September	6,745	1,533
	October	0	0
	November	0	1,113
	December	0	246

[a] Pit pumping to the west-side tributaries has occurred since 2011, however detailed discharge records only exist for 2018 to 2019. Beginning in 2011, dewatering of Phase 3 (while it was actively mined) was discharged to Wolfram Creek until the end of 2015. Phase 3 sat dormant (filling) until January 2017, when it was dewatered to a tailings pond. Discharge from Phase 3 to Wolfram Creek began again in early 2018 and is ongoing. Phase 6 was dewatered to Mickelson Creek through 2015 and then to Leask and Wolfram creeks (primarily Leask) starting in early 2016 and continued until the end of 2019. Mickelson Creek received pit pumping discharge in 2015 only, Leask Creek received discharge from 2016 to present, and Wolfram Creek received discharge from 2011 to present. The other west side tributaries (including Thompson Creek) did not receive pit pumping discharge. Typical discharge rates were 3,000 to 5,000 m^3/day during most of the year and up to 15,000 m^3/day in peak freshet. Detailed documentation of discharge began in 2018 (presented above) and will be ongoing.

[b] Combined discharge volumes pumped from Phase 3 and Phase 6 pits.

Table C.2: Concentrations of Selenium Species Measured in Water Samples, January to December, 2017 to 2019

Waterbody Type	Waterbody	Site ID	Sample Date	Dissolved Selenium Species (µg/L)									
				Selenate	Selenite	Dimethylselenoxide	Methylseleninic Acid	Selenocyanate	Selenomethionine	Selenosulphate	Methanselenonic Acid	Unknown Species	Sum of Species
Reference	Main Stem Elk River	GH_ER2	7-May-19	1.0	< 0.050	<0.010	<0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	1.00
Mine-exposed	Leask Creek	GH_LC1	15-Jul-19	182	5.9	0.043	0.18	<0.040	<0.010	<0.060	< 0.010	<0.060	188.2
		GH_LC2	11-Jul-19	178	4.5	<0.010	0.055	<0.040	<0.010	<0.060	< 0.010	<0.060	182.51
	Wolfram Creek	GH_WC1	29-Jan-19	148	2.1	0.019	0.037	<0.040	<0.010	<0.060	0.036	<0.060	150.2
			5-Feb-19	80	1.2	< 0.010	0.017	<0.040	<0.010	<0.060	0.015	<0.060	81.1
			21-Feb-19	143	1.8	0.028	0.033	< 0.040	< 0.010	< 0.060	0.022	< 0.060	144.9
			22-Feb-19	117	1.5	0.011	0.015	< 0.040	< 0.010	< 0.060	0.014	< 0.060	118.5
			23-Feb-19	161	2.1	0.019	0.026	< 0.040	< 0.010	< 0.060	0.024	< 0.060	163.1
			24-Feb-19	161	2.1	0.019	0.023	< 0.040	< 0.010	< 0.060	0.027	< 0.060	163.2
			25-Feb-19	118	1.5	< 0.010	0.025	< 0.040	< 0.010	< 0.060	0.012	< 0.060	119.6
			26-Feb-19	149	1.9	0.020	0.033	< 0.040	< 0.010	< 0.060	0.018	< 0.060	151.0
			27-Feb-19	148	1.9	0.021	0.037	< 0.040	< 0.010	< 0.060	0.029	< 0.060	150.0
			28-Feb-19	154	2.1	0.028	0.039	< 0.040	< 0.010	< 0.060	0.029	< 0.060	156.2
			1-Mar-19	129	1.7	0.020	0.032	< 0.040	< 0.010	< 0.060	0.023	< 0.060	130.8
			2-Mar-19	157	2.0	0.028	0.028	< 0.040	< 0.010	< 0.060	0.026	< 0.060	159.1
			3-Mar-19	146	1.9	0.022	0.031	< 0.040	< 0.010	< 0.060	0.024	< 0.060	148.0
			4-Mar-19	139	1.9	0.022	0.031	< 0.040	< 0.010	< 0.060	0.019	< 0.060	140.9
			5-Mar-19	153	2.0	0.026	0.037	< 0.040	< 0.010	< 0.060	0.023	< 0.060	155.1
			14-Mar-19	108	1.8	0.018	0.036	< 0.040	< 0.010	< 0.060	0.012	< 0.060	109.8
			19-Mar-19	96	1.7	0.017	0.029	< 0.040	< 0.010	< 0.060	0.015	< 0.060	97.9
			26-Mar-19	97	1.6	0.021	0.027	< 0.040	< 0.010	< 0.060	0.015	< 0.060	98.8
			2-Apr-19	114	1.9	0.019	0.054	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	116.0
			9-Apr-19	115	2.0	0.034	0.035	< 0.040	< 0.010	< 0.060	0.011	< 0.060	117.1
			16-Apr-19	133	1.9	0.016	0.054	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	135.0
			25-Apr-19	128	1.6	0.023	0.046	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	129.7
			9-May-19	171	2.0	0.018	0.078	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	173.1
			14-May-19	160	2.0	0.017	0.086	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	162.1
			21-May-19	135	1.8	0.018	0.084	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	136.9
			27-May-19	141	1.8	0.012	0.088	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	142.9
		GH_WC2	19-Mar-18	90	1.5	0.023	0.027	<0.040	<0.010	< 0.010	-	<0.060	91.38
			29-Jan-19	166	2.0	0.013	0.029	<0.040	<0.010	<0.060	0.029	<0.060	168.1
			5-Feb-19	131	1.7	0.013	0.023	<0.040	<0.010	<0.060	0.023	<0.060	132.8
			21-Feb-19	131	1.8	0.021	0.025	< 0.040	< 0.010	< 0.060	0.018	< 0.060	132.8
			22-Feb-19	143	1.9	0.024	0.025	< 0.040	< 0.010	< 0.060	0.022	< 0.060	144.9
			23-Feb-19	137	1.8	0.012	0.022	< 0.040	< 0.010	< 0.060	0.022	< 0.060	138.9
			24-Feb-19	156	2.0	0.017	0.030	< 0.040	< 0.010	< 0.060	0.023	< 0.060	314.1
			25-Feb-19	154	2.0	0.025	0.024	< 0.040	< 0.010	< 0.060	0.024	< 0.060	156.0
			26-Feb-19	151	2.0	< 0.010	0.030	< 0.040	< 0.010	< 0.060	0.015	< 0.060	153.0
			27-Feb-19	123	1.7	0.018	0.022	< 0.040	< 0.010	< 0.060	0.021	< 0.060	124.7
			28-Feb-19	145	1.9	0.025	0.036	< 0.040	< 0.010	< 0.060	0.020	< 0.060	291.9
			1-Mar-19	143	1.9	0.019	0.023	< 0.040	< 0.010	< 0.060	0.024	< 0.060	144.9
			2-Mar-19	150	1.9	0.015	0.027	< 0.040	< 0.010	< 0.060	0.018	< 0.060	152.0
			3-Mar-19	155	2.0	0.017	0.027	< 0.040	< 0.010	< 0.060	0.024	< 0.060	157.0
			4-Mar-19	141	1.8	0.018	0.0250	< 0.040	< 0.010	< 0.060	0.020	< 0.060	142.8
			5-Mar-19	111	1.5	0.012	0.0250	< 0.040	< 0.010	< 0.060	0.015	< 0.060	112.5
			14-Mar-19	124	2.2	0.017	0.038	< 0.040	< 0.010	< 0.060	0.012	< 0.060	126.2
			19-Mar-19	69	1.3	< 0.010	0.024	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	70.3
			26-Mar-19	104	1.7	0.019	0.027	< 0.040	< 0.010	< 0.060	0.015	< 0.060	105.7
			2-Apr-19	99	1.7	0.015	0.029	< 0.040	< 0.010	< 0.060	0.011	< 0.060	100.6
			9-Apr-19	120	2.1	0.030	0.021	< 0.040	< 0.010	< 0.060	0.013	< 0.060	122.1
			16-Apr-19	135	1.7	0.011	0.032	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	136.8
			24-Apr-19	140	1.7	0.016	0.027	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	141.7
			30-Apr-19	141	1.6	0.015	0.035	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	142.7
			9-May-19	147	1.8	0.018	0.045	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	148.9
			14-May-19	136	1.8	0.018	0.037	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	137.8
			21-May-19	135	1.7	< 0.010	0.055	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	136.7
			28-May-19	135	1.8	< 0.010	0.055	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	136.8
			29-Jul-19	63	1.3	< 0.010	0.023	< 0.040	< 0.010	< 0.060	0.011	< 0.060	63.9
	Thompson Creek	GH_TC1	16-May-19	62	1.4	0.036	0.068	<0.040	<0.010	<0.060	< 0.010	<0.060	63.0
		GH_TC2	16-May-19	42	1.1	0.032	0.065	<0.040	<0.010	<0.060	< 0.010	<0.060	43.6
			24-Jul-19	49	1.7	0.011	0.083	<0.040	<0.010	<0.060	< 0.010	<0.060	50.6
	Elk River Side Channel	GH_ER1A	30-Apr-19	1.5	< 0.050	< 0.010	< 0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	1.5
			30-Apr-19	68	0.18	< 0.010	< 0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	67.7
			20-May-19	0.95	< 0.050	< 0.010	< 0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	0.9
			22-May-19	1.7	< 0.050	< 0.010	< 0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	1.7
			26-Jul-19	0.51	< 0.050	< 0.010	< 0.010	<0.040	<0.010	<0.060	< 0.010	<0.060	0.5

Table C.2: Concentrations of Selenium Species Measured in Water Samples, January to December, 2017 to 2019

Waterbody Type	Waterbody	Site ID	Sample Date	Dissolved Selenium Species (µg/L)									
				Selenate	Selenite	Dimethylselenoxide	Methylseleninic Acid	Selenocyanate	Selenomethionine	Selenosulphate	Methanselenonic Acid	Unknown Species	Sum of Species
Mine-exposed	Main Stem Elk River	GH_ERC	6-Jun-17	1.2	0.038	< 0.005	< 0.005	< 0.015	< 0.005	< 0.020	-	0.016	1.3
			5-Sep-17	1.0	< 0.015	< 0.005	< 0.005	< 0.015	< 0.005	< 0.015	-	< 0.015	1.0
			5-Dec-17	0.67	< 0.015	< 0.005	< 0.005	< 0.015	< 0.005	< 0.015	-	< 0.015	0.7
			27-Feb-18	1.9	< 0.015	< 0.005	< 0.005	< 0.015	< 0.005	< 0.015	< 0.010	< 0.015	1.9
			27-Feb-18	2.2	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.2
			5-Jun-18	1.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.010	-	< 0.060	1.4
			12-Sep-18	0.77	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	0.8
			5-Feb-19	1.1	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.1
			21-Feb-19	1.9	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.9
			22-Feb-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			23-Feb-19	2.1	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.1
			24-Feb-19	2.3	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.3
			25-Feb-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			26-Feb-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			28-Feb-19	2.2	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.2
			1-Mar-19	1.9	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.9
			2-Mar-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			3-Mar-19	2.1	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.1
			4-Mar-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			5-Mar-19	1.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.4
			14-Mar-19	2.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.4
			19-Mar-19	2.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.4
			26-Mar-19	2.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.4
			3-Apr-19	2.8	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.8
			9-Apr-19	2.1	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.1
			16-Apr-19	2.7	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.7
			22-Apr-19	2.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.4
			30-Apr-19	1.7	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.7
			7-May-19	2.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.0
			14-May-19	2.9	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	2.9
			21-May-19	1.5	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.5
			28-May-19	1.4	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.4
			4-Jun-19	1.3	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.3
			26-Jul-19	1.0	< 0.050	< 0.010	< 0.010	< 0.040	< 0.010	< 0.060	< 0.010	< 0.060	1.0

Note: The sum of species was calculated using zero for values reported as < LRL.

Table C.3: British Columbia Water Quality Guidelines, Site-Specific Elk Valley Water Quality Plan (EVWWQP) Benchmarks, and Interim Screening Values for Parameters Assessed in the GHO LAEMP, 2019

Variable			Units	British Columbia Water Quality Guidelines [1]				Site-Specific Benchmark [2]
				Long-term Average	Short-term Maximum	Year	Status	
Non-Metals		Total Alkalinity	mg/L	For dissolved calcium = < 4mg/L, WQG = <10 For dissolved calcium = 4 to 8 mg/L, WQG = 10 to 20 For dissolved calcium = > 8 mg/L, WQG = > 20	-	2015	Working	-
		Unionized Ammonia [3]	mg/L	pH and Temperature dependent (tabular)	pH and Temperature dependent (tabular)	2009	Approved	-
		Chloride	mg/L	150	600	2003	Approved	-
		Fluoride	mg/L	-	For hardness ≤ 10 mg/L, WQG = 0.4 For hardness > 10 mg/L, WQG = [-51.73 + 92.57 × $\log_{10}$(hardness)]×0.01 Maximum applicable hardness = 385 mg/L	1990	Approved	-
		Nitrate-N	mg/L	3	33	2009	Approved	EVWQP benchmark = BCWQG = 3 mg/L
		Nitrite-N [4]	mg/L	0.02 to 0.20	0.06 to 0.60	2009	Approved	-
		Dissolved oxygen [5]	mg/L	For buried embryo/alevin life stages, WQG (water column) = 11 WQG (interstitial) = 8 For other life stages, WQG (water column) = 8	For buried embryo/alevin life stages, WQG (water column) = 9 WQG (interstitial) = 6 For other life stages, WQG (water column) = 5	1997	Approved	-
		pH [6]	pH units	6.5 - 9.0		1991	Approved	-
		Sulphate [7]	mg/L	128 to 429 Maximum applicable hardness = 250 mg/L	-	2013	Approved	Level 1 EVWQP Benchmark = BCWQG = 429 mg/L
		Total Dissolved Solids	mg/L	-	-	-	-	Level 1 EVWQP Benchmark = 1,000 mg/L
Metals and Metalloids	Total	Antimony (III)	mg/L	0.009	-	2015	Working	-
		Arsenic	mg/L	-	0.005	2002	Approved	-
		Barium	mg/L	1	-	2015	Working	-
		Beryllium	mg/L	0.00013	-	2015	Working	-
		Boron	mg/L	1.2	-	2003	Approved	-
		Chromium [8]	mg/L	For Cr(VI), WQG = 0.001 For Cr(III), WQG = 0.0089	-	2015	Working	-
		Iron	mg/L	-	1	2008	Approved	-
		Lead [7]	mg/L	For hardness ≤ 8 mg/L, none proposed For hardness 8 to 360 mg/L, WQG = 0.001×{3.31+ exp[1.273 × ln(hardness) - 4.704]} No more than 20% of samples in a 30-d period should be >1.5X the guideline. Maximum applicable hardness = 360 mg/L	For hardness ≤ 8 mg/L, WQG ≤ 0.003 For hardness 8 to 360 mg/L, WQG = 0.001×{exp[1.273 × ln(hardness) - 1.460]} Maximum applicable hardness = 360 mg/L	1987	Approved	-
		Manganese [7]	mg/L	For hardness 37 to 450 mg/L, WQG ≤ 0.004 × hardness + 0.605 Maximum applicable hardness = 450 mg/L	For hardness 25 to 259 mg/L, WQG ≤ 0.01102 × hardness + 0.54 Maximum applicable hardness = 259 mg/L	2001	Approved	-
		Mercury [9]	mg/L	MeHg ≤ 0.5% of THg, WQG = 0.00002 Else, WQG = [0.0001/(MeHg/THg)] OR When MeHg = 0.5% of THg, WQG= 0.00002 When MeHg = 1.0% of THg, WQG = 0.00001 When MeHg = 8.0% of THg, WQG= 0.00000125	-	2001	Approved	-
		Molybdenum	mg/L	1	2	1986	Approved	-
		Nickel [7]	mg/L	-	-	-	-	Level 1 Interim Screening Value = 0.0053 Level 2 Interim Screening Value = 0.015 Level 3 Interim Screening Value = 0.022
		Selenium	μg/L	2	-	2014	Approved	Level 1 EVWQP Benchmark = 19 Level 2 EVWQP Benchmark = 74
		Silver [6]	mg/L	For hardness ≤ 100 mg/L, WQG = 0.00005 For hardness > 100 mg/L, WQG = 0.0015	For hardness ≤ 100 mg/L, WQG = 0.0001 For hardness > 100 mg/L, WQG = 0.003	1996	Approved	-
		Thallium	mg/L	0.0008	-	1997	Working	-
		Uranium	mg/L	0.0085	-	2011	Working	-
		Zinc [7]	mg/L	For hardness ≤ 90 mg/L, WQG = 0.0075 For hardness 90 to 330 mg/L, WQG = [7.5 + 0.75 (hardness - 90)]×0.001; Maximum applicable hardness = 330 mg/L	For hardness ≤ 90 mg/L, WQG = 0.033 For hardness 90 to 500 mg/L, WQG = [33 + 0.75 (hardness - 90)]×0.001; Maximum applicable hardness = 500 mg/L	1999	Approved	-
	Dissolved	Aluminum	mg/L	When pH ≥ 6.5, WQG = 0.05 When pH < 6.5, WQG = exp[1.6 - 3.327(median pH)+ 0.402 (median pH)^2]	When pH ≥ 6.5, WQG = 0.1 When pH < 6.5, WQG = exp[1.209 - 2.426(pH)+ 0.286 (pH)^2]	2001	Approved	-
		Cadmium [7]	μg/L	For hardness = 3.4 to 285 mg/L, WQG = {exp[0.736×ln(hardness) - 4.943]} Maximum applicable hardness = 285 mg/L	For hardness = 7 to 455 mg/L, WQG = {exp[1.03×ln(hardness)-5.274]} Maximum applicable hardness = 455 mg/L	2015	Approved	Level 1 EVWQP Benchmark = $10^{0.83(\log(\text{hardness}))-2.53}$ Maximum applicable hardness = 285 mg/L
		Copper	mg/L	Biotic Ligand Model	Biotic Ligand Model	2019	Approved	-
		Iron	mg/L	-	WQG = 0.35 mg/L	2008	Approved	-

[1] British Columbia Working (BCMOE 2017) or Accepted (BCMOE 2019) Water Quality Guidelines for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness), guidelines were screened using concurrent values.

[2] When appropriate, site-specific Elk Valley Water Quality Plan Benchmarks (EVWQP; Teck 2014) or interim screening values were applied in addition to or instead of BC water quality guidelines. Interim screening values are displayed for nickel (Golder 2017; Coal Mountain Operations Aquatic Health Assessment Report).

[3] Temperature and pH dependent; range of minimum and maximum values.

[4] Dependent on concurrent chloride, range of values reported (BCMOE 2019)

[5] Dissolved oxygen guidelines represent a minimum value, and so exceedances were quantified below this guideline.

[6] Unrestricted change permitted within this pH range.

[7] For hardness-based guidelines, concurrent hardness values were used for calculating guidelines. If hardness values exceeding the maximum applicable hardness, then guidelines were determined using the maximum applicable hardness. If hardness values is lower than the minimum hardness, then guidelines were determined using the minimum hardness.

[8] Chromium(VI) is the dominant oxidation state in oxygenated environments, and so its guideline was applied.

[9] The most conservative guideline (0.00000125 mg/L) was applied.

Table C.4: Scale of the Severity (SEV) of Ill Effects associated with Excess Suspended Sediment (Newcombe and Jensen 1996), and Calculated Total Suspended Solids (TSS) Concentrations for Each SEV

SEV	Description of Effect	TSS (mg/L)[a]
Nill Effect		
0	No behavioral effects	0.004
Behavioral Effects		
1	Alarm reaction	0.01
2	Abandonment of cover	0.05
3	Avoidance response	0.2
Sublethal Effects		
4	Short-term reduction in feeding rates; short-term reduction in feeding success	0.8
5	Minor physiological stress: increase in rate of coughing; increased respiration rate	3
6	Moderate physiological stress	12
7	Moderate habitat degradation; impaired homing	46
8	Indications of major physiological stress: long-term reduction in feeding rate; long-term reduction in feeding success; poor condition	178
Lethal and Paralethal Effects		
9	Reduced growth rate: delayed hatching: reduced fish density	690
10	0-20% mortality; increased predation; moderate to severe habitat degradation	2,673
11	>20-40% mortality	10,354
12	>40-60% mortality	40,110
13	>60-80% mortality	155,384
14	>80-l00% mortality	601,953

[a] Calculated TSS concentration at each effect level using model by Newcombe and Jensen (1996). The benchmarks provided assume one week of exposure to juvenile and adult salmonids, with TSS particle sizes 0.5 to 250 µm (Group 1 from Newcombe and Jensen 1996).

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Dissolved Solids (mg/L)	Lab pH	Field pH	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Total Chloride (mg/L)	Total Fluoride (mg/L)	Total Antimony (mg/L)	Total Arsenic (mg/L)	Total Barium (mg/L)	Total Beryllium (mg/L)	Total Boron (mg/L)	Total Chromium (mg/L)	Total Cobalt (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)
GH_BR_F	**n**	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	Annual Minimum	146	8.20	8.10	8.80	132	0.0253	<0.00100	<0.00500	3.21	<0.500	0.0880	<0.000100	0.000190	0.129	<0.0000200	<0.0100	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	208	8.50	8.60	13.0	219	0.456	<0.00100	0.0422	5.93	<0.500	0.134	0.000160	0.000270	0.261	<0.0000200	<0.0100	0.000120	<0.000100	0.0580	0.0000640
	Annual Mean	179	8.36	8.46	10.6	186	0.160	<0.00100	0.0126	5.05	<0.500	0.120	0.000117	0.000228	0.195	<0.0000200	<0.0100	0.000104	<0.000100	0.0252	0.0000513
	Annual Median	188	8.39	8.50	10.4	193	0.0786	<0.00100	0.00660	5.46	<0.500	0.128	0.000110	0.000220	0.189	<0.0000200	<0.0100	<0.000100	<0.000100	0.0210	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0%	100%	36%	0%	100%	0%	18%	0%	0%	100%	100%	73%	100%	27%	91%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WOLF	**n**	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
	Annual Minimum	197	8.24	8.18	8.50	170	0.0352	<0.00100	<0.00500	9.17	<0.500	0.0830	<0.000100	0.000160	0.100	<0.0000200	0.0140	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	271	8.55	8.60	13.3	232	1.07	0.00180	0.0281	19.6	<0.500	0.147	0.000130	0.000270	0.151	<0.0000200	0.0320	0.000240	<0.000100	0.151	0.000139
	Annual Mean	218	8.38	8.39	10.9	200	0.283	0.00104	0.00970	14.1	<0.500	0.126	0.000102	0.000195	0.118	<0.0000200	0.0213	0.000107	<0.000100	0.0258	0.0000540
	Annual Median	212	8.41	8.39	10.8	200	0.174	<0.00100	0.00790	14.2	<0.500	0.130	<0.000100	0.000190	0.117	<0.0000200	0.0210	<0.000100	<0.000100	0.0160	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0%	95%	41%	0%	100%	0%	86%	0%	0%	100%	0%	86%	100%	23%	95%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WILLOW	**n**	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
	Annual Minimum	206	8.08	6.83	8.40	197	0.0831	<0.00100	<0.00500	11.2	<0.500	0.0960	<0.000100	0.000180	0.157	<0.0000200	<0.0100	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	303	8.52	8.35	13.1	276	0.720	0.00710	0.0529	24.0	0.880	0.165	0.000110	0.000280	0.232	<0.0000200	0.0170	0.000270	0.000120	0.0670	0.0000690
	Annual Mean	230	8.31	8.07	10.5	219	0.284	0.00130	0.0109	17.1	0.550	0.145	0.000101	0.000225	0.197	<0.0000200	0.0131	0.000119	0.000101	0.0237	0.0000508
	Annual Median	225	8.31	8.12	10.3	217	0.197	<0.00100	0.00640	17.4	<0.500	0.150	<0.000100	0.000220	0.196	<0.0000200	0.0130	<0.000100	<0.000100	0.0180	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	91%	39%	0%	70%	0%	83%	0%	0%	100%	9%	74%	96%	17%	96%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WILLOW _SP1	**n**	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Annual Minimum	208	8.45	8.65	8.00	191	<0.00500	<0.00100	<0.00500	12.1	<0.500	0.137	<0.000100	0.000200	0.156	<0.0000200	0.0120	0.000100	<0.000100	0.0200	<0.0000500
	Annual Maximum	211	8.61	8.91	8.60	266	0.107	0.00160	<0.00500	13.1	<0.500	0.139	<0.000100	0.000230	0.163	<0.0000200	0.0120	0.000210	<0.000100	0.0650	<0.0000500
	Annual Mean	210	8.53	8.78	8.30	228	0.0560	0.00130	<0.00500	12.6	<0.500	0.138	<0.000100	0.000215	0.160	<0.0000200	0.0120	0.000155	<0.000100	0.0425	<0.0000500
	Annual Median	210	8.53	8.78	8.30	228	0.0560	0.00130	<0.00500	12.6	<0.500	0.138	<0.000100	0.000215	0.160	<0.0000200	0.0120	0.000155	<0.000100	0.0425	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	50%	50%	100%	0%	100%	0%	100%	0%	0%	100%	0%	0%	100%	0%	100%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WADE	**n**	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	237	8.08	8.07	7.70	201	0.106	<0.00100	<0.00500	7.97	<0.500	0.0940	0.000150	0.000240	0.109	<0.0000200	<0.0100	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	311	8.53	8.49	13.3	273	1.47	<0.00100	0.0206	41.2	0.640	0.166	0.000200	0.000400	0.154	<0.0000200	0.0660	0.000320	0.000190	0.211	0.000203
	Annual Mean	279	8.38	8.36	11.0	241	0.569	<0.00100	0.0112	32.4	0.537	0.138	0.000174	0.000307	0.131	<0.0000200	0.0445	0.000195	0.000116	0.0703	0.0000913
	Annual Median	275	8.41	8.39	11.3	240	0.474	<0.00100	0.00925	33.2	0.520	0.152	0.000170	0.000300	0.130	<0.0000200	0.0420	0.000200	<0.000100	0.0530	0.0000665
	% < LRL	0%	0%	0%	0%	0%	0.0%	100%	20%	0%	40%	0%	0%	0%	0%	100%	10%	40%	80%	40%	50%
	% > BCWQG[a]	-	0%	0%	10%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	10%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Dissolved Solids (mg/L)	Lab pH	Field pH	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Total Chloride (mg/L)	Total Fluoride (mg/L)	Total Antimony (mg/L)	Total Arsenic (mg/L)	Total Barium (mg/L)	Total Beryllium (mg/L)	Total Boron (mg/L)	Total Chromium (mg/L)	Total Cobalt (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)
GH_COUGAR	n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Annual Minimum	228	8.27	8.33	13.4	178	0.194	<0.00100	0.00630	16.4	0.890	0.0730	0.000110	0.000260	0.103	<0.0000200	0.0170	<0.000100	<0.000100	0.0290	<0.0000500
	Annual Maximum	228	8.27	8.33	13.4	178	0.194	<0.00100	0.00630	16.4	0.890	0.0730	0.000110	0.000260	0.103	<0.0000200	0.0170	<0.000100	<0.000100	0.0290	<0.0000500
	Annual Mean	228	8.27	8.33	13.4	178	0.194	<0.00100	0.00630	16.4	0.890	0.0730	0.000110	0.000260	0.103	<0.0000200	0.0170	<0.000100	<0.000100	0.0290	<0.0000500
	Annual Median	228	8.27	8.33	13.4	178	0.194	<0.00100	0.00630	16.4	0.890	0.0730	0.000110	0.000260	0.103	<0.0000200	0.0170	<0.000100	<0.000100	0.0290	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%	100%	100%	0%	100%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_NNC	n	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
	Annual Minimum	210	7.93	7.73	7.80	166	0.368	<0.00100	<0.00500	9.74	<0.500	0.0730	<0.000100	0.000160	0.0785	<0.0000200	0.0190	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	296	8.61	8.02	12.1	275	2.31	0.00200	0.0967	13.5	0.560	0.144	0.000150	0.000310	0.143	<0.0000200	0.0330	0.000320	0.000140	0.276	0.000225
	Annual Mean	249	8.24	7.87	9.74	234	0.899	0.00106	0.0150	12.0	0.505	0.120	0.000103	0.000221	0.112	<0.0000200	0.0271	0.000120	0.000103	0.0586	0.0000681
	Annual Median	249	8.24	7.87	9.60	234	0.799	<0.00100	0.0109	12.4	<0.500	0.123	<0.000100	0.000200	0.112	<0.0000200	0.0260	<0.000100	<0.000100	0.0390	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	90%	24%	0%	86%	0%	86%	0%	0%	100%	0%	81%	86%	5%	81%
	% > BCWQG[a]	-	0%	0%	5%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	5%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_BR_D	n	17	17	16	16	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	Annual Minimum	196	7.93	7.78	7.30	154	<0.00500	<0.00100	<0.00500	3.66	<0.500	0.0670	0.000100	0.000220	0.0833	<0.0000200	0.0100	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	322	8.52	8.27	12.6	286	0.941	<0.00100	0.0262	36.9	0.710	0.108	0.000210	0.000460	0.169	<0.0000200	0.0340	0.000320	0.000110	0.0610	0.0000590
	Annual Mean	245	8.23	7.97	9.56	231	0.174	<0.00100	0.0107	8.34	0.513	0.0952	0.000146	0.000297	0.126	<0.0000200	0.0159	0.000124	0.000101	0.0228	0.0000505
	Annual Median	237	8.24	7.97	9.55	234	0.0551	<0.00100	0.00860	7.19	<0.500	0.0990	0.000140	0.000280	0.129	<0.0000200	0.0150	<0.000100	<0.000100	0.0150	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	11.8%	100%	12%	0%	88%	0%	0%	0%	0%	100%	0%	65%	94%	12%	88%
	% > BCWQG[a]	-	0%	0%	6%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	6%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_MC1	n	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
	Annual Minimum	305	8.25	8.20	8.30	212	<0.00500	<0.00100	<0.00500	66.2	1.30	0.121	0.000260	0.000200	0.0588	<0.0000200	0.0260	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	431	8.63	8.68	14.4	321	1.09	0.00280	0.0612	111	4.95	0.239	0.000380	0.000370	0.0895	<0.0000200	0.0450	0.000160	0.000330	0.0970	0.0000700
	Annual Mean	352	8.45	8.49	10.6	258	0.187	0.00114	0.0114	83.6	2.20	0.200	0.000322	0.000281	0.0717	<0.0000200	0.0347	0.000104	0.000114	0.0175	0.0000511
	Annual Median	348	8.48	8.51	10.5	254	0.0664	<0.00100	0.00870	83.8	1.99	0.204	0.000320	0.000260	0.0708	<0.0000200	0.0330	<0.000100	<0.000100	<0.0100	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	4.3%	91%	13%	0%	0%	0%	0%	0%	0%	100%	0%	87%	91%	70%	91%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_LC2	n	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	Annual Minimum	1,220	8.03	8.05	7.70	251	16.6	0.00150	<0.00500	523	3.10	0.120	0.00221	0.000310	0.0315	<0.0000200	0.0200	<0.000100	0.000210	<0.0100	<0.0000500
	Annual Maximum	2,070	8.39	8.54	14.2	351	70.5	0.0217	0.0556	934	7.60	0.270	0.00466	0.000600	0.0581	<0.0000400	0.0400	0.000290	0.00295	<0.0200	<0.000100
	Annual Mean	1,760	8.28	8.32	10.8	290	54.2	0.00521	0.0131	827	5.72	0.183	0.00274	0.000430	0.0458	<0.0000200	0.0303	0.000116	0.000492	0.0102	<0.0000500
	Annual Median	1,820	8.29	8.34	10.8	288	64.0	0.00150	0.00935	856	5.85	0.180	0.00246	0.000415	0.0480	<0.0000200	0.0305	<0.000100	0.000305	<0.0100	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	54%	14%	0%	0%	0%	0%	0%	0%	100%	0%	82%	0%	93%	100%
	% > BCWQG[a]	-	0%	0%	4%	0%	100%	0%	7%	100%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	4%	-	79%	0%	7%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	100%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Dissolved Solids (mg/L)	Lab pH	Field pH	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Total Chloride (mg/L)	Total Fluoride (mg/L)	Total Antimony (mg/L)	Total Arsenic (mg/L)	Total Barium (mg/L)	Total Beryllium (mg/L)	Total Boron (mg/L)	Total Chromium (mg/L)	Total Cobalt (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)
GH_LC1	n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
	Annual Minimum	1,310	8.13	7.80	8.70	192	16.3	<0.00500	<0.00500	628	3.30	<0.100	0.00234	0.000280	0.0306	<0.0000200	0.0180	<0.000100	0.000230	<0.0100	<0.0000500
	Annual Maximum	1,840	8.40	8.38	11.1	315	66.4	0.198	0.0361	866	6.00	0.280	0.00458	0.000470	0.0442	<0.0000400	0.0360	<0.000200	0.00252	<0.0200	<0.000100
	Annual Mean	1,560	8.25	8.15	10.3	270	37.3	0.0590	0.0126	745	4.37	0.207	0.00350	0.000391	0.0376	<0.0000200	0.0257	<0.000100	0.000871	0.0113	<0.0000500
	Annual Median	1,470	8.24	8.17	10.6	278	25.7	0.0138	0.0111	708	3.60	0.210	0.00394	0.000390	0.0350	<0.0000200	0.0230	<0.000100	0.000630	<0.0100	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	14%	43%	0%	0%	14%	0%	0%	0%	100%	0%	100%	0%	71%	100%
	% > BCWQG[a]	-	0%	0%	0%	0%	100%	29%	0%	100%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	43%	29%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	100%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WC2	n	47	47	45	45	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
	Annual Minimum	1,560	8.03	6.71	8.60	246	41.6	<0.00500	<0.00500	656	2.60	<0.0500	0.00134	<0.000200	0.0535	<0.0000200	0.0200	<0.000100	0.000170	<0.0100	<0.0000500
	Annual Maximum	2,700	8.40	8.83	14.0	350	84.4	0.0161	0.194	1,430	6.00	0.200	0.00259	0.000770	0.0916	<0.0000400	0.0380	0.000450	0.00533	0.257	0.000208
	Annual Mean	2,150	8.22	8.18	11.5	281	64.0	0.00690	0.0187	1,030	4.71	0.107	0.00208	0.000321	0.0709	<0.0000200	0.0270	0.000127	0.000494	0.0338	0.0000618
	Annual Median	2,170	8.21	8.30	11.7	269	61.5	0.00590	0.0101	1,030	5.00	0.120	0.00207	0.000300	0.0704	<0.0000200	0.0260	<0.000100	0.000230	<0.0100	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	36%	17%	0%	0%	34%	0%	4%	0%	100%	0%	72%	6%	60%	83%
	% > BCWQG[a]	-	0%	0%	0%	0%	100%	0%	9%	100%	0%	-	0%	-	0%	0%	0%	0%	2%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	100%	0%	9%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	100%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_WC1	n	32	32	41	41	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
	Annual Minimum	1,130	8.05	6.99	1.70	214	30.2	<0.00500	<0.00500	461	<2.50	<0.100	0.00105	0.000200	0.0567	<0.0000200	0.0200	<0.000100	0.000180	<0.0100	<0.0000500
	Annual Maximum	2,860	8.33	8.50	14.4	347	86.3	0.0548	0.129	1,420	6.60	<0.200	0.00253	0.00122	0.106	0.000114	0.0350	0.00200	0.00173	2.54	0.00112
	Annual Mean	2,190	8.20	8.20	10.9	270	67.3	0.0133	0.0250	1,020	4.96	0.122	0.00205	0.000350	0.0674	0.0000229	0.0260	0.000184	0.000371	0.119	0.0000941
	Annual Median	2,260	8.19	8.25	11.4	268	75.4	0.00920	0.0146	1,030	5.20	0.120	0.00207	0.000300	0.0652	<0.0000200	0.0250	<0.000100	0.000230	0.0130	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	16%	19%	0%	3%	41%	0%	0%	0%	97%	0%	69%	16%	47%	72%
	% > BCWQG[a]	-	0%	0%	2%	0%	100%	9%	0%	100%	0%	-	0%	-	0%	0%	0%	3%	0%	-	0%
	% > BCWQG[b]	-	-	-	2%	-	97%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	3%	0%
	% > Level 1 EVWQP Benchmark	100%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_TC2	n	14	14	27	27	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
	Annual Minimum	758	8.11	7.80	8.70	165	6.47	<0.00500	0.00610	455	11.2	<0.100	0.000110	0.000150	0.0488	<0.0000200	0.0150	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	1,750	8.38	8.55	17.3	269	18.5	0.0638	0.0712	939	18.6	0.170	<0.000200	0.000330	0.0792	<0.0000400	0.0255	0.000220	<0.000200	0.0570	<0.000100
	Annual Mean	1,260	8.26	8.31	12.5	209	11.9	0.0242	0.0306	692	14.3	0.111	0.000147	0.000230	0.0663	<0.0000200	0.0216	0.000117	<0.000100	0.0218	<0.0000500
	Annual Median	1,340	8.27	8.31	12.5	203	11.4	0.0202	0.0204	748	14.3	0.105	0.000150	0.000230	0.0647	<0.0000200	0.0220	<0.000100	<0.000100	0.0170	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	21%	0%	0%	0%	50%	7%	7%	0%	100%	7%	79%	100%	21%	100%
	% > BCWQG[a]	-	0%	0%	0%	0%	100%	0%	29%	100%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	29%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	57%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_TC1	n	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
	Annual Minimum	833	8.12	8.10	7.40	161	0.540	<0.00500	<0.00500	451	11.0	<0.100	0.000110	0.000180	0.0503	<0.0000200	0.0150	<0.000100	<0.000100	<0.0100	<0.0000500
	Annual Maximum	2,050	8.51	8.65	13.4	287	19.4	0.0575	0.0644	943	18.0	0.120	0.000190	0.000370	0.0899	<0.0000200	0.0270	0.000990	0.000180	0.256	0.000152
	Annual Mean	1,150	8.33	8.38	9.99	206	9.91	0.0138	0.0165	625	13.9	0.104	0.000144	0.000233	0.0649	<0.0000200	0.0209	0.000160	0.000103	0.0420	0.0000548
	Annual Median	998	8.34	8.36	9.50	194	8.48	0.00890	0.0110	565	13.6	<0.100	0.000140	0.000220	0.0652	<0.0000200	0.0205	0.000100	<0.000100	0.0245	<0.0000500
	% < LRL	0%	0%	0%	0%	0%	0.0%	25%	11%	0%	0%	54%	0%	0%	0%	100%	0%	46%	96%	11%	89%
	% > BCWQG[a]	-	0%	0%	7%	0%	96%	0%	0%	100%	0%	-	0%	-	0%	0%	0%	0%	0%	-	0%
	% > BCWQG[b]	-	-	-	7%	-	0%	0%	0%	-	0%	0%	-	0%	-	-	-	-	0%	0%	0%
	% > Level 1 EVWQP Benchmark	50%	-	-	-	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

▨ > 5% of samples exceed the guideline or benchmark.
▧ > 50% of samples exceed the guideline or benchmark.
■ > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline

[a] Long-term average BCQWG for the Protection of Aquatic Life. [b] Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures. [c] Benchmarks are interim screening values 1-3.

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Lithium (mg/L)	Total Manganese (mg/L)	Total Molybdenum (mg/L)	Total Nickel (mg/L)[c]	Total Selenium (mg/L)	Total Sliver (mg/L)	Total Thallium (mg/L)	Total Uranium (mg/L)	Total Zinc (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
GH_BR_F	n	11	11	11	11	11	11	11	11	11	11	11	11	11
	Annual Minimum	0.00910	0.000260	0.000456	0.000600	0.000482	<0.0000100	<0.0000100	0.000619	<0.00300	<0.00300	0.00000950	0.000520	<0.0100
	Annual Maximum	0.0133	0.00416	0.000532	0.000980	0.00106	<0.0000100	<0.0000100	0.00123	<0.00300	0.0123	0.0000143	0.000750	0.0230
	Annual Mean	0.0120	0.00100	0.000506	0.000762	0.000645	<0.0000100	<0.0000100	0.000934	<0.00300	0.00554	0.0000119	0.000635	0.0120
	Annual Median	0.0124	0.000450	0.000506	0.000750	0.000635	<0.0000100	<0.0000100	0.000954	<0.00300	0.00340	0.0000118	0.000630	<0.0100
	% < LRL	0%	9%	0%	0%	0%	100%	100%	0%	100%	27%	0%	0%	73%
	% > BCWQG[a]	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_WOLF	n	22	22	22	22	22	22	22	22	22	22	22	22	22
	Annual Minimum	0.00720	0.000340	0.000374	<0.000500	0.000424	<0.0000100	<0.0000100	0.000330	<0.00300	<0.00300	<0.00000500	0.000420	<0.0100
	Annual Maximum	0.0132	0.00480	0.000505	0.000710	0.000967	<0.0000100	<0.0000100	0.000558	0.00830	0.00500	0.0000134	0.000650	<0.0100
	Annual Mean	0.0103	0.00105	0.000446	0.000545	0.000665	<0.0000100	<0.0000100	0.000395	0.00345	0.00319	0.00000764	0.000475	<0.0100
	Annual Median	0.00990	0.000685	0.000438	0.000525	0.000671	<0.0000100	<0.0000100	0.000381	<0.00300	<0.00300	0.00000765	0.000420	<0.0100
	% < LRL	0%	0%	0%	45%	0%	100%	100%	0%	91%	82%	14%	50%	100%
	% > BCWQG[a]	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_WILLOW	n	23	23	23	23	23	23	23	23	23	23	23	23	23
	Annual Minimum	0.00880	0.000130	0.000421	<0.000500	0.000676	<0.0000100	<0.0000100	0.000403	<0.00300	<0.00300	0.00000700	0.000350	<0.0100
	Annual Maximum	0.0139	0.0400	0.000611	0.00117	0.00296	<0.0000100	<0.0000100	0.000638	0.0108	0.00550	0.0000138	<0.000500	0.0140
	Annual Mean	0.0116	0.00262	0.000546	0.000579	0.00133	<0.0000100	<0.0000100	0.000498	0.00334	0.00342	0.0000103	0.000350	0.0102
	Annual Median	0.0116	0.000680	0.000550	0.000510	0.00122	<0.0000100	<0.0000100	0.000485	<0.00300	<0.00300	0.0000103	0.000350	<0.0100
	% < LRL	0%	0%	0%	48%	0%	100%	100%	0%	96%	78%	0%	91%	87%
	% > BCWQG[a]	-	0%	0%	-	13%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_WILLOW_SP1	n	2	2	2	2	2	2	2	2	2	2	2	2	2
	Annual Minimum	0.00970	0.000650	0.000576	<0.000500	0.00124	<0.0000100	<0.0000100	0.000467	<0.00300	0.00420	<0.00000500	<0.000500	<0.0100
	Annual Maximum	0.0103	0.00140	0.000592	0.000560	0.00148	<0.0000100	<0.0000100	0.000522	<0.00300	0.00750	0.00000550	<0.000500	<0.0100
	Annual Mean	0.0100	0.00102	0.000584	0.000530	0.00136	<0.0000100	<0.0000100	0.000494	<0.00300	0.00585	0.00000525	<0.000500	<0.0100
	Annual Median	0.0100	0.00102	0.000584	0.000530	0.00136	<0.0000100	<0.0000100	0.000494	<0.00300	0.00585	0.00000525	<0.000500	<0.0100
	% < LRL	0%	0%	0%	50%	0%	100%	100%	0%	100%	0%	50%	100%	100%
	% > BCWQG[a]	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_WADE	n	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	0.00240	0.000120	0.00117	0.000630	0.000466	<0.0000100	<0.0000100	0.000368	<0.00300	<0.00300	0.00000870	<0.000500	<0.0100
	Annual Maximum	0.0259	0.00668	0.00153	0.00125	0.00740	0.0000120	0.0000200	0.00108	<0.00300	0.00890	0.0000252	0.00109	0.0150
	Annual Mean	0.0185	0.00214	0.00131	0.000859	0.00319	0.0000102	0.0000117	0.000899	<0.00300	0.00424	0.0000162	0.000578	0.0107
	Annual Median	0.0188	0.00179	0.00129	0.000830	0.00264	<0.0000100	<0.0000100	0.000944	<0.00300	0.00325	0.0000161	0.000500	<0.0100
	% < LRL	0%	0%	0%	0%	0%	90%	60%	0%	100%	30%	0%	40%	80%
	% > BCWQG[a]	-	0%	0%	-	80%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Lithium (mg/L)	Total Manganese (mg/L)	Total Molybdenum (mg/L)	Total Nickel (mg/L)[c]	Total Selenium (mg/L)	Total Sliver (mg/L)	Total Thallium (mg/L)	Total Uranium (mg/L)	Total Zinc (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
GH_COUGAR	n	1	1	1	1	1	1	1	1	1	1	1	1	1
	Annual Minimum	0.00530	0.00118	0.00112	0.000760	0.000695	<0.0000100	0.0000140	0.000412	0.00700	0.00440	0.0000408	0.000710	<0.0100
	Annual Maximum	0.00530	0.00118	0.00112	0.000760	0.000695	<0.0000100	0.0000140	0.000412	0.00700	0.00440	0.0000408	0.000710	<0.0100
	Annual Mean	0.00530	0.00118	0.00112	0.000760	0.000695	<0.0000100	0.0000140	0.000412	0.00700	0.00440	0.0000408	0.000710	<0.0100
	Annual Median	0.00530	0.00118	0.00112	0.000760	0.000695	<0.0000100	0.0000140	0.000412	0.00700	0.00440	0.0000408	0.000710	<0.0100
	% < LRL	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%
	% > BCWQG[a]	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_NNC	n	21	21	21	21	21	21	21	21	21	21	21	21	21
	Annual Minimum	0.00540	0.000260	0.000831	<0.000500	0.000210	<0.0000100	<0.0000100	0.000221	<0.00300	<0.00300	0.00000910	0.000330	<0.0100
	Annual Maximum	0.00950	0.0650	0.00127	0.000840	0.000449	0.0000100	0.0000230	0.000381	0.00470	0.00780	0.000132	0.000590	0.0420
	Annual Mean	0.00750	0.0111	0.00110	0.000536	0.000312	0.0000100	0.0000109	0.000322	0.00310	0.00331	0.0000182	0.000374	0.0130
	Annual Median	0.00750	0.00669	0.00111	<0.000500	0.000312	<0.0000100	<0.0000100	0.000326	<0.00300	<0.00300	0.0000124	0.000380	<0.0100
	% < LRL	0%	0%	0%	76%	0%	95%	90%	0%	90%	76%	0%	81%	52%
	% > BCWQG[a]	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_BR_D	n	17	17	17	17	17	17	17	17	17	17	17	17	17
	Annual Minimum	0.00220	0.000150	0.000950	<0.000500	0.000136	<0.0000100	<0.0000100	0.000179	<0.00300	<0.00300	0.0000195	0.000610	<0.0100
	Annual Maximum	0.0160	0.0193	0.00175	0.00119	0.00717	<0.0000100	0.0000100	0.00110	0.00710	0.00860	0.0000306	0.000970	0.0150
	Annual Mean	0.00366	0.00298	0.00117	0.000751	0.000640	<0.0000100	0.0000100	0.000354	0.00324	0.00429	0.0000246	0.000727	0.0104
	Annual Median	0.00310	0.000790	0.00110	0.000690	0.000191	<0.0000100	<0.0000100	0.000287	<0.00300	0.00400	0.0000246	0.000680	<0.0100
	% < LRL	0%	0%	0%	6%	0%	100%	94%	0%	94%	6%	0%	0%	82%
	% > BCWQG[a]	-	0%	0%	-	6%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_MC1	n	23	23	23	23	23	23	23	23	23	23	23	23	23
	Annual Minimum	0.0282	0.000130	0.00204	0.00111	0.00144	<0.0000100	<0.0000100	0.00170	<0.00300	<0.00300	0.0000198	0.000480	<0.0100
	Annual Maximum	0.0433	0.00687	0.00323	0.00263	0.0121	<0.0000100	0.0000150	0.00236	0.00980	<0.00300	0.0000325	0.000680	<0.0100
	Annual Mean	0.0333	0.000927	0.00268	0.00172	0.00348	<0.0000100	0.0000102	0.00197	0.00364	<0.00300	0.0000263	0.000516	<0.0100
	Annual Median	0.0327	0.000410	0.00270	0.00164	0.00242	<0.0000100	<0.0000100	0.00195	<0.00300	<0.00300	0.0000261	0.000480	<0.0100
	% < LRL	0%	0%	0%	0%	0%	100%	96%	0%	87%	100%	0%	61%	100%
	% > BCWQG[a]	-	0%	0%	-	70%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_LC2	n	28	28	28	28	28	28	28	28	28	28	28	28	28
	Annual Minimum	0.119	0.000390	0.0131	0.0431	0.0352	<0.0000100	0.0000260	0.00814	<0.00300	<0.00300	0.00000870	0.000390	<0.0100
	Annual Maximum	0.245	0.00235	0.0328	0.142	0.255	<0.0000200	0.0000710	0.0141	0.0434	<0.00300	0.0000710	0.00163	<0.0200
	Annual Mean	0.174	0.000752	0.0165	0.0686	0.182	<0.0000100	0.0000372	0.0118	0.00558	<0.00300	0.0000197	0.000796	<0.0100
	Annual Median	0.175	0.000660	0.0144	0.0589	0.220	<0.0000100	0.0000350	0.0124	<0.00300	<0.00300	0.0000146	0.000830	<0.0100
	% < LRL	0%	4%	0%	0%	0%	100%	0%	0%	71%	100%	39%	7%	100%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	96%	0%	0%	0%	4%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	100%	86%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	100%	-	-	-	-	-	-	-	-	-

Table C.5: Summary of Water Chemistry Data for Key Parameters for the West-Side Tributary Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Lithium (mg/L)	Total Manganese (mg/L)	Total Molybdenum (mg/L)	Total Nickel (mg/L)[c]	Total Selenium (mg/L)	Total Sliver (mg/L)	Total Thallium (mg/L)	Total Uranium (mg/L)	Total Zinc (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
GH_LC1	n	7	7	7	7	7	7	7	7	7	7	7	7	7
	Annual Minimum	0.153	0.000550	0.0131	0.0491	0.0331	<0.0000100	0.0000340	0.00816	<0.00300	<0.00300	<0.00000500	0.000390	<0.0100
	Annual Maximum	0.218	0.00180	0.0331	0.135	0.218	<0.0000200	0.0000510	0.0135	0.0393	<0.00300	0.0000590	0.000710	<0.0100
	Annual Mean	0.185	0.00111	0.0215	0.0945	0.107	<0.0000100	0.0000433	0.0108	0.00923	<0.00300	0.0000143	0.000527	<0.0100
	Annual Median	0.186	0.00102	0.0219	0.0928	0.0758	<0.0000100	0.0000410	0.0106	<0.00300	<0.00300	<0.0000100	0.000550	<0.0100
	% < LRL	0%	0%	0%	0%	0%	100%	0%	0%	57%	100%	71%	29%	100%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	86%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	100%	57%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	100%	-	-	-	-	-	-	-	-	-
GH_WC2	n	47	47	47	47	49	47	47	47	47	47	47	47	47
	Annual Minimum	0.0931	0.000540	0.00645	0.0312	0.0846	<0.0000100	0.0000140	0.0103	<0.00300	<0.00300	<0.00000500	0.000260	<0.0100
	Annual Maximum	0.218	0.00627	0.0143	0.203	0.233	<0.0000200	0.0000380	0.0218	0.0402	0.00310	0.0000525	0.000800	<0.0200
	Annual Mean	0.138	0.00199	0.0117	0.0796	0.150	0.0000101	0.0000224	0.0163	0.00556	0.00300	0.0000251	0.000363	<0.0100
	Annual Median	0.133	0.00142	0.0122	0.0719	0.152	<0.0000100	0.0000220	0.0160	<0.00300	<0.00300	0.0000270	0.000330	<0.0100
	% < LRL	0%	0%	0%	0%	0%	98%	9%	0%	79%	98%	21%	70%	100%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	100%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	100%	-	-	-	-	-	-	-	-	-
GH_WC1	n	32	32	32	32	39	32	32	32	32	32	32	32	32
	Annual Minimum	0.0722	0.000750	0.00643	0.0271	0.0781	<0.0000100	0.0000190	0.00808	<0.00300	<0.00300	<0.00000500	0.000270	<0.0100
	Annual Maximum	0.219	0.0260	0.0144	0.203	0.241	0.0000310	0.0000960	0.0212	0.0190	0.00770	0.0000696	0.00193	0.0300
	Annual Mean	0.133	0.00285	0.0118	0.0788	0.149	0.0000107	0.0000259	0.0158	0.00565	0.00315	0.0000273	0.000503	0.0109
	Annual Median	0.130	0.00182	0.0125	0.0704	0.156	<0.0000100	0.0000235	0.0156	0.00310	<0.00300	0.0000300	0.000510	<0.0100
	% < LRL	0%	0%	0%	0%	0%	97%	6%	0%	56%	97%	16%	41%	94%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	97%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	100%	100%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	100%	-	-	-	-	-	-	-	-	-
GH_TC2	n	14	14	14	14	14	14	14	14	14	14	14	14	14
	Annual Minimum	0.0140	0.00143	0.00108	0.000920	0.0667	<0.0000100	<0.0000100	0.00274	<0.00300	<0.00300	0.00000650	0.000280	<0.0100
	Annual Maximum	0.0240	0.0102	0.00140	0.00141	0.159	<0.0000200	<0.0000200	0.00574	<0.00600	0.00380	0.0000215	<0.000500	0.0100
	Annual Mean	0.0195	0.00555	0.00123	0.00115	0.111	<0.0000100	0.0000100	0.00414	<0.00300	0.00307	0.0000144	0.000333	0.0100
	Annual Median	0.0192	0.00562	0.00125	0.00112	0.118	<0.0000100	<0.0000100	0.00440	<0.00300	<0.00300	0.0000164	0.000340	<0.0100
	% < LRL	0%	0%	0%	0%	0%	100%	93%	0%	100%	86%	0%	79%	93%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	79%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_TC1	n	28	28	28	28	28	28	28	28	28	28	28	28	27
	Annual Minimum	0.0139	0.000810	0.00109	0.000870	0.0648	<0.0000100	<0.0000100	0.00266	<0.00300	<0.00300	0.00000520	0.000260	<0.0100
	Annual Maximum	0.0240	0.0187	0.00142	0.00153	0.186	0.0000240	0.0000140	0.00547	0.00870	0.00340	0.0000270	<0.000500	<0.0200
	Annual Mean	0.0181	0.00430	0.00127	0.00118	0.100	0.0000105	0.0000102	0.00370	0.00320	0.00301	0.0000160	0.000270	<0.0100
	Annual Median	0.0183	0.00337	0.00129	0.00119	0.0869	<0.0000100	<0.0000100	0.00343	<0.00300	<0.00300	0.0000156	0.000270	<0.0100
	% < LRL	0%	0%	0%	0%	0%	96%	86%	0%	96%	96%	0%	89%	100%
	% > BCWQG[a]	-	0%	0%	-	100%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	-	0%	0%	-	-	0%	-	-	0%	0%	0%	0%	0%
	% > Level 1 EVWQP Benchmark	-	-	-	0%	100%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	0%	89%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	0%	-	-	-	-	-	-	-	-	-

▒ > 5% of samples exceed the guideline or benchmark.

░ > 50% of samples exceed the guideline or benchmark.

▓ > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline

[a] Long-term average BCQWG for the Protection of Aquatic Life. [b] Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures. [c] Benchmarks are interim screening values 1-3.

Table C.6: Temporal Changes in Water Chemistry Analytes at West-side Tributary Stations, GHO LAEMP, 2012 to 2019

Parameter	Status	Station	Annual Variation [a]		Q1. Is there a positive or negative change in concentrations since the base year (b) of monitoring? Magnitude of Difference (MOD)[b] and Significance (bolded) from Base Year (b) [c]								Q2. Is the 2019 annual mean greater or less than all annual historical means (2012 - 2018) and the previous year (2018)?[c]									
			DF	P-Value	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019	2019 vs. 2012-2018	2019 vs. 2018
Total Selenium	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	<0.001	b	-10	-	-	**-19**	-	-14	**-22**	A	AB	-	-	BC	-	ABC	C	ns	ns
		GH_WILLOW	6	<0.001	b	40	60	62	**114**	-	-5.9	17	BC	ABC	AB	AB	A	-	C	BC	ns	ns
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	0.013	b	-27	0.42	-29	-24	16	-	-	A	A	A	A	A	A	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	<0.001	-	-	b	-8.3	24	11	**26**	**57**	-	-	CD	D	BC	BCD	B	A	↑	↑
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	5.2	5.8	**298**	**143**	**134**	98	**107**	D	CD	CD	A	AB	AB	ABCD	BC	ns	ns
		GH_LC2	7	<0.001	b	50	88	104	22	78	**356**	**248**	C	C	BC	BC	C	BC	A	AB	ns	ns
		GH_LC1	3	<0.001	-	-	-	-	b	52	**282**	84	-	-	-	-	B	B	A	AB	ns	ns
		GH_WC2	7	<0.001	b	0.74	51	21	12	**189**	**195**	**295**	B	B	B	B	B	A	A	A	ns	ns
		GH_WC1	2	<0.001	-	-	-	-	b	-	**138**	**261**	-	-	-	-	C	-	B	A	↑	↑
		GH_TC2	7	<0.001	b	9.4	12	-16	-10	5.7	**32**	12	BC	AB	AB	C	BC	AB	A	AB	ns	ns
		GH_TC1	7	<0.001	b	6.0	4.5	**-20**	-13	-0.38	**28**	12	BC	ABC	ABC	D	CD	BC	A	AB	ns	ns
Nitrate-N	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	0.002	b	70	-	-	44	-	-42	27	AB	A	-	-	A	-	B	A	ns	↑
		GH_WILLOW	6	<0.001	b	68	29	71	41	-	-50	65	AB	A	A	A	A	-	B	A	ns	↑
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	<0.001	b	-40	-36	**-71**	**-73**	**-64**	-	-	A	ABC	AB	CD	D	BCD	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	<0.001	-	-	b	**193**	**501**	**4,044**	**3,649**	**4,726**	-	-	C	B	B	A	A	A	ns	ns
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	-6.9	-52	**1,809**	**916**	-4.6	-60	-63	B	B	B	A	A	B	B	B	ns	ns
		GH_LC2	7	<0.001	b	54	33	1.3	-9.3	33	**140**	68	BC	ABC	BC	BC	C	BC	A	AB	ns	ns
		GH_LC1	3	<0.001	-	-	-	-	b	**69**	**147**	20	-	-	-	-	C	AB	A	BC	ns	↓
		GH_WC2	7	<0.001	b	8.9	**60**	31	35	**191**	**186**	**218**	C	BC	B	BC	BC	A	A	A	ns	ns
		GH_WC1	2	<0.001	-	-	-	-	b	-	**107**	**160**	-	-	-	-	B	-	A	A	ns	ns
		GH_TC2	7	<0.001	b	-1.8	-7.6	**-30**	**-28**	**-22**	-3.7	-9.4	A	AB	AB	D	CD	BCD	AB	ABC	ns	ns
		GH_TC1	7	<0.001	b	-10	-18	**-36**	**-31**	**-27**	-6.0	-16	A	AB	ABCD	D	CD	BCD	A	ABC	ns	ns

▨	P-value < 0.05		
🟩	> 20% Decrease in concentration	🟦	> 25% Increase in concentration
🟩	> 33% Decrease in concentration	🟦	> 50% Increase in concentration
🟩	> 43% Decrease in concentration	🟦	> 75% Increase in concentration
🟩	> 50% Decrease in concentration	🟦	> 100% Increase in concentration
bold	Significant increase or decrease from base year (b)		
🟩	Significantly < than all historical years (or 2018)		
🟦	Significantly > than all historical years (or 2018)		

Notes: "ns" = not significant. "-" = insufficient data.

[a] *Year* p-value from an ANOVA with factors *Year* and *Month.*

[b] Magnitude of Difference (MOD) = $[\text{Mean}_{\text{given year}} - \text{Mean}_{\text{year b}}] / \text{Mean}_{\text{year b}} \times 100\%$.

[c] Significance amongs year determined using all pairwise comparisons using Tukey's honestly signifciant differences method. Years that share a letter are not significantly different. Letters assigned such that the mean with with highest magnitude is assigned "A".

Table C.6: Temporal Changes in Water Chemistry Analytes at West-side Tributary Stations, GHO LAEMP, 2012 to 2019

Parameter	Status	Station	Annual Variation [a]		Q1. Is there a positive or negative change in concentrations since the base year (b) of monitoring?								Q2. Is the 2019 annual mean greater or less than all annual historical means (2012 - 2018) and the previous year (2018)?[c]									
					Magnitude of Difference (MOD)[b] and Significance (bolded) from Base Year (b) [c]																	
			DF	P-Value	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019	2019 vs. 2012-2018	2019 vs. 2018
Sulphate	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	0.453	b	ns	-	-	ns	-	ns	ns	ns	ns	-	-	ns	-	ns	ns	ns	ns
		GH_WILLOW	6	<0.001	b	23	**46**	**40**	32	-	32	7.7	C	ABC	A	AB	ABC	-	ABC	BC	ns	ns
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	<0.001	b	-4.5	**31**	**24**	**65**	**55**	-	-	D	D	BC	C	A	AB	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	<0.001	-	-	b	**36**	**38**	8.3	-8.1	7.4	-	-	C	A	AB	BC	C	C	ns	ns
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	-18	-3.1	**414**	**449**	45	35	28	B	B	B	A	A	B	B	B	ns	ns
		GH_LC2	7	<0.001	b	43	**162**	**284**	**271**	**307**	**326**	**321**	C	C	B	A	AB	A	A	A	ns	ns
		GH_LC1	3	0.812	-	-	-	-	b	ns	ns	ns	-	-	-	-	ns	ns	ns	ns	ns	ns
		GH_WC2	7	<0.001	b	4.4	7.9	**52**	**79**	**85**	**144**	**206**	E	E	DE	CD	C	BC	AB	A	ns	ns
		GH_WC1	2	<0.001	-	-	-	-	b	-	**49**	**82**	-	-	-	-	C	-	B	A	↑	↑
		GH_TC2	7	<0.001	b	7.8	19	4.1	11	21	**38**	**36**	B	B	AB	B	B	AB	A	A	ns	ns
		GH_TC1	7	<0.001	b	2.6	13	0.53	11	19	**38**	**35**	C	C	BC	C	C	ABC	A	AB	ns	ns
Total Dissolved Solids	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	<0.001	b	3.6	-	-	**14**	-	**16**	**12**	C	BC	-	-	AB	-	A	AB	ns	ns
		GH_WILLOW	6	0.014	b	2.9	11	11	6.8	-	9.6	0.50	A	A	A	A	A	-	A	A	ns	ns
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	<0.001	b	3.7	**16**	**23**	**24**	**18**	-	-	C	BC	AB	A	A	AB	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	<0.001	-	-	b	**12**	**11**	**13**	8.6	1.9	-	-	C	A	AB	A	ABC	BC	ns	ns
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	0.12	5.4	**169**	**162**	16	16	9.3	B	B	B	A	A	B	B	B	ns	ns
		GH_LC2	7	<0.001	b	**40**	**86**	**131**	**127**	**151**	**178**	**159**	D	C	B	AB	AB	A	A	A	ns	ns
		GH_LC1	3	0.279	-	-	-	-	b	ns	ns	ns	-	-	-	-	ns	ns	ns	ns	ns	ns
		GH_WC2	7	<0.001	b	5.4	13	**33**	**57**	**78**	**104**	**153**	F	EF	EF	DE	CD	BC	B	A	↑	↑
		GH_WC1	2	<0.001	-	-	-	-	b	-	**42**	**72**	-	-	-	-	C	-	B	A	↑	↑
		GH_TC2	7	0.067	b	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
		GH_TC1	7	<0.001	b	2.6	10	-1.1	6.1	14	**26**	**22**	C	C	ABC	C	BC	ABC	A	AB	ns	ns

▨	P-value < 0.05
🟩	> 20% Decrease in concentration
🟩	> 33% Decrease in concentration
🟩	> 43% Decrease in concentration
🟩	> 50% Decrease in concentration
bold	Significant increase or decrease from base year (b)
🟩	Significantly < than all historical years (or 2018)
🟦	Significantly > than all historical years (or 2018)
🟦	> 25% Increase in concentration
🟦	> 50% Increase in concentration
🟦	> 75% Increase in concentration
🟦	> 100% Increase in concentration

Notes: "ns" = not significant. "-" = insufficient data.

[a] *Year* p-value from an ANOVA with factors *Year* and *Month.*

[b] Magnitude of Difference (MOD) = [Mean$_{\text{given year}}$ − Mean$_{\text{year b}}$] /Mean$_{\text{year b}}$ × 100%.

[c] Significance amongs year determined using all pairwise comparisons using Tukey's honestly signifciant differences method. Years that share a letter are not significantly different. Letters assigned such that the mean with with highest magnitude is assigned "A".

Table C.6: Temporal Changes in Water Chemistry Analytes at West-side Tributary Stations, GHO LAEMP, 2012 to 2019

Parameter	Status	Station	Annual Variation [a]		Q1. Is there a positive or negative change in concentrations since the base year (b) of monitoring? Magnitude of Difference (MOD)[b] and Significance (bolded) from Base Year (b) [c]								Q2. Is the 2019 annual mean greater or less than all annual historical means (2012 - 2018) and the previous year (2018)?[c]									
			DF	P-Value	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019	2019 vs. 2012-2018	2019 vs. 2018
Total Nickel	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	0.062	b	ns	-	-	ns	-	ns	ns	ns	ns	-	-	ns	-	ns	ns	ns	ns
		GH_WILLOW	6	0.792	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns	-	ns	ns	ns	ns
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	0.160	b	ns	ns	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	<0.001	-	-	b	2.8	17	16	**85**	-5.7	-	-	B	B	B	B	A	B	ns	↓
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	22	-3.4	**1,328**	**1,485**	169	128	54	B	B	B	A	A	B	B	B	ns	ns
		GH_LC2	7	<0.001	b	46	**187**	**404**	**371**	**481**	**416**	**512**	C	C	B	A	AB	A	A	A	ns	ns
		GH_LC1	3	0.083	-	-	-	-	b	ns	ns	ns	-	-	-	-	ns	ns	ns	ns	ns	ns
		GH_WC2	7	<0.001	b	-28	-28	-6.5	13	-9.1	**55**	38	BCD	D	CD	BCD	ABC	BCD	A	AB	ns	ns
		GH_WC1	2	0.001	-	-	-	-	b	-	**60**	25	-	-	-	-	B	-	A	AB	ns	ns
		GH_TC2	7	<0.001	b	**107**	**78**	-32	1.9	**-49**	**-66**	**-73**	B	A	A	BC	B	CD	DE	E	ns	ns
		GH_TC1	7	<0.001	b	**80**	49	**-42**	-25	**-54**	**-69**	**-75**	BC	A	AB	DE	CD	EF	FG	G	ns	ns
Uranium	Reference	GH_BR_F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mine-exposed	GH_WOLF	4	<0.001	b	8.3	-	-	**28**	-	22	**57**	C	BC	-	-	B	-	BC	A	↑	↑
		GH_WILLOW	6	0.015	b	4.8	21	-1.7	-13	-	3.3	2.1	AB	AB	A	AB	B	-	AB	AB	ns	ns
		GH_WILLOW_SP1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WILLOW_S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_WADE	5	<0.001	b	13	**62**	**56**	**47**	16	-	-	B	B	A	A	A	B	-	-	-	-
		GH_COUGAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_NNC	5	0.060	-	-	b	ns	ns	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns	ns	ns
		GH_BR_D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		GH_MC1	7	<0.001	b	2.8	10	**599**	**723**	**179**	**156**	**140**	C	C	C	A	A	B	B	B	ns	ns
		GH_LC2	7	<0.001	b	29	**95**	**277**	**305**	**321**	**293**	**295**	C	C	B	A	A	A	A	A	ns	ns
		GH_LC1	3	0.002	-	-	-	-	b	-2.1	**-24**	**-24**	-	-	-	-	A	AB	C	BC	ns	ns
		GH_WC2	7	<0.001	b	3.3	21	**50**	**90**	**83**	**120**	**191**	E	E	DE	CD	BC	BC	AB	A	ns	ns
		GH_WC1	2	<0.001	-	-	-	-	b	-	**20**	**61**	-	-	-	-	C	-	B	A	↑	↑
		GH_TC2	7	<0.001	b	25	**31**	-8.7	2.1	-6.3	14	12	BC	AB	A	C	BC	C	ABC	ABC	ns	ns
		GH_TC1	7	<0.001	b	19	18	-15	-2.9	-8.7	11	8.0	ABC	A	A	C	ABC	BC	AB	AB	ns	ns

▨	P-value < 0.05		
🟩	> 20% Decrease in concentration	🟦	> 25% Increase in concentration
🟩	> 33% Decrease in concentration	🟦	> 50% Increase in concentration
🟩	> 43% Decrease in concentration	🟦	> 75% Increase in concentration
🟩	> 50% Decrease in concentration	🟦	> 100% Increase in concentration
bold	Significant increase or decrease from base year (b)		
🟩	Significantly < than all historical years (or 2018)		
🟦	Significantly > than all historical years (or 2018)		

Notes: "ns" = not significant. "-" = insufficient data.

[a] *Year* p-value from an ANOVA with factors *Year* and *Month.*

[b] Magnitude of Difference (MOD) = $[\text{Mean}_{\text{given year}} - \text{Mean}_{\text{year b}}] / \text{Mean}_{\text{year b}} \times 100\%$.

[c] Significance amongs year determined using all pairwise comparisons using Tukey's honestly signifciant differences method. Years that share a letter are not significantly different. Letters assigned such that the mean with with highest magnitude is assigned "A".

Table C.7: Summary of Water Chemistry Data for Key Parameters for the Elk River Side Channel Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Dissolved Solids (mg/L)	Lab pH	Field pH	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Total Chloride (mg/L)	Total Fluoride (mg/L)	Total Antimony (mg/L)	Total Arsenic (mg/L)	Total Barium (mg/L)	Total Beryllium (mg/L)	Total Boron (mg/L)	Total Chromium (mg/L)
GH_ERSC4	n	10	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	141	8.19	7.79	9.40	118	0.0399	<0.00100	<0.00500	14.3	<0.500	0.143	<0.000100	<0.000100	0.0379	<0.0000200	<0.0100	0.000200
	Annual Maximum	181	8.43	8.44	14.0	203	0.111	0.00530	0.0836	24.2	0.780	0.174	0.000110	0.000780	0.0524	0.0000710	<0.0100	0.00227
	Annual Mean	167	8.30	8.23	10.9	147	0.0820	0.00148	0.0224	20.4	0.528	0.159	0.000101	0.000193	0.0457	0.0000251	<0.0100	0.000489
	Annual Median	168	8.26	8.25	10.5	146	0.0894	<0.00100	0.00780	21.0	<0.500	0.163	<0.000100	0.000135	0.0462	<0.0000200	<0.0100	0.000285
	% < LRL	0%	0%	0%	0%	0%	0%	80%	30%	0%	90%	0%	90%	10%	0%	90%	100%	0%
	% > BCWQG^{a}	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	10%
	% > BCWQG^{b}	-	-	-	0%	-	0%	0%	0%	-	10%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_ER1A	n	14	14	15	14	14	14	14	14	14	14	14	14	14	14	14	14	14
	Annual Minimum	155	8.05	7.63	8.00	126	0.0628	<0.00100	<0.00500	17.0	<0.500	0.120	<0.000100	0.000100	0.0367	<0.0000200	<0.0100	0.000230
	Annual Maximum	1,140	8.44	8.33	11.8	315	32.3	0.0109	0.0175	523	3.60	0.179	0.000540	0.000660	0.149	0.0000580	0.0180	0.00415
	Annual Mean	242	8.29	8.19	10.0	149	2.60	0.00171	0.00761	57.1	0.763	0.155	0.000136	0.000255	0.0517	0.0000266	0.0106	0.000821
	Annual Median	174	8.30	8.22	10.0	138	0.292	<0.00100	0.00640	21.6	<0.500	0.158	<0.000100	0.000190	0.0449	<0.0000200	<0.0100	0.000450
	% < LRL	0%	0%	0%	0%	0%	0%	93%	21%	0%	71%	0%	71%	0%	0%	71%	93%	0%
	% > BCWQG^{a}	-	0%	0%	0%	0%	7%	0%	0%	7%	0%	-	0%	-	0%	0%	0%	21%
	% > BCWQG^{b}	-	-	-	0%	-	0%	0%	0%	-	7%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	7%	-	-	-	-	-	-	-	7%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RG_GH-SCW1	n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Annual Minimum	151	8.20	7.54	9.52	130	0.0401	<0.00100	0.00590	16.5	<0.500	0.160	<0.000100	<0.000100	0.0415	<0.0000200	<0.0100	0.000260
	Annual Maximum	196	8.35	8.18	13.0	148	0.232	<0.00100	0.0495	22.2	<0.500	0.186	<0.000100	0.000260	0.0459	0.0000210	<0.0100	0.000640
	Annual Mean	171	8.31	7.96	10.7	140	0.136	<0.00100	0.0172	20.5	<0.500	0.174	<0.000100	0.000177	0.0434	0.0000202	<0.0100	0.000396
	Annual Median	166	8.34	8.09	10.4	140	0.129	<0.00100	0.0102	21.3	<0.500	0.174	<0.000100	0.000145	0.0427	<0.0000200	<0.0100	0.000310
	% < LRL	0%	0%	0%	0%	0%	0.0%	100%	0%	0%	100%	0%	100%	20%	0%	80%	100%	0%
	% > BCWQG^{a}	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	0%
	% > BCWQG^{b}	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RG_GH-SCW3	n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	149	8.23	7.52	9.04	131	0.124	<0.00100	<0.00500	16.4	<0.500	<0.100	<0.000100	0.000130	0.0410	<0.0000200	<0.0100	<0.000100
	Annual Maximum	1,670	8.44	8.81	14.0	249	15.7	0.0361	0.0409	890	16.4	0.189	0.000140	0.000350	0.0711	0.0000210	0.0200	0.000710
	Annual Mean	690	8.32	8.12	11.0	176	5.54	0.00607	0.0116	340	7.60	0.142	0.000106	0.000208	0.0538	0.0000201	0.0135	0.000315
	Annual Median	572	8.34	8.13	10.3	164	4.09	0.00260	0.00655	256	7.14	0.156	<0.000100	0.000185	0.0536	<0.0000200	0.0105	0.000275
	% < LRL	0%	0%	0%	0%	0%	0.0%	50%	20%	0%	30%	20%	70%	0%	0%	90%	50%	20%
	% > BCWQG^{a}	-	0%	0%	0%	0%	50%	10%	20%	40%	0%	-	0%	-	0%	0%	0%	0%
	% > BCWQG^{b}	-	-	-	0%	-	0%	0%	20%	-	0%	20%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	20%	-	-	-	-	-	-	-	40%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_ERSC2	n	6	6	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6
	Annual Minimum	178	8.19	8.16	8.50	128	0.362	<0.00100	<0.00500	28.8	<0.500	0.132	<0.000100	0.000120	0.0384	<0.0000200	<0.0100	0.000200
	Annual Maximum	274	8.43	8.76	10.5	146	1.22	0.00670	0.0166	79.7	1.25	0.258	0.000120	0.000520	0.0539	0.0000490	<0.0100	0.00161
	Annual Mean	212	8.30	8.40	9.46	140	0.658	0.00200	0.00748	44.6	0.822	0.170	0.000105	0.000270	0.0467	0.0000285	<0.0100	0.000715
	Annual Median	198	8.28	8.33	9.20	142	0.544	<0.00100	<0.00500	37.3	0.785	0.160	<0.000100	0.000180	0.0464	<0.0000200	<0.0100	0.000365
	% < LRL	0%	0%	0%	0%	0%	0%	67%	67%	0%	17%	0%	67%	0%	0%	67%	100%	0%
	% > BCWQG^{a}	-	0%	0%	0%	0%	0%	0%	33%	0%	0%	-	0%	-	0%	0%	0%	33%
	% > BCWQG^{b}	-	-	-	0%	-	0%	0%	33%	-	0%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

▨ > 5% of samples exceed the guideline or benchmark.
🟦 > 50% of samples exceed the guideline or benchmark.
🟦 > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline.

[a] Long-term average BCQWG for the Protection of Aquatic Life. b Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures. [c] Benchmarks are interim screening values 1-3.

Table C.7: Summary of Water Chemistry Data for Key Parameters for the Elk River Side Channel Stations, GHO LAEMP, 2019

Station	Summary Statistic	Total Cobalt (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)	Total Lithium (mg/L)	Total Manganese (mg/L)	Total Molybdenum (mg/L)	Total Nickel (mg/L) [c]	Total Selenium (mg/L)	Total Sliver (mg/L)	Total Thallium (mg/L)	Total Uranium (mg/L)	Total Zinc (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
GH_ERSC4	n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	<0.000100	<0.0100	<0.0000500	0.00170	0.000870	0.000742	<0.000500	0.000662	<0.0000100	<0.0000100	0.000633	<0.00300	<0.00300	<0.00000500	0.293	<0.0100
	Annual Maximum	0.000570	1.34	0.000722	0.00250	0.0713	0.00107	0.00246	0.00111	0.0000230	0.0000360	0.000886	0.0111	0.00470	0.00000790	0.402	<0.0100
	Annual Mean	0.000147	0.161	0.000122	0.00203	0.00973	0.000973	0.000724	0.000912	0.0000113	0.0000126	0.000758	0.00381	0.00317	0.00000589	0.355	<0.0100
	Annual Median	<0.000100	0.0175	<0.0000500	0.00195	0.00221	0.000989	<0.000500	0.000942	<0.0000100	<0.0000100	0.000736	<0.00300	<0.00300	0.00000550	0.355	<0.0100
	% < LRL	90%	20%	80%	0%	0%	0%	70%	0%	90%	90%	0%	90%	90%	50%	80%	100%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	60%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_ER1A	n	14	14	14	14	14	14	14	16	14	14	14	14	14	14	14	14
	Annual Minimum	<0.000100	<0.0100	<0.0000500	0.00190	0.00107	0.000864	<0.000500	0.000915	<0.0000100	<0.0000100	0.000664	<0.00300	<0.00300	<0.00000500	0.318	<0.0100
	Annual Maximum	0.000440	1.19	0.000727	0.0708	0.0586	0.00357	0.00208	0.0855	0.0000230	0.0000290	0.00614	0.0102	0.00430	0.0000661	3.37	<0.0100
	Annual Mean	0.000158	0.269	0.000207	0.00756	0.0153	0.00118	0.000886	0.00668	0.0000120	0.0000140	0.00118	0.00429	0.00316	0.0000117	0.589	<0.0100
	Annual Median	<0.000100	0.117	0.000108	0.00265	0.00761	0.000999	0.000555	0.00138	<0.0000100	<0.0000100	0.000790	<0.00300	<0.00300	0.00000730	0.388	<0.0100
	% < LRL	64%	7%	21%	0%	0%	0%	43%	0%	79%	71%	0%	64%	79%	7%	93%	100%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	13%	0%	0%	0%	0%	0%	0%	21%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	6%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	6%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-
RG_GH-SCW1	n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Annual Minimum	<0.000100	<0.0100	<0.0000500	0.00180	0.00121	0.000768	<0.000500	0.000791	<0.0000100	<0.0000100	0.000677	<0.00300	<0.00300	<0.00000500	0.302	<0.0100
	Annual Maximum	0.000170	0.252	0.000271	0.00260	0.0276	0.00108	0.000820	0.00127	<0.0000100	<0.0000100	0.000817	0.00340	0.00300	0.00000750	0.390	<0.0100
	Annual Mean	0.000120	0.106	0.000120	0.00218	0.00956	0.000979	0.000596	0.000985	<0.0000100	<0.0000100	0.000739	0.00308	0.00300	0.00000627	0.358	<0.0100
	Annual Median	<0.000100	0.0535	<0.0000500	0.00210	0.00456	0.00101	0.000510	0.000850	<0.0000100	<0.0000100	0.000748	<0.00300	<0.00300	0.00000670	0.370	<0.0100
	% < LRL	60%	20%	60%	0%	0%	0%	40%	0%	100%	100%	0%	80%	80%	20%	100%	100%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	20%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-
RG_GH-SCW3	n	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Annual Minimum	<0.000100	0.0140	<0.0000500	0.00170	0.00152	0.000692	<0.000500	0.000978	<0.0000100	<0.0000100	0.000630	<0.00300	<0.00300	<0.00000500	0.292	<0.0100
	Annual Maximum	0.000180	0.307	0.000228	0.0241	0.0258	0.00134	0.00128	0.140	<0.0000100	0.0000110	0.00541	0.00400	0.00540	0.0000181	1.98	<0.0100
	Annual Mean	0.000110	0.0976	0.0000931	0.0104	0.00665	0.00111	0.000837	0.0516	<0.0000100	0.0000101	0.00236	0.00310	0.00328	0.00000940	1.02	<0.0100
	Annual Median	<0.000100	0.0830	0.0000670	0.00900	0.00425	0.00110	0.000770	0.0366	<0.0000100	<0.0000100	0.00203	<0.00300	<0.00300	0.00000850	0.862	<0.0100
	% < LRL	80%	0%	40%	0%	0%	0%	10%	0%	100%	80%	0%	90%	80%	20%	70%	100%
	% > BCWQG[a]	0%	-	20%	-	0%	0%	-	70%	0%	0%	0%	0%	0%	0%	0%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	60%	-	-	-	-	-	10%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	40%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_ERSC2	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Annual Minimum	<0.000100	0.0200	<0.0000500	0.00280	0.00204	0.000879	<0.000500	0.00271	<0.0000100	<0.0000100	0.000706	<0.00300	<0.00300	0.00000720	0.337	<0.0100
	Annual Maximum	0.000340	0.686	0.000576	0.00470	0.0366	0.00115	0.00162	0.00948	0.0000200	0.0000510	0.000978	0.00670	0.00370	0.0000160	0.563	<0.0100
	Annual Mean	0.000172	0.253	0.000210	0.00347	0.0147	0.00104	0.000855	0.00464	0.0000123	0.0000207	0.000837	0.00420	0.00323	0.00000975	0.456	<0.0100
	Annual Median	<0.000100	0.0740	0.0000830	0.00330	0.00521	0.00106	0.000545	0.00370	<0.0000100	0.0000155	0.000836	<0.00300	<0.00300	0.00000880	0.466	<0.0100
	% < LRL	67%	0%	50%	0%	0%	0%	33%	0%	67%	50%	0%	67%	67%	0%	83%	100%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	100%	0%	0%	0%	0%	0%	0%	17%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-

▨ > 5% of samples exceed the guideline or benchmark.
▨ > 50% of samples exceed the guideline or benchmark.
▨ > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline.

[a] Long-term average BCQWG for the Protection of Aquatic Life. b Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures. [c] Benchmarks are interim screening values 1-3.

Table C.8: Temporal Changes in Water Chemistry Analytes at Elk River Side Channel Stations, GHO LAEMP, 2015 to 2019

Parameter	Status	Station	Annual Variation [a]		Q1. Is there a positive or negative change in concentrations since the base year (b) of monitoring? Magnitude of Difference (MOD)[b] and Significance (bolded) from Base Year (b) [c]					Q2. Is the 2019 annual mean greater or less than all annual historical means (2015 - 2018) and the previous year (2018)?[c]							
			DF	P-Value	2015	2016	2017	2018	2019	2014	2015	2016	2017	2018	2019	2019 vs. 2015-2018	2019 vs. 2018
Total Selenium	Mine-exposed	GH_ERSC4	3	0.257	-	b	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns
		GH_ER1A	4	0.165	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	0.964	-	-	-	b	ns	-	-	-	-	ns	ns	ns	ns
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate-N	Mine-exposed	GH_ERSC4	3	0.037	-	b	38	-14	-1.0	-	-	AB	A	B	AB	ns	ns
		GH_ER1A	4	0.593	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	0.864	-	-	-	b	ns	-	-	-	-	ns	ns	ns	ns
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	Mine-exposed	GH_ERSC4	3	0.044	-	b	-1.8	-10	-2.2	-	-	A	A	A	A	ns	ns
		GH_ER1A	4	0.916	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	0.502	-	-	-	b	ns	-	-	-	-	ns	ns	ns	ns
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	Mine-exposed	GH_ERSC4	3	0.157	-	b	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns
		GH_ER1A	4	0.933	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	0.543	-	-	-	b	ns	-	-	-	-	ns	ns	ns	ns
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nickel	Mine-exposed	GH_ERSC4	3	0.235	-	b	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns
		GH_ER1A	4	0.606	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	<0.001	-	-	-	b	**-33**	-	-	-	-	A	B	↓	↓
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	Mine-exposed	GH_ERSC4	3	1.000	-	b	ns	ns	ns	-	-	ns	ns	ns	ns	ns	ns
		GH_ER1A	4	0.803	b	ns	ns	ns	ns	-	ns	ns	ns	ns	ns	ns	ns
		RG_GH-SCW3	1	0.796	-	-	-	b	ns	-	-	-	-	ns	ns	ns	ns
		GH_ERSC2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

▨	P-value < 0.05
🟩	> 20% Decrease in concentration
🟩	> 33% Decrease in concentration
🟩	> 43% Decrease in concentration
🟩	> 50% Decrease in concentration
🟦	> 25% Increase in concentration
🟦	> 50% Increase in concentration
🟦	> 75% Increase in concentration
🟦	> 100% Increase in concentration
bold	Significant increase or decrease from base year (b)
🟩	Significantly < than all historical years (or 2018)
🟦	Significantly > than all historical years (or 2018)

Notes: "ns" = not significant. "-" = insufficient data.

[a] *Year* p-value from an ANOVA with factors *Year* and *Month*.

[b] Magnitude of Difference (MOD) = $[\text{Mean}_{\text{given year}} - \text{Mean}_{\text{year b}}] / \text{Mean}_{\text{year b}} \times 100\%$.

[c] Significance amongs year determined using all pairwise comparisons using Tukey's honestly signifciant differences method. Years that share a letter are not significantly different. Letters assigned such that the mean with with highest magnitude is assigned "A".

Table C.9: Statistical Comparisons of Differences in Monthly Mean Concentrations of Water Quality Parameters Between GHO LAEMP Side Channel Stations and the Main Stem Station Upstream of Mine Operations (GH_ER2), 2016 to 2019

ANOVA Model[a]					Post-hoc Contrasts with Downstream Station (GH_ER2)[b] and Magnitude of Difference (MOD) by Station[c]						T-Test for Overall difference	
					GH_ERSC4		GH_ER1A		GH_ERSC2			
Parameter	Model Term	DF	F	P-Value	P-Value	MOD	P-Value	MOD	P-Value	MOD	P-Value	MOD
Nitrate-N	Year	3	0.140	0.936							-	-
	Station	2	32.5	<0.001	<0.001	28%	<0.001	342%	<0.001	1451%		
	Year x Station	6	0.946	0.467								
	Error	79	-									
Nitrite-N	Year	3	0.631	0.607							0.00200	102%
	Station	2	0.959	0.407								
	Year x Station	6	0.554	0.759								
	Error	14	-									
Orthophosphate	Year	3	3	0.870							0.0610	-
	Station	2	2	0.110								
	Year x Station	6	6	0.917								
	Error	75	-									
Total Phosphorus	Year	3	3	0.372							0.0640	-
	Station	2	2	0.641								
	Year x Station	6	6	0.649								
	Error	75	-									
Sulphate	Year	3	0.270	0.847							-	-
	Station	2	27.7	<0.001	0.00234	9%	<0.001	66%	<0.001	284%		
	Year x Station	6	1.02	0.421								
	Error	79	-									
Total Dissolved Solids	Year	3	0.35	0.791							-	-
	Station	2	12	<0.001	0.219		0.0095	24%	<0.001	60%		
	Year x Station	6	0.95	0.462								
	Error	79	-									
Total Suspended Solids (mg/L)	Year	3	2.17	0.100							<0.001	73%
	Station	2	0.290	0.749								
	Year x Station	6	0.144	0.990								
	Error	66	-									
Cadmium (Dissolved)	Year	3	0.527	0.665							-	-
	Station	2	7.18	0.00147	0.318		0.00467	41%	<0.001	69%		
	Year x Station	6	0.741	0.618								
	Error	69	-									
Cobalt (Dissolved)	Year	Concentrations < LRL			Concentrations < LRL							
	Station											
	Year x Station											
	Error	-	-									
Antimony (Total)	Year	3	0.399	0.756							0.0230	30%
	Station	2	1.35	0.285								
	Year x Station	6	0.145	0.988								
	Error	17	-									
Barium (Total)	Year	3	1.25	0.297							<0.001	11%
	Station	2	1.34	0.269								
	Year x Station	6	0.747	0.614								
	Error	79	-									
Boron (Total)	Year	Concentrations < LRL			Concentrations < LRL							
	Station											
	Year x Station											
	Error	-	-									
Lithium (Total)	Year	3	0.10	0.957							<0.001	69%
	Station	2	10	<0.001	0.00191	14%	<0.001	102%	<0.001	153%		
	Year x Station	6	0.5	0.797								
	Error	76	-									
Manganese (Total)	Year	3	0.185	0.907							0.41	-
	Station	2	0.238	0.789								
	Year x Station	6	0.732	0.626								
	Error	79	-									
Molybdenum (Total)	Year	3	0.124	0.946							-	-
	Station	2	3.65	0.0304	0.0944		0.005	23%	<0.001	13%		
	Year x Station	6	0.454	0.840								
	Error	79	-									
Nickel (Total)	Year	3	1.14	0.343							<0.001	51%
	Station	2	0.416	0.662								
	Year x Station	6	0.108	0.995								
	Error	41	-									
Selenium (Total)	Year	3	0.655	0.582							-	-
	Station	2	48.8	<0.001	0.00807	9%	<0.001	107%	<0.001	887%		
	Year x Station	6	1.19	0.321								
	Error	79	-									
Uranium (Total)	Year	3	0.0338	0.992							-	-
	Station	2	4.96	0.00931	0.00427	6%	0.005	30%	<0.001	38%		
	Year x Station	6	0.755	0.607								
	Error	79	-									
Zinc (Total)	Year	3	2.31	0.0994							0.321	-
	Station	2	0.281	0.757								
	Year x Station	5	0.563	0.727								
	Error	26	-									

▒	P-value < 0.05.
🟦	Positive MOD (higher concentration of analyte at side channel station(s) relative to GH_ER2).
🟩	Negative MOD (lower concentration of analyte at side channel station(s) relative to GH_ER2).

a Analysis of Variance (ANOVA) conducted on the relative differences between areas, calculated as $\log_{10}$(Side Channel) − $\log_{10}$(GH_ER2) with Year, Station and Year x Station as model terms. Values less than the laboratory reporting limit (LRL) were replaced with the LRL when only one of the two paired samples was < LRL. No difference was calculated when both paired samples were < LRL. Only comparisons with more than three difference values for all time periods were included.

b Post-hoc calculated as a one-sample t-test on the relative differences between each station [$\log_{10}$(Side Channel) − $\log_{10}$(GH_ER2)] for parameters with a significant station term in the ANOVA model.

c Magnitude of difference (MOD) calculated as the side channel concentration (10^[$\log_{10}$(side-channel)]) minus the downstream concentration (10^[$\log_{10}$(GH_ER2)]) divided by the downstream concentration (10^[$\log_{10}$(GH_ER2)]) and multiplied by 100 to represent the percent difference between the side channel station and downstream, relative to downstream.

Table C.10: Statistical Comparisons of Differences in Monthly Mean Concentrations of Water Quality Parameters Between GHO LAEMP Side Channel Stations and the Main Stem Station Downstream of Mine Operations (GH_ERC), 2016 to 2019

ANOVA Model[a]					Post-hoc Contrasts with Downstream Station (GH_ERC)[b] and Magnitude of Difference (MOD) by Station[c]						T-Test for Overall difference	
					GH_ERSC4		GH_ER1A		GH_ERSC2			
Parameter	Model Term	DF	F	P-Value	P-Value	MOD	P-Value	MOD	P-Value	MOD	P-Value	MOD
Nitrate-N	Year	3	0.115	0.951							-	-
	Station	2	29.7	<0.001	<0.001	-75%	0.632		<0.001	204%		
	Year x Station	6	0.794	0.577								
	Error	79	-									
Nitrite-N	Year	3	0.535	0.663							0.0220	52%
	Station	2	0.622	0.546								
	Year x Station	5	0.647	0.667								
	Error	22	-									
Orthophosphate	Year	3	0.205	0.892							0.0770	-
	Station	2	3.14	0.0507								
	Year x Station	6	0.423	0.861								
	Error	57	-									
Total Phosphorus	Year	3	0.736	0.534							0.582	-
	Station	2	0.387	0.680								
	Year x Station	6	0.717	0.637								
	Error	71	-									
Sulphate	Year	3	0.535	0.660							-	-
	Station	2	32.2	<0.001	<0.001	-26%	0.413		<0.001	164%		
	Year x Station	6	1.04	0.409								
	Error	79	-									
Total Dissolved Solids	Year	3	0.638	0.593							-	-
	Station	2	13.3	<0.001	<0.001	-7%	0.160		<0.001	47%		
	Year x Station	6	0.911	0.491								
	Error	79	-									
Total Suspended Solids (mg/L)	Year	3	0.721	0.543							0.402	-
	Station	2	0.307	0.737								
	Year x Station	6	0.433	0.855								
	Error	70	-									
Cadmium (Dissolved)	Year	3	0.742	0.530							-	-
	Station	2	6.93	0.00168	0.032	-12%	0.220		0.00147	44%		
	Year x Station	6	0.647	0.692								
	Error	79	-									
Cobalt (Dissolved)	Year	Concentrations < LRL			Concentrations < LRL							
	Station											
	Year x Station											
	Error	-	-									
Antimony (Total)	Year	3	0.390	0.762							0.177	-
	Station	2	2.16	0.141								
	Year x Station	6	0.257	0.951								
	Error	20	-									
Barium (Total)	Year	3	0.634	0.595							<0.001	-8%
	Station	2	2.14	0.125								
	Year x Station	6	0.900	0.499								
	Error	79	-									
Boron (Total)	Year	Concentrations < LRL			Concentrations < LRL							
	Station											
	Year x Station											
	Error	-	-									
Lithium (Total)	Year	3	0.685	0.564							0.314	-
	Station	2	11.6	<0.001	<0.001	-27%	0.160		<0.001	70%		
	Year x Station	6	0.618	0.715								
	Error	79	-									
Manganese (Total)	Year	3	0.334	0.801							0.110	-
	Station	2	1.35	0.265								
	Year x Station	6	0.316	0.927								
	Error	79	-									
Molybdenum (Total)	Year	3	0.261	0.854							-	-
	Station	2	3.69	0.0295	0.503		0.0219	18%	0.00453	6%		
	Year x Station	6	0.374	0.893								
	Error	79	-									
Nickel (Total)	Year	3	1.05	0.381							0.0020	30%
	Station	2	0.494	0.614								
	Year x Station	6	0.145	0.989								
	Error	42	-									
Selenium (Total)	Year	3	0.475	0.701							0.219	-
	Station	2	56.2	<0.001	<0.001	-44%	0.653		<0.001	388%		
	Year x Station	6	1.18	0.327								
	Error	79	-									
Uranium (Total)	Year	3	0.237	0.870							0.0050	11%
	Station	2	4.95	0.0094	0.126		0.0449	20%	<0.001	25%		
	Year x Station	6	0.736	0.622								
	Error	79	-									
Zinc (Total)	Year	3	0.226	0.877							0.136	-
	Station	2	0.723	0.494								
	Year x Station	5	0.376	0.861								
	Error	29	-									

▨	P-value < 0.05.
🟦	Positive MOD (higher concentration of analyte at side channel stations relative to GH_ERC).
🟩	Negative MOD (lower concentration of analyte at side channel stations relative to GH_ERC).

[a] Analysis of Variance (ANOVA) conducted on the relative differences between areas, calculated as $\log_{10}$(Side Channel) − $\log_{10}$(GH_ERC) with Year, Station and Year x Station as model terms. Values less than the laboratory reporting limit (LRL) were replaced with the LRL when only one of the two paired samples was < LRL. No difference was calculated when both paired samples were < LRL. Only comparisons with more than three difference values for all time periods were included.

[b] Post-hoc calculated as a one-sample t-test on the relative differences between each station [$\log_{10}$(Side Channel) − $\log_{10}$(GH_ERC)] for parameters with a significant station term in the ANOVA model.

[c] Magnitude of difference (MOD) calculated as the side channel concentration (10^[$\log_{10}$(side-channel)]) minus the downstream concentration (10^[$\log_{10}$(GH_ERC)]) divided by the downstream concentration (10^[$\log_{10}$(GH_ERC)]) and multiplied by 100 to represent the percent difference between the side channel station and downstream, relative to downstream.

Table C.11: Summary of Water Chemistry Data for Key Parameters for Main Stem Elk River Stations Downstream (GH_ERC) and Upstream (GH_GH2) of Mining Operations, GHO LAEMP, 2019

Station	Summary Statistic	Total Dissolved Solids (mg/L)	Lab pH	Field pH	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	Sulphate (mg/L)	Total Chloride (mg/L)	Total Fluoride (mg/L)	Total Antimony (mg/L)	Total Arsenic (mg/L)	Total Barium (mg/L)	Total Beryllium (mg/L)	Total Boron (mg/L)	Total Chromium (mg/L)
GH_ER2 (Reference)	n	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
	Annual Minimum	144	8.09	7.48	8.70	115	0.0290	<0.00100	<0.00500	12.1	<0.500	0.0860	<0.000100	<0.000100	0.0328	<0.0000200	<0.0100	0.000170
	Annual Maximum	212	8.44	8.36	12.6	196	0.115	0.00120	0.0598	24.9	0.830	0.187	<0.000100	0.000560	0.0515	0.0000400	<0.0100	0.00148
	Annual Mean	170	8.26	8.11	10.9	145	0.0786	0.00101	0.0140	20.3	0.517	0.154	<0.000100	0.000164	0.0436	0.0000213	<0.0100	0.000377
	Annual Median	167	8.26	8.17	11.1	144	0.0892	<0.00100	0.00860	22.4	<0.500	0.160	<0.000100	0.000130	0.0451	<0.0000200	<0.0100	0.000300
	% < LRL	0%	0%	0%	0%	0%	0%	97%	19%	0%	95%	0%	100%	19%	0%	92%	100%	0%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	8%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	0%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GH_ERC (Mine-exposed)	n	56	56	54	54	56	56	56	56	56	56	56	56	56	56	56	56	56
	Annual Minimum	152	7.82	7.08	9.16	128	0.141	<0.00100	<0.00500	18.2	<0.500	0.109	<0.000100	<0.000100	0.0418	<0.0000200	<0.0100	0.000180
	Annual Maximum	257	8.43	8.66	12.6	218	0.906	0.00640	0.115	43.2	0.810	0.201	0.000130	0.000830	0.0654	0.0000860	<0.0100	0.00247
	Annual Mean	197	8.18	7.98	10.8	154	0.486	0.00118	0.0195	30.3	0.524	0.154	0.000101	0.000166	0.0553	0.0000234	<0.0100	0.000418
	Annual Median	196	8.20	7.99	10.9	153	0.530	<0.00100	0.00820	31.8	<0.500	0.154	<0.000100	0.000110	0.0562	<0.0000200	<0.0100	0.000290
	% < LRL	0%	0%	0%	0%	0%	0%	84%	36%	0%	79%	0%	95%	25%	0%	93%	100%	0%
	% > BCWQG[a]	-	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	-	0%	0%	0%	7%
	% > BCWQG[b]	-	-	-	0%	-	0%	0%	0%	-	5%	0%	-	0%	-	0%	-	-
	% > Level 1 EVWQP Benchmark	0%	-	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

▨ > 5% of samples exceed the guideline or benchmark.
🟦 > 50% of samples exceed the guideline or benchmark.
🟦 > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline.

[a] Long-term average BCQWG for the Protection of Aquatic Life.

[b] Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures.

[c] Benchmarks are interim screening values 1-3.

Table C.11: Summary of Water Chemistry Data for Key Parameters for Main Stem Elk River Stations Downstream (GH_ERC) and Upstream (GH_GH2) of Mining Operations, GHO LAEMP, 2019

Station	Summary Statistic	Total Cobalt (mg/L)	Total Iron (mg/L)	Total Lead (mg/L)	Total Lithium (mg/L)	Total Manganese (mg/L)	Total Molybdenum (mg/L)	Total Nickel (mg/L)[c]	Total Selenium (mg/L)	Total Sliver (mg/L)	Total Thallium (mg/L)	Total Uranium (mg/L)	Total Zinc (mg/L)	Dissolved Aluminum (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Copper (mg/L)	Dissolved Iron (mg/L)
GH_ER2 (Reference)	n	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
	Annual Minimum	<0.000100	<0.0100	<0.0000500	0.00140	0.000520	0.000743	<0.000500	0.000668	<0.0000100	<0.0000100	0.000610	<0.00300	<0.00300	<0.00000500	0.294	<0.0100
	Annual Maximum	0.000300	0.820	0.000444	0.00230	0.0391	0.00117	0.00158	0.00119	0.0000150	0.0000260	0.000851	0.00700	0.00530	0.0000103	0.387	<0.0100
	Annual Mean	0.000114	0.0834	0.0000838	0.00177	0.00533	0.000995	0.000579	0.000936	0.0000102	0.0000110	0.000749	0.00331	0.00319	0.00000652	0.335	<0.0100
	Annual Median	<0.000100	0.0220	<0.0000500	0.00180	0.00209	0.000995	<0.000500	0.000961	<0.0000100	<0.0000100	0.000759	<0.00300	<0.00300	0.00000650	0.337	<0.0100
	% < LRL	92%	22%	78%	0%	0%	0%	89%	0%	92%	92%	0%	86%	86%	22%	89%	100%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	0%	0%	0%	0%	0%	0%	0%	43%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-
GH_ERC (Mine-exposed)	n	56	56	56	56	56	56	56	60	56	56	56	56	56	56	56	56
	Annual Minimum	<0.000100	<0.0100	<0.0000500	0.00190	0.000110	0.000875	<0.000500	0.00105	<0.0000100	<0.0000100	0.000687	<0.00300	<0.00300	<0.00000500	0.317	<0.0100
	Annual Maximum	0.000600	1.36	0.00101	0.00360	0.0749	0.00119	0.00275	0.00333	0.0000300	0.0000500	0.000949	0.0126	0.00560	0.0000452	0.449	0.0130
	Annual Mean	0.000130	0.107	0.000109	0.00285	0.00602	0.00104	0.000633	0.00206	0.0000111	0.0000121	0.000838	0.00351	0.00308	0.00000754	0.370	0.0101
	Annual Median	<0.000100	<0.0100	<0.0000500	0.00290	0.000495	0.00105	<0.000500	0.00206	<0.0000100	<0.0000100	0.000850	<0.00300	<0.00300	0.00000660	0.366	<0.0100
	% < LRL	93%	68%	80%	0%	2%	0%	91%	0%	91%	93%	0%	91%	96%	16%	91%	98%
	% > BCWQG[a]	0%	-	0%	-	0%	0%	-	62%	0%	0%	0%	0%	0%	0%	64%	-
	% > BCWQG[b]	0%	-	0%	0%	0%	0%	-	-	-	-	-	-	-	-	-	-
	% > Level 1 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	0%	-	-
	% > Level 2 EVWQP Benchmark	-	-	-	-	-	-	0%	0%	-	-	-	-	-	-	-	-
	% > Level 3 EVWQP Benchmark	-	-	-	-	-	-	0%	-	-	-	-	-	-	-	-	-

▨ > 5% of samples exceed the guideline or benchmark.
▨ > 50% of samples exceed the guideline or benchmark.
▨ > 95% of samples exceed the guideline or benchmark.

Notes: "LRL" = laboratory reporting limit. "BCWQG" = British Columbia Working or Accepted Water Quality Guideline.

[a] Long-term average BCQWG for the Protection of Aquatic Life.

[b] Short-term maximum BCQWG for the Protection of Aquatic Life. For guidelines dependent on other analytes (e.g., hardness or chloride), guidelines were screened using concurrent concentrations. When concurrent hardness or chloride concentrations were not measured, the most conservative concentration observed for that station was used to estimate the guidelines or benchmark. All summary statistics are reported to 3 significant figures.

[c] Benchmarks are interim screening values 1-3.

Table C.12: Temporal Changes in Water Chemistry Analytes at Main Stem Elk River Stations Downstream (GH_ERC) and Upstream (GH_ER2) of Mine Influence, GHO LAEMP, 2012 to 2019

Parameter	Status	Station	Annual Variation [a]		Q1. Is there a positive or negative change in concentrations since the base year (b) of monitoring? Magnitude of Difference (MOD)[b] and Significance (bolded) from Base Year (b) [c]								Q2. Is the 2019 annual mean greater or less than all annual historical means (2012 - 2018) and the previous year (2018)?[c]									
			DF	P-Value	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019	2019 vs. 2012-2018	2019 vs. 2018
Total Selenium	Reference	GH_ER2	7	<0.001	b	-5.9	-2.2	3.6	**11**	**10**	**13**	**22**	DE	E	DE	CD	BC	BC	AB	A	ns	ns
	Mine-exposed	GH_ERC	4	<0.001	-	-	-	b	1.7	-1.5	**19**	**31**	-	-	-	C	BC	C	AB	A	ns	ns
Nitrate-N	Reference	GH_ER2	7	<0.001	b	14	**87**	**104**	**97**	**102**	**87**	**94**	B	B	A	A	A	A	A	A	ns	ns
	Mine-exposed	GH_ERC	4	0.011	-	-	-	b	17	-1.3	15	**38**	-	-	-	B	AB	B	AB	A	ns	ns
Sulphate	Reference	GH_ER2	7	<0.001	b	4.2	**11**	**20**	**29**	**19**	**21**	**28**	D	CD	BC	AB	A	AB	AB	A	ns	ns
	Mine-exposed	GH_ERC	4	<0.001	-	-	-	b	**35**	-0.35	-4.2	5.4	-	-	-	B	A	B	B	B	ns	ns
Total Dissolved Solids	Reference	GH_ER2	7	<0.001	b	**7.7**	4.5	**10**	**12**	**9.7**	**7.5**	5.7	C	AB	BC	AB	A	AB	AB	ABC	ns	ns
	Mine-exposed	GH_ERC	4	<0.001	-	-	-	b	**10**	-0.34	-2.9	-2.0	-	-	-	B	A	B	B	B	ns	ns
Total Nickel	Reference	GH_ER2	7	0.089	b	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
	Mine-exposed	GH_ERC	4	0.129	-	-	-	b	ns	ns	ns	ns	-	-	-	ns	ns	ns	ns	ns	ns	ns
Uranium	Reference	GH_ER2	7	0.010	b	2.8	2.8	3.5	**6.9**	1.7	4.7	5.0	B	AB	AB	AB	A	AB	AB	AB	ns	ns
	Mine-exposed	GH_ERC	4	0.350	-	-	-	b	ns	ns	ns	ns	-	-	-	ns	ns	ns	ns	ns	ns	ns

⬜ P-value < 0.05

🟩 > 20% Decrease in concentration

🟩 > 33% Decrease in concentration

🟩 > 43% Decrease in concentration

🟩 > 50% Decrease in concentration

🟦 > 25% Increase in concentration

🟦 > 50% Increase in concentration

🟦 > 75% Increase in concentration

🟦 > 100% Increase in concentration

bold Significant increase or decrease from base year (b)

🟩 Significantly < than all historical years (or 2018)

🟦 Significantly > than all historical years (or 2018)

Notes: "ns" = not significant. "-" = insufficient data.

[a] *Year* p-value from an ANOVA with factors *Year* and *Month.*

[b] Magnitude of Difference (MOD) = $[\text{Mean}_{\text{given year}} - \text{Mean}_{\text{year b}}] / \text{Mean}_{\text{year b}} \times 100\%$.

[c] Significance amongs year determined using all pairwise comparisons using Tukey's honestly signifciant differences method. Years that share a letter are not significantly different. Letters assigned such that the mean with with highest magnitude is assigned "A".

Table C.13: Difference in Monthly Mean Concentrations of Water Quality Parameters Between Main Stem Elk River Stations Downstream (GH_ERC) and Upstream (GH_GH2) of Mining Operations, GHO LAEMP, 2016 to 2019

ANOVA Model Testing for Relative Difference Between Areas (Downstream − Upstream) Among Years [a]					Post-hoc Contrasts[b] (Downstream vs. Upstream) and Magnitude of Difference (MOD[c]) (Downstream Relative to Upstream)			
					P-value (MOD)			
Parameter	**Model Term**	**DF**	**F**	**P-value**	**2016**	**2017**	**2018**	**2019**
Nitrate-N	Year	3	2.45	0.0764	<0.001 (424%)			
	Error	44	-	-				
Nitrite-N	Year	Concentrations < LRL			Concentrations < LRL			
	Error							
Orthophosphate	Year	3	0.0923	0.964	0.412 (4.8%)			
	Error	32	-	-				
Total Phosphorus	Year	3	0.497	0.686	0.223 (13%)			
	Error	40	-	-				
Sulphate	Year	3	6.03	0.00156	<0.001 (84%)	<0.001 (47%)	<0.001 (39%)	<0.001 (44%)
	Error	44	-	-				
Total Dissolved Solids	Year	3	3.22	0.0315	<0.001 (20%)	<0.001 (10%)	<0.001 (9%)	<0.001 (12%)
	Error	44	-	-				
Total Suspended Solids	Year	3	1.92	0.145	<0.001 (52%)			
	Error	35	-	-				
Cadmium (Dissolved)	Year	3	0.134	0.939	<0.001 (16%)			
	Error	42	-	-				
Cobalt (Dissolved)	Year	Concentrations < LRL			Concentrations < LRL			
	Error							
Antimony (Total)	Year	Concentrations < LRL			Concentrations < LRL			
	Error							
Barium (Total)	Year	3	1.96	0.134	<0.001 (23%)			
	Error	44	-	-				
Boron (Total)	Year	Concentrations < LRL			Concentrations < LRL			
	Error							
Lithium (Total)	Year	3	3.10	0.0363	<0.001 (43%)	<0.001 (77%)	<0.001 (54%)	<0.001 (57%)
	Error	43	-	-				
Manganese (Total)	Year	3	1.78	0.165	0.016 (-28%)			
	Error	44	-	-				
Molybdenum (Total)	Year	3	7.30	<0.001	0.107 (-4.5%)	0.025 (5.4%)	0.001 (7.6%)	0.003 (4.6%)
	Error	44	-	-				
Nickel (Total)	Year	3	0.739	0.546	0.028 (17%)			
	Error	14	-	-				
Selenium (Total)	Year	3	2.84	0.0485	<0.001 (82%)	<0.001 (78%)	<0.001 (111%)	<0.001 (115%)
	Error	44	-	-				
Uranium (Total)	Year	3	1.11	0.357	<0.001 (9.4%)			
	Error	44	-	-				
Zinc (Total)	Year	3	0.670	0.584	0.113 (18%)			
	Error	15	-	-				

▨	P-value < 0.05.
🟦	Positive MOD (higher concentration of analyte at the Downstream station GH_ERC relative to Upstream GH_ER2).
🟩	Negative MOD (lower concentration of analyte at Downstream station GH_ERC relative to Upstream GH_ER2).

[a] One way Analysis of Variance (ANOVA) conducted on the relative differences between areas, calculated as $\log_{10}$(downsteam) − $\log_{10}$(upstream) with year. Values less than the laboratory reporting limit (LRL) were replaced with the LRL when only one of the two paired samples was < LRL. No difference was calculated when both paired samples were < LRL. Only comparisons with more than three difference values for all time periods were included.

[b] Post-hoc calculated as a one-sample t-test on the relative differences between stations [$\log_{10}$(downstream) − $\log_{10}$(upstream)]. Conducted separately by year when there was a significant year term in the ANOVA model.

[c] Magnitude of difference (MOD) calculated as the downstream concentration $10^\wedge(\text{Mean}_{GH\_ERC}]$ minus the upstream concentration $10^\wedge(\text{Mean}_{GH\_ER2})$ divided by the upstream concentration $10^\wedge(\text{Mean}_{GH\_ER2})$ and multplied by 100% (Mean_{GH_XXX} is in $\log_{10}$ units) to represent the percent difference between the downstream and upstream stations, relative to upstream.

APPENDIX D

GROUNDWATER-SURFACE WATER INTERACTIONS

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ATTENTION: Cait Good, Lead Regional Monitoring
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REFERENCE: **Assessment of Groundwater – Surface Water Interactions in Support of the GHO LAEMP**

1 Introduction

SNC-Lavalin Inc. (SNC-Lavalin) has evaluated groundwater and surface water interactions proximal to the Elk River side channel in support of the Greenhills Operations (GHO) Local Aquatic Effects Monitoring Program (LAEMP); herein referred to as "the Project". An understanding of local aquatic effects of the west side tributaries of GHO to immediate receiving environments is required in Section 9.3.3 of Permit 107517[1]. This report provides an update to the groundwater and surface water assessment completed in 2019 (SNC-Lavalin, 2019).

1.1 Background

GHO is one of Teck's five coal mines in the Elk Valley. The Elk River side channel is located between the Elk River and the western flank of the Greenhills Ridge at GHO and flows from directly south of Leask Creek to south of Thompson Creek, where it converges with the Elk River (Drawing 1).

Since 2017, Minnow Environmental Inc. (Minnow) and Lotic Environmental Ltd. (Lotic) have completed and implemented a Study Design and monitoring program for the GHO LAEMP (Minnow and Lotic, 2017, 2018a, 2018b, 2019). In support of the LAEMP, SNC-Lavalin reviewed and compiled groundwater and surface water information available within and proximal to the Elk River side channel (SNC-Lavalin, 2019). The report presented a summary of groundwater and surface water data, an assessment of the potential groundwater–surface water interactions, and identified gaps in knowledge, which are summarized in Section 1.1.1.

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[1] Permit 107517, amended April 4, 2019.

1.1.1 2018 Data Gaps

The following table summarizes the data gaps and uncertainties identified in the groundwater–surface water interaction assessment completed in support of the 2018 LAEMP (SNC-Lavalin, 2019).

Table A: 2018 LAEMP Data Gaps

Area	Data Gap/Uncertainty	Recommendations
Elk River Valley		
Side Channel and Associated Tributaries	Surface water stations are not surveyed to a common datum.	Survey surface water stations to a common with groundwater monitoring wells.
Wolfram Creek	Shallow groundwater conditions between Wolfram Pond and the side channel (GH_ER1A) are unknown.	Install a groundwater monitoring network upgradient of GH_ER1A. Collect groundwater level and quality data from newly installed wells. Review results from seep survey conducted at GHO.
Thompson Creek	Groundwater conditions in the vicinity of Thompson Creek confluence and further south in the side channel are unknown.	Install a groundwater monitoring network in the vicinity of the confluence with Thompson Creek and further to the south where pooled areas have been mapped and sampled and an influence from Thompson Creek suspected. Review results from seep survey conducted at GHO.
Pools and Permanently Wetted Area	There is increasing mine-influence in pools and the permanently wetted area in the side channel noted in 2018 as compared to 2017, which is identified as an uncertainty.	Field mapping, as well as analytical data associated with additional pools included in the 2019 program. Comparison of results to surface water and groundwater trends.
Downgradient of the Side Channel (GH_MW-ERSC-1)	The origin of periodic mine-influenced water in monitoring well GH_MW-ERSC-1 is not well understood.	Improve the groundwater monitoring network in the vicinity of this well. Review results from seep survey conducted at GHO.

Since the 2019 assessment, groundwater investigations in the vicinity of the Elk River side channel have been on-going as part of other programs including the Site-Specific Groundwater Monitoring Program (SSGMP), Regional Groundwater Monitoring Program (RGMP), Cougar Pit Phase 2 Expansion Project (CPX2), and the Mass Balance Investigation (MBI) Program. Significant overlap between the groundwater components of the LAEMP and these programs exist, and many of the gaps identified in Table A are being filled as part of these programs and discussed further in sections below.

1.2 Objective

The objective of this study is to use 2019 data to provide an update on the current understanding of groundwater-surface water interaction along the Elk River side channel to support Key Question #4 in the LAEMP:

- *What is the interaction between surface water and groundwater in the Elk River side channel?*

In addition to the question above, the results of the Project will provide information to support Key Question #3d:

- *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)?*

As a supplement to the 2019 report, this report assists Teck in meeting their commitments to the Environmental Monitoring Committee (EMC) to consider groundwater as part of the LAEMP.

2 Available Data

The following describes the data that were used in the updated groundwater-surface water assessment.

2.1 Groundwater and Surface Water Data

Groundwater data were collected in 2019 as part of the on-going SSGMP, RGMP and CPX2 Programs as shown in Table B below. Monitoring well and relevant surface water locations are shown on Drawing 2. For the purpose of this report and consistent with the LAEMP, results for the Project are discussed from north to south and split into: Reach 3 (Upstream and Downstream of GH_ER1A), Reach 2 and Reach 1 (West and East/Middle). Reach 3 Upstream of GH_ER1A is further subdivided into the Side Channel and Wolfram Creek.

Table B: Summary of Relevant 2019 Groundwater Data

Well ID	Water Level Data	Chemistry Data	Source
Reach 3 (Upstream of GH_ER1A)			
Side Channel			
GH_MW_WC1-A	Y	Y	SSGMP/CPX2
GH_MW_WC1-B	Y	Y	SSGMP/CPX2
GH_MW_WC1-C	Y	Y	SSGMP/CPX2
Wolfram Creek			
GH_GA-MW-2	Y	Y	SSGMP/RGMP
Reach 2			
GH_GA-MW-3	Y	Y	SSGMP/RGMP

Notes:
'Y' indicates data were available.

Groundwater elevations and analytical chemistry results from monitoring wells sampled in 2019 as part of the SSGMP and RGMP have been reported and summarized in the *2019 Annual Report: Elk Valley Regional and Site-Specific Groundwater Monitoring Programs*; herein referred to as the "2019 Annual Report" (SNC-Lavalin, 2020). Groundwater elevations and analytical results for monitoring wells sampled as part of CPX2 will be presented under a separate cover as a requirement for the Baseline Environmental Assessment.

The groundwater-surface water interaction assessment completed in 2019 included areas upgradient and downgradient of the side channel (i.e., monitoring wells GH_GA-MW-4 and GH_ERSC-1, respectively). The groundwater quality in the Leask drainage, upgradient of the side channel, has been described in detail in the 2019 groundwater-surface water interaction assessment and GHO SSGMP (SNC-Lavalin, 2020). The Leask drainage was determined to not be related to the side channel; therefore, no further assessment on the effects of water quality from this drainage on the side channel is necessary. The downgradient area near GH_MW-ERSC-1 was not included in this updated assessment as it was also not considered to be relevant to the water quality in the side channel. The MBI is currently investigating these areas and groundwater assessment results will be reported under that program.

Surface water results including instantaneous flow, water levels, and analytical chemistry data for select stations have been provided by Teck and Minnow. Relevant surface water stations, isolated pools, and wetted areas are shown on Drawing 2. SNC-Lavalin understands that only select isolated pools were sampled for water quality; larger pools and pools containing fish were targeted. Since completing the groundwater-surface water assessment, the station codes associated with the pool locations were updated. The updated location codes for all pools sampled for water quality between 2017 and 2019 are shown in Table 2.2 of Attachment 1. This report focusses on isolated pools and wetted areas sampled for water quality in 2019. Spatial distribution maps of wetted areas between 2017 and 2019 have also been provided by Minnow and included as Attachment 2.

2.1.1 Groundwater and Surface Water Hydrographs and Flows

Long-term data for groundwater elevations were reviewed for wells situated proximal to the Elk River side channel. These data were compared to continuously logged water levels at surface water stations established for the LAEMP along the Elk River and side channel. Groundwater and corrected surface water elevations from January 2017 to December 2019 were plotted on hydrographs and compared to precipitation data obtained from the General Office Continuous Monitoring Station at GHO (652345 E, 5550219 N; 1975 metres above sea level [m asl]). Surface water levels were corrected and normalized based on available survey data. Hydrographs are presented in Figures 1 and 2 and a time-series graph presenting instantaneous flow at select surface water stations is included as Figure 3.

2.1.2 Groundwater and Surface Water Quality

The major ion distribution (proportions of calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulphate, and chloride) of groundwater and surface water (including the isolated pools and wetted area) are discussed in detail in the 2018 groundwater-surface water assessment (SNC-Lavalin, 2019). Piper plots have been updated to present major ion data for locations that were sampled in 2019 separated by reaches (Figures 4 and 5). Where several surface water samples for the Elk River and side channel stations were collected throughout 2019, average for the year concentrations were plotted. Review of the data indicated consistency in water type; as such an average was considered appropriate. All samples from groundwater, isolated pools and wetted areas are presented.

Available groundwater and surface water chemistry for the Project were also compared to the *Contaminated Sites Regulation* (CSR) Standards (ENV, 2019) and the *BC Water Quality Guidelines* (BCWQG) (ENV, 2018); these were primary screening criteria outlined in the 2019 Annual Report (SNC-Lavalin, 2020).To understand potential groundwater pathways of mine-related constituents, time series graphs for available groundwater and surface water constituents of interest (CI) that have historically exceeded applicable criteria (nitrate-N, sulphate, and dissolved selenium) are shown in Figures 6 to 14. Where applicable, primary screening criteria are shown.

2.1.3 Spatial Distribution of Wetted Areas

Monthly assessments along the side channel and flood areas were conducted by Lotic to identify wet and dry sections, as well as surface connectivity of the west side tributaries to the side channel. Attachment 2 includes maps which have been prepared for the 2019 LAEMP report by Minnow and Lotic presenting wet and dry locations at various time periods since 2017. The 2019 monthly results are summarized in Table C.

Table C: Summary of Spatial Distribution of Dry and Wetted Areas Along the Side Channel in 2019

Month	Reach 3		Reach 2	Reach 1	
	Upstream GH_ER1A	Downstream GH_ER1A	Wetted Area	West	East/Middle
January	PD	D	W	D	D
February	PD	D	W	D	D
March	PD	D	W	D	D
April	PD	D	W	D	D
May	PD	D	W	D	PD
June	W	W	W	W	W
July	W	W	W	W	PW
August	PW	W	W	W	PW
September	PW	W	W	W	PW
October	PW	D	W	D	PD
November	PW	D	W	D	D
December	PD	D	W	D	D

Notes:
"D" denotes Dry; "PD" denotes Predominantly Dry; "W" denotes Wet; "PW" denotes Predominantly Wet.

3 Updated Groundwater-Surface Water Assessment

The following sections provide an updated analysis of groundwater surface water interaction by reach, including interpretation of the main influence on water quality in the isolated pools and permanently wetted areas in each of the reaches in the LAEMP.

3.1 Reach 3

Discussion below is presented by surface water flow path, as follows: side channel upstream of GH_ER1A which is seasonally connected to the Elk River; Wolfram Creek situated in the valley bottom (i.e., Wolfram Pond discharge); and side channel downstream of GH_ER1A after the confluence with Wolfram Creek.

3.1.1 Side Channel (Upstream of GH_ER1A)

The side channel commences approximately 200 m south of where Leask Drainage confluences with the Elk River. Surface water station GH_ERSC4 is located along the northern boundary of Reach 3 within the side channel and provides an indication of water quality entering the side channel from the Elk River (Drawing 2). Surface water elevations at GH_ERSC4 fluctuate seasonally with the Elk River with higher elevations measured from April to July (Figure 1; SNC-Lavalin, 2019). Concentrations of Cl at GH_ERSC4 have historically been less than the applicable criteria and similar to concentrations farther upstream in the Elk River (GH_ER2; Figures 6 to 8). In 2019, the upper side channel was wetted in January and May to November, which is consistent with flow measurements at GH_ERSC4 (Figure 3; Attachment 2).

Nested monitoring wells GH_MW_WC1-A/B/C, installed in support of the CPX2 project in October 2019, are located near the side channel and upstream of where seven isolated pools have been sampled in Reach 3 since 2017 (Drawing 2). Groundwater concentrations of Cl from shallow well GH_MW_WC1-C, as well as the major ion distribution were similar to surface water upstream and downstream in the side channel (GH_ERSC4 and GH_ER1A, respectively; Figures 4 and 6 to 8). A downward vertical gradient exists between shallow and intermediate groundwater at GH_MW_WC1, as inferred through higher elevations in the shallow well, indicating downward vertical migration of groundwater (Figure 2). Flows along Reach 3 appear to decrease from GH_ERSC4 to GH_ER1A by on average 0.05 m^3/s (Figure 3). These lines of evidence indicate that the side channel in Reach 3 upstream of GH_ER1A infiltrates (i.e., loses) to ground and is the main influence on groundwater chemistry in this area; therefore, no groundwater contribution to the side channel occurs in this area.

3.1.1.1 Isolated Pools

Since 2017, six isolated pools (SC3-P7, SC3-P6, SC3-P10, SC3-P9, SC3-P14, SC3-P8) have been sampled upstream of GH_ER1A and prior to the confluence with Wolfram Creek (Table 2.2 in Attachment 1). All of the pools have contained relatively low (i.e., below criteria) concentrations of Cl and were calcium bicarbonate type water (Figures 4 and 6 to 8). Pools in this Reach were typically smaller than 20 m by 3 m (Pool SC3-P7 in December 2019) in size. Flows from the Elk River are inferred to be the main influence on these pools as evidenced by similar major ion distributions between the Elk River (GH_ER2 and GH_ERC) and the side channel (GH_ERSC4). These isolated pools are interpreted to be a result of side channel flows receding or seasonal drying of the side channel (i.e., infiltration) and are not groundwater fed.

3.1.2 Wolfram Creek

The unlined Wolfram Ponds are located at the base of Wolfram Creek and promote surface water infiltration into the ground in this area. In 2019, flow was measured at GH_WC1 (where Wolfram Ponds decants towards the side channel) throughout the year, except in January and February. Flow rates ranged from 0.006 m^3/s to 0.008 m^3/s, with the highest flows measured between August and November 2019 (Figure 3). Although a defined channel exists near the outlet, overland flow over the last three years was only observed in June and July 2019, indicating the majority of surface water in Wolfram Creek infiltrates to ground in the vicinity of the ponds. However, surface water in 2019 in the creek downstream of the ponds but upstream of GH_ER1A appeared to gain farther downstream in May, August and September 2019 based on the spatial distribution of wetted areas (Attachment 2). This suggests a seasonal shallow groundwater contribution during these time periods.

Concentrations of Cl in surface water from Wolfram Creek and Ponds (GH_WC1 and GH_WC2) have historically been greater than the applicable criteria (Figures 6 to 8). Deep monitoring well GH_GA-MW-2 (near GH_WC1) has contained measurable concentrations of Cl, but orders of magnitude below Wolfram Creek (Figures 6 to 8). Although the hydrograph for GH_GA-MW-2 shows clear similarities to GH_ERSC4 during and after freshet, infiltration of mine-influenced surface water from Wolfram Creek to the valley bottom has increased over time and is affecting groundwater quality in this drainage (Figure 1; SNC-Lavalin, 2020).

Surface water station GH_ER1A is located in the side channel downstream of Wolfram Creek. Elevated concentrations of Cl relative to the applicable criteria and relative to concentrations upstream at GH_ERSC4 have been measured at this surface water station since 2017 (Figures 6 to 8). Seasonal step changes of up to one order of magnitude in concentrations in Cl at this location are interpreted to be coincident with snow melt in the Wolfram drainage, with elevated concentrations measured between April and June (Figures 6 to 8). A shallow groundwater flow path from mine-influenced Wolfram Creek is interpreted to seasonally influence water quality at GH_ER1A, which is supported by the observations of wetted areas before the confluence of the side channel in May 2019 (Attachment 2). As such, loading of Cl from the mine-influenced drainage to the side channel increases during times of expected peak flows and a seasonal groundwater baseflow to the side channel component exists in this area. In August, after the entire Reach 3 was wetted, concentrations of Cl at GH_ER1A decreased and were consistent with upstream GH_ERSC4 indicating mixing with the Elk River water had occurred.

3.1.2.1 Isolated Pool SC2-P13

Isolated pool SC3-P13 is the side channel pool closest to and downstream of the confluence with Wolfram Creek (Drawing 2 and Table 2.2 in Attachment 1). This pool was observed in April and May 2019 and the size of pool ranged from approximately 10 m by 3 m (April) to 175 m by 5 m (May). This pool did not exist in 2017 or 2018 but its presence in 2019 is inferred to result from a higher contribution of shallow groundwater discharge, predominantly in May. In previous years, shallow groundwater still occurred as evidenced by water quality at ER1A (see above), but in 2019 the shallow flow path resulted in pool SC2-P13. During both sampling events concentrations of Cl in the pool were greater than the applicable criteria and greater than in the pools located farther upstream in the side channel. The elevated concentrations of Cl and calcium sulphate-bicarbonate water type are indicative of mine-influenced water at this location (Figures 4 and 6 to 8). The greatest concentrations of Cl in this pool were measured in May. Observations by Lotic indicated Wolfram Creek was losing to ground from January to May 2019 and that the channel subsequently gained farther downstream in May before the creek intersects with the side channel. As Wolfram Creek was dry downstream of Wolfram Ponds prior to the formation of the pool, the origin of the pool is inferred to be a result of seasonal groundwater discharge.

3.1.3 Side Channel (Downstream of GH_ER1A)

Surface water elevations at GH_ER1A have fluctuated by approximately 1.5 m since 2017. Measurable (i.e., non-zero) surface water elevations at GH_ER1A only commence in the spring (late-April to July) compared to the more continuous hydrograph for GH_ERSC4, indicative that infiltration occurs along the upper portion of Reach 3 (Figure 1) and no groundwater base flow was present. This is also evidenced by the spatial distribution of wetted areas as discussed above. The distribution of wetted areas downstream of GH_ER1A indicate that the side channel loses to ground (i.e., infiltrates) in this area. Flows at GH_ER1A and GH_ERSC4 during freshet could not be logged due to the high water levels in the side channel (Figure 3).

3.1.3.1 Isolated Pools

Since 2017, five pools have been sampled between surface water station GH_ER1A and Reach 2 (SC3-P11, SC3-P12, SC3-P15, SC3-P4, and SC3-P3; Table 2.2 in Attachment 1). Pools in this area were typically observed in the winter, one month after the side channel was wet (October/November), and/or in April during spring thaw. Only pools SC3-P11 and SC3-P15 were observed in 2019 and their occurrences were limited to one month and the largest pool observed was approximately 10 m by 3 m in size in April 2019 (SC3-P15). The major ion chemistry for these pools are consistent with the distribution of ions measured in the side channel at GH_ER1A and GH_ERSC5 (calcium bicarbonate; Figure 4). Similar to the isolated pools identified upstream of GH_ER1A, the water quality in these pools is interpreted to result from side channel flows receding or seasonal drying (i.e., infiltration) and are therefore not groundwater fed.

3.2 Reach 2 (Wetted Area)

A permanently wetted area (Reach 2) is located at the confluence of Thompson Creek and the side channel. A greater mean surface flow through the winter months at Thompson Creek contributes to continued wetness in this area (Teck, 2017). Instantaneous flow measurements since 2017 were up to four times greater at Thompson Creek compared to Wolfram Creek (Figure 3; SNC-Lavalin, 2019) indicating a greater contribution of water from this creek. Unlike at Wolfram Creek, no pit pumping has been directed to Thompson Creek since 2017.

As indicated in SNC-Lavalin (2019) seasonal fluctuations in groundwater levels at GH_GA-MW-3 suggest the well is predominantly influenced by snow melt in the upper catchment rather than from the side channel (Figure 2). The greatest elevations monitored at GH_GA-MW-3 have been between March and June, consistent with higher flow rates recorded at GH_TC1 measured in the spring and early summer (Figure 3). Overall decreasing trends in nitrate-N, sulphate, and dissolved selenium have been identified in groundwater at GH_GA-MW-3 and overall, the major ion chemistry had become increasingly more bicarbonate-rich up until 2018 (SNC-Lavalin, 2020; Figure 5), indicating a reduced mine-influence since 2015. However, during peak flows in Thompson Creek, the water type shifts at this well to predominantly calcium-sulphate type water, indicating seasonal mine-influence on groundwater during spring months still occurred (SNC-Lavalin, 2019). In 2019, concentrations of sulphate increased throughout the year in groundwater and were greatest in the winter (December; Figure 10). The increase in mine-influence in groundwater during the winter of 2019 may be related to losses to ground as evidenced by the differences in flows between GH_TC2 (Lower Thompson Sedimentation Pond) and GH_TC1 (Thompson Creek; Figure 3). Higher concentrations of sulphate during the winter of 2019 were also measured at both surface water stations (GH_TC1 and GH_TC2; Figure 10).

3.2.1 Permanently Wetted Area

Surface water samples (RG_GH-SCW1 to –SCW3) have been collected in Reach 2 since 2017 and of these locations surface water samples were only collected from RG_GH-SCW1 and RG_GH-SCW3 in 2019 (Drawing 2). Surface water samples at locations RG_GH-SCW2 and RG_GH-SCW3 (located at the outlet for Reach 2) contained concentrations of CI and major ion distributions similar to values measured in Thompson Creek (Figure 5 and Figures 9 to 11; SNC-Lavalin, 2019), indicative that Thompson Creek is influencing water quality in the wetted area. Surface water location RG_GH-SCW1 is located at the inlet to Reach 2 slightly upstream of the confluence with Thompson Creek in the wetted area and contained lower concentrations of CI relative to Thompson Creek (Figures 9 to 11). The major ion distribution at this location was also more consistent with water originating upstream from the side channel at GH_ERSC5 (Figure 5).

3.3 Reach 1 (West and East/Middle)

Surface water in the side channel at GH_ERSC2 (approximately 300 m south of the confluence with Thompson Creek) is inferred to be influenced by mixing with surface water from Thompson Creek as evidenced by concentrations of Cl above the applicable criteria, a similar major ion distribution, and overland connectivity to the side channel (SNC-Lavalin, 2019). Reach 1 dries up downstream of Reach 2 during the winter months and instantaneous flow data for GH_ERSC2 and surface water level data at ERSCDS (approximately 1 km south of GH_ERSC2) between 2017 and 2019 indicates no flow was measured at these times (Figures 2 and 3; Attachment 2). The side channel receives flow from the groundwater-fed wetted area between Reach 2 and station GH_ERCS2 until October 2019, at which point flows are inferred to infiltrate to ground in this area. Surface water levels at ERSCDS, located near the southern confluence between the side channel and the Elk River, fluctuated by approximately 1 m, with the greatest levels measured between late-April and late-July. Similar to GH_ER1, flows only occurred during freshet in the Elk River, indicating there is no groundwater base flow and the side channel is losing to ground in this area (i.e., infiltration is predominant). This is supported by the spatial distribution of wetted areas (Attachment 2).

3.3.1 Isolated Pools

In 2019, seven of the nine previously sampled isolated pools (SC2-P1, SC2-P5, SC4-P1, SC2-P10, SC2-P7, SC2-P2, and SC2-P3) that contained water for at least part of the year were sampled for water quality (Table 2.2 in Attachment 1). The water in these isolated pools are inferred to result from seasonal drying or receding of the side channel (i.e., infiltration) and are not groundwater fed except for pools SC2-P1, SC2-P2 and SC2-P3. Along Reach 1 West, major ion chemistry ranged from calcium bicarbonate to calcium bicarbonate-sulphate type water (Figure 5). Similar water types suggest that the side channel influences the isolated pools in the west side channel. In 2019, isolated pools along Reach 1 East were predominantly calcium sulphate rich, with the exception of SC2-P5, which contained a higher bicarbonate content (Figure 5). All of these pools also contained elevated concentrations of Cl above applicable criteria (Figures 12 to 14). The spatial distribution of wetted areas in Reach 1, as well as instantaneous flow measurements at GH_ERSC2 indicate that almost every isolated pool in Reach 1 dried at least once between 2017 and 2019 (Attachment 2). The isolated pools were typically mapped in areas that had been wetted in the previous month, indicative that the pools are stagnant water as the side channel recedes. Pool SC2-P3 was persistent year-round since 2017 and in 2019 the pool size was greatest in May at approximately 12 m by 3 m. Pool SC2-P1 has been identified in 2018 and 2019. In 2019, this pool was observed during every month except for March and was greatest in size in May (approximately 15 m by 2.5 m). In March, Pool SC2-P1 may have been frozen to substrate. Isolated pool SC2-P2 was observed in April 2018 and between October 2018 and December 2019; however, samples were collected in January and February 2019 indicating the pool was not frozen. Based on the presence of water in these pools during winter months and elevated concentrations of Cl relative to the applicable standards, a groundwater pathway for mine-influenced water originating from upland areas at GHO is inferred.

4 Summary

The Elk River side channel undergoes seasonal flooding and braiding with variable flow throughout the year. The surficial deposits underlying the side channel generally comprise fluvial and glaciofluvial sand and gravels (SNC-Lavalin, 2019). Review of the mapping performed by Minnow and Lotic since 2017 suggests that the seasonal flow in the side channel infiltrates to ground across the majority of the channel and develops isolated pools in seasons outside of freshet, except in at Pool SC3-P13, SC2-P3, SC2-P1, and SC2-P2. No ice or snow on Pool SC2-P3 was documented in 2019; however, a thin layer was observed over the majority of the pool during the winter months in 2017 and 2018. The fact that limited ice develops on the pool suggests groundwater discharge is occurring to this pool. Isolated pool SC2-P1 was generally observed year-round in 2019, except for in March, and pool SC2-P2 was observed during the winter months. The persistence of these pools during the winter months also suggests a groundwater base flow exists in the vicinity of the pools. Pool SC3-P13 was also not wetted year-round and was not observed in 2017 or 2018; however, a shallow groundwater flow path from Wolfram Creek in this area is inferred to be present based on water quality at GH_ER1A.

Concentrations of CI generally increase along the side channel flow path, which is inferred to result from loading of CI from mine-influenced tributaries on the west side of GHO (Figures 6 to 14). Since overland flow from Wolfram Creek to the side channel appears to be seasonal, loading to the side channel is inferred to be through shallow groundwater flow paths in addition to Thompson Creek, as identified in the 2018 LAEMP (Minnow, 2019; SNC-Lavalin, 2019).

Table D summarizes the predominant pathways for isolated pools and permanently wetted areas in the side channel from north to south. Overall, the four pools identified as groundwater fed (Pools SC3-P13, SC2-P3, SC2-P1, and SC2-P2) are relatively small in size and did not result in sustained flows in the side channel (Table E).

Table D: Summary of Groundwater Influence on Isolated Pools and Wetted Area in 2019

Reach	Station ID	Water Type	CI Above Applicable Standards	Wetted Year Round (Y/N)	Groundwater Contributions
Reach 3 (Upstream of GH_ER1A)	***Side Channel***				
	SC3-P7	*Calcium bicarbonate*	N	N	N
	SC3-P6	*Calcium bicarbonate*			
	SC3-P10	*Calcium bicarbonate*			
	SC3-P9	Calcium bicarbonate			
	SC3-P14	*Calcium bicarbonate*			
	SC3-P8	*Calcium bicarbonate*			
	Wolfram Creek				
	SC3-P13	Calcium sulphate-bicarbonate	Y	N	Y

Table D (Cont'd): Summary of Groundwater Influence on Isolated Pools and Wetted Area in 2019

Reach	Station ID	Water Type	Cl Above Applicable Standards	Wetted Year Round (Y/N)	Groundwater Contributions
Reach 3 (Downstream of GH_ER1A)	SC3-P11	Calcium bicarbonate	N	N	N
	SC3-P12	*Calcium bicarbonate*			
	SC3-P15	Calcium bicarbonate			
	SC3-P4	*Calcium bicarbonate*			
	SC3-P3	*Calcium bicarbonate*			
Reach 2 (Wetted Area)	RG_GH_SCW1	Calcium bicarbonate	N	Y	N
	RG_GH_SCW2	*Calcium bicarbonate/sulphate*	Y	Y	
	RG_GH_SCW3	Calcium sulphate/bicarbonate		N	
Reach 1 (West)	SC1-P2	Calcium bicarbonate	Y	N	N
	SC1-P1	Calcium bicarbonate-sulphate			
Reach 1 (Middle)	SC4-P1	Calcium sulphate-bicarbonate			
Reach 1 (East)	SC2-P4	*Calcium-magnesium sulphate*	Y	N	N
	SC2-P1	Calcium sulphate	Y	Maybe	Y
	SC2-P5	Calcium bicarbonate	Y	N	N
	SC2-P6	*Calcium bicarbonate*	N	N	
	SC2-P10	Calcium sulphate	Y	N	
	SC2-P7	Calcium bicarbonate-sulphate	Y	N	
	SC2-P2	Calcium sulphate	Y	Maybe	Y
	SC2-P3	Calcium sulphate	Y	Y	Y

Notes:
"*italics*" sample not collected in 2019, water type presented was calculated from 2017/2018 dataset.
"-" denotes no data available.

Table E: Summary of Groundwater Fed Isolated Pool Sizes in 2019

Reach	Station ID	Maximum Surface Area (m^3)	Depth (m)	Month Showing Greatest Extent Observed
Reach 3 (Upstream of GH_ER1A)	SC3-P13	875	0.20	May
Reach 1 (East)	SC2-P1	37.5	0.40	May
	SC2-P2	NM	NM	NM
	SC2-P3	36.0	0.30	May

Notes:
“NM” denotes not measured.

5 Conclusions and Recommendations

SNC-Lavalin has updated groundwater and surface water information and interpretation relating to the GHO LAEMP. This report presents an updated assessment of the potential groundwater–surface water interactions along the Elk River side channel. The main conclusions of the 2019 study were:

- Updated hydrographs, vertical gradients, wetting/drying surveys and water quality data support the conceptual model that the side channel predominantly infiltrates to ground and recharges groundwater.
- Localized areas of groundwater discharge occur near the confluence with Wolfram Creek (SC3-P13) and downstream of Thompson Creek (SC2-P3, SC2-P1 and SC2-P2). These discharge areas do not result in sustained flows in the side channel.
- The Elk River is the main influence on the water quality at the majority of surface water stations and pools in the Elk River side channel. However, concentrations of Cl in surface water increase along the side channel flow path, indicating loading from the mine-influenced tributaries is occurring, with the majority of the loading occurring from Thompson Creek.
- The water quality in isolated pools is a result of seasonal drying or receding of the side channel (i.e., infiltration), except for pools SC3-P13, SC2-P3, SC2-P1, and SC2-P2 which are influenced by groundwater. Pool SC3-P13 is not persistent on a year over year basis, and the three other pools are limited in areal extent.

The 2018 LAEMP recommended to fill data gaps/uncertainties associated with groundwater–surface water interaction along the Elk River side channel. Several of the gaps are planned to be addressed by new monitoring well installations in 2020 and collection of additional groundwater data in support of on-going programs such as the GHO SSGMP, RGMP, MBI, and CPX2.

Table F: 2018 Data Gap Status Update

Area	Data Gap/Uncertainty	Recommendations	Status
Elk River Valley			
Side Channel and Associated Tributaries	Surface water stations are not surveyed to a common datum.	Survey surface water stations to a common with groundwater monitoring wells.	Select surface water stations have been surveyed and tied into the current groundwater monitoring network.
Wolfram Creek	Shallow groundwater conditions between Wolfram Pond and the side channel (GH_ER1A) are unknown.	Install a groundwater monitoring network upgradient of GH_ER1A. Collect groundwater level and quality data from newly installed wells. Review results from seep survey conducted at GHO.	Groundwater monitoring network with shallow wells is currently being developed through CPX2 baseline and Mass Balance Investigation programs. Drilling commenced in 2019 and will continue in 2020. Results from seep survey will be reviewed in the context of new monitoring wells.
Thompson Creek	Groundwater conditions in the vicinity of Thompson Creek confluence and further south in the side channel are unknown.	Install a groundwater monitoring network in the vicinity of the confluence with Thompson Creek and further to the south where pooled areas have been mapped and sampled and an influence from Thompson Creek suspected. Review results from seep survey conducted at GHO.	Groundwater monitoring network with shallow wells is currently being developed through the Mass Balance Investigation program. Drilling commenced in 2019 and will continue in 2020. Results from seep survey will be reviewed in the context of new monitoring wells.
Pools and Permanently Wetted Area	There is increasing mine-influence in pools and the permanently wetted area in the side channel noted in 2018 as compared to 2017, which is identified as an uncertainty.	Field mapping, as well as analytical data associated with additional pools included in the 2019 program. Comparison of results to surface water and groundwater trends.	Mapping has been conducted in 2019. Analytical results compared to surface water and groundwater as part of 2019 LAEMP reporting.
Downgradient of the Side Channel (GH_MW-ERSC-1)	The origin of periodic mine-influenced water in monitoring well GH_MW-ERSC-1 is not well understood.	Improve the groundwater monitoring network in the vicinity of this well. Review results from seep survey conducted at GHO.	This gap will be investigated as part of the Mass Balance Investigation in 2020.

6 References

British Columbia Ministry of Environment and Climate Change Strategy, 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Summary Report. March 2018.

British Columbia Ministry of Environment and Climate Change Strategy, 2019. Contaminated Sites Regulation (CSR), B.C. Reg. 375/96, includes amendments up to B.C. Reg. 13/2019, January 24, 2019.

Minnow Environmental Inc. and Lotic Environmental, 2017. Study Design (2017) for Local Aquatic Effects Monitoring Program (LAEMP) at Teck's Greenhills Operation. Prepared for Teck Coal Limited, dated May 2017.

Minnow Environmental Inc. and Lotic Environmental, 2018a. 2017 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report. Prepared for Teck Coal Limited, dated May 2018.

Minnow Environmental Inc. and Lotic Environmental, 2018b. 2018 to 2020 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Study Design. Prepared for Teck Coal Limited, dated May 2018.

Minnow Environmental Inc. and Lotic Environmental, 2019. 2018 Greenhills Operation Local Aquatic Effects Monitoring Program (LAEMP) Report. Prepared for Teck Coal Limited, dated May 2018.

SNC-Lavalin Inc., 2019. Assessment of Groundwater – Surface Water Interaction for LAEMP West Side of GHO. Prepared for Teck Coal Limited, dated May 30, 2019.

SNC-Lavalin Inc., 2020. 2019 Annual Report: Elk Valley Regional and Site-Specific Groundwater Monitoring Programs. Prepared for Teck Coal Limited, dated March 31, 2020.

Teck Coal Ltd., 2017. 2017 Elk Valley Regional Water Quality Model Update – Overview Report (with Annexes), dated October 2017.

7 Closure

We trust this work plan meets your current requirements and greatly appreciate the opportunity to assist Teck with this project. If you have any questions, please contact Stefan Humphries in our Nelson office at 250.354.1664.

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40773

May 29'20

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KC/tr/gc
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Figures

1: Hydrograph for Reach 3 and Precipitation Data
2: Hydrograph for Reaches 2 and 1 and Precipitation Data
3: Time-Series Graph of Instantaneous Flow
4: Piper Plot (Reach 3, 2019)
5: Piper Plot (Reaches 2 and 1, 2019)
6: Nitrate-N Concentrations in Reach 3
7: Sulphate Concentrations in Reach 3
8: Dissolved Selenium Concentrations in Reach 3
9: Nitrate-N Concentrations in Reach 2
10: Sulphate Concentrations in Reach 2
11: Dissolved Selenium Concentrations in Reach 2
12: Nitrate-N Concentrations in Reach 1
13: Sulphate Concentrations in Reach 1
14: Dissolved Selenium Concentrations in Reach 1

Drawings

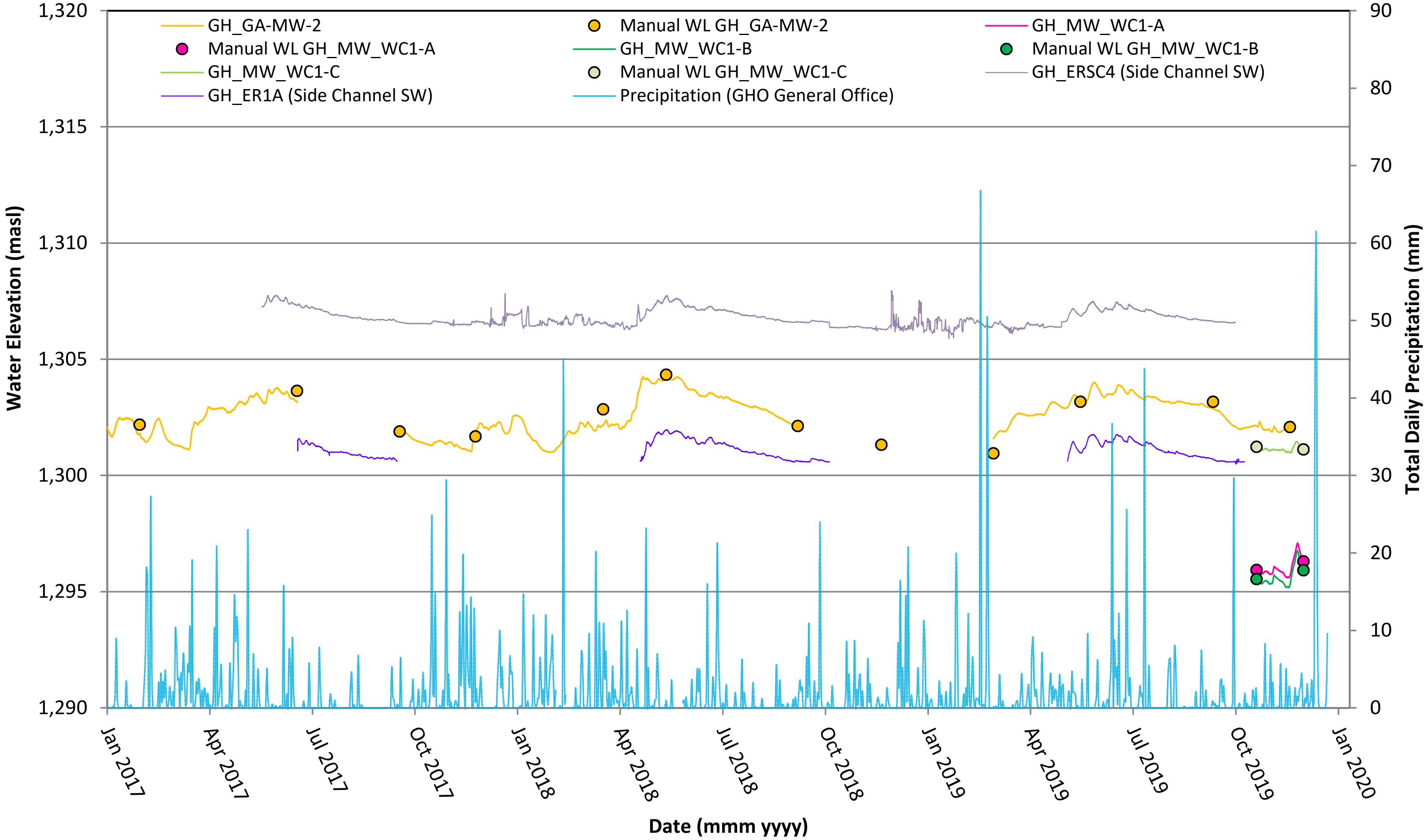
1: Site Location Plan
2: GHO Elk River Side Channel Site Plan

Attachments

1: Surface Water Station IDs (2017 to 2019)
2: Spatial Distribution of Wet and Dry Locations

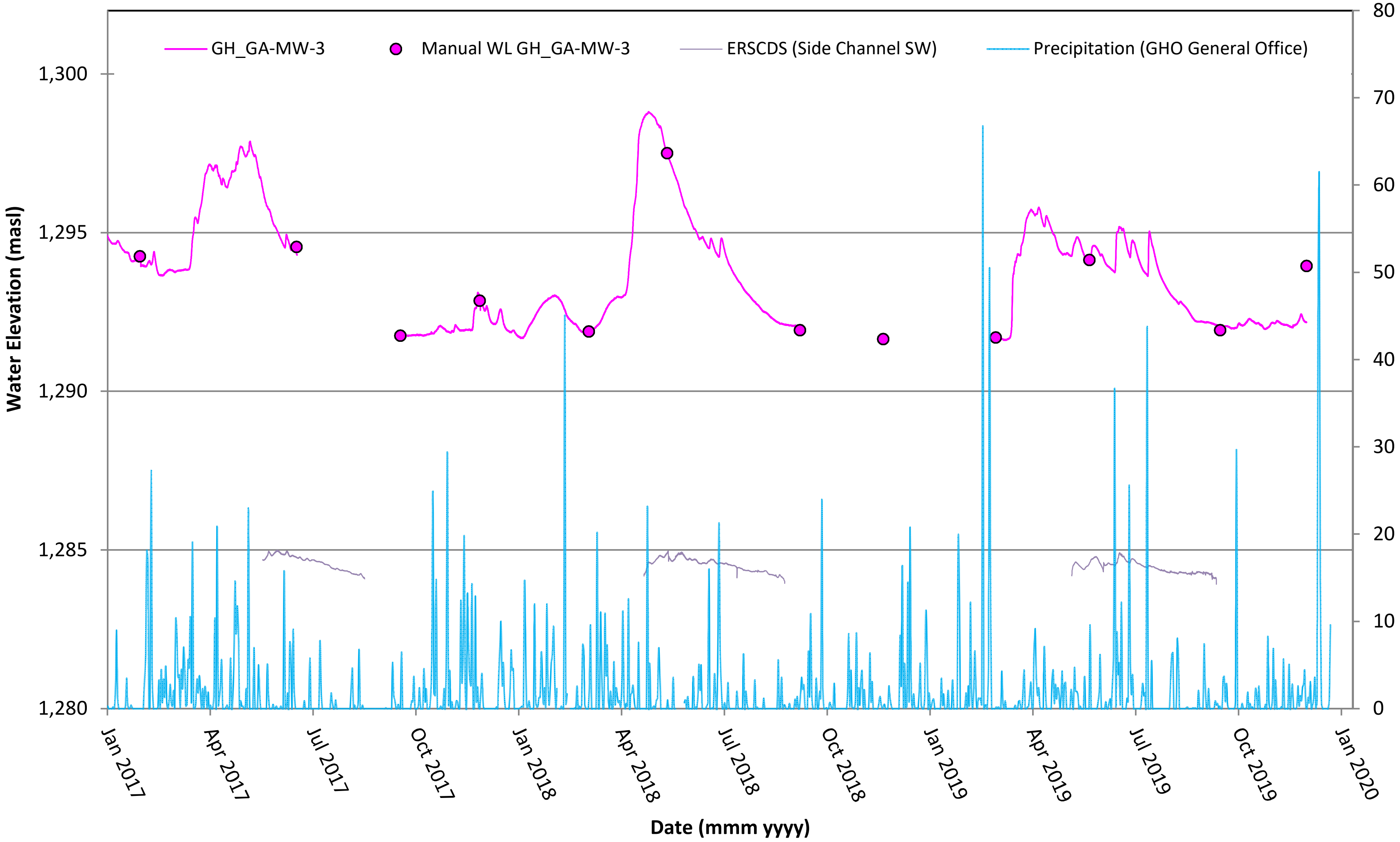
Figures

Figure 1: Hydrograph for Reach 3 and Precipitation Data



Note: Surface water elevations normalized based on available survey data

Figure 2: Hydrograph for Reaches 2 and 1 and Precipitation Data



Note: Surface water elevations normalized based on available survey data.

Figure 3: Time-Series Graph of Instantaneous Flow

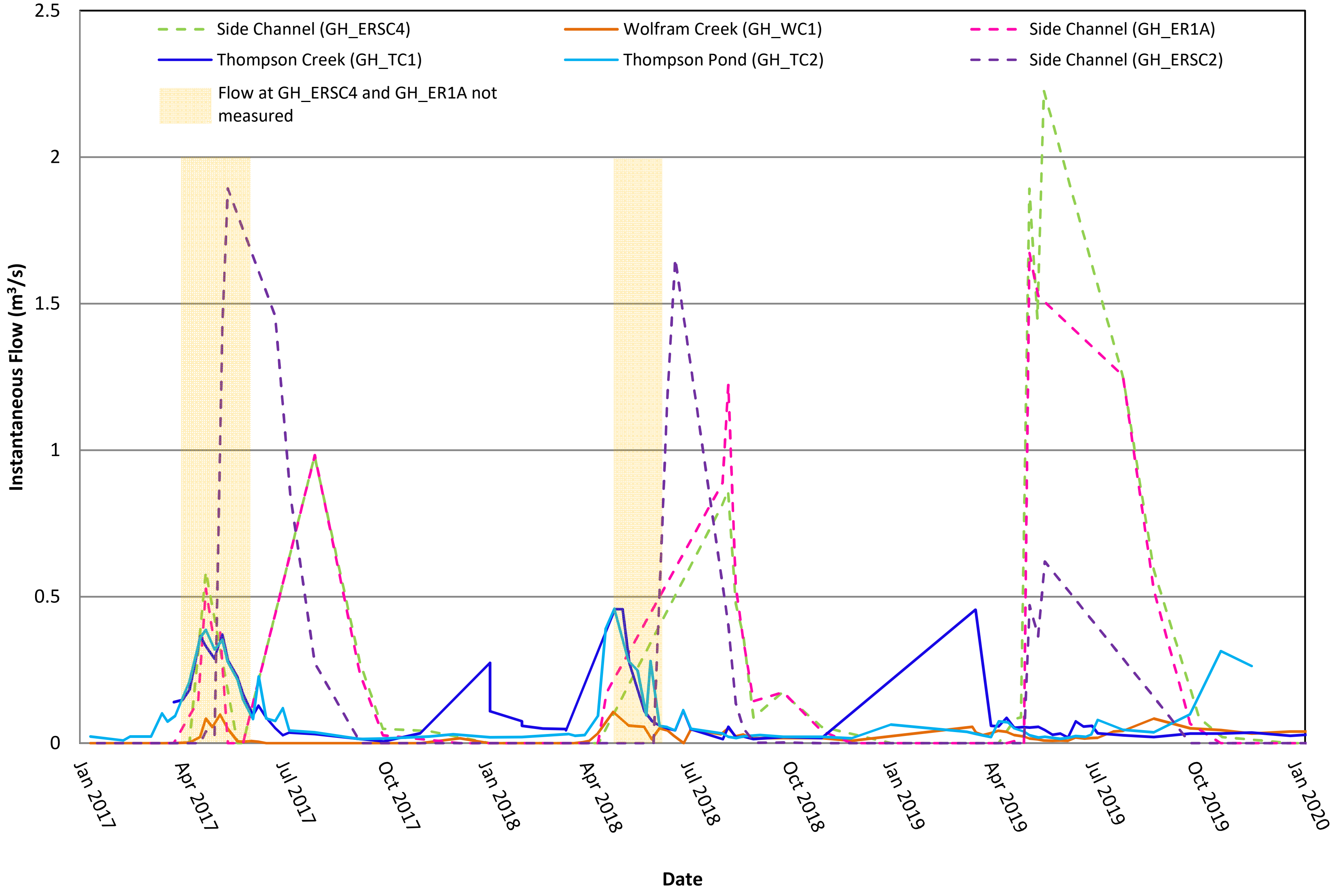
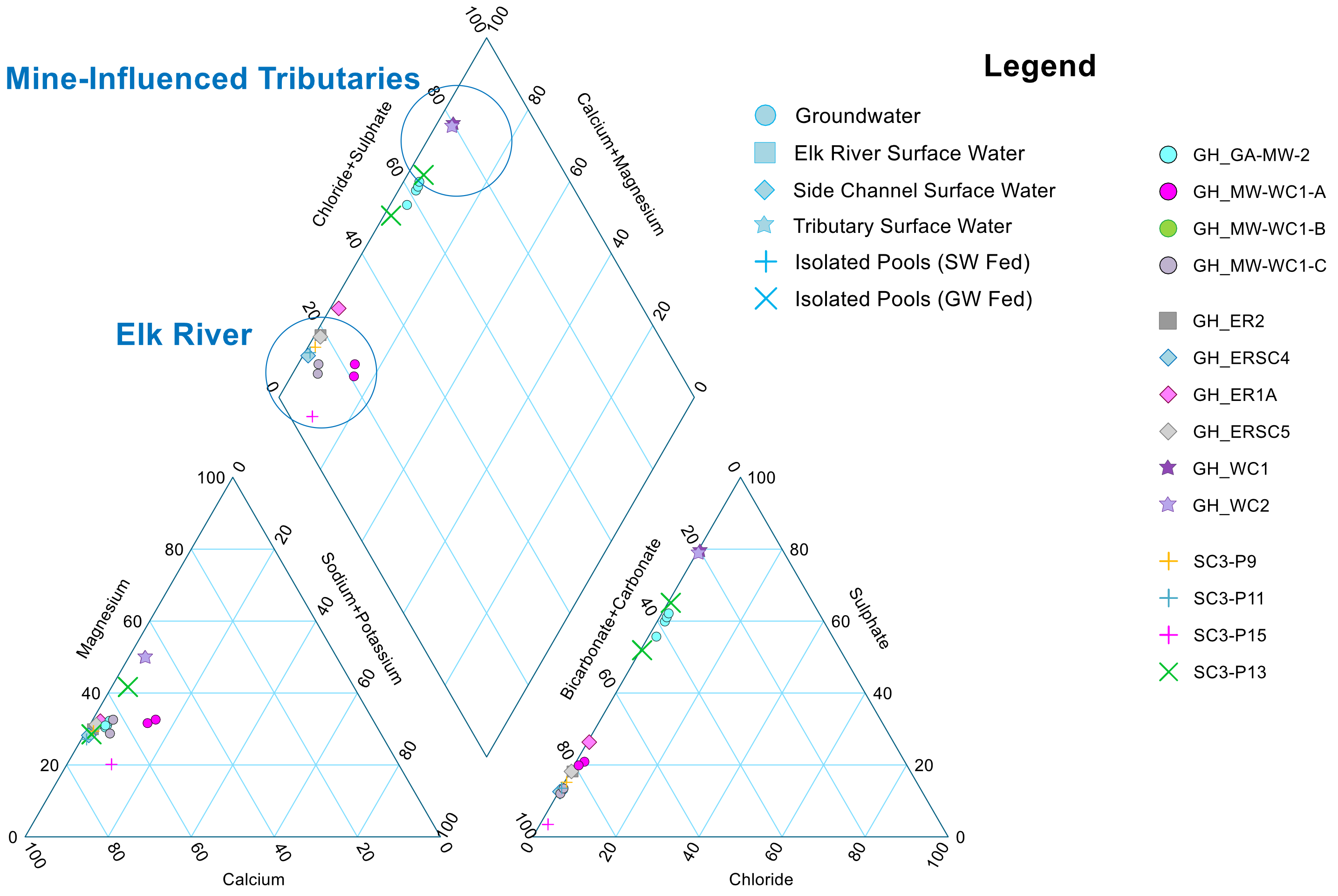
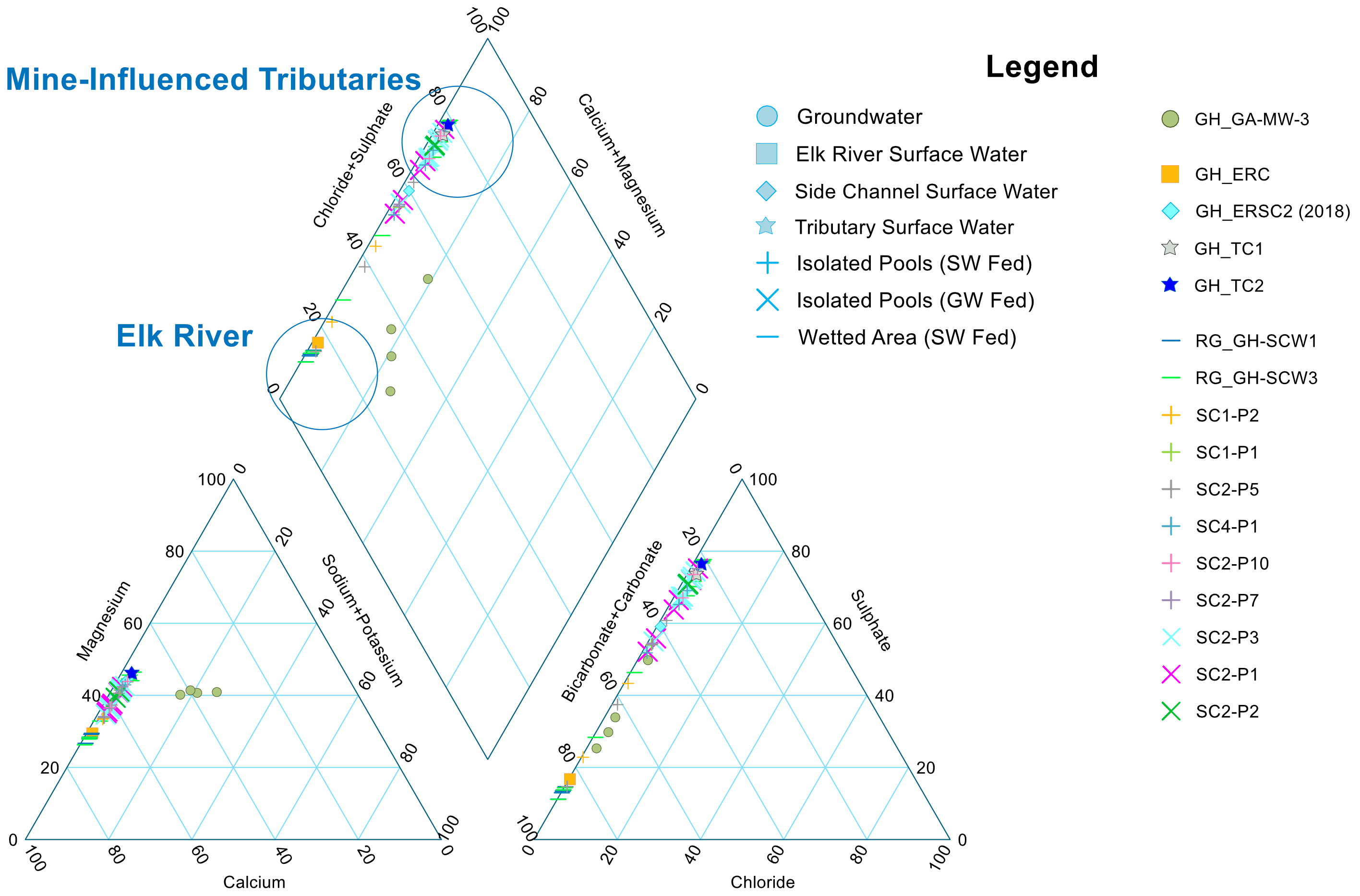


Figure 4: Piper Plot
(Upstream and Reach 3; 2019)



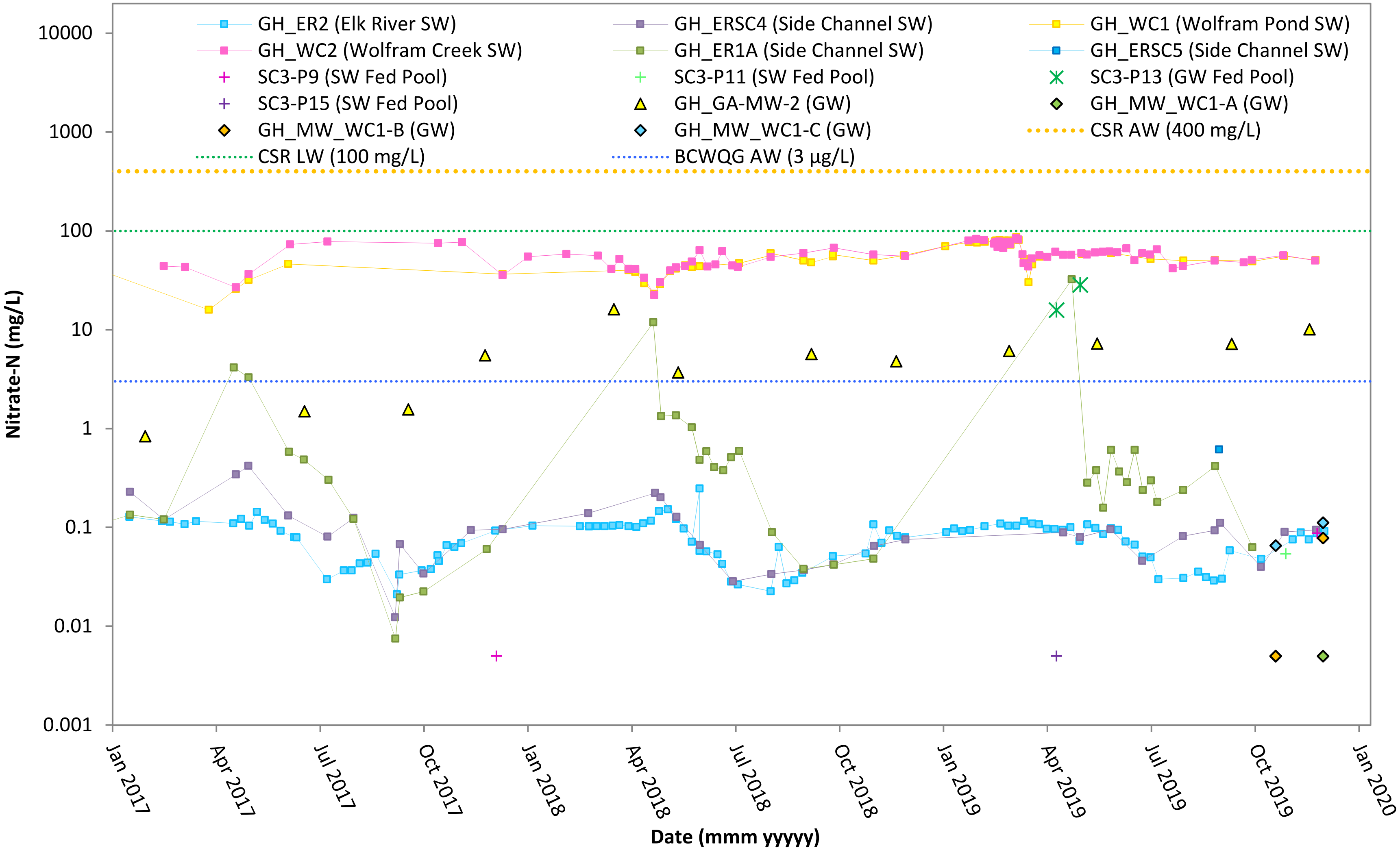
Note:
Average 2019 major ion distributions are presented for surface water results for the Elk River, side channel and tributaries for comparison purposes.
Only results for isolated pools sampled in 2019 are presented.

Figure 5: Piper Plot
(Reaches 2 and 1; 2019)



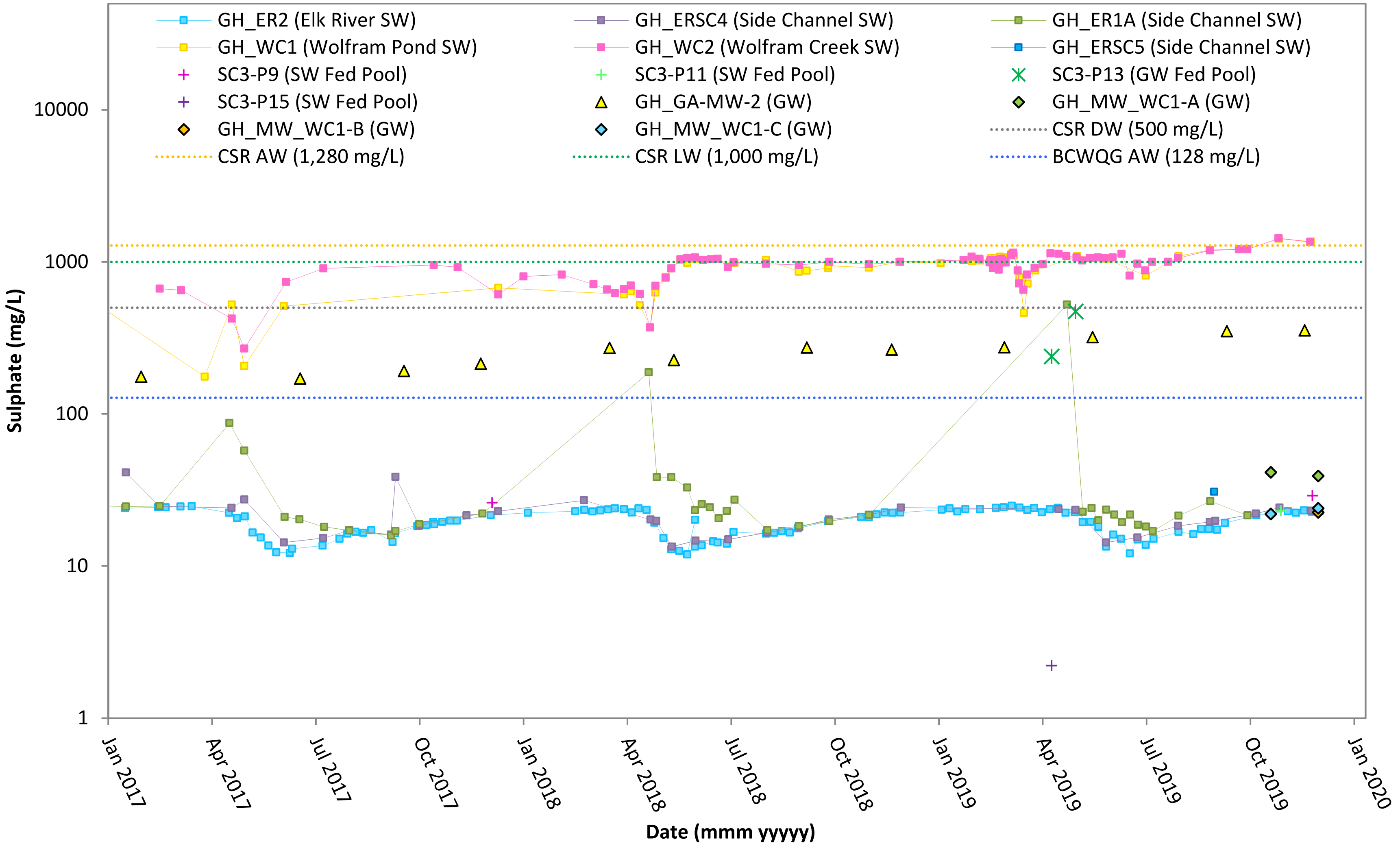
Note:
Average 2019 major ion distributions are presented for surface water results for the Elk River, side channel and tributaries for comparison purposes.
Average 2018 major ion distribution for GH_ERSC2 has been presented.
Only results for isolated pools and permanently wetted areas sampled in 2019 are presented.

Figure 6: Nitrate-N Concentrations in Reach 3



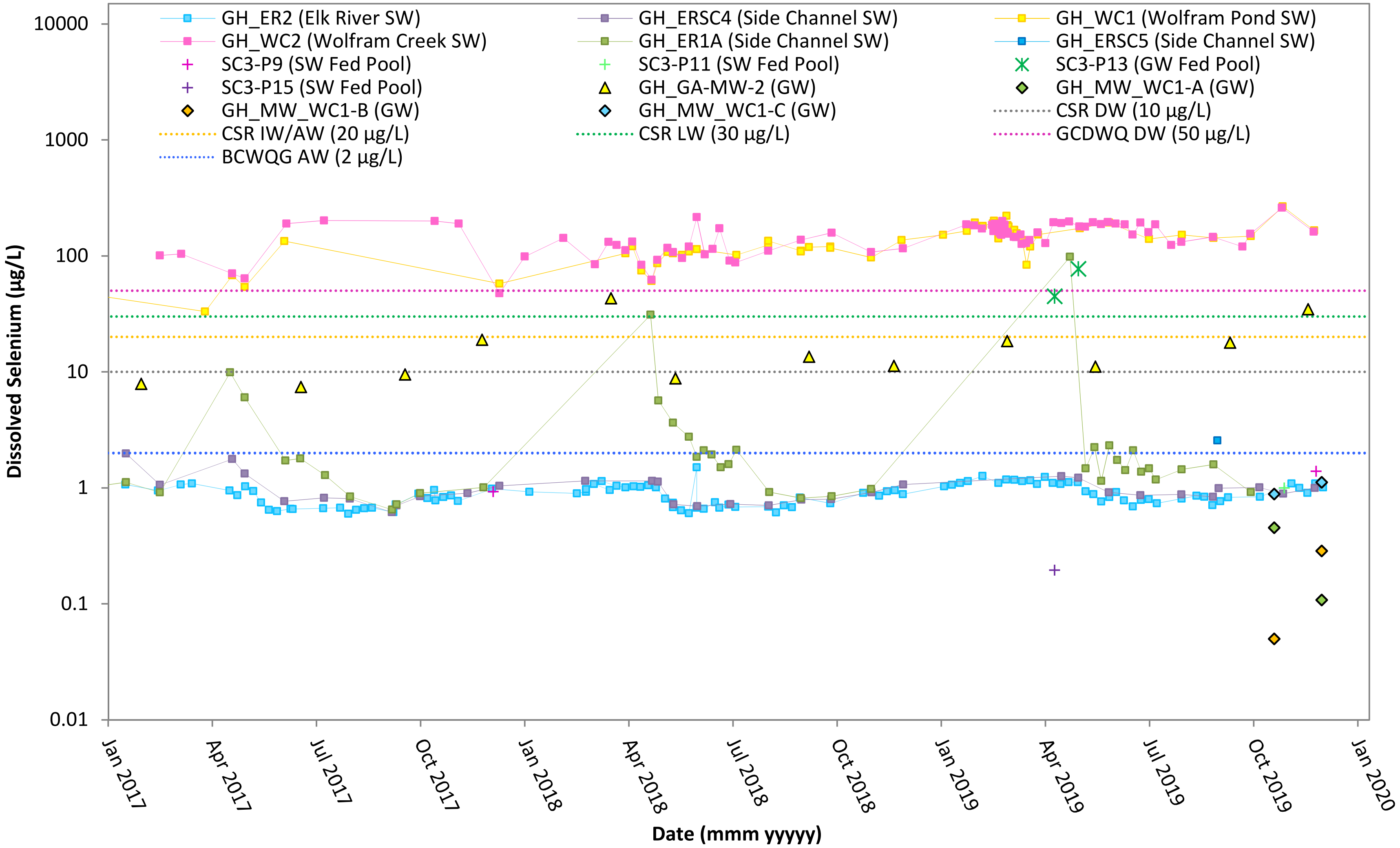
Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
For concentrations measured below the analytical detection limit, the detection limit (0.005 µg/L) was utilized for plotting purposes.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 7: Sulphate Concentrations in Reach 3



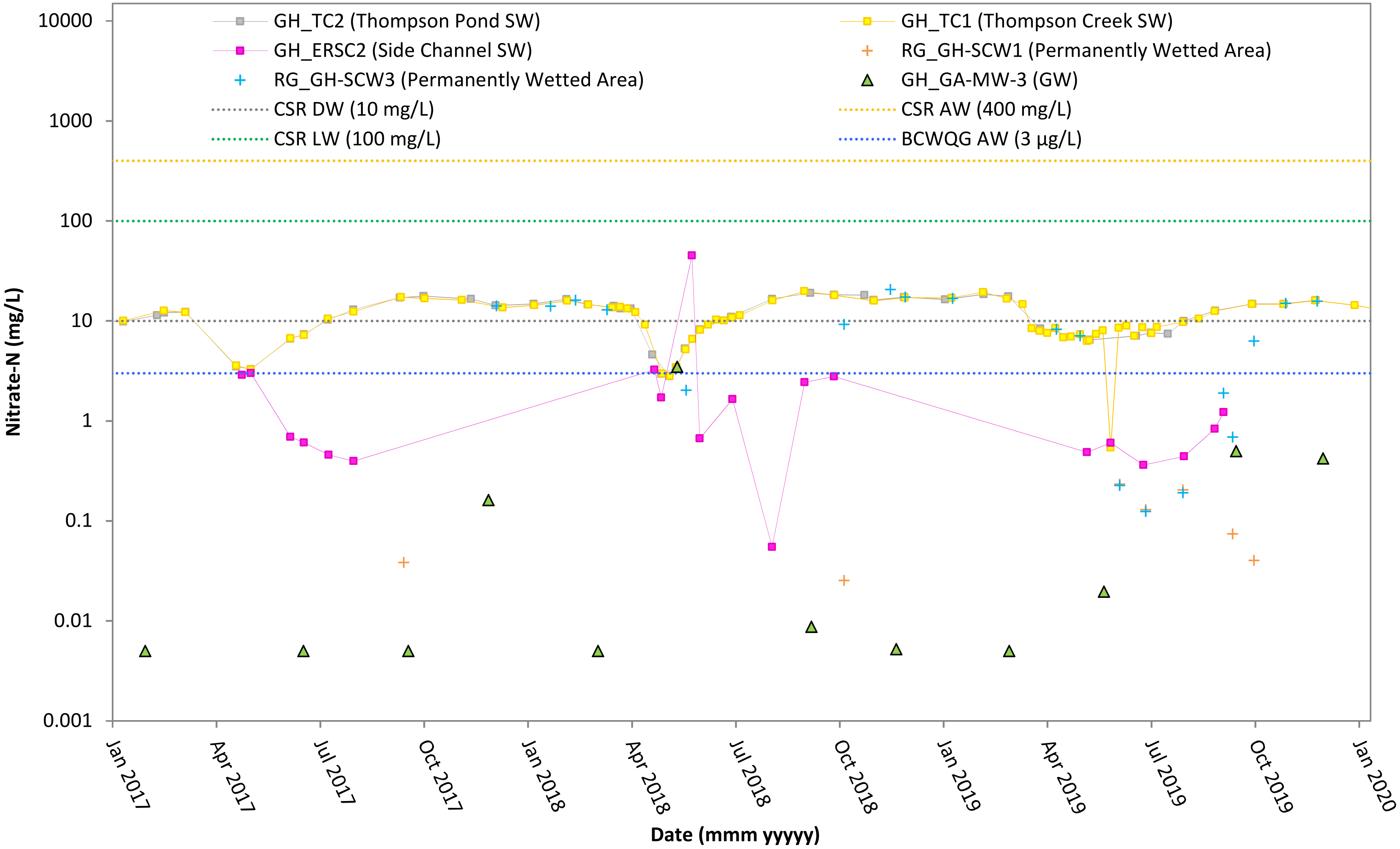
Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 8: Dissolved Selenium Concentrations in Reach 3



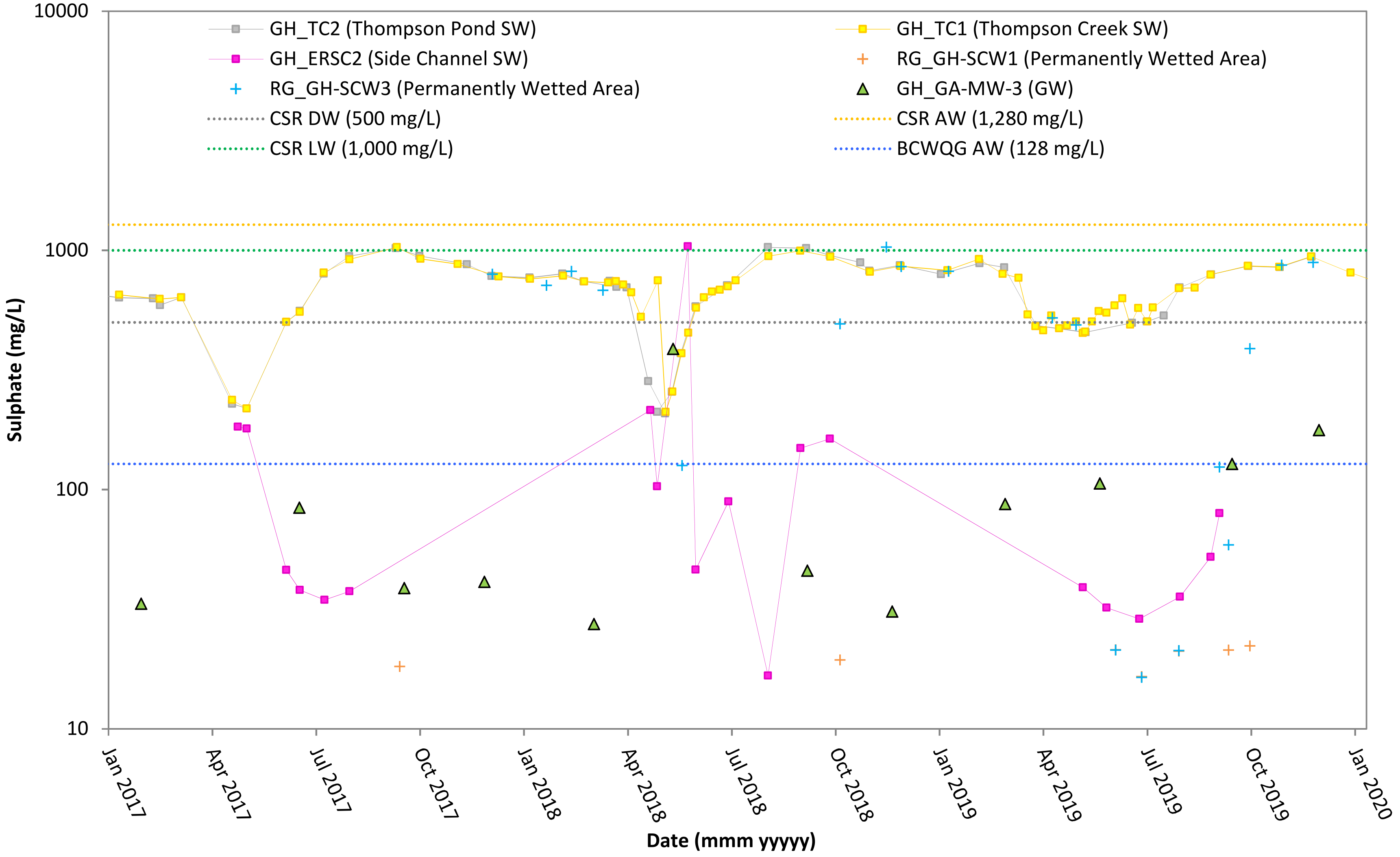
Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
For concentrations measured below the analytical detection limit, the detection limit (0.05 µg/L) was utilized for plotting purposes.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 9: Nitrate-N Concentrations in Reach 2



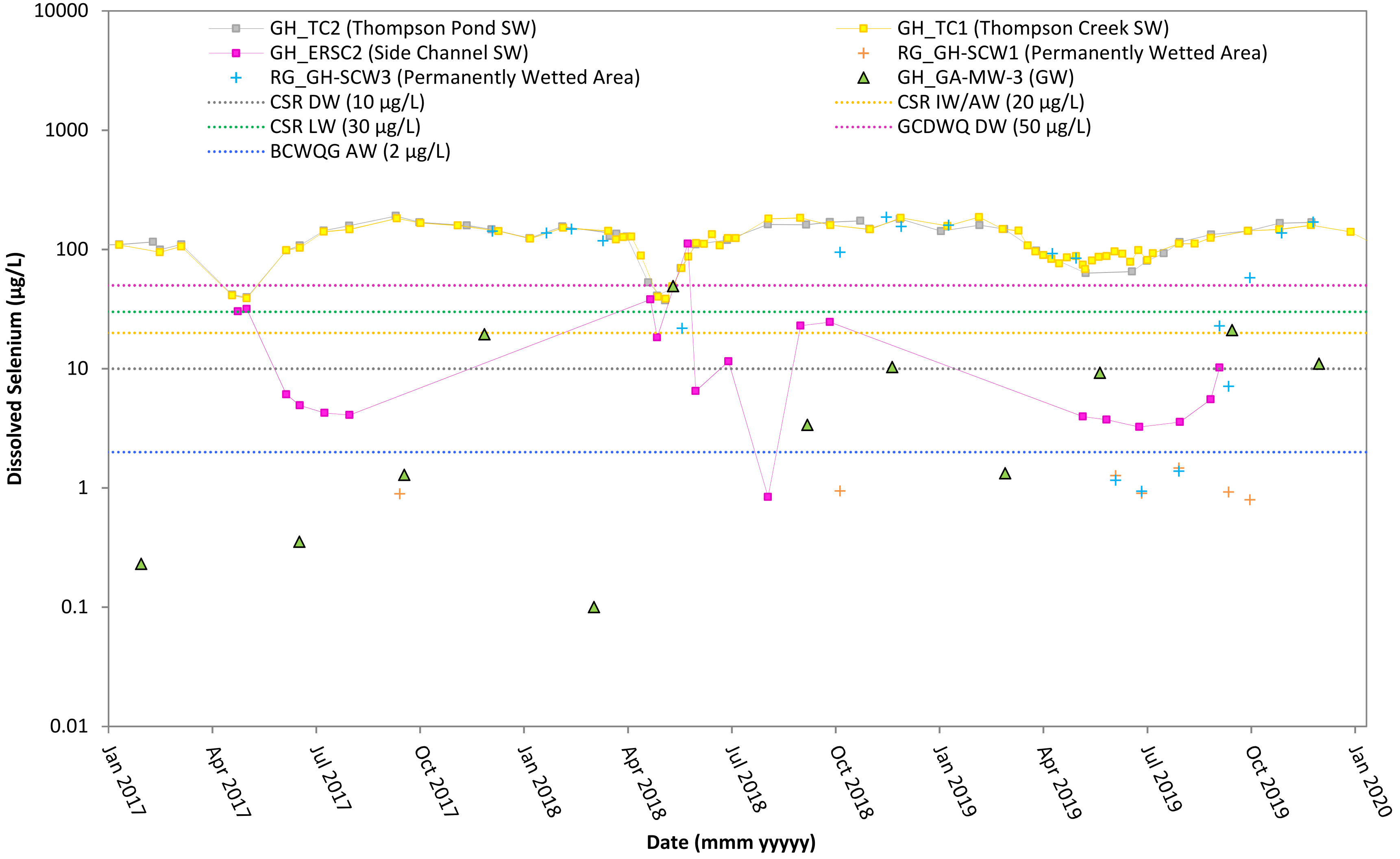
Note: Surface water location RG_GHSCW2 (permanently wetted area) was not sampled in 2019 and was therefore not included in the time-series graph.
For concentrations measured below the analytical detection limit, the detection limit (0.005 mg/L) was utilized for plotting purposes.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 10: Sulphate Concentrations in Reach 2



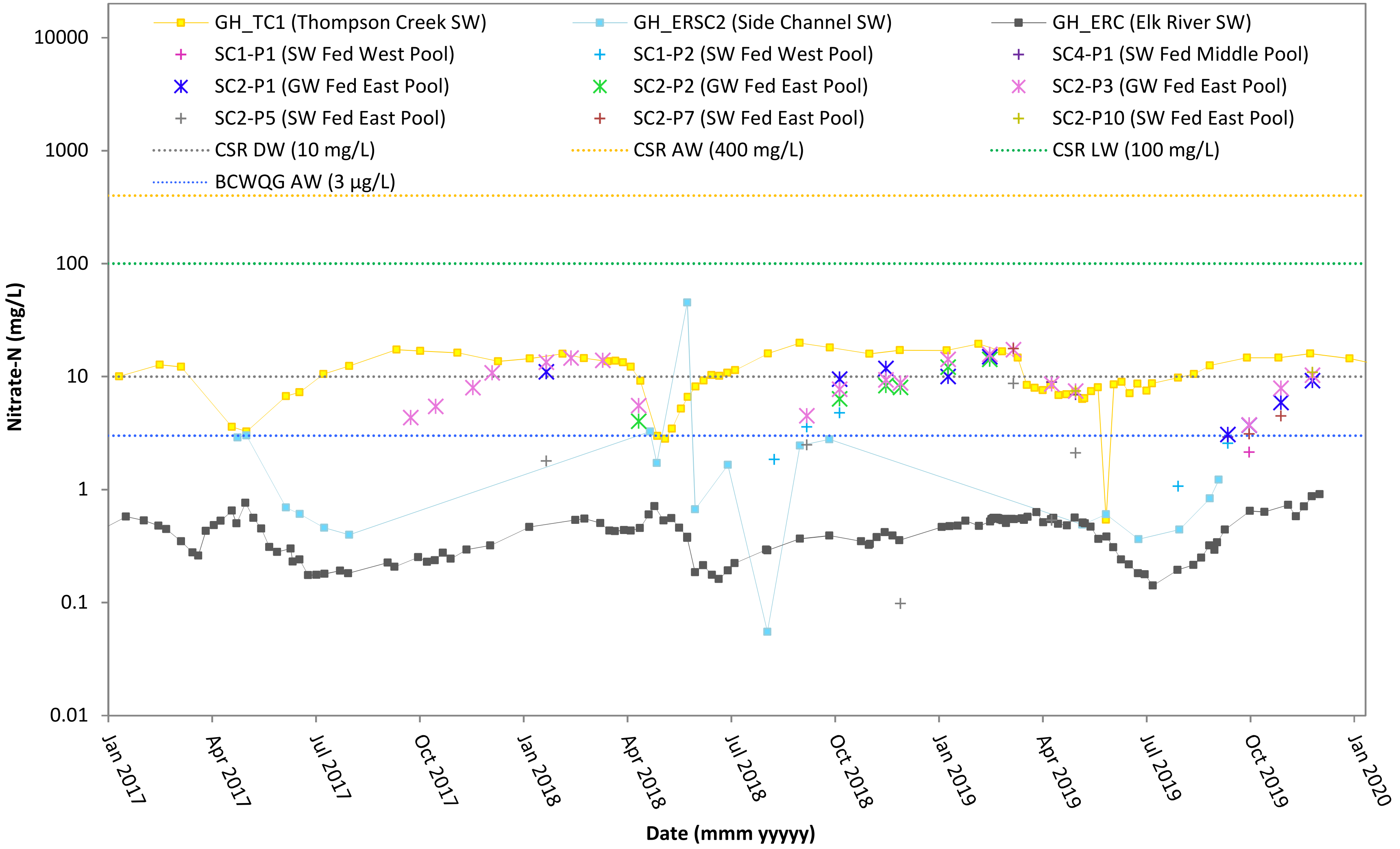
Note: Surface water location RG_GHSCW2 (permanently wetted area) was not sampled in 2019 and was therefore not included in the time-series graph.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 11: Dissolved Selenium Concentrations in Reach 2



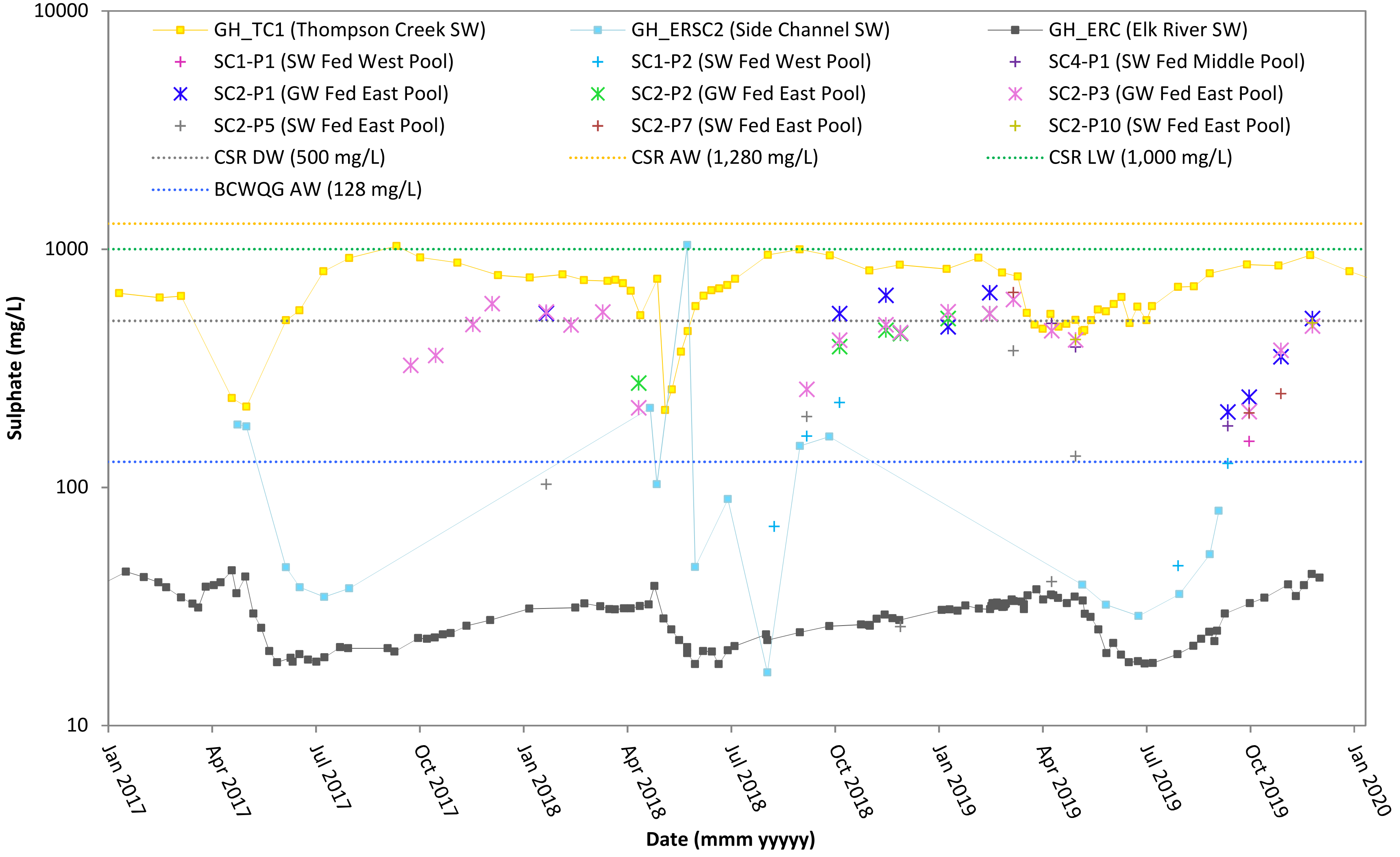
Note: Surface water location RG_GHSCW2 (permanently wetted area) was not sampled in 2019 and was therefore not included in the time-series graph.
For concentrations measured below the analytical detection limit, the detection limit (0.10 µg/L) was utilized for plotting purposes.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 12: Nitrate-N Concentrations in Reach 1



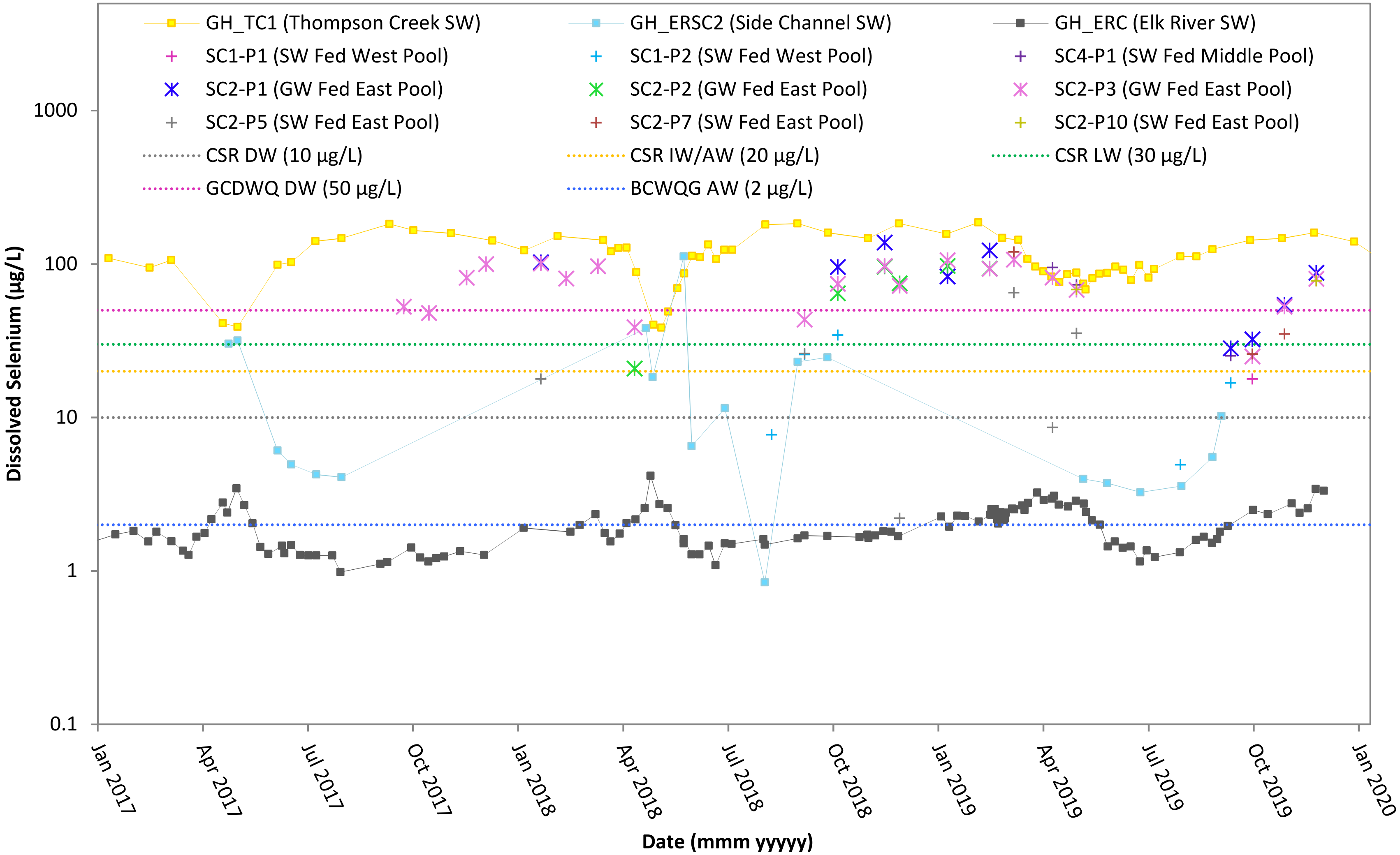
Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Figure 13: Sulphate Concentrations in Reach 1



Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

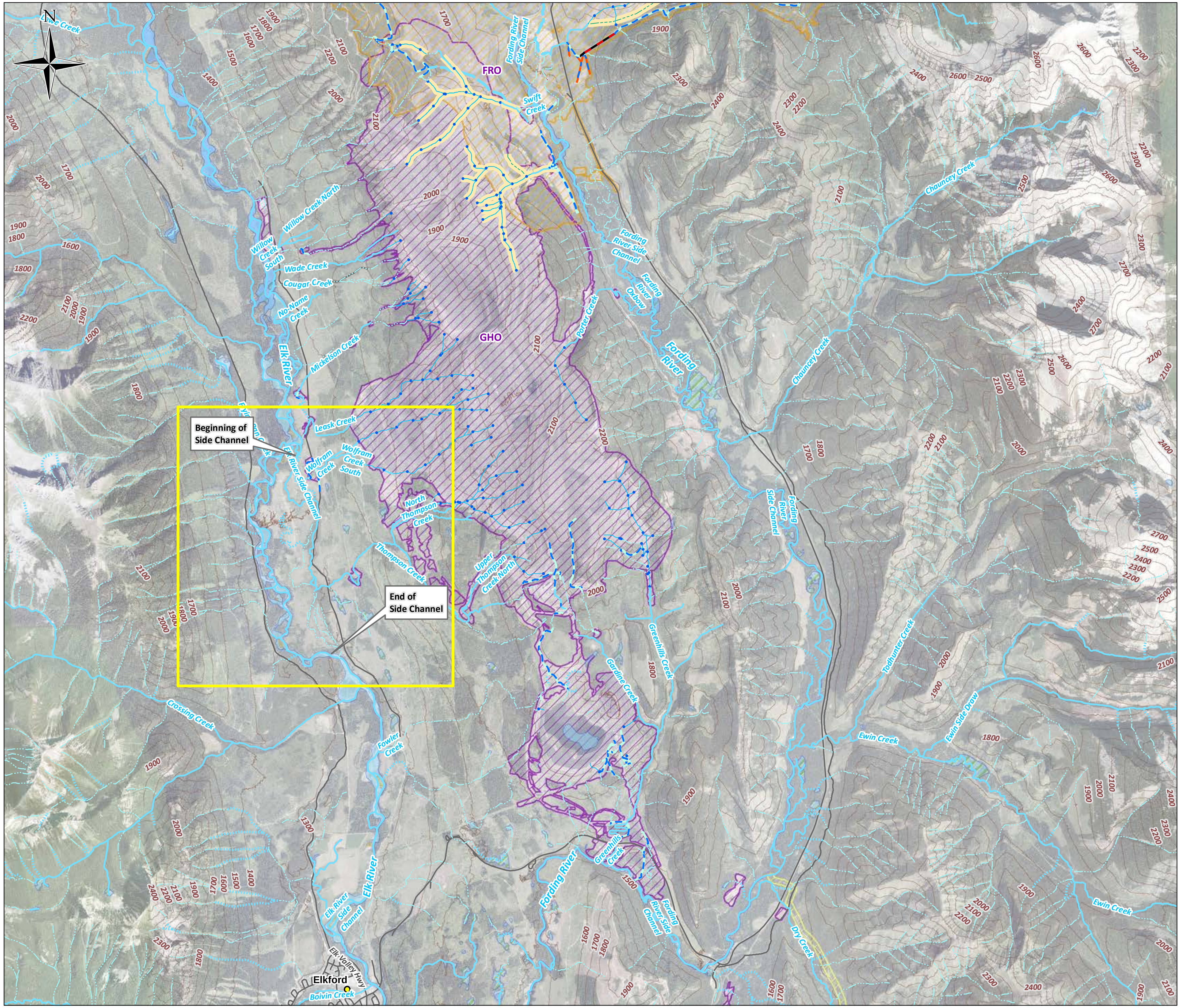
Figure 14: Dissolved Selenium Concentrations in Reach 1

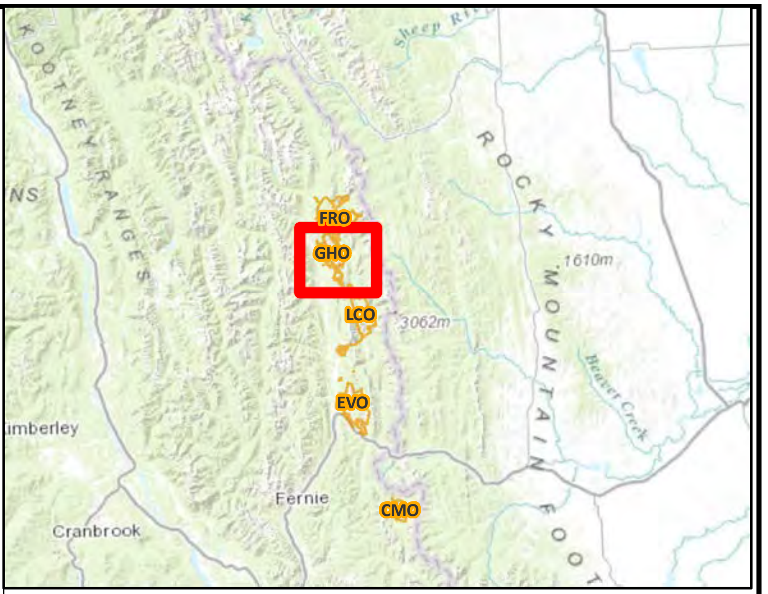


Note: Only results for isolated pools obersved in 2019 are presented along with historical data for these pools.
Logarithmic scale has been applied based on distribution of concentrations relative to applicable screening criteria.

Drawings

1: Site Location Plan
2: GHO Elk River Side Channel Site Plan





Legend

Water Features
- Intermittent Stream
- Stream Ditch
- Indefinite Stream
- Stream
- Subsurface
- Culvert
- Ditch
- Rock Drain
- Water Pipeline
- Island
- Lake
- River Bed
- Wetland

Site Features
- Secondary Road
- Topographic Contours (100m)
- FRO Permitted Boundary
- GHO Permitted Boundary
- LCO Permitted Boundary
- Side Channel Project Boundary

NOTES:
1. Original in colour.
2. Numerical scale reflects full-size print. Print scaling will distort this scale; however, scale bar will remain accurate.
3. Intended for illustration purposes. Accuracy has not been verified for construction or navigation purposes.

REFERENCES:
1. Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
2. Data provided by Teck Coal (2017).

REVISIONS:
0 - AO - 2018-10-09 - DRAFT - LH
1 - AO - 2018-10-25 - FINAL - KM
2 - AM - 2020-05-21- FINAL - KC

0 0.5 1 2 3 4 5
km

CLIENT:
Teck Coal Ltd.

PROJECT LOCATION:
Greenhills Operations, BC

SNC·LAVALIN

Site Location Plan

BY: AO	SCALE: 1:70,000	DATE: 2020-05-21	REF No: Drawing 1 REV: 2
CHK'D: KC	Proj Coord Sys: NAD 1983 UTM Zone 11N		

MXD Path: P:\Current Projects\Teck Coal Ltd\GISCAD\GIS\Map Series\655483_GHO\655483-001_SitePlan3.mxd

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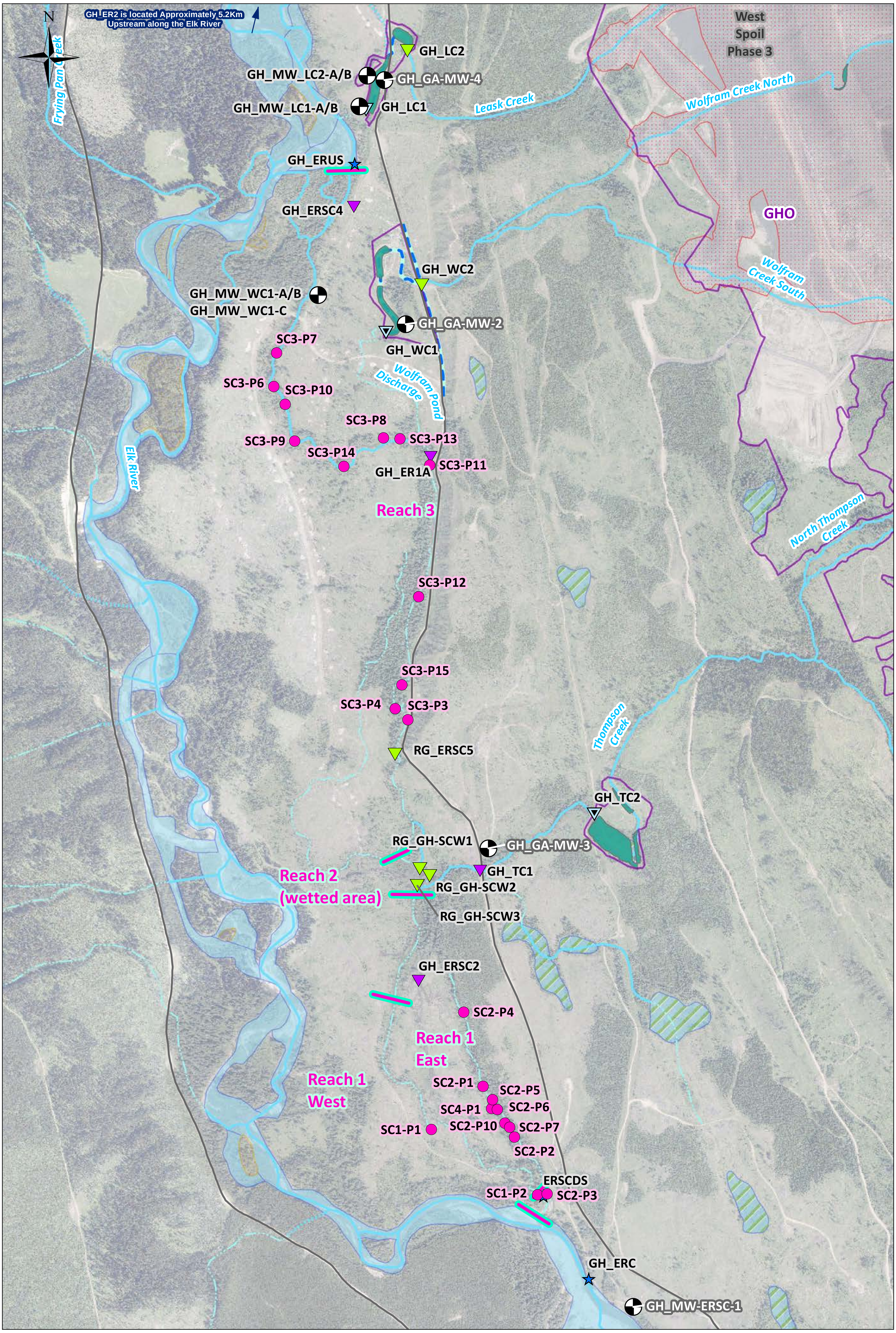

Legend

Groundwater Stations

◐ Monitoring Well

Surface Water Stations

★ Compliance Point
▼ Receiving Environment Surface Water Monitoring Station
▽ Authorized Discharge
▼ Permitted / non-permitted surface water monitoring station
● Pools
▬ Reaches

Site Features

▬ Secondary Road
☐ GHO Permitted Boundary
▨ Waste Dump (Spoils)
■ Tailings/Settling Pond

Water Features

- - Intermittent Stream
▬ Ditch
··· Indefinite Stream
▬ Stream
▨ Island
■ Lake
■ River Bed
▨ Wetland

Notes:
1. Intended for illustration purposes only.
2. Original in colour.
3. Site location is approximate.

References:
1. Information provided by Teck Coal Ltd.
2. Mapped Aquifers are from Water Resources Atlas (BC ENV)

Revisons:
0 - AO - 2019-01-09- DRAFT - KC
1 - AM - 2020-05-21- DRAFT - KC

0 50 100 200 300 400 500
Meters

PROJECT LOCATION:
Greenhills Operations, BC

CLIENT NAME:
Teck Coal Ltd.

SNC·LAVALIN

GHO Elk River Side Channel Site Plan

CHK'D: KC
BY: AO
DATE: 2020-05-21
SCALE: 1:20,000
COORD SYS: NAD 1983 UTM Zone 11N
Ref Num:
REV: 1
Drawing 2

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Attachment 1

Surface Water Station IDs (2017 to 2019)

Table 2.2: Pools Assessed for Habitat, Biota, and Water Chemistry, GHO LAEMP [a]

General Pool Area Description	Water Station Code			UTM (NAD83, 11U)		Wetted and Flowing (W), Wetted Isolated Pool (P), and Dry (D)																															
	EQuIS	2018 / 2019 GHO LAEMP Report	2017 GHO LAEMP Report[b]	Easting	Northing	2017								2018												2019											
						May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December
Side channel upstream of station GH_ER1A	RG_GH-SC3-P7	SC3-P7	Pool-U-1	647843	5552016	W	W	W	W	W	W	P	D	D	D	D	D	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	D
	RG_GH-SC3-P6	SC3-P6	Pool-U-2	647833	5551900	W	W	W	W	W	W	P	D	D	D	D	P	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	P
	RG_GH-SC3-P10	SC3-P10	Pool-U-3	647873	5551838	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	W	P	D	D	D	D	W	W	W	W	W	W	W	D
	RG_GH-SC3-P9	SC3-P9	Pool-U-4	647906	5551710	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	W	D	D	D	D	D	W	W	W	W	W	W	W	P
	RG_GH-SC3-P14	SC3-P14	- [c]	648076	5551622	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	D	D	W	W	W	W	W	D	D
	RG_GH-SC3-P8	SC3-P8	Pool-U-5	648214	5551721	W	W	W	W	W	W	D	P	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	D	D
	RG_GH-SC3-P13	SC3-P13	- [c]	648271	5551718	W	W	W	W	W	W	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	P	P	W	W	W	W	W	D	D
Side channel downstream of station GH_ER1A, upstream of Thompson wetland	RG_GH-SC3-P11	SC3-P11	- [c]	648374	5551627	W	W	W	W	W	P	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	P	W	W	W	W	D	P	D
	RG_GH-SC3-P12	SC3-P12	- [c]	648336	5551170	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	W	P	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC3-P15	SC3-P15	- [c]	648278	5550864	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	W	W	D	D	D	D	D	P	D	W	W	W	W	D	D	D
	RG_GH-SC3-P4	SC3-P4	Pool-M-2	648255	5550781	W	W	W	W	W	P	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC3-P3	SC3-P3	Pool-M-1	648299	5550743	W	W	W	W	W	D	D	D	D	D	D	P	W	W	W	W	W	W	D	D	D	D	D	D	D	W	W	W	W	D	D	D
Western channel downstream of Thompson wetland	RG_GH-SC1-P1	SC1-P1	Pool-W-2	648380	5549321	W	W	W	W	P	D	D	P	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	W	W	P	D	D
	RG_GH-SC1-P2	SC1-P2	Pool-W-1	648730	5549114	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	P	P	P	D	D	D	D	D	P	P	W	W	P	P	P	D	D
Middle channel downstream of Thompson wetland	RG_GH-SC4-P1	SC4-P1	- [c]	648589	5549393	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	P	P	D	D	D	D	D	D	P	P	W	W	W	P	D	D	D
Eastern channel downstream of Thompson wetland	RG_GH-SC2-P4	SC2-P4	Pool-E-1	648492	5549728	W	W	W	P	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	D	D	D	D	D
	RG_GH-SC2-P1	SC2-P1	Pool-E-2	648559	5549470	W	W	W	W	P	D	D	D	P	D	D	D	W	W	W	W	P	P	P	P	P	P	D	P	P	W	W	W	P	P	P	P
	RG_GH-SC2-P5	SC2-P5	Pool-E-3	648592	5549424	W	W	W	W	P	D	D	D	P	D	D	P	W	W	W	W	P	P	P	P	D	D	P	P	P	W	W	W	W	P	P	P
	RG_GH-SC2-P6	SC2-P6	- [c]	648609	5549390	W	W	W	W	D	D	D	D	D	D	D	P	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC2-P10	SC2-P10	- [c]	648635	5549343	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	D	D	P	W	W	W	W	P	P	P
	RG_GH-SC2-P7	SC2-P7	- [c]	648652	5549329	W	W	W	W	D	D	D	D	D	D	D	D	W	W	W	W	D	D	D	D	D	D	P	D	D	W	W	W	W	P	P	P
	RG_GH-SC2-P2	SC2-P2	Pool-E-6	648668	5549294	W	W	W	W	P	D	D	D	D	D	D	D	W	W	W	W	D	P	P	P	P	P	D	D	D	W	W	W	W	D	D	D
	RG_GH-SC2-P3	SC2-P3	Pool-E-7	648782	5549097	W	W	W	W	P	P	P	P	P	P	P	P	W	W	W	W	P	P	P	P	P	P	P	P	P	W	W	W	W	P	P	P

[a] This table excludes isolated pools that were not sampled for water quality. See Appendix Figures A.1 to A.28 and Appendix Tables B.8 to B.17.

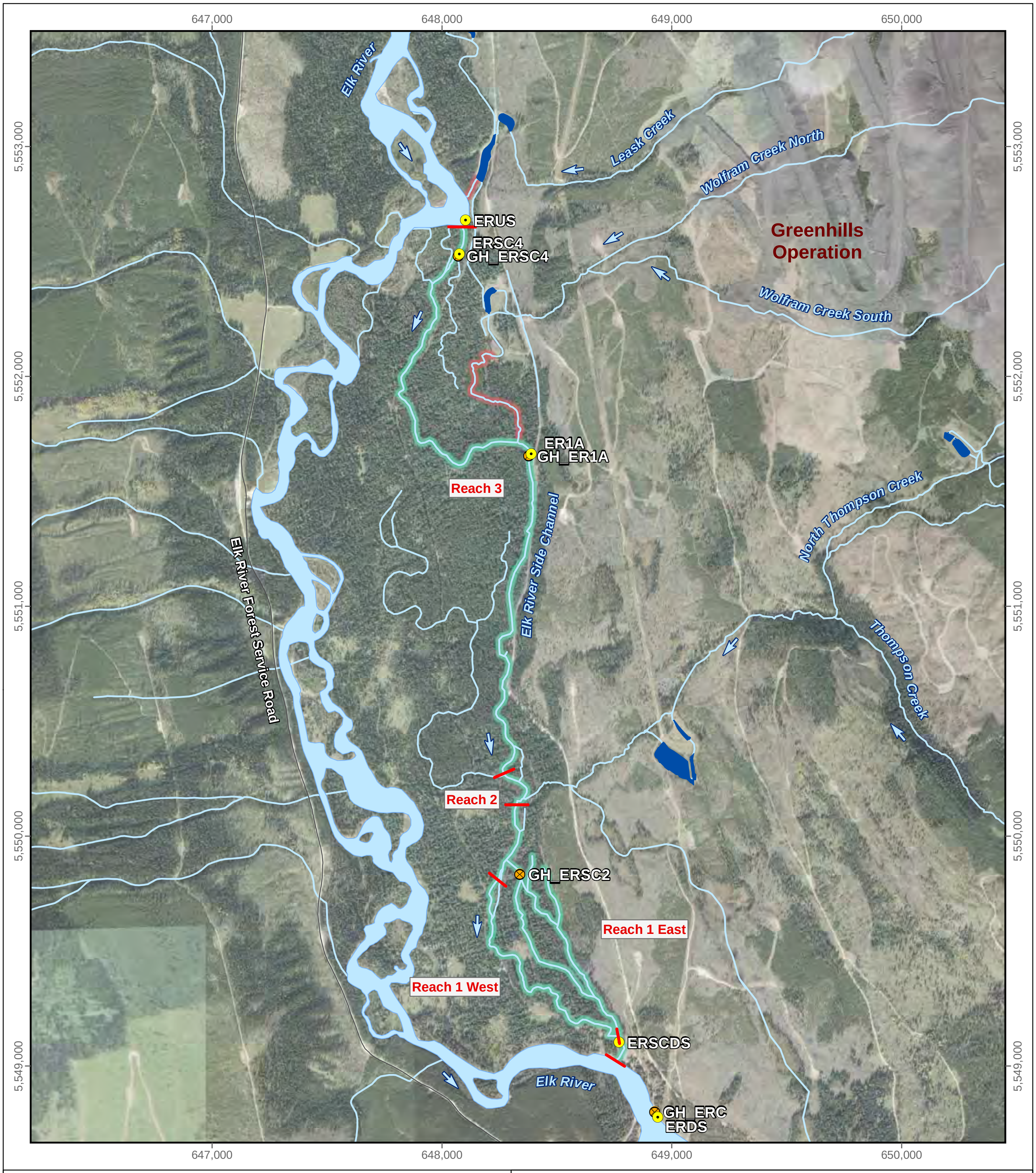
[b] Relative to this report, a different naming convention was used in the 2017 GHO LAEMP, and is provided here for context. Pool samples are listed with the prefix "RG_GH-" in EQuIS, but for simplicity the prefix is not displayed in the 2018 GHO LAEMP. The 2018 naming convention follows "field logic" and pools were numbered as they were observed.

[c] Pool was not sampled for the 2017 GHO LAEMP (Minnow and Lotic 2018a).

W	Location was wetted and flowing (i.e., water connected to the upstream/downstream channel, and not an isolated pool).
P	Location was a wetted isolated pool.
D	Location was dry.

Attachment 2

Spatial Distribution of Wet and Dry Locations



LEGEND

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

Elk River Side Channel Wet and Dry Locations, May to July 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N W E S

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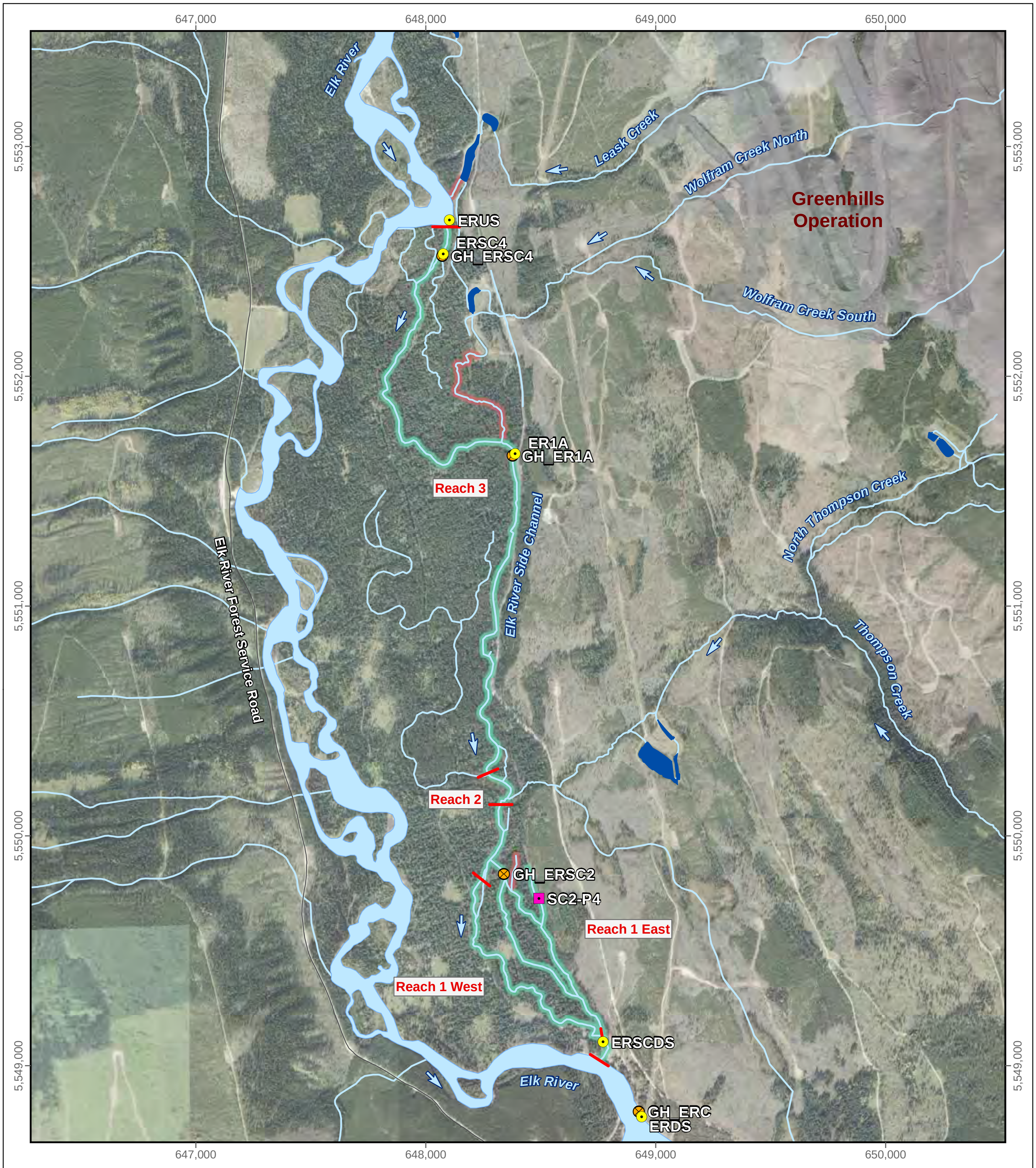
Figure A.1

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
—	Dry channel
—	Wetted channel
■	Settling pond

Elk River Side Channel Wet and Dry Locations, August 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N E S W

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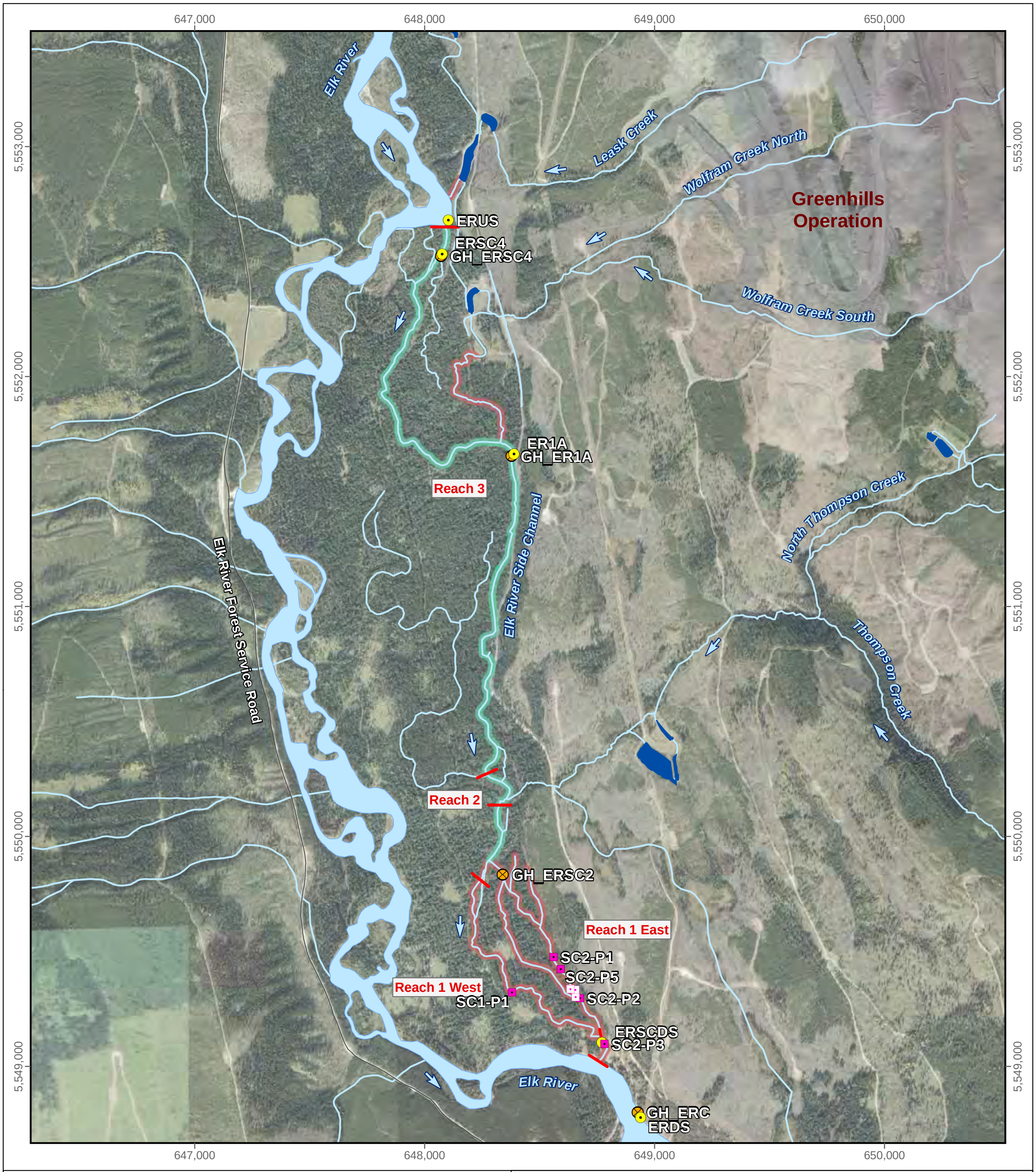
Figure A.2

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, September 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

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N
W E
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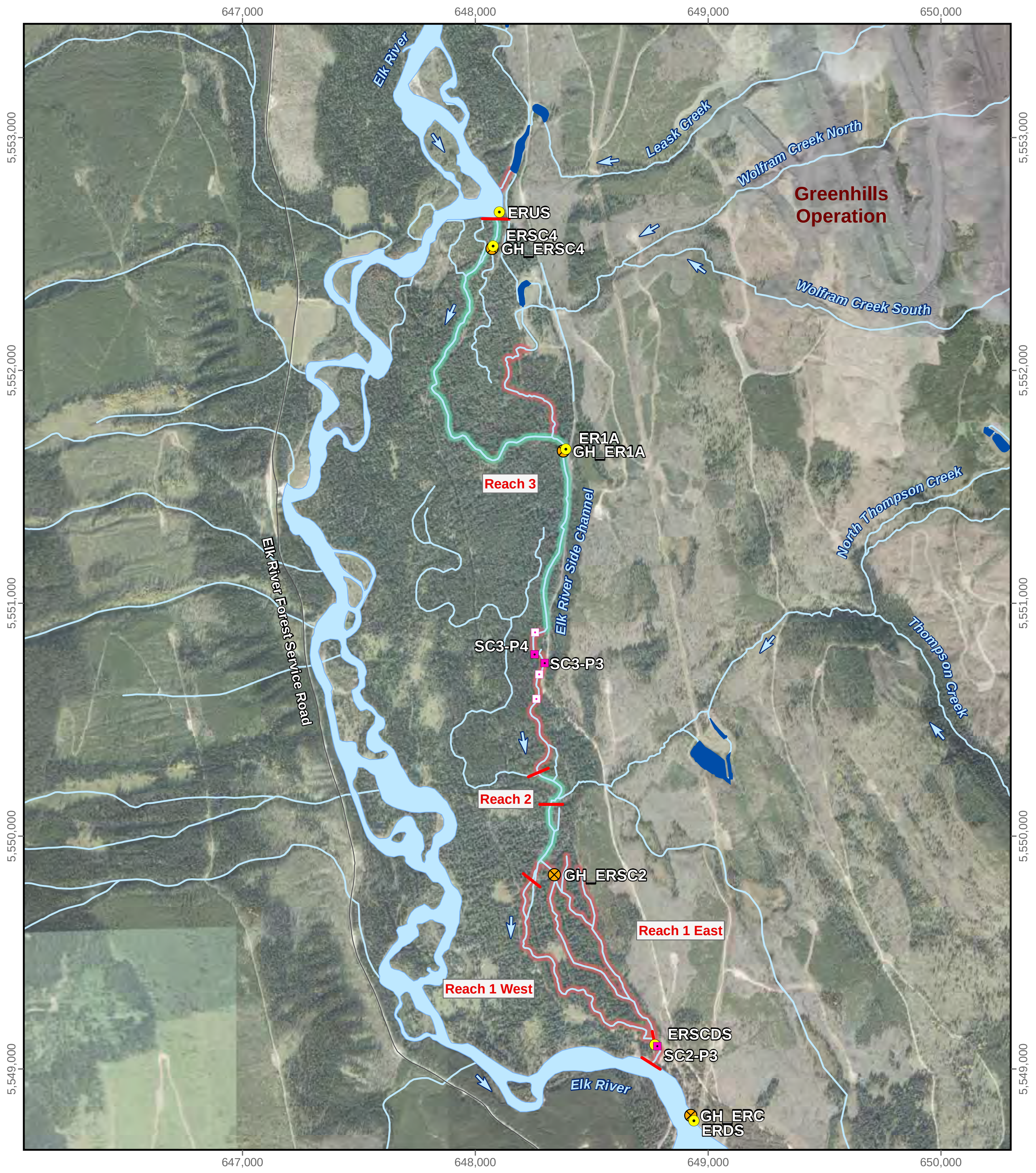
Figure A.3

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- ▬ Dry channel
- ▬ Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, October 2017 (Minnow and Lotic 2018a)

0 0.4 0.8 1.6 km

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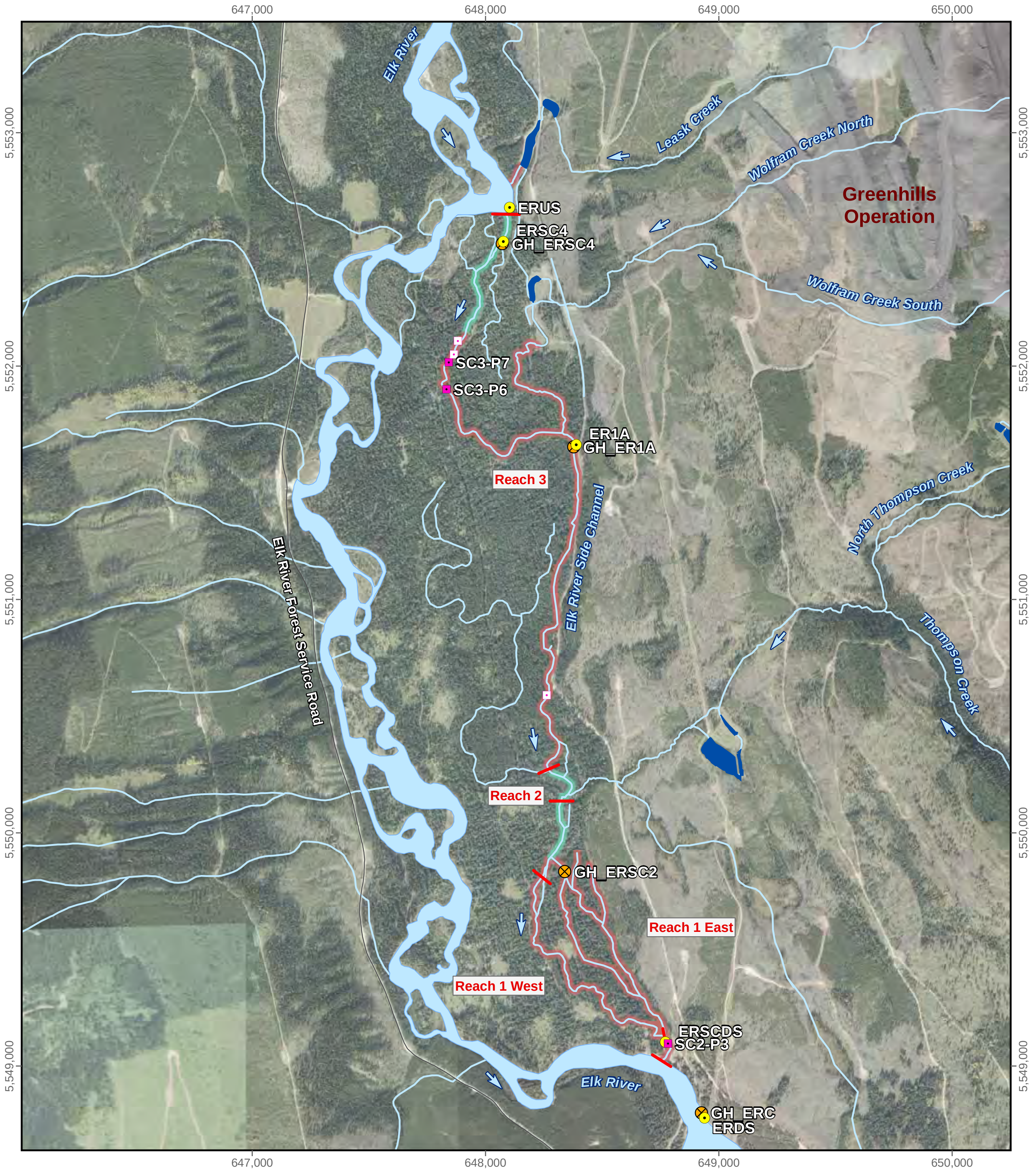
Figure A.4

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- — Dry channel
- — Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, November 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

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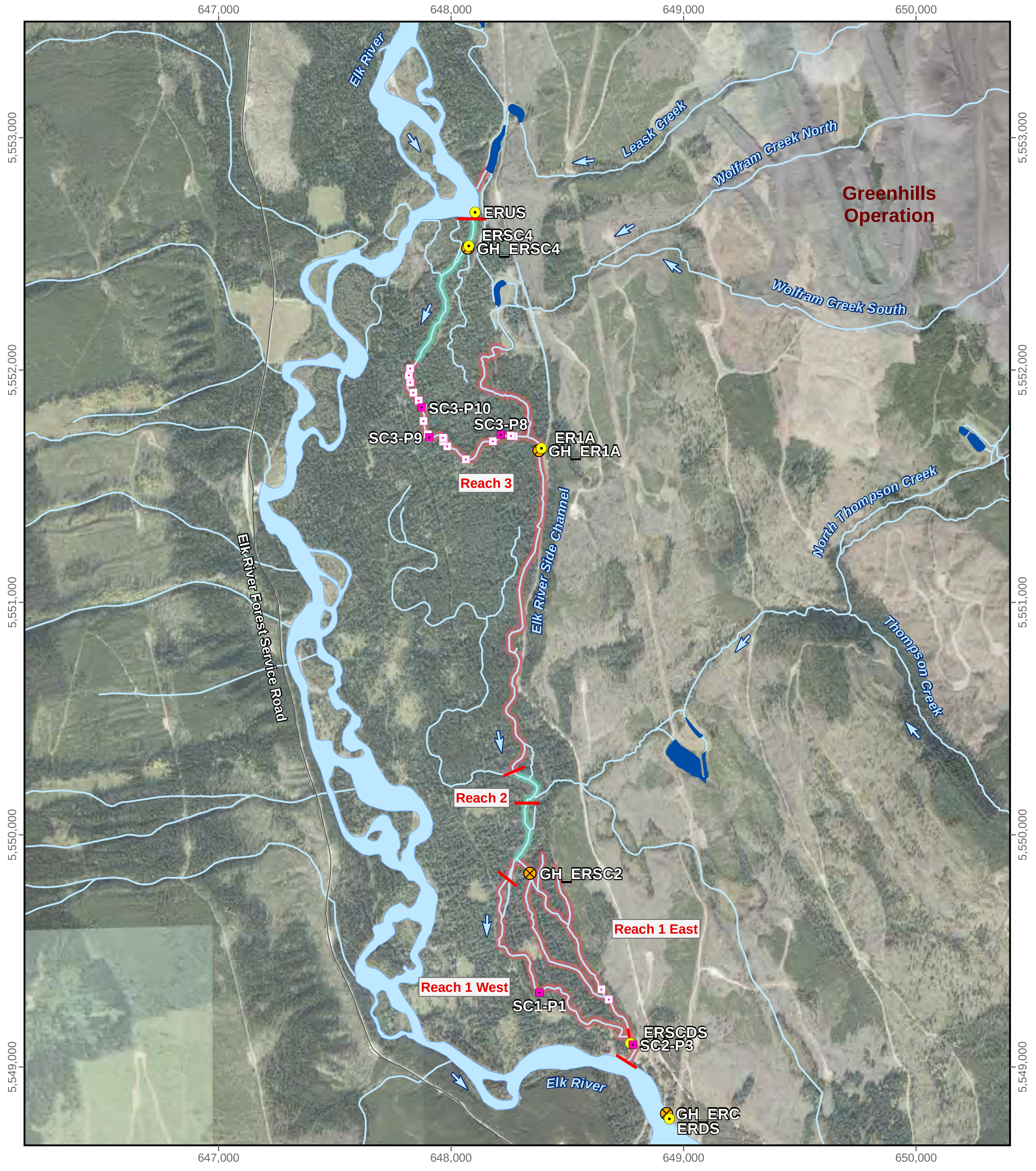
Figure A.5

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.5 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
- ― Dry channel
- ― Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, December 2017 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N E S W

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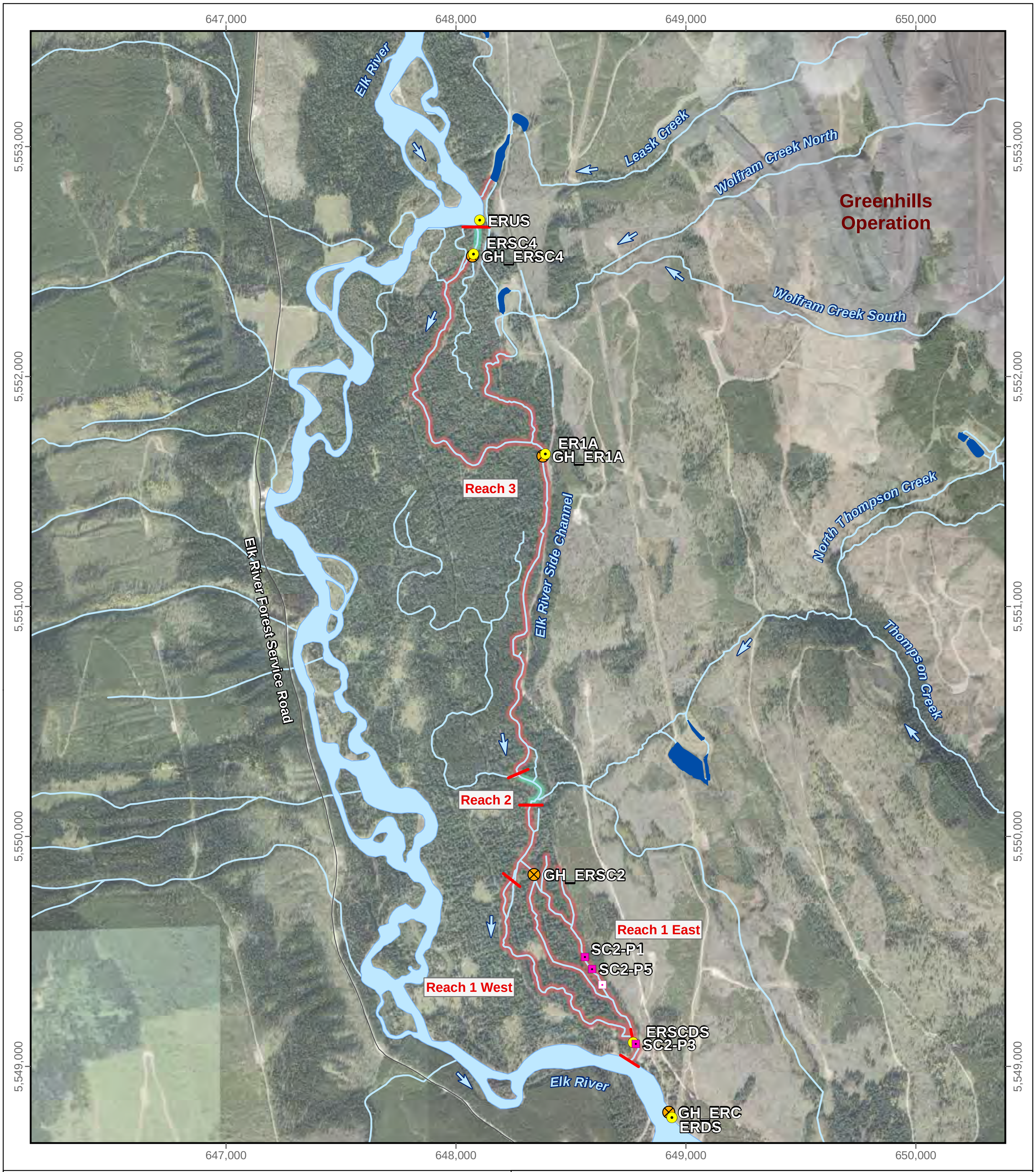
Figure A.6

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 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
- ▬ Dry channel
- ▬ Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, January 2018 (Minnow and Lotic 2018a)

0 0.4 0.8 1.6 km

N W E S

Datum: NAD 83 Map Projection: UTM Zone 11N
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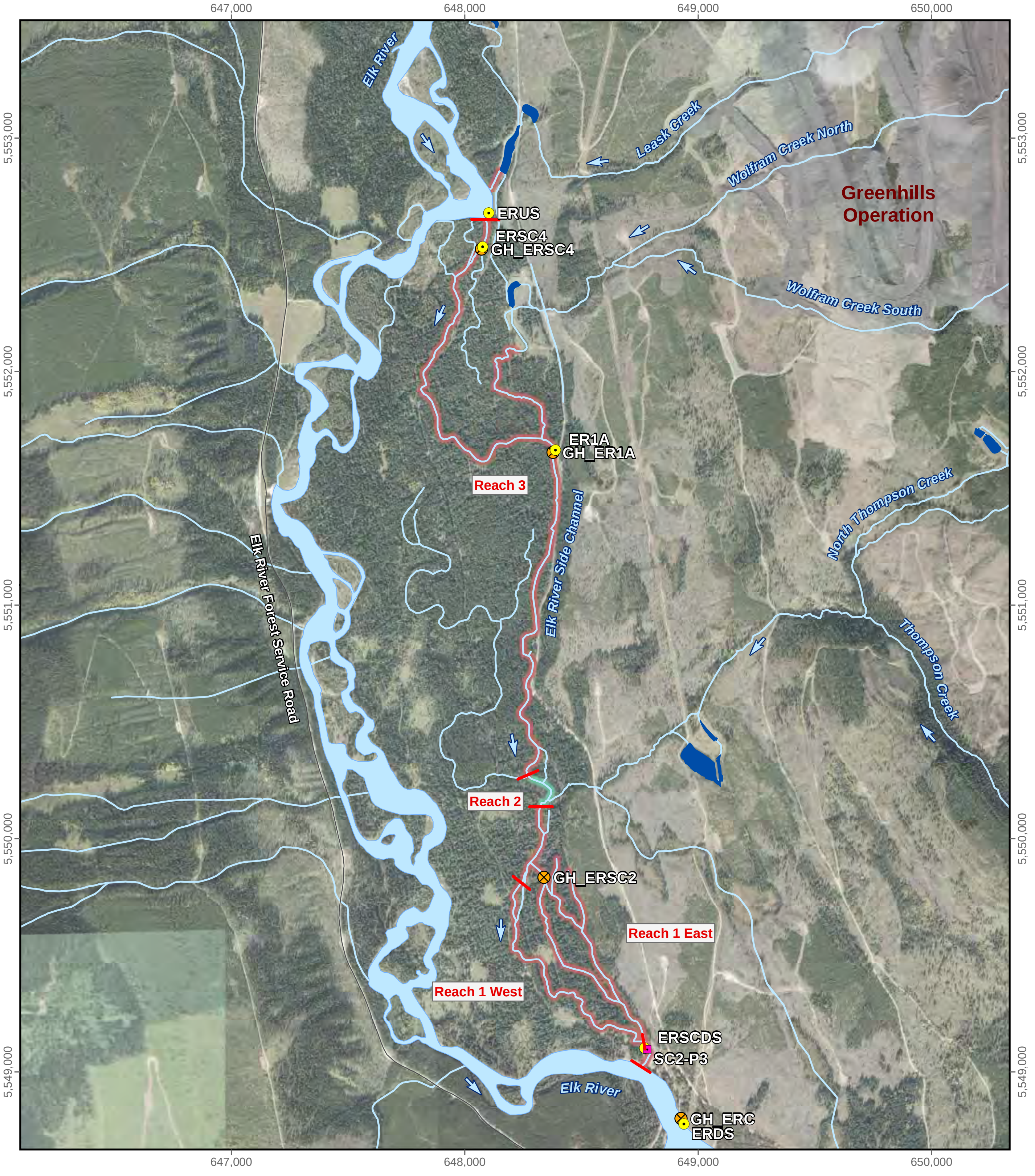
Figure A.7

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.7 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
- ▬ Dry channel
- ▬ Wetted channel
- ■ Settling pond

Elk River Side Channel Wet and Dry Locations, February to March 2018 (Minnow and Lotic 2018a)

0 375 750 1,500 Meters

N W E S

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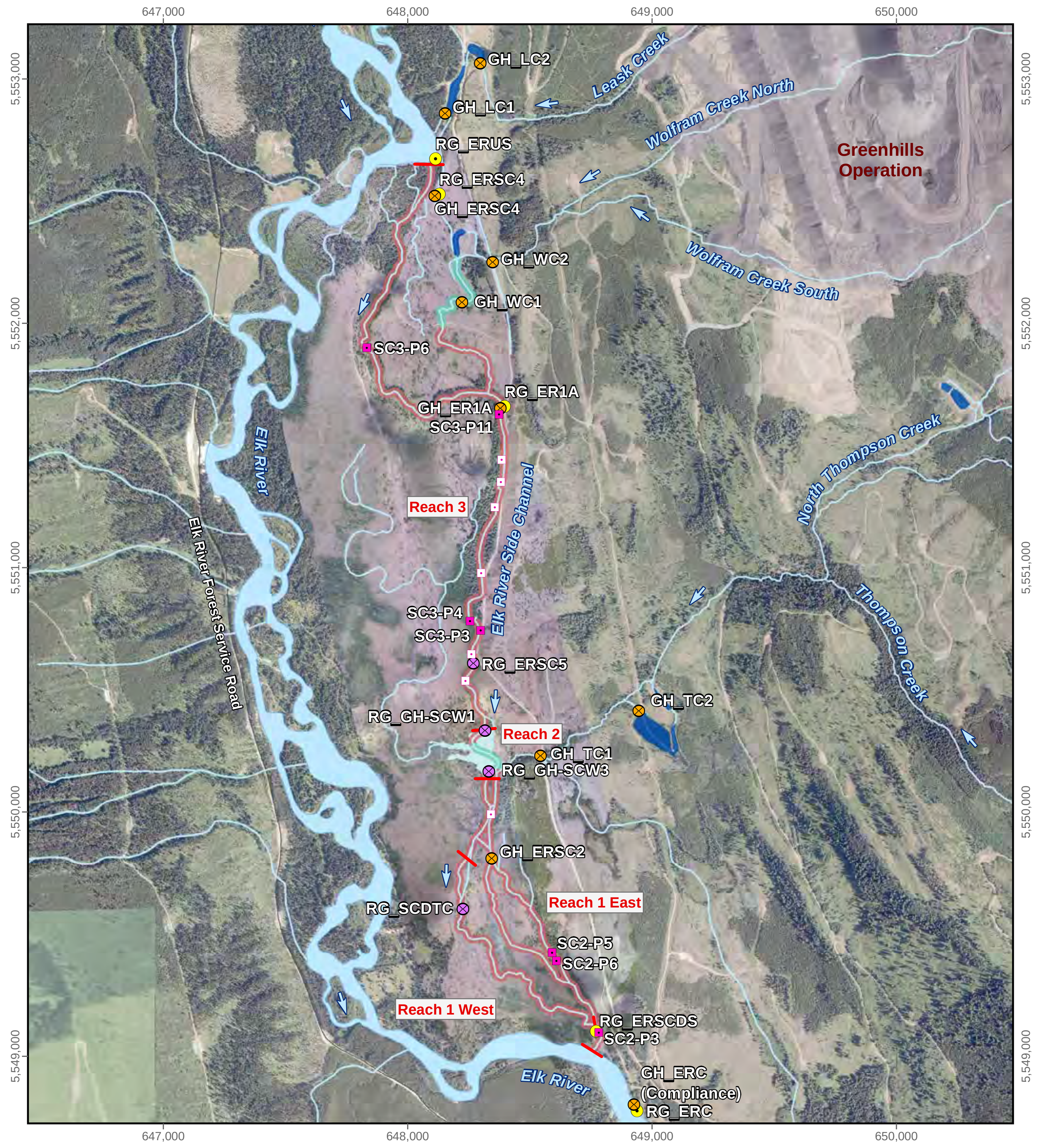
Figure A.8

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.8 Elk Side Channel Wet and Dry.mxd



LEGEND

■ Pool, Water Quality Sampling

□ Pool

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

● Staff Gauge Location

— Reach Break

— Dry Channel

— Wetted Channel

▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, April 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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Figure A.9

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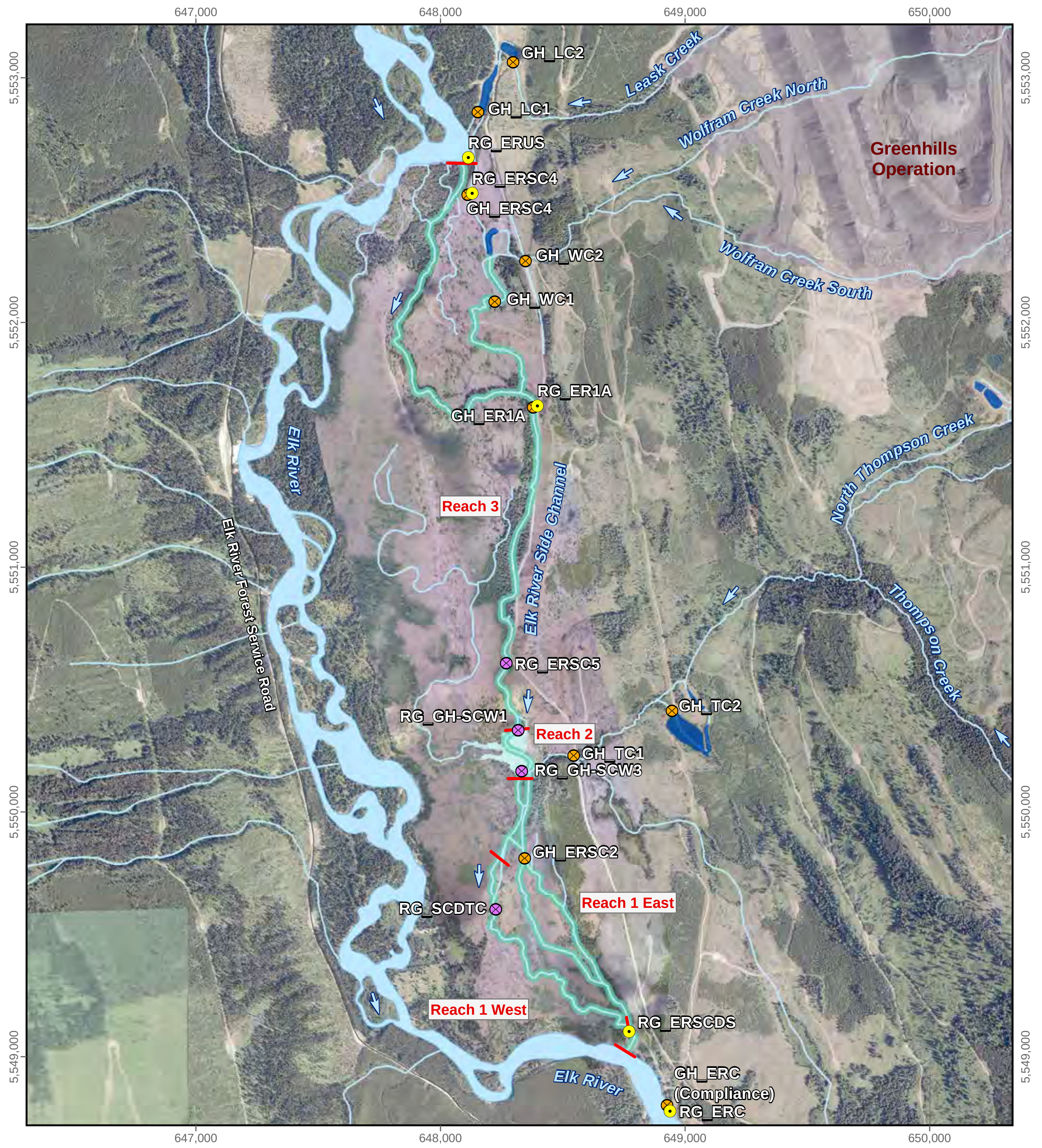

LEGEND

- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- ▬ Dry Channel
- ▬ Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, May 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.10

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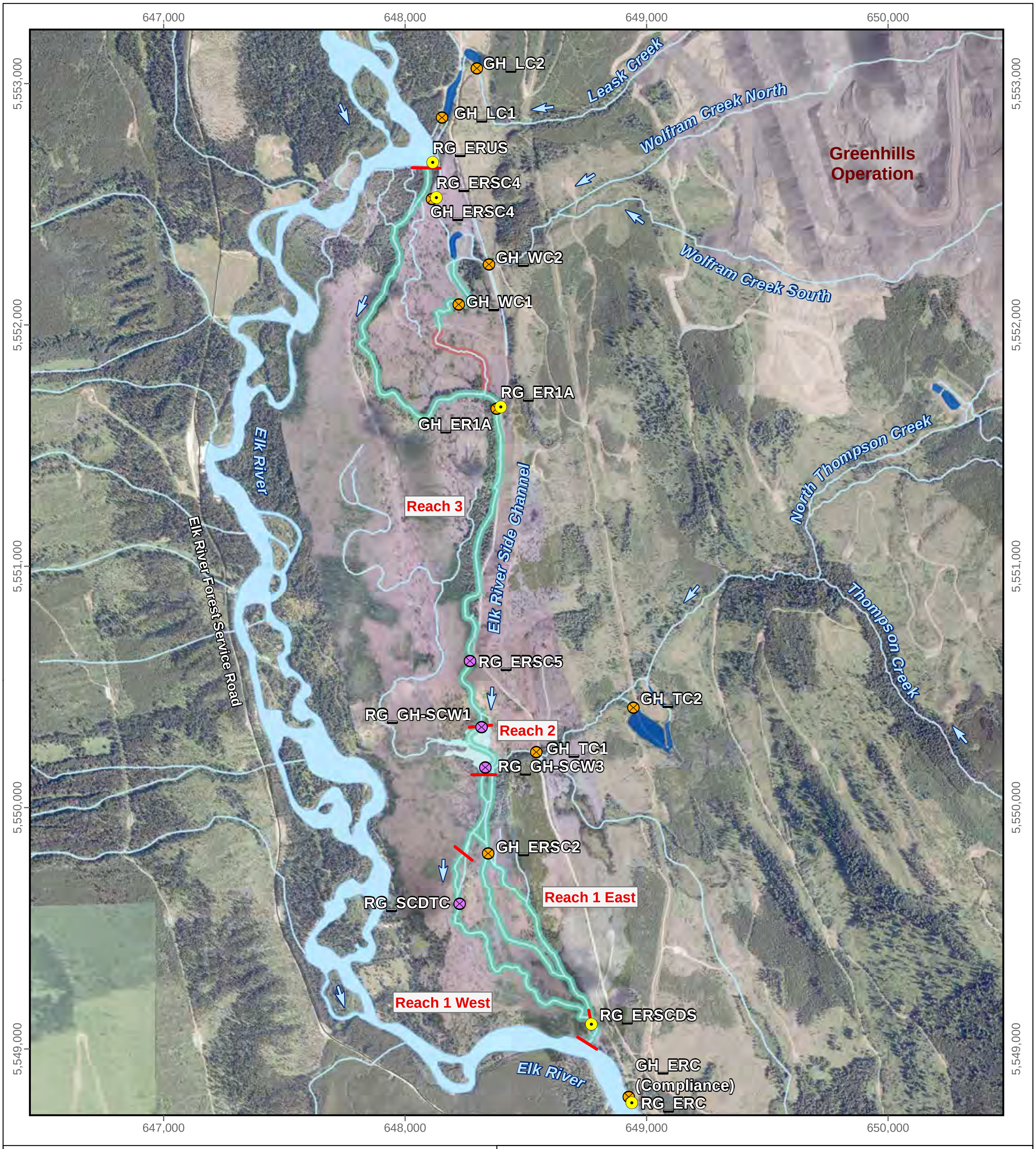

LEGEND

- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ― Reach Break
- ▬ Dry Channel
- ▬ Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, June 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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Figure A.11

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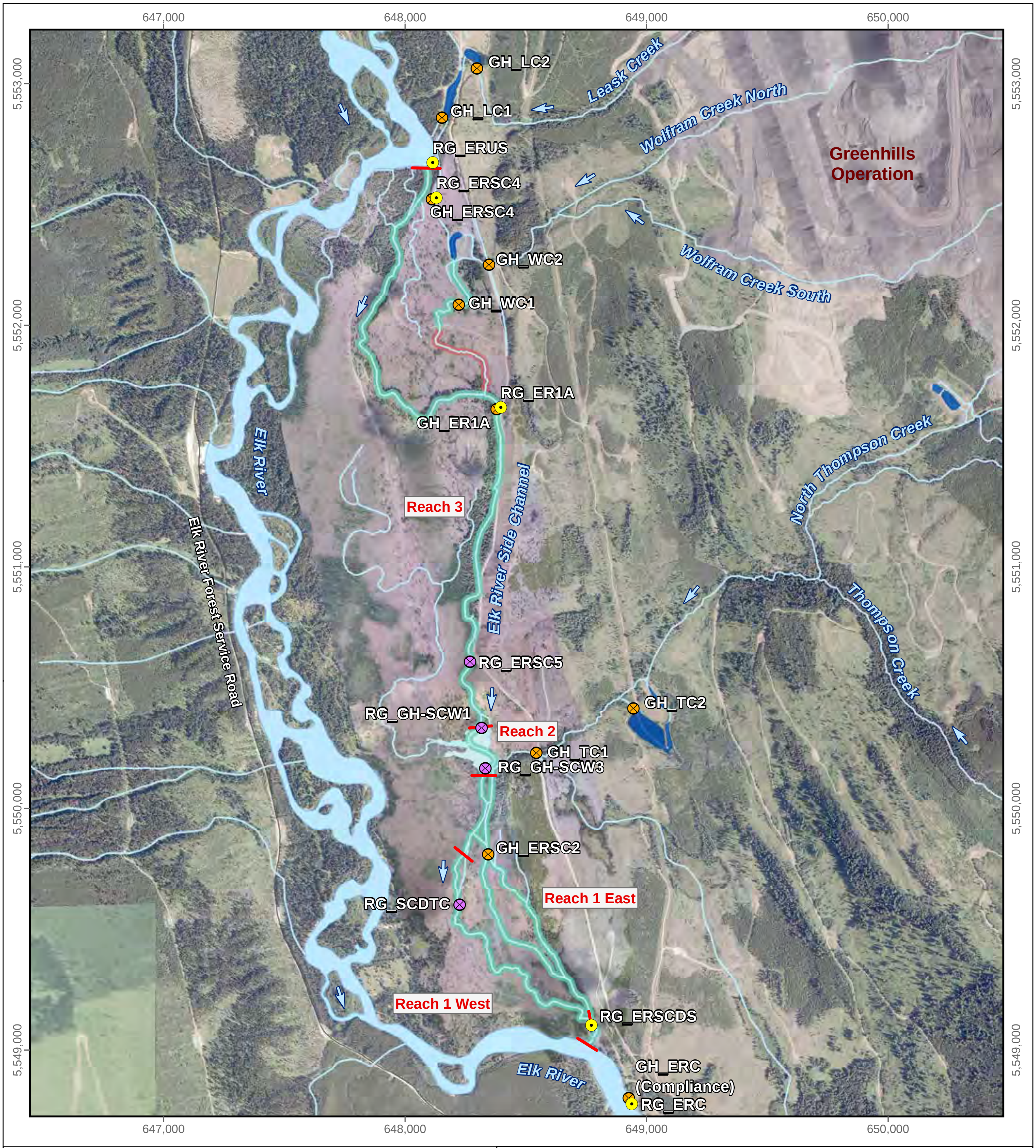

LEGEND

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

⊙ Staff Gauge Location

— Reach Break

— Dry Channel

— Wetted Channel

▇ Settling Pond

Elk River Side Channel Wet and Dry Locations, July 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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Figure A.12

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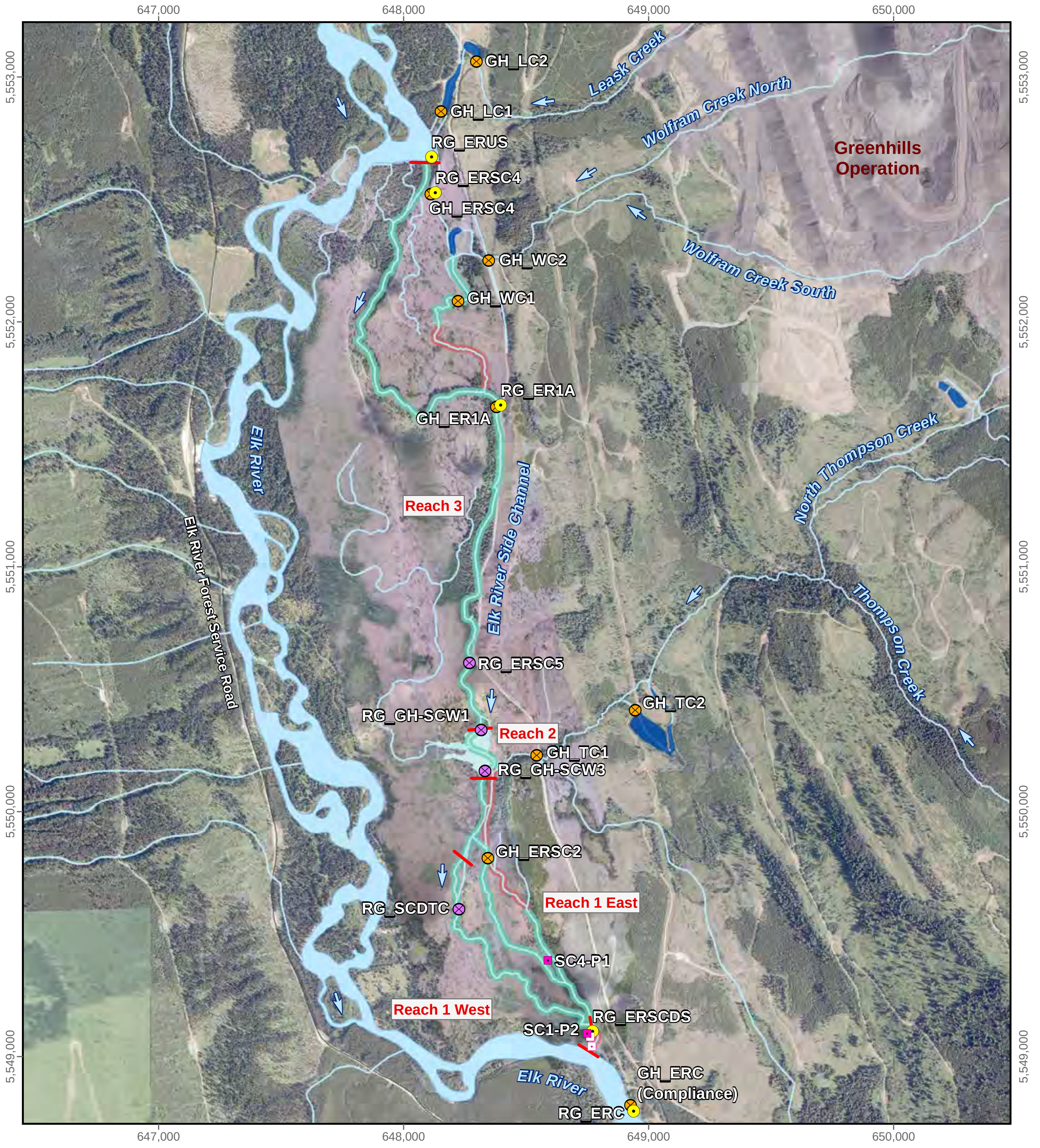

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- ▬ Dry Channel
- ▬ Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, August 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.13

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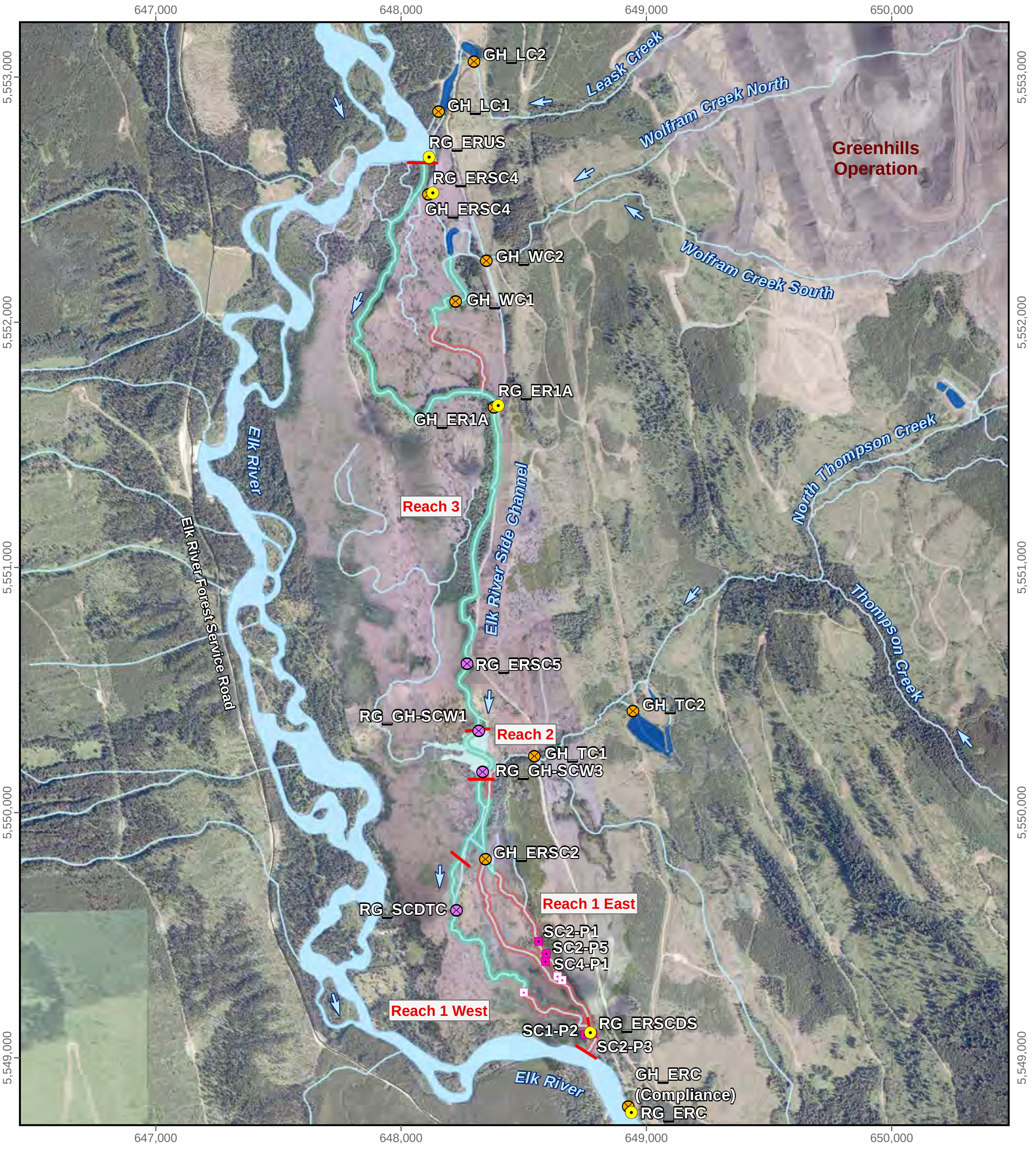

LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- — Dry Channel
- — Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, September 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.14

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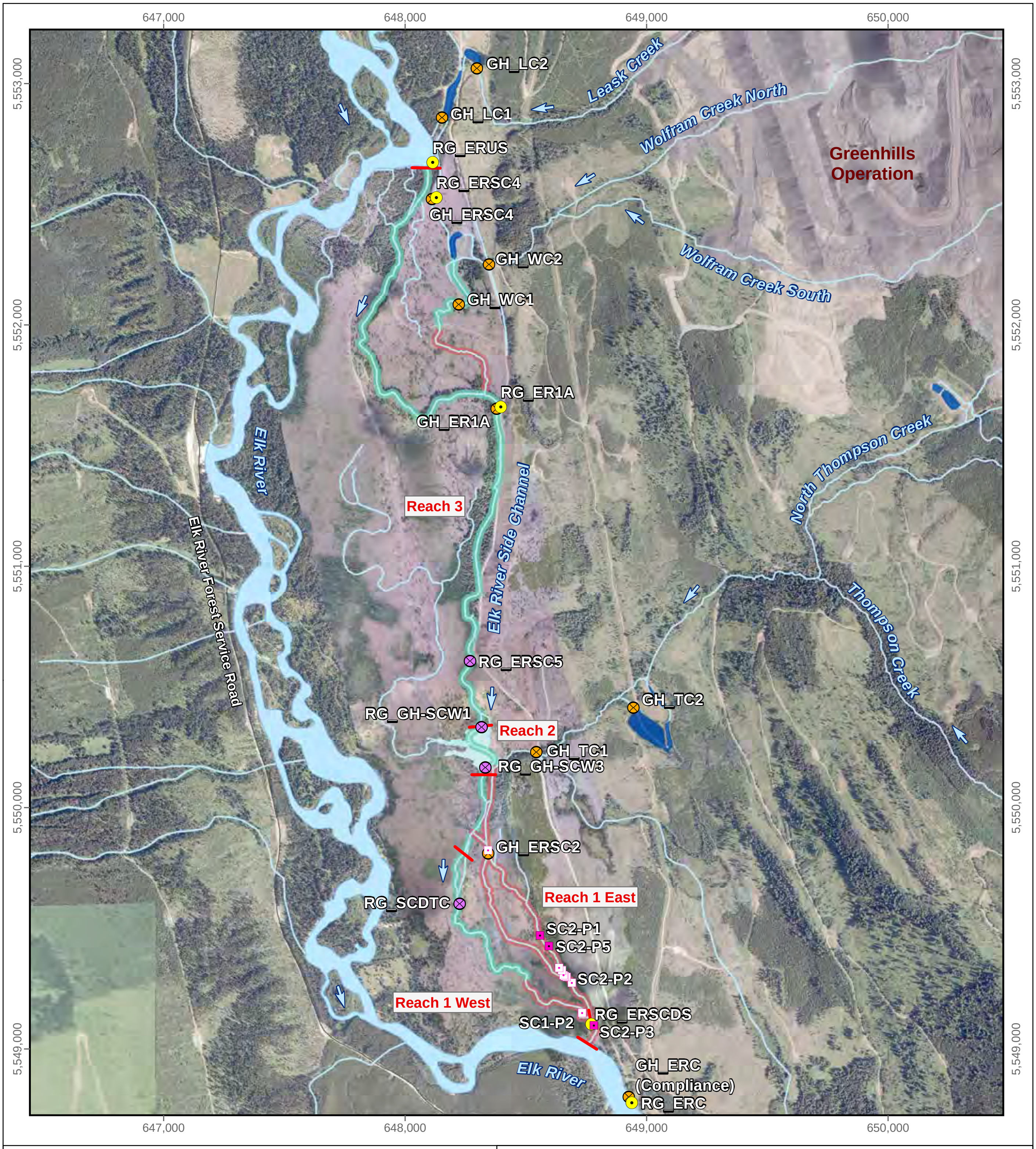

LEGEND

■	Pool, Water Quality Sampling	▬	Reach Break
▫	Pool	▬	Dry Channel
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed	▬	Wetted Channel
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing	■	Settling Pond

Elk River Side Channel Wet and Dry Locations, October 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.15

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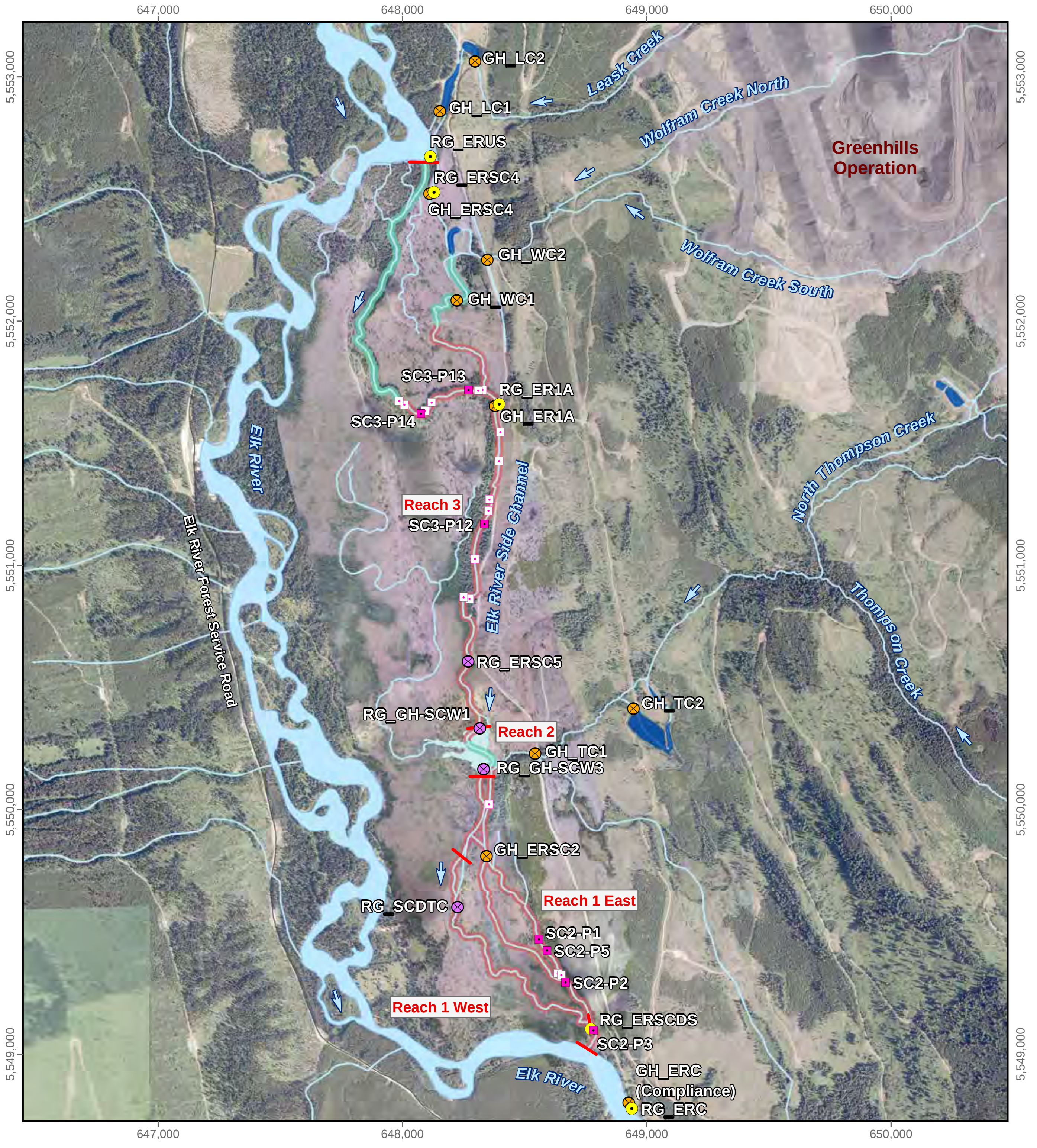

LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- — Dry Channel
- — Wetted Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, November 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

N W E S

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Figure A.16

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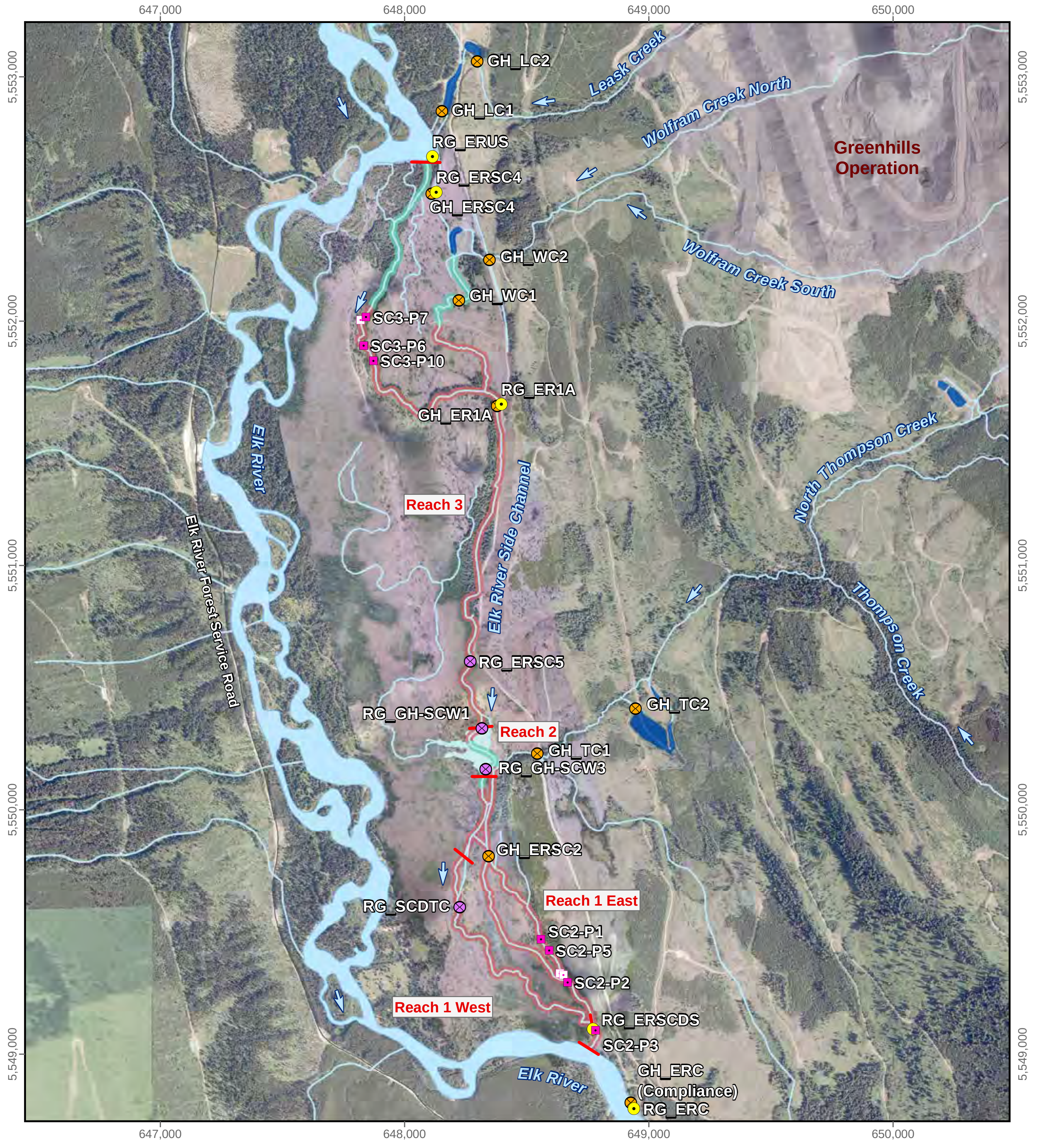

LEGEND

■ Pool, Water Quality Sampling

□ Pool

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

⊙ Staff Gauge Location

— Reach Break

— Dry Channel

— Wetted Channel

■ Settling Pond

Elk River Side Channel Wet and Dry Locations, December 2018 (Minnow and Lotic 2019)

0 250 500 1,000 Meters

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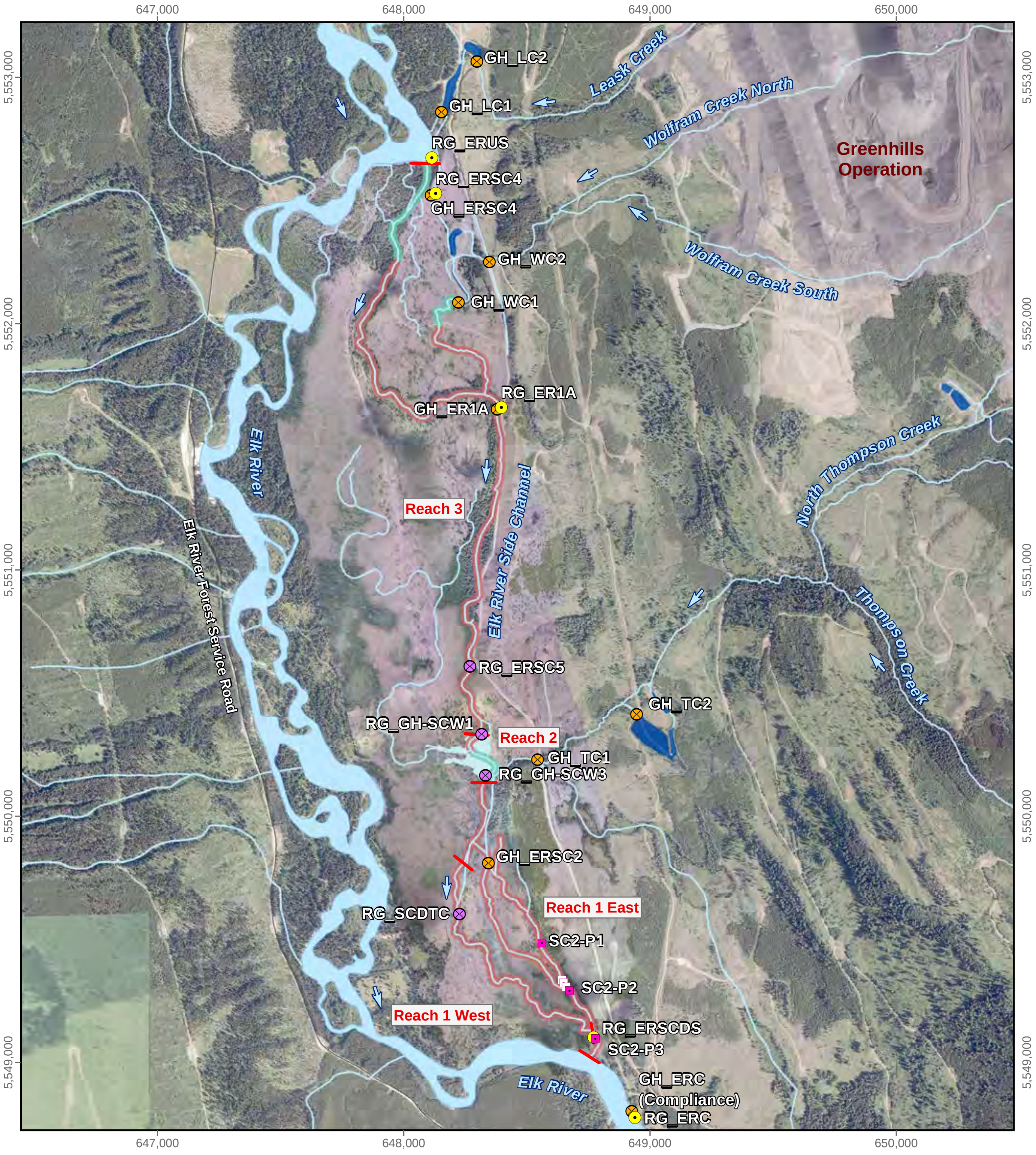
Figure A.17



LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- — Reach Break
- — Wetted Channel
- — Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, January 2019

0 250 500 1,000 Meters

N W E S

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Figure A.18

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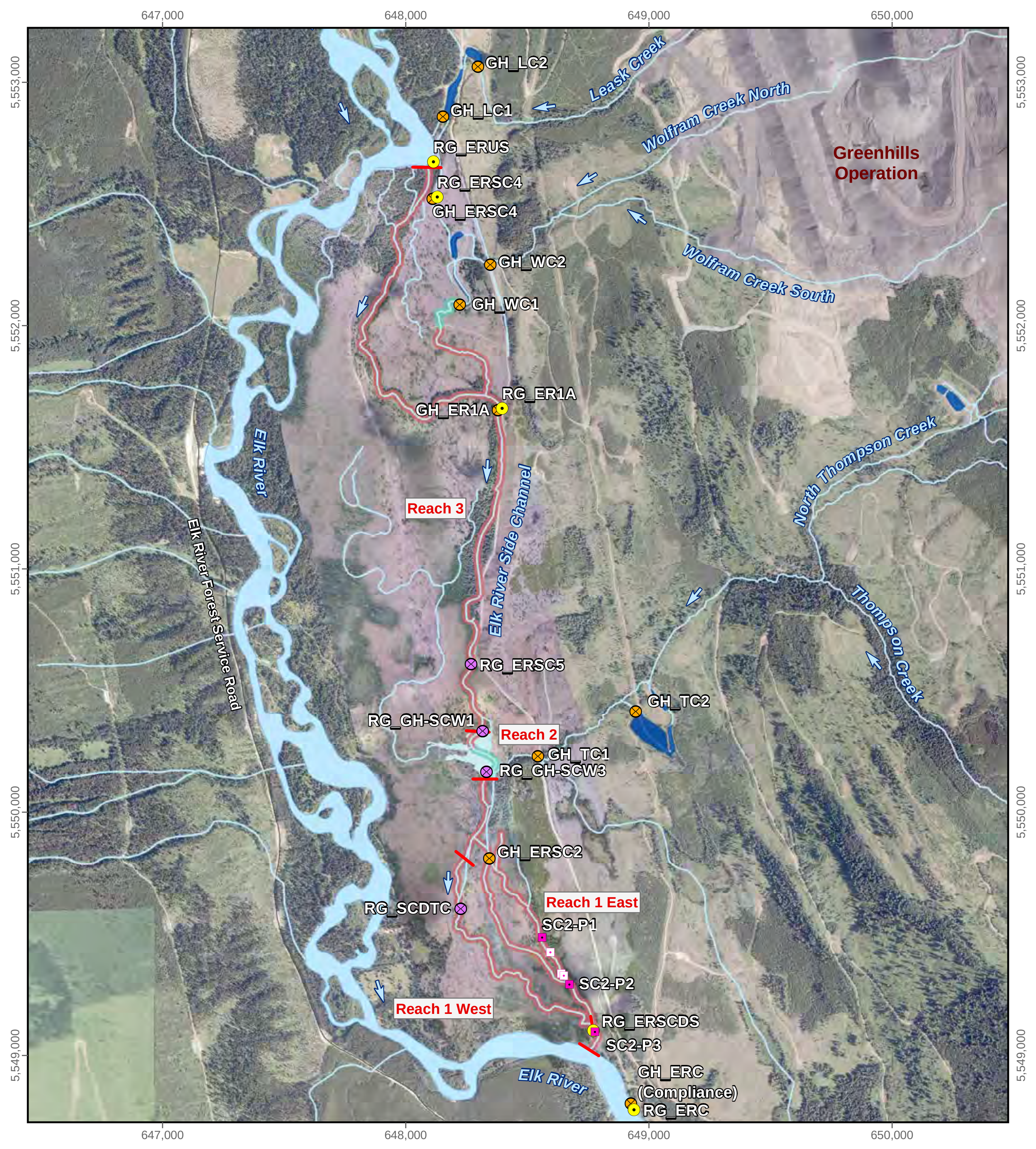

LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- — Wetted Channel
- — Dry Channel
- ▇ Settling Pond

Elk River Side Channel Wet and Dry Locations, February 2019

0 250 500 1,000 Meters

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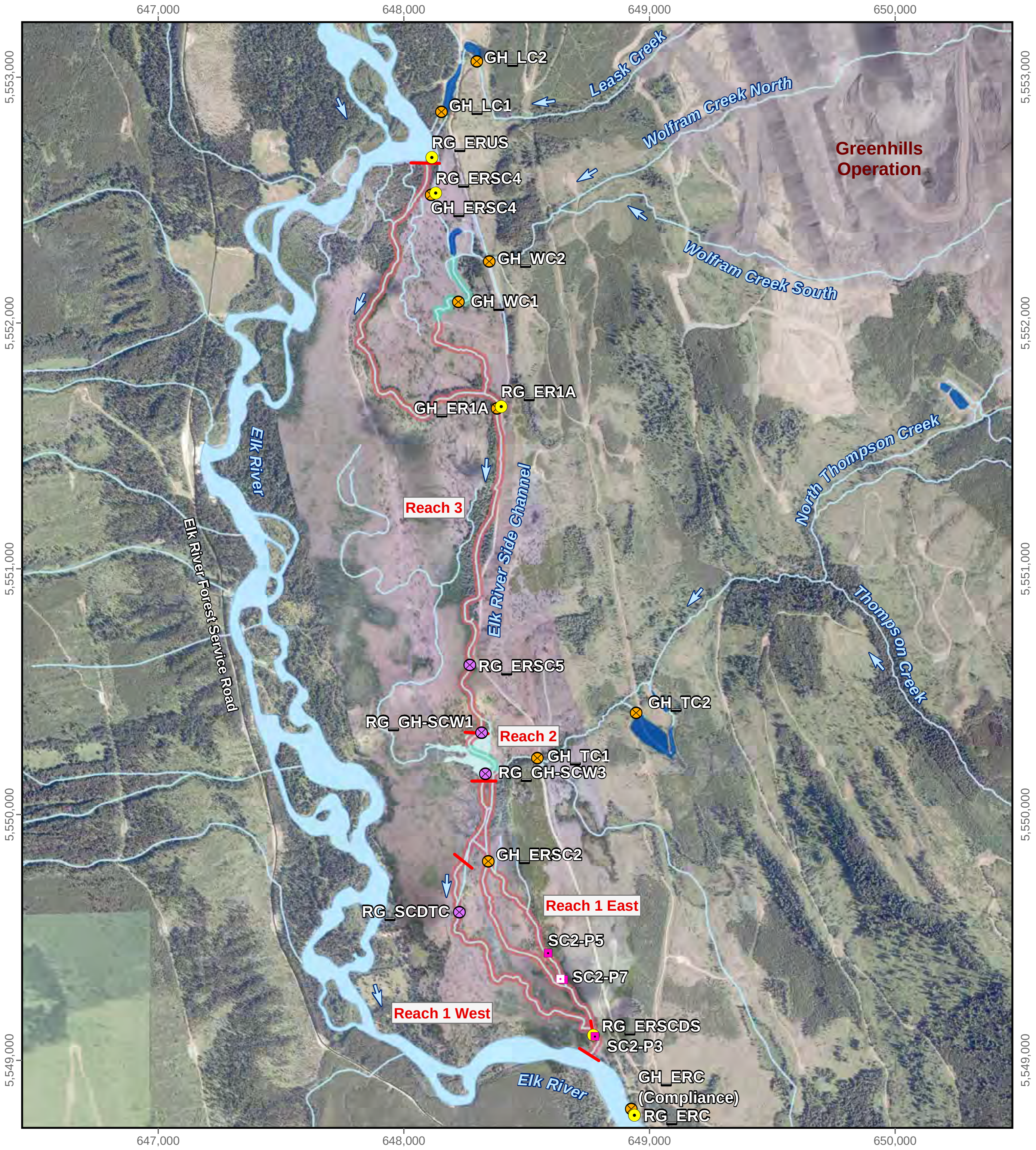
Figure A.19

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.19 Elk River Side Channel -February.mxd



LEGEND

■	Pool, Water Quality Sampling	🟥	Reach Break
□	Pool	🟩	Wetted Channel
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed	🟥	Dry Channel
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing	🟦	Settling Pond
●	Staff Gauge Location		

Elk River Side Channel Wet and Dry Locations, March 2019

0 250 500 1,000 Meters

N W E S

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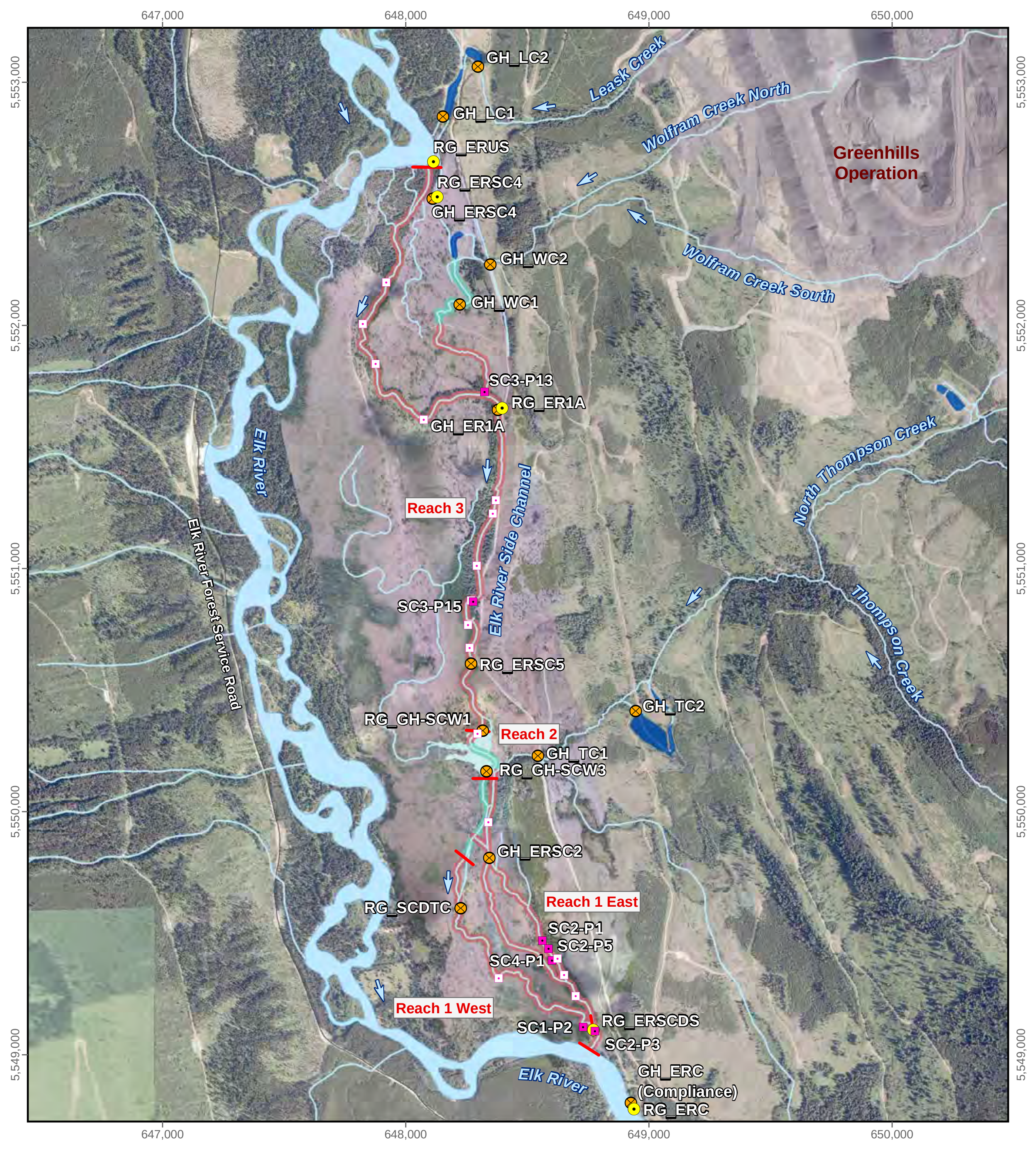
Figure A.20

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.20 Elk River Side Channel - March.mxd



LEGEND

- ▪ Pool, Water Quality Sampling
- ▫ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- ― Reach Break
- ― Wetted Channel
- ― Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, April 2019

0 250 500 1,000 Meters

N W E S

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Figure A.21

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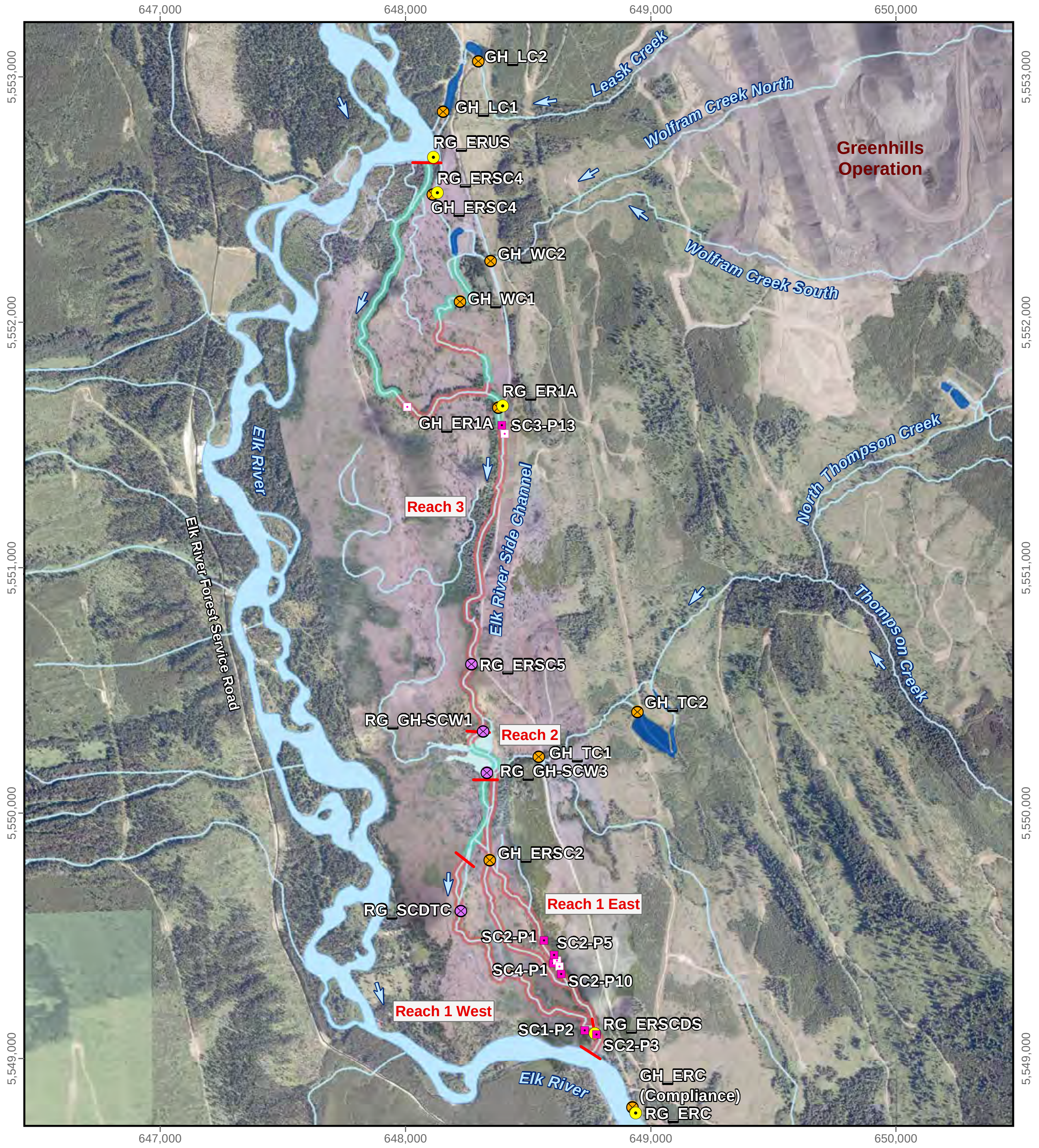

LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ▬ Reach Break
- ▬ Wetter Channel
- ▬ Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, May 2019

0 250 500 1,000 Meters

N W E S

Projection: North American Datum 1983 UTM Zone 11
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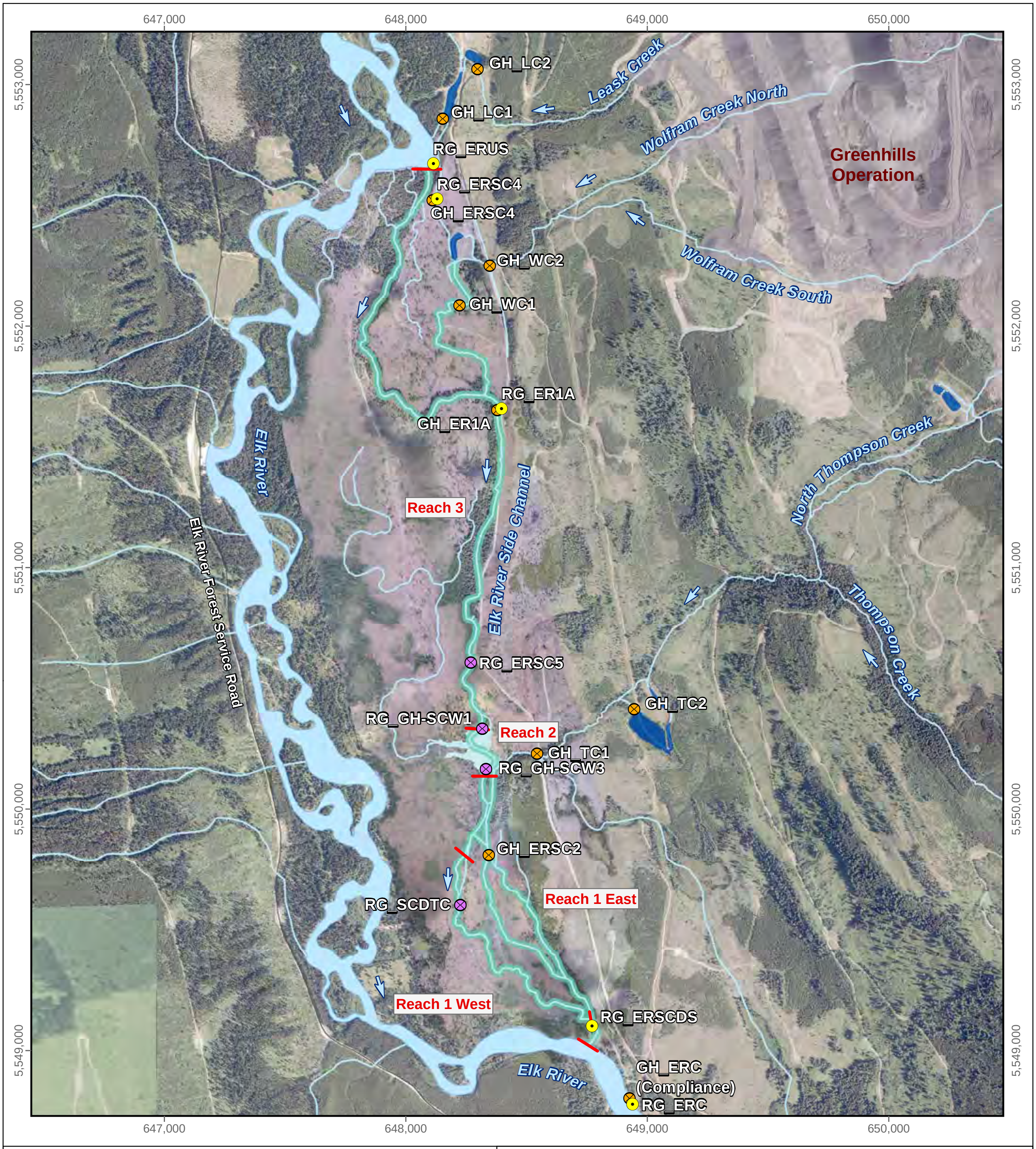
Figure A.22

Document Path: S:\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.22 Elk River Side Channel - May.mxd



LEGEND

⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed

⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing

⊙ Staff Gauge Location

— Reach Break

— Wetted Channel

■ Settling Pond

Elk River Side Channel Wet and Dry Locations, June and July 2019

0 250 500 1,000 Meters

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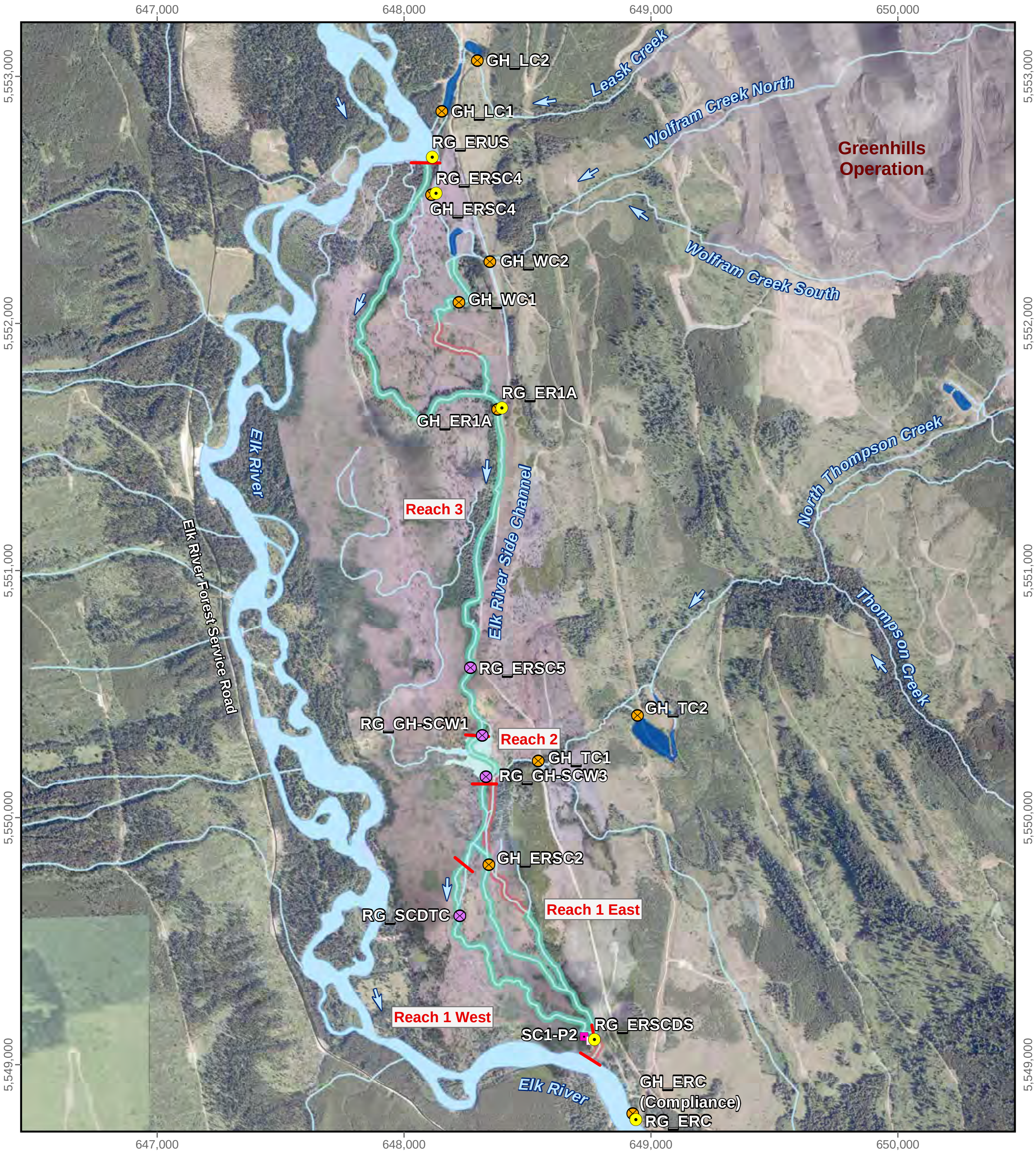
Figure A.23

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.23 Elk River Side Channel-June & July.mxd



LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- 🟩 Wetter Channel
- 🟥 Dry Channel
- 🟦 Settling Pond

Elk River Side Channel Wet and Dry Locations, August 2019

0 250 500 1,000 Meters

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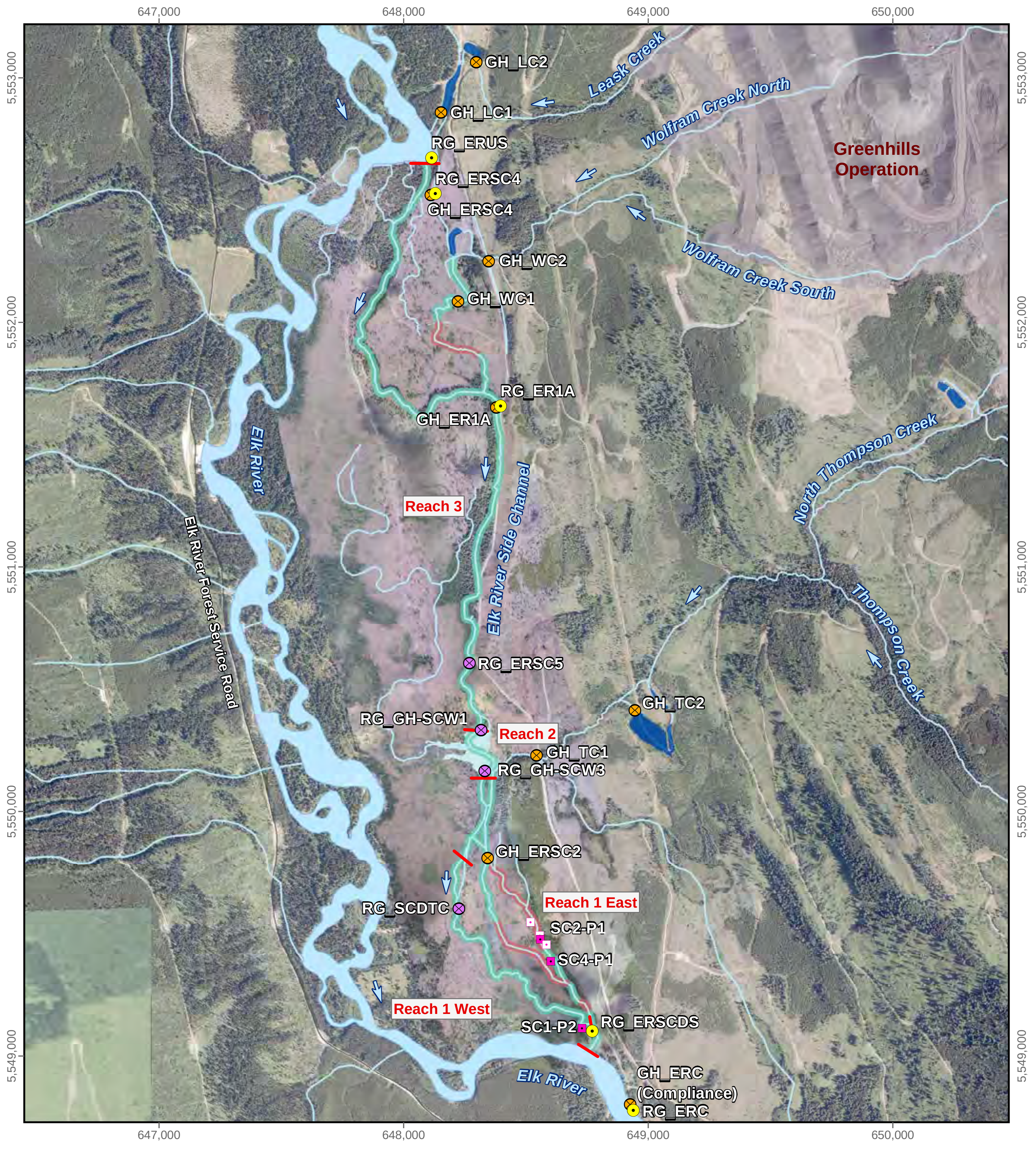
Figure A.24



LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ━ Reach Break
- ━ Wetted Channel
- ━ Dry Channel
- ■ Settling Pond

Elk River Side Channel Wet and Dry Locations, September 2019

0 250 500 1,000 Meters

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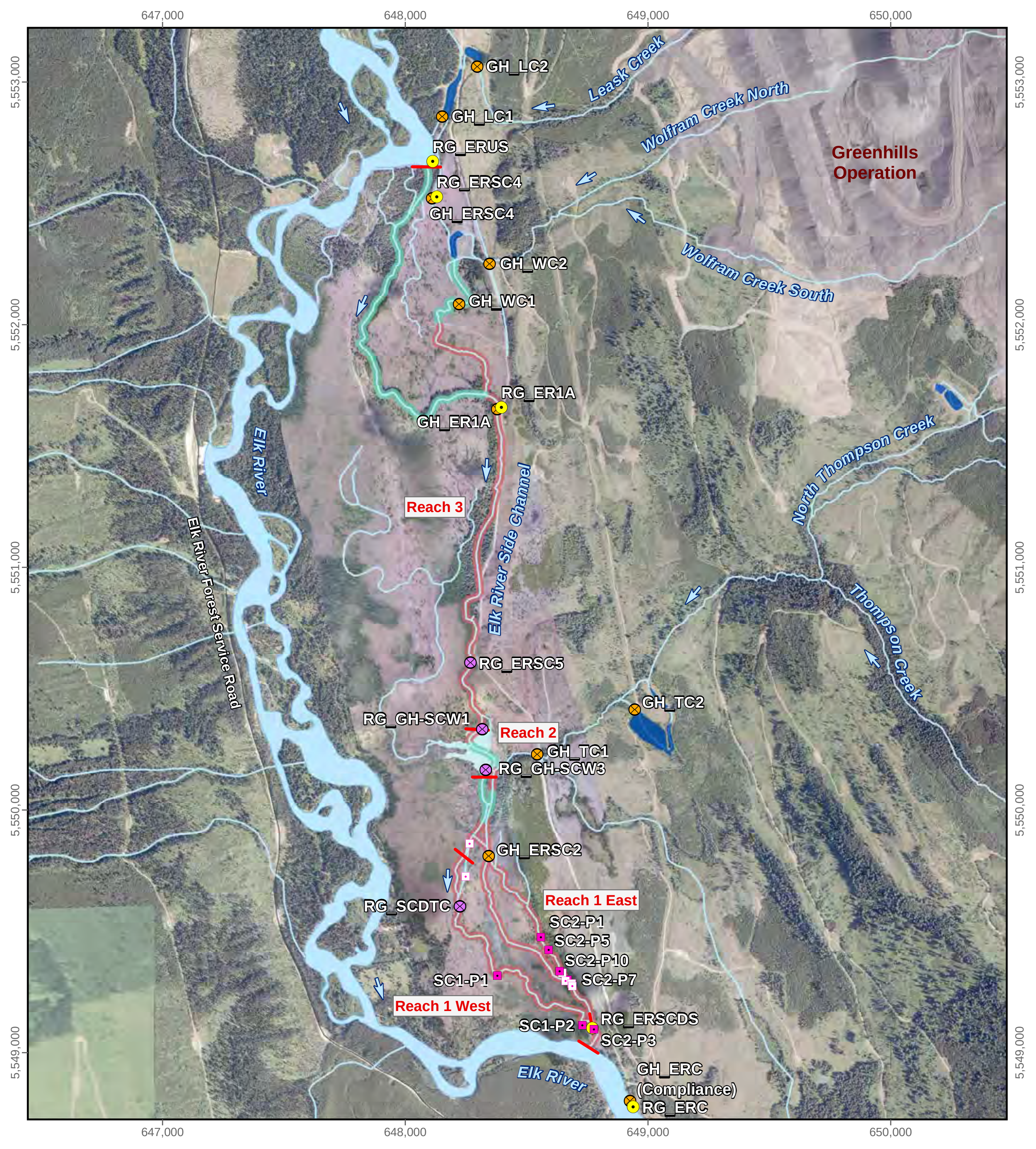
Figure A.25

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.25 Elk River Side Channel-Sept.mxd



LEGEND

■	Pool, Water Quality Sampling	▬	Reach Break
▫	Pool	▬	Wetted Channel
⊗	Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed	▬	Dry Channel
⊗	GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing	▬	Settling Pond
●	Staff Gauge Location		

Elk River Side Channel Wet and Dry Locations, October 2019

0 250 500 1,000 Meters

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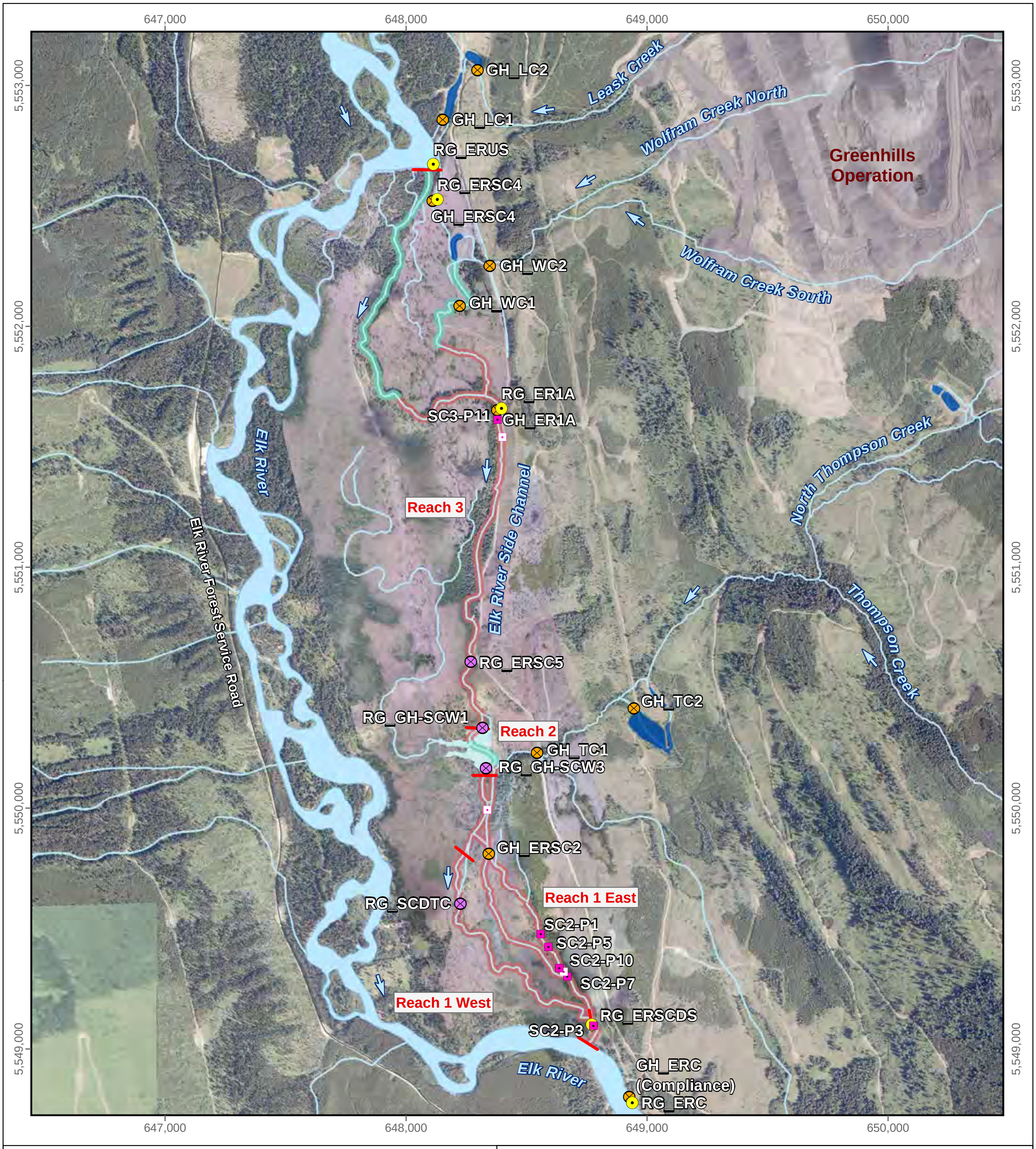
Figure A.26

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.26 Elk River Side Channel-Oct.mxd



LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ● Staff Gauge Location
- — Reach Break
- — Wetted Channel
- — Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, November 2019

0 250 500 1,000 Meters

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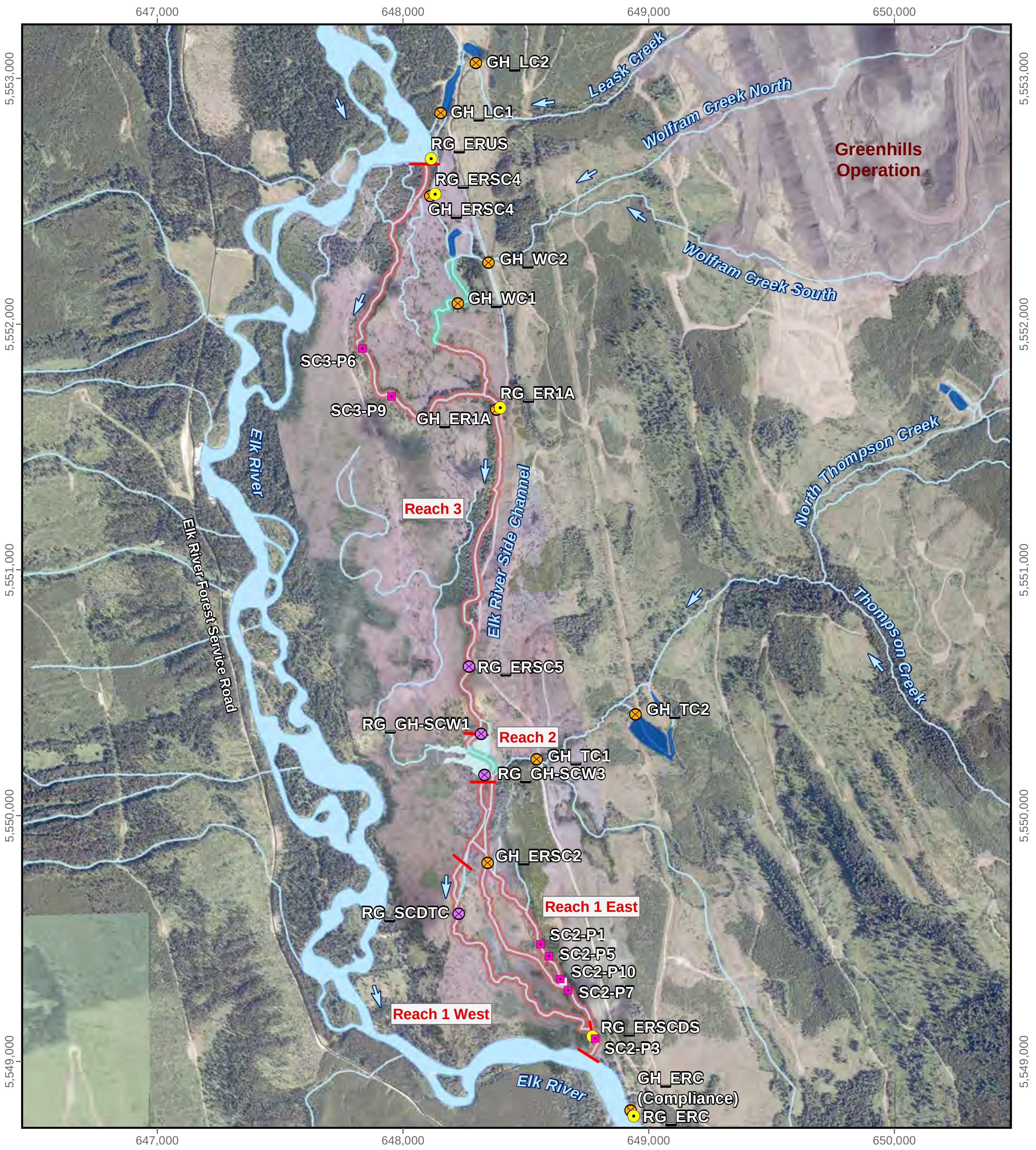
Figure A.27

Document Path: \\10.72.2.2\Data\Projects\197202\197202.0011 - Teck GHO LAEMP 2019\4 - GIS\Report\19-11 Fig A.27 Elk River Side Channel-Nov.mxd



LEGEND

- ■ Pool, Water Quality Sampling
- □ Pool
- ⊗ Routine Water Quality Monitoring Station (Permit 107517), Mine-exposed
- ⊗ GHO LAEMP Mine-exposed Water Quality Sampling Location, Flowing
- ⊙ Staff Gauge Location
- ▬ Reach Break
- ▬ Wetted Channel
- ▬ Dry Channel
- ▬ Settling Pond

Elk River Side Channel Wet and Dry Locations, December 2019

0 250 500 1,000 Meters

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Figure A.28

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY COMPOSITION

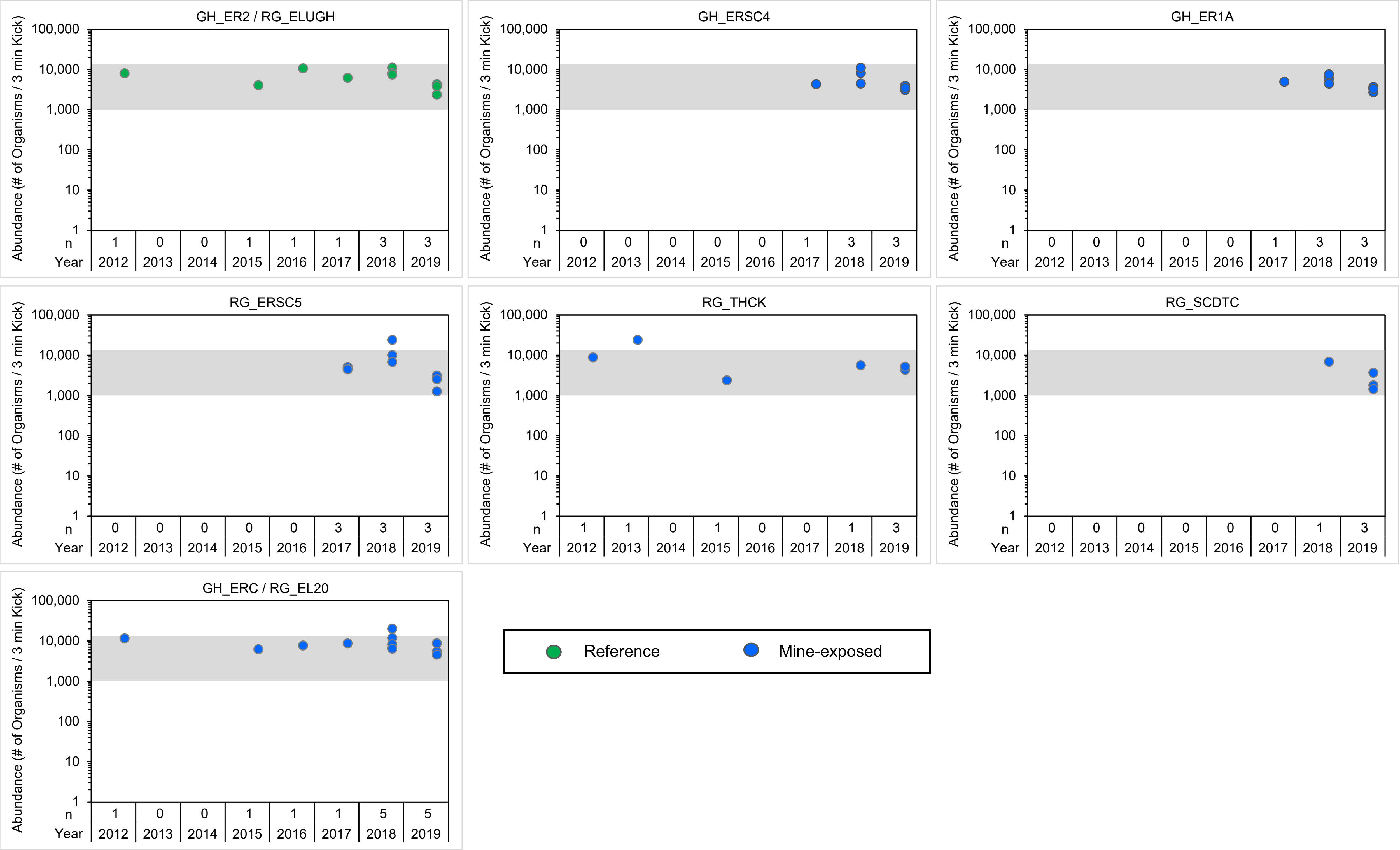

Figure E.1: **Benthic Invertebrate Community Abundance, GHO LAEMP, 2012 to 2019**

Notes: Grey shading represents the normal range defined as the 2.5 th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP). n = the sample size for a given year.

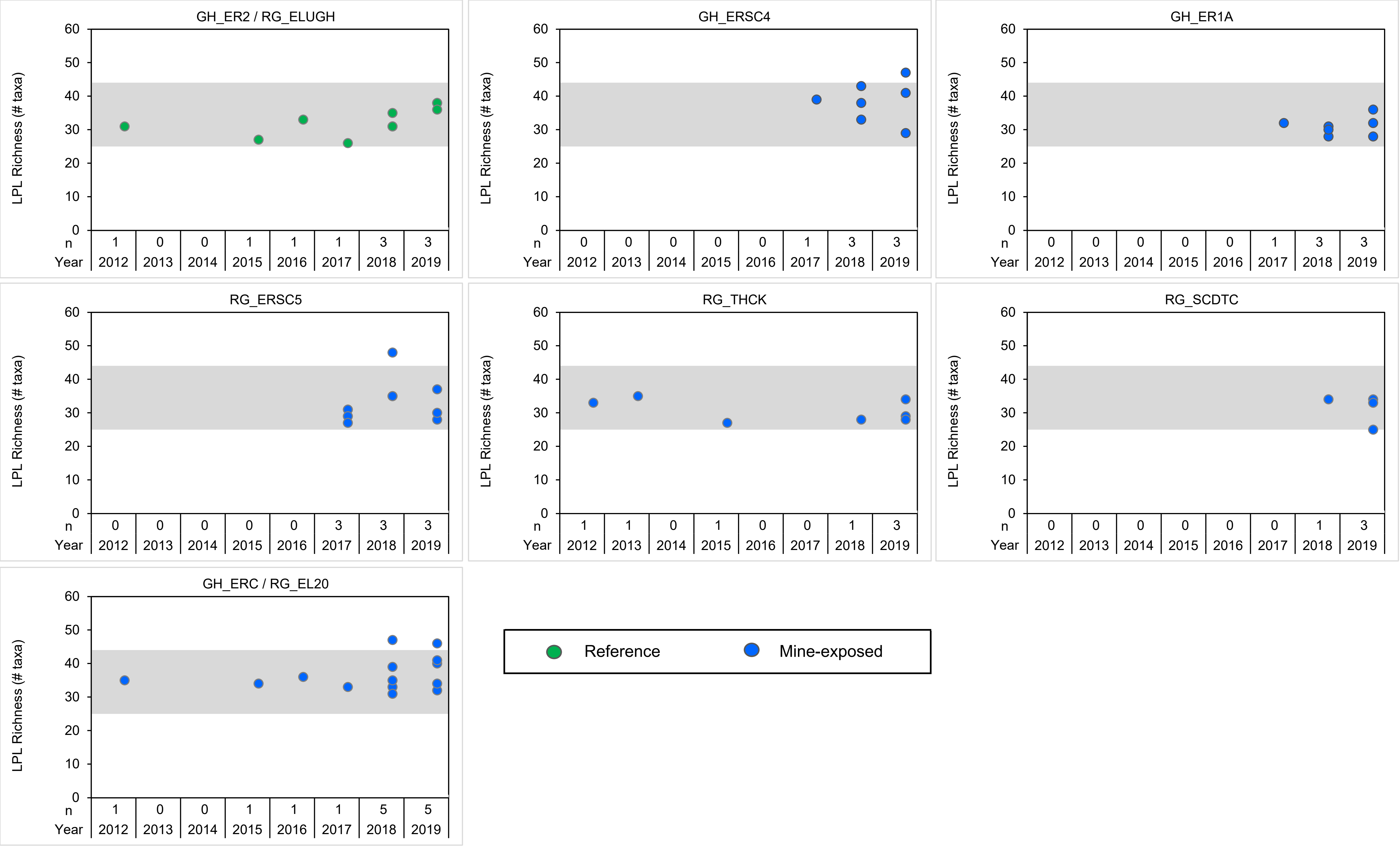

Figure E.2: Benthic Invertebrate Community LPL Richness, GHO LAEMP, 2012 to 2019

Notes: Grey shading represents the normal range defined as the 2.5 th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

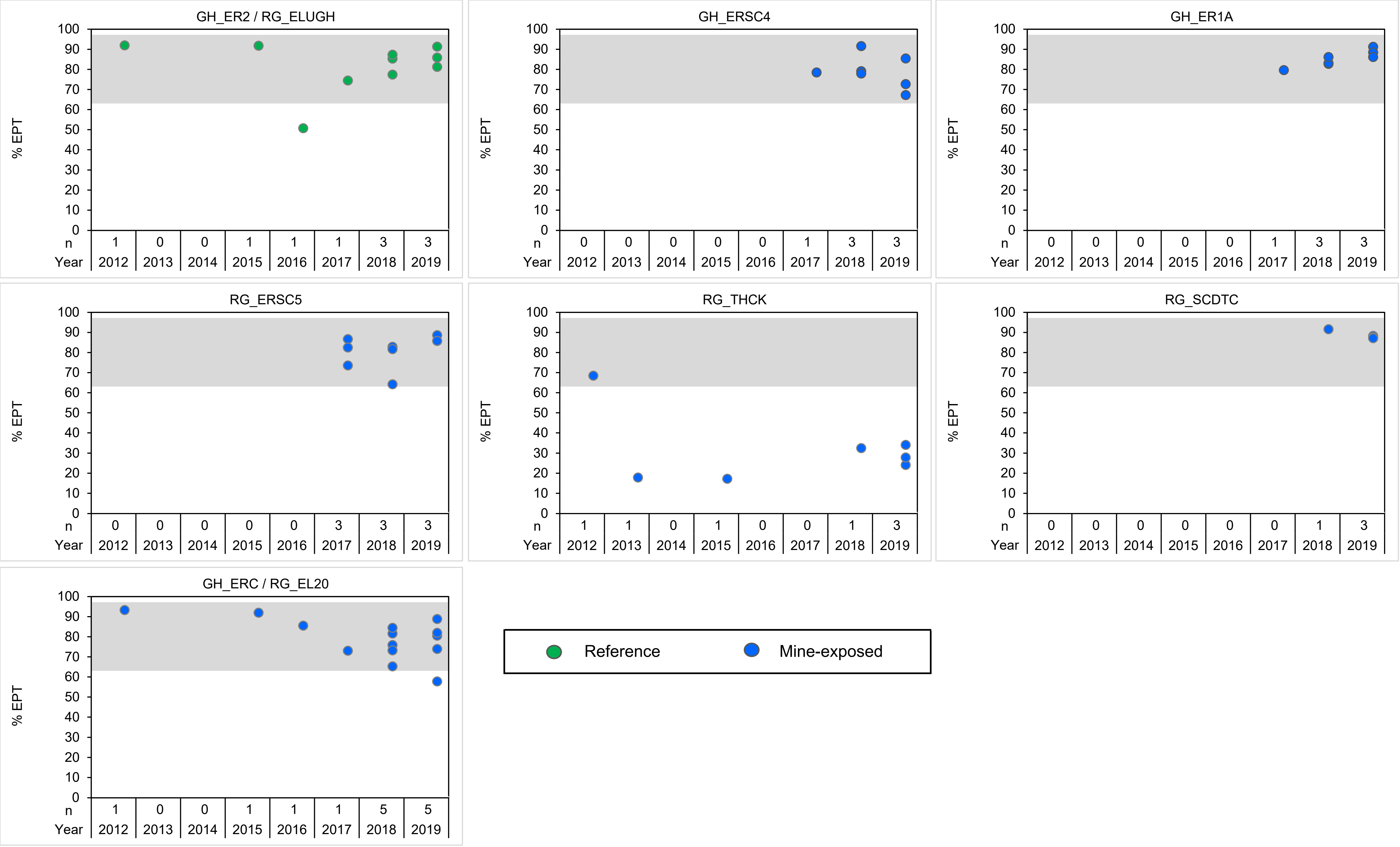

Figure E.3: **Benthic Invertebrate Community % EPT, GHO LAEMP, 2012 to 2019**

Notes: Grey shading represents the normal range defined as the 2.5 th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

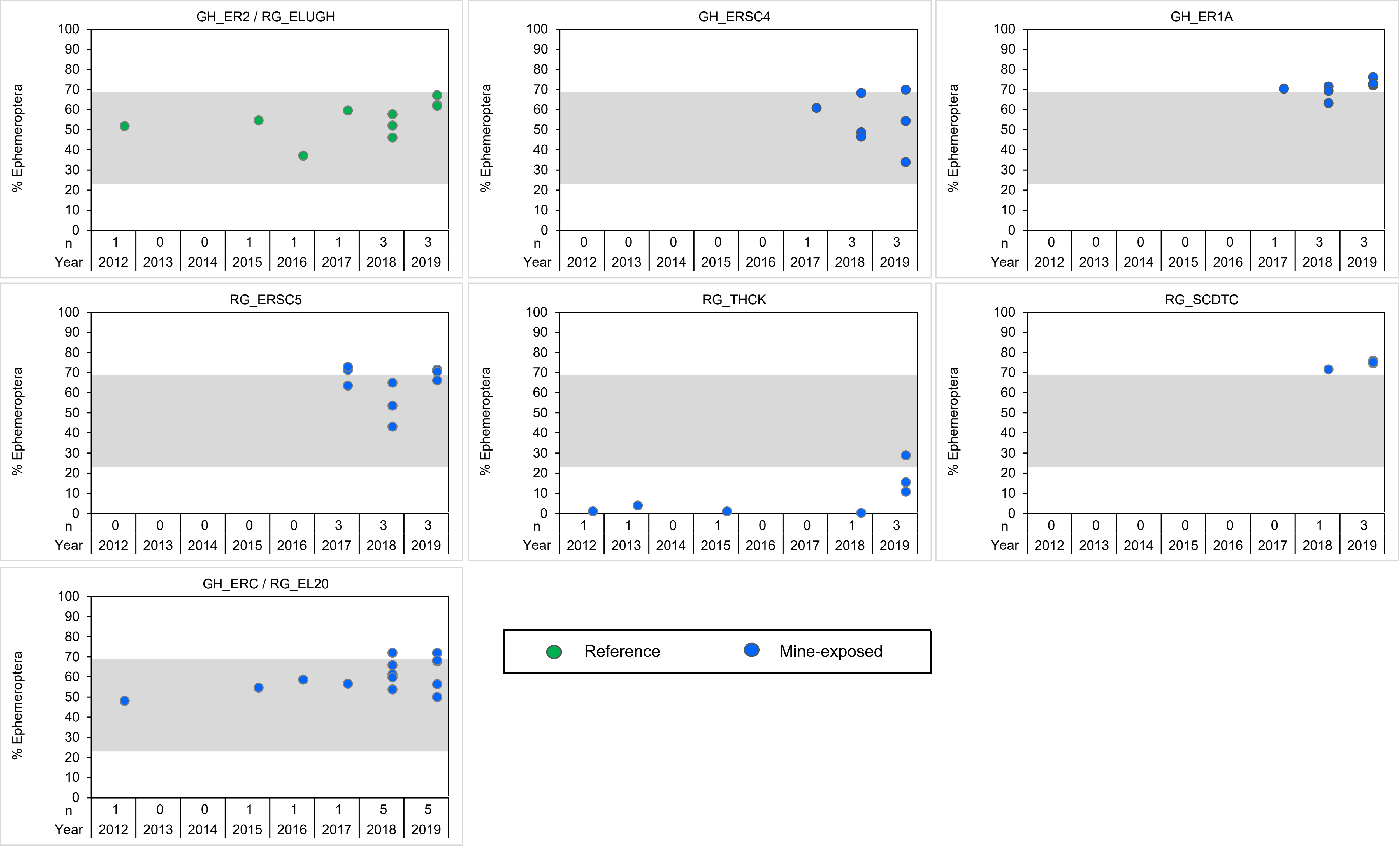

Figure E.4: Benthic Invertebrate Community % Ephemeroptera, GHO LAEMP, 2012 to 2019

Notes: Grey shading represents the normal range defined as the 2.5 th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

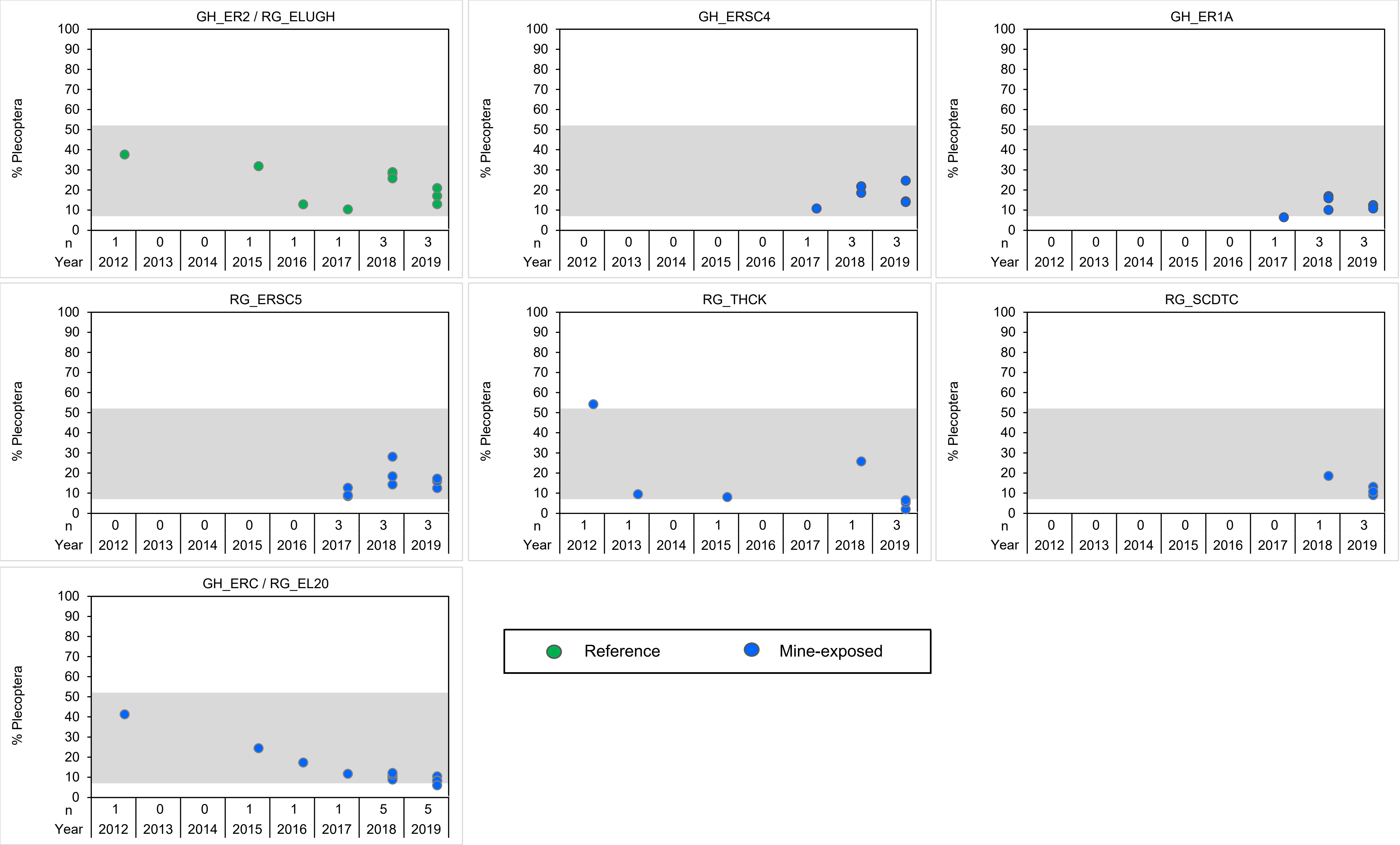

Figure E.5: **Benthic Invertebrate Community % Plecoptera, GHO LAEMP, 2012 to 2019**

Notes: Grey shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

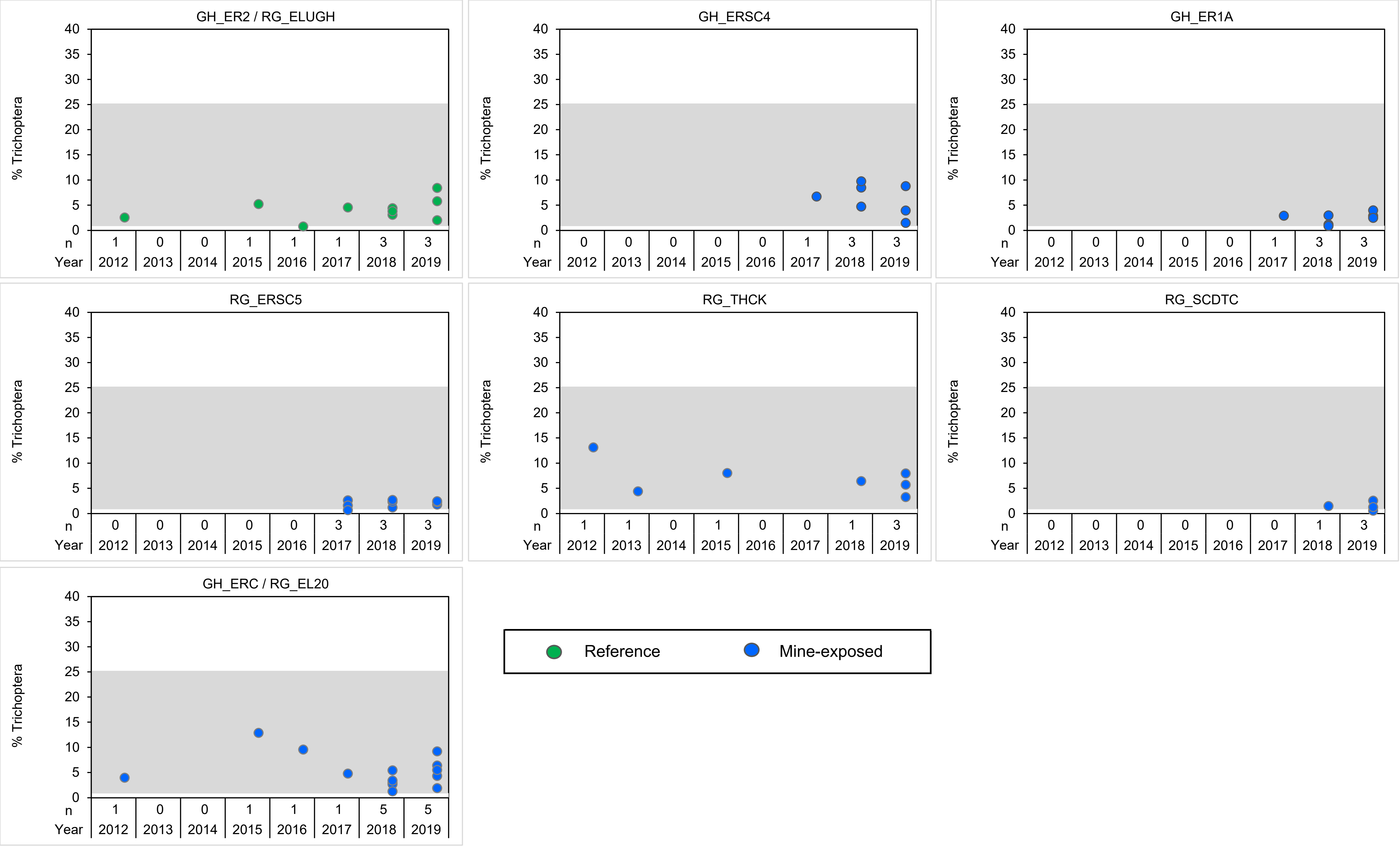

Figure E.6: Benthic Invertebrate Community % Trichoptera, GHO LAEMP, 2012 to 2019

Notes: Grey shading represents the normal range defined as the 2.5th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

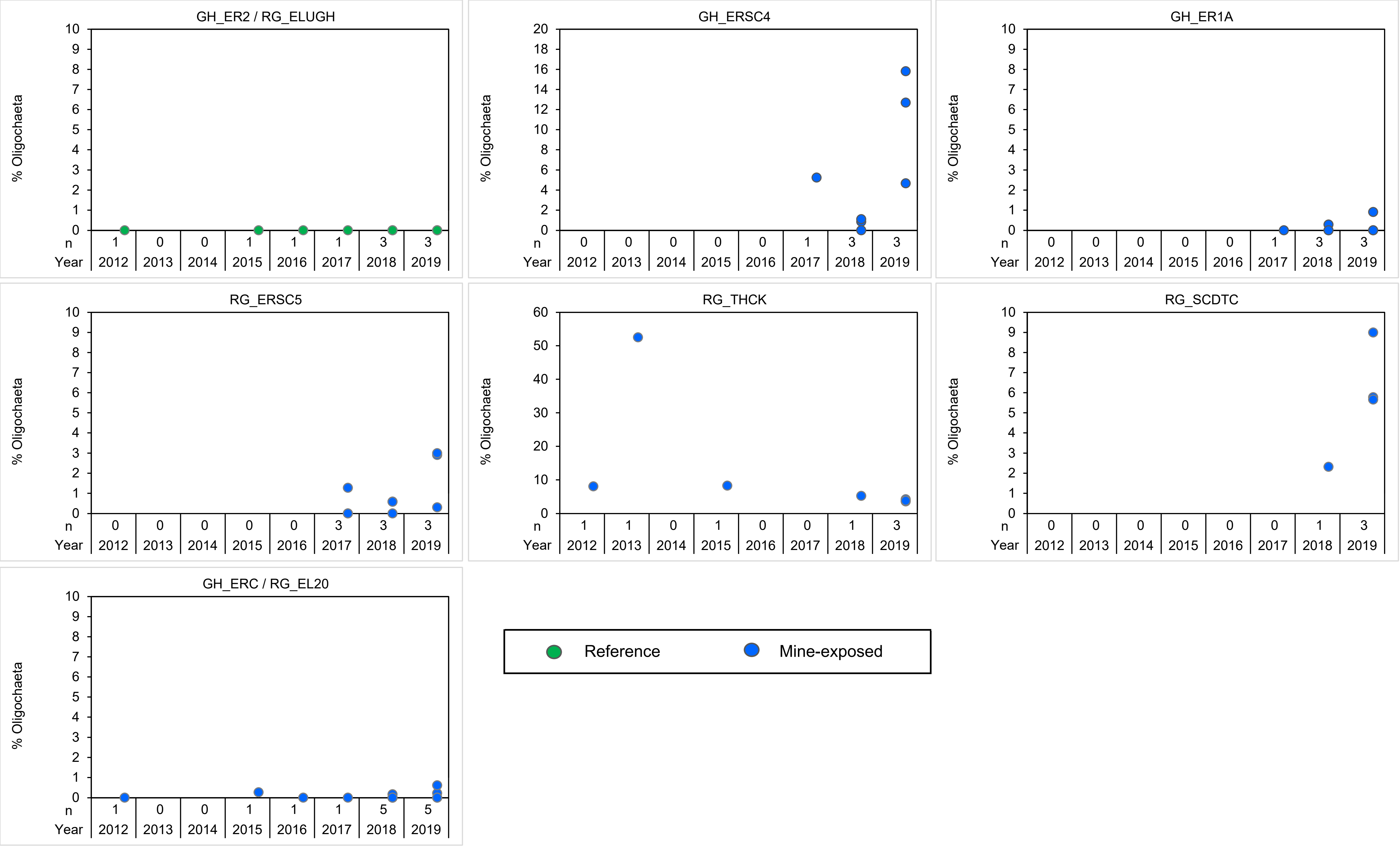

Figure E.7: **Benthic Invertebrate Community % Oligochaeta, GHO LAEMP, 2012 to 2019**

Note: The normal range has not been calculated for % Oligochaeta. GH_ERSC4 and RG_THCK y-axis scales differ from the other stations presented, n = the sample size for a given year.

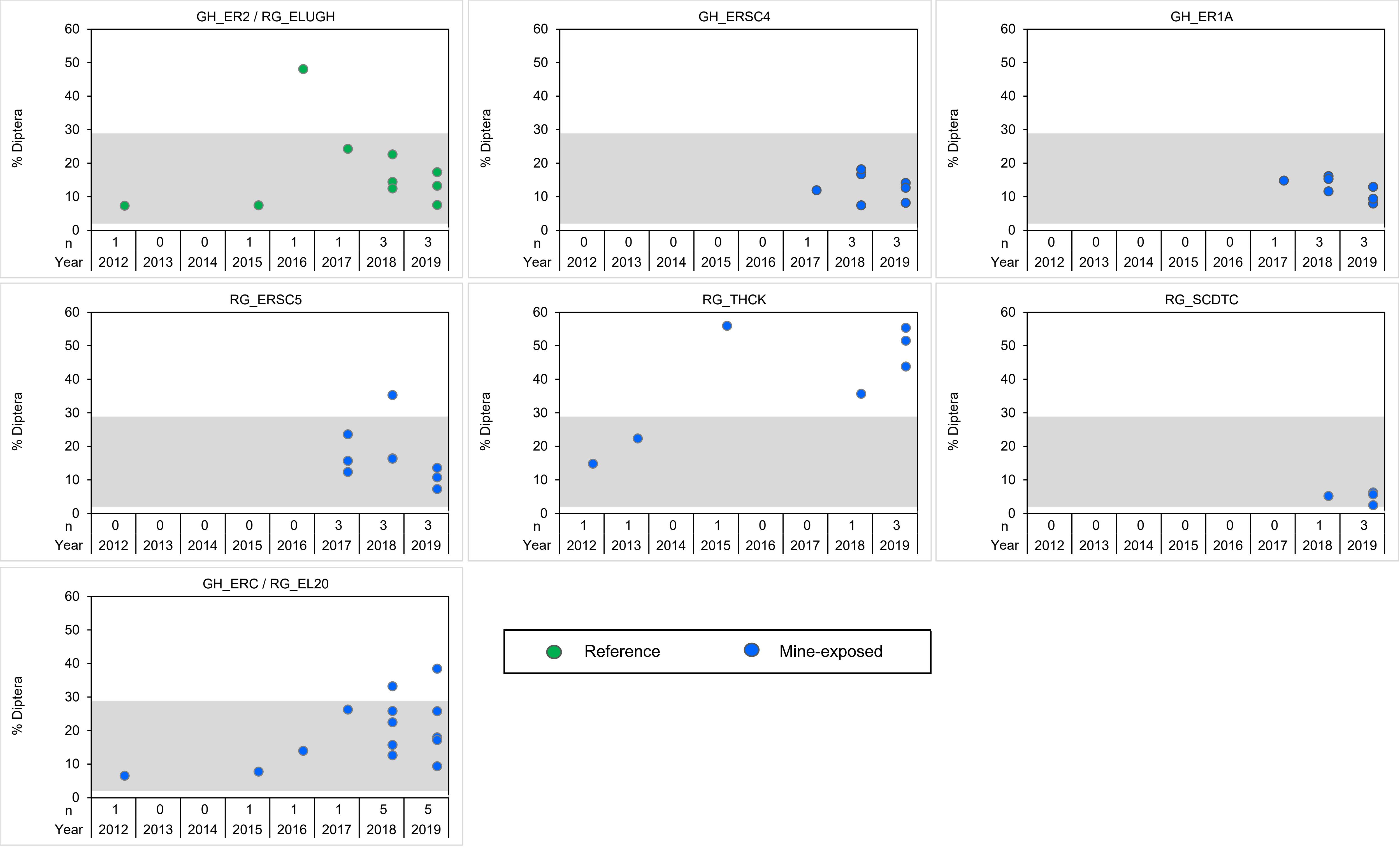

Figure E.8: **Benthic Invertebrate Community % Diptera, GHO LAEMP, 2012 to 2019**

Notes: Grey shading represents the normal range defined as the 2.5 th and 97.5th percentiles of the 2012 and 2015 reference area data from the Regional Aquatic Environmental Monitoring Program (RAEMP), n = the sample size for a given year.

Table E.1: Benthic Invertebrate Community Data, GHO LAEMP, 2019

Area Type	**Reference**					**Mine-exposed**															
Station	**GH_ER2 / EL20**					**GH_ERSC4**			**GH_ER1A**			**RG_ERSC5**			**RG_THCK**			**RG_SCDTC**			**GH_ERC / RG_ELUGH**		
Sample ID	RG_EL20_BIC-1	RG_EL20_BIC-2	RG_EL20_BIC-3	RG_EL20_BIC-4	RG_EL20_BIC-5	GH_ERSC4_BIC-1	GH_ERSC4_BIC-2	GH_ERSC4_BIC-3	GH_ER1A_BIC-1	GH_ER1A_BIC-2	GH_ER1A_BIC-3	RG_ERSC5_BIC-1	RG_ERSC5_BIC-2	RG_ERSC5_BIC-3	RG_THCK_BIC-1	RG_THCK_BIC-2	RG_THCK_BIC-3	RG_SCDTC_BIC-1	RG_SCDTC_BIC-2	RG_SCDTC_BIC-3	RG_ELUGH_BIC-1	RG_ELUGH_BIC-2	RG_ELUGH_BIC-3
Sample Date	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	10-Sep-19	10-Sep-19	10-Sep-19	09-Sep-19	09-Sep-19	09-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	11-Sep-19	11-Sep-19	11-Sep-19	05-Sep-19	05-Sep-19	05-Sep-19
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	13	13	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	20	17	0	40	43	33	20	0	0	0	40	0	6	0	0	0	0	10	79	5	7	0	22
| Family: Baetidae	1,520	667	367	960	471	356	300	280	362	467	350	491	164	138	33	33	71	470	246	214	33	138	122
Acentrella	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0
Baetis	600	267	600	440	271	89	90	90	354	289	210	282	94	100	633	233	543	310	208	136	33	63	89
Baetis fuscatus gr.	0	17	0	20	29	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	7	13	22
Baetis rhodani group	1,240	917	783	1,480	671	144	80	210	438	356	290	373	204	308	800	200	200	200	100	77	67	213	222
Diphetor hageni	0	0	0	0	0	11	0	0	0	0	20	0	0	0	0	0	0	0	4	0	0	0	0
| Family: Ephemerellidae	400	417	133	680	286	389	310	50	77	22	10	36	20	200	0	0	0	40	25	27	93	138	156
Caudatella	0	0	0	0	0	0	10	0	0	0	30	18	0	31	0	0	0	0	0	0	0	0	0
Drunella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella grandis group	20	50	0	80	29	56	30	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Drunella coloradensis	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Drunella doddsii	240	200	200	120	100	0	0	80	46	33	90	100	48	31	0	0	0	60	4	23	133	413	344
Ephemerella	20	0	0	0	0	33	10	0	0	11	20	9	0	15	0	0	0	0	0	0	0	13	0
| Family: Heptageniidae	1,400	667	783	1,660	243	167	330	1,080	492	811	980	518	240	485	17	0	0	1,310	558	486	767	1,063	967
Cinygmula	180	150	33	200	71	0	10	0	46	33	110	0	14	0	0	0	0	60	25	14	140	25	156
Epeorus	220	167	117	40	71	11	0	80	115	144	40	236	42	192	0	0	0	200	108	64	87	300	189
Rhithrogena	460	100	50	240	0	44	480	520	131	467	160	173	56	185	0	0	0	80	8	41	80	250	300
| Order: Plecoptera	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	120	83	33	120	14	22	50	50	0	22	10	0	6	0	0	0	0	50	8	5	67	100	56
| Family: Chloroperlidae	0	0	0	0	0	0	10	30	15	0	10	9	2	0	0	0	0	20	0	0	13	88	56
Sweltsa	20	50	33	20	0	0	10	30	15	44	0	18	6	15	0	0	0	0	0	5	53	88	33
| Family: Leuctridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	13	0
Paraleuctra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0
| Family: Nemouridae	0	17	0	0	0	0	0	0	23	0	0	0	8	15	0	0	14	10	0	5	0	0	0
Malenka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	14	0	0	0	0	0	0
Zapada	40	17	17	20	0	11	10	30	15	67	30	45	10	15	0	22	14	40	8	18	7	38	11
Zapada oregonensis group	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zapada cinctipes	20	17	17	180	57	389	130	120	69	78	130	64	66	138	100	156	300	30	8	9	13	13	22
Zapada columbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
| Family: Perlidae	80	67	33	100	29	22	20	20	31	11	10	36	10	8	0	0	0	10	0	0	0	50	33
Hesperoperla	20	0	17	20	14	33	0	60	38	22	20	9	0	8	0	0	0	0	0	0	0	75	67
| Family: Perlodidae	80	100	117	40	71	333	100	20	15	0	10	0	12	54	0	0	0	20	0	9	7	38	44
Isoperla	40	17	83	60	14	133	30	0	38	33	40	55	20	69	0	0	0	20	0	0	0	0	0
Kogotus	20	17	0	20	29	11	10	0	0	0	0	0	8	0	0	0	0	30	50	27	0	0	11
Megarcys	20	0	0	0	0	0	0	0	0	0	0	18	0	8	0	0	0	0	8	0	0	38	11
Skwala	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pteronarcyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteronarcella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
| Family: Taeniopterygidae	460	67	100	140	43	11	40	120	69	178	90	136	54	108	0	0	0	250	79	77	187	363	144
| Order: Trichoptera	0	17	17	0	0	0	0	0	0	78	0	0	4	0	67	11	0	0	29	5	0	0	22
| Family: Apataniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apatania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Pedomoecus sierra	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Brachycentridae	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachycentrus	40	17	33	120	29	56	40	0	8	11	10	0	6	15	0	0	0	0	0	5	20	138	22
Brachycentrus americanus	140	0	67	0	29	144	20	0	31	11	40	9	0	15	0	0	0	0	0	0	0	0	67
Micrasema	0	0	0	0	0	11	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0
| Family: Glossosomatidae	20	17	17	20	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	40	100	117	220	14	33	30	40	23	11	20	27	4	0	0	0	0	0	0	0	7	25	11
| Family: Hydropsychidae	240	33	183	60	14	0	0	0	0	0	0	0	2	8	0	11	14	0	0	0	7	113	56
Arctopsyche	40	17	50	20	0	11	0	10	15	11	10	0	0	0	0	0	0	0	0	0	7	75	22
Hydropsyche	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parapsyche	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	29	0	0	5	0	0	0
| Family: Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroptila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
| Family: Lepidostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidostoma	40	0	0	20	0	0	10	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0
| Family: Limnephilidae	0	0	0	0	0	22	20	0	0	0	0	0	2	0	0	11	0	0	0	0	0	0	0
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila	0	0	0	20	0	0	0	0	0	0	0	18	8	0	50	144	157	20	17	5	0	13	0
Rhyacophila betteni group	0	0	0	0	0	0	0	0	0	0	0	0	2	0	17	11	0	0	0	0	0	0	0
Rhyacophila brunnea/vemna group	0	17	17	0	0	22	0	0	0	0	0	0	0	0	33	133	86	0	0	0	0	0	22
Rhyacophila atrata complex	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila narvae	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E.1: **Benthic Invertebrate Community Data, GHO LAEMP, 2019**

Area Type	**Reference**					**Mine-exposed**																	
Station	**GH_ER2 / EL20**					**GH_ERSC4**			**GH_ER1A**			**RG_ERSC5**			**RG_THCK**			**RG_SCDTC**			**GH_ERC / RG_ELUGH**		
Sample ID	RG_EL20_BIC-1	RG_EL20_BIC-2	RG_EL20_BIC-3	RG_EL20_BIC-4	RG_EL20_BIC-5	GH_ERSC4_BIC-1	GH_ERSC4_BIC-2	GH_ERSC4_BIC-3	GH_ER1A_BIC-1	GH_ER1A_BIC-2	GH_ER1A_BIC-3	RG_ERSC5_BIC-1	RG_ERSC5_BIC-2	RG_ERSC5_BIC-3	RG_THCK_BIC-1	RG_THCK_BIC-2	RG_THCK_BIC-3	RG_SCDTC_BIC-1	RG_SCDTC_BIC-2	RG_SCDTC_BIC-3	RG_ELUGH_BIC-1	RG_ELUGH_BIC-2	RG_ELUGH_BIC-3
Sample Date	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	10-Sep-19	10-Sep-19	10-Sep-19	09-Sep-19	09-Sep-19	09-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	11-Sep-19	11-Sep-19	11-Sep-19	05-Sep-19	05-Sep-19	05-Sep-19
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Curculionidae	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Hydroporinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
| Family: Elmidae	0	0	0	0	0	0	0	10	0	0	0	0	2	0	250	300	257	0	0	5	0	0	0
Heterlimnius	20	0	0	0	0	0	10	10	8	11	0	0	0	0	500	266	600	0	0	0	0	0	0
Narpus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
| Family: Hydrophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bezzia/ Palpomyia	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Mallochohelea	40	0	0	0	0	11	0	0	0	0	0	0	0	0	0	11	29	0	0	0	40	50	0
| Family: Chironomidae	80	200	133	160	171	178	80	20	62	67	50	27	20	54	133	133	186	30	25	5	73	13	78
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
| Tribe: Tanytarsini	0	17	0	0	0	0	0	0	0	11	0	0	6	0	0	0	0	0	0	0	0	0	0
Constempellina sp. C	0	0	0	0	0	0	0	10	0	0	10	0	0	0	0	0	0	0	0	0	0	13	11
Corynocera	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	17	40	0	11	0	0	54	11	40	0	0	0	167	44	29	10	4	5	27	25	11
Stempellinella	0	67	17	120	43	11	10	0	0	0	0	0	0	8	0	0	0	0	0	0	13	38	11
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diamesa	40	0	17	20	0	0	0	0	0	0	0	0	0	0	33	0	0	0	4	0	0	0	0
Pagastia	40	17	0	0	14	22	0	0	0	0	10	0	2	0	0	0	0	0	4	0	0	0	0
Potthastia gaedii group	40	167	183	80	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
Brillia	20	0	0	0	0	22	10	0	8	11	0	36	6	0	17	0	0	0	4	5	0	0	22
Corynoneura	20	0	0	0	0	0	10	0	0	0	0	0	0	0	300	178	329	0	0	0	7	0	0
Eukiefferiella	100	67	133	60	43	33	50	20	0	0	0	27	0	146	133	44	57	0	8	5	13	38	44
Hydrobaenus	20	0	0	0	14	11	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophyes	0	17	0	0	0	0	10	0	0	0	0	18	12	0	100	22	0	10	4	5	0	0	0
Orthocladius complex	220	283	750	680	986	33	0	0	31	0	0	0	0	0	0	0	0	0	0	23	7	25	122
Orthocladius lignicola	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parorthocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Rheocricotopus	40	0	0	80	0	11	0	0	0	22	30	0	12	31	0	11	14	0	8	0	7	0	0
Thienemanniella	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Tvetenia	60	50	0	40	43	0	50	10	8	22	80	18	18	62	83	56	100	0	8	14	7	38	22
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	11	0	0	0	0	0	0	0
| Tribe: Pentaneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pentaneura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	14	0	0	0	0	0	0
| Family: Dixidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dixa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	11	14	0	0	0	0	0	0
| Family: Dolichopodidae	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Empididae	20	17	0	0	0	0	0	0	0	11	10	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	50	67	0	14	33	20	20	0	22	0	0	0	8	50	11	57	0	4	5	0	0	0
Clinocera	20	0	0	80	29	0	0	0	8	0	10	0	0	0	0	0	0	0	0	0	7	0	0
Neoplasta	20	0	67	40	0	11	0	0	0	0	0	0	0	0	83	22	57	0	0	0	0	13	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	0	17	0	80	71	111	80	150	46	156	150	0	16	23	117	22	29	20	17	9	187	63	144
| Family: Simuliidae	0	0	0	0	0	11	0	0	0	0	10	27	0	0	150	255	200	0	0	0	7	0	0
Prosimulium/Helodon	0	0	0	0	0	0	10	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	0	0	33	0	10	0	0	0	173	0	15	750	1,411	1,500	20	0	5	7	0	0
| Family: Tanyderidae	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	20	0	0	0	0	0	10	0	0	0	0	0	0	0	0	11	0	0	0	0	0	13	0
Antocha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Dicranota	0	0	0	0	0	0	30	30	0	11	0	0	0	0	100	111	86	0	0	0	0	0	0
Hexatoma	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	44
Rhabdomastix	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Thysanoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	20	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
| Family: Feltriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feltria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	11	14	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Hygrobates	0	0	0	0	0	11	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table E.1: Benthic Invertebrate Community Data, GHO LAEMP, 2019

Area Type	Reference					Mine-exposed																	
Station	**GH_ER2 / EL20**					**GH_ERSC4**			**GH_ER1A**			**RG_ERSC5**			**RG_THCK**			**RG_SCDTC**			**GH_ERC / RG_ELUGH**		
Sample ID	RG_EL20_BIC-1	RG_EL20_BIC-2	RG_EL20_BIC-3	RG_EL20_BIC-4	RG_EL20_BIC-5	GH_ERSC4_BIC-1	GH_ERSC4_BIC-2	GH_ERSC4_BIC-3	GH_ER1A_BIC-1	GH_ER1A_BIC-2	GH_ER1A_BIC-3	RG_ERSC5_BIC-1	RG_ERSC5_BIC-2	RG_ERSC5_BIC-3	RG_THCK_BIC-1	RG_THCK_BIC-2	RG_THCK_BIC-3	RG_SCDTC_BIC-1	RG_SCDTC_BIC-2	RG_SCDTC_BIC-3	RG_ELUGH_BIC-1	RG_ELUGH_BIC-2	RG_ELUGH_BIC-3
Sample Date	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	10-Sep-19	10-Sep-19	10-Sep-19	09-Sep-19	09-Sep-19	09-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	04-Sep-19	04-Sep-19	04-Sep-19	11-Sep-19	11-Sep-19	11-Sep-19	05-Sep-19	05-Sep-19	05-Sep-19
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	100	33	17	40	157	67	40	20	8	33	30	9	4	0	0	0	0	10	8	14	27	38	33
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	20	17	0	0	0	0	0	0	8	0	0	0	2	0	17	11	14	0	0	5	0	0	0
| Family: Torrenticolidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Testudacarus	0	0	0	20	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Oribatida	0	0	0	0	0	0	0	0	0	0	0	0	4	8	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	0	0	11	0	0	0	0	0	0	2	0	0	11	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Gammaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Basommatophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Planorbidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	111	0	0	0	0	0	0	0
| Order: Hypsogastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrobiidae	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	20	17	0	0	0	622	390	160	0	33	0	91	38	8	217	156	86	330	104	82	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Tubificinae with hair chaetae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114	0	0	0	0	0	0
Totals:	**8,780**	**5,393**	**5,435**	**8,740**	**4,570**	**3,927**	**3,070**	**3,420**	**2,707**	**3,653**	**3,250**	**3,124**	**1,268**	**2,547**	**5,152**	**4,328**	**5,242**	**3,670**	**1,798**	**1,454**	**2,351**	**4,315**	**3,852**

Methods and QC Report 2019

Project ID: GHO LAEMP (19-11)

Client: Minnow Environmental

Prepared by:
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Sample Reception

On September 24, 2019, Cordillera Consulting received 23 benthic samples from Minnow Environmental. 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

Project	Site	Sample	CC#	Date	Size	# of Jars
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-1	CC200993	9/11/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-2	CC200994	9/11/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-3	CC200995	9/11/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_EL20_BIC-1	CC200996	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_EL20_BIC-2	CC200997	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_EL20_BIC-3	CC200998	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_EL20_BIC-4	CC200999	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_EL20_BIC-5	CC201000	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-1	CC201001	9/8/2019	400µM	2
GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-2	CC201002	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-3	CC201003	9/8/2019	400µM	1
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-1	CC201004	9/9/2019	400µM	1
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-2	CC201005	9/9/2019	400µM	1
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-3	CC201006	9/9/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_THCK_BIC-1	CC201007	9/4/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_THCK_BIC-2	CC201008	9/4/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_THCK_BIC-3	CC201009	9/4/2019	400µM	1
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-1	CC201010	9/10/2019	400µM	2
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-2	CC201011	9/10/2019	400µM	2
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-3	CC201012	9/10/2019	400µM	2
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-1	CC201013	9/5/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-2	CC201014	9/5/2019	400µM	1
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-3	CC201015	9/5/2019	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

Project	Site	Sample	Date	CC#	400 micron fraction	
					% Sampled	# Invertebrates
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-1	11-Sep-19	CC200993	10%	367
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-2	11-Sep-19	CC200994	24%	433
GHO LAEMP (19-11)	2019	RG_SCDTC_BIC-3	11-Sep-19	CC200995	22%	318
GHO LAEMP (19-11)	2019	RG_EL20_BIC-1	08-Sep-19	CC200996	5%	439
GHO LAEMP (19-11)	2019	RG_EL20_BIC-2	08-Sep-19	CC200997	6%	325
GHO LAEMP (19-11)	2019	RG_EL20_BIC-3	08-Sep-19	CC200998	6%	326
GHO LAEMP (19-11)	2019	RG_EL20_BIC-4	08-Sep-19	CC200999	5%	437
GHO LAEMP (19-11)	2019	RG_EL20_BIC-5	08-Sep-19	CC201000	7%	320

GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-1	08-Sep-19	CC201001	11%	344
GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-2	08-Sep-19	CC201002	50%	634
GHO LAEMP (19-11)	2019	RG_ERSC5_BIC-3	08-Sep-19	CC201003	13%	331
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-1	09-Sep-19	CC201004	13%	352
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-2	09-Sep-19	CC201005	9%	329
GHO LAEMP (19-11)	2019	GH_ER1A_BIC-3	09-Sep-19	CC201006	10%	325
GHO LAEMP (19-11)	2019	RG_THCK_BIC-1	04-Sep-19	CC201007	6%	309
GHO LAEMP (19-11)	2019	RG_THCK_BIC-2	04-Sep-19	CC201008	9%	390
GHO LAEMP (19-11)	2019	RG_THCK_BIC-3	04-Sep-19	CC201009	7%	367
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-1	10-Sep-19	CC201010	9%	354
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-2	10-Sep-19	CC201011	10%	307
GHO LAEMP (19-11)	2019	GH_ERSC4_BIC-3	10-Sep-19	CC201012	10%	363
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-1	05-Sep-19	CC201013	15%	352
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-2	05-Sep-19	CC201014	8%	344
GHO LAEMP (19-11)	2019	RG_ELUGH_BIC-3	05-Sep-19	CC201015	9%	347

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 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 (95% for CABIN samples).
- 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

				Total from Sample	Percent Efficiency
Site - QC, Sample - QC1, CC# - CC200994, Percent sampled = 20%, Sieve size = 400					
Ephemeroptera		3			
Plecoptera		2			
Oligochaeta		1			

Total:		**6**		**433**	**99%**
Site - QC, Sample - QC2, CC# - CC200997, Percent sampled = 6%, Sieve size = 400					
Diptera		2			
Chironomidae		1			
Ephemeroptera		1			
Plecoptera		2			
Total:		**6**		**325**	**98%**
Site - QC, Sample - QC3, CC# - CC201005, Percent sampled = 9%, Sieve size = 400					
No Invertebrates Found		0			
Total:		**0**		**329**	**100%**

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 project. 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.

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 error 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.

Table 4 Summary of Sub Sample efficiency

Table to come at a later date

Taxonomic Effort

The next procedure was the identification to genus-species level where possible of all the organisms in the sample.

- Identifications were made at the genus/species level for all insect organisms found including Chironomidae (Based on CABIN protocol).
- Non-insect organisms (except those not included in CABIN count) were identified to genus/species where possible and to a minimum of family level with intact and mature specimens.
- The Standard Taxonomic Effort lists compiled by the CABIN manual[1], SAFIT[2], and PNAMP[3] were used as a guide line for what level of identification to achieve where the condition and maturity of the organism enabled.
- Organisms from the same families/order were kept in separate vials with 80% ethanol and an interior label of printed laser paper.
- Chironomidae was identified to genus/species level where possible and was aided by slide mounts. CMC-10 was used to clear and mount the slide.
- Oligochaetes was identified to family/genus level with the aid of slide mounts. CMC-10 was used to clear and mount the slide.
- Other Annelida (leeches, polychaetes) were identified to the family/genus/species level with undamaged, mature specimens.
- Mollusca was identified to family and genus/species where possible
- Decapoda, Amphipoda and Isopoda were identified at family/genus/species level where possible.
- Bryozoans and Nemata remained at the phylum level
- Hydrachnidae and Cnidaria were identified at the family/genus level where possible.
- When requested, reference collections were made containing at least one individual from each taxa listed. Organisms represented will have been identified to the lowest practical level.
- Reference collection specimens were stored in 55 mm glass vials with screw-cap lids with polyseal inserts (museum quality). They were labeled with taxa name, site code, date identified and taxonomist name. The same information was applied to labels on the slide mounts.

Taxonomists

The taxonomists for this project were certified by the Society of Freshwater Science (SFS) Taxonomic Certification Program at level 2 which is the required certification for CABIN projects:

Scott Finlayson: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae (East/West); Group 4 Oligochaeta

Adam Bliss: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae

Rita Avery: Group 1 General Arthropods (East/West); Group 2 EPT (East/West)

Taxonomic QC

Taxonomic QC was performed in house by someone other than the original taxonomist.

- Quality control protocol involved complete, blind re-identification and re-enumeration of at least 10% of samples by a second SFS-certified taxonomist.
- Samples for taxonomic quality control were randomly selected and quality control procedures were conducted as the project progresses through the laboratories.

- The second (QC) taxonomist will calculate and record four types of errors:
    1. Misidentification error
    2. Enumeration error
    3. Questionable taxonomic resolution error
    4. Insufficient taxonomic resolution error

The QC coordinator then calculates the following estimates of taxonomic precision.

1. The percent total identification error rate is calculated as:

$$\frac{Sum\ of\ incorrect\ identifications}{total\ organisms\ counted\ in\ audit} * (100)$$

The average total identification error rate of audited samples did not exceed 5%. All samples that exceed a 5% error rate were re-evaluated to determine whether repeated errors or patterns in error contributed.

2. The percent difference in enumeration (PDE) to quantify the consistency of specimen counts.

$$PDE = \frac{|n_1 - n_2|}{n_1 + n_2} x100$$

3. The percent taxonomic disagreement (PTD) to quantify the shared precision between two sets of identifications.

$$PTD = \left(1 - \left[\frac{a}{N}\right]\right) x100$$

4. Bray Curtis dissimilarity Index to quantify the differences in identifications.

$$BC_{ij} = 1 - \frac{2C_{ij}}{S_j + S_i}$$

Error Summary

All samples report errors within the acceptable limits for CABIN Laboratory methods (less than 5% error).

Table 5 Summary of taxonomic error following QC

Site	Taxa Identified	% Error	PDE	PTD	Bray - Curtis Dissimilarity index
Site - 2019, Sample - RG_SCDTC_BIC-1, CC# - CC200993, Percent sampled = 10%, Sieve size = 400	364	0.00	0.41039672	4.35967302	0.03967168
Site - 2019, Sample - RG_EL20_BIC-3, CC# - CC200998, Percent sampled = 6%, Sieve size = 400	321	0.00	0.77279753	2.14723926	0.01391036
Site - 2019, Sample - GH_ERSC4_BIC-3, CC# - CC201012, Percent sampled = 10%, Sieve size = 400	340	0.00	0.29325513	0.87719298	0.0058651

There will always be disagreements between taxonomists regarding the degree of taxonomic resolution in immature specimens and when laboratories make use of different keys for certain groups (Mollusks is an especially disputed group). It is always possible that some taxa found by the original taxonomist were overlooked in QC.

All of the Taxonomic QC samples that were observed passed testing according to the CABIN misidentification protocols. See the tables below for results from taxonomic QC audit.

Error Rationale

Site - 2019, Sample - RG_SCDTC_BIC-1, CC# - CC200993, Percent sampled = 10%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficient Taxonomic Resolution	Comments
Ameletus	1	1						
Baetidae	47	35	No			X		
Baetis	31	43	No			X		

Baetis rhodani group	20	20						
Capniidae	5	5						
Chironomidae	3	3						
Chloroperlidae	2	2						
Cinygmula	6	6						
Drunella doddsii	6	6						
Epeorus	20	20						
Ephemerellidae	4	4						
Heptageniidae	131	127	No			X		
Isoperla	2	2						
Kogotus	3	3						
Lebertia	1	1						
Limnophyes	1	1						
Lumbriculidae	33	33						
Micropsectra	1	1						
Nemouridae	1	1						
Pericoma/Telmatoscopus	2	2						
Perlidae	1	1						
Perlodidae	2	2						
Rhithrogena	8	8						
Rhyacophila	1	1						
Rhyacophila	1	1						
Simulium	2	2						
Taeniopterygidae	25	26	No			X		
Zapada	4	4						
Zapada cinctipes	3	3						
Total:	**367**	**364**						
					0	4	0	
% Total Misidentification Rate =	misidentifications total number	x100 =	0.00	**Pass**				

Site - 2019, Sample - RG_EL20_BIC-3, CC# - CC200998, Percent sampled = 6%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficient Taxonomic Resolution	Comments
Arctopsyche	3	3						
Baetidae	22	22						
Baetis	36	37	No			X		

Baetis rhodani group	47	44	No			X		
Brachycentrus	2	2						
Brachycentrus americanus	4	4						
Capniidae	2	2						
Chelifera/ Metachela	4	4						
Chironomidae	8	8						
Cinygmula	2	2						
Diamesa	1	1						
Drunella doddsii	12	12						
Epeorus	7	7						
Ephemerellidae	8	7	No			X		
Eukiefferiella	8	8						
Glossosoma	7	7						
Glossosomatidae	1	1						
Heptageniidae	47	44	No			X		
Hesperoperla	1	1						
Hexatoma	1	1						
Hydropsychidae	11	11						
Isoperla	5	5						
Lebertia	1	1						
Micropsectra	1	1						
Neoplasta	4	4						
Orthocladius complex	45	46	No			X		
Perlidae	2	2						
Perlodidae	7	7						
Potthastia gaedii group	11	11						
Rhithrogena	3	3						
Rhyacophila brunnea/vemna group	1	1						
Stempellinella	1	1						
Sweltsa	2	2						
Taeniopterygidae	6	6						
Trichoptera	1	1						
Zapada	1	1						
Zapada cinctipes	1	1						
Total:	**326**	**321**						
					0	**5**	**0**	
% Total Misidentification Rate =	misidentifications	x100 =	0.00	**Pass**				
	total number							

Site - 2019, Sample - GH_ERSC4_BIC-3, CC# - CC201012, Percent sampled = 10%, Sieve size = 400	Laboratory Count	QC Audit Count	Agreement	Misidentification	Questionable Taxonomic Resolution	Enumeration	Insufficient Taxonomic Resolution	Comments
Arctopsyche	1	1						
Baetidae	28	27	No			X		
Baetis	9	10	No			X		
Baetis rhodani group	21	21						
Capniidae	5	5						
Chelifera/ Metachela	2	2						
Chironomidae	2	2						
Chloroperlidae	3	3						
Constempellina sp. C	1	1						
Dicranota	3	3						
Drunella doddsii	8	8						
Elmidae	1	1						
Epeorus	8	8						
Ephemerellidae	5	5						
Eukiefferiella	2	2						
Gastropoda	1	1						
Glossosoma	4	4						
Heptageniidae	108	106	No			X		
Hesperoperla	6	6						
Heterlimnius	1	1						
Hydrobiidae	1	1						
Lebertia	2	2						
Lumbriculidae	16	16						
Pericoma/Telmatoscopus	15	15						
Perlidae	2	2						
Perlodidae	2	2						
Rhithrogena	52	52						
Simulium	1	1						
Sweltsa	3	3						
Taeniopterygidae	12	12						
Tanyderidae	1	1						
Tvetenia	1	1						
Zapada	3	3						
Zapada cinctipes	12	12						

Total:	**342**	**340**						
					0	**3**	**0**	
% Total Misidentification Rate =	misidentifications	x100 =	0.00	**Pass**				
	total number							

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[3] Pacific Northwest Aquatic Monitoring Partnership (Accessed 2015). www.pnamp.org

Taxonomic Keys

Below is a reference list of taxonomic keys utilized by taxonomists at Cordillera Consulting. Cordillera taxonomists routinely seek out new literature to ensure the most accurate identification keys are being utilized. This is not reflective of the exhaustive list of resources that we use for identification. A more complete list of taxonomic resources can be found at Southwest Association of Freshwater Invertebrate Taxonomists. (2015).
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APPENDIX F

BENTHIC INVERTEBRATE TISSUE

Table F.1: **Metal Concentrations in Composite Benthic Invertebrate Tissue Samples, September 2019**

Analyte		Units	Reference					Mine-exposed			Mine-exposed					
			GH_ER2 / EL20					GH_ERSC4			GH_ER1A			RG_ERSC5		
			GH_ER2-1	GH_ER2-2	GH_ER2-3	GH_ER2-4	GH_ER2-5	GH_ERSC4-1	GH_ERSC4-2	GH_ERSC4-3	GH_ER1A-1	GH_ER1A-2	GH_ER1A-3	RG_ERSC5-1	RG_ERSC5-2	RG_ERSC5-3
			8-Sep-19	8-Sep-19	8-Sep-19	8-Sep-19	8-Sep-19	10-Sep-19	10-Sep-19	10-Sep-19	9-Sep-19	9-Sep-19	9-Sep-19	8-Sep-19	8-Sep-19	8-Sep-19
Physical Tests	Moisture	%	83.48	77.30	83.54	81.84	82.89	83.56	80.26	83.21	86.78	83.06	83.58	82.47	80.05	78.72
Metals	Aluminum	µg/g dw	2,300	630	1,300	1,800	2,200	980	1,700	510	1,200	1,200	1,700	3,400	3,200	4,000
	Antimony	µg/g dw	0.09	0.03	0.07	0.04	0.09	0.06	0.06	0.05	0.11	0.08	0.14	0.19	0.14	0.16
	Arsenic	µg/g dw	1.8	0.90	1.3	0.88	1.70	1.1	1.2	0.63	1.4	0.99	1.4	1.8	1.9	2.6
	Barium	µg/g dw	28	9.5	16	19	24	36	28	20	24	38	30	38	39	44
	Beryllium	µg/g dw	0.12	0.02	0.05	0.07	0.09	0.05	0.07	0.02	0.05	0.05	0.06	0.14	0.13	0.2
	Boron	µg/g dw	5	<1	2	3	4	3	4	2	3	<5	8	8	7	8
	Cadmium	µg/g dw	2.7	2.1	2.7	1.8	3.8	2.1	2.9	1.5	6.8	3.4	4.7	6.0	5.6	8.6
	Chromium	µg/g dw	5.2	1.3	2.6	3.2	4.6	2.4	3.4	1.1	2.7	2.4	3.3	6.4	5.9	8.3
	Cobalt	µg/g dw	2.1	1.5	1.8	1.3	2.3	1.4	0.99	0.67	2.5	1.3	1.9	2.3	2.5	2.6
	Copper	µg/g dw	17	22	19	19	17	19	19	21	19	22	19	17	16	18
	Iron	µg/g dw	2,200	440	860	1,100	1,800	910	1,200	390	900	870	1,100	2,400	2,500	3,300
	Lead	µg/g dw	1.1	0.22	0.47	0.57	0.78	0.53	0.67	0.28	0.48	0.50	0.60	1.5	1.4	1.8
	Manganese	µg/g dw	114	36	61	56	83	160	130	92	110	140	110	142	175	170
	Mercury	µg/g dw	0.020	0.021	0.022	0.024	0.02	0.040	0.040	0.037	0.030	0.030	0.030	0.033	0.039	0.060
	Molybdenum	µg/g dw	0.68	0.26	0.43	0.35	0.51	0.39	0.39	0.29	0.53	0.39	0.54	0.67	0.69	0.79
	Nickel	µg/g dw	5.2	1.9	3.2	2.9	4.3	8.0	3.7	2.7	5.5	4.0	5.0	7.6	9.3	8.8
	Selenium	µg/g dw	5.4	5.8	6.6	4.2	5.9	4.8	5.8	4.8	7.7	5.1	6.8	7.5	7.4	13
	Silver	µg/g dw	0.16	0.19	0.19	0.21	0.16	0.18	0.20	0.20	0.12	0.17	0.16	0.13	0.17	0.46
	Strontium	µg/g dw	25	13	14	16	24	11	18	10	11	16	15	39	33	38
	Thallium	µg/g dw	0.068	0.021	0.037	0.042	0.06	0.04	0.05	0.02	0.05	0.04	0.05	0.1	0.095	0.13
	Tin	µg/g dw	0.05	<0.05	<0.05	<0.05	0.06	<0.1	<0.1	<0.05	<0.1	<0.2	<0.1	0.08	0.07	<0.1
	Titanium	µg/g dw	13.0	6.6	11	15	17	6.7	13	3.9	9.4	9.0	11	21	18	22
	Uranium	µg/g dw	0.27	0.064	0.18	0.13	0.20	0.24	0.18	0.14	0.12	0.14	0.16	0.36	0.56	0.46
	Vanadium	µg/g dw	8.2	2.1	4.2	5.5	7.1	4.2	6.0	1.8	4.4	4.3	5.5	11	11	15
	Zinc	µg/g dw	180	290	260	290	210	320	350	380	260	380	330	170	220	190

▨	Value > upper limit of normal range of selenium (7.79 µg/g dw; Minnow 2018).
🟦	Value > EVWQP level 1 benchmark of 11 µg/g dw dw for dietary effects of selenium to fish. (Level 1 benchmark for effects to invertebrates is 13 µg/g dw dw.)
■	Value > EVWQP level 2 benchmark of 18 µg/g dw for dietary effects of selenium to fish.
🟩	Value > EVWQP level 3 benchmark of 26 µg/g dw for dietary effects of selenium to fish. (41 µg/g dw is the level 3 benchmark for dietary effects of selenium to birds.)

Note: For each level, the lowest benchmark is shown (i.e, most conservative benchmark of effects to benthic invertebrates, dietary effects to fish, and dietary effects to birds).

Table F.1: Metal Concentrations in Composite Benthic Invertebrate Tissue Samples, September 2019

Analyte		Units	Mine-exposed												Mine-exposed		
			GH_TC2 / RG_THCK			RG_GH_SCW3			GH_ERSC2			RG_SCDTC			GH_ERC / RG_ELUGH		
			GH_TC2-1	GH_TC2-2	GH_TC2-3	RG_GH_ SCW3-1	RG_GH_ SCW3-2	RG_GH_ SCW3-3	GH_ERSC2-1	GH_ERSC2-2	GH_ERSC2-3	RG_ SCDTC-1	RG_ SCDTC-2	RG_ SCDTC-3	GH_ERC-1	GH_ERC-2	GH_ERC-3
			4-Sep-19	4-Sep-19	4-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19	11-Sep-19	11-Sep-19	11-Sep-19	5-Sep-19	5-Sep-19	5-Sep-19
Physical Tests	Moisture	%	83.41	80.85	84.22	84.25	90.31	90.09	78.07	75.95	78.83	87.42	88.65	80.51	80.25	80.43	80.41
Metals	Aluminum	µg/g dw	6,600	6,100	2,700	5,000	5,600	5,600	7,000	3,200	4,100	2,800	4,000	6,700	280	510	190
	Antimony	µg/g dw	0.14	0.08	0.08	0.10	0.18	0.17	0.10	0.07	0.09	0.22	0.16	0.22	0.04	0.05	<0.02
	Arsenic	µg/g dw	4.2	3.6	2.7	4.4	2.3	2.8	3.4	1.9	2.2	2.0	2.2	2.9	0.69	1.60	0.88
	Barium	µg/g dw	119	90	65	43	52	52	53	29	38	28	40	63	8.4	17.0	7.5
	Beryllium	µg/g dw	0.28	0.26	0.12	0.21	0.24	0.23	0.24	0.11	0.15	0.10	0.16	0.30	<0.02	0.02	<0.02
	Boron	µg/g dw	15	13	10	10	12	11	12	5	7	5	8	12	<5	<5	<2
	Cadmium	µg/g dw	1.9	1.7	1.7	10	3.3	6.3	13	9.4	10	7.5	9.2	6.8	1.2	2.9	1.1
	Chromium	µg/g dw	8.5	8.3	3.4	9.1	10.0	11	11	5.7	7.3	4.7	6.7	9.4	0.8	1.3	0.5
	Cobalt	µg/g dw	2.4	1.9	1.2	2.0	2.8	3.0	2.8	2.2	2.9	2.8	2.7	3.5	<0.5	1.40	0.82
	Copper	µg/g dw	16	18	16	16	24	19	28	33	28	21	19	21	17	14	23
	Iron	µg/g dw	5,200	5,000	2,200	3,600	4,100	4,200	4,000	2,100	2,700	1,700	2,600	6,700	270	440	160
	Lead	µg/g dw	3.2	3.1	1.3	2.2	2.5	2.4	2.3	1.0	1.4	1.4	1.5	3.5	0.17	0.23	0.08
	Manganese	µg/g dw	180	130	120	97	220	190	120	68	94	93	93	150	40	100	45
	Mercury	µg/g dw	0.12	0.10	0.12	0.19	0.06	0.04	0.06	0.05	0.04	0.03	0.04	0.06	0.02	0.03	0.02
	Molybdenum	µg/g dw	0.93	0.71	0.59	1.1	1.7	2.0	0.78	0.57	0.58	0.75	0.79	0.91	0.21	0.42	0.19
	Nickel	µg/g dw	11	8.1	5.9	8.3	14	12	7.8	4.6	5.6	6.6	7.3	11	1.2	2.7	1.0
	Selenium	µg/g dw	53	61	78	55	7.6	7.3	12	8.1	7.4	10	9.6	9.2	3.5	6.4	5.5
	Silver	µg/g dw	0.16	0.16	0.12	1.5	0.23	0.15	0.29	0.13	0.12	0.14	0.14	0.16	0.18	0.13	0.24
	Strontium	µg/g dw	66	35	16	23	26	31	31	16	22	15	19	23	10.0	9.3	16.0
	Thallium	µg/g dw	0.23	0.18	0.12	0.17	0.17	0.16	0.17	0.09	0.11	0.08	0.11	0.15	0.02	0.02	0.01
	Tin	µg/g dw	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1
	Titanium	µg/g dw	26	28	14	28	30	28	46	29	27	21	26	24	2.3	3.8	1.6
	Uranium	µg/g dw	0.72	0.41	0.98	0.40	0.47	0.54	0.41	0.18	0.28	0.17	0.25	0.29	0.06	0.09	0.03
	Vanadium	µg/g dw	19	19	8.1	17	19	19	20	9.8	13	9.1	13	18	2.0	2.1	0.7
	Zinc	µg/g dw	160	190	210	170	130	160	240	200	250	190	200	190	250	200	300

▨	Value > upper limit of normal range of selenium (7.79 µg/g dw; Minnow 2018).
🟦	Value > EVWQP level 1 benchmark of 11 µg/g dw dw for dietary effects of selenium to fish. (Level 1 benchmark for effects to invertebrates is 13 µg/g dw dw.)
■	Value > EVWQP level 2 benchmark of 18 µg/g dw for dietary effects of selenium to fish.
🟩	Value > EVWQP level 3 benchmark of 26 µg/g dw for dietary effects of selenium to fish. (41 µg/g dw is the level 3 benchmark for dietary effects of selenium to birds.)

Note: For each level, the lowest benchmark is shown (i.e, most conservative benchmark of effects to benthic invertebrates, dietary effects to fish, and dietary effects to birds).

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

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Toll-free: 1-800-240-8808
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SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.
2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jennifer Ings

Date Samples Received: Sep-19-2019 Client P.O.: 616225

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 Section 2 authorized by Keith Gipman, Supervisor
Results from Lab Section 6 authorized by Marion McConnell, Supervisor

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* 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.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

SASKATCHEWAN RESEARCH COUNCIL
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SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

2 Lamb Street
Georgetown, ON L7G 3M9
Attn: Jennifer Ings

Sample #: **2019053168**
Date Sampled: **Sep 05, 2019**
Sample Matrix: **TISSUE**
Description: **09/05/2019 GH_ELUGH_INV-1_2019-09-05**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	280	40	5	0.0881
Antimony	ug/g	0.04	0.03	0.02	0.0881
Arsenic	ug/g	0.69	0.2	0.05	0.0881
Barium	ug/g	8.4	2	0.5	0.0881
Beryllium	ug/g	<0.02		0.02	0.0881
Boron	ug/g	<5		5	0.0881
Cadmium	ug/g	1.2	0.2	0.02	0.0881
Chromium	ug/g	0.8	0.6	0.5	0.0881
Cobalt	ug/g	<0.5		0.5	0.0881
Copper	ug/g	17	2	0.5	0.0881
Iron	ug/g	270	40	5	0.0881
Lead	ug/g	0.17	0.09	0.05	0.0881
Manganese	ug/g	40	6	0.5	0.0881
Mercury	ug/g	0.02	0.01	0.01	0.0881
Molybdenum	ug/g	0.21	0.1	0.05	0.0881
Nickel	ug/g	1.2	0.5	0.5	0.0881
Selenium	ug/g	3.5	0.5	0.05	0.0881
Silver	ug/g	0.18	0.06	0.02	0.0881
Strontium	ug/g	10	1	0.1	0.0881
Thallium	ug/g	0.02	0.01	0.01	0.0881
Tin	ug/g	<0.2		0.2	0.0881
Titanium	ug/g	2.3	0.9	0.5	0.0881
Uranium	ug/g	0.06	0.03	0.02	0.0881
Vanadium	ug/g	2.0	0.5	0.2	0.0881
Zinc	ug/g	250	40	5	0.0881
Lab Section 6					
Moisture	%	80.25	8	0.02	0.0881

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.

Oct 18, 2019

Minnow Environmental Inc.

Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053169**	Client PO #:	**616225**
Date Sampled:	**Sep 05, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/05/2019 GH_ELUGH_INV-2_2019-09-05**		

Analyte	**Units**	**Result**	**+/-**	**DL**	**Weight (g)**
Lab Section 2					
Aluminum	ug/g	510	50	5	0.0954
Antimony	ug/g	0.05	0.03	0.02	0.0954
Arsenic	ug/g	1.6	0.2	0.05	0.0954
Barium	ug/g	17	2	0.5	0.0954
Beryllium	ug/g	0.02	0.02	0.02	0.0954
Boron	ug/g	<5		5	0.0954
Cadmium	ug/g	2.9	0.3	0.02	0.0954
Chromium	ug/g	1.3	0.8	0.5	0.0954
Cobalt	ug/g	1.4	0.5	0.5	0.0954
Copper	ug/g	14	2	0.5	0.0954
Iron	ug/g	440	70	5	0.0954
Lead	ug/g	0.23	0.1	0.05	0.0954
Manganese	ug/g	100	10	0.5	0.0954
Mercury	ug/g	0.03	0.02	0.01	0.0954
Molybdenum	ug/g	0.42	0.1	0.05	0.0954
Nickel	ug/g	2.7	0.5	0.5	0.0954
Selenium	ug/g	6.4	0.6	0.05	0.0954
Silver	ug/g	0.13	0.05	0.02	0.0954
Strontium	ug/g	9.3	1	0.1	0.0954
Thallium	ug/g	0.02	0.01	0.01	0.0954
Tin	ug/g	<0.2		0.2	0.0954
Titanium	ug/g	3.8	1	0.5	0.0954
Uranium	ug/g	0.09	0.04	0.02	0.0954
Vanadium	ug/g	2.1	0.5	0.2	0.0954
Zinc	ug/g	200	30	5	0.0954
Lab Section 6					
Moisture	%	80.43	8	0.02	0.0954

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053170**	Client PO #:	**616225**
Date Sampled:	**Sep 05, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/05/2019 GH_ELUGH_INV-3_2019-09-05**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	190	30	5	0.118
Antimony	ug/g	<0.02		0.02	0.118
Arsenic	ug/g	0.88	0.1	0.02	0.118
Barium	ug/g	7.5	0.8	0.05	0.118
Beryllium	ug/g	<0.02		0.02	0.118
Boron	ug/g	<2		2	0.118
Cadmium	ug/g	1.1	0.2	0.02	0.118
Chromium	ug/g	0.5	0.2	0.1	0.118
Cobalt	ug/g	0.82	0.1	0.02	0.118
Copper	ug/g	23	2	0.1	0.118
Iron	ug/g	160	20	5	0.118
Lead	ug/g	0.08	0.04	0.02	0.118
Manganese	ug/g	45	4	0.2	0.118
Mercury	ug/g	0.02	0.01	0.01	0.118
Molybdenum	ug/g	0.19	0.1	0.05	0.118
Nickel	ug/g	1.0	0.2	0.1	0.118
Selenium	ug/g	5.5	0.6	0.02	0.118
Silver	ug/g	0.24	0.06	0.02	0.118
Strontium	ug/g	16	2	0.1	0.118
Thallium	ug/g	0.01	0.01	0.01	0.118
Tin	ug/g	<0.1		0.1	0.118
Titanium	ug/g	1.6	0.7	0.5	0.118
Uranium	ug/g	0.03	0.02	0.01	0.118
Vanadium	ug/g	0.7	0.4	0.2	0.118
Zinc	ug/g	300	30	1	0.118
Lab Section 6					
Moisture	%	80.41	8	0.02	0.118

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053171**
Date Sampled: **Sep 04, 2019**
Sample Matrix: **TISSUE**
Description: **09/04/2019 GH_THCK_INV-1_2019-09-04**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	**Units**	**Result**	**+/-**	**DL**	**Weight (g)**
Lab Section 2					
Aluminum	ug/g	6600	700	50	0.1423
Antimony	ug/g	0.14	0.05	0.02	0.1423
Arsenic	ug/g	4.2	0.4	0.02	0.1423
Barium	ug/g	119	10	0.05	0.1423
Beryllium	ug/g	0.28	0.07	0.02	0.1423
Boron	ug/g	15	2	2	0.1423
Cadmium	ug/g	1.9	0.3	0.02	0.1423
Chromium	ug/g	8.5	1	0.1	0.1423
Cobalt	ug/g	2.4	0.2	0.02	0.1423
Copper	ug/g	16	2	0.1	0.1423
Iron	ug/g	5200	500	50	0.1423
Lead	ug/g	3.2	0.3	0.02	0.1423
Manganese	ug/g	180	20	0.2	0.1423
Mercury	ug/g	0.12	0.03	0.01	0.1423
Molybdenum	ug/g	0.93	0.2	0.05	0.1423
Nickel	ug/g	11	1	0.1	0.1423
Selenium	ug/g	53	5	0.2	0.1423
Silver	ug/g	0.16	0.05	0.02	0.1423
Strontium	ug/g	66	7	0.1	0.1423
Thallium	ug/g	0.23	0.03	0.01	0.1423
Tin	ug/g	<0.1		0.1	0.1423
Titanium	ug/g	26	4	0.5	0.1423
Uranium	ug/g	0.72	0.1	0.01	0.1423
Vanadium	ug/g	19	3	0.2	0.1423
Zinc	ug/g	160	20	1	0.1423
Lab Section 6					
Moisture	%	83.41	8	0.02	0.1423

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053172**
Date Sampled: **Sep 04, 2019**
Sample Matrix: **TISSUE**
Description: **09/04/2019 GH_THCK_INV-2_2019-09-04**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	6100	600	50	0.1574
Antimony	ug/g	0.08	0.04	0.02	0.1574
Arsenic	ug/g	3.6	0.4	0.02	0.1574
Barium	ug/g	90	9	0.05	0.1574
Beryllium	ug/g	0.26	0.06	0.02	0.1574
Boron	ug/g	13	2	2	0.1574
Cadmium	ug/g	1.7	0.2	0.02	0.1574
Chromium	ug/g	8.3	1	0.1	0.1574
Cobalt	ug/g	1.9	0.3	0.02	0.1574
Copper	ug/g	18	2	0.1	0.1574
Iron	ug/g	5000	500	50	0.1574
Lead	ug/g	3.1	0.3	0.02	0.1574
Manganese	ug/g	130	10	0.2	0.1574
Mercury	ug/g	0.10	0.02	0.01	0.1574
Molybdenum	ug/g	0.71	0.2	0.05	0.1574
Nickel	ug/g	8.1	1	0.1	0.1574
Selenium	ug/g	61	6	0.2	0.1574
Silver	ug/g	0.16	0.05	0.02	0.1574
Strontium	ug/g	35	4	0.1	0.1574
Thallium	ug/g	0.18	0.04	0.01	0.1574
Tin	ug/g	<0.1		0.1	0.1574
Titanium	ug/g	28	4	0.5	0.1574
Uranium	ug/g	0.41	0.06	0.01	0.1574
Vanadium	ug/g	19	3	0.2	0.1574
Zinc	ug/g	190	20	1	0.1574
Lab Section 6					
Moisture	%	80.85	8	0.02	0.1574

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053173**
Date Sampled: **Sep 04, 2019**
Sample Matrix: **TISSUE**
Description: **09/04/2019 GH_THCK_INV-3_2019-09-04**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	2700	400	50	0.1088
Antimony	ug/g	0.08	0.04	0.02	0.1088
Arsenic	ug/g	2.7	0.3	0.02	0.1088
Barium	ug/g	65	6	0.05	0.1088
Beryllium	ug/g	0.12	0.03	0.02	0.1088
Boron	ug/g	10	2	2	0.1088
Cadmium	ug/g	1.7	0.2	0.02	0.1088
Chromium	ug/g	3.4	0.5	0.1	0.1088
Cobalt	ug/g	1.2	0.2	0.02	0.1088
Copper	ug/g	16	2	0.1	0.1088
Iron	ug/g	2200	200	5	0.1088
Lead	ug/g	1.3	0.2	0.02	0.1088
Manganese	ug/g	120	10	0.2	0.1088
Mercury	ug/g	0.12	0.03	0.01	0.1088
Molybdenum	ug/g	0.59	0.1	0.05	0.1088
Nickel	ug/g	5.9	0.9	0.1	0.1088
Selenium	ug/g	78	8	0.2	0.1088
Silver	ug/g	0.12	0.05	0.02	0.1088
Strontium	ug/g	16	2	0.1	0.1088
Thallium	ug/g	0.12	0.03	0.01	0.1088
Tin	ug/g	<0.1		0.1	0.1088
Titanium	ug/g	14	2	0.5	0.1088
Uranium	ug/g	0.98	0.1	0.01	0.1088
Vanadium	ug/g	8.1	1	0.2	0.1088
Zinc	ug/g	210	20	1	0.1088
Lab Section 6					
Moisture	%	84.22	8	0.02	0.1088

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053174**
Date Sampled: **Sep 10, 2019**
Sample Matrix: **TISSUE**
Description: **09/10/2019 GH_ERSC4_INV-1_2019-09-10**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	980	100	5	0.181
Antimony	ug/g	0.06	0.03	0.02	0.181
Arsenic	ug/g	1.1	0.2	0.02	0.181
Barium	ug/g	36	4	0.05	0.181
Beryllium	ug/g	0.05	0.02	0.02	0.181
Boron	ug/g	3	2	2	0.181
Cadmium	ug/g	2.1	0.2	0.02	0.181
Chromium	ug/g	2.4	0.4	0.1	0.181
Cobalt	ug/g	1.4	0.2	0.02	0.181
Copper	ug/g	19	2	0.1	0.181
Iron	ug/g	910	90	5	0.181
Lead	ug/g	0.53	0.08	0.02	0.181
Manganese	ug/g	160	20	0.2	0.181
Mercury	ug/g	0.04	0.02	0.01	0.181
Molybdenum	ug/g	0.39	0.1	0.05	0.181
Nickel	ug/g	8.0	1	0.1	0.181
Selenium	ug/g	4.8	0.5	0.02	0.181
Silver	ug/g	0.18	0.06	0.02	0.181
Strontium	ug/g	11	1	0.1	0.181
Thallium	ug/g	0.04	0.02	0.01	0.181
Tin	ug/g	<0.1		0.1	0.181
Titanium	ug/g	6.7	2	0.5	0.181
Uranium	ug/g	0.24	0.04	0.01	0.181
Vanadium	ug/g	4.2	0.6	0.2	0.181
Zinc	ug/g	320	30	1	0.181
Lab Section 6					
Moisture	%	83.56	8	0.02	0.181

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053175**	Client PO #:	**616225**
Date Sampled:	**Sep 10, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/10/2019 GH_ERSC4_INV-2_2019-09-10**		

Analyte	**Units**	**Result**	**+/-**	**DL**	**Weight (g)**
Lab Section 2					
Aluminum	ug/g	1700	200	50	0.1907
Antimony	ug/g	0.06	0.03	0.02	0.1907
Arsenic	ug/g	1.2	0.2	0.02	0.1907
Barium	ug/g	28	3	0.05	0.1907
Beryllium	ug/g	0.07	0.02	0.02	0.1907
Boron	ug/g	4	2	2	0.1907
Cadmium	ug/g	2.9	0.3	0.02	0.1907
Chromium	ug/g	3.4	0.5	0.1	0.1907
Cobalt	ug/g	0.99	0.1	0.02	0.1907
Copper	ug/g	19	2	0.1	0.1907
Iron	ug/g	1200	100	5	0.1907
Lead	ug/g	0.67	0.1	0.02	0.1907
Manganese	ug/g	130	10	0.2	0.1907
Mercury	ug/g	0.04	0.02	0.01	0.1907
Molybdenum	ug/g	0.39	0.1	0.05	0.1907
Nickel	ug/g	3.7	0.6	0.1	0.1907
Selenium	ug/g	5.8	0.6	0.02	0.1907
Silver	ug/g	0.20	0.05	0.02	0.1907
Strontium	ug/g	18	2	0.1	0.1907
Thallium	ug/g	0.05	0.02	0.01	0.1907
Tin	ug/g	<0.1		0.1	0.1907
Titanium	ug/g	13	2	0.5	0.1907
Uranium	ug/g	0.18	0.04	0.01	0.1907
Vanadium	ug/g	6.0	0.9	0.2	0.1907
Zinc	ug/g	350	40	1	0.1907
Lab Section 6					
Moisture	%	80.26	8	0.02	0.1907

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053176**	Client PO #:	**616225**
Date Sampled:	**Sep 10, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/10/2019 GH_ERSC4_INV-3_2019-09-10**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	510	50	2	0.3058
Antimony	ug/g	0.05	0.02	0.01	0.3058
Arsenic	ug/g	0.63	0.09	0.01	0.3058
Barium	ug/g	20	2	0.02	0.3058
Beryllium	ug/g	0.02	0.01	0.01	0.3058
Boron	ug/g	2	1	1	0.3058
Cadmium	ug/g	1.5	0.2	0.01	0.3058
Chromium	ug/g	1.1	0.2	0.05	0.3058
Cobalt	ug/g	0.67	0.1	0.01	0.3058
Copper	ug/g	21	2	0.05	0.3058
Iron	ug/g	390	40	2	0.3058
Lead	ug/g	0.28	0.04	0.01	0.3058
Manganese	ug/g	92	9	0.1	0.3058
Mercury	ug/g	0.037	0.01	0.005	0.3058
Molybdenum	ug/g	0.29	0.07	0.02	0.3058
Nickel	ug/g	2.7	0.4	0.05	0.3058
Selenium	ug/g	4.8	0.5	0.01	0.3058
Silver	ug/g	0.20	0.03	0.01	0.3058
Strontium	ug/g	10	1	0.05	0.3058
Thallium	ug/g	0.020	0.01	0.005	0.3058
Tin	ug/g	<0.05		0.05	0.3058
Titanium	ug/g	3.9	1	0.2	0.3058
Uranium	ug/g	0.14	0.02	0.005	0.3058
Vanadium	ug/g	1.8	0.4	0.1	0.3058
Zinc	ug/g	380	40	0.5	0.3058
Lab Section 6					
Moisture	%	83.21	8	0.02	0.3058

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053177**	Client PO #:	**616225**
Date Sampled:	**Sep 09, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/09/2019 GH_ER1A_INV-1_2019-09-09**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	1200	100	5	0.1495
Antimony	ug/g	0.11	0.04	0.02	0.1495
Arsenic	ug/g	1.4	0.2	0.02	0.1495
Barium	ug/g	24	2	0.05	0.1495
Beryllium	ug/g	0.05	0.02	0.02	0.1495
Boron	ug/g	3	2	2	0.1495
Cadmium	ug/g	6.8	0.7	0.02	0.1495
Chromium	ug/g	2.7	0.4	0.1	0.1495
Cobalt	ug/g	2.5	0.2	0.02	0.1495
Copper	ug/g	19	2	0.1	0.1495
Iron	ug/g	900	90	5	0.1495
Lead	ug/g	0.48	0.07	0.02	0.1495
Manganese	ug/g	110	10	0.2	0.1495
Mercury	ug/g	0.03	0.02	0.01	0.1495
Molybdenum	ug/g	0.53	0.1	0.05	0.1495
Nickel	ug/g	5.5	0.8	0.1	0.1495
Selenium	ug/g	7.7	0.8	0.02	0.1495
Silver	ug/g	0.12	0.05	0.02	0.1495
Strontium	ug/g	11	1	0.1	0.1495
Thallium	ug/g	0.05	0.02	0.01	0.1495
Tin	ug/g	<0.1		0.1	0.1495
Titanium	ug/g	9.4	2	0.5	0.1495
Uranium	ug/g	0.12	0.03	0.01	0.1495
Vanadium	ug/g	4.4	0.7	0.2	0.1495
Zinc	ug/g	260	30	1	0.1495
Lab Section 6					
Moisture	%	86.78	9	0.02	0.1495

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053178**
Date Sampled: **Sep 09, 2019**
Sample Matrix: **TISSUE**
Description: **09/09/2019 GH_ER1A_INV-2_2019-09-09**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	1200	100	5	0.0992
Antimony	ug/g	0.08	0.04	0.02	0.0992
Arsenic	ug/g	0.99	0.2	0.05	0.0992
Barium	ug/g	38	6	0.5	0.0992
Beryllium	ug/g	0.05	0.02	0.02	0.0992
Boron	ug/g	<5		5	0.0992
Cadmium	ug/g	3.4	0.3	0.02	0.0992
Chromium	ug/g	2.4	1	0.5	0.0992
Cobalt	ug/g	1.3	0.5	0.5	0.0992
Copper	ug/g	22	3	0.5	0.0992
Iron	ug/g	870	90	5	0.0992
Lead	ug/g	0.50	0.1	0.05	0.0992
Manganese	ug/g	140	10	0.5	0.0992
Mercury	ug/g	0.03	0.02	0.01	0.0992
Molybdenum	ug/g	0.39	0.1	0.05	0.0992
Nickel	ug/g	4.0	0.5	0.5	0.0992
Selenium	ug/g	5.1	0.5	0.05	0.0992
Silver	ug/g	0.17	0.06	0.02	0.0992
Strontium	ug/g	16	2	0.1	0.0992
Thallium	ug/g	0.04	0.02	0.01	0.0992
Tin	ug/g	<0.2		0.2	0.0992
Titanium	ug/g	9.0	2	0.5	0.0992
Uranium	ug/g	0.14	0.05	0.02	0.0992
Vanadium	ug/g	4.3	0.6	0.2	0.0992
Zinc	ug/g	380	60	5	0.0992
Lab Section 6					
Moisture	%	83.06	8	0.02	0.0992

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452
Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053179**
Date Sampled: **Sep 09, 2019**
Sample Matrix: **TISSUE**
Description: **09/09/2019 GH_ER1A_INV-3_2019-09-09**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	1700	200	50	0.1848
Antimony	ug/g	0.14	0.05	0.02	0.1848
Arsenic	ug/g	1.4	0.2	0.02	0.1848
Barium	ug/g	30	3	0.05	0.1848
Beryllium	ug/g	0.06	0.02	0.02	0.1848
Boron	ug/g	8	2	2	0.1848
Cadmium	ug/g	4.7	0.5	0.02	0.1848
Chromium	ug/g	3.3	0.5	0.1	0.1848
Cobalt	ug/g	1.9	0.3	0.02	0.1848
Copper	ug/g	19	2	0.1	0.1848
Iron	ug/g	1100	100	5	0.1848
Lead	ug/g	0.60	0.09	0.02	0.1848
Manganese	ug/g	110	10	0.2	0.1848
Mercury	ug/g	0.03	0.02	0.01	0.1848
Molybdenum	ug/g	0.54	0.1	0.05	0.1848
Nickel	ug/g	5.0	0.8	0.1	0.1848
Selenium	ug/g	6.8	0.7	0.02	0.1848
Silver	ug/g	0.16	0.05	0.02	0.1848
Strontium	ug/g	15	2	0.1	0.1848
Thallium	ug/g	0.05	0.02	0.01	0.1848
Tin	ug/g	<0.1		0.1	0.1848
Titanium	ug/g	11	2	0.5	0.1848
Uranium	ug/g	0.16	0.04	0.01	0.1848
Vanadium	ug/g	5.5	0.8	0.2	0.1848
Zinc	ug/g	330	30	1	0.1848
Lab Section 6					
Moisture	%	83.58	8	0.02	0.1848

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053180**	Client PO #:	**616225**
Date Sampled:	**Sep 08, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/08/2019 RG_ERSC5_INV-1_2019-09-08**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	3400	300	20	0.2847
Antimony	ug/g	0.19	0.05	0.01	0.2847
Arsenic	ug/g	1.8	0.2	0.01	0.2847
Barium	ug/g	38	4	0.02	0.2847
Beryllium	ug/g	0.14	0.04	0.01	0.2847
Boron	ug/g	8	1	1	0.2847
Cadmium	ug/g	6.0	0.6	0.01	0.2847
Chromium	ug/g	6.4	0.6	0.05	0.2847
Cobalt	ug/g	2.3	0.2	0.01	0.2847
Copper	ug/g	17	2	0.05	0.2847
Iron	ug/g	2400	200	20	0.2847
Lead	ug/g	1.5	0.2	0.01	0.2847
Manganese	ug/g	142	10	0.1	0.2847
Mercury	ug/g	0.033	0.01	0.005	0.2847
Molybdenum	ug/g	0.67	0.1	0.02	0.2847
Nickel	ug/g	7.6	0.8	0.05	0.2847
Selenium	ug/g	7.5	0.8	0.01	0.2847
Silver	ug/g	0.13	0.03	0.01	0.2847
Strontium	ug/g	39	4	0.05	0.2847
Thallium	ug/g	0.10	0.02	0.005	0.2847
Tin	ug/g	0.08	0.05	0.05	0.2847
Titanium	ug/g	21	2	0.2	0.2847
Uranium	ug/g	0.36	0.05	0.005	0.2847
Vanadium	ug/g	11	1	0.1	0.2847
Zinc	ug/g	170	20	0.5	0.2847
Lab Section 6					
Moisture	%	82.47	8	0.02	0.2847

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053181**	Client PO #:	**616225**
Date Sampled:	**Sep 08, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/08/2019 RG_ERSC5_INV-2_2019-09-08**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	3200	300	20	0.3645
Antimony	ug/g	0.14	0.04	0.01	0.3645
Arsenic	ug/g	1.9	0.2	0.01	0.3645
Barium	ug/g	39	4	0.02	0.3645
Beryllium	ug/g	0.13	0.03	0.01	0.3645
Boron	ug/g	7	1	1	0.3645
Cadmium	ug/g	5.6	0.6	0.01	0.3645
Chromium	ug/g	5.9	0.6	0.05	0.3645
Cobalt	ug/g	2.5	0.2	0.01	0.3645
Copper	ug/g	16	2	0.05	0.3645
Iron	ug/g	2500	200	20	0.3645
Lead	ug/g	1.4	0.1	0.01	0.3645
Manganese	ug/g	175	20	0.1	0.3645
Mercury	ug/g	0.039	0.01	0.005	0.3645
Molybdenum	ug/g	0.69	0.1	0.02	0.3645
Nickel	ug/g	9.3	0.9	0.05	0.3645
Selenium	ug/g	7.4	0.7	0.01	0.3645
Silver	ug/g	0.17	0.04	0.01	0.3645
Strontium	ug/g	33	3	0.05	0.3645
Thallium	ug/g	0.095	0.02	0.005	0.3645
Tin	ug/g	0.07	0.05	0.05	0.3645
Titanium	ug/g	18	3	0.2	0.3645
Uranium	ug/g	0.56	0.06	0.005	0.3645
Vanadium	ug/g	11	1	0.1	0.3645
Zinc	ug/g	220	20	0.5	0.3645
Lab Section 6					
Moisture	%	80.05	8	0.02	0.3645

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053182**
Date Sampled: **Sep 08, 2019**
Sample Matrix: **TISSUE**
Description: **09/08/2019 RG_ERSC5_INV-3_2019-09-08**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	4000	600	50	0.2189
Antimony	ug/g	0.16	0.05	0.02	0.2189
Arsenic	ug/g	2.6	0.3	0.02	0.2189
Barium	ug/g	44	4	0.05	0.2189
Beryllium	ug/g	0.20	0.05	0.02	0.2189
Boron	ug/g	8	2	2	0.2189
Cadmium	ug/g	8.6	0.9	0.02	0.2189
Chromium	ug/g	8.3	1	0.1	0.2189
Cobalt	ug/g	2.6	0.3	0.02	0.2189
Copper	ug/g	18	2	0.1	0.2189
Iron	ug/g	3300	500	50	0.2189
Lead	ug/g	1.8	0.3	0.02	0.2189
Manganese	ug/g	170	20	0.2	0.2189
Mercury	ug/g	0.06	0.02	0.01	0.2189
Molybdenum	ug/g	0.79	0.2	0.05	0.2189
Nickel	ug/g	8.8	1	0.1	0.2189
Selenium	ug/g	13	1	0.02	0.2189
Silver	ug/g	0.46	0.07	0.02	0.2189
Strontium	ug/g	38	4	0.1	0.2189
Thallium	ug/g	0.13	0.03	0.01	0.2189
Tin	ug/g	<0.1		0.1	0.2189
Titanium	ug/g	22	3	0.5	0.2189
Uranium	ug/g	0.46	0.07	0.01	0.2189
Vanadium	ug/g	15	2	0.2	0.2189
Zinc	ug/g	190	20	1	0.2189
Lab Section 6					
Moisture	%	78.72	8	0.02	0.2189

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053183**
Date Sampled: **Sep 12, 2019**
Sample Matrix: **TISSUE**
Description: **09/12/2019 RG_GH-SCW3_INV-1_2019-09-12**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	5000	500	50	0.1782
Antimony	ug/g	0.10	0.04	0.02	0.1782
Arsenic	ug/g	4.4	0.4	0.02	0.1782
Barium	ug/g	43	4	0.05	0.1782
Beryllium	ug/g	0.21	0.05	0.02	0.1782
Boron	ug/g	10	2	2	0.1782
Cadmium	ug/g	10	1	0.02	0.1782
Chromium	ug/g	9.1	1	0.1	0.1782
Cobalt	ug/g	2.0	0.2	0.02	0.1782
Copper	ug/g	16	2	0.1	0.1782
Iron	ug/g	3600	500	50	0.1782
Lead	ug/g	2.2	0.2	0.02	0.1782
Manganese	ug/g	97	10	0.2	0.1782
Mercury	ug/g	0.19	0.05	0.01	0.1782
Molybdenum	ug/g	1.1	0.2	0.05	0.1782
Nickel	ug/g	8.3	1	0.1	0.1782
Selenium	ug/g	55	6	0.2	0.1782
Silver	ug/g	1.5	0.2	0.02	0.1782
Strontium	ug/g	23	2	0.1	0.1782
Thallium	ug/g	0.17	0.04	0.01	0.1782
Tin	ug/g	<0.1		0.1	0.1782
Titanium	ug/g	28	4	0.5	0.1782
Uranium	ug/g	0.40	0.06	0.01	0.1782
Vanadium	ug/g	17	2	0.2	0.1782
Zinc	ug/g	170	20	1	0.1782
Lab Section 6					
Moisture	%	84.25	8	0.02	0.1782

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053184**
Date Sampled: **Sep 12, 2019**
Sample Matrix: **TISSUE**
Description: **09/12/2019 RG_GH-SCW3_INV-2_2019-09-12**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	5600	600	50	0.1203
Antimony	ug/g	0.18	0.06	0.02	0.1203
Arsenic	ug/g	2.3	0.2	0.02	0.1203
Barium	ug/g	52	5	0.05	0.1203
Beryllium	ug/g	0.24	0.06	0.02	0.1203
Boron	ug/g	12	2	2	0.1203
Cadmium	ug/g	3.3	0.3	0.02	0.1203
Chromium	ug/g	10	1	0.1	0.1203
Cobalt	ug/g	2.8	0.3	0.02	0.1203
Copper	ug/g	24	2	0.1	0.1203
Iron	ug/g	4100	600	50	0.1203
Lead	ug/g	2.5	0.2	0.02	0.1203
Manganese	ug/g	220	20	0.2	0.1203
Mercury	ug/g	0.06	0.02	0.01	0.1203
Molybdenum	ug/g	1.7	0.2	0.05	0.1203
Nickel	ug/g	14	1	0.1	0.1203
Selenium	ug/g	7.6	0.8	0.02	0.1203
Silver	ug/g	0.23	0.06	0.02	0.1203
Strontium	ug/g	26	3	0.1	0.1203
Thallium	ug/g	0.17	0.04	0.01	0.1203
Tin	ug/g	0.1	0.1	0.1	0.1203
Titanium	ug/g	30	4	0.5	0.1203
Uranium	ug/g	0.47	0.07	0.01	0.1203
Vanadium	ug/g	19	3	0.2	0.1203
Zinc	ug/g	130	10	1	0.1203
Lab Section 6					
Moisture	%	90.31	9	0.02	0.1203

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053185**
Date Sampled: **Sep 12, 2019**
Sample Matrix: **TISSUE**
Description: **09/12/2019 RG_GH-SCW3_INV-3_2019-09-12**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	5600	600	50	0.1772
Antimony	ug/g	0.17	0.06	0.02	0.1772
Arsenic	ug/g	2.8	0.3	0.02	0.1772
Barium	ug/g	52	5	0.05	0.1772
Beryllium	ug/g	0.23	0.06	0.02	0.1772
Boron	ug/g	11	2	2	0.1772
Cadmium	ug/g	6.3	0.6	0.02	0.1772
Chromium	ug/g	11	1	0.1	0.1772
Cobalt	ug/g	3.0	0.3	0.02	0.1772
Copper	ug/g	19	2	0.1	0.1772
Iron	ug/g	4200	600	50	0.1772
Lead	ug/g	2.4	0.2	0.02	0.1772
Manganese	ug/g	190	20	0.2	0.1772
Mercury	ug/g	0.04	0.02	0.01	0.1772
Molybdenum	ug/g	2.0	0.3	0.05	0.1772
Nickel	ug/g	12	1	0.1	0.1772
Selenium	ug/g	7.3	0.7	0.02	0.1772
Silver	ug/g	0.15	0.05	0.02	0.1772
Strontium	ug/g	31	3	0.1	0.1772
Thallium	ug/g	0.16	0.04	0.01	0.1772
Tin	ug/g	0.1	0.1	0.1	0.1772
Titanium	ug/g	28	4	0.5	0.1772
Uranium	ug/g	0.54	0.08	0.01	0.1772
Vanadium	ug/g	19	3	0.2	0.1772
Zinc	ug/g	160	20	1	0.1772
Lab Section 6					
Moisture	%	90.09	9	0.02	0.1772

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053186**
Date Sampled: **Sep 11, 2019**
Sample Matrix: **TISSUE**
Description: **09/11/2019 RG_SCDTC_INV-1_2019-09-11**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	**Units**	**Result**	**+/-**	**DL**	**Weight (g)**
Lab Section 2					
Aluminum	ug/g	2800	400	50	0.1035
Antimony	ug/g	0.22	0.06	0.02	0.1035
Arsenic	ug/g	2.0	0.2	0.02	0.1035
Barium	ug/g	28	3	0.05	0.1035
Beryllium	ug/g	0.10	0.02	0.02	0.1035
Boron	ug/g	5	2	2	0.1035
Cadmium	ug/g	7.5	0.8	0.02	0.1035
Chromium	ug/g	4.7	0.7	0.1	0.1035
Cobalt	ug/g	2.8	0.3	0.02	0.1035
Copper	ug/g	21	2	0.1	0.1035
Iron	ug/g	1700	200	5	0.1035
Lead	ug/g	1.4	0.2	0.02	0.1035
Manganese	ug/g	93	9	0.2	0.1035
Mercury	ug/g	0.03	0.02	0.01	0.1035
Molybdenum	ug/g	0.75	0.2	0.05	0.1035
Nickel	ug/g	6.6	1	0.1	0.1035
Selenium	ug/g	10	1	0.02	0.1035
Silver	ug/g	0.14	0.05	0.02	0.1035
Strontium	ug/g	15	2	0.1	0.1035
Thallium	ug/g	0.08	0.03	0.01	0.1035
Tin	ug/g	<0.1		0.1	0.1035
Titanium	ug/g	21	3	0.5	0.1035
Uranium	ug/g	0.17	0.04	0.01	0.1035
Vanadium	ug/g	9.1	1	0.2	0.1035
Zinc	ug/g	190	20	1	0.1035
Lab Section 6					
Moisture	%	87.42	9	0.02	0.1035

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053187**
Date Sampled: **Sep 11, 2019**
Sample Matrix: **TISSUE**
Description: **09/11/2019 RG_SCDTC_INV-2_2019-09-11**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	4000	600	50	0.1029
Antimony	ug/g	0.16	0.05	0.02	0.1029
Arsenic	ug/g	2.2	0.2	0.02	0.1029
Barium	ug/g	40	4	0.05	0.1029
Beryllium	ug/g	0.16	0.03	0.02	0.1029
Boron	ug/g	8	2	2	0.1029
Cadmium	ug/g	9.2	0.9	0.02	0.1029
Chromium	ug/g	6.7	1	0.1	0.1029
Cobalt	ug/g	2.7	0.3	0.02	0.1029
Copper	ug/g	19	2	0.1	0.1029
Iron	ug/g	2600	400	50	0.1029
Lead	ug/g	1.5	0.2	0.02	0.1029
Manganese	ug/g	93	9	0.2	0.1029
Mercury	ug/g	0.04	0.02	0.01	0.1029
Molybdenum	ug/g	0.79	0.2	0.05	0.1029
Nickel	ug/g	7.3	1	0.1	0.1029
Selenium	ug/g	9.6	1	0.02	0.1029
Silver	ug/g	0.14	0.05	0.02	0.1029
Strontium	ug/g	19	2	0.1	0.1029
Thallium	ug/g	0.11	0.03	0.01	0.1029
Tin	ug/g	<0.1		0.1	0.1029
Titanium	ug/g	26	4	0.5	0.1029
Uranium	ug/g	0.25	0.04	0.01	0.1029
Vanadium	ug/g	13	2	0.2	0.1029
Zinc	ug/g	200	20	1	0.1029
Lab Section 6					
Moisture	%	88.65	9	0.02	0.1029

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053188**
Date Sampled: **Sep 11, 2019**
Sample Matrix: **TISSUE**
Description: **09/11/2019 RG_SCDTC_INV-3_2019-09-11**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	6700	700	50	0.0926
Antimony	ug/g	0.22	0.06	0.02	0.0926
Arsenic	ug/g	2.9	0.4	0.05	0.0926
Barium	ug/g	63	6	0.5	0.0926
Beryllium	ug/g	0.30	0.08	0.02	0.0926
Boron	ug/g	12	5	5	0.0926
Cadmium	ug/g	6.8	0.7	0.02	0.0926
Chromium	ug/g	9.4	2	0.5	0.0926
Cobalt	ug/g	3.5	0.5	0.5	0.0926
Copper	ug/g	21	3	0.5	0.0926
Iron	ug/g	6700	700	50	0.0926
Lead	ug/g	3.5	0.5	0.05	0.0926
Manganese	ug/g	150	20	0.5	0.0926
Mercury	ug/g	0.06	0.02	0.01	0.0926
Molybdenum	ug/g	0.91	0.2	0.05	0.0926
Nickel	ug/g	11	2	0.5	0.0926
Selenium	ug/g	9.2	0.9	0.05	0.0926
Silver	ug/g	0.16	0.05	0.02	0.0926
Strontium	ug/g	23	2	0.1	0.0926
Thallium	ug/g	0.15	0.04	0.01	0.0926
Tin	ug/g	<0.2		0.2	0.0926
Titanium	ug/g	24	4	0.5	0.0926
Uranium	ug/g	0.29	0.07	0.02	0.0926
Vanadium	ug/g	18	3	0.2	0.0926
Zinc	ug/g	190	30	5	0.0926
Lab Section 6					
Moisture	%	80.51	8	0.02	0.0926

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053189**
Date Sampled: **Sep 08, 2019**
Sample Matrix: **TISSUE**
Description: **09/08/2019 GH_EL20_INV-1_2019-09-08**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	2300	200	20	0.283
Antimony	ug/g	0.09	0.03	0.01	0.283
Arsenic	ug/g	1.8	0.2	0.01	0.283
Barium	ug/g	28	3	0.02	0.283
Beryllium	ug/g	0.12	0.03	0.01	0.283
Boron	ug/g	5	1	1	0.283
Cadmium	ug/g	2.7	0.3	0.01	0.283
Chromium	ug/g	5.2	0.5	0.05	0.283
Cobalt	ug/g	2.1	0.2	0.01	0.283
Copper	ug/g	17	2	0.05	0.283
Iron	ug/g	2200	200	20	0.283
Lead	ug/g	1.1	0.1	0.01	0.283
Manganese	ug/g	114	10	0.1	0.283
Mercury	ug/g	0.020	0.01	0.005	0.283
Molybdenum	ug/g	0.68	0.1	0.02	0.283
Nickel	ug/g	5.2	0.5	0.05	0.283
Selenium	ug/g	5.4	0.5	0.01	0.283
Silver	ug/g	0.16	0.04	0.01	0.283
Strontium	ug/g	25	2	0.05	0.283
Thallium	ug/g	0.068	0.02	0.005	0.283
Tin	ug/g	0.05	0.05	0.05	0.283
Titanium	ug/g	13	2	0.2	0.283
Uranium	ug/g	0.27	0.04	0.005	0.283
Vanadium	ug/g	8.2	1	0.1	0.283
Zinc	ug/g	180	20	0.5	0.283
Lab Section 6					
Moisture	%	83.48	8	0.02	0.283

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053190**
Date Sampled: **Sep 08, 2019**
Sample Matrix: **TISSUE**
Description: **09/08/2019 GH_EL20_INV-2_2019-09-08**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	630	90	20	0.5061
Antimony	ug/g	0.03	0.02	0.01	0.5061
Arsenic	ug/g	0.90	0.1	0.01	0.5061
Barium	ug/g	9.5	1	0.02	0.5061
Beryllium	ug/g	0.02	0.01	0.01	0.5061
Boron	ug/g	<1		1	0.5061
Cadmium	ug/g	2.1	0.2	0.01	0.5061
Chromium	ug/g	1.3	0.2	0.05	0.5061
Cobalt	ug/g	1.5	0.2	0.01	0.5061
Copper	ug/g	22	2	0.05	0.5061
Iron	ug/g	440	40	2	0.5061
Lead	ug/g	0.22	0.03	0.01	0.5061
Manganese	ug/g	36	4	0.1	0.5061
Mercury	ug/g	0.021	0.01	0.005	0.5061
Molybdenum	ug/g	0.26	0.06	0.02	0.5061
Nickel	ug/g	1.9	0.3	0.05	0.5061
Selenium	ug/g	5.8	0.6	0.01	0.5061
Silver	ug/g	0.19	0.05	0.01	0.5061
Strontium	ug/g	13	1	0.05	0.5061
Thallium	ug/g	0.021	0.01	0.005	0.5061
Tin	ug/g	<0.05		0.05	0.5061
Titanium	ug/g	6.6	1	0.2	0.5061
Uranium	ug/g	0.064	0.02	0.005	0.5061
Vanadium	ug/g	2.1	0.3	0.1	0.5061
Zinc	ug/g	290	30	0.5	0.5061
Lab Section 6					
Moisture	%	77.30	8	0.02	0.5061

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053191**
Date Sampled: **Sep 08, 2019**
Sample Matrix: **TISSUE**
Description: **09/08/2019 GH_EL20_INV-3_2019-09-08**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	1300	200	20	0.3282
Antimony	ug/g	0.07	0.02	0.01	0.3282
Arsenic	ug/g	1.3	0.1	0.01	0.3282
Barium	ug/g	16	2	0.02	0.3282
Beryllium	ug/g	0.05	0.01	0.01	0.3282
Boron	ug/g	2	1	1	0.3282
Cadmium	ug/g	2.7	0.3	0.01	0.3282
Chromium	ug/g	2.6	0.4	0.05	0.3282
Cobalt	ug/g	1.8	0.2	0.01	0.3282
Copper	ug/g	19	2	0.05	0.3282
Iron	ug/g	860	100	20	0.3282
Lead	ug/g	0.47	0.07	0.01	0.3282
Manganese	ug/g	61	6	0.1	0.3282
Mercury	ug/g	0.022	0.01	0.005	0.3282
Molybdenum	ug/g	0.43	0.06	0.02	0.3282
Nickel	ug/g	3.2	0.5	0.05	0.3282
Selenium	ug/g	6.6	0.7	0.01	0.3282
Silver	ug/g	0.19	0.05	0.01	0.3282
Strontium	ug/g	14	1	0.05	0.3282
Thallium	ug/g	0.037	0.01	0.005	0.3282
Tin	ug/g	<0.05		0.05	0.3282
Titanium	ug/g	11	2	0.2	0.3282
Uranium	ug/g	0.18	0.03	0.005	0.3282
Vanadium	ug/g	4.2	0.6	0.1	0.3282
Zinc	ug/g	260	30	0.5	0.3282
Lab Section 6					
Moisture	%	83.54	8	0.02	0.3282

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019053192**	Client PO #:	**616225**
Date Sampled:	**Sep 08, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/08/2019 GH_EL20_INV-4_2019-09-08**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	1800	300	20	0.3889
Antimony	ug/g	0.04	0.02	0.01	0.3889
Arsenic	ug/g	0.88	0.1	0.01	0.3889
Barium	ug/g	19	2	0.02	0.3889
Beryllium	ug/g	0.07	0.01	0.01	0.3889
Boron	ug/g	3	1	1	0.3889
Cadmium	ug/g	1.8	0.2	0.01	0.3889
Chromium	ug/g	3.2	0.5	0.05	0.3889
Cobalt	ug/g	1.3	0.1	0.01	0.3889
Copper	ug/g	19	2	0.05	0.3889
Iron	ug/g	1100	200	20	0.3889
Lead	ug/g	0.57	0.08	0.01	0.3889
Manganese	ug/g	56	6	0.1	0.3889
Mercury	ug/g	0.024	0.01	0.005	0.3889
Molybdenum	ug/g	0.35	0.09	0.02	0.3889
Nickel	ug/g	2.9	0.4	0.05	0.3889
Selenium	ug/g	4.2	0.4	0.01	0.3889
Silver	ug/g	0.21	0.03	0.01	0.3889
Strontium	ug/g	16	2	0.05	0.3889
Thallium	ug/g	0.042	0.01	0.005	0.3889
Tin	ug/g	<0.05		0.05	0.3889
Titanium	ug/g	15	2	0.2	0.3889
Uranium	ug/g	0.13	0.02	0.005	0.3889
Vanadium	ug/g	5.5	0.8	0.1	0.3889
Zinc	ug/g	290	30	0.5	0.3889
Lab Section 6					
Moisture	%	81.84	8	0.02	0.3889

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019053193**
Date Sampled: **Sep 08, 2019**
Sample Matrix: **TISSUE**
Description: **09/08/2019 GH_EL20_INV-5_2019-09-08**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	2200	200	20	0.3432
Antimony	ug/g	0.09	0.03	0.01	0.3432
Arsenic	ug/g	1.7	0.2	0.01	0.3432
Barium	ug/g	24	2	0.02	0.3432
Beryllium	ug/g	0.09	0.02	0.01	0.3432
Boron	ug/g	4	1	1	0.3432
Cadmium	ug/g	3.8	0.4	0.01	0.3432
Chromium	ug/g	4.6	0.7	0.05	0.3432
Cobalt	ug/g	2.3	0.2	0.01	0.3432
Copper	ug/g	17	2	0.05	0.3432
Iron	ug/g	1800	300	20	0.3432
Lead	ug/g	0.78	0.1	0.01	0.3432
Manganese	ug/g	83	8	0.1	0.3432
Mercury	ug/g	0.020	0.01	0.005	0.3432
Molybdenum	ug/g	0.51	0.08	0.02	0.3432
Nickel	ug/g	4.3	0.6	0.05	0.3432
Selenium	ug/g	5.9	0.6	0.01	0.3432
Silver	ug/g	0.16	0.04	0.01	0.3432
Strontium	ug/g	24	2	0.05	0.3432
Thallium	ug/g	0.060	0.02	0.005	0.3432
Tin	ug/g	0.06	0.05	0.05	0.3432
Titanium	ug/g	17	2	0.2	0.3432
Uranium	ug/g	0.20	0.03	0.005	0.3432
Vanadium	ug/g	7.1	1	0.1	0.3432
Zinc	ug/g	210	20	0.5	0.3432
Lab Section 6					
Moisture	%	82.89	8	0.02	0.3432

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019056198**	Client PO #:	**616225**
Date Sampled:	**Sep 12, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/12/2019 RG_ERSC2_INV-1_2019-09-12**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	7000	700	50	0.214
Antimony	ug/g	0.10	0.04	0.02	0.214
Arsenic	ug/g	3.4	0.3	0.02	0.214
Barium	ug/g	53	5	0.05	0.214
Beryllium	ug/g	0.24	0.06	0.02	0.214
Boron	ug/g	12	2	2	0.214
Cadmium	ug/g	13	1	0.02	0.214
Chromium	ug/g	11	1	0.1	0.214
Cobalt	ug/g	2.8	0.3	0.02	0.214
Copper	ug/g	28	3	0.1	0.214
Iron	ug/g	4000	600	50	0.214
Lead	ug/g	2.3	0.2	0.02	0.214
Manganese	ug/g	120	10	0.2	0.214
Mercury	ug/g	0.06	0.02	0.01	0.214
Molybdenum	ug/g	0.78	0.2	0.05	0.214
Nickel	ug/g	7.8	1	0.1	0.214
Selenium	ug/g	12	1	0.02	0.214
Silver	ug/g	0.29	0.07	0.02	0.214
Strontium	ug/g	31	3	0.1	0.214
Thallium	ug/g	0.17	0.04	0.01	0.214
Tin	ug/g	0.1	0.1	0.1	0.214
Titanium	ug/g	46	7	0.5	0.214
Uranium	ug/g	0.41	0.06	0.01	0.214
Vanadium	ug/g	20	2	0.2	0.214
Zinc	ug/g	240	20	1	0.214
Lab Section 6					
Moisture	%	78.07	8	0.02	0.214

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #: **2019056199**
Date Sampled: **Sep 12, 2019**
Sample Matrix: **TISSUE**
Description: **09/12/2019 RG_ERSC2_INV-2_2019-09-12**

Client PO #: **616225**
Date Received: **Sep 19, 2019**

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	3200	500	50	0.1318
Antimony	ug/g	0.07	0.04	0.02	0.1318
Arsenic	ug/g	1.9	0.3	0.02	0.1318
Barium	ug/g	29	3	0.05	0.1318
Beryllium	ug/g	0.11	0.02	0.02	0.1318
Boron	ug/g	5	2	2	0.1318
Cadmium	ug/g	9.4	0.9	0.02	0.1318
Chromium	ug/g	5.7	0.8	0.1	0.1318
Cobalt	ug/g	2.2	0.2	0.02	0.1318
Copper	ug/g	33	3	0.1	0.1318
Iron	ug/g	2100	300	50	0.1318
Lead	ug/g	1.0	0.2	0.02	0.1318
Manganese	ug/g	68	7	0.2	0.1318
Mercury	ug/g	0.05	0.02	0.01	0.1318
Molybdenum	ug/g	0.57	0.1	0.05	0.1318
Nickel	ug/g	4.6	0.7	0.1	0.1318
Selenium	ug/g	8.1	0.8	0.02	0.1318
Silver	ug/g	0.13	0.05	0.02	0.1318
Strontium	ug/g	16	2	0.1	0.1318
Thallium	ug/g	0.09	0.03	0.01	0.1318
Tin	ug/g	<0.1		0.1	0.1318
Titanium	ug/g	29	4	0.5	0.1318
Uranium	ug/g	0.18	0.04	0.01	0.1318
Vanadium	ug/g	9.8	1	0.2	0.1318
Zinc	ug/g	200	20	1	0.1318
Lab Section 6					
Moisture	%	75.95	8	0.02	0.1318

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

SRC Group # 2019-13452

Oct 18, 2019

Minnow Environmental Inc.

Sample #:	**2019056200**	Client PO #:	**616225**
Date Sampled:	**Sep 12, 2019**	Date Received:	**Sep 19, 2019**
Sample Matrix:	**TISSUE**		
Description:	**09/12/2019 RG_ERSC2_INV-3_2019-09-12**		

Analyte	Units	Result	+/-	DL	Weight (g)
Lab Section 2					
Aluminum	ug/g	4100	600	50	0.1628
Antimony	ug/g	0.09	0.04	0.02	0.1628
Arsenic	ug/g	2.2	0.2	0.02	0.1628
Barium	ug/g	38	4	0.05	0.1628
Beryllium	ug/g	0.15	0.03	0.02	0.1628
Boron	ug/g	7	2	2	0.1628
Cadmium	ug/g	10	1	0.02	0.1628
Chromium	ug/g	7.3	1	0.1	0.1628
Cobalt	ug/g	2.9	0.3	0.02	0.1628
Copper	ug/g	28	3	0.1	0.1628
Iron	ug/g	2700	400	50	0.1628
Lead	ug/g	1.4	0.2	0.02	0.1628
Manganese	ug/g	94	9	0.2	0.1628
Mercury	ug/g	0.04	0.02	0.01	0.1628
Molybdenum	ug/g	0.58	0.1	0.05	0.1628
Nickel	ug/g	5.6	0.8	0.1	0.1628
Selenium	ug/g	7.4	0.7	0.02	0.1628
Silver	ug/g	0.12	0.05	0.02	0.1628
Strontium	ug/g	22	2	0.1	0.1628
Thallium	ug/g	0.11	0.03	0.01	0.1628
Tin	ug/g	<0.1		0.1	0.1628
Titanium	ug/g	27	4	0.5	0.1628
Uranium	ug/g	0.28	0.04	0.01	0.1628
Vanadium	ug/g	13	2	0.2	0.1628
Zinc	ug/g	250	20	1	0.1628
Lab Section 6					
Moisture	%	78.83	8	0.02	0.1628

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 3.5 °C upon receipt.

Results are reported on a dry basis.
Variability in detection limits due to sample size.
There was no sample remaining to perform rechecks due to limited sample weight submitted to the laboratory.

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Oct 18, 2019

This report was generated for samples included in SRC Group # 2019-13452

Quality Control Report

Jennifer Ings
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
Aluminum	ug/g	1340	1210
Aluminum	ug/g	1340	1320
Arsenic	ug/g	6.87	6.84
Arsenic	ug/g	6.87	7.37
Cadmium	ug/g	0.299	0.323
Cadmium	ug/g	0.299	0.302
Chromium	ug/g	1.57	1.48
Chromium	ug/g	1.57	1.55
Copper	ug/g	14.4	13.8
Copper	ug/g	14.4	14.1
Iron	ug/g	312	288
Iron	ug/g	312	313
Lead	ug/g	0.404	0.389
Lead	ug/g	0.404	0.390
Manganese	ug/g	2.70	2.53
Manganese	ug/g	2.70	2.73
Mercury	ug/g	0.364	0.328
Mercury	ug/g	0.364	0.340
Nickel	ug/g	1.20	1.15
Nickel	ug/g	1.20	1.18
Selenium	ug/g	3.74	3.64
Selenium	ug/g	3.74	3.76
Silver	ug/g	0.0245	0.0262
Silver	ug/g	0.0245	0.0255
Zinc	ug/g	47.8	43.5
Zinc	ug/g	47.8	45.7

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

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

Roxane Ortmann - Quality Assurance Supervisor

APPENDIX G

DATA COLLECTED CONCURRENT WITH SEPTEMBER BIOLOGICAL SAMPLES

DATA COLLECTED CONCURRENT WITH SEPTEMBER BIOLOGICAL SAMPLES

Field Data

Photo G.1: GH_ER2 benthic invertebrate sampling location, September 2017

Photo G.2: GH_ER2 benthic invertebrate sampling location, September 2018

Photo G.3: GH_ER2 benthic invertebrate sampling location, September 2019

Photo G.4: Looking downstream from RG_ERUS, May 2018

Photo G.5: Looking downstream from RG_ERUS, Sept 2018

Photo G.6: Looking downstream from RG_ERUS, June 2019

Photo G.7: Looking downstream from RG_ERUS, February 2020

Photo G.8: Looking upstream from RG_ERC, May 2018

Photo G.9: Looking upstream from RG_ERC, October 2018

Photo G.10: Looking upstream from RG_ERC, July 2019

Photo G.11: Looking upstream from RG_ERC, February 2020

Photo G.12: Looking upstream at GH_ERC, September 2017

Photo G.13: **Looking upstream at GH_ERC, September 2018**

Photo G.14: **GH_ERSC4 benthic invertebrate sampling location, September 2017**

Photo G.15: Looking upstream from GH_ERSC4 staff gauge, May 2018

Photo G.16: GH_ERSC4 benthic invertebrate sampling location, September 2018

Photo G.17: Looking upstream from GH_ERSC4 staff gauge, September 2018

Photo G.18: Looking upstream from GH_ERSC4 staff gauge, July 2019

Photo G.19: GH_ERSC4 benthic invertebrate sampling location, September 2019

Photo G.20: Cross section of GH_ERSC4 staff gauge, February 2020

Photo G.21: **GH_ER1A benthic invertebrate sampling location, September 2017**

Photo G.22: **Cross section at GH_ER1A staff gauge, August 2018**

Photo G.23: **GH_ER1A benthic invertebrate sampling location, September 2018**

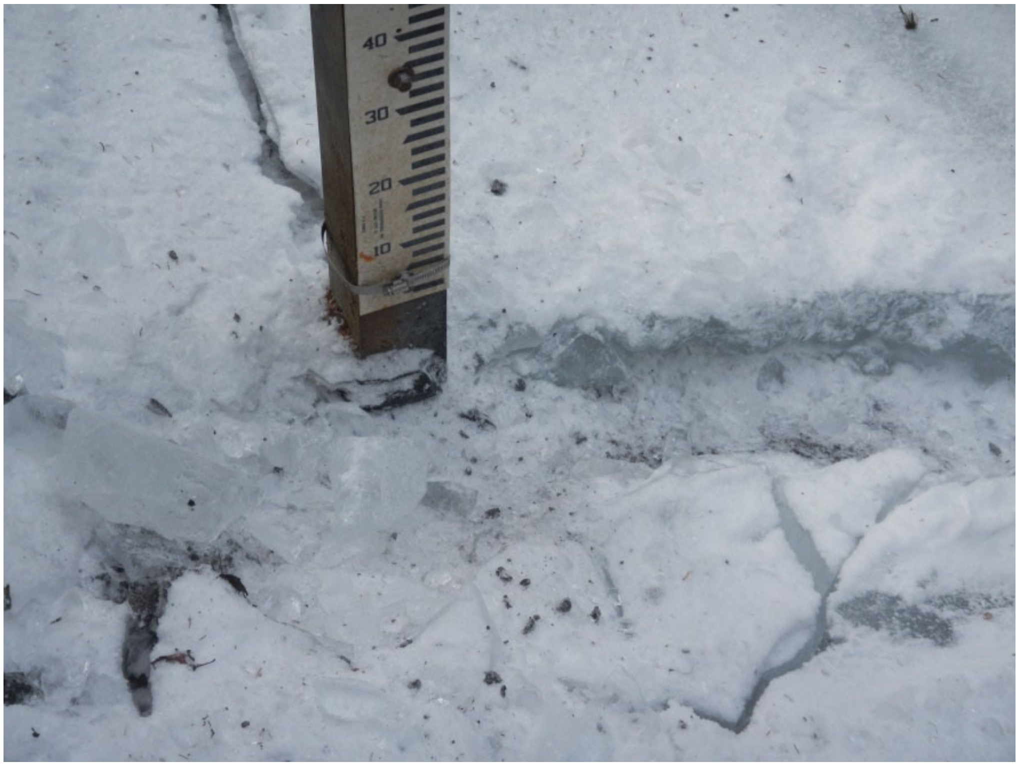

Photo G.24: Dewatered at GH_ER1A staff gauge, November 2018

Photo G.25: Cross section of GH_ER1A staff gauge, August 2019

Photo G.26: GH_ER1A benthic invertebrate sampling location, September 2019

Photo G.27: Looking downstream from GH_ER1A staff gauge (dewatered), February 2020

Photo G.28: GH_ERSC5 benthic invertebrate sampling location, September 2017

Photo G.29: GH_ERSC5 benthic invertebrate sampling location, September 2018

Photo G.30: **GH_ERSC5 benthic invertebrate sampling location, September 2019**

Photo G.31: **GH_ERSC5 benthic invertebrate sampling location, September 2019**

Photo G.32: RG_GH-SCW3, September 2017

Photo G.33: RG_GH-SCW3, September 2018

Photo G.34: RG_GH-SCW3, September 2018

Photo G.35: RG_GH-SCW3, September 2018

Photo G.36: RG_GH-SCW3, September 2019

Photo G.37: RG_GH-SCW3, September 2019

Photo G.38: **GH_ERSC2 benthic invertebrate sampling location, September 2017**

Photo G.39: **GH_ERSC2 (dewatered), September 2018**

Photo G.40: GH_ERSC2 benthic invertebrate sampling location, September 2019

Photo G.41: GH_ERSC2 benthic invertebrate sampling location, September 2019

Photo G.42: RG_SCDTC benthic invertebrate sampling location, September 2018

Photo G.43: RG_SCDTC benthic invertebrate sampling location, September 2019

Photo G.44: Looking downstream from RG_ERSCDS, May 2018

Photo G.45: Looking downstream from RG_ERSCDS, November 2018 (dewatered)

Photo G.46: Looking downstream from RG_ERSCDS, July 2019

Photo G.47: Looking downstream from RG_ERSCDS (dewatered), February 2020

Photo G.48: **GH_TC2 benthic invertebrate sampling location, September 2018**

Photo G.49: **GH_TC2 benthic invertebrate sampling location, September 2019**

Photo G.50: **GH_TC2 benthic invertebrate sampling location, September 2019**

Table G.1: Chemistry of Water Samples Collected Concurrent with Biological Samples, September 2019

	Analyte	Units	LDL	BC Water Quality Guidelines		Reference	Mine-exposed							
						GH_ER2 / EL20	GH_ERSC4	GH_ER1A	RG_ERSC5	GH_TC2 / RG_THCK	RG_GH_SCW3	GH_ERSC2	RG_SCDTC	GH_ERC / RG_ELUGH
				30-Day Average	Short-term Maximum	05-Sep-19	09-Sep-19	09-Sep-19	08-Sep-19	04-Sep-19	12-Sep-19	12-Sep-19	11-Sep-19	08-Sep-19
Physical Tests	Conductivity (@ 25°C)	µS/cm	2.0	-	-	275	289	322	324	1,620	520	427	440	315
	Hardness (as $CaCO_3$)	mg/L	0.50	-	-	146	158	174	169	1,070	339	237	246	164
	pH	pH	0.10	6.5 - 9.0		8.36	8.39	8.42	8.36	8.31	8.23	8.29	8.28	8.32
	ORP	mV	-1,000	-	-	296	415	441	264	277	458	345	347	338
	Total Suspended Solids	mg/L	1.0	-	-	<1.0	<1.0	<1.0	2.0	2.3	6.2	3.3	1.9	<1.0
	Total Dissolved Solids	mg/L	20	-	-	171	177	207	190	1,430	353	274	274	176
	Turbidity	NTU	0.10	-	-	0.36	0.22	0.37	0.62	0.98	1.23	0.72	0.39	0.44
Anions and Nutrients	Acidity (as $CaCO_3$)	mg/L	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Bicarbonate (as $CaCO_3$)	mg/L	1.0	-	-	135	138	139	141	165	146	146	148	144
	Alkalinity, Carbonate (as $CaCO_3$)	mg/L	1.0	-	-	3.0	3.8	3.8	2.8	2.6	<1.0	<1.0	<1.0	2.2
	Alkalinity, Hydroxide (as $CaCO_3$)	mg/L	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as $CaCO_3$)	mg/L	1.0	10 - 20 minimum		138	142	143	143	167	146	146	148	146
	Ammonia as N	mg/L	0.0050	2.4 - 8.3	0.46 - 1.6	0.0057	<0.0050	<0.0050	0.0061	0.0141	0.0056	<0.0050	0.0057	0.0057
	Bromide (Br)	mg/L	0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.25	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl)	mg/L	0.50	150	600	<0.50	<0.50	<0.50	<0.50	14.1	1.98	1.25	1.32	<0.50
	Fluoride (F)	mg/L	0.020	-	1.5 - 1.9[a]	0.163	0.164	0.160	0.170	<0.10	0.154	0.160	0.158	0.185
	Ion Balance	%	-100	-	-	94.1	98.3	98.1	96.5	100	121	102	103	96.8
	Nitrate (as N)	mg/L	0.0050	3.0	32.8	0.0416	0.111	0.694	0.613	12.9	1.90	1.22	1.34	0.291
	Nitrite (as N)	mg/L	0.0010	0.02 - 0.2	0.06 - 0.6	<0.0010	0.0015	0.0025	<0.0010	0.016	0.0026	0.0067	0.0012	0.0064
	Total Kjeldahl Nitrogen	mg/L	0.050	-	-	<0.050	<0.050	0.33	0.195	0.131	0.360	0.329	0.309	<0.050
	Orthophosphate-Dissolved (as P)	mg/L	0.0010	-	-	<0.0010	0.0010	<0.0010	0.0012	0.0011	0.0010	0.001	0.0014	0.0017
	Phosphorus (P)-Total	mg/L	0.0020	0.005 - 0.015[a]		<0.0020	<0.0020	<0.0020	<0.0020	0.0048	0.0033	0.0033	<0.0020	<0.0020
	Sulphate (SO_4)	mg/L	0.30	309 - 429[a]	-	17.5	19.8	32.9	30.8	826	124	79.7	84.7	22.6
	Anion Sum	meq/L	-	-	-	3.14	3.26	3.60	3.56	21.9	5.69	4.70	4.87	3.42
	Cation Sum	meq/L	-	-	-	2.96	3.20	3.53	3.43	22	6.91	4.82	5.01	3.32
	Cation - Anion Balance	%	-	-	-	-3	-0.9	-1.0	-1.8	0.2	9.7	1.2	1.5	-1.6
Organic / Inorganic Carbon	Dissolved Organic Carbon	mg/L	0.50	-	-	<0.50	<0.50	<0.50	0.85	2.92	0.65	0.65	0.56	0.65
	Total Organic Carbon	mg/L	0.50	-	-	0.53	0.67	0.81	0.83	3.06	0.70	0.67	0.68	0.65
Total Metals	Aluminum (Al)	mg/L	0.0030	-	-	0.0073	0.0127	0.0101	0.0103	0.0295	0.0386	0.0274	0.0105	0.0077
	Antimony (Sb)	mg/L	0.00010	0.009	-	<0.00010	<0.00010	<0.00010	<0.00010	0.00017	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)	mg/L	0.00010	-	0.005	0.00016	0.00010	0.00011	0.00011	0.00021	0.00018	0.00013	0.00012	0.00011
	Barium (Ba)	mg/L	0.00010	1.0	-	0.0405	0.0458	0.0487	0.0459	0.0644	0.0524	0.0510	0.0481	0.0504
	Beryllium (Be)	µg/L	0.020	0.13	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
	Bismuth (Bi)	mg/L	0.00005	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	0.010	1.2	-	<0.010	<0.010	<0.010	<0.010	0.027	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)	µg/L	0.0050	-	-	0.0124	0.0076	0.0095	0.0075	0.0186	0.016	0.013	0.013	0.0090
	Calcium (Ca)	mg/L	0.050	-	-	43.6	45.0	49.1	47.9	203	79.0	56.8	56.3	45.2
	Chromium (Cr)	mg/L	0.00010	-	-	0.00019	0.00020	0.00020	0.00018	<0.00010	0.00028	0.00025	0.00022	0.00019
	Cobalt (Co)	µg/L	0.10	4.0	110	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Copper (Cu)	mg/L	0.00050	0.006 - 0.01[a]	0.016 - 0.04[a]	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Iron (Fe)	mg/L	0.010	-	1.0	0.011	0.015	0.016	0.015	0.037	0.064	0.043	0.016	0.011
	Lead (Pb)	mg/L	0.000050	0.009 - 0.02[a]	0.13 - 0.42[a]	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000058	<0.000050	<0.000050	<0.000050
	Lithium (Li)	mg/L	0.0010	-	-	0.0018	0.0024	0.0038	0.0036	0.0235	0.0071	0.0047	0.0051	0.0024
	Magnesium (Mg)	mg/L	0.10	-	-	9.97	10.4	13.1	13.5	133	34.1	20.8	21.1	12.1
	Manganese (Mn)	mg/L	0.00010	1.3 - 2.6[a]	2.2 - 3.4[a]	0.00143	0.0020	0.0021	0.00154	0.00346	0.00371	0.00285	0.00118	0.00135
	Mercury (Hg)	µg/L	0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Molybdenum (Mo)	mg/L	0.000050	0.073	-	0.00110	0.0010	0.0010	0.00108	0.00130	0.0012	0.0011	0.0011	0.00102

Table G.1: Chemistry of Water Samples Collected Concurrent with Biological Samples, September 2019

	Analyte	Units	LDL	BC Water Quality Guidelines		Reference	Mine-exposed							
						GH_ER2 / EL20	GH_ERSC4	GH_ER1A	RG_ERSC5	GH_TC2 / RG_THCK	RG_GH_SCW3	GH_ERSC2	RG_SCDTC	GH_ERC / RG_ELUGH
				30-Day Average	Short-term Maximum	05-Sep-19	09-Sep-19	09-Sep-19	08-Sep-19	04-Sep-19	12-Sep-19	12-Sep-19	11-Sep-19	08-Sep-19
Total Metals	Nickel (Ni)	mg/L	0.00050	0.13 - 0.15[a]	-	<0.00050	<0.00050	<0.00050	<0.00050	0.00103	0.00066	0.00053	0.00055	<0.00050
	Potassium (K)	mg/L	0.050	-	-	0.332	0.380	0.440	0.425	1.82	0.688	0.533	0.533	0.378
	Selenium (Se)	µg/L	0.050	-	2.0	0.745	0.838	2.07	2.05	128	22.0	9.48	9.99	1.23
	Silicon (Si)	mg/L	0.10	-	-	1.75	1.82	1.84	1.77	3.41	2.14	1.92	1.90	1.93
	Silver (Ag)	mg/L	0.000010	0.0015	0.003	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)	mg/L	0.050	-	-	0.653	0.692	1.03	0.984	10.9	2.61	1.49	1.51	0.775
	Strontium (Sr)	mg/L	0.00020	-	-	0.221	0.192	0.218	0.227	0.484	0.279	0.241	0.240	0.217
	Thallium (Tl)	mg/L	0.000010	0.0008	-	<0.000010	<0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)	mg/L	0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)	mg/L	0.000010	0.0085	-	0.000649	0.000730	0.00086	0.000785	0.00479	0.00142	0.00098	0.00102	0.000687
	Vanadium (V)	mg/L	0.00050	-	-	0.00055	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)	mg/L	0.0030	0.05 - 0.19[a]	0.08 - 0.34[a]	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0035	<0.0030
Dissolved Metals	Aluminum (Al)	mg/L	0.0030	0.05	0.10	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
	Antimony (Sb)	mg/L	0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	0.00015	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)	mg/L	0.0001	-	-	<0.00010	0.00012	0.00011	0.00011	0.00021	0.00013	0.00012	0.00011	0.00011
	Barium (Ba)	mg/L	0.000100	-	-	0.0404	0.0442	0.0473	0.0471	0.0667	0.0508	0.0486	0.0480	0.0530
	Beryllium (Be)	µg/L	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
	Bismuth (Bi)	mg/L	0.000050	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)	mg/L	0.010	-	-	<0.010	<0.010	<0.010	<0.010	0.025	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)	µg/L	0.0050	0.28 - 0.46[a]	0.9 - 2.8[a]	0.0052	0.0066	0.0089	0.0088	0.0121	0.0090	0.0072	0.0065	0.0067
	Calcium (Ca)	mg/L	0.050	-	-	43.0	44.4	46.9	46.3	224	80.2	61.0	63.2	46.0
	Chromium (Cr)	mg/L	0.00010	-	-	0.00017	0.00020	0.00019	0.00019	<0.00010	0.00014	0.00020	0.00018	0.00018
	Cobalt (Co)	µg/L	0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Copper (Cu)	mg/L	0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Iron (Fe)	mg/L	0.010	-	0.35	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Lead (Pb)	mg/L	0.000050	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)	mg/L	0.0010	-	-	0.0016	0.0023	0.0038	0.0038	0.0220	0.0073	0.0050	0.0055	0.0027
	Magnesium (Mg)	mg/L	0.10	-	-	9.46	11.5	13.7	13.0	124	33.6	20.5	21.5	11.9
	Manganese (Mn)	mg/L	0.00010	-	-	0.00025	0.00057	0.00023	0.00025	0.00034	0.00111	0.00086	0.00026	0.00031
	Mercury (Hg)	mg/L	0.0000050	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)	mg/L	0.000050	-	-	0.00108	0.00106	0.00105	0.00111	0.00131	0.00122	0.00113	0.00117	0.00109
	Nickel (Ni)	mg/L	0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	0.0009	0.00053	<0.00050	<0.00050	<0.00050
	Potassium (K)	mg/L	0.050	-	-	0.332	0.380	0.439	0.419	1.85	0.725	0.563	0.575	0.389
	Selenium (Se)	µg/L	0.050	-	-	0.710	0.991	2.45	2.56	126	22.8	10.2	10.6	1.61
	Silicon (Si)	mg/L	0.050	-	-	1.62	1.83	1.86	1.85	2.97	2.12	2.00	1.97	2.00
	Silver (Ag)	mg/L	0.000010	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)	mg/L	0.050	-	-	0.593	0.731	1.08	1.02	12.1	2.90	1.68	1.77	0.809
	Strontium (Sr)	mg/L	0.00020	-	-	0.214	0.206	0.216	0.231	0.523	0.278	0.248	0.251	0.213
	Thallium (Tl)	mg/L	0.000010	-	-	<0.000010	<0.000010	<0.000010	<0.000010	0.000014	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)	mg/L	0.00010	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)	mg/L	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)	mg/L	0.000010	-	-	0.000618	0.000754	0.000854	0.000816	0.00449	0.00158	0.00112	0.00113	0.000736
	Vanadium (V)	mg/L	0.00050	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)	mg/L	0.0010	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010

▨ Value > 30-day average chronic guideline.

🟦 Value > short-term maximum guideline.

Table G.2: ***In Situ*** **Water Quality at Biological Monitoring Areas, GHO LAEMP, September 2019**

Field Parameters		Date	Station	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Specific Conductivity (µS/cm)	Conductivity (µS/cm)	pH
Reference	GH_ER2 / ELUGH	5-Sep-19	Station 1	8.47	11.52	98.4	269	-	7.70
			Station 2	8.88	11.58	99.4	273	190	7.40
			Station 3	9.26	11.39	99.5	277	196	7.26
Mine-exposed	GH_ERSC4	10-Sep-19	Station 1	8.51	-	-	203	297	7.66
			Station 2	8.58	-	-	206	299	7.85
			Station 3	8.59	-	-	200	291	7.85
	GH_ER1A	9-Sep-19	Station 1	9.46	-	-	-	-	8.25
			Station 2	9.49	-	-	-	-	8.20
			Station 3	9.61	-	-	-	-	8.37
	RG_ERSC5	8-Sep-19	Station 1	8.75	11.58	99.4	387	264	8.63
			Station 2	9.62	11.18	98.2	387	274	-
			Station 3	9.99	10.98	97.3	388	277	-
	GH_TC2 / THCK	4-Sep-19	Station 1	15.78	8.11	82.2	1,673	1,379	7.68
			Station 2	15.88	9.14	89.9	1,675	1,383	7.71
			Station 3	15.92	8.49	86.4	1,676	1,385	7.72
	RG_GH-SCW3	12-Sep-19	Station 1	-	-	-	-	-	-
			Station 2	-	-	-	-	-	-
			Station 3	-	-	-	-	-	-
	GH_ERSC2	12-Sep-19	Station 1	-	-	-	-	-	-
			Station 2	-	-	-	-	-	-
			Station 3	-	-	-	-	-	-
	RG_SCDTC	11-Sep-19	Station 1	8.83	-	-	-	-	-
			Station 2	8.73	-	-	-	-	-
			Station 3	8.62	-	-	-	-	-
	GH_ERC / EL20	8-Sep-19	Station 1	8.90	9.84	99.2	332	230	8.28
			Station 2	9.30	9.98	101.4	332	233	8.29
			Station 3	-	-	-	-	-	-
			Station 4	-	-	-	-	-	-
			Station 5	-	-	-	-	-	-

Note: "-" data not collected due to malfunctioning YSI.

Table G.3: Chemistry of Sediment Samples Collected Concurrent with Biological Samples, September 2019

Analyte		Units	LRL	BC Sediment Quality Guidelines		Reference									
						RG_GH-ER2 / EL20									
				Lower SQG	Upper SQG	GH_ER2-1	GH_ER2-2	GH_ER2-3	GH_ER2-4	GH_ER2-5	Minimum	Median	Maximum	Mean	Standard Deviation
						08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19	08-Sep-19					
Physical Tests	Moisture	%	0.25	-	-	53.2	34.4	34.0	49.0	57.7	34.0	49.0	57.7	45.7	10.9
	pH(1:2 Soil:Water)	pH	0.10	-	-	7.60	7.74	7.86	7.93	7.56	7.56	7.74	7.93	7.74	0.160
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	7.8	<1.0	<1.0	1.30	<1.00	<1.00	7.80	2.42	3.68
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	3.5	<1.0	<1.0	<1.0	<1.00	<1.00	3.50	1.50	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	1.3	5.2	<1.0	<1.0	<1.0	<1.00	<1.00	5.20	1.90	2.21
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	8.1	14.4	<1.0	<1.0	2.5	<1.00	2.50	14.4	5.40	5.79
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	12.3	15.4	7.7	7.8	9.1	7.70	9.10	15.4	10.5	3.33
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	17.0	17.5	44.5	43.8	21.5	17.0	21.5	44.5	28.9	14.1
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	25.2	15.6	24.8	24.7	27.9	15.6	24.8	27.9	23.6	4.68
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	29.8	16.7	18.4	19.0	30.4	16.7	19.0	30.4	22.9	6.67
	% Clay (<4 µm)	%	1.0	-	-	6.1	3.9	3.8	3.8	5.4	3.80	3.90	6.10	4.60	1.08
	Texture	-	-	-	-	Silt loam	Sandy loam	Sandy loam	Sandy loam	Silt loam	-	-	-	-	-
	Total Organic Carbon	%	0.050	-	-	6.95	3.50	2.06	1.93	4.57	1.93	3.50	6.95	3.80	2.07
Metals	Aluminum (Al)	mg/kg	50	-	-	6,630	6,620	4,980	6,130	7,190	4,980	6,620	7,190	6,310	833
	Antimony (Sb)	mg/kg	0.10	-	-	0.46	0.47	0.37	0.40	0.47	0.370	0.460	0.470	0.434	0.0462
	Arsenic (As)	mg/kg	0.10	5.9	17	5.48	5.97	4.68	5.33	5.97	4.68	5.48	5.97	5.49	0.534
	Barium (Ba)	mg/kg	0.50	-	-	141	140	121	137	161	121	140	161	140	14.2
	Beryllium (Be)	mg/kg	0.10	-	-	0.55	0.56	0.41	0.49	0.60	0.410	0.550	0.600	0.522	0.0740
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.200	<0.200	<0.200	<0.200	-
	Boron (B)	mg/kg	5.0	-	-	8.0	7.3	5.0	5.9	8.4	5.00	7.30	8.40	6.92	1.43
	Cadmium (Cd)	mg/kg	0.020	0.60	3.5	0.913	0.866	0.598	0.701	0.966	0.598	0.866	0.966	0.809	0.154
	Calcium (Ca)	mg/kg	50	-	-	69,700	87,800	56,200	62,700	62,900	56,200	62,900	87,800	67,900	12,100
	Chromium (Cr)	mg/kg	0.50	37	90	17.5	17.9	12.7	15.1	18.2	12.7	17.5	18.2	16.3	2.35
	Cobalt (Co)	mg/kg	0.10	-	-	4.04	4.02	3.31	3.84	4.50	3.31	4.02	4.50	3.94	0.429
	Copper (Cu)	mg/kg	0.50	36	197	12.8	12.0	8.4	9.4	13.1	8.39	12.0	13.1	11.1	2.12
	Iron (Fe)	mg/kg	50	21,200	43,766	11,900	13,400	10,300	11,700	13,100	10,300	11,900	13,400	12,100	1,240
	Lead (Pb)	mg/kg	0.50	35	91	6.88	6.80	5.71	6.50	7.40	5.71	6.80	7.40	6.66	0.621
	Lithium (Li)	mg/kg	2.0	-	-	9.8	9.9	8.2	9.3	11.2	8.20	9.80	11.2	9.68	1.08
	Magnesium (Mg)	mg/kg	20	-	-	15,400	18,400	16,100	17,600	15,800	15,400	16,100	18,400	16,700	1,280
	Manganese (Mn)	mg/kg	1.0	460	1,100	383	434	402	464	591	383	434	591	455	82.2
	Mercury (Hg)	mg/kg	0.0050	0.17	0.49	0.0285	0.0236	0.0204	0.0223	0.0364	0.0204	0.0236	0.0364	0.0262	0.00642
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.17	1.25	1.03	1.17	1.32	1.03	1.17	1.32	1.19	0.108
	Nickel (Ni)	mg/kg	0.50	16	75	19.5	19.5	15.1	17.3	21.7	15.1	19.5	21.7	18.6	2.51
	Phosphorus (P)	mg/kg	50	-	-	1,390	1,600	1,320	1,460	1,360	1,320	1,390	1,600	1,430	110
	Potassium (K)	mg/kg	100	-	-	1,510	1,440	1,000	1,240	1,570	1,000	1,440	1,570	1,350	233
	Selenium (Se)	mg/kg	0.20	2.0	-	1.15	0.97	0.50	0.63	1.11	0.500	0.970	1.15	0.872	0.292
	Silver (Ag)	mg/kg	0.10	0.50	-	0.19	0.17	0.13	0.14	0.20	0.130	0.170	0.200	0.166	0.0305
	Sodium (Na)	mg/kg	50	-	-	95	111	84	94	92	84.0	94.0	111	95.2	9.83
	Strontium (Sr)	mg/kg	0.50	-	-	103	123	77.1	85.4	100	77.1	99.5	123	97.6	17.7
	Sulfur (S)	mg/kg	1,000	-	-	<1,000	<1,000	<1,000	<1,000	<1,000	-	-	-	-	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.196	0.191	0.146	0.167	0.206	0.146	0.191	0.206	0.181	0.0243
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.00	<2.00	<2.00	<2.00	-
	Titanium (Ti)	mg/kg	1.0	-	-	14.3	15.7	11.7	10.7	13.1	10.7	13.1	15.7	13.1	1.99
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.500	<0.500	<0.500	<0.500	-
	Uranium (U)	mg/kg	0.050	-	-	1.15	1.22	0.862	0.964	1.09	0.862	1.09	1.22	1.06	0.144
	Vanadium (V)	mg/kg	0.20	-	-	30.7	30.7	22.7	27.1	31.3	22.7	30.7	31.3	28.5	3.64
	Zinc (Zn)	mg/kg	2.0	123	315	81.3	84.2	66.7	75.6	89.8	66.7	81.3	89.8	79.5	8.81
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.00	<1.00	<1.00	<1.00	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.0067	0.089	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acenaphthylene	mg/kg	0.0050	0.0059	0.13	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acridine	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Anthracene	mg/kg	0.0040	0.047	0.25	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.00400	<0.00400	<0.00400	<0.00400	-
	Benz(a)anthracene	mg/kg	0.010	0.032	0.39	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(a)pyrene	mg/kg	0.010	0.032	0.78	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(b+j+k)fluoranthene	mg/kg	0.015	-	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.0150	<0.0150	<0.0150	<0.0150	-
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Chrysene	mg/kg	0.010	0.057	0.86	0.028	0.011	0.011	0.014	0.026	0.0110	0.0140	0.0280	0.0180	0.00834
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.0062	0.14	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Fluoranthene	mg/kg	0.010	0.11	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Fluorene	mg/kg	0.010	0.021	0.14	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.20	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.072	0.017	0.021	0.030	0.065	0.0170	0.0300	0.0720	0.0410	0.0257
	2-Methylnaphthalene	mg/kg	0.010	0.020	0.20	0.093	0.023	0.027	0.037	0.082	0.0230	0.0370	0.0930	0.0524	0.0327
	Naphthalene	mg/kg	0.010	0.035	0.39	0.048	0.010	0.011	0.016	0.037	0.0100	0.0160	0.0480	0.0244	0.0171
	Perylene	mg/kg	0.010	-	-	0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	0.0100	0.0100	-
	Phenanthrene	mg/kg	0.010	0.042	0.52	0.107	0.029	0.038	0.050	0.100	0.0290	0.0500	0.107	0.0648	0.0362
	Pyrene	mg/kg	0.010	0.053	0.88	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	d10-Acenaphthene	%	-	-	-	77.4	72.6	66.9	69.9	64.4	64.4	69.9	77.4	70.2	5.05
	d12-Chrysene	%	-	-	-	89.0	86.5	86.3	88.1	91.7	86.3	88.1	91.7	88.3	2.20
	d8-Naphthalene	%	-	-	-	68.6	63.9	58.7	64.1	57.7	57.7	63.9	68.6	62.6	4.45
	d10-Phenanthrene	%	-	-	-	84.6	82.4	78.9	79.5	82.0	78.9	82.0	84.6	81.5	2.31
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0200	<0.0200	<0.0200	<0.0200	-
	IACR (CCME)	mg/kg	0.15	-	-	<0.15	<0.15	<0.15	<0.15	<0.15	<0.150	<0.150	<0.150	<0.150	-

▨ Value > Lower SQG.

🟦 Value > Upper SQG.

Notes: All summary stats calculated to 3 significant figures, "-" indicates no guideline or no data.

Table G.3: Chemistry of Sediment Samples Collected Concurrent with Biological Samples, September 2019

Analyte		Units	LRL	BC Sediment Quality Guidelines		Mine-exposed									
						RG_GH-SCW3									
				Lower SQG	Upper SQG	RG_GH-SCW3-1	RG_GH-SCW3-2	RG_GH-SCW3-3	RG_GH-SCW3-4	RG_GH-SCW3-5	Minimum	Median	Maximum	Mean	Standard Deviation
						12-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19	12-Sep-19					
Physical Tests	Moisture	%	0.25	-	-	45.3	54.1	51.1	40.0	29.8	29.8	45.3	54.1	44.1	9.64
	pH(1:2 Soil:Water)	pH	0.10	-	-	7.52	7.56	7.55	7.84	7.83	7.52	7.56	7.84	7.66	0.160
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	2.9	<1.0	<1.0	<1.0	1.90	<1.00	<1.00	2.90	1.56	0.566
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.00	<1.00	<1.00	<1.00	-
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	1.5	2.2	1.4	<1.0	<1.0	<1.00	1.40	2.20	1.42	0.383
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	7.3	5.3	5.0	<1.0	1.3	<1.00	5.00	7.30	3.98	2.74
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	16.0	10.0	11.5	9.2	7.5	7.50	10.0	16.0	10.8	3.23
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	20.0	17.8	18.6	29.8	34.4	17.8	20.0	34.4	24.1	7.51
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	21.5	26.2	25.1	26.4	25.8	21.5	25.8	26.4	25.0	2.02
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	24.7	31.4	30.4	27.9	23.7	23.7	27.9	31.4	27.6	3.39
	% Clay (<4 µm)	%	1.0	-	-	5.7	7.0	7.9	6.0	4.5	4.50	6.00	7.90	6.22	1.29
	Texture	-	-	-	-	Sandy loam	Silt loam	Silt loam	Silt loam	Sandy loam	-	-	-	-	-
	Total Organic Carbon	%	0.050	-	-	3.97	5.08	5.06	3.34	3.17	3.17	3.97	5.08	4.12	0.914
Metals	Aluminum (Al)	mg/kg	50	-	-	7,930	8,880	7,050	7,330	6,270	6,270	7,330	8,880	7,490	979
	Antimony (Sb)	mg/kg	0.10	-	-	0.54	0.58	0.44	0.40	0.36	0.360	0.440	0.580	0.464	0.0932
	Arsenic (As)	mg/kg	0.10	5.9	17	6.88	6.40	5.29	4.94	4.45	4.45	5.29	6.88	5.59	1.02
	Barium (Ba)	mg/kg	0.50	-	-	155	170	136	134	121	121	136	170	143	19.3
	Beryllium (Be)	mg/kg	0.10	-	-	0.63	0.68	0.56	0.53	0.45	0.450	0.560	0.680	0.570	0.0892
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.200	<0.200	<0.200	<0.200	-
	Boron (B)	mg/kg	5.0	-	-	8.0	10.7	8.4	8.7	7.6	7.60	8.40	10.7	8.68	1.20
	Cadmium (Cd)	mg/kg	0.020	0.60	3.5	1.06	1.14	0.849	0.758	0.655	0.655	0.849	1.14	0.892	0.204
	Calcium (Ca)	mg/kg	50	-	-	69,500	65,500	52,100	54,700	51,100	51,100	54,700	69,500	58,600	8,370
	Chromium (Cr)	mg/kg	0.50	37	90	19.2	20.9	16.3	16.7	14.5	14.5	16.7	20.9	17.5	2.53
	Cobalt (Co)	mg/kg	0.10	-	-	5.00	4.97	3.89	3.69	3.17	3.17	3.89	5.00	4.14	0.812
	Copper (Cu)	mg/kg	0.50	36	197	14.3	14.9	11.6	10.2	8.57	8.57	11.6	14.9	11.9	2.68
	Iron (Fe)	mg/kg	50	21,200	43,766	15,300	14,800	12,000	11,200	10,100	10,100	12,000	15,300	12,700	2,270
	Lead (Pb)	mg/kg	0.50	35	91	8.68	8.78	6.87	6.43	5.77	5.77	6.87	8.78	7.31	1.36
	Lithium (Li)	mg/kg	2.0	-	-	12.4	13.0	10.4	10.5	9.1	9.10	10.5	13.0	11.1	1.59
	Magnesium (Mg)	mg/kg	20	-	-	19,100	15,900	13,200	15,000	14,600	13,200	15,000	19,100	15,600	2,210
	Manganese (Mn)	mg/kg	1.0	460	1,100	443	486	382	419	321	321	419	486	410	62.6
	Mercury (Hg)	mg/kg	0.0050	0.17	0.49	0.0377	0.0449	0.0397	0.0345	0.0248	0.0248	0.0377	0.0449	0.0363	0.00747
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.33	1.36	1.06	1.04	0.91	0.910	1.06	1.36	1.14	0.196
	Nickel (Ni)	mg/kg	0.50	16	75	23.5	24.2	18.6	17.4	14.8	14.8	18.6	24.2	19.7	4.04
	Phosphorus (P)	mg/kg	50	-	-	1,670	1,470	1,170	1,240	1,210	1,170	1,240	1,670	1,350	213
	Potassium (K)	mg/kg	100	-	-	1,720	2,120	1,570	1,680	1,400	1,400	1,680	2,120	1,700	266
	Selenium (Se)	mg/kg	0.20	2.0	-	2.64	1.70	1.19	0.97	0.99	0.970	1.19	2.64	1.50	0.703
	Silver (Ag)	mg/kg	0.10	0.50	-	0.22	0.25	0.19	0.17	0.14	0.140	0.190	0.250	0.194	0.0428
	Sodium (Na)	mg/kg	50	-	-	117	97	82	88	82	82.0	88.0	117	93.2	14.7
	Strontium (Sr)	mg/kg	0.50	-	-	98	111	83.5	84.4	73.1	73.1	84.4	111	89.9	14.6
	Sulfur (S)	mg/kg	1,000	-	-	<1,000	<1,000	<1,000	<1,000	<1,000	-	-	-	-	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.217	0.256	0.194	0.180	0.158	0.158	0.194	0.256	0.201	0.0375
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.00	<2.00	<2.00	<2.00	-
	Titanium (Ti)	mg/kg	1.0	-	-	13.8	14.7	13.3	13.9	12.4	12.4	13.8	14.7	13.6	0.847
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.500	<0.500	<0.500	<0.500	-
	Uranium (U)	mg/kg	0.050	-	-	1.31	1.30	0.984	0.949	0.893	0.893	0.984	1.31	1.09	0.201
	Vanadium (V)	mg/kg	0.20	-	-	36	37	30	31	26	26.3	30.5	37.4	31.9	4.52
	Zinc (Zn)	mg/kg	2.0	123	315	105	101	79.5	75.5	65.7	65.7	79.5	105	85.3	16.9
	Zirconium (Zr)	mg/kg	1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.00	<1.00	<1.00	<1.00	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.0067	0.089	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acenaphthylene	mg/kg	0.0050	0.0059	0.13	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acridine	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Anthracene	mg/kg	0.0040	0.047	0.25	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.00400	<0.00400	<0.00400	<0.00400	-
	Benz(a)anthracene	mg/kg	0.010	0.032	0.39	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(a)pyrene	mg/kg	0.010	0.032	0.78	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(b+j+k)fluoranthene	mg/kg	0.015	-	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.0150	<0.0150	<0.0150	<0.0150	-
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Chrysene	mg/kg	0.010	0.057	0.86	0.016	0.018	0.021	0.015	0.019	0.0150	0.0180	0.0210	0.0178	0.00239
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.0062	0.14	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Fluoranthene	mg/kg	0.010	0.11	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Fluorene	mg/kg	0.010	0.021	0.14	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.20	3.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.033	0.038	0.051	0.021	0.030	0.0210	0.0330	0.0510	0.0346	0.0111
	2-Methylnaphthalene	mg/kg	0.010	0.020	0.20	0.050	0.049	0.064	0.030	0.039	0.0300	0.0490	0.0640	0.0464	0.0128
	Naphthalene	mg/kg	0.010	0.035	0.39	0.018	0.020	0.027	0.011	0.017	0.0110	0.0180	0.0270	0.0186	0.00577
	Perylene	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Phenanthrene	mg/kg	0.010	0.042	0.52	0.047	0.053	0.071	0.037	0.049	0.0370	0.0490	0.0710	0.0514	0.0124
	Pyrene	mg/kg	0.010	0.053	0.88	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	d10-Acenaphthene	%	-	-	-	74.7	72.1	74.4	68.5	72.4	68.5	72.4	74.7	72.4	2.48
	d12-Chrysene	%	-	-	-	80.5	82.8	81.6	83.1	85.6	80.5	82.8	85.6	82.7	1.91
	d8-Naphthalene	%	-	-	-	69.5	62.4	69.0	59.6	65.2	59.6	65.2	69.5	65.1	4.25
	d10-Phenanthrene	%	-	-	-	80.7	78.3	83.5	72.8	78.2	72.8	78.3	83.5	78.7	3.95
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0200	<0.0200	<0.0200	<0.0200	-
	IACR (CCME)	mg/kg	0.15	-	-	<0.15	<0.15	<0.15	<0.15	<0.15	<0.150	<0.150	<0.150	<0.150	-

▨ Value > Lower SQG.

🟦 Value > Upper SQG.

Notes: All summary stats calculated to 3 significant figures, "-" indicates no guideline

Table G.3: Chemistry of Sediment Samples Collected Concurrent with Biological Samples, September 2019

Analyte		Units	LRL	BC Sediment Quality Guidelines		Mine-exposed							
						GH_ERC / RG_ELUGH							
				Lower SQG	Upper SQG	GH_ERC-1	GH_ERC-2	GH_ERC-3	Minimum	Median	Maximum	Mean	Standard Deviation
						05-Sep-19	05-Sep-19	05-Sep-19					
Physical Tests	Moisture	%	0.25	-	-	48.1	49.1	37.4	37.4	48.1	49.1	44.9	6.49
	pH(1:2 Soil:Water)	pH	0.10	-	-	8.25	8.36	8.43	8.25	8.36	8.43	8.35	0.0907
Particle Size	% Gravel (>2 mm)	%	1.0	-	-	<1.0	<1.0	<1.0	<1.00	<1.00	<1.00	<1.00	-
	% Sand (2.00 mm - 1.00 mm)	%	1.0	-	-	2.5	4.9	<1.0	<1.00	2.50	4.90	2.80	1.60
	% Sand (1.00 mm - 0.50 mm)	%	1.0	-	-	3.8	8.4	<1.0	<1.00	3.80	8.40	4.40	3.07
	% Sand (0.50 mm - 0.25 mm)	%	1.0	-	-	15.2	16.3	4.7	4.70	15.2	16.3	12.1	6.40
	% Sand (0.25 mm - 0.125 mm)	%	1.0	-	-	19.4	23.9	16.5	16.5	19.4	23.9	19.9	3.73
	% Sand (0.125 mm - 0.063 mm)	%	1.0	-	-	16.6	16.3	42.0	16.3	16.6	42.0	25.0	14.8
	% Silt (0.063 mm - 0.0312 mm)	%	1.0	-	-	16.9	12.3	18.8	12.3	16.9	18.8	16.0	3.34
	% Silt (0.0312 mm - 0.004 mm)	%	1.0	-	-	19.9	13.5	14.1	13.5	14.1	19.9	15.8	3.53
	% Clay (<4 µm)	%	1.0	-	-	4.9	3.8	3.3	3.30	3.80	4.90	4.00	0.819
	Texture	-	-	-	-	Sandy loam	Loamy sand	Sandy loam / Loamy sand	-	-	-	-	-
	Total Organic Carbon	%	0.050	-	-	3.60	2.50	2.18	2.18	2.50	3.60	2.76	0.745
Metals	Aluminum (Al)	mg/kg	50	-	-	6,580	4,970	5,210	4,970	5,210	6,580	5,590	869
	Antimony (Sb)	mg/kg	0.10	-	-	0.51	0.46	0.42	0.420	0.460	0.510	0.463	0.0451
	Arsenic (As)	mg/kg	0.10	5.9	17	5.09	4.72	4.45	4.45	4.72	5.09	4.75	0.321
	Barium (Ba)	mg/kg	0.50	-	-	124	106	97.3	97.3	106	124	109	13.6
	Beryllium (Be)	mg/kg	0.10	-	-	0.49	0.41	0.39	0.390	0.410	0.490	0.430	0.0529
	Bismuth (Bi)	mg/kg	0.20	-	-	<0.20	<0.20	<0.20	<0.200	<0.200	<0.200	<0.200	-
	Boron (B)	mg/kg	5.0	-	-	8.3	5.6	5.4	5.40	5.60	8.30	6.43	1.62
	Cadmium (Cd)	mg/kg	0.020	0.60	3.5	0.780	0.613	0.566	0.566	0.613	0.780	0.653	0.112
	Calcium (Ca)	mg/kg	50	-	-	59,200	61,500	49,600	49,600	59,200	61,500	56,800	6,310
	Chromium (Cr)	mg/kg	0.50	37	90	16.1	12.2	12.3	12.2	12.3	16.1	13.5	2.22
	Cobalt (Co)	mg/kg	0.10	-	-	3.96	3.43	3.30	3.30	3.43	3.96	3.56	0.350
	Copper (Cu)	mg/kg	0.50	36	197	9.92	7.97	7.18	7.18	7.97	9.92	8.36	1.41
	Iron (Fe)	mg/kg	50	21,200	43,766	11,500	10,600	9,630	9,630	10,600	11,500	10,600	935
	Lead (Pb)	mg/kg	0.50	35	91	6.18	7.19	5.14	5.14	6.18	7.19	6.17	1.03
	Lithium (Li)	mg/kg	2.0	-	-	9.7	7.5	7.5	7.50	7.50	9.70	8.23	1.27
	Magnesium (Mg)	mg/kg	20	-	-	12,700	11,500	12,000	11,500	12,000	12,700	12,100	603
	Manganese (Mn)	mg/kg	1.0	460	1,100	459	358	351	351	358	459	389	60.4
	Mercury (Hg)	mg/kg	0.0050	0.17	0.49	0.0331	0.0257	0.0244	0.0244	0.0257	0.0331	0.0277	0.00469
	Molybdenum (Mo)	mg/kg	0.10	-	-	1.34	1.13	1.10	1.10	1.13	1.34	1.19	0.131
	Nickel (Ni)	mg/kg	0.50	16	75	18.3	14.8	14.2	14.2	14.8	18.3	15.8	2.21
	Phosphorus (P)	mg/kg	50	-	-	1,170	1,130	1,150	1,130	1,150	1,170	1,150	20.0
	Potassium (K)	mg/kg	100	-	-	1,780	1,220	1,230	1,220	1,230	1,780	1,410	320
	Selenium (Se)	mg/kg	0.20	2.0	-	0.93	0.61	0.57	0.570	0.610	0.930	0.703	0.197
	Silver (Ag)	mg/kg	0.10	0.50	-	0.17	0.14	0.12	0.120	0.140	0.170	0.143	0.0252
	Sodium (Na)	mg/kg	50	-	-	86	77	74	74.0	77.0	86.0	79.0	6.24
	Strontium (Sr)	mg/kg	0.50	-	-	103	100	82	82.1	99.9	103	95.0	11.3
	Sulfur (S)	mg/kg	1,000	-	-	<1,000	<1,000	<1,000	-	-	-	-	-
	Thallium (Tl)	mg/kg	0.050	-	-	0.176	0.138	0.137	0.137	0.138	0.176	0.150	0.0222
	Tin (Sn)	mg/kg	2.0	-	-	<2.0	<2.0	<2.0	<2.00	<2.00	<2.00	<2.00	-
	Titanium (Ti)	mg/kg	1.0	-	-	28.2	19.5	20.2	19.5	20.2	28.2	22.6	4.83
	Tungsten (W)	mg/kg	0.50	-	-	<0.50	<0.50	<0.50	<0.500	<0.500	<0.500	<0.500	-
	Uranium (U)	mg/kg	0.050	-	-	0.984	0.877	0.838	0.838	0.877	0.984	0.900	0.0756
	Vanadium (V)	mg/kg	0.20	-	-	28.8	23.6	23.1	23.1	23.6	28.8	25.2	3.16
	Zinc (Zn)	mg/kg	2.0	123	315	79.5	67.7	64.0	64.0	67.7	79.5	70.4	8.10
	Zirconium (Zr)	mg/kg	1.0	-	-	1.20	<1.0	<1.0	<1.00	<1.00	1.20	1.07	-
Polycyclic Aromatic Hydrocarbons	Acenaphthene	mg/kg	0.0050	0.0067	0.089	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acenaphthylene	mg/kg	0.0050	0.0059	0.13	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Acridine	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Anthracene	mg/kg	0.0040	0.047	0.25	<0.0040	<0.0040	<0.0040	<0.00400	<0.00400	<0.00400	<0.00400	-
	Benz(a)anthracene	mg/kg	0.010	0.032	0.39	<0.010	<0.020	<0.010	<0.0100	<0.0100	<0.0200	<0.0100	-
	Benzo(a)pyrene	mg/kg	0.010	0.032	0.78	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(b&j)fluoranthene	mg/kg	0.010	-	-	0.011	0.017	<0.010	<0.0100	0.0110	0.0170	0.0127	0.00400
	Benzo(b+j+k)fluoranthene	mg/kg	0.015	-	-	<0.015	0.02	<0.015	<0.0150	<0.0150	0.0190	0.0163	-
	Benzo(e)pyrene	mg/kg	0.010	-	-	<0.010	0.02	<0.010	<0.0100	<0.0100	0.0150	0.0117	-
	Benzo(g,h,i)perylene	mg/kg	0.010	0.17	3.2	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Benzo(k)fluoranthene	mg/kg	0.010	0.24	13	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Chrysene	mg/kg	0.010	0.057	0.86	0.031	0.056	0.014	0.0140	0.0310	0.0560	0.0337	0.0211
	Dibenz(a,h)anthracene	mg/kg	0.0050	0.0062	0.14	<0.0050	<0.0050	<0.0050	<0.00500	<0.00500	<0.00500	<0.00500	-
	Fluoranthene	mg/kg	0.010	0.11	2.4	<0.010	0.013	<0.010	<0.0100	<0.0100	0.0130	0.0110	-
	Fluorene	mg/kg	0.010	0.021	0.14	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	Indeno(1,2,3-c,d)pyrene	mg/kg	0.010	0.20	3.2	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	1-Methylnaphthalene	mg/kg	0.010	-	-	0.067	0.126	0.020	0.0200	0.0670	0.126	0.0710	0.0531
	2-Methylnaphthalene	mg/kg	0.010	0.020	0.20	0.079	0.153	0.023	0.0230	0.0790	0.153	0.0850	0.0652
	Naphthalene	mg/kg	0.010	0.035	0.39	0.035	0.081	<0.010	<0.0100	0.0350	0.0810	0.0420	0.0307
	Perylene	mg/kg	0.010	-	-	<0.010	0.01	<0.010	<0.0100	<0.0100	0.0110	0.0103	-
	Phenanthrene	mg/kg	0.010	0.042	0.52	0.107	0.222	0.037	0.0370	0.107	0.222	0.122	0.0934
	Pyrene	mg/kg	0.010	0.053	0.88	0.010	0.017	<0.010	<0.0100	0.0100	0.0170	0.0123	0.00467
	Quinoline	mg/kg	0.010	-	-	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	-
	d10-Acenaphthene	%	-	-	-	92.9	81.7	65.4	65.4	81.7	92.9	80.0	13.8
	d12-Chrysene	%	-	-	-	101.8	90.4	76.2	76.2	90.4	102	89.5	12.8
	d8-Naphthalene	%	-	-	-	81.9	76.0	58.7	58.7	76.0	81.9	72.2	12.1
	d10-Phenanthrene	%	-	-	-	101.5	91.1	77.3	77.3	91.1	102	90.0	12.1
	B(a)P Total Potency Equivalent	mg/kg	0.020	-	-	<0.020	<0.020	<0.020	<0.0200	<0.0200	<0.0200	<0.0200	-
	IACR (CCME)	mg/kg	0.15	-	-	0.16	0.22	<0.15	<0.150	0.160	0.220	0.177	0.0400

▨ Value > Lower SQG.

🟦 Value > Upper SQG.

Notes: All summary stats calculated to 3 significant figures, "-" indicates no guideline

Table G.4: **Habitat Information Associated with Mine-exposed and Reference Areas Sampled during the Benthic Invertebrate Survey, GHO LAEMP, September 2019**

	Area Type	Reference	Mine-exposed					
	Area ID	**GH_EL2 / ELUGH**	**GH_ERSC4**	**GH_ER1A**	**RG_ERSC5**	**GH_TC2 / THCK**	**RG_SCDTC**	**GH_ERC / EL20**
Station 1	Easting	646533	648041	648391	648265	648559	648222	649129
	Northing	5557512	5552486	5551410	5550658	5550222	5549576	5548542
	Date	05-Sep-19	10-Sep-19	09-Sep-19	08-Sep-19	04-Sep-19	11-Sep-19	08-Sep-19
	Samplers' Initials	MS	MS	MS	MS	MS	MS	MW
	Number of Jars	1	1	1	2	1	1	1
	Total Kick Distance (m)	9	10	4	5	2.5	6	15
	Full Transect (Yes / No)	N	N	N	Y	Y	Y	N
	Number of Transects	partial	partial	partial	1.5	1	2	0.33
Station 2	Easting	646513	648088	648408	648266	648567	648222	649107
	Northing	5557534	5552568	5551504	5550663	5550222	5549587	5548539
	Date	05-Sep-19	10-Sep-19	09-Sep-19	08-Sep-19	04-Sep-19	11-Sep-19	08-Sep-19
	Samplers' Initials	MS	MS	MS	MS	MS	MS	MW
	Number of Jars	1	1	1	1	1	1	1
	Total Kick Distance (m)	7	9	5	3	2.7	5	20
	Full Transect (Yes / No)	N	N	N	N	Y	Y	N
	Number of Transects	partial	partial	partial	partial	1	2	0.5
Station 3	Easting	646504	648102	648394	648266	648570	648223	649065
	Northing	5557613	5552577	5551517	5550683	5550220	5549607	5548640
	Date	05-Sep-19	10-Sep-19	09-Sep-19	08-Sep-19	04-Sep-19	11-Sep-19	08-Sep-19
	Samplers' Initials	BM	MS	MS	MS	MS	MS	MW
	Number of Jars	1	1	1	1	1	1	1
	Total Kick Distance (m)	7.5	10	5	3	3	8	15
	Full Transect (Yes / No)	N	Y	N	N	Y	Y	N
	Number of Transects	partial	2	partial	partial	1	3	0.5
Station 4	Easting	-	-	-	-	-	-	648972
	Northing	-	-	-	-	-	-	5548686
	Date	-	-	-	-	-	-	08-Sep-19
	Samplers' Initials	-	-	-	-	-	-	MW
	Number of Jars	-	-	-	-	-	-	1
	Total Kick Distance (m)	-	-	-	-	-	-	15
	Full Transect (Yes / No)	-	-	-	-	-	-	N
	Number of Transects	-	-	-	-	-	-	0.33
Station 5	Easting	-	-	-	-	-	-	648896
	Northing	-	-	-	-	-	-	5548824
	Date	-	-	-	-	-	-	08-Sep-19
	Samplers' Initials	-	-	-	-	-	-	MW
	Number of Jars	-	-	-	-	-	-	1
	Total Kick Distance (m)	-	-	-	-	-	-	15
	Full Transect (Yes / No)	-	-	-	-	-	-	N
	Number of Transects	-	-	-	-	-	-	0.5

Note: "-" indicates only three (3) stations sampled for the area.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ER2 / ELUGH (1)					GH_ER2 / ELUGH (2)					GH_ER2 / ELUGH (3)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	3.9	-	1	0	0	3.4	-	1	0	0	1.0	-
2	0	0	5.0	-	2	0	0	3.2	-	2	0	0	5.5	-
3	0	0	1.5	-	3	0	0	sand	-	3	0	0	1.4	-
4	0	0	5.5	-	4	0	0	1.4	-	4	0	0	6.3	-
5	0	0	0.9	-	5	0	0	11.0	-	5	0	0	11.0	-
6	0	0	2.2	-	6	0	0	sand	-	6	0	0	17.0	-
7	0	0	7.3	-	7	0	0	7.2	-	7	0	0	1.8	-
8	0	0	4.8	-	8	0	0	8.3	-	8	0	0	4.2	-
9	0	0	9.3	-	9	0	0	sand	-	9	0	0	3.7	-
10	0	0	13.0	0.5	10	0	0	5.4	0.5	10	0	0	2.4	0.5
11	0	0	6.1	-	11	0	0	3.1	-	11	0	0	5.2	-
12	0	0	2.9	-	12	0	0	10.0	-	12	0	0	10.0	-
13	0	0	4.3	-	13	0	0	2.2	-	13	0	0	11.5	-
14	0	0	5.0	-	14	0	0	8.3	-	14	0	0	12.8	-
15	0	0	6.0	-	15	0	0	5.1	-	15	0	0	15.5	-
16	0	0	4.0	-	16	0	0	sand	-	16	0	0	3.5	-
17	0	0	3.1	-	17	0	0	4.6	-	17	0	0	8.5	-
18	0	0	2.9	-	18	0	0	1.8	-	18	0	0	8.2	-
19	0	0	8.8	-	19	0	0	3.7	-	19	0	0	3.3	-
20	0	0	4.8	0.5	20	0	0	2.6	0	20	0	0	13.0	0
21	0	0	3.1	-	21	0	0	5.0	-	21	0	0	sand	-
22	0	0	3.0	-	22	0	0	sand	-	22	0	0	sand	-
23	0	0	6.8	-	23	0	0	1.7	-	23	0	0	10.5	-
24	0	0	2.8	-	24	0	0	7.2	-	24	0	0	9.5	-
25	0	0	3.1	-	25	0	0	4.5	-	25	0	0	10.0	-
26	0	0	6.7	-	26	0	0	8.2	-	26	0	0	10.0	-
27	0	0	2.5	-	27	0	0	5.4	-	27	0	0	10.5	-
28	0	0	1.5	-	28	0	0	4.7	-	28	0	0	5.8	-
29	0	0	1.0	-	29	0	0	7.6	-	29	0	0	7.3	-
30	0	0	6.7	0.25	30	0	0	22.0	0.5	30	0	0	11.6	0
31	0	0	5.0	-	31	0	0	1.5	-	31	0	0	3.3	-
32	0	0	1.5	-	32	0	0	3.1	-	32	0	0	11.0	-
33	0	0	2.8	-	33	0	0	8.5	-	33	0	0	4.5	-
34	0	0	sand	-	34	0	0	3.1	-	34	0	0	5.2	-
35	0	0	1.2	-	35	0	0	6.4	-	35	0	0	3.9	-
36	0	0	6.5	-	36	0	0	1.8	-	36	0	0	5.7	-
37	0	0	1.5	-	37	0	0	7.2	-	37	0	0	7.0	-
38	0	0	2.0	-	38	0	0	9.3	-	38	0	0	10.0	-
39	0	0	5.1	-	39	0	0	4.2	-	39	0	0	2.1	-
40	0	0	7.2	0.25	40	0	0	8.0	0	40	0	0	14.5	0
41	0	0	2.0	-	41	0	0	13.0	-	41	0	0	5.6	-
42	0	0	2.6	-	42	0	0	7.2	-	42	0	0	10.0	-
43	0	0	9.2	-	43	0	0	sand	-	43	0	0	1.9	-
44	0	0	5.0	-	44	0	0	5.4	-	44	0	0	3.7	-
45	0	0	2.6	-	45	0	0	0.8	-	45	0	0	3.0	-
46	0	0	4.4	-	46	0	0	5.7	-	46	0	0	0.7	-
47	0	0	4.9	-	47	0	0	4.5	-	47	0	0	3.8	-
48	0	0	3.7	-	48	0	0	4.5	-	48	0	0	9.8	-
49	0	0	1.7	-	49	0	0	3.2	-	49	0	0	10.0	-
50	0	0	1.9	0	50	0	0	11.5	0.25	50	0	0	4.0	0.25
51	0	0	2.2	-	51	0	0	8.2	-	51	0	0	9.5	-
52	0	0	3.1	-	52	0	0	6.0	-	52	0	0	3.5	-
53	0	0	6.7	-	53	0	0	3.2	-	53	0	0	8.6	-
54	0	0	3.9	-	54	0	0	1.4	-	54	0	0	3.2	-
55	0	0	1.4	-	55	0	0	3.5	-	55	0	0	4.3	-
56	0	0	4.8	-	56	0	0	3.4	-	56	0	0	11.5	-
57	0	0	6.4	-	57	0	0	sand	-	57	0	0	8.2	-
58	0	0	1.5	-	58	0	0	sand	-	58	0	0	1.7	-
59	0	0	1.5	-	59	0	0	1.7	-	59	0	0	sand	-
60	0	0	4.3	0.25	60	0	0	5.0	0	60	0	0	1.4	0.5
61	0	0	2.4	-	61	0	0	3.5	-	61	0	0	sand	-
62	0	0	2.3	-	62	0	0	1.5	-	62	0	0	s	-
63	0	0	2.1	-	63	0	0	3.0	-	63	0	0	9.9	-
64	0	0	1.3	-	64	0	0	5.6	-	64	0	0	5.2	-
65	0	0	7.2	-	65	0	0	sand	-	65	0	0	15.4	-
66	0	0	2.2	-	66	0	0	2.8	-	66	0	0	9.8	-
	0	0	5.3	-	67	0	0	2.5	-	67	0	0	5.3	-
68	0	0	4.0	-	68	0	0	4.3	-	68	0	0	4.8	-
69	0	0	4.3	-	69	0	0	5.0	-	69	0	0	4.7	-
70	0	0	5.5	0.25	70	0	0	4.5	0.5	70	0	0	3.2	0.75
71	0	0	2.6	-	71	0	0	11.2	-	71	0	0	3.7	-
72	0	0	1.4	-	72	0	0	6.3	-	72	0	0	8.0	-
73	0	0	6.2	-	73	0	0	4.5	-	73	0	0	2.8	-
74	0	0	1.4	-	74	0	0	sand	-	74	0	0	9.2	-
75	0	0	1.8	-	75	0	0	1.4	-	75	0	0	5.0	-
76	0	0	1.2	-	76	0	0	3.3	-	76	0	0	7.2	-
77	0	0	0.8	-	77	0	0	sand	-	77	0	0	4.0	-
78	0	0	2.6	-	78	0	0	4.1	-	78	0	0	20.5	-
79	0	0	7.9	-	79	0	0	3.1	-	79	0	0	6.7	-
80	0	0	3.9	0.25	80	0	0	11.2	0.75	80	0	0	14.5	0.5
81	0	0	1.7	-	81	0	0	4.4	-	81	0	0	7.2	-
82	0	0	3.1	-	82	0	0	sand	-	82	0	0	13.0	-
83	0	0	6.5	-	83	0	0	10.1	-	83	0	0	5.2	-
84	0	0	0.6	-	84	0	0	sand	-	84	0	0	10.0	-
85	0	0	3.7	-	85	0	0	2.2	-	85	0	0	8.5	-
86	0	0	2.7	-	86	0	0	3.4	-	86	0	0	7.0	-
87	0	0	4.2	-	87	0	0	6.7	-	87	0	0	12.0	-
88	0	0	1.8	-	88	0	0	3.8	-	88	0	0	17.5	-
89	0	0	5.8	-	89	0	0	7.9	-	89	0	0	9.2	-
90	0	0	5.5	0.5	90	0	0	6.2	0.25	90	0	0	15.7	0.75
91	0	0	2.8	-	91	0	0	6.5	-	91	0	0	7.3	-
92	0	0	1.1	-	92	0	0	5.0	-	92	0	0	7.8	-
93	0	0	1.9	-	93	0	0	5.5	-	93	0	0	sand	-
94	0	0	1.1	-	94	0	0	0.9	-	94	0	0	18.0	-
95	0	0	2.2	-	95	0	0	4.8	-	95	0	0	7.9	-
96	0	0	5.1	-	96	0	0	3.7	-	96	0	0	10.1	-
97	0	0	2.2	-	97	0	0	4.4	-	97	0	0	10.4	-
98	0	0	4.6	-	98	0	0	4.3	-	98	0	0	11.1	-
99	0	0	5.8	-	99	0	0	1.8	-	99	0	0	7.7	-
100	0	0	5.7	0.25	100	0	0	8.9	0.75	100	0	0	6.8	0
Minimum	**0.0**	**0.0**	**0.6**	**0**	**Minimum**	**0.0**	**0.0**	**0.8**	**0**	**Minimum**	**0.0**	**0.0**	**0.7**	**0**
Maximum	**0.0**	**0.0**	**13.0**	**0.5**	**Maximum**	**0.0**	**0.0**	**22.0**	**0.75**	**Maximum**	**0.0**	**0.0**	**20.5**	**0.75**
Mean	**0.0**	**0.0**	**3.8**	**0.3**	**Mean**	**0.0**	**0.0**	**5.3**	**0.4**	**Mean**	**0.0**	**0.0**	**7.7**	**0.3**
Standard dev.	**0.0**	**0.0**	**2.3**	**0.2**	**Standard dev.**	**0.0**	**0.0**	**3.3**	**0.3**	**Standard dev.**	**0.0**	**0.0**	**4.3**	**0.3**
Geometric mean	**na**	**na**	**3.2**	**na**	**Geometric mean**	**na**	**na**	**4.4**	**na**	**Geometric mean**	**na**	**na**	**6.4**	**na**
Median	**0.0**	**0.0**	**3.1**	**0**	**Median**	**0.0**	**0.0**	**4.5**	**0**	**Median**	**0.0**	**0.0**	**7.3**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ERSC4 (1)					GH_ERSC4 (2)					GH_ERSC4 (3)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	silt	-	1	0	-	silt	-	1	0	1	5.5	-
2	0	0	silt	-	2	0	-	silt	-	2	0	1	2.7	-
3	0	0	2.7	-	3	0	1	1.2	-	3	0	1	3.8	-
4	0	0	silt	-	4	0	0	1.0	-	4	0	0	6.1	-
5	0	0	silt	-	5	0	1	1.2	-	5	0	1	6.4	-
6	0	0	1.6	-	6	0	0	sand	-	6	0	0	5.3	-
7	0	0	1.2	-	7	0	0	0.5	-	7	0	0	5.6	-
8	0	0	1.3	-	8	0	0	1.4	-	8	0	1	6.0	-
9	0	0	1.1	-	9	0	0	silt	-	9	0	1	7.9	-
10	0	0	silt	1	10	0	0	silt	1	10	0	1	6.9	0
11	0	0	3.2	-	11	0	0	silt	-	11	0	0	6.3	-
12	0	0	silt	-	12	0	0	0.9	-	12	0	1	7.0	-
13	0	0	silt	-	13	0	0	silt	-	13	0	1	7.5	-
14	0	0	silt	-	14	0	0	1.0	-	14	0	1	4.2	-
15	0	0	3.4	-	15	0	0	0.9	-	15	0	0	2.9	-
16	0	0	silt	-	16	0	0	1.4	-	16	0	1	5.2	-
17	0	0	silt	-	17	0	0	0.7	-	17	0	0	2.0	-
18	0	0	1.8	-	18	0	0	1.4	-	18	0	-	silt	-
19	0	0	1.2	-	19	0	1	0.9	-	19	0	1	3.3	-
20	0	0	3.2	0.75	20	0	1	2.0	0	20	0	1	4.5	0.5
21	0	0	silt	-	21	0	0	0.9	-	21	0	1	sand	-
22	0	0	silt	-	22	0	0	sand	-	22	0	1	5.7	-
23	0	0	silt	-	23	0	0	0.8	-	23	0	1	5.7	-
24	0	0	1.5	-	24	0	0	sand	-	24	0	0	3.9	-
25	0	0	silt	-	25	0	0	sand	-	25	0	1	5.8	-
26	0	0	silt	-	26	0	0	0.6	-	26	0	0	6.0	-
27	0	0	3.4	-	27	0	0	0.8	-	27	0	1	7.1	-
28	0	0	3.0	-	28	0	0	1.0	-	28	0	1	8.2	-
29	0	0	silt	-	29	0	0	1.3	-	29	0	1	9.6	-
30	0	1	3.3	0.25	30	0	0	0.6	0	30	0	1	5.3	0.75
31	0	0	sand	-	31	0	0	sand	-	31	0	0	5.3	-
32	0	0	silt	-	32	0	0	0.6	-	32	0	1	6.0	-
33	0	0	0.9	-	33	0	0	1.5	-	33	0	0	4.0	-
34	0	0	silt	-	34	0	1	1.3	-	34	0	0	7.7	-
35	0	0	2.7	-	35	0	0	0.7	-	35	0	1	6.5	-
36	0	0	1.0	-	36	0	0	0.9	-	36	0	1	5.3	-
37	0	0	1.4	-	37	0	1	1.3	-	37	0	1	5.5	-
38	0	0	silt	-	38	0	0	0.5	-	38	0	0	5.0	-
39	0	0	silt	-	39	0	1	1.3	-	39	0	0	5.6	-
40	0	0	silt	1	40	0	1	1.2	0	40	0	1	4.0	0
41	0	0	silt	-	41	0	0	2.0	-	41	0	0	3.9	-
42	0	1	2.2	-	42	0	0	silt	-	42	0	1	3.8	-
43	0	0	sand	-	43	0	0	0.9	-	43	0	1	5.6	-
44	0	0	1.1	-	44	0	0	1.6	-	44	0	0	4.7	-
45	0	0	0.3	-	45	0	1	2.7	-	45	0	1	5.3	-
46	0	0	sand	-	46	0	1	1.6	-	46	0	1	5.2	-
47	0	0	silt	-	47	0	0	1.6	-	47	0	s	sand	-
48	0	0	sand	-	48	0	0	1.1	-	48	0	1	5.0	-
49	0	0	silt	-	49	0	0	1.2	-	49	0	1	4.2	-
50	0	1	1.5	0	50	0	1	1.1	0	50	0	1	3.9	0.75
51	0	0	silt	-	51	0	1	1.8	-	51	0	0	3.2	-
52	0	0	silt	-	52	0	1	2.0	-	52	0	1	9.0	-
53	0	0	silt	-	53	0	-	silt	-	53	0	1	5.7	-
54	0	0	silt	-	54	0	1	1.6	-	54	0	1	8.3	-
55	0	1	3.4	-	55	0	0	0.9	-	55	0	1	6.9	-
56	0	0	silt	-	56	0	0	silt	-	56	0	1	6.7	-
57	0	0	1.7	-	57	0	0	0.9	-	57	0	1	3.3	-
58	0	0	1.0	-	58	0	1	3.1	-	58	0	0	5.3	-
59	0	0	silt	-	59	0	1	3.9	-	59	0	1	4.9	-
60	0	0	silt	1	60	0	1	2.5	0.5	60	0	1	7.6	0.75
61	0	1	3.0	-	61	0	1	2.6	-	61	0	0	4.8	-
62	0	0	1.8	-	62	0	0	1.9	-	62	0	0	4.0	-
63	0	0	0.9	-	63	0	0	silt	-	63	0	0	7.4	-
64	0	1	1.7	-	64	0	0	2.2	-	64	0	1	8.9	-
65	0	0	1.2	-	65	0	0	silt	-	65	0	0	3.3	-
66	0	0	1.5	-	66	0	0	silt	-	66	0	0	4.3	-
67	0	0	silt	-	67	0	0	0.6	-	67	0	1	3.7	-
68	0	1	3.3	-	68	0	0	silt	-	68	0	0	5.3	-
69	0	0	1.9	-	69	0	0	1.9	-	69	0	1	6.4	-
70	0	1	2.0	0.75	70	0	1	1.8	0.25	70	0	0	5.7	0.75
71	0	0	silt	-	71	0	0	1.1	-	71	0	1	5.3	-
72	0	0	sand	-	72	0	0	2.5	-	72	0	0	3.8	-
73	0	0	silt	-	73	0	0	1.6	-	73	0	1	4.2	-
74	0	0	1.5	-	74	0	0	1.3	-	74	0	1	6.2	-
75	0	0	3.1	-	75	0	0	silt	-	75	0	0	4.1	-
76	0	0	silt	-	76	0	0	1.2	-	76	0	1	5.0	-
77	0	0	silt	-	77	0	0	0.8	-	77	0	1	3.4	-
78	0	1	2.9	-	78	0	0	0.9	-	78	0	1	4.3	-
79	0	0	silt	-	79	0	1	1.7	-	79	0	0	7.7	-
80	0	0	3.8	0	80	0	1	2.1	0.25	80	0	1	7.5	0.75
81	0	0	silt	-	81	0	1	0.5	-	81	0	0	7.3	-
82	0	0	sand	-	82	0	1	2.6	-	82	0	1	7.2	-
83	0	0	silt	-	83	0	1	1.7	-	83	0	1	2.9	-
84	0	0	sand	-	84	0	1	0.9	-	84	0	0	3.6	-
85	0	0	1.0	-	85	0	1	1.3	-	85	0	0	5.7	-
86	0	0	0.6	-	86	0	1	1.0	-	86	0	1	4.3	-
87	0	0	silt	-	87	0	0	1.9	-	87	0	1	5.0	-
88	0	0	silt	-	88	0	0	1.0	-	88	0	0	6.8	-
89	0	0	silt	-	89	0	0	silt	-	89	0	1	7.8	-
90	0	0	2.2	0	90	0	0	1.1	0	90	0	1	5.2	0.5
91	0	0	sand	-	91	0	0	silt	-	91	0	0	5.8	-
92	0	0	1.9	-	92	0	1	1.2	-	92	0	0	4.6	-
93	0	0	1.4	-	93	0	-	silt	-	93	0	0	4.4	-
94	0	0	0.6	-	94	0	-	silt	-	94	0	0	4.1	-
95	0	0	silt	-	95	0	0	1.0	-	95	0	1	3.4	-
96	0	0	sand	-	96	0		silt	-	96	0	1	4.5	-
97	0	0	0.7	-	97	0	1	0.5	-	97	0	1	4.0	-
98	0	0	silt	-	98	0		silt	-	98	0	1	6.1	-
99	0	0	silt	-	99	0	0	0.5	-	99	0	1	8.6	-
100	0	1	1.7	0.25	100	0	1	1.2	0	100	0	1	3.8	0
Minimum	**0.0**	**0.0**	**0.3**	**0**	**Minimum**	**0.0**	**0.0**	**0.5**	**0**	**Minimum**	**0.0**	**0.0**	**2.0**	**0**
Maximum	**0.0**	**1.0**	**3.8**	**1**	**Maximum**	**0.0**	**1.0**	**3.9**	**1**	**Maximum**	**0.0**	**1.0**	**9.6**	**0.75**
Mean	**0.0**	**0.1**	**1.9**	**0.5**	**Mean**	**0.0**	**0.3**	**1.3**	**0.2**	**Mean**	**0.0**	**0.6**	**5.4**	**0.5**
Standard dev.	**0.0**	**0.3**	**0.9**	**0.4**	**Standard dev.**	**0.0**	**0.5**	**0.7**	**0.3**	**Standard dev.**	**0.0**	**0.5**	**1.6**	**0.3**
Geometric mean	**na**	**na**	**1.7**	**na**	**Geometric mean**	**na**	**na**	**1.2**	**na**	**Geometric mean**	**na**	**na**	**5.2**	**na**
Median	**0.0**	**0.0**	**1.7**	**1**	**Median**	**0.0**	**0.0**	**1.2**	**0**	**Median**	**0.0**	**1.0**	**5.3**	**1**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ER1A (1)					GH_ER1A (2)					GH_ER1A (3)				
Rock	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**
1	0	1	7.4	-	1	-	-	silt	-	1	0	1	7.8	-
2	0	1	12.4	-	2	0	1	3.1	-	2	0	0	4.3	-
3	0	1	4.3	-	3	0	0	1.8	-	3	0	0	6.3	-
4	0	0	4.1	-	4	0	1	1.5	-	4	0	1	6.1	-
5	0	1	8.9	-	5	0	0	1.7	-	5	0	0	3.9	-
6	0	1	8.0	-	6	0	0	2.1	-	6	0	1	6.7	-
7	0	1	10.2	-	7	0	1	1.9	-	7	0	0	6.2	-
8	0	1	7.9	-	8	0	1	0.8	-	8	0	0	4.2	-
9	0	1	6.5	-	9	0	0	1.8	-	9	0	1	7.0	-
10	0	1	6.0	0.25	10	0	1	3.2	0.25	10	0	0	4.9	0
11	0	0	4.0	-	11	0	0	1.2	-	11	0	0	2.7	-
12	0	0	7.6	-	12	0	0	1.4	-	12	0	0	5.1	-
13	0	1	6.5	-	13	0	1	1.1	-	13	0	1	9.9	-
14	0	1	7.7	-	14	0	0	1.6	-	14	0	0	4.4	-
15	0	0	5.6	-	15	0	0	0.9	-	15	0	1	6.3	-
16	0	0	5.5	-	16	0	0	1.2	-	16	0	0	5.0	-
17	0	1	5.8	-	17	0	0	1.6	-	17	0	0	3.0	-
18	0	0	6.0	-	18	0	0	1.1	-	18	0	1	7.5	-
19	0	0	8.5	-	19	0	1	1.6	-	19	0	1	8.2	-
20	0	1	7.4	0.25	20	0	0	1.4	0	20	0	0	4.9	0
21	0	0	5.7	-	21	0	0	3.5	-	21	0	1	3.7	-
22	0	1	12.0	-	22	0	0	2.0	-	22	0	1	5.6	-
23	0	1	6.9	-	23	0	0	5.0	-	23	0	0	5.5	-
24	0	0	6.4	-	24	0	1	3.9	-	24	0	0	4.6	-
25	0	0	4.8	-	25	0	0	4.6	-	25	0	1	6.8	-
26	0	0	7.0	-	26	0	0	2.6	-	26	0	1	5.2	-
27	0	0	8.8	-	27	0	1	8.2	-	27	0	0	5.2	-
28	0	0	7.9	-	28	0	0	3.1	-	28	0	0	4.7	-
29	0	1	7.2	-	29	0	0	2.9	-	29	0	1	11.9	-
30	0	1	11.0	0.5	30	0	0	2.6	0.25	30	0	0	7.8	0.25
31	0	1	5.5	-	31	0	0	2.2	-	31	0	1	5.3	-
32	0	0	7.6	-	32	0	0	2.5	-	32	0	1	6.8	-
33	0	1	7.9	-	33	0	0	2.6	-	33	0	0	6.3	-
34	0	0	4.8	-	34	0	0	3.9	-	34	0	1	4.6	-
35	0	0	7.2	-	35	0	0	3.1	-	35	0	0	3.5	-
36	0	1	6.4	-	36	0	0	1.4	-	36	0	1	3.8	-
37	0	1	9.0	-	37	0	1	2.7	-	37	0	0	4.3	-
38	0	1	8.2	-	38	0	0	1.9	-	38	0	1	5.9	-
39	0	1	12.1	-	39	0	0	2.7	-	39	0	1	4.8	-
40	0	1	10.9	0.25	40	0	s	sand	1	40	0	1	6.3	0
41	0	1	12.4	-	41	0	0	1.7	-	41	0	1	5.4	-
42	0	0	3.5	-	42	0	0	2.2	-	42	0	1	6.5	-
43	0	0	7.5	-	43	0	1	1.0	-	43	0	0	6.6	-
44	0	0	1.7	-	44	0	0	0.9	-	44	0	0	5.4	-
45	0	0	4.9	-	45	0	1	3.1	-	45	0	1	7.9	-
46	0	1	7.9	-	46	0	0	4.9	-	46	0	1	7.5	-
47	0	0	3.5	-	47	0	1	4.6	-	47	0	1	4.4	-
48	0	0	3.8	-	48	0	0	7.8	-	48	0	1	13.2	-
49	0	0	5.0	-	49	0	1	6.5	-	49	0	0	6.2	-
50	0	1	3.2	0.25	50	0	1	3.5	0.25	50	0	1	11.3	0.25
51	0	1	5.4	-	51	0	1	4.0	-	51	0	1	6.7	-
52	0	1	30.0	-	52	0	0	3.6	-	52	0	0	5.0	-
53	0	0	18.0	-	53	0	1	5.6	-	53	0	0	1.5	-
54	0	1	7.1	-	54	0	0	2.9	-	54	0	0	4.8	-
55	0	0	8.5	-	55	0	0	3.9	-	55	0	0	5.4	-
56	0	0	3.6	-	56	0	1	6.8	-	56	0	0	5.0	-
57	0	1	11.6	-	57	0	0	3.4	-	57	0	1	6.7	-
58	0	1	9.1	-	58	0	0	5.6	-	58	0	1	8.7	-
59	0	0	11.0	-	59	0	0	2.5	-	59	0	1	9.1	-
60	0	0	6.6	0	60	0	0	1.4	0	60	0	1	12.7	0.25
61	0	0	6.0	-	61	0	1	4.5	-	61	0	1	6.0	-
62	0	1	9.5	-	62	0	1	3.9	-	62	0	0	7.1	-
63	0	0	6.3	-	63	0	1	4.6	-	63	0	1	6.1	-
64	0	0	7.0	-	64	0	0	5.1	-	64	0	0	8.0	-
65	0	1	6.4	-	65	0	0	2.1	-	65	0	0	5.1	-
66	0	0	2.8	-	66	0	1	5.4	-	66	0		sand	-
67	0	0	7.9	-	67	0	1	3.8	-	67	0	0	1.4	-
68	0	0	3.7	-	68	0	0	6.7	-	68	0	0	6.6	-
69	0	1	6.1	-	69	0	1	4.9	-	69	0	0	7.8	-
70	0	1	8.4	0.5	70	0	1	6.0	0.75	70	0	0	7.6	0
71	0	0	6.3	-	71	0	1	7.9	-	71	0	1	8.3	-
72	0	1	6.5	-	72	0	0	8.2	-	72	0	0	7.9	-
73	0	0	9.8	-	73	0	0	2.9	-	73	0	0	7.9	-
74	0	0	2.0	-	74	0	-	sand	-	74	0	0	1.2	-
75	0	1	8.2	-	75	0	0	1.6	-	75	0	0	8.4	-
76	0	0	7.8	-	76	0	0	3.1	-	76	0	0	5.0	-
77	0	1	3.9	-	77	0	0	5.1	-	77	0	1	5.2	-
78	0	1	7.4	-	78	0	1	3.8	-	78	0	1	8.0	-
79	0	0	10.2	-	79	0	1	2.3	-	79	0	1	5.7	-
80	0	0	5.3	0	80	0	1	13.6	0.25	80	0	0	5.3	0.25
81	0	1	7.4	-	81	0	0	2.0	-	81	0	0	6.7	-
82	0	1	8.7	-	82	0	0	5.4	-	82	0	1	4.5	-
83	0	1	3.6	-	83	0	0	1.5	-	83	0	0	5.7	-
84	0	0	5.1	-	84	0	0	5.6	-	84	0	0	2.7	-
85	0	0	6.9	-	85	0	1	6.8	-	85	0	0	3.1	-
86	0	0	6.1	-	86	0	1	9.5	-	86	0	1	8.5	-
87	0	0	4.9	-	87	0	0	1.6	-	87	0	1	6.5	-
88	0	1	6.2	-	88	0	1	8.8	-	88	0	0	4.9	-
89	0	1	11.4	-	89	0	0	3.7	-	89	0	0	2.3	-
90	0	1	7.4	0.25	90	0	0	1.6	0	90	0	0	2.4	0
91	0	0	11.0	-	91	0	0	1.6	-	91	0	0	9.5	-
92	0	1	8.8	-	92	0	0	2.0	-	92	0	1	5.4	-
93	0	0	3.5	-	93	0	1	3.1	-	93	0	1	5.5	-
94	0	0	4.8	-	94	0	0	1.1	-	94	0	1	5.8	-
95	0	0	8.4	-	95	0	0	2.0	-	95	0	1	6.7	-
96	0	0	6.6	-	96	0	0	3.1	-	96	0	0	8.0	-
97	0	0	3.3	-	97	0	0	1.9	-	97	0	1	5.5	-
98	0	0	8.2	-	98	0	0	1.5	-	98	0	1	6.0	-
99	0	0	5.7	-	99	0	0	2.1	-	99	0	1	4.4	-
100	0	0	13.5	0.75	100	0	0	3.0	0	100	0	0	3.6	0
Minimum	**0.0**	**0.0**	**1.7**	**0**	**Minimum**	**0.0**	**0.0**	**0.8**	**0**	**Minimum**	**0.0**	**0.0**	**1.2**	**0**
Maximum	**0.0**	**1.0**	**30.0**	**0.75**	**Maximum**	**0.0**	**1.0**	**13.6**	**1**	**Maximum**	**0.0**	**1.0**	**13.2**	**0.25**
Mean	**0.0**	**0.5**	**7.3**	**0.3**	**Mean**	**0.0**	**0.3**	**3.4**	**0.3**	**Mean**	**0.0**	**0.5**	**6.0**	**0.1**
Standard dev.	**0.0**	**0.5**	**3.5**	**0.2**	**Standard dev.**	**0.0**	**0.5**	**2.3**	**0.3**	**Standard dev.**	**0.0**	**0.5**	**2.2**	**0.1**
Geometric mean	**na**	**na**	**6.7**	**na**	**Geometric mean**	**na**	**na**	**2.8**	**na**	**Geometric mean**	**na**	**na**	**5.6**	**na**
Median	**0.0**	**0.0**	**7.0**	**0**	**Median**	**0.0**	**0.0**	**2.9**	**0**	**Median**	**0.0**	**0.0**	**5.7**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ERSC5 (1)					GH_ERSC5 (2)					GH_ERSC5 (3)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	5.3	-	1	0	0	5.9	-	1	0	0	15.5	-
2	0	0	5.8	-	2	0	0	8.1	-	2	0	0	6.6	-
3	0	0	2.2	-	3	0	0	6.5	-	3	0	0	6.9	-
4	0	0	7.3	-	4	0	0	4.9	-	4	0	0	5.5	-
5	0	0	7.6	-	5	0	0	8.5	-	5	0	0	8.6	-
6	0	0	7.0	-	6	0	0	9.8	-	6	0	0	9.6	-
7	0	0	4.1	-	7	0	0	4.3	-	7	0	0	5.2	-
8	0	0	2.6	-	8	0	0	5.7	-	8	0	0	10.9	-
9	0	0	3.8	-	9	0	0	8.9	-	9	0	0	4.6	-
10	0	0	3.1	0	10	0	0	7.6	0	10	0	0	7.1	0.25
11	0	0	9.4	-	11	0	0	6.4	-	11	0	0	8.9	-
12	0	0	4.4	-	12	0	0	11.1	-	12	0	0	10.5	-
13	0	0	11.0	-	13	0	0	7.8	-	13	0	0	6.4	-
14	0	0	4.9	-	14	0	0	10.4	-	14	0	0	6.1	-
15	0	0	5.1	-	15	0	0	10.5	-	15	0	0	9.4	-
16	0	0	1.3	-	16	0	0	4.8	-	16	0	0	7.9	-
17	0	0	1.9	-	17	0	0	7.8	-	17	0	0	11.4	-
18	0	0	5.4	-	18	0	0	4.6	-	18	0	0	6.4	-
19	0	0	10.2	-	19	0	0	10.5	-	19	0	0	6.9	-
20	0	0	9.5	0.5	20	0	0	12.0	0.75	20	0	0	6.3	0.25
21	0	0	6.2	-	21	0	0	5.0	-	21	0	0	11.2	-
22	0	0	4.3	-	22	0	0	5.2	-	22	0	0	8.0	-
23	0	0	4.9	-	23	0	0	7.6	-	23	0	0	14.1	-
24	0	0	2.7	-	24	0	0	8.0	-	24	0	0	15.0	-
25	0	0	7.6	-	25	0	0	4.9	-	25	0	0	9.4	-
26	0	0	5.7	-	26	0	0	7.1	-	26	0	0	7.6	-
27	0	0	3.2	-	27	0	0	4.7	-	27	0	0	5.6	-
28	0	0	3.8	-	28	0	0	4.4	-	28	0	0	8.5	-
29	0	0	2.9	-	29	0	0	6.5	-	29	0	0	5.2	-
30	0	0	6.1	0.25	30	0	0	17.5	0.75	30	0	0	7.5	0
31	0	0	5.4	-	31	0	0	3.6	-	31	0	0	10.3	-
32	0	0	6.8	-	32	0	0	6.3	-	32	0	0	7.2	-
33	0	0	2.5	-	33	0	0	5.2	-	33	0	0	1.3	-
34	0	0	5.7	-	34	0	0	8.8	-	34	0	0	1.5	-
35	0	0	7.8	-	35	0	0	9.4	-	35	0	0	10.3	-
36	0	0	3.8	-	36	0	0	5.9	-	36	0	0	6.9	-
37	0	0	7.4	-	37	0	0	7.5	-	37	0	0	7.3	-
38	0	0	5.3	-	38	0	0	4.6	-	38	0	0	6.6	-
39	0	0	7.2	-	39	0	0	8.6	-	39	0	0	10.1	-
40	0	0	6.5	0.75	40	0	0	5.2	0.75	40	0	0	5.9	0
41	0	0	7.2	-	41	0	0	5.9	-	41	0	0	2.4	-
42	0	0	7.8	-	42	0	0	5.6	-	42	0	0	9.1	-
43	0	0	3.6	-	43	0	0	10.6	-	43	0	0	21.0	-
44	0	0	7.4	-	44	0	0	8.9	-	44	0	0	6.0	-
45	0	0	7.8	-	45	0	0	6.5	-	45	0	0	2.6	-
46	0	0	8.6	-	46	0	0	8.0	-	46	0	0	6.1	-
47	0	0	3.4	-	47	0	0	12.0	-	47	0	0	5.4	-
48	0	0	5.2	-	48	0	0	7.1	-	48	0	0	4.0	-
49	0	0	2.6	-	49	0	0	13.5	-	49	0	0	8.5	-
50	0	0	11.2	0	50	0	0	5.8	0.25	50	0	0	7.0	0
51	0	0	4.7	-	51	0	0	6.9	-	51	0	0	6.6	-
52	0	0	5.6	-	52	0	0	9.1	-	52	0	0	5.7	-
53	0	0	3.9	-	53	0	0	2.9	-	53	0	0	9.9	-
54	0	0	2.8	-	54	0	0	4.4	-	54	0	0	6.1	-
55	0	0	8.1	-	55	0	0	4.6	-	55	0	0	5.7	-
56	0	0	3.4	-	56	0	0	2.9	-	56	0	0	10.1	-
57	0	0	5.0	-	57	0	0	8.4	-	57	0	0	6.5	-
58	0	0	4.4	-	58	0	0	7.9	-	58	0	0	5.9	-
59	0	0	5.7	-	59	0	0	4.4	-	59	0	0	3.4	-
60	0	0	6.9	0.5	60	0	0	4.9	0	60	0	0	8.5	0.5
61	0	0	3.7	-	61	0	0	5.8	-	61	0	0	5.9	-
62	0	0	3.1	-	62	0	0	3.8	-	62	0	0	9.4	-
63	0	0	6.6	-	63	0	0	2.9	-	63	0	0	3.7	-
64	0	0	5.8	-	64	0	0	2.4	-	64	0	0	6.3	-
65	0	0	3.9	-	65	0	0	3.4	-	65	0	0	6.9	-
66	0	0	sand	-	66	0	0	7.9	-	66	0	0	10.0	-
67	0	0	4.7	-	67	0	0	3.9	-	67	0	0	8.3	-
68	0	0	1.5	-	68	0	0	4.6	-	68	0	0	3.2	-
69	0	0	4.6	-	69	0	0	10.0	-	69	0	0	9.5	-
70	0	0	6.5	0.25	70	0	0	7.0	0.5	70	0	0	8.0	0
71	0	0	14.9	-	71	0	0	4.4	-	71	0	0	5.5	-
72	0	0	11.8	-	72	0	0	10.1	-	72	0	0	8.0	-
73	0	0	5.3	-	73	0	0	5.7	-	73	0	0	4.9	-
74	0	0	sand	-	74	0	0	8.9	-	74	0	0	6.3	-
75	0	0	4.0	-	75	0	0	2.5	-	75	0	0	5.0	-
76	0	0	9.1	-	76	0	0	2.5	-	76	0	0	4.9	-
77	0	0	3.7	-	77	0	0	6.9	-	77	0	0	8.7	-
78	0	0	10.0	-	78	0	0	6.1	-	78	0	0	5.0	-
79	0	0	7.1	-	79	0	0	11.7	-	79	0	0	12.6	-
80	0	0	6.6	0.25	80	0	0	4.1	0.25	80	0	0	7.4	0.5
81	0	0	6.8	-	81	0	0	5.1	-	81	0	0	8.1	-
82	0	0	7.5	-	82	0	0	14.5	-	82	0	0	7.7	-
83	0	0	3.4	-	83	0	0	8.8	-	83	0	0	9.0	-
84	0	0	4.1	-	84	0	0	3.9	-	84	0	0	8.9	-
85	0	0	5.2	-	85	0	0	4.9	-	85	0	0	6.7	-
86	0	0	4.4	-	86	0	0	4.4	-	86	0	0	2.6	-
87	0	0	5.0	-	87	0	0	4.4	-	87	0	0	5.9	-
88	0	0	4.6	-	88	0	0	9.7	-	88	0	0	4.6	-
89	0	0	5.3	-	89	0	0	18.0	-	89	0	0	3.9	-
90	0	0	9.4	0.5	90	0	0	3.5	0	90	0	0	9.8	0.5
91	0	0	3.4	-	91	0	0	15.0	-	91	0	0	5.1	-
92	0	0	sand	-	92	0	0	4.9	-	92	0	0	4.4	-
93	0	0	5.1	-	93	0	0	5.0	-	93	0	0	1.1	-
94	0	0	4.9	-	94	0	0	3.9	-	94	0	0	8.4	-
95	0	0	3.8	-	95	0	0	2.7	-	95	0	0	16.5	-
96	0	0	2.6	-	96	0	0	10.5	-	96	0	0	4.1	-
97	0	0	4.0	-	97	0	0	5.8	-	97	0	0	6.0	-
98	0	0	6.0	-	98	0	0	6.1	-	98	0	0	6.3	-
99	0	0	7.9	-	99	0	0	9.9	-	99	0	0	4.1	-
100	0	0	7.4	0.25	100	0	0	10.5	0.75	100	0	0	2.1	0
Minimum	**0.0**	**0.0**	**1.3**	**0**	**Minimum**	**0.0**	**0.0**	**2.4**	**0**	**Minimum**	**0.0**	**0.0**	**1.1**	**0**
Maximum	**0.0**	**0.0**	**14.9**	**0.75**	**Maximum**	**0.0**	**0.0**	**18.0**	**0.75**	**Maximum**	**0.0**	**0.0**	**21.0**	**0.5**
Mean	**0.0**	**0.0**	**5.6**	**0.3**	**Mean**	**0.0**	**0.0**	**7.0**	**0.4**	**Mean**	**0.0**	**0.0**	**7.3**	**0.2**
Standard dev.	**0.0**	**0.0**	**2.4**	**0.2**	**Standard dev.**	**0.0**	**0.0**	**3.2**	**0.3**	**Standard dev.**	**0.0**	**0.0**	**3.2**	**0.2**
Geometric mean	**na**	**na**	**5.1**	**na**	**Geometric mean**	**na**	**na**	**6.3**	**na**	**Geometric mean**	**na**	**na**	**6.5**	**na**
Median	**0.0**	**0.0**	**5.3**	**0**	**Median**	**0.0**	**0.0**	**6.2**	**0**	**Median**	**0.0**	**0.0**	**6.8**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_TC2 / THCK (1)					GH_TC2 / THCK (2)					GH_TC2 / THCK (3)				
Rock	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**	**Rock**	**Concreted Status**	**Calcite Presence**	**Intermediate Axis (cm)**	**Embedd -edness**
1	0	1	2.4	-	1	0	1	2.9	-	1	0	0	8.8	-
2	0	0	1.9	-	2	0	1	3.4	-	2	0	0	4.5	-
3	0	1	4.2	-	3	0	1	3.1	-	3	0	0	1.0	-
4	0	0	3.9	-	4	0	0	1.4	-	4	0	0	sand	-
5	0	1	3.8	-	5	0	-	sand	-	5	0	1	7.6	-
6	0	0	0.9	-	6	0	s	s	-	6	0	0	9.8	-
7	0	1	2.0	-	7	0	0	6.9	-	7	0	0	7.4	-
8	0	0	1.4	-	8	0	-	sand	-	8	0	1	8.5	-
9	0	0	2.1	-	9	0	-	sand	-	9	0	1	12.5	-
10	0	1	7.5	0.5	10	0	-	sand	1	10	0	0	7.5	0.75
11	0	1	4.5	-	11	0	1	2.6	-	11	0	0	2.0	-
12	0	0	8.0	-	12	0	1	3.3	-	12	0	-	sand	-
13	0	0	0.7	-	13	0	1	5.8	-	13	0	0	2.6	-
14	0	1	2.8	-	14	0	0	2.7	-	14	0	-	sand	-
15	0	0	2.4	-	15	0	0	1.6	-	15	0	-	sand	-
16	0	1	5.5	-	16	0	0	0.6	-	16	0	0	2.3	-
17	0	0	1.5	-	17	0	0	9.9	-	17	0	0	4.3	-
18	0	0	1.1	-	18	0	1	3.5	-	18	0	0	7.5	-
19	0	1	2.0	-	19	0	1	3.8	-	19	0	1	4.7	-
20	0	0	1.5	0	20	0	1	2.2	0.5	20	0	1	2.1	0
21	0	0	3.3	-	21	0	0	5.2	-	21	0	0	9.5	-
22	0	1	2.0	-	22	0	0	2.2	-	22	0	0	1.4	-
23	0	-	sand	-	23	0	1	5.4	-	23	0	1	3.3	-
24	0	-	sand	-	24	0	1	6.9	-	24	0	1	5.1	-
25	0	1	4.5	-	25	0	1	2.2	-	25	0	0	6.7	-
26	0	0	3.2	-	26	0	0	4.7	-	26	0	0	3.1	-
27	0	0	5.7	-	27	0	1	3.8	-	27	0	0	4.8	-
28	0	1	5.5	-	28	0	1	3.2	-	28	0	0	3.3	-
29	0	1	6.9	-	29	0	1	2.5	-	29	0	0	3.2	-
30	0	1	2.5	0.75	30	0	0	4.1	0	30	0	0	6.1	0.5
31	0	0	1.0	-	31	0	1	3.3	-	31	0	0	7.3	-
32	0	1	5.5	-	32	0	0	4.1	-	32	0	1	5.3	-
33	0	0	2.5	-	33	0	0	4.0	-	33	0	0	6.5	-
34	0	0	4.0	-	34	0	1	5.2	-	34	0	0	3.4	-
35	0	1	4.0	-	35	0	1	2.3	-	35	0	1	2.6	-
36	0	0	3.0	-	36	0	0	1.7	-	36	0	0	1.6	-
37	0	1	9.0	-	37	0	1	1.5	-	37	0	0	3.6	-
38	0	0	1.2	-	38	0	-	sand	-	38	0	1	11.8	-
39	0	-	sand	-	39	0	1	0.7	-	39	0	0	8.0	-
40	0	0	2.7	0.5	40	0	1	2.0	0	40	0	0	4.8	0
41	0	0	3.7	-	41	0	1	1.8	-	41	0	1	3.4	-
42	0	-	sand	-	42	0	0	4.4	-	42	0	1	4.3	-
43	0	-	sand	-	43	0	0	7.1	-	43	0	0	9.3	-
44	0	0	1.4	-	44	0	-	sand	-	44	0	0	5.1	-
45	0	-	sand	-	45	0	1	2.9	-	45	0	-	sand	-
46	0	s	1.7	-	46	0	-	sand	-	46	0	0	4.7	-
47	0	-	sand	-	47	0	0	2.7	-	47	0	-	sand	-
48	0	1	2.9	-	48	0	0	3.6	-	48	0	0	2.6	-
49	0	0	3.5	-	49	0	1	6.7	-	49	0	1	6.2	-
50	0	0	s	0.5	50	0	0	2.4	0	50	0	0	4.4	0
51	0	0	2.0	-	51	0	1	3.6	-	51	0	0	3.8	-
52	0	1	1.9	-	52	0	0	1.7	-	52	0	0	1.4	-
53	0	1	3.5	-	53	0	0	4.5	-	53	0	-	sand	-
54	0	1	3.3	-	54	0	0	2.6	-	54	0	0	0.9	-
55	0	1	6.9	-	55	0	0	4.8	-	55	0	0	4.2	-
56	0	1	3.0	-	56	0	1	6.8	-	56	0	0	2.3	-
57	0	-	sand	-	57	0	0	4.1	-	57	0	0	3.1	-
58	0	0	2.2	-	58	0	1	4.3	-	58	0	0	4.2	-
59	0	0	3.5	-	59	0	0	3.5	-	59	0	1	3.8	-
60	0	-	sand	1	60	0	0	1.1	0	60	0	0	10.0	0.5
61	0	0	1.2	-	61	0	0	4.5	-	61	0	1	12.3	-
62	0	0	1.5	-	62	0	0	2.7	-	62	0	1	6.5	-
63	0	1	4.4	-	63	0	1	2.2	-	63	0	1	3.8	-
64	0	0	1.5	-	64	0	0	1.4	-	64	0	-	sand	-
65	0	1	1.9	-	65	0	1	4.4	-	65	0	0	4.8	-
66	0	0	2.0	-	66	0	1	1.4	-	66	0	0	3.3	-
67	0	-	sand	-	67	0	1	0.9	-	67	0	0	1.1	-
68	0	0	2.2	-	68	0	0	1.3	-	68	0	1	4.7	-
69	0	1	2.0	-	69	0	1	3.9	-	69	0	0	8.0	-
70	0	1	9.0	0	70	0	-	sand	1	70	0	0	3.9	0
71	0	0	1.9	-	71	0	0	4.3	-	71	0	0	9.7	-
72	0	0	5.5	-	72	0	0	4.1	-	72	0	0	3.8	-
73	0	1	3.9	-	73	0	0	3.1	-	73	0	1	3.2	-
74	0	1	5.2	-	74	0	1	2.8	-	74	0		6.0	-
75	0	-	sand	-	75	0	1	2.1	-	75	0	-	silt	-
76	0	1	5.0	-	76	0	-	sand	-	76	0	-	sand	-
77	0	s	sand	-	77	0	1	4.1	-	77	0	0	12.6	-
78	0	-	sand	-	78	0	1	3.7	-	78	0	0	4.4	-
79	0	-	sand	-	79	0	0	2.6	-	79	0	1	4.3	-
80	0	0	1.9	0.5	80	0	1	2.8	0.5	80	0	0	3.2	0.25
81	0	0	0.9	-	81	0	0	3.3	-	81	0	0	6.0	-
82	0	1	3.5	-	82	0	0	1.9	-	82	0	0	10.5	-
83	0	1	3.2	-	83	0	-	sand	-	83	0	0	4.5	-
84	0	0	1.8	-	84	0	-	sand	-	84	0	1	11.5	-
85	0	0	0.6	-	85	0	1	3.3	-	85	0	0	8.5	-
86	0	0	4.0	-	86	0	-	sand	-	86	0	0	9.6	-
87	0	1	2.5	-	87	0	1	3.7	-	87	0	0	8.8	-
88	0	0	1.6	-	88	0	-	sand	-	88	0	0	7.7	-
89	0	-	sand	-	89	0	1	1.9	-	89	0	0	6.3	-
90	0	1	2.8	0.75	90	0	0	1.7	0.75	90	0	0	7.8	0.75
91	0	-	sand	-	91	0	1	1.0	-	91	0	1	4.8	-
92	0	1	2.2	-	92	0	1	2.3	-	92	0	-	sand	-
93	0	-	sand	-	93	0	1	4.9	-	93	0	1	4.4	-
94	0	1	4.2	-	94	0	0	2.2	-	94	0	-	sand	-
95	0	-	sand	-	95	0	0	4.4	-	95	0	1	3.3	-
96	0	-	sand	-	96	0	1	2.5	-	96	0	-	sand	-
97	0	1	3.2	-	97	0	1	4.4	-	97	0	1	6.3	-
98	0	1	5.5	-	98	0	1	5.4	-	98	0	0	3.4	-
99	0	0	0.8	-	99	0	0	4.2	-	99	0	0	6.2	-
100	0	0	3.5	0	100	0	0	6.0	0	100	0	0	2.9	0.5
Minimum	**0.0**	**0.0**	**0.6**	**0**	**Minimum**	**0.0**	**0.0**	**0.6**	**0**	**Minimum**	**0.0**	**0.0**	**0.9**	**0**
Maximum	**0.0**	**1.0**	**9.0**	**1**	**Maximum**	**0.0**	**1.0**	**9.9**	**1**	**Maximum**	**0.0**	**1.0**	**12.6**	**0.75**
Mean	**0.0**	**0.5**	**3.2**	**0.5**	**Mean**	**0.0**	**0.5**	**3.4**	**0.4**	**Mean**	**0.0**	**0.3**	**5.5**	**0.3**
Standard dev.	**0.0**	**0.5**	**1.9**	**0.3**	**Standard dev.**	**0.0**	**0.5**	**1.7**	**0.4**	**Standard dev.**	**0.0**	**0.5**	**2.9**	**0.3**
Geometric mean	**na**	**na**	**2.7**	**na**	**Geometric mean**	**na**	**na**	**3.0**	**na**	**Geometric mean**	**na**	**na**	**4.7**	**na**
Median	**0.0**	**0.0**	**2.8**	**1**	**Median**	**0.0**	**1.0**	**3.3**	**0**	**Median**	**0.0**	**0.0**	**4.7**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

RG_SCDTC (1)					RG_SCDTC (2)					RG_SCDTC (3)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	7.6	-	1	0	1	5.6	-	1	0	0	5.2	-
2	0	0	6.2	-	2	0	1	8.2	-	2	0	0	4.2	-
3	0	0	5.9	-	3	0	0	6.3	-	3	0	0	3.1	-
4	0	0	5.3	-	4	0	1	7.4	-	4	0	0	3.8	-
5	0	1	5.2	-	5	0	0	4.0	-	5	0	0	4.4	-
6	0	0	5.6	-	6	0	1	9.2	-	6	0	1	2.8	-
7	0	0	5.1	-	7	0	1	4.7	-	7	0	0	1.9	-
8	0	0	9.4	-	8	0	0	6.6	-	8	0	0	5.3	-
9	0	0	5.7	-	9	0	0	4.6	-	9	0	0	2.7	-
10	0	1	4.9	0.25	10	0	1	18.5	0.75	10	0	0	3.9	0
11	0	1	5.3	-	11	0	0	3.4	-	11	0	1	5.0	-
12	0	0	5.4	-	12	0	1	5.7	-	12	0	0	8.9	-
13	0	1	7.8	-	13	0	1	11.5	-	13	0	0	3.8	-
14	0	0	12.5	-	14	0	1	11.0	-	14	0	1	7.9	-
15	0	1	10.6	-	15	0	1	8.6	-	15	0	1	11.0	-
16	0	1	6.2	-	16	0	1	5.0	-	16	0	1	8.1	-
17	0	1	4.9	-	17	0	1	5.3	-	17	0	1	3.3	-
18	0	0	1.7	-	18	0	1	5.6	-	18	0	0	5.8	-
19	0	1	6.0	-	19	0	0	4.2	-	19	0	0	2.4	-
20	0	1	5.1	0	20	0	1	5.9	0.25	20	0	0	3.6	0.25
21	0	0	4.9	-	21	0	1	6.0	-	21	0	1	7.0	-
22	0	0	5.1	-	22	0	1	6.8	-	22	0	0	9.0	-
23	0	1	5.7	-	23	0	0	4.1	-	23	0	1	6.8	-
24	0	0	6.9	-	24	0	1	6.2	-	24	0	1	6.9	-
25	0	0	6.8	-	25	0	0	5.3	-	25	0	0	6.6	-
26	0	1	8.4	-	26	0	0	4.5	-	26	0	0	6.2	-
27	0	1	7.3	-	27	0	0	5.2	-	27	0	1	7.5	-
28	0	1	5.7	-	28	0	1	15.2	-	28	0	1	8.3	-
29	0	1	2.9	-	29	0	1	7.8	-	29	0	0	2.8	-
30	0	0	6.3	0.25	30	0	0	4.2	0	30	0	1	8.0	0.25
31	0	0	5.6	-	31	0	0	4.4	-	31	0	0	1.6	-
32	0	0	5.5	-	32	0	0	3.9	-	32	0	1	6.9	-
33	0	1	8.8	-	33	0	0	6.5	-	33	0	1	7.0	-
34	0	0	5.7	-	34	0	1	4.5	-	34	0	1	3.5	-
35	0	1	9.4	-	35	0	0	1.6	-	35	0	1	5.2	-
36	0	0	5.6	-	36	0	1	6.0	-	36	0	1	5.5	-
37	0	1	9.3	-	37	0	0	2.2	-	37	0	0	4.0	-
38	0	1	6.5	-	38	0	1	5.7	-	38	0	0	4.1	-
39	0	1	6.9	-	39	0	0	2.5	-	39	0	1	5.2	-
40	0	0	4.0	0	40	0	1	4.4	0.5	40	0	0	4.3	0
41	0	1	6.5	-	41	0	1	4.5	-	41	0	0	3.7	-
42	0	0	4.3	-	42	0	0	7.6	-	42	0	0	3.6	-
43	0	0	4.1	-	43	0	1	5.2	-	43	0	0	5.1	-
44	0	0	5.2	-	44	0	0	4.7	-	44	0	0	3.9	-
45	0	0	3.3	-	45	0	1	6.5	-	45	0	1	6.2	-
46	0	0	5.7	-	46	0	0	s	-	46	0	1	8.1	-
47	0	0	6.6	-	47	0	1	12.6	-	47	0	1	10.1	-
48	0	0	4.9	-	48	0	1	5.8	-	48	0	1	8.6	-
49	0	0	5.4	-	49	0	1	9.9	-	49	0	1	7.1	-
50	0	0	3.9	0.25	50	0	1	7.2	0.5	50	0	0	4.2	0
51	0	1	7.6	-	51	0	1	7.6	-	51	0	0	5.8	-
52	0	1	11.4	-	52	0	1	8.8	-	52	0	1	5.2	-
53	0	0	6.9	-	53	0	0	4.3	-	53	0	0	5.5	-
54	0	1	6.6	-	54	0	0	2.2	-	54	0	1	7.3	-
55	0	0	6.8	-	55	0	1	7.9	-	55	0	0	4.9	-
56	0	0	4.2	-	56	0	1	5.4	-	56	0	1	9.9	-
57	0	0	6.7	-	57	0	1	5.9	-	57	0	0	7.8	-
58	0	1	6.1	-	58	0	1	4.7	-	58	0	0	6.4	-
59	0	1	7.9	-	59	0	0	4.9	-	59	0	1	13.1	-
60	0	1	11.7	0.75	60	0	1	5.6	0.25	60	0	0	5.4	0.25
61	0	1	10.6	-	61	0	0	5.0	-	61	0	0	6.7	-
62	0	1	5.2	-	62	0	1	5.8	-	62	0	1	3.8	-
63	0	0	3.9	-	63	0	1	12.7	-	63	0	1	3.5	-
64	0	0	5.3	-	64	0	0	10.0	-	64	0	1	5.5	-
65	0	1	5.6	-	65	0	1	5.3	-	65	0	0	6.1	-
66	0	0	4.3	-	66	0	0	5.3	-	66	0	0	6.2	-
67	0	0	3.9	-	67	0	1	8.4	-	67	0	1	5.8	-
68	0	0	3.4	-	68	0	0	4.4	-	68	0	1	10.5	-
69	0	0	4.4	-	69	0	1	6.0	-	69	0	1	5.4	-
70	0	0	4.8	0	70	0	1	8.6	0.75	70	0	1	9.2	0
71	0	1	7.0	-	71	0	1	6.9	-	71	0	1	5.6	-
72	0	1	5.2	-	72	0	0	5.0	-	72	0	0	8.8	-
73	0	0	6.1	-	73	0	1	4.7	-	73	0	0	4.8	-
74	0	0	2.2	-	74	0	1	4.9	-	74	0	0	4.0	-
75	0	1	4.9	-	75	0	s	s	-	75	0	1	4.9	-
76	0	1	7.8	-	76	0	1	6.0	-	76	0	0	5.2	-
77	0	0	6.0	-	77	0	0	9.0	-	77	0	0	5.7	-
78	0	0	5.8	-	78	0	0	4.0	-	78	0	0	4.9	-
79	0	1	6.7	-	79	0	1	3.9	-	79	0	1	11.5	-
80	0	0	7.2	0.25	80	0	1	7.3	0.75	80	0	0	6.6	0
81	0	1	7.0	-	81	0	1	10.9	-	81	0	1	8.7	-
82	0	0	3.4	-	82	0	1	5.3	-	82	0	1	5.5	-
83	0	0	6.6	-	83	0	1	12.1	-	83	0	0	5.7	-
84	0	0	5.6	-	84	0	1	4.0	-	84	0	1	6.8	-
85	0	1	4.3	-	85	0	0	6.0	-	85	0	1	5.7	-
86	0	1	4.6	-	86	0	1	7.0	-	86	0	0	11.1	-
87	0	0	4.3	-	87	0	1	9.2	-	87	0	0	6.7	-
88	0	0	2.2	-	88	0	1	4.3	-	88	0	0	8.7	-
89	0	0	2.5	-	89	0	0	3.2	-	89	0	1	8.1	-
90	0	1	3.9	0	90	0	0	4.3	0	90	0	0	3.8	0
91	0	1	4.5	-	91	0	1	6.4	-	91	0	1	8.8	-
92	0	0	5.7	-	92	0	0	5.2	-	92	0	0	4.9	-
93	0	0	7.9	-	93	0	0	3.5	-	93	0	0	8.5	-
94	0	1	8.8	-	94	0	0	8.3	-	94	0	0	7.1	-
95	0	0	9.4	-	95	0	0	4.2	-	95	0	0	1.6	-
96	0	1	9.0	-	96	0	0	4.3	-	96	0	0	8.5	-
97	0	0	5.8	-	97	0	0	4.2	-	97	0	0	6.2	-
98	0	0	5.9	-	98	0	0	6.6	-	98	0	0	8.1	-
99	0	0	3.2	-	99	0	0	4.5	-	99	0	0	4.6	-
100	0	0	4.1	0	100	0	0	8.6	0	100	0	1	5.6	0.25
Minimum	**0.0**	**0.0**	**1.7**	**0**	**Minimum**	**0.0**	**0.0**	**1.6**	**0**	**Minimum**	**0.0**	**0.0**	**1.6**	**0**
Maximum	**0.0**	**1.0**	**12.5**	**0.75**	**Maximum**	**0.0**	**1.0**	**18.5**	**0.75**	**Maximum**	**0.0**	**1.0**	**13.1**	**0.25**
Mean	**0.0**	**0.4**	**6.0**	**0.2**	**Mean**	**0.0**	**0.6**	**6.3**	**0.4**	**Mean**	**0.0**	**0.4**	**6.0**	**0.1**
Standard dev.	**0.0**	**0.5**	**2.1**	**0.2**	**Standard dev.**	**0.0**	**0.5**	**2.7**	**0.3**	**Standard dev.**	**0.0**	**0.5**	**2.3**	**0.1**
Geometric mean	**na**	**na**	**5.6**	**na**	**Geometric mean**	**na**	**na**	**5.8**	**na**	**Geometric mean**	**na**	**na**	**5.6**	**na**
Median	**0.0**	**0.0**	**5.7**	**0**	**Median**	**0.0**	**1.0**	**5.6**	**0**	**Median**	**0.0**	**0.0**	**5.7**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ERC / EL20 (1)					GH_ERC / EL20 (2)					GH_ERC / EL20 (3)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	12.0	-	1	0	0	9.4	-	1	0	1	13.0	-
2	0	0	4.8	-	2	0	0	13.2	-	2	0	1	5.0	-
3	0	0	7.7	-	3	0	0	6.5	-	3	0	1	4.4	-
4	0	0	14.0	-	4	0	0	7.0	-	4	0	1	9.3	-
5	0	0	14.1	-	5	0	0	4.3	-	5	0	0	6.1	-
6	0	0	5.7	-	6	0	0	8.2	-	6	0	1	14.6	-
7	0	0	12.9	-	7	0	0	7.5	-	7	0	0	3.0	-
8	0	0	4.3	-	8	0	1	7.5	-	8	0	0	9.4	-
9	0	0	8.2	-	9	0	1	7.0	-	9	0	0	3.4	-
10	0	0	9.9	0.25	10	0	0	6.5	0.25	10	0	0	5.6	0.5
11	0	0	7.1	-	11	0	1	7.0	-	11	1	1	3.6	-
12	0	1	4.3	-	12	0	0	3.4	-	12	0	0	3.1	-
13	0	0	11.0	-	13	0	1	5.5	-	13	0	1	3.5	-
14	0	0	9.1	-	14	0	1	7.0	-	14	0	0	8.0	-
15	0	0	5.2	-	15	0	1	6.9	-	15	0	1	14.3	-
16	0	0	6.1	-	16	0	1	11.0	-	16	0	0	0.9	-
17	0	0	4.4	-	17	0	1	6.6	-	17	1	1	11.7	-
18	0	0	9.9	-	18	0	1	8.3	-	18	0	1	3.1	-
19	0	0	2.4	-	19	0	0	7.6	-	19	0	0	2.6	-
20	0	0	8.0	0.25	20	0	0	7.4	0.5	20	0	1	6.5	0
21	0	0	7.9	-	21	0	1	10.2	-	21	0	1	5.5	-
22	0	0	3.4	-	22	0	0	6.5	-	22	0	1	4.6	-
23	0	0	6.0	-	23	0	1	8.5	-	23	0	1	6.3	-
24	0	0	7.1	-	24	0	1	12.0	-	24	0	1	4.9	-
25	0	0	3.2	-	25	0	0	9.1	-	25	0	0	13.0	-
26	0	0	9.4	-	26	0	1	9.0	-	26	0	0	2.4	-
27	0	0	3.6	-	27	0	0	6.6	-	27	0	0	3.6	-
28	0	0	4.5	-	28	0	1	4.0	-	28	0	0	4.0	-
29	0	0	7.4	-	29	0	1	2.6	-	29	0	1	9.4	-
30	0	0	8.5	0.5	30	0	1	8.6	0.25	30	0	0	14.4	0.5
31	0	0	2.7	-	31	0	0	5.6	-	31	0	0	15.7	-
32	0	0	10.6	-	32	0	1	15.1	-	32	0	0	16.5	-
33	0	0	7.4	-	33	0	0	4.2	-	33	0	0	6.8	-
34	0	0	8.2	-	34	0	1	8.6	-	34	0	1	6.9	-
35	0	0	6.4	-	35	0	0	3.1	-	35	0	1	11.3	-
36	-	-	sand	-	36	0	0	9.2	-	36	0	0	4.6	-
37	0	0	7.6	-	37	0	1	7.3	-	37	0	1	14.0	-
38	0	0	11.3	-	38	0	1	9.0	-	38	0	0	10.0	-
39	0	0	4.9	-	39	0	0	6.0	-	39	0	1	5.0	-
40	0	0	3.7	0	40	0	1	8.0	0.75	40	0	1	8.2	0.5
41	0	0	5.6	-	41	0	1	7.0	-	41	0	0	10.7	-
42	0	1	4.4	-	42	0	1	4.0	-	42	0	1	6.0	-
43	0	0	8.3	-	43	0	1	7.1	-	43	-	-	s	-
44	0	0	8.9	-	44	0	0	8.2	-	44	0	0	3.0	-
45	0	0	1.5	-	45	0	1	9.0	-	45	0	0	4.9	-
46	0	0	3.0	-	46	0	0	6.4	-	46	0	0	6.3	-
47	0	0	5.7	-	47	0	0	4.3	-	47	0	0	6.9	-
48	0	0	6.3	-	48	0	1	13.1	-	48	0	0	6.2	-
49	0	0	3.5	-	49	0	0	4.2	-	49	0	0	3.0	-
50	0	0	11.0	0	50	0	1	5.9	0.5	50	0	1	6.2	0.5
51	0	0	6.2	-	51	0	1	8.0	-	51	0	0	4.7	-
52	0	0	4.9	-	52	0	1	6.2	-	52	0	1	6.9	-
53	0	0	12.6	-	53	0	1	4.4	-	53	0	1	11.3	-
54	0	0	7.1	-	54	0	1	9.0	-	54	0	0	7.1	-
55	0	0	sand	-	55	0	1	7.2	-	55	0	0	8.0	-
56	0	0	8.4	-	56	0	0	4.2	-	56	0	0	1.5	-
57	0	0	5.1	-	57	0	0	1.9	-	57	0	0	3.1	-
58	0	0	5.0	-	58	0	0	8.9	-	58	0	1	16.6	-
59	0	0	12.0	-	59	0	0	4.3	-	59	0	1	7.1	-
60	0	0	4.1	0	60	0	1	5.5	0.5	60	0	0	6.0	0
61	0	0	2.6	-	61	0	0	5.9	-	61	0	0	8.1	-
62	0	0	0.8	-	62	0	0	5.4	-	62	0	1	4.7	-
63	0	0	4.3	-	63	0	0	3.6	-	63	-	-	s	-
64	0	0	6.3	-	64	0	1	8.6	-	64	0	0	4.6	-
65	0	0	9.1	-	65	0	1	7.6	-	65	0	0	5.3	-
66	0	0	0.5	-	66	0	0	5.4	-	66	0	0	9.7	-
67	0	s	s	-	67	0	0	8.6	-	67	0	1	4.5	-
68	0	0	2.1	-	68	0	0	7.2	-	68	0	1	8.6	-
69	0	0	5.6	-	69	0	1	11.6	-	69	0	1	12.1	-
70	0	0	6.9	0	70	0	0	2.6	0.25	70	0	1	8.0	0.25
71	0	0	sand	-	71	0	1	9.4	-	71	0	0	7.6	-
72	0	0	5.5	-	72	0	0	5.4	-	72	0	0	8.9	-
73	0	0	2.7	-	73	0	0	8.9	-	73	0	1	12.0	-
74	0	1	6.5	-	74	0	0	2.1	-	74	0	1	6.5	-
75	0	0	6.2	-	75	0	0	5.4	-	75	0	1	4.9	-
76	0	0	7.0	-	76	0	0	6.0	-	76	0	0	3.7	-
77	0	0	4.6	-	77	0	1	4.1	-	77	0	1	6.5	-
78	0	0	2.1	-	78	0	1	6.9	-	78	0	0	3.1	-
79	0	0	2.0	-	79	0	1	8.0	-	79	0	0	4.4	-
80	0	1	5.5	0	80	0	1	4.5	0.5	80	0	1	7.1	0.25
81	0	0	3.7	-	81	0	1	6.5	-	81	0	0	5.6	-
82	0	0	3.1	-	82	0	1	6.3	-	82	0	0	6.2	-
83	0	0	4.7	-	83	0	0	2.6	-	83	0	1	14.3	-
84	0	0	5.0	-	84	0	0	3.4	-	84	0	1	3.9	-
85	0	0	2.0	-	85	0	0	5.6	-	85	0	0	3.1	-
86	0	s	s	-	86	0	1	6.3	-	86	0	0	2.0	-
87	0	0	11.3	-	87	0	0	4.3	-	87	0	1	8.6	-
88	0	0	5.0	-	88	0	1	4.4	-	88	0	1	18.5	-
89	0	0	6.2	-	89	0	0	4.6	-	89	0	1	6.5	-
90	0	0	3.3	0	90	0	0	3.6	0.25	90	0	0	4.7	0.25
91	0	1	4.3	-	91	0	1	6.4	-	91	0	0	7.7	-
92	0	0	2.2	-	92	0	1	7.6	-	92	0	0	8.2	-
93	0	0	5.0	-	93	0	1	9.5	-	93	0	1	20.0	-
94	0	0	4.5	-	94	0	0	5.4	-	94	0	1	16.5	-
95	0	0	13.2	-	95	0	0	4.6	-	95	0	0	s	-
96	0	1	4.6	-	96	0	1	7.1	-	96	0	0	5.0	-
97	0	0	1.7	-	97	0	1	4.6	-	97	0	1	6.0	-
98	0	0	10.0	-	98	0	0	4.5	-	98	0	0	6.2	-
99	0	0	1.6	-	99	0	1	9.2	-	99	0	0	3.0	-
100	0	0	4.3	0	100	0	1	6.0	0.75	100	0	0	5.6	0
Minimum	**0.0**	**0.0**	**0.5**	**0**	**Minimum**	**0.0**	**0.0**	**1.9**	**0.25**	**Minimum**	**0.0**	**0.0**	**0.9**	**0**
Maximum	**0.0**	**1.0**	**14.1**	**0.5**	**Maximum**	**0.0**	**1.0**	**15.1**	**0.75**	**Maximum**	**1.0**	**1.0**	**20.0**	**0.5**
Mean	**0.0**	**0.1**	**6.2**	**0.1**	**Mean**	**0.0**	**0.5**	**6.7**	**0.5**	**Mean**	**0.0**	**0.5**	**7.3**	**0.3**
Standard dev.	**0.0**	**0.2**	**3.2**	**0.2**	**Standard dev.**	**0.0**	**0.5**	**2.5**	**0.2**	**Standard dev.**	**0.1**	**0.5**	**4.1**	**0.2**
Geometric mean	**na**	**na**	**5.3**	**na**	**Geometric mean**	**na**	**na**	**6.2**	**na**	**Geometric mean**	**na**	**na**	**6.2**	**na**
Median	**0.0**	**0.0**	**5.6**	**0**	**Median**	**0.0**	**1.0**	**6.6**	**1**	**Median**	**0.0**	**0.0**	**6.2**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.5: Pebble and Calcite Count for the GHO LAEMP, September 2019

GH_ERC / EL20 (4)					GH_ERC / EL20 (5)				
Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness	Rock	Concreted Status	Calcite Presence	Intermediate Axis (cm)	Embedd -edness
1	0	0	7.8	-	1	0	0	11.0	-
2	0	0	7.9	-	2	0	0	7.0	-
3	0	1	11.2	-	3	0	0	19.2	-
4	0	1	9.8	-	4	0	1	13.2	-
5	0	0	7.2	-	5	0	0	8.6	-
6	0	0	8.2	-	6	0	0	9.4	-
7	0	1	6.7	-	7	0	1	1.0	-
8	0	1	8.3	-	8	0	1	2.5	-
9	0	0	3.9	-	9	0	1	16.4	-
10	0	1	6.2	0.25	10	0	0	5.0	0.25
11	0	0	7.9	-	11	0	0	8.5	-
12	0	0	8.7	-	12	0	0	10.2	-
13	0	0	4.9	-	13	0	0	16.0	-
14	0	1	12.6	-	14	0	0	21.5	-
15	0	1	11.2	-	15	0	0	14.3	-
16	0	0	3.6	-	16	0	0	8.0	-
17	0	0	6.0	-	17	0	0	4.9	-
18	0	0	2.9	-	18	0	1	4.5	-
19	0	1	5.3	-	19	0	0	5.5	-
20	0	1	3.4	0.75	20	0	0	4.2	0.25
21	0	1	6.6	-	21	0	0	5.1	-
22	0	1	6.4	-	22	0	0	15.5	-
23	0	1	6.5	-	23	0	0	8.4	-
24	0	1	16.0	-	24	0	0	17.5	-
25	0	1	7.0	-	25	0	0	4.3	-
26	0	1	5.3	-	26	0	1	11.6	-
27	0	1	10.4	-	27	0	0	7.0	-
28	0	1	8.6	-	28	0	0	10.4	-
29	0	1	7.9	-	29	0	1	10.9	-
30	0	1	10.1	0.25	30	0	0	4.0	0.75
31	0	1	9.5	-	31	0	0	2.6	-
32	0	1	15.2	-	32	0	0	4.4	-
33	0	1	8.3	-	33	0	0	1.1	-
34	0	1	5.6	-	34	0	0	5.7	-
35	0	0	1.3	-	35	0	0	5.5	-
36	0	1	6.2	-	36	0	0	9.4	-
37	0	1	7.4	-	37	0	0	s	-
38	0	1	6.5	-	38	0	0	3.0	-
39	0	1	7.6	-	39	0	0	3.2	-
40	0	0	12.2	0.25	40	0	0	4.9	0.5
41	0	1	5.6	-	41	0	0	6.7	-
42	0	1	10.6	-	42	0	1	13.1	-
43	0	1	4.2	-	43	0	0	4.6	-
44	0	0	0.9	-	44	0	0	s	-
45	0	0	2.0	-	45	0	1	6.6	-
46	0	1	5.2	-	46	0	0	4.9	-
47	0	1	2.1	-	47	0	0	3.5	-
48	0	0	14.0	-	48	0	0	4.9	-
49	0	1	8.0	-	49	0	0	7.0	-
50	0	0	5.1	0.25	50	0	0	6.2	0.75
51	0	0	5.6	-	51	0	1	7.6	-
52	0	1	5.7	-	52	0	1	9.7	-
53	0	1	10.3	-	53	0	0	3.4	-
54	0	1	5.2	-	54	0	0	9.1	-
55	0	1	10.1	-	55	0	1	10.1	-
56	0	1	14.2	-	56	0	0	21.3	-
57	0	1	9.7	-	57	0	0	3.6	-
58	0	0	9.6	-	58	0	0	5.0	-
59	0	1	5.4	-	59	0	0	5.1	-
60	0	0	4.0	0	60	0	0	7.5	0
61	0	0	6.1	-	61	0	0	6.6	-
62	0	0	3.6	-	62	0	0	4.3	-
63	0	1	21.6	-	63	0	0	8.2	-
64	0	0	5.4	-	64	0	0	1.9	-
65	0	1	6.2	-	65	0	0	1.4	-
66	0	1	11.1	-	66	0	0	4.2	-
67	0	1	10.9	-	67	0	1	7.1	-
68	0	1	7.4	-	68	0	1	5.6	-
69	0	0	6.0	-	69	0	1	4.0	-
70	0	0	10.1	0	70	0	0	5.1	0.5
71	0	0	7.0	-	71	0	1	3.9	-
72	0	0	5.8	-	72	0	1	5.9	-
73	0	0	3.3	-	73	0	1	7.2	-
74	0	0	3.5	-	74	0	1	7.2	-
75	0	0	5.0	-	75	0	0	4.9	-
76	0	0	3.2	-	76	0	0	13.4	-
77	0	0	1.6	-	77	0	0	3.2	-
78	0	0	2.9	-	78	0	0	8.2	-
79	0	1	10.4	-	79	0	0	6.4	-
80	0	1	17.0	0	80	0	0	8.0	0
81	0	0	18.1	-	81	0	0	7.3	-
82	0	0	5.9	-	82	0	0	9.1	-
83	0	0	5.6	-	83	0	1	10.7	-
84	0	1	6.7	-	84	0	0	13.2	-
85	0	0	15.4	-	85	0	1	5.1	-
86	0	1	10.3	-	86	0	0	22.3	-
87	0	1	4.6	-	87	0	1	6.2	-
88	0	1	6.6	-	88	0	0	4.1	-
89	0	1	7.0	-	89	0	0	7.2	-
90	0	0	4.6	0.25	90	0	0	6.1	0.5
91	0	1	8.0	-	91	0	1	6.1	-
92	0	1	7.4	-	92	0	1	7.0	-
93	0	1	14.4	-	93	0	1	6.4	-
94	0	1	12.3	-	94	0	0	3.0	-
95	0	1	11.3	-	95	0	1	10.0	-
96	0	1	9.4	-	96	0	0	9.5	-
97	0	1	19.6	-	97	0	0	6.3	-
98	0	1	7.3	-	98	0	0	4.4	-
99	0	1	10.6	-	99	0	0	s	-
100	0	1	17.4	0.25	100	0	1	7.6	0
Minimum	**0.0**	**0.0**	**0.9**	**0**	**Minimum**	**0.0**	**0.0**	**1.0**	**0**
Maximum	**0.0**	**1.0**	**21.6**	**0.75**	**Maximum**	**0.0**	**1.0**	**22.3**	**0.75**
Mean	**0.0**	**0.6**	**8.0**	**0.2**	**Mean**	**0.0**	**0.3**	**7.6**	**0.4**
Standard dev.	**0.0**	**0.5**	**4.1**	**0.2**	**Standard dev.**	**0.0**	**0.4**	**4.4**	**0.3**
Geometric mean	**na**	**na**	**6.9**	**na**	**Geometric mean**	**na**	**na**	**6.4**	**na**
Median	**0.0**	**1.0**	**7.1**	**0**	**Median**	**0.0**	**0.0**	**6.6**	**0**

Note: "-" indicates embeddedness measured every tenth pebble, na = not applicable.

Table G.6: Channel Depth and Velocity Data, GHO LAEMP, September 2019

Replicate			1	2	3	4	5	Mean
Reference	**GH_ER2 / ELUGH**							
	1	Depth (cm)	17	25	48	71	100	52.2
		Velocity (m/s)	0.412	0.731	0.645	0.887	0.725	0.68
	2	Depth (cm)	18	36	47	53	51	41
		Velocity (m/s)	0.835	0.745	0.903	0.816	0.741	0.808
	3	Depth (cm)	30	57	53	50	33	44.6
		Velocity (m/s)	0.659	0.746	0.54	0.836	0.547	0.6656
Mine-exposed	**GH_ERSC4**							
	1	Depth (cm)	19.5	28	23	29	25	24.9
		Velocity (m/s)	0.263	0.174	0.592	0.524	0.514	0.4134
	2	Depth (cm)	14.5	34.9	32.3	26.4	23.8	26.38
		Velocity (m/s)	0.424	0.23	0.423	0.738	0.168	0.3966
	3	Depth (cm)	29.2	21.4	18.3	11.7	8.3	17.78
		Velocity (m/s)	0.523	0.808	0.636	0.318	0.381	0.5332
	GH_ER1A							
	1	Depth (cm)	19	24	30.5	32	44	29.9
		Velocity (m/s)	0.189	0.573	0.616	0.378	0.425	0.4362
	2	Depth (cm)	8	11.5	14	21.5	27	16.4
		Velocity (m/s)	0.116	0.112	0.298	0.409	0.365	0.26
	3	Depth (cm)	11	25	21	22	33	22.4
		Velocity (m/s)	0.172	0.135	0.15	0.172	0.293	0.1844
	RG_ERSC5							
	1	Depth (cm)	18	17.5	19	17	11	16.5
		Velocity (m/s)	0.416	0.42	0.46	0.599	0.264	0.4318
	2	Depth (cm)	15	25	25	17	18	20
		Velocity (m/s)	0.471	0.567	0.69	0.336	0.259	0.4646
	3	Depth (cm)	13	13	18	18	18	16
		Velocity (m/s)	0.294	0.445	0.707	0.933	0.977	0.6712
	GH_TC2 / THCK							
	1	Depth (cm)	10.5	6.5	11.5	6	5	7.9
		Velocity (m/s)	0.219	0.077	0.067	0.565	0.29	0.2436
	2	Depth (cm)	7	7	9.8	8.4	3	7.04
		Velocity (m/s)	0.274	0.434	0.466	0.287	0.074	0.307
	3	Depth (cm)	5.4	9.5	7.8	10	5	7.54
		Velocity (m/s)	0.192	0.389	0.486	0.077	0.038	0.2364
	RG_SCDTC							
	1	Depth (cm)	5.9	11.7	15.3	17.7	18.7	13.86
		Velocity (m/s)	0.081	0.339	0.354	0.394	0.4	0.3136
	2	Depth (cm)	8.4	13.3	12.6	8.3	13.7	11.26
		Velocity (m/s)	0.351	0.423	0.456	0.498	0.322	0.41
	3	Depth (cm)	11.4	11	10.5	15.7	16.3	12.98
		Velocity (m/s)	0.283	0.316	0.504	0.55	0.724	0.4754
	GH_ERC / EL20							
	1	Depth (cm)	20	55	65	43	52	47
		Velocity (m/s)	0.4	0.88	1.17	0.850	1.28	0.916
	2	Depth (cm)	12	26.5	39	47	56	36.1
		Velocity (m/s)	0.35	0.55	0.65	0.95	0.6	0.62
	3	Depth (cm)	8.5	13	39	69	62	38.3
		Velocity (m/s)	0.06	0.16	0.35	0.980	0.66	0.442
	4	Depth (cm)	17	60	64	53	48	48.4
		Velocity (m/s)	0.19	0.810	0.93	0.97	1.03	0.786
	5	Depth (cm)	12	36	49	63	65	45
		Velocity (m/s)	0.470	0.780	0.97	0.91	0.95	0.816

Notes: Velocity measurements were taken at five randomly chosen locations throughout the kick sample area. Velocity was measured at the bottom of the water column.

Table G.7: **Habitat Information Associated with Mine-exposed and Reference Areas Sampled during the Benthic Invertebrate Survey, GHO LAEMP, September 2019**

Station ID		Reference	Mine-exposed							
		GH_ER2 / ELUGH	GH_ERSC4	GH_ER1A	RG_ERSC5	GH_TC2 / THCK	RG_GH-SCW3	GH_ERSC2	RG_SCDTC	GH_ERC / EL20
Waterbody		Elk River Mainstem	Elk River Side Channel	Elk River Side Channel	Elk River Side Channel	Thompson Creek	Elk River Side Channel	Elk River Side Channel downstream from Thompson Creek	Elk River Mainstream	Elk River
Date Sampled		5-Sep-19	10-Sep-19	9-Sep-19	8-Sep-19	4-Sep-19	12-Sep-19	12-Sep-19	11-Sep-19	8-Sep-19
Zone 11 UTMs - E		646534	648111	648379	648265	648559	648365	648341	648222	649131
Zone 11 UTMs - N		5557508	5552522	5551653	5550658	6550222	5550212	5549812	5549587	5548540
Habitat Characteristics										
Site Access Description		Take Round Prairie Road north, then turn left at Branch F Creek	Take Round Prairie Road north, near UTMs, take small logging road and walk ~40 m to side channel	Round Prairie Road w side	Beside Round Prairie Road	Round Prairie Road, east side at Thompson Creek	Park on Round Prairie Road km 107.5 and follow Thompson creek into site	Round Prairie Road to km 107 follow orange and pink flags thru to cutblock	Round Prairie Road to km 107; follow pink and orange flags thru cutblock	Forest road straight out of Elkford
Surrounding Land Use		forest, logging, mining	logging, livestock, mining	forest, logging, livestock, road	forest, logging, livestock, mining	logging, mining	logging, livestock and mining	logging, livestock, mining	logging, livestock, mining	logging, residential
Length of Reach Assessed (m)		100	30	50	50	30	50	50	50	100
Substrate	% Bedrock	0	0	0	0	0	0	0	0	0
	% Boulder	10	0	10	0	0	0	0	0	0
	% Cobble	20	15	30	30	40	5	5	30	70
	% Pebble	0	0	0	0	0	0	0	0	0
	% Gravel	30	15	20	40	20	5	5	10	20
	% Sand/Finer	40	70	40	30	40	90	90	40	10
Bank Stability		stable, no erosion	moderate	unstable, substantial erosion	stable, no erosion	stable, no erosion	moderate	stable, no erosion	unstable, substantial erosion	unstable, substantial erosion
Water Colour & Clarity		colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear	colourless, clear
Channel Measurements										
Bankfull Width (m)		200	10	7.5	7.5	3.8	flooded	-	7	55
Wetted Width (m)		19.4	8.2	6.8	4.7	1.7	flooded	-	4.5	30
Bankfull-Wetted Depth (cm)		20	1.5	1.9	1.5	210	flooded	-	2.5	14

Note: "-" indicates not measured.

DATA COLLECTED CONCURRENT WITH SEPTEMBER BIOLOGICAL SAMPLES

Laboratory Water Data

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 06-SEP-19
Report Date: 13-SEP-19 17:05 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2342971

Project P.O. #: VPO00616180
Job Reference: REGIONAL EFFECTS PROGRAM
C of C Numbers: Regional Effects
Legal Site Desc:

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2342971-1				
	Description	WS				
	Sampled Date	04-SEP-19				
	Sampled Time	13:30				
	Client ID	GH_TC2_WS_2019-09-04_1330				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (@ 25C) (uS/cm)	1620				
	Hardness (as CaCO3) (mg/L)	1070				
	pH (pH)	8.31				
	ORP (mV)	277				
	Total Suspended Solids (mg/L)	2.3				
	Total Dissolved Solids (mg/L)	DLHC 1430				
	Turbidity (NTU)	0.98				
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	165				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	2.6				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	167				
	Ammonia as N (mg/L)	0.0141				
	Bromide (Br) (mg/L)	DLHC <0.25				
	Chloride (Cl) (mg/L)	DLHC 14.1				
	Fluoride (F) (mg/L)	DLHC <0.10				
	Ion Balance (%)	100				
	Nitrate (as N) (mg/L)	DLHC 12.9				
	Nitrite (as N) (mg/L)	DLHC 0.0159				
	Total Kjeldahl Nitrogen (mg/L)	TKNI 0.131				
	Orthophosphate-Dissolved (as P) (mg/L)	0.0011				
	Phosphorus (P)-Total (mg/L)	0.0048				
	Sulfate (SO4) (mg/L)	DLHC 826				
	Anion Sum (meq/L)	21.9				
	Cation Sum (meq/L)	22.0				
	Cation - Anion Balance (%)	0.2				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	2.92				
	Total Organic Carbon (mg/L)	3.06				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0295				
	Antimony (Sb)-Total (mg/L)	0.00017				
	Arsenic (As)-Total (mg/L)	0.00021				
	Barium (Ba)-Total (mg/L)	0.0644				
	Beryllium (Be)-Total (ug/L)	<0.020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.027				
	Cadmium (Cd)-Total (ug/L)	0.0186				

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2342971-1
	Description	WS
	Sampled Date	04-SEP-19
	Sampled Time	13:30
	Client ID	GH_TC2_WS_2019-09-04_1330
Grouping	**Analyte**	
WATER		
Total Metals	Calcium (Ca)-Total (mg/L)	203
	Chromium (Cr)-Total (mg/L)	<0.00010
	Cobalt (Co)-Total (ug/L)	<0.10
	Copper (Cu)-Total (mg/L)	<0.00050
	Iron (Fe)-Total (mg/L)	0.037
	Lead (Pb)-Total (mg/L)	<0.000050
	Lithium (Li)-Total (mg/L)	0.0235
	Magnesium (Mg)-Total (mg/L)	133
	Manganese (Mn)-Total (mg/L)	0.00346
	Mercury (Hg)-Total (ug/L)	<0.00050
	Molybdenum (Mo)-Total (mg/L)	0.00130
	Nickel (Ni)-Total (mg/L)	0.00103
	Potassium (K)-Total (mg/L)	1.82
	Selenium (Se)-Total (ug/L)	128
	Silicon (Si)-Total (mg/L)	3.41
	Silver (Ag)-Total (mg/L)	<0.000010
	Sodium (Na)-Total (mg/L)	10.9
	Strontium (Sr)-Total (mg/L)	0.484
	Thallium (Tl)-Total (mg/L)	0.000010
	Tin (Sn)-Total (mg/L)	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.010
	Uranium (U)-Total (mg/L)	0.00479
	Vanadium (V)-Total (mg/L)	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030
Dissolved Metals	Dissolved Mercury Filtration Location	LAB
	Dissolved Metals Filtration Location	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.0030
	Antimony (Sb)-Dissolved (mg/L)	0.00015
	Arsenic (As)-Dissolved (mg/L)	0.00021
	Barium (Ba)-Dissolved (mg/L)	0.0667
	Beryllium (Be)-Dissolved (ug/L)	<0.020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050
	Boron (B)-Dissolved (mg/L)	0.025
	Cadmium (Cd)-Dissolved (ug/L)	0.0121
	Calcium (Ca)-Dissolved (mg/L)	224
	Chromium (Cr)-Dissolved (mg/L)	<0.00010
	Cobalt (Co)-Dissolved (ug/L)	<0.10

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2342971-1				
	Description	WS				
	Sampled Date	04-SEP-19				
	Sampled Time	13:30				
	Client ID	GH_TC2_WS_2019-09-04_1330				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)	<0.00050				
	Iron (Fe)-Dissolved (mg/L)	<0.010				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0220				
	Magnesium (Mg)-Dissolved (mg/L)	124				
	Manganese (Mn)-Dissolved (mg/L)	0.00034				
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00131				
	Nickel (Ni)-Dissolved (mg/L)	0.00093				
	Potassium (K)-Dissolved (mg/L)	1.85				
	Selenium (Se)-Dissolved (ug/L)	126				
	Silicon (Si)-Dissolved (mg/L)	2.97				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	12.1				
	Strontium (Sr)-Dissolved (mg/L)	0.523				
	Thallium (Tl)-Dissolved (mg/L)	0.000014				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.010				
	Uranium (U)-Dissolved (mg/L)	0.00449				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	<0.0010				

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

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Sample was Filtered and Preserved at the laboratory - DOC/DIS METALS LAB FILTER/PRESERVE

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2342971-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2342971-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2342971-1
Matrix Spike	Selenium (Se)-Dissolved	MS-B	L2342971-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2342971-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2342971-1
Matrix Spike	Uranium (U)-Dissolved	MS-B	L2342971-1
Matrix Spike	Aluminum (Al)-Total	MS-B	L2342971-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2342971-1
Matrix Spike	Cadmium (Cd)-Total	MS-B	L2342971-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2342971-1
Matrix Spike	Cobalt (Co)-Total	MS-B	L2342971-1
Matrix Spike	Copper (Cu)-Total	MS-B	L2342971-1
Matrix Spike	Iron (Fe)-Total	MS-B	L2342971-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2342971-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L2342971-1
Matrix Spike	Nickel (Ni)-Total	MS-B	L2342971-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2342971-1
Matrix Spike	Zinc (Zn)-Total	MS-B	L2342971-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
TKNI	TKN result may be biased low due to Nitrate interference. Nitrate-N is > 10x TKN.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACIDITY-PCT-CL	Water	Acidity by Automatic Titration	APHA 2310 Acidity

This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.

ALK-MAN-CL	Water	Alkalinity (Species) by Manual Titration	APHA 2320 ALKALINITY

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

BR-L-IC-N-CL	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

C-DIS-ORG-LOW-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon

Reference Information

dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

C-TOT-ORG-LOW-CL Water Total Organic Carbon APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-L-PCT-CL Water Electrical Conductivity (EC) APHA 2510B

Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25C.

F-IC-N-CL Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-U-CVAF-VA Water Total Mercury in Water by CVAFS (Ultra) EPA 1631 REV. E

This analysis is carried out using procedures adapted from Method 1631 Rev. E. by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry.

IONBALANCE-BC-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL Water Ammonia, Total (as N) J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

NO3-L-IC-N-CL Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ORP-CL Water Oxidation redution potential by elect. ASTM D1498

This analysis is carried out in accordance with the procedure described in the "ASTM" method D1498 "Oxidation-Reduction Potential of Water" published by the American Society for Testing and Materials (ASTM). Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

P-T-L-COL-CL Water Phosphorus (P)-Total APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-CL Water pH APHA 4500 H-Electrode

pH is determined in the laboratory using a pH electrode. All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)

PO4-DO-L-COL-CL Water Orthophosphate-Dissolved (as P) APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SO4-IC-N-CL Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-CL Water Total Dissolved Solids APHA 2540 C

A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 °C. The increase in vial weight represents the total dissolved solids (TDS).

TECKCOAL-IONBAL-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

TKN-L-F-CL Water Total Kjeldahl Nitrogen APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-L-CL Water Total Suspended Solids APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

TURBIDITY-CL Water Turbidity APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** 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:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Regional Effects

Reference Information

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

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-PCT-CL	**Water**							
Batch R4789448								
WG3155958-14 LCS								
Acidity (as CaCO3)			100.4		%		85-115	08-SEP-19
WG3155958-13 MB								
Acidity (as CaCO3)			1.3		mg/L		2	08-SEP-19
ALK-MAN-CL	**Water**							
Batch R4789379								
WG3155938-11 LCS								
Alkalinity, Total (as CaCO3)			103.6		%		85-115	08-SEP-19
WG3155938-10 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	08-SEP-19
BE-D-L-CCMS-VA	**Water**							
Batch R4796861								
WG3157969-2 LCS								
Beryllium (Be)-Dissolved			95.3		%		80-120	11-SEP-19
WG3157969-1 MB		**LF**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	11-SEP-19
WG3157969-4 MS		**L2342971-1**						
Beryllium (Be)-Dissolved			91.8		%		70-130	11-SEP-19
BE-T-L-CCMS-VA	**Water**							
Batch R4802688								
WG3157841-2 LCS								
Beryllium (Be)-Total			96.9		%		80-120	12-SEP-19
WG3157841-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	12-SEP-19
BR-L-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Bromide (Br)			100.5		%		85-115	06-SEP-19
WG3156041-5 MB								
Bromide (Br)			<0.050		mg/L		0.05	06-SEP-19
C-DIS-ORG-LOW-CL	**Water**							
Batch R4798448								
WG3158769-2 LCS								
Dissolved Organic Carbon			94.4		%		80-120	10-SEP-19
WG3158769-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	10-SEP-19
C-TOT-ORG-LOW-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TOT-ORG-LOW-CL	**Water**							
Batch R4798448								
WG3158769-2 LCS								
Total Organic Carbon			102.7		%		80-120	10-SEP-19
WG3158769-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	10-SEP-19
CL-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Chloride (Cl)			101.0		%		90-110	06-SEP-19
WG3156041-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	06-SEP-19
EC-L-PCT-CL	**Water**							
Batch R4789379								
WG3155938-11 LCS								
Conductivity (@ 25C)			100.1		%		90-110	08-SEP-19
WG3155938-10 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	08-SEP-19
F-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Fluoride (F)			103.0		%		90-110	06-SEP-19
WG3156041-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	06-SEP-19
HG-D-CVAA-VA	**Water**							
Batch R4795914								
WG3157872-2 LCS								
Mercury (Hg)-Dissolved			98.2		%		80-120	11-SEP-19
WG3157872-1 MB		**LF**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	11-SEP-19
HG-T-U-CVAF-VA	**Water**							
Batch R4801113								
WG3159601-2 LCS								
Mercury (Hg)-Total			103.0		%		80-120	12-SEP-19
WG3159601-1 MB								
Mercury (Hg)-Total			<0.00050		ug/L		0.0005	12-SEP-19
MET-D-CCMS-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4796861								
WG3157969-2 LCS								
Aluminum (Al)-Dissolved			101.5		%		80-120	11-SEP-19
Antimony (Sb)-Dissolved			99.3		%		80-120	11-SEP-19
Arsenic (As)-Dissolved			101.1		%		80-120	11-SEP-19
Barium (Ba)-Dissolved			101.9		%		80-120	11-SEP-19
Bismuth (Bi)-Dissolved			96.5		%		80-120	11-SEP-19
Boron (B)-Dissolved			98.2		%		80-120	11-SEP-19
Cadmium (Cd)-Dissolved			99.4		%		80-120	11-SEP-19
Calcium (Ca)-Dissolved			96.6		%		80-120	11-SEP-19
Chromium (Cr)-Dissolved			104.0		%		80-120	11-SEP-19
Cobalt (Co)-Dissolved			102.3		%		80-120	11-SEP-19
Copper (Cu)-Dissolved			99.4		%		80-120	11-SEP-19
Iron (Fe)-Dissolved			98.5		%		80-120	11-SEP-19
Lead (Pb)-Dissolved			95.8		%		80-120	11-SEP-19
Lithium (Li)-Dissolved			90.9		%		80-120	11-SEP-19
Magnesium (Mg)-Dissolved			98.7		%		80-120	11-SEP-19
Manganese (Mn)-Dissolved			103.1		%		80-120	11-SEP-19
Molybdenum (Mo)-Dissolved			98.0		%		80-120	11-SEP-19
Nickel (Ni)-Dissolved			101.2		%		80-120	11-SEP-19
Potassium (K)-Dissolved			103.2		%		80-120	11-SEP-19
Selenium (Se)-Dissolved			100.0		%		80-120	11-SEP-19
Silicon (Si)-Dissolved			98.4		%		60-140	11-SEP-19
Silver (Ag)-Dissolved			96.8		%		80-120	11-SEP-19
Sodium (Na)-Dissolved			104.6		%		80-120	11-SEP-19
Strontium (Sr)-Dissolved			98.3		%		80-120	11-SEP-19
Thallium (Tl)-Dissolved			93.3		%		80-120	11-SEP-19
Tin (Sn)-Dissolved			97.0		%		80-120	11-SEP-19
Titanium (Ti)-Dissolved			96.8		%		80-120	11-SEP-19
Uranium (U)-Dissolved			92.6		%		80-120	11-SEP-19
Vanadium (V)-Dissolved			103.2		%		80-120	11-SEP-19
Zinc (Zn)-Dissolved			95.6		%		80-120	11-SEP-19
WG3157969-1 MB		**LF**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	11-SEP-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4796861								
WG3157969-1 MB		**LF**						
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	11-SEP-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	11-SEP-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	11-SEP-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	11-SEP-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	11-SEP-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	11-SEP-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	11-SEP-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	11-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	11-SEP-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	11-SEP-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	11-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	11-SEP-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	11-SEP-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	11-SEP-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	11-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	11-SEP-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	11-SEP-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	11-SEP-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	11-SEP-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	11-SEP-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	11-SEP-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	11-SEP-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	11-SEP-19
WG3157969-4 MS		**L2342971-1**						
Aluminum (Al)-Dissolved			99.3		%		70-130	11-SEP-19
Antimony (Sb)-Dissolved			97.9		%		70-130	11-SEP-19
Arsenic (As)-Dissolved			103.8		%		70-130	11-SEP-19
Barium (Ba)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Bismuth (Bi)-Dissolved			86.9		%		70-130	11-SEP-19
Boron (B)-Dissolved			99.4		%		70-130	11-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4796861								
WG3157969-4 MS		**L2342971-1**						
Cadmium (Cd)-Dissolved			100.9		%		70-130	11-SEP-19
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Chromium (Cr)-Dissolved			103.4		%		70-130	11-SEP-19
Cobalt (Co)-Dissolved			98.1		%		70-130	11-SEP-19
Copper (Cu)-Dissolved			94.2		%		70-130	11-SEP-19
Iron (Fe)-Dissolved			97.7		%		70-130	11-SEP-19
Lead (Pb)-Dissolved			91.0		%		70-130	11-SEP-19
Lithium (Li)-Dissolved			92.7		%		70-130	11-SEP-19
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Manganese (Mn)-Dissolved			100.0		%		70-130	11-SEP-19
Molybdenum (Mo)-Dissolved			95.8		%		70-130	11-SEP-19
Nickel (Ni)-Dissolved			96.8		%		70-130	11-SEP-19
Potassium (K)-Dissolved			97.2		%		70-130	11-SEP-19
Selenium (Se)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Silicon (Si)-Dissolved			91.6		%		70-130	11-SEP-19
Silver (Ag)-Dissolved			91.6		%		70-130	11-SEP-19
Sodium (Na)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Thallium (Tl)-Dissolved			87.0		%		70-130	11-SEP-19
Tin (Sn)-Dissolved			96.0		%		70-130	11-SEP-19
Titanium (Ti)-Dissolved			97.7		%		70-130	11-SEP-19
Uranium (U)-Dissolved			N/A	MS-B	%		-	11-SEP-19
Vanadium (V)-Dissolved			102.7		%		70-130	11-SEP-19
Zinc (Zn)-Dissolved			93.9		%		70-130	11-SEP-19
MET-T-CCMS-VA	**Water**							
Batch R4802688								
WG3157841-2 LCS								
Aluminum (Al)-Total			99.7		%		80-120	12-SEP-19
Antimony (Sb)-Total			100.5		%		80-120	12-SEP-19
Arsenic (As)-Total			98.5		%		80-120	12-SEP-19
Barium (Ba)-Total			96.7		%		80-120	12-SEP-19
Bismuth (Bi)-Total			99.6		%		80-120	12-SEP-19
Boron (B)-Total			100.7		%		80-120	12-SEP-19
Cadmium (Cd)-Total			99.7		%		80-120	12-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4802688								
WG3157841-2 LCS								
Calcium (Ca)-Total			97.9		%		80-120	12-SEP-19
Chromium (Cr)-Total			99.4		%		80-120	12-SEP-19
Cobalt (Co)-Total			97.8		%		80-120	12-SEP-19
Copper (Cu)-Total			98.9		%		80-120	12-SEP-19
Iron (Fe)-Total			101.2		%		80-120	12-SEP-19
Lead (Pb)-Total			97.7		%		80-120	12-SEP-19
Lithium (Li)-Total			96.7		%		80-120	12-SEP-19
Magnesium (Mg)-Total			100.4		%		80-120	12-SEP-19
Manganese (Mn)-Total			100.8		%		80-120	12-SEP-19
Molybdenum (Mo)-Total			98.2		%		80-120	12-SEP-19
Nickel (Ni)-Total			99.0		%		80-120	12-SEP-19
Potassium (K)-Total			100.5		%		80-120	12-SEP-19
Selenium (Se)-Total			101.9		%		80-120	12-SEP-19
Silicon (Si)-Total			103.0		%		80-120	12-SEP-19
Silver (Ag)-Total			99.0		%		80-120	12-SEP-19
Sodium (Na)-Total			102.3		%		80-120	12-SEP-19
Strontium (Sr)-Total			96.8		%		80-120	12-SEP-19
Thallium (Tl)-Total			98.0		%		80-120	12-SEP-19
Tin (Sn)-Total			97.1		%		80-120	12-SEP-19
Titanium (Ti)-Total			96.7		%		80-120	12-SEP-19
Uranium (U)-Total			96.8		%		80-120	12-SEP-19
Vanadium (V)-Total			101.7		%		80-120	12-SEP-19
Zinc (Zn)-Total			99.1		%		80-120	12-SEP-19
WG3157841-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	12-SEP-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Boron (B)-Total			<0.010		mg/L		0.01	12-SEP-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	12-SEP-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	12-SEP-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	12-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4802688								
WG3157841-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Iron (Fe)-Total			<0.010		mg/L		0.01	12-SEP-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	12-SEP-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	12-SEP-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Potassium (K)-Total			<0.050		mg/L		0.05	12-SEP-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Silicon (Si)-Total			<0.10		mg/L		0.1	12-SEP-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Sodium (Na)-Total			<0.050		mg/L		0.05	12-SEP-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	12-SEP-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	12-SEP-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	12-SEP-19
NH3-L-F-CL	**Water**							
Batch R4797611								
WG3157258-14 LCS								
Ammonia as N			109.9		%		85-115	10-SEP-19
WG3157258-13 MB								
Ammonia as N			<0.0050		mg/L		0.005	10-SEP-19
NO2-L-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Nitrite (as N)			102.4		%		90-110	06-SEP-19
WG3156041-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	06-SEP-19
NO3-L-IC-N-CL	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Nitrate (as N)			101.4		%		90-110	06-SEP-19
WG3156041-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	06-SEP-19
ORP-CL	**Water**							
Batch R4798668								
WG3156476-1 CRM		**CL-ORP**						
ORP			226		mV		210-230	09-SEP-19
P-T-L-COL-CL	**Water**							
Batch R4794549								
WG3157489-67 LCS								
Phosphorus (P)-Total			95.6		%		80-120	10-SEP-19
WG3157489-65 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	10-SEP-19
PH-CL	**Water**							
Batch R4789379								
WG3155938-11 LCS								
pH			7.03		pH		6.9-7.1	08-SEP-19
PO4-DO-L-COL-CL	**Water**							
Batch R4785668								
WG3154558-10 LCS								
Orthophosphate-Dissolved (as P)			98.0		%		80-120	06-SEP-19
WG3154558-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	06-SEP-19
SO4-IC-N-CL	**Water**							
Batch R4789491								
WG3156041-6 LCS								
Sulfate (SO4)			101.2		%		90-110	06-SEP-19
WG3156041-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	06-SEP-19
SOLIDS-TDS-CL	**Water**							
Batch R4789208								
WG3153835-14 LCS								
Total Dissolved Solids			97.2		%		85-115	06-SEP-19
WG3153835-13 MB								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TDS-CL	**Water**							
Batch R4789208								
WG3153835-13 MB								
Total Dissolved Solids			<10		mg/L		10	06-SEP-19
TKN-L-F-CL	**Water**							
Batch R4795109								
WG3157524-10 LCS								
Total Kjeldahl Nitrogen			106.3		%		75-125	10-SEP-19
WG3157524-14 LCS								
Total Kjeldahl Nitrogen			106.5		%		75-125	10-SEP-19
WG3157524-18 LCS								
Total Kjeldahl Nitrogen			103.0		%		75-125	11-SEP-19
WG3157524-2 LCS								
Total Kjeldahl Nitrogen			105.8		%		75-125	10-SEP-19
WG3157524-6 LCS								
Total Kjeldahl Nitrogen			104.9		%		75-125	10-SEP-19
WG3157524-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-13 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-17 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	11-SEP-19
WG3157524-5 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-9 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
TSS-L-CL	**Water**							
Batch R4797049								
WG3156335-10 LCS								
Total Suspended Solids			96.9		%		85-115	10-SEP-19
WG3156335-9 MB								
Total Suspended Solids			<1.0		mg/L		1	10-SEP-19
TURBIDITY-CL	**Water**							
Batch R4785610								
WG3154591-11 LCS								
Turbidity			94.5		%		85-115	06-SEP-19
WG3154591-10 MB								
Turbidity			<0.10		NTU		0.1	06-SEP-19

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Oxidation redution potential by elect.							
	1	04-SEP-19 13:30	09-SEP-19 09:00	0.25	115	hours	EHTR-FM
pH							
	1	04-SEP-19 13:30	08-SEP-19 09:00	0.25	91	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2342971 were received on 06-SEP-19 09:50.

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.

Teck

Page 1 of 1

COC ID:	**Regional Effects Program**	TURNAROUND TIME:	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/~~RAEMP~~ 6HO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
Address	421 Pine Avenue		
City	Sparwood	Province	BC
Postal Code	V0B 2G0	Country	Canada
Phone Number	250-425-8202		

LABORATORY

Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
Email	Lyudmyla.Shvets@ALSGlobal.com		
Address	2559 29 Street NE		
City	Calgary	Province	AB
Postal Code	T1Y 7B5	Country	Canada
Phone Number	403-407-1800		

OTHER INFO

Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	X	X	X
Email 2:	carlie.meyer@teck.com	X	X	X
Email 3:	teckcoal@equisonline.com			X
Email 4:	jtester@minnow.ca	X	X	X
Email 5:				
PO number	VPO00616180			

SAMPLE DETAILS / **ANALYSIS REQUESTED**

L2342971-COFC

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	HG-T-U-CVAF-VA	ALS_Package-DOC	ALS_Package-TKN/TOC	HG-D-CVAF-VA	TECKCOAL-MET-D-VA	TECKCOAL-MET-T-VA	TECKCOAL-ROUTINE-VA					
								N	N	N	N	N	N	N					
								NONE	NONE	H2SO4	NONE	NONE	HNO3	NONE					
GH_TC2_WS_2019-09-04_1330	GH_TC2	WS	No	4-Sep-19	13:30:00	G	7	1	1	1	1	1	1	1					

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
VPO00616180	Jennifer Ings/Minnow	September 5, 2019	DK 9/6	0950

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X	Sampler's Name	Jennifer Ings	Mobile #	519-500-3444
Priority (2-3 business days) - 50% surcharge					
Emergency (1 Business Day) - 100% surcharge		Sampler's Signature	Jennifer Ings	Date/Time	September 5, 2019
For Emergency <1 Day, ASAP or Weekend - Contact ALS					

7°C

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 07-SEP-19
Report Date: 16-SEP-19 09:33 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2343316

Project P.O. #:	VPO00616180
Job Reference:	REGIONAL EFFECTS PROGRAM
C of C Numbers:	Regional Effects
Legal Site Desc:	

Lyudmyla Shvets, B.Sc.
Account Manager

	Sample ID	L2343316-1				
	Description	WS				
	Sampled Date	05-SEP-19				
	Sampled Time	09:30				
	Client ID	GH_ER2_WS_2019-09-05_0930				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (@ 25C) (uS/cm)	275				
	Hardness (as CaCO3) (mg/L)	146				
	pH (pH)	8.36				
	ORP (mV)	296				
	Total Suspended Solids (mg/L)	<1.0				
	Total Dissolved Solids (mg/L)	171 DLHC				
	Turbidity (NTU)	0.36				
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	135				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	3.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	138				
	Ammonia as N (mg/L)	0.0057				
	Bromide (Br) (mg/L)	<0.050				
	Chloride (Cl) (mg/L)	<0.50				
	Fluoride (F) (mg/L)	0.163				
	Ion Balance (%)	94.1				
	Nitrate (as N) (mg/L)	0.0416				
	Nitrite (as N) (mg/L)	<0.0010				
	Total Kjeldahl Nitrogen (mg/L)	<0.050				
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010				
	Phosphorus (P)-Total (mg/L)	<0.0020				
	Sulfate (SO4) (mg/L)	17.5				
	Anion Sum (meq/L)	3.14				
	Cation Sum (meq/L)	2.96				
	Cation - Anion Balance (%)	-3.0				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	<0.50				
	Total Organic Carbon (mg/L)	0.53				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0073				
	Antimony (Sb)-Total (mg/L)	<0.00010				
	Arsenic (As)-Total (mg/L)	0.00016				
	Barium (Ba)-Total (mg/L)	0.0405				
	Beryllium (Be)-Total (ug/L)	<0.020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	<0.010				
	Cadmium (Cd)-Total (ug/L)	0.0124				

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2343316-1
	Description	WS
	Sampled Date	05-SEP-19
	Sampled Time	09:30
	Client ID	GH_ER2_WS_2019-09-05_0930
Grouping	**Analyte**	
WATER		
Total Metals	Calcium (Ca)-Total (mg/L)	43.6
	Chromium (Cr)-Total (mg/L)	0.00019
	Cobalt (Co)-Total (ug/L)	<0.10
	Copper (Cu)-Total (mg/L)	<0.00050
	Iron (Fe)-Total (mg/L)	0.011
	Lead (Pb)-Total (mg/L)	<0.000050
	Lithium (Li)-Total (mg/L)	0.0018
	Magnesium (Mg)-Total (mg/L)	9.97
	Manganese (Mn)-Total (mg/L)	0.00143
	Mercury (Hg)-Total (ug/L)	<0.00050
	Molybdenum (Mo)-Total (mg/L)	0.00110
	Nickel (Ni)-Total (mg/L)	<0.00050
	Potassium (K)-Total (mg/L)	0.332
	Selenium (Se)-Total (ug/L)	0.745
	Silicon (Si)-Total (mg/L)	1.75
	Silver (Ag)-Total (mg/L)	<0.000010
	Sodium (Na)-Total (mg/L)	0.653
	Strontium (Sr)-Total (mg/L)	0.221
	Thallium (Tl)-Total (mg/L)	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.010
	Uranium (U)-Total (mg/L)	0.000649
	Vanadium (V)-Total (mg/L)	0.00055
	Zinc (Zn)-Total (mg/L)	<0.0030
Dissolved Metals	Dissolved Mercury Filtration Location	LAB
	Dissolved Metals Filtration Location	LAB
	Aluminum (Al)-Dissolved (mg/L)	<0.0030
	Antimony (Sb)-Dissolved (mg/L)	<0.00010
	Arsenic (As)-Dissolved (mg/L)	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0404
	Beryllium (Be)-Dissolved (ug/L)	<0.020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010
	Cadmium (Cd)-Dissolved (ug/L)	0.0052
	Calcium (Ca)-Dissolved (mg/L)	43.0
	Chromium (Cr)-Dissolved (mg/L)	0.00017
	Cobalt (Co)-Dissolved (ug/L)	<0.10

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2343316-1				
	Description	WS				
	Sampled Date	05-SEP-19				
	Sampled Time	09:30				
	Client ID	GH_ER2_WS_2019-09-05_0930				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)	<0.00050				
	Iron (Fe)-Dissolved (mg/L)	<0.010				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0016				
	Magnesium (Mg)-Dissolved (mg/L)	9.46				
	Manganese (Mn)-Dissolved (mg/L)	0.00025				
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00108				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Potassium (K)-Dissolved (mg/L)	0.332				
	Selenium (Se)-Dissolved (ug/L)	0.710				
	Silicon (Si)-Dissolved (mg/L)	1.62				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	0.593				
	Strontium (Sr)-Dissolved (mg/L)	0.214				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.010				
	Uranium (U)-Dissolved (mg/L)	0.000618				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	<0.0010				

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2343316-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2343316-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2343316-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2343316-1
Matrix Spike	Boron (B)-Total	MS-B	L2343316-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2343316-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2343316-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2343316-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2343316-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACIDITY-PCT-CL	Water	Acidity by Automatic Titration	APHA 2310 Acidity

This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.

ALK-MAN-CL	Water	Alkalinity (Species) by Manual Titration	APHA 2320 ALKALINITY

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

BR-L-IC-N-CL	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

C-DIS-ORG-LOW-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

C-TOT-ORG-LOW-CL	Water	Total Organic Carbon	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

EC-L-PCT-CL Water Electrical Conductivity (EC) APHA 2510B

Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25C.

F-IC-N-CL Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-U-CVAF-VA Water Total Mercury in Water by CVAFS (Ultra) EPA 1631 REV. E

This analysis is carried out using procedures adapted from Method 1631 Rev. E. by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry.

IONBALANCE-BC-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL Water Ammonia, Total (as N) J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-CL Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ORP-CL Water Oxidation redution potential by elect. ASTM D1498

This analysis is carried out in accordance with the procedure described in the "ASTM" method D1498 "Oxidation-Reduction Potential of Water" published by the American Society for Testing and Materials (ASTM). Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

P-T-L-COL-CL Water Phosphorus (P)-Total APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-CL Water pH APHA 4500 H-Electrode

pH is determined in the laboratory using a pH electrode. All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)

PO4-DO-L-COL-CL Water Orthophosphate-Dissolved (as P) APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

Reference Information

SO4-IC-N-CL Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-CL Water Total Dissolved Solids APHA 2540 C

A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 °C. The increase in vial weight represents the total dissolved solids (TDS).

TECKCOAL-IONBAL-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

TKN-L-F-CL Water Total Kjeldahl Nitrogen APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-L-CL Water Total Suspended Solids APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

TURBIDITY-CL Water Turbidity APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** 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:

Laboratory Definition Code	**Laboratory Location**
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Regional Effects

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: L2343316 Report Date: 16-SEP-19

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-PCT-CL	**Water**							
Batch R4789448								
WG3155958-17 LCS								
Acidity (as CaCO3)			102.3		%		85-115	08-SEP-19
WG3155958-16 MB								
Acidity (as CaCO3)			1.5		mg/L		2	08-SEP-19
ALK-MAN-CL	**Water**							
Batch R4789379								
WG3155938-17 LCS								
Alkalinity, Total (as CaCO3)			100.6		%		85-115	08-SEP-19
WG3155938-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	08-SEP-19
BE-D-L-CCMS-VA	**Water**							
Batch R4803049								
WG3159222-2 LCS								
Beryllium (Be)-Dissolved			97.2		%		80-120	12-SEP-19
WG3159222-1 MB		**LF**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	12-SEP-19
WG3159222-4 MS		**L2343316-1**						
Beryllium (Be)-Dissolved			94.7		%		70-130	12-SEP-19
BE-T-L-CCMS-VA	**Water**							
Batch R4802988								
WG3158531-2 LCS								
Beryllium (Be)-Total			94.3		%		80-120	12-SEP-19
WG3158531-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	12-SEP-19
BR-L-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Bromide (Br)			103.4		%		85-115	07-SEP-19
WG3156275-1 MB								
Bromide (Br)			<0.050		mg/L		0.05	07-SEP-19
C-DIS-ORG-LOW-CL	**Water**							
Batch R4797272								
WG3158422-6 LCS								
Dissolved Organic Carbon			105.0		%		80-120	10-SEP-19
WG3158422-5 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	10-SEP-19
C-TOT-ORG-LOW-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TOT-ORG-LOW-CL	**Water**							
Batch R4797272								
WG3158422-6 LCS								
Total Organic Carbon			107.4		%		80-120	10-SEP-19
WG3158422-5 MB								
Total Organic Carbon			<0.50		mg/L		0.5	10-SEP-19
CL-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Chloride (Cl)			101.1		%		90-110	07-SEP-19
WG3156275-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	07-SEP-19
EC-L-PCT-CL	**Water**							
Batch R4789379								
WG3155938-17 LCS								
Conductivity (@ 25C)			99.6		%		90-110	08-SEP-19
WG3155938-16 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	08-SEP-19
F-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Fluoride (F)			108.5		%		90-110	07-SEP-19
WG3156275-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	07-SEP-19
HG-D-CVAA-VA	**Water**							
Batch R4799935								
WG3158797-2 LCS								
Mercury (Hg)-Dissolved			97.8		%		80-120	12-SEP-19
WG3158797-1 MB								
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	12-SEP-19
HG-T-U-CVAF-VA	**Water**							
Batch R4806346								
WG3161007-2 LCS								
Mercury (Hg)-Total			96.6		%		80-120	13-SEP-19
WG3161007-1 MB								
Mercury (Hg)-Total			<0.00050		ug/L		0.0005	13-SEP-19
MET-D-CCMS-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4803049								
WG3159222-2 LCS								
Aluminum (Al)-Dissolved			97.8		%		80-120	12-SEP-19
Antimony (Sb)-Dissolved			102.1		%		80-120	12-SEP-19
Arsenic (As)-Dissolved			99.0		%		80-120	12-SEP-19
Barium (Ba)-Dissolved			99.7		%		80-120	12-SEP-19
Bismuth (Bi)-Dissolved			94.4		%		80-120	12-SEP-19
Boron (B)-Dissolved			101.0		%		80-120	12-SEP-19
Cadmium (Cd)-Dissolved			100.1		%		80-120	12-SEP-19
Calcium (Ca)-Dissolved			103.4		%		80-120	12-SEP-19
Chromium (Cr)-Dissolved			100.1		%		80-120	12-SEP-19
Cobalt (Co)-Dissolved			98.6		%		80-120	12-SEP-19
Copper (Cu)-Dissolved			99.0		%		80-120	12-SEP-19
Iron (Fe)-Dissolved			99.6		%		80-120	12-SEP-19
Lead (Pb)-Dissolved			97.0		%		80-120	12-SEP-19
Lithium (Li)-Dissolved			96.6		%		80-120	12-SEP-19
Magnesium (Mg)-Dissolved			99.2		%		80-120	12-SEP-19
Manganese (Mn)-Dissolved			99.3		%		80-120	12-SEP-19
Molybdenum (Mo)-Dissolved			101.2		%		80-120	12-SEP-19
Nickel (Ni)-Dissolved			98.6		%		80-120	12-SEP-19
Potassium (K)-Dissolved			101.2		%		80-120	12-SEP-19
Selenium (Se)-Dissolved			99.0		%		80-120	12-SEP-19
Silicon (Si)-Dissolved			97.9		%		60-140	12-SEP-19
Silver (Ag)-Dissolved			95.8		%		80-120	12-SEP-19
Sodium (Na)-Dissolved			102.4		%		80-120	12-SEP-19
Strontium (Sr)-Dissolved			105.6		%		80-120	12-SEP-19
Thallium (Tl)-Dissolved			97.3		%		80-120	12-SEP-19
Tin (Sn)-Dissolved			101.1		%		80-120	12-SEP-19
Titanium (Ti)-Dissolved			99.9		%		80-120	12-SEP-19
Uranium (U)-Dissolved			98.0		%		80-120	12-SEP-19
Vanadium (V)-Dissolved			99.2		%		80-120	12-SEP-19
Zinc (Zn)-Dissolved			94.1		%		80-120	12-SEP-19
WG3159222-1 MB		**LF**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	12-SEP-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4803049								
WG3159222-1 MB		**LF**						
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	12-SEP-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	12-SEP-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	12-SEP-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	12-SEP-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	12-SEP-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	12-SEP-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	12-SEP-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	12-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	12-SEP-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	12-SEP-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	12-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	12-SEP-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	12-SEP-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	12-SEP-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	12-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	12-SEP-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	12-SEP-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	12-SEP-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	12-SEP-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	12-SEP-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	12-SEP-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	12-SEP-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	12-SEP-19
WG3159222-4 MS		**L2343316-1**						
Aluminum (Al)-Dissolved			95.6		%		70-130	12-SEP-19
Antimony (Sb)-Dissolved			94.7		%		70-130	12-SEP-19
Arsenic (As)-Dissolved			98.5		%		70-130	12-SEP-19
Barium (Ba)-Dissolved			N/A	MS-B	%		-	12-SEP-19
Bismuth (Bi)-Dissolved			84.3		%		70-130	12-SEP-19
Boron (B)-Dissolved			97.6		%		70-130	12-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4803049								
WG3159222-4 MS		**L2343316-1**						
Cadmium (Cd)-Dissolved			95.5		%		70-130	12-SEP-19
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	12-SEP-19
Chromium (Cr)-Dissolved			94.9		%		70-130	12-SEP-19
Cobalt (Co)-Dissolved			93.5		%		70-130	12-SEP-19
Copper (Cu)-Dissolved			93.1		%		70-130	12-SEP-19
Iron (Fe)-Dissolved			95.0		%		70-130	12-SEP-19
Lead (Pb)-Dissolved			89.5		%		70-130	12-SEP-19
Lithium (Li)-Dissolved			94.9		%		70-130	12-SEP-19
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	12-SEP-19
Manganese (Mn)-Dissolved			94.4		%		70-130	12-SEP-19
Molybdenum (Mo)-Dissolved			94.5		%		70-130	12-SEP-19
Nickel (Ni)-Dissolved			92.1		%		70-130	12-SEP-19
Potassium (K)-Dissolved			99.0		%		70-130	12-SEP-19
Selenium (Se)-Dissolved			100.8		%		70-130	12-SEP-19
Silicon (Si)-Dissolved			91.5		%		70-130	12-SEP-19
Silver (Ag)-Dissolved			91.1		%		70-130	12-SEP-19
Sodium (Na)-Dissolved			103.1		%		70-130	12-SEP-19
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	12-SEP-19
Thallium (Tl)-Dissolved			89.4		%		70-130	12-SEP-19
Tin (Sn)-Dissolved			94.9		%		70-130	12-SEP-19
Titanium (Ti)-Dissolved			95.6		%		70-130	12-SEP-19
Uranium (U)-Dissolved			93.0		%		70-130	12-SEP-19
Vanadium (V)-Dissolved			95.6		%		70-130	12-SEP-19
Zinc (Zn)-Dissolved			90.7		%		70-130	12-SEP-19
MET-T-CCMS-VA	**Water**							
Batch R4802988								
WG3158531-2 LCS								
Aluminum (Al)-Total			97.7		%		80-120	12-SEP-19
Antimony (Sb)-Total			102.2		%		80-120	12-SEP-19
Arsenic (As)-Total			98.0		%		80-120	12-SEP-19
Barium (Ba)-Total			96.6		%		80-120	12-SEP-19
Bismuth (Bi)-Total			94.6		%		80-120	12-SEP-19
Boron (B)-Total			93.2		%		80-120	12-SEP-19
Cadmium (Cd)-Total			100.9		%		80-120	12-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4802988								
WG3158531-2 LCS								
Calcium (Ca)-Total			98.0		%		80-120	12-SEP-19
Chromium (Cr)-Total			100.8		%		80-120	12-SEP-19
Cobalt (Co)-Total			98.4		%		80-120	12-SEP-19
Copper (Cu)-Total			98.4		%		80-120	12-SEP-19
Iron (Fe)-Total			96.2		%		80-120	12-SEP-19
Lead (Pb)-Total			94.4		%		80-120	12-SEP-19
Lithium (Li)-Total			96.8		%		80-120	12-SEP-19
Magnesium (Mg)-Total			98.3		%		80-120	12-SEP-19
Manganese (Mn)-Total			99.7		%		80-120	12-SEP-19
Molybdenum (Mo)-Total			99.6		%		80-120	12-SEP-19
Nickel (Ni)-Total			99.3		%		80-120	12-SEP-19
Potassium (K)-Total			97.4		%		80-120	12-SEP-19
Selenium (Se)-Total			98.8		%		80-120	12-SEP-19
Silicon (Si)-Total			102.4		%		80-120	12-SEP-19
Silver (Ag)-Total			98.0		%		80-120	12-SEP-19
Sodium (Na)-Total			108.8		%		80-120	12-SEP-19
Strontium (Sr)-Total			97.9		%		80-120	12-SEP-19
Thallium (Tl)-Total			92.7		%		80-120	12-SEP-19
Tin (Sn)-Total			98.7		%		80-120	12-SEP-19
Titanium (Ti)-Total			94.7		%		80-120	12-SEP-19
Uranium (U)-Total			96.9		%		80-120	12-SEP-19
Vanadium (V)-Total			101.2		%		80-120	12-SEP-19
Zinc (Zn)-Total			99.99		%		80-120	12-SEP-19
WG3158531-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	12-SEP-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Boron (B)-Total			<0.010		mg/L		0.01	12-SEP-19
Cadmium (Cd)-Total			<0.000005C		mg/L		0.000005	12-SEP-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	12-SEP-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	12-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4802988								
WG3158531-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Iron (Fe)-Total			<0.010		mg/L		0.01	12-SEP-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	12-SEP-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	12-SEP-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Potassium (K)-Total			<0.050		mg/L		0.05	12-SEP-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	12-SEP-19
Silicon (Si)-Total			<0.10		mg/L		0.1	12-SEP-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Sodium (Na)-Total			<0.050		mg/L		0.05	12-SEP-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	12-SEP-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	12-SEP-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	12-SEP-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	12-SEP-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	12-SEP-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	12-SEP-19
NH3-L-F-CL	**Water**							
Batch R4801689								
WG3158588-2 LCS								
Ammonia as N			104.0		%		85-115	11-SEP-19
WG3158588-1 MB								
Ammonia as N			<0.0050		mg/L		0.005	11-SEP-19
NO2-L-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Nitrite (as N)			102.7		%		90-110	07-SEP-19
WG3156275-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	07-SEP-19
NO3-L-IC-N-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Nitrate (as N)			101.3		%		90-110	07-SEP-19
WG3156275-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	07-SEP-19
ORP-CL	**Water**							
Batch R4798668								
WG3156476-3 CRM		**CL-ORP**						
ORP			216		mV		210-230	09-SEP-19
P-T-L-COL-CL	**Water**							
Batch R4794549								
WG3157489-83 LCS								
Phosphorus (P)-Total			102.7		%		80-120	10-SEP-19
WG3157489-81 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	10-SEP-19
PH-CL	**Water**							
Batch R4789379								
WG3155938-17 LCS								
pH			7.03		pH		6.9-7.1	08-SEP-19
PO4-DO-L-COL-CL	**Water**							
Batch R4787749								
WG3155163-12 LCS								
Orthophosphate-Dissolved (as P)			99.3		%		80-120	08-SEP-19
WG3155163-6 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	08-SEP-19
SO4-IC-N-CL	**Water**							
Batch R4790231								
WG3156275-2 LCS								
Sulfate (SO4)			101.5		%		90-110	07-SEP-19
WG3156275-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	07-SEP-19
SOLIDS-TDS-CL	**Water**							
Batch R4793289								
WG3155681-8 LCS								
Total Dissolved Solids			102.2		%		85-115	09-SEP-19
WG3155681-7 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TDS-CL	**Water**							
Batch R4793289								
WG3155681-7 MB								
Total Dissolved Solids			<10		mg/L		10	09-SEP-19
TKN-L-F-CL	**Water**							
Batch R4795109								
WG3157524-10 LCS								
Total Kjeldahl Nitrogen			106.3		%		75-125	10-SEP-19
WG3157524-14 LCS								
Total Kjeldahl Nitrogen			106.5		%		75-125	10-SEP-19
WG3157524-18 LCS								
Total Kjeldahl Nitrogen			103.0		%		75-125	11-SEP-19
WG3157524-2 LCS								
Total Kjeldahl Nitrogen			105.8		%		75-125	10-SEP-19
WG3157524-6 LCS								
Total Kjeldahl Nitrogen			104.9		%		75-125	10-SEP-19
WG3157524-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-13 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-17 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	11-SEP-19
WG3157524-5 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
WG3157524-9 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	10-SEP-19
TSS-L-CL	**Water**							
Batch R4801248								
WG3158841-10 LCS								
Total Suspended Solids			97.8		%		85-115	11-SEP-19
WG3158841-9 MB								
Total Suspended Solids			<1.0		mg/L		1	11-SEP-19
TURBIDITY-CL	**Water**							
Batch R4788663								
WG3155656-8 LCS								
Turbidity			94.5		%		85-115	07-SEP-19
WG3155656-7 MB								
Turbidity			<0.10		NTU		0.1	07-SEP-19

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
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Oxidation redution potential by elect.							
	1	05-SEP-19 09:30	09-SEP-19 15:30	0.25	102	hours	EHTR-FM
pH							
	1	05-SEP-19 09:30	08-SEP-19 09:00	0.25	72	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2343316 were received on 07-SEP-19 08:05.

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.

Teck

Page 1 of 1

COC ID:	**Regional Effects Program**	**TURNAROUND TIME:**	Regular

PROJECT/CLIENT INFO			
Facility Name / Job#	Regional Effects Program/GHO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
Address	421 Pine Avenue		
City	Sparwood	Province	BC
Postal Code	V0B 2G0	Country	Canada
Phone Number	250-425-8202		

LABORATORY			
Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
Email	Lyudmyla.Shvets@ALSGlobal.com		
Address	2559 29 Street NE		
City	Calgary	Province	AB
Postal Code	T1Y 7B5	Country	Canada
Phone Number	403-407-1800		

OTHER INFO				
Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	X	X	X
Email 2:	carlie.meyer@teck.com	X	X	X
Email 3:	teckcoal@equisonline.com			X
Email 4:	jtester@minnow.ca	X	X	X
Email 5:				
PO number	*VPO00616180*			

SAMPLE DETAILS — **ANALYSIS REQUESTED** — Filtered - F: Field, L: Lab, FL: Field & Lab, N: None

L2343316-COFC

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Ma...	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	HG-T-U-CVAF-VA	ALS_Package-DOC	ALS_Package-TKN/TOC	HG-D-CVAF-VA	TECKCOAL-MET-D-VA	TECKCOAL-MET-T-VA	TECKCOAL-ROUTINE-VA
FIL.								N	N	N	N	N	N	N
PRESERV.								NONE	NONE	H2SO4	NONE	NONE	HNO3	NONE
GH_ER2_WS_2019-09-05_0930	GH_ER2	WS	No	5-Sep-19	9:30:00	G	7	1	1	1	1	1	1	1

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	**RELINQUISHED BY/AFFILIATION**	**DATE/TIME**	**ACCEPTED BY/AFFILIATION**	**DATE/TIME**
VPO00616180	Jennifer Ings/Minnow	September 6, 2019	DM	09/07/19 8:05AM

SERVICE REQUEST (rush - subject to availability)	
Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	Jennifer Ings	Mobile #	519-500-3444
Sampler's Signature		Date/Time	September 6, 2019

5.8°C

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 10-SEP-19
Report Date: 17-SEP-19 13:22 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2344588

Project P.O. #:	VPO00616180
Job Reference:	REGIONAL EFFECTS PROGRAM
C of C Numbers:	REGIONAL EFFECTS PRO
Legal Site Desc:	

Lyudmyla Shvets, B.Sc.
Account Manager

	Sample ID	L2344588-1	L2344588-2			
	Description	WS	WS			
	Sampled Date	08-SEP-19	08-SEP-19			
	Sampled Time	08:30	09:27			
	Client ID	GH_ERC_WS_2019-09-08_0830	RG_ERSC5_WS_2019-09-08_0927			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (@ 25C) (uS/cm)	315	324			
	Hardness (as CaCO3) (mg/L)	164	169			
	pH (pH)	8.32	8.36			
	ORP (mV)	338	264			
	Total Suspended Solids (mg/L)	<1.0	2.0			
	Total Dissolved Solids (mg/L)	176	190			
	Turbidity (NTU)	0.44	0.62			
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	144	141			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	2.2	2.8			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	146	143			
	Ammonia as N (mg/L)	0.0057	0.0061			
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	<0.50	<0.50			
	Fluoride (F) (mg/L)	0.185	0.170			
	Ion Balance (%)	96.8	96.5			
	Nitrate (as N) (mg/L)	0.291	0.613			
	Nitrite (as N) (mg/L)	0.0064	<0.0010			
	Total Kjeldahl Nitrogen (mg/L)	<0.050	0.195			
	Orthophosphate-Dissolved (as P) (mg/L)	0.0017	0.0012			
	Phosphorus (P)-Total (mg/L)	<0.0020	<0.0020			
	Sulfate (SO4) (mg/L)	22.6	30.8			
	Anion Sum (meq/L)	3.42	3.56			
	Cation Sum (meq/L)	3.32	3.43			
	Cation - Anion Balance (%)	-1.6	-1.8			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	0.65	0.85			
	Total Organic Carbon (mg/L)	0.65	0.83			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0077	0.0103			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00011	0.00011			
	Barium (Ba)-Total (mg/L)	0.0504	0.0459			
	Beryllium (Be)-Total (ug/L)	<0.020	<0.020			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Total (ug/L)	0.0090	0.0075			

* 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**	L2344588-1 WS 08-SEP-19 08:30 GH_ERC_WS_2019-09-08_0830	L2344588-2 WS 08-SEP-19 09:27 RG_ERSC5_WS_2019-09-08_0927			
Grouping	**Analyte**					
WATER						
Total Metals	Calcium (Ca)-Total (mg/L)	45.2	47.9			
	Chromium (Cr)-Total (mg/L)	0.00019	0.00018			
	Cobalt (Co)-Total (ug/L)	<0.10	<0.10			
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050			
	Iron (Fe)-Total (mg/L)	0.011	0.015			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	0.0024	0.0036			
	Magnesium (Mg)-Total (mg/L)	12.1	13.5			
	Manganese (Mn)-Total (mg/L)	0.00135	0.00154			
	Mercury (Hg)-Total (ug/L)	<0.00050	<0.00050			
	Molybdenum (Mo)-Total (mg/L)	0.00102	0.00108			
	Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050			
	Potassium (K)-Total (mg/L)	0.378	0.425			
	Selenium (Se)-Total (ug/L)	1.23	2.05			
	Silicon (Si)-Total (mg/L)	1.93	1.77			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	0.775	0.984			
	Strontium (Sr)-Total (mg/L)	0.217	0.227			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.000687	0.000785			
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			
Dissolved Metals	Dissolved Mercury Filtration Location	LAB	LAB			
	Dissolved Metals Filtration Location	LAB	LAB			
	Aluminum (Al)-Dissolved (mg/L)	<0.0030	<0.0030			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00011	0.00011			
	Barium (Ba)-Dissolved (mg/L)	0.0530	0.0471			
	Beryllium (Be)-Dissolved (ug/L)	<0.020	<0.020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (ug/L)	0.0067	0.0088			
	Calcium (Ca)-Dissolved (mg/L)	46.0	46.3			
	Chromium (Cr)-Dissolved (mg/L)	0.00018	0.00019			
	Cobalt (Co)-Dissolved (ug/L)	<0.10	<0.10			

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID Description Sampled Date Sampled Time Client ID	L2344588-1 WS 08-SEP-19 08:30 GH_ERC_WS_2019-09-08_0830	L2344588-2 WS 08-SEP-19 09:27 RG_ERSC5_WS_2019-09-08_0927			
Grouping	**Analyte**						
WATER							
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)		<0.00050	<0.00050			
	Iron (Fe)-Dissolved (mg/L)		<0.010	<0.010			
	Lead (Pb)-Dissolved (mg/L)		<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)		0.0027	0.0038			
	Magnesium (Mg)-Dissolved (mg/L)		11.9	13.0			
	Manganese (Mn)-Dissolved (mg/L)		0.00031	0.00025			
	Mercury (Hg)-Dissolved (mg/L)		<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)		0.00109	0.00111			
	Nickel (Ni)-Dissolved (mg/L)		<0.00050	<0.00050			
	Potassium (K)-Dissolved (mg/L)		0.389	0.419			
	Selenium (Se)-Dissolved (ug/L)		1.61	2.56			
	Silicon (Si)-Dissolved (mg/L)		2.00	1.85			
	Silver (Ag)-Dissolved (mg/L)		<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)		0.809	1.02			
	Strontium (Sr)-Dissolved (mg/L)		0.213	0.231			
	Thallium (Tl)-Dissolved (mg/L)		<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)		<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)		<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)		0.000736	0.000816			
	Vanadium (V)-Dissolved (mg/L)		<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)		<0.0010	<0.0010			

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

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Sample was Filtered and Preserved at the laboratory - DOC/D-METAL/D-HG FILTERED AND PRESERVED AT THE LAB

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Mercury (Hg)-Total	MS-B	L2344588-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2344588-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2344588-1, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2344588-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2344588-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2344588-1, -2
Matrix Spike	Barium (Ba)-Total	MS-B	L2344588-1, -2
Matrix Spike	Calcium (Ca)-Total	MS-B	L2344588-1, -2
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2344588-1, -2
Matrix Spike	Sodium (Na)-Total	MS-B	L2344588-1, -2
Matrix Spike	Strontium (Sr)-Total	MS-B	L2344588-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACIDITY-PCT-CL	Water	Acidity by Automatic Titration	APHA 2310 Acidity

This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-MAN-CL	Water	Alkalinity (Species) by Manual Titration	APHA 2320 ALKALINITY

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-CL	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-LOW-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LOW-CL	Water	Total Organic Carbon	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

Reference Information

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-L-PCT-CL	Water	Electrical Conductivity (EC)	APHA 2510B

Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25C.

F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-U-CVAF-VA	Water	Total Mercury in Water by CVAFS (Ultra)	EPA 1631 REV. E

This analysis is carried out using procedures adapted from Method 1631 Rev. E. by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry.

IONBALANCE-BC-CL	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL	Water	Ammonia, Total (as N)	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ORP-CL	Water	Oxidation redution potential by elect.	ASTM D1498

This analysis is carried out in accordance with the procedure described in the "ASTM" method D1498 "Oxidation-Reduction Potential of Water" published by the American Society for Testing and Materials (ASTM). Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

P-T-L-COL-CL	Water	Phosphorus (P)-Total	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

Reference Information

PH-CL Water pH APHA 4500 H-Electrode

pH is determined in the laboratory using a pH electrode. All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)

PO4-DO-L-COL-CL Water Orthophosphate-Dissolved (as P) APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SO4-IC-N-CL Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-CL Water Total Dissolved Solids APHA 2540 C

A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 °C. The increase in vial weight represents the total dissolved solids (TDS).

TECKCOAL-IONBAL-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

TKN-L-F-CL Water Total Kjeldahl Nitrogen APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-L-CL Water Total Suspended Solids APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

TURBIDITY-CL Water Turbidity APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** 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:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

REGIONAL EFFECTS
PRO

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: L2344588 Report Date: 17-SEP-19

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-PCT-CL	**Water**							
Batch R4801069								
WG3159412-12 DUP		**L2344588-2**						
Acidity (as CaCO3)		<1.0	<1.0	RPD-NA	mg/L	N/A	20	11-SEP-19
WG3159412-11 LCS								
Acidity (as CaCO3)			103.2		%		85-115	11-SEP-19
WG3159412-10 MB								
Acidity (as CaCO3)			1.6		mg/L		2	11-SEP-19
ALK-MAN-CL	**Water**							
Batch R4800936								
WG3159420-14 LCS								
Alkalinity, Total (as CaCO3)			101.7		%		85-115	11-SEP-19
WG3159420-17 LCS								
Alkalinity, Total (as CaCO3)			103.2		%		85-115	11-SEP-19
WG3159420-13 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	11-SEP-19
WG3159420-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	11-SEP-19
BE-D-L-CCMS-VA	**Water**							
Batch R4806483								
WG3160572-2 LCS								
Beryllium (Be)-Dissolved			94.7		%		80-120	13-SEP-19
WG3160572-1 MB		**LF**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	13-SEP-19
BE-T-L-CCMS-VA	**Water**							
Batch R4804468								
WG3160380-2 LCS								
Beryllium (Be)-Total			93.2		%		80-120	13-SEP-19
WG3160380-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	13-SEP-19
BR-L-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Bromide (Br)			98.9		%		85-115	10-SEP-19
WG3158443-9 MB								
Bromide (Br)			<0.050		mg/L		0.05	10-SEP-19
C-DIS-ORG-LOW-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-LOW-CL	**Water**							
Batch R4807370								
WG3161821-10 LCS								
Dissolved Organic Carbon			107.7		%		80-120	13-SEP-19
WG3161821-9 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	13-SEP-19
C-TOT-ORG-LOW-CL	**Water**							
Batch R4807370								
WG3161821-10 LCS								
Total Organic Carbon			107.8		%		80-120	13-SEP-19
WG3161821-9 MB								
Total Organic Carbon			<0.50		mg/L		0.5	13-SEP-19
CL-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Chloride (Cl)			99.2		%		90-110	10-SEP-19
WG3158443-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	10-SEP-19
EC-L-PCT-CL	**Water**							
Batch R4800936								
WG3159420-14 LCS								
Conductivity (@ 25C)			98.2		%		90-110	11-SEP-19
WG3159420-17 LCS								
Conductivity (@ 25C)			98.7		%		90-110	11-SEP-19
WG3159420-13 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	11-SEP-19
WG3159420-16 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	11-SEP-19
F-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Fluoride (F)			100.7		%		90-110	10-SEP-19
WG3158443-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	10-SEP-19
HG-D-CVAA-VA	**Water**							
Batch R4811610								
WG3162788-2 LCS								
Mercury (Hg)-Dissolved			106.6		%		80-120	16-SEP-19
WG3162788-1 MB		**LF**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-CVAA-VA	**Water**							
Batch R4811610								
WG3162788-1 MB		**LF**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	16-SEP-19
HG-T-U-CVAF-VA	**Water**							
Batch R4806387								
WG3161216-7 DUP		**L2344588-1**						
Mercury (Hg)-Total		<0.00050	<0.00050	RPD-NA	ug/L	N/A	20	13-SEP-19
WG3161216-2 LCS								
Mercury (Hg)-Total			107.1		%		80-120	13-SEP-19
WG3161216-1 MB								
Mercury (Hg)-Total			<0.00050		ug/L		0.0005	13-SEP-19
WG3161216-8 MS		**L2344588-2**						
Mercury (Hg)-Total			93.1		%		70-130	13-SEP-19
MET-D-CCMS-VA	**Water**							
Batch R4806483								
WG3160572-2 LCS								
Aluminum (Al)-Dissolved			99.8		%		80-120	13-SEP-19
Antimony (Sb)-Dissolved			101.3		%		80-120	13-SEP-19
Arsenic (As)-Dissolved			97.8		%		80-120	13-SEP-19
Barium (Ba)-Dissolved			100.1		%		80-120	13-SEP-19
Bismuth (Bi)-Dissolved			95.0		%		80-120	13-SEP-19
Boron (B)-Dissolved			95.4		%		80-120	13-SEP-19
Cadmium (Cd)-Dissolved			98.9		%		80-120	13-SEP-19
Calcium (Ca)-Dissolved			97.3		%		80-120	13-SEP-19
Chromium (Cr)-Dissolved			98.7		%		80-120	13-SEP-19
Cobalt (Co)-Dissolved			97.7		%		80-120	13-SEP-19
Copper (Cu)-Dissolved			98.6		%		80-120	13-SEP-19
Iron (Fe)-Dissolved			95.9		%		80-120	13-SEP-19
Lead (Pb)-Dissolved			95.8		%		80-120	13-SEP-19
Lithium (Li)-Dissolved			95.9		%		80-120	13-SEP-19
Magnesium (Mg)-Dissolved			96.4		%		80-120	13-SEP-19
Manganese (Mn)-Dissolved			100.7		%		80-120	13-SEP-19
Molybdenum (Mo)-Dissolved			98.2		%		80-120	13-SEP-19
Nickel (Ni)-Dissolved			97.7		%		80-120	13-SEP-19
Potassium (K)-Dissolved			97.0		%		80-120	13-SEP-19
Selenium (Se)-Dissolved			99.6		%		80-120	13-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4806483								
WG3160572-2 LCS								
Silicon (Si)-Dissolved			98.9		%		60-140	13-SEP-19
Silver (Ag)-Dissolved			95.5		%		80-120	13-SEP-19
Sodium (Na)-Dissolved			102.2		%		80-120	13-SEP-19
Strontium (Sr)-Dissolved			100.5		%		80-120	13-SEP-19
Thallium (Tl)-Dissolved			95.3		%		80-120	13-SEP-19
Tin (Sn)-Dissolved			96.3		%		80-120	13-SEP-19
Titanium (Ti)-Dissolved			91.7		%		80-120	13-SEP-19
Uranium (U)-Dissolved			96.4		%		80-120	13-SEP-19
Vanadium (V)-Dissolved			100.5		%		80-120	13-SEP-19
Zinc (Zn)-Dissolved			100.8		%		80-120	13-SEP-19
WG3160572-1 MB		**LF**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	13-SEP-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	13-SEP-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	13-SEP-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	13-SEP-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	13-SEP-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	13-SEP-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	13-SEP-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	13-SEP-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	13-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	13-SEP-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	13-SEP-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	13-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	13-SEP-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	13-SEP-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	13-SEP-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	13-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	13-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4806483								
WG3160572-1 MB		**LF**						
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	13-SEP-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	13-SEP-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	13-SEP-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	13-SEP-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	13-SEP-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	13-SEP-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	13-SEP-19
MET-T-CCMS-VA	**Water**							
Batch R4804468								
WG3160380-2 LCS								
Aluminum (Al)-Total			101.0		%		80-120	13-SEP-19
Antimony (Sb)-Total			99.9		%		80-120	13-SEP-19
Arsenic (As)-Total			98.9		%		80-120	13-SEP-19
Barium (Ba)-Total			98.0		%		80-120	13-SEP-19
Bismuth (Bi)-Total			100.6		%		80-120	13-SEP-19
Boron (B)-Total			90.7		%		80-120	13-SEP-19
Cadmium (Cd)-Total			100.7		%		80-120	13-SEP-19
Calcium (Ca)-Total			93.1		%		80-120	13-SEP-19
Chromium (Cr)-Total			97.0		%		80-120	13-SEP-19
Cobalt (Co)-Total			99.5		%		80-120	13-SEP-19
Copper (Cu)-Total			97.1		%		80-120	13-SEP-19
Iron (Fe)-Total			92.8		%		80-120	13-SEP-19
Lead (Pb)-Total			95.6		%		80-120	13-SEP-19
Lithium (Li)-Total			91.7		%		80-120	13-SEP-19
Magnesium (Mg)-Total			101.3		%		80-120	13-SEP-19
Manganese (Mn)-Total			100.0		%		80-120	13-SEP-19
Molybdenum (Mo)-Total			97.8		%		80-120	13-SEP-19
Nickel (Ni)-Total			100.1		%		80-120	13-SEP-19
Potassium (K)-Total			102.9		%		80-120	13-SEP-19
Selenium (Se)-Total			96.5		%		80-120	13-SEP-19
Silicon (Si)-Total			102.0		%		80-120	13-SEP-19
Silver (Ag)-Total			94.5		%		80-120	13-SEP-19
Sodium (Na)-Total			102.7		%		80-120	13-SEP-19
Strontium (Sr)-Total			97.6		%		80-120	13-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4804468								
WG3160380-2 LCS								
Thallium (Tl)-Total			97.6		%		80-120	13-SEP-19
Tin (Sn)-Total			97.6		%		80-120	13-SEP-19
Titanium (Ti)-Total			86.6		%		80-120	13-SEP-19
Uranium (U)-Total			96.8		%		80-120	13-SEP-19
Vanadium (V)-Total			99.5		%		80-120	13-SEP-19
Zinc (Zn)-Total			99.0		%		80-120	13-SEP-19
WG3160380-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	13-SEP-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	13-SEP-19
Boron (B)-Total			<0.010		mg/L		0.01	13-SEP-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	13-SEP-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	13-SEP-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Copper (Cu)-Total			<0.00050		mg/L		0.0005	13-SEP-19
Iron (Fe)-Total			<0.010		mg/L		0.01	13-SEP-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	13-SEP-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	13-SEP-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	13-SEP-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	13-SEP-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	13-SEP-19
Potassium (K)-Total			<0.050		mg/L		0.05	13-SEP-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	13-SEP-19
Silicon (Si)-Total			<0.10		mg/L		0.1	13-SEP-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	13-SEP-19
Sodium (Na)-Total			<0.050		mg/L		0.05	13-SEP-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	13-SEP-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	13-SEP-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	13-SEP-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	13-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4804468								
WG3160380-1 MB								
Uranium (U)-Total			<0.000010		mg/L		0.00001	13-SEP-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	13-SEP-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	13-SEP-19
NH3-L-F-CL	**Water**							
Batch R4806992								
WG3160252-10 LCS								
Ammonia as N			102.2		%		85-115	12-SEP-19
WG3160252-9 MB								
Ammonia as N			<0.0050		mg/L		0.005	12-SEP-19
NO2-L-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Nitrite (as N)			100.3		%		90-110	10-SEP-19
WG3158443-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	10-SEP-19
NO3-L-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Nitrate (as N)			99.6		%		90-110	10-SEP-19
WG3158443-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	10-SEP-19
ORP-CL	**Water**							
Batch R4800709								
WG3159014-1 CRM		**CL-ORP**						
ORP			226		mV		210-230	11-SEP-19
WG3159014-2 DUP		**L2344588-1**						
ORP		338	331	J	mV	6.8	15	11-SEP-19
P-T-L-COL-CL	**Water**							
Batch R4798570								
WG3158662-18 LCS								
Phosphorus (P)-Total			102.5		%		80-120	11-SEP-19
WG3158662-17 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	11-SEP-19
PH-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-CL	**Water**							
Batch R4800936								
WG3159420-14 LCS								
pH			7.03		pH		6.9-7.1	11-SEP-19
WG3159420-17 LCS								
pH			7.03		pH		6.9-7.1	11-SEP-19
PO4-DO-L-COL-CL	**Water**							
Batch R4795230								
WG3157448-18 LCS								
Orthophosphate-Dissolved (as P)			97.9		%		80-120	10-SEP-19
WG3157448-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	10-SEP-19
SO4-IC-N-CL	**Water**							
Batch R4797291								
WG3158443-10 LCS								
Sulfate (SO4)			97.9		%		90-110	10-SEP-19
WG3158443-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	10-SEP-19
SOLIDS-TDS-CL	**Water**							
Batch R4801730								
WG3158128-2 LCS								
Total Dissolved Solids			98.9		%		85-115	11-SEP-19
WG3158128-1 MB								
Total Dissolved Solids			<10		mg/L		10	11-SEP-19
TKN-L-F-CL	**Water**							
Batch R4801170								
WG3159658-10 LCS								
Total Kjeldahl Nitrogen			101.4		%		75-125	12-SEP-19
WG3159658-11 LCS								
Total Kjeldahl Nitrogen			106.4		%		75-125	12-SEP-19
WG3159658-12 LCS								
Total Kjeldahl Nitrogen			101.1		%		75-125	12-SEP-19
WG3159658-13 LCS								
Total Kjeldahl Nitrogen			103.1		%		75-125	13-SEP-19
WG3159658-14 LCS								
Total Kjeldahl Nitrogen			100.9		%		75-125	13-SEP-19
WG3159658-16 LCS								
Total Kjeldahl Nitrogen			101.1		%		75-125	13-SEP-19
WG3159658-8 LCS								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-L-F-CL	**Water**							
Batch R4801170								
WG3159658-8 LCS								
Total Kjeldahl Nitrogen			99.5		%		75-125	12-SEP-19
WG3159658-9 LCS								
Total Kjeldahl Nitrogen			101.6		%		75-125	12-SEP-19
WG3159658-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	12-SEP-19
WG3159658-15 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	13-SEP-19
WG3159658-2 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	12-SEP-19
WG3159658-3 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	12-SEP-19
WG3159658-4 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	12-SEP-19
WG3159658-5 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	12-SEP-19
WG3159658-6 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	13-SEP-19
WG3159658-7 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	13-SEP-19
TSS-L-CL	**Water**							
Batch R4807649								
WG3160658-6 LCS								
Total Suspended Solids			97.4		%		85-115	13-SEP-19
WG3160658-5 MB								
Total Suspended Solids			<1.0		mg/L		1	13-SEP-19
TURBIDITY-CL	**Water**							
Batch R4796388								
WG3157710-14 LCS								
Turbidity			98.0		%		85-115	10-SEP-19
WG3157710-13 MB								
Turbidity			<0.10		NTU		0.1	10-SEP-19

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:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Oxidation redution potential by elect.							
	1	08-SEP-19 08:30	11-SEP-19 12:10	0.25	76	hours	EHTR-FM
	2	08-SEP-19 09:27	11-SEP-19 12:10	0.25	75	hours	EHTR-FM
pH							
	1	08-SEP-19 08:30	11-SEP-19 09:00	0.25	72	hours	EHTR-FM
	2	08-SEP-19 09:27	11-SEP-19 09:00	0.25	72	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2344588 were received on 10-SEP-19 09:00.

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.

Teck

Page 1 of 1

COC ID:	**Regional Effects Program**	**TURNAROUND TIME:**	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/GHO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
Address	421 Pine Avenue		
City	Sparwood	Province	BC
Postal Code	V0B 2G0	Country	Canada
Phone Number	250-425-8202		

LABORATORY

Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
Email	Lyudmyla.Shvets@ALSGlobal.com		
Address	2559 29 Street NE		
City	Calgary	Province	AB
Postal Code	T1Y 7B5	Country	Canada
Phone Number	403-407-1800		

OTHER INFO

Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	x	x	x
Email 2:	carlie.meyer@teck.com	x	x	x
Email 3:	teckcoal@equisonline.com			x
Email 4:	jtester@minnow.ca	x	x	x
Email 5:				
PO number	*VPO00616180*			

SAMPLE DETAILS / **ANALYSIS REQUESTED**

L2344588-COFC

Filtered - F: Field, L: Lab, FL: Field & Lab, N: None

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	HG-T-U-CVAF-VA	ALS_Package-DOC	ALS_Package-TKN/TOC	HG-D-CVAF-VA	TECKCOAL-MET-D-VA	TECKCOAL-MET-T-VA	TECKCOAL-ROUTINE-VA
Filt.								N	N	N	N	N	N	N
PRESERV.								NONE	NONE	H2SO4	NONE	NONE	HNO3	NONE
GH_ERC_WS_2019-09-08_0830	GH_ERC	WS	No	8-Sep-19	8:30:00	G	7	1	1	1	1	1	1	1
RG_ERSC5_WS_2019-09-08_0927	RG_ERSC5	WS	No	8-Sep-19	9:27:00	G	7	1	1	1	1	1	1	1

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS

VPO00616180

RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
Jennifer Ings/Minnow	September 9, 2019		9/10 900

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	**Jennifer Ings**	**Mobile #**	**519-500-3444**
Sampler's Signature		**Date/Time**	**September 9, 2019**

9

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 12-SEP-19
Report Date: 20-SEP-19 19:03 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2346368

Project P.O. #:	VPO00616180
Job Reference:	REGIONAL EFFECTS PROGRAM
C of C Numbers:	REGIONAL
Legal Site Desc:	

Lyudmyla Shvets, B.Sc.
Account Manager

	Sample ID	L2346368-1	L2346368-2	L2346368-3	L2346368-4	L2346368-5
	Description	WS	WS	WS	WS	WS
	Sampled Date	10-SEP-19	09-SEP-19	10-SEP-19	09-SEP-19	10-SEP-19
	Sampled Time	11:00	09:00	10:00	12:33	11:00
	Client ID	RG_FBLANK_WS_2019-09-10_1100	GH_ERSC4_WS_2019-09-10_0900	RG_RIVER_WS_2019-09-10_1000	RG_ER1A_WS_2019-09-09_1233	RG_TRIP_WS_2019-09-10_1100
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (@ 25C) (uS/cm)	<2.0	289	291	322	<2.0
	Hardness (as CaCO3) (mg/L)	<0.50	158	157	174	<0.50
	pH (pH)	5.39	8.39	8.41	8.42	5.44
	ORP (mV)	497	415	479	441	453
	Total Suspended Solids (mg/L)	<1.0	<1.0	2.2	<1.0	<1.0
	Total Dissolved Solids (mg/L)	<10	177 DLHC	185 DLHC	207 DLHC	<10
	Turbidity (NTU)	<0.10	0.22	0.23	0.37	<0.10
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	1.5	<1.0	<1.0	<1.0	1.5
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	<1.0	138	140	139	<1.0
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	3.8	4.4	3.8	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	<1.0	142	144	143	<1.0
	Ammonia as N (mg/L)	0.0419 RRV	<0.0050	<0.0050	<0.0050	<0.0050
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50
	Fluoride (F) (mg/L)	<0.020	0.164	0.162	0.160	<0.020
	Ion Balance (%)	0.0	98.3	96.2	98.1	0.0
	Nitrate (as N) (mg/L)	<0.0050	0.111	0.0771	0.694	<0.0050
	Nitrite (as N) (mg/L)	<0.0010	0.0015	<0.0010	0.0025	<0.0010
	Total Kjeldahl Nitrogen (mg/L)	0.054 RRV	<0.050	0.052	0.330	<0.050
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	0.0010	0.0011	<0.0010	<0.0010
	Phosphorus (P)-Total (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Sulfate (SO4) (mg/L)	<0.30	19.8	19.8	32.9	<0.30
	Anion Sum (meq/L)	<0.10	3.26	3.30	3.60	<0.10
	Cation Sum (meq/L)	<0.10	3.20	3.18	3.53	<0.10
	Cation - Anion Balance (%)	0.0	-0.9	-1.9	-1.0	0.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		<0.50	<0.50	<0.50	<0.50
	Total Organic Carbon (mg/L)	<0.50	0.67	0.68	0.81	<0.50
Total Metals	Aluminum (Al)-Total (mg/L)	<0.0030	0.0127	0.0074	0.0101	<0.0030
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	<0.00010	0.00010	<0.00010	0.00011	<0.00010
	Barium (Ba)-Total (mg/L)	<0.00010	0.0458	0.0462	0.0487	<0.00010
	Beryllium (Be)-Total (ug/L)	<0.020	<0.020	<0.020	<0.020	<0.020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (ug/L)	<0.0050	0.0076	0.0072	0.0095	<0.0050

	Sample ID	L2346368-1	L2346368-2	L2346368-3	L2346368-4	L2346368-5
	Description	WS	WS	WS	WS	WS
	Sampled Date	10-SEP-19	09-SEP-19	10-SEP-19	09-SEP-19	10-SEP-19
	Sampled Time	11:00	09:00	10:00	12:33	11:00
	Client ID	RG_FBLANK_WS_2019-09-10_1100	GH_ERSC4_WS_2019-09-10_0900	RG_RIVER_WS_2019-09-10_1000	RG_ER1A_WS_2019-09-09_1233	RG_TRIP_WS_2019-09-10_1100
Grouping	**Analyte**					
WATER						
Total Metals	Calcium (Ca)-Total (mg/L)	<0.050	45.0	46.6	49.1	<0.050
	Chromium (Cr)-Total (mg/L)	<0.00010	0.00020	0.00021	0.00020	<0.00010
	Cobalt (Co)-Total (ug/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Iron (Fe)-Total (mg/L)	<0.010	0.015	0.014	0.016	<0.010
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	<0.0010	0.0024	0.0025	0.0038	<0.0010
	Magnesium (Mg)-Total (mg/L)	<0.10	10.4	10.5	13.1	<0.10
	Manganese (Mn)-Total (mg/L)	<0.00010	0.00195	0.00206	0.00206	<0.00010
	Mercury (Hg)-Total (ug/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Molybdenum (Mo)-Total (mg/L)	<0.000050	0.000982	0.00105	0.00104	<0.000050
	Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	0.00052	<0.00050	<0.00050
	Potassium (K)-Total (mg/L)	<0.050	0.380	0.377	0.440	<0.050
	Selenium (Se)-Total (ug/L)	<0.050	0.838	0.876	2.07	<0.050
	Silicon (Si)-Total (mg/L)	<0.10	1.82	1.85	1.84	<0.10
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	<0.050	0.692	0.701	1.03	<0.050
	Strontium (Sr)-Total (mg/L)	<0.00020	0.192	0.202	0.218	<0.00020
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	<0.000010	0.000730	0.000773	0.000860	<0.000010
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Dissolved Metals	Dissolved Mercury Filtration Location		LAB	LAB	LAB	LAB
	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Aluminum (Al)-Dissolved (mg/L)		<0.0030	<0.0030	<0.0030	<0.0030
	Antimony (Sb)-Dissolved (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)		0.00012	0.00010	0.00011	<0.00010
	Barium (Ba)-Dissolved (mg/L)		0.0442	0.0445	0.0473	<0.00010
	Beryllium (Be)-Dissolved (ug/L)		<0.020	<0.020	<0.020	<0.020
	Bismuth (Bi)-Dissolved (mg/L)		<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)		<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Dissolved (ug/L)		0.0066	0.0072	0.0089	<0.0050
	Calcium (Ca)-Dissolved (mg/L)	<0.050	44.4	44.1	46.9	<0.050
	Chromium (Cr)-Dissolved (mg/L)		0.00020	0.00017	0.00019	<0.00010
	Cobalt (Co)-Dissolved (ug/L)		<0.10	<0.10	<0.10	<0.10

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

	Sample ID	L2346368-1	L2346368-2	L2346368-3	L2346368-4	L2346368-5
	Description	WS	WS	WS	WS	WS
	Sampled Date	10-SEP-19	09-SEP-19	10-SEP-19	09-SEP-19	10-SEP-19
	Sampled Time	11:00	09:00	10:00	12:33	11:00
	Client ID	RG_FBLANK_WS_2019-09-10_1100	GH_ERSC4_WS_2019-09-10_0900	RG_RIVER_WS_2019-09-10_1000	RG_ER1A_WS_2019-09-09_1233	RG_TRIP_WS_2019-09-10_1100
Grouping	**Analyte**					
WATER						
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Iron (Fe)-Dissolved (mg/L)		<0.010	<0.010	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)		<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)		0.0023	0.0023	0.0038	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	<0.0050	11.5	11.4	13.7	<0.10
	Manganese (Mn)-Dissolved (mg/L)		0.00057	0.00056	0.00023	<0.00010
	Mercury (Hg)-Dissolved (mg/L)		<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)		0.00106	0.00105	0.00105	<0.000050
	Nickel (Ni)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Potassium (K)-Dissolved (mg/L)	<0.050	0.380	0.374	0.439	<0.050
	Selenium (Se)-Dissolved (ug/L)		0.991	0.918	2.45	<0.050
	Silicon (Si)-Dissolved (mg/L)		1.83	1.82	1.86	<0.050
	Silver (Ag)-Dissolved (mg/L)		<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	<0.050	0.731	0.725	1.08	<0.050
	Strontium (Sr)-Dissolved (mg/L)		0.206	0.208	0.216	<0.00020
	Thallium (Tl)-Dissolved (mg/L)		<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)		<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)		0.000754	0.000747	0.000854	<0.000010
	Vanadium (V)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010

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

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Sample was Filtered and Preserved at the laboratory - DOC, DIS METALS LAB FILTER/PRESERVE

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2346368-2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2346368-2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2346368-2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2346368-2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2346368-2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACIDITY-PCT-CL	Water	Acidity by Automatic Titration	APHA 2310 Acidity

This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-MAN-CL	Water	Alkalinity (Species) by Manual Titration	APHA 2320 ALKALINITY

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-CL	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-LOW-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LOW-CL	Water	Total Organic Carbon	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-L-PCT-CL Water Electrical Conductivity (EC) APHA 2510B

Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25C.

F-IC-N-CL Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-CL Water Hardness APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-U-CVAF-VA Water Total Mercury in Water by CVAFS (Ultra) EPA 1631 REV. E

This analysis is carried out using procedures adapted from Method 1631 Rev. E. by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry.

IONBALANCE-BC-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-CL Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL Water Ammonia, Total (as N) J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-CL Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ORP-CL Water Oxidation redution potential by elect. ASTM D1498

This analysis is carried out in accordance with the procedure described in the "ASTM" method D1498 "Oxidation-Reduction Potential of Water" published by the American Society for Testing and Materials (ASTM). Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

Reference Information

P-T-L-COL-CL Water Phosphorus (P)-Total APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-CL Water pH APHA 4500 H-Electrode

pH is determined in the laboratory using a pH electrode. All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)

PO4-DO-L-COL-CL Water Orthophosphate-Dissolved (as P) APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SO4-IC-N-CL Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-CL Water Total Dissolved Solids APHA 2540 C

A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 °C. The increase in vial weight represents the total dissolved solids (TDS).

TECKCOAL-IONBAL-CL Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

TKN-L-F-CL Water Total Kjeldahl Nitrogen APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-L-CL Water Total Suspended Solids APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

TURBIDITY-CL Water Turbidity APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** 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:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

REGIONAL

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: L2346368 Report Date: 20-SEP-19

Client:	Teck Coal Ltd. 421 Pine Avenue Sparwood BC V0B 2G0
Contact:	Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-PCT-CL	**Water**							
Batch R4809828								
WG3162552-18 DUP		**L2346368-3**						
Acidity (as CaCO3)		<1.0	<1.0	RPD-NA	mg/L	N/A	20	13-SEP-19
WG3162552-17 LCS								
Acidity (as CaCO3)			104.5		%		85-115	13-SEP-19
WG3162552-16 MB								
Acidity (as CaCO3)			1.4		mg/L		2	13-SEP-19
ALK-MAN-CL	**Water**							
Batch R4809453								
WG3162562-18 DUP		**L2346368-4**						
Alkalinity, Total (as CaCO3)		143	145		mg/L	1.4	20	13-SEP-19
WG3162562-17 LCS								
Alkalinity, Total (as CaCO3)			102.8		%		85-115	13-SEP-19
WG3162562-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	13-SEP-19
BE-D-L-CCMS-VA	**Water**							
Batch R4816494								
WG3162600-2 LCS								
Beryllium (Be)-Dissolved			100.8		%		80-120	17-SEP-19
WG3162600-1 MB		**LF**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	17-SEP-19
BE-T-L-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-3 DUP		**L2346368-2**						
Beryllium (Be)-Total		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	16-SEP-19
WG3162194-2 LCS								
Beryllium (Be)-Total			110.9		%		80-120	16-SEP-19
WG3162194-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	16-SEP-19
WG3162194-4 MS		**L2346368-1**						
Beryllium (Be)-Total			98.4		%		70-130	16-SEP-19
BR-L-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Bromide (Br)		<0.050	<0.050	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Bromide (Br)			101.6		%		85-115	12-SEP-19
WG3160753-13 MB								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BR-L-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-13 MB								
Bromide (Br)			<0.050		mg/L		0.05	12-SEP-19
WG3160753-16 MS		**L2346368-1**						
Bromide (Br)			107.9		%		75-125	12-SEP-19
C-DIS-ORG-LOW-CL	**Water**							
Batch R4818591								
WG3165184-2 LCS								
Dissolved Organic Carbon			103.8		%		80-120	17-SEP-19
WG3165184-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	17-SEP-19
C-TOT-ORG-LOW-CL	**Water**							
Batch R4818591								
WG3165184-2 LCS								
Total Organic Carbon			101.6		%		80-120	17-SEP-19
WG3165184-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	17-SEP-19
CL-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Chloride (Cl)		<0.50	<0.50	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Chloride (Cl)			101.0		%		90-110	12-SEP-19
WG3160753-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	12-SEP-19
WG3160753-16 MS		**L2346368-1**						
Chloride (Cl)			106.8		%		75-125	12-SEP-19
EC-L-PCT-CL	**Water**							
Batch R4809453								
WG3162562-18 DUP		**L2346368-4**						
Conductivity (@ 25C)		322	324		uS/cm	0.6	10	13-SEP-19
WG3162562-17 LCS								
Conductivity (@ 25C)			97.8		%		90-110	13-SEP-19
WG3162562-16 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	13-SEP-19
F-IC-N-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Fluoride (F)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Fluoride (F)			105.0		%		90-110	12-SEP-19
WG3160753-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	12-SEP-19
WG3160753-16 MS		**L2346368-1**						
Fluoride (F)			110.8		%		75-125	12-SEP-19
HG-D-CVAA-VA	**Water**							
Batch R4821972								
WG3165929-2 LCS								
Mercury (Hg)-Dissolved			99.4		%		80-120	19-SEP-19
WG3165929-1 MB		**LF**						
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	19-SEP-19
HG-T-U-CVAF-VA	**Water**							
Batch R4818037								
WG3164673-5 DUP		**L2346368-2**						
Mercury (Hg)-Total		<0.00050	<0.00050	RPD-NA	ug/L	N/A	20	18-SEP-19
WG3164673-2 LCS								
Mercury (Hg)-Total			104.5		%		80-120	18-SEP-19
WG3164673-1 MB								
Mercury (Hg)-Total			<0.00050		ug/L		0.0005	18-SEP-19
WG3164673-6 MS		**L2346368-3**						
Mercury (Hg)-Total			108.4		%		70-130	18-SEP-19
MET-D-CCMS-CL	**Water**							
Batch R4811135								
WG3163119-2 LCS								
Calcium (Ca)-Dissolved			100.2		%		80-120	16-SEP-19
Magnesium (Mg)-Dissolved			103.7		%		80-120	16-SEP-19
Potassium (K)-Dissolved			103.3		%		80-120	16-SEP-19
Sodium (Na)-Dissolved			101.0		%		80-120	16-SEP-19
WG3163119-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	16-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	16-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	16-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	16-SEP-19
MET-D-CCMS-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4816494								
WG3162600-2 LCS								
Aluminum (Al)-Dissolved			103.8		%		80-120	17-SEP-19
Antimony (Sb)-Dissolved			97.3		%		80-120	17-SEP-19
Arsenic (As)-Dissolved			98.2		%		80-120	17-SEP-19
Barium (Ba)-Dissolved			99.4		%		80-120	17-SEP-19
Bismuth (Bi)-Dissolved			94.6		%		80-120	17-SEP-19
Boron (B)-Dissolved			100.8		%		80-120	17-SEP-19
Cadmium (Cd)-Dissolved			95.2		%		80-120	17-SEP-19
Calcium (Ca)-Dissolved			96.7		%		80-120	17-SEP-19
Chromium (Cr)-Dissolved			101.1		%		80-120	17-SEP-19
Cobalt (Co)-Dissolved			98.5		%		80-120	17-SEP-19
Copper (Cu)-Dissolved			99.5		%		80-120	17-SEP-19
Iron (Fe)-Dissolved			100.4		%		80-120	17-SEP-19
Lead (Pb)-Dissolved			97.2		%		80-120	17-SEP-19
Lithium (Li)-Dissolved			98.3		%		80-120	17-SEP-19
Magnesium (Mg)-Dissolved			104.2		%		80-120	17-SEP-19
Manganese (Mn)-Dissolved			101.6		%		80-120	17-SEP-19
Molybdenum (Mo)-Dissolved			94.6		%		80-120	17-SEP-19
Nickel (Ni)-Dissolved			100.4		%		80-120	17-SEP-19
Potassium (K)-Dissolved			102.0		%		80-120	17-SEP-19
Selenium (Se)-Dissolved			97.5		%		80-120	17-SEP-19
Silicon (Si)-Dissolved			103.2		%		60-140	17-SEP-19
Silver (Ag)-Dissolved			100.5		%		80-120	17-SEP-19
Sodium (Na)-Dissolved			104.6		%		80-120	17-SEP-19
Strontium (Sr)-Dissolved			98.2		%		80-120	17-SEP-19
Thallium (Tl)-Dissolved			99.6		%		80-120	17-SEP-19
Tin (Sn)-Dissolved			97.1		%		80-120	17-SEP-19
Titanium (Ti)-Dissolved			99.8		%		80-120	17-SEP-19
Uranium (U)-Dissolved			101.5		%		80-120	17-SEP-19
Vanadium (V)-Dissolved			101.6		%		80-120	17-SEP-19
Zinc (Zn)-Dissolved			104.6		%		80-120	17-SEP-19
WG3162600-1 MB		**LF**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	17-SEP-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4816494								
WG3162600-1 MB		**LF**						
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	17-SEP-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	17-SEP-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	17-SEP-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	17-SEP-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	17-SEP-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	17-SEP-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	17-SEP-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	17-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	17-SEP-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	17-SEP-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	17-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	17-SEP-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	17-SEP-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	17-SEP-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	17-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	17-SEP-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	17-SEP-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	17-SEP-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	17-SEP-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	17-SEP-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	17-SEP-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	17-SEP-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	17-SEP-19
MET-T-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-3 DUP		**L2346368-2**						
Aluminum (Al)-Total		0.0127	0.0087	J	mg/L	0.0040	0.006	16-SEP-19
Antimony (Sb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	16-SEP-19
Arsenic (As)-Total		0.00010	<0.00010	RPD-NA	mg/L	N/A	20	16-SEP-19
Barium (Ba)-Total		0.0458	0.0463		mg/L	1.0	20	16-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-3 DUP		**L2346368-2**						
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	16-SEP-19
Boron (B)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	16-SEP-19
Cadmium (Cd)-Total		0.0000076	0.0000074		mg/L	3.1	20	16-SEP-19
Calcium (Ca)-Total		45.0	47.7		mg/L	5.7	20	16-SEP-19
Chromium (Cr)-Total		0.00020	0.00023		mg/L	15	20	16-SEP-19
Cobalt (Co)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	16-SEP-19
Copper (Cu)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	16-SEP-19
Iron (Fe)-Total		0.015	0.014		mg/L	7.3	20	16-SEP-19
Lead (Pb)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	16-SEP-19
Lithium (Li)-Total		0.0024	0.0025		mg/L	4.9	20	16-SEP-19
Magnesium (Mg)-Total		10.4	10.8		mg/L	3.9	20	16-SEP-19
Manganese (Mn)-Total		0.00195	0.00198		mg/L	1.7	20	16-SEP-19
Molybdenum (Mo)-Total		0.000982	0.00108		mg/L	9.2	20	16-SEP-19
Nickel (Ni)-Total		<0.00050	0.00051	RPD-NA	mg/L	N/A	20	16-SEP-19
Potassium (K)-Total		0.380	0.384		mg/L	1.0	20	16-SEP-19
Selenium (Se)-Total		0.000838	0.000738		mg/L	13	20	16-SEP-19
Silicon (Si)-Total		1.82	1.85		mg/L	1.7	20	16-SEP-19
Silver (Ag)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	16-SEP-19
Sodium (Na)-Total		0.692	0.704		mg/L	1.8	20	16-SEP-19
Strontium (Sr)-Total		0.192	0.201		mg/L	5.0	20	16-SEP-19
Thallium (Tl)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	16-SEP-19
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	16-SEP-19
Titanium (Ti)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	16-SEP-19
Uranium (U)-Total		0.000730	0.000757		mg/L	3.7	20	16-SEP-19
Vanadium (V)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	16-SEP-19
Zinc (Zn)-Total		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	16-SEP-19
WG3162194-2 LCS								
Aluminum (Al)-Total			104.1		%		80-120	16-SEP-19
Antimony (Sb)-Total			105.0		%		80-120	16-SEP-19
Arsenic (As)-Total			101.7		%		80-120	16-SEP-19
Barium (Ba)-Total			105.4		%		80-120	16-SEP-19
Bismuth (Bi)-Total			100.4		%		80-120	16-SEP-19
Boron (B)-Total			113.0		%		80-120	16-SEP-19
Cadmium (Cd)-Total			104.1		%		80-120	16-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-2 LCS								
Calcium (Ca)-Total			113.8		%		80-120	16-SEP-19
Chromium (Cr)-Total			100.6		%		80-120	16-SEP-19
Cobalt (Co)-Total			103.4		%		80-120	16-SEP-19
Copper (Cu)-Total			101.3		%		80-120	16-SEP-19
Iron (Fe)-Total			98.2		%		80-120	16-SEP-19
Lead (Pb)-Total			105.8		%		80-120	16-SEP-19
Lithium (Li)-Total			113.1		%		80-120	16-SEP-19
Magnesium (Mg)-Total			103.1		%		80-120	16-SEP-19
Manganese (Mn)-Total			102.0		%		80-120	16-SEP-19
Molybdenum (Mo)-Total			101.6		%		80-120	16-SEP-19
Nickel (Ni)-Total			101.2		%		80-120	16-SEP-19
Potassium (K)-Total			106.0		%		80-120	16-SEP-19
Selenium (Se)-Total			99.8		%		80-120	16-SEP-19
Silicon (Si)-Total			102.2		%		80-120	16-SEP-19
Silver (Ag)-Total			104.8		%		80-120	16-SEP-19
Sodium (Na)-Total			105.8		%		80-120	16-SEP-19
Strontium (Sr)-Total			103.1		%		80-120	16-SEP-19
Thallium (Tl)-Total			104.0		%		80-120	16-SEP-19
Tin (Sn)-Total			102.6		%		80-120	16-SEP-19
Titanium (Ti)-Total			98.7		%		80-120	16-SEP-19
Uranium (U)-Total			114.4		%		80-120	16-SEP-19
Vanadium (V)-Total			104.1		%		80-120	16-SEP-19
Zinc (Zn)-Total			103.6		%		80-120	16-SEP-19
WG3162194-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	16-SEP-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	16-SEP-19
Boron (B)-Total			<0.010		mg/L		0.01	16-SEP-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	16-SEP-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	16-SEP-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	16-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	16-SEP-19
Iron (Fe)-Total			<0.010		mg/L		0.01	16-SEP-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	16-SEP-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	16-SEP-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	16-SEP-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	16-SEP-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	16-SEP-19
Potassium (K)-Total			<0.050		mg/L		0.05	16-SEP-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	16-SEP-19
Silicon (Si)-Total			<0.10		mg/L		0.1	16-SEP-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	16-SEP-19
Sodium (Na)-Total			<0.050		mg/L		0.05	16-SEP-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	16-SEP-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	16-SEP-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	16-SEP-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	16-SEP-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	16-SEP-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	16-SEP-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	16-SEP-19
WG3162194-4 MS		**L2346368-1**						
Aluminum (Al)-Total			94.5		%		70-130	16-SEP-19
Antimony (Sb)-Total			100.2		%		70-130	16-SEP-19
Arsenic (As)-Total			95.1		%		70-130	16-SEP-19
Barium (Ba)-Total			94.4		%		70-130	16-SEP-19
Bismuth (Bi)-Total			105.7		%		70-130	16-SEP-19
Boron (B)-Total			98.2		%		70-130	16-SEP-19
Cadmium (Cd)-Total			102.0		%		70-130	16-SEP-19
Calcium (Ca)-Total			102.2		%		70-130	16-SEP-19
Chromium (Cr)-Total			95.8		%		70-130	16-SEP-19
Cobalt (Co)-Total			99.7		%		70-130	16-SEP-19
Copper (Cu)-Total			99.0		%		70-130	16-SEP-19
Iron (Fe)-Total			96.1		%		70-130	16-SEP-19
Lead (Pb)-Total			99.5		%		70-130	16-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4812049								
WG3162194-4 MS		**L2346368-1**						
Lithium (Li)-Total			101.7		%		70-130	16-SEP-19
Magnesium (Mg)-Total			94.8		%		70-130	16-SEP-19
Manganese (Mn)-Total			94.7		%		70-130	16-SEP-19
Molybdenum (Mo)-Total			93.5		%		70-130	16-SEP-19
Nickel (Ni)-Total			97.7		%		70-130	16-SEP-19
Potassium (K)-Total			97.8		%		70-130	16-SEP-19
Selenium (Se)-Total			97.7		%		70-130	16-SEP-19
Silicon (Si)-Total			92.6		%		70-130	16-SEP-19
Silver (Ag)-Total			101.9		%		70-130	16-SEP-19
Sodium (Na)-Total			98.4		%		70-130	16-SEP-19
Strontium (Sr)-Total			92.8		%		70-130	16-SEP-19
Thallium (Tl)-Total			101.5		%		70-130	16-SEP-19
Tin (Sn)-Total			96.8		%		70-130	16-SEP-19
Titanium (Ti)-Total			91.3		%		70-130	16-SEP-19
Uranium (U)-Total			107.9		%		70-130	16-SEP-19
Vanadium (V)-Total			97.9		%		70-130	16-SEP-19
Zinc (Zn)-Total			102.3		%		70-130	16-SEP-19
NH3-L-F-CL	**Water**							
Batch R4820535								
WG3165737-2 LCS								
Ammonia as N			102.9		%		85-115	18-SEP-19
WG3165737-6 LCS								
Ammonia as N			113.8		%		85-115	18-SEP-19
WG3165737-1 MB								
Ammonia as N			<0.0050		mg/L		0.005	18-SEP-19
WG3165737-5 MB								
Ammonia as N			<0.0050		mg/L		0.005	18-SEP-19
NO2-L-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Nitrite (as N)			103.0		%		90-110	12-SEP-19
WG3160753-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	12-SEP-19
WG3160753-16		**L2346368-1**						

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-16 MS		**L2346368-1**						
Nitrite (as N)			108.8		%		75-125	12-SEP-19
NO3-L-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Nitrate (as N)			101.2		%		90-110	12-SEP-19
WG3160753-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	12-SEP-19
WG3160753-16 MS		**L2346368-1**						
Nitrate (as N)			106.9		%		75-125	12-SEP-19
ORP-CL	**Water**							
Batch R4809150								
WG3162559-3 CRM		**CL-ORP**						
ORP			227		mV		210-230	14-SEP-19
WG3162559-4 DUP		**L2346368-1**						
ORP		497	492	J	mV	5.4	15	14-SEP-19
P-T-L-COL-CL	**Water**							
Batch R4824051								
WG3166984-2 LCS								
Phosphorus (P)-Total			98.6		%		80-120	19-SEP-19
WG3166984-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	19-SEP-19
PH-CL	**Water**							
Batch R4809453								
WG3162562-18 DUP		**L2346368-4**						
pH		8.42	8.42	J	pH	0.00	0.2	13-SEP-19
WG3162562-17 LCS								
pH			7.04		pH		6.9-7.1	13-SEP-19
PO4-DO-L-COL-CL	**Water**							
Batch R4803488								
WG3159797-39 LCS								
Orthophosphate-Dissolved (as P)			104.4		%		80-120	12-SEP-19
WG3159797-10 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	12-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-CL	**Water**							
Batch R4804829								
WG3160753-15 DUP		**L2346368-1**						
Sulfate (SO4)		<0.30	<0.30	RPD-NA	mg/L	N/A	20	12-SEP-19
WG3160753-14 LCS								
Sulfate (SO4)			101.1		%		90-110	12-SEP-19
WG3160753-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-SEP-19
WG3160753-16 MS		**L2346368-1**						
Sulfate (SO4)			107.0		%		75-125	12-SEP-19
SOLIDS-TDS-CL	**Water**							
Batch R4809749								
WG3160660-8 LCS								
Total Dissolved Solids			98.9		%		85-115	13-SEP-19
WG3160660-7 MB								
Total Dissolved Solids			<10		mg/L		10	13-SEP-19
TKN-L-F-CL	**Water**							
Batch R4819105								
WG3164332-31 DUP		**L2346368-1**						
Total Kjeldahl Nitrogen		0.054	0.054		mg/L	0.3	20	17-SEP-19
WG3164332-10 LCS								
Total Kjeldahl Nitrogen			101.3		%		75-125	17-SEP-19
WG3164332-14 LCS								
Total Kjeldahl Nitrogen			100.4		%		75-125	17-SEP-19
WG3164332-18 LCS								
Total Kjeldahl Nitrogen			98.6		%		75-125	17-SEP-19
WG3164332-2 LCS								
Total Kjeldahl Nitrogen			97.2		%		75-125	17-SEP-19
WG3164332-22 LCS								
Total Kjeldahl Nitrogen			97.7		%		75-125	17-SEP-19
WG3164332-26 LCS								
Total Kjeldahl Nitrogen			96.4		%		75-125	17-SEP-19
WG3164332-30 LCS								
Total Kjeldahl Nitrogen			97.5		%		75-125	17-SEP-19
WG3164332-34 LCS								
Total Kjeldahl Nitrogen			97.2		%		75-125	17-SEP-19
WG3164332-6 LCS								
Total Kjeldahl Nitrogen			97.0		%		75-125	17-SEP-19
WG3164332-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-L-F-CL	**Water**							
Batch R4819105								
WG3164332-13 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-17 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-21 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-25 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-29 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-33 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-5 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-9 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	17-SEP-19
WG3164332-32 MS		**L2346368-1**						
Total Kjeldahl Nitrogen			102.1		%		70-130	19-SEP-19
TSS-L-CL	**Water**							
Batch R4807649								
WG3160658-12 LCS								
Total Suspended Solids			91.3		%		85-115	13-SEP-19
WG3160658-14 LCS								
Total Suspended Solids			88.2		%		85-115	13-SEP-19
WG3160658-11 MB								
Total Suspended Solids			<1.0		mg/L		1	13-SEP-19
WG3160658-13 MB								
Total Suspended Solids			<1.0		mg/L		1	13-SEP-19
TURBIDITY-CL	**Water**							
Batch R4806565								
WG3161381-21 DUP		**L2346368-1**						
Turbidity		<0.10	<0.10	RPD-NA	NTU	N/A	15	13-SEP-19
WG3161381-20 LCS								
Turbidity			99.5		%		85-115	13-SEP-19
WG3161381-19 MB								
Turbidity			<0.10		NTU		0.1	13-SEP-19

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

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.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Oxidation redution potential by elect.							
	1	10-SEP-19 11:00	14-SEP-19 09:45	0.25	95	hours	EHTR-FM
	2	09-SEP-19 09:00	14-SEP-19 09:45	0.25	121	hours	EHTR-FM
	3	10-SEP-19 10:00	14-SEP-19 09:45	0.25	96	hours	EHTR-FM
	4	09-SEP-19 12:33	14-SEP-19 09:45	0.25	117	hours	EHTR-FM
	5	10-SEP-19 11:00	14-SEP-19 09:45	0.25	95	hours	EHTR-FM
Turbidity							
	2	09-SEP-19 09:00	13-SEP-19 09:20	3	4	days	EHTL
	4	09-SEP-19 12:33	13-SEP-19 09:20	3	4	days	EHTL
pH							
	1	10-SEP-19 11:00	13-SEP-19 09:00	0.25	70	hours	EHTR-FM
	2	09-SEP-19 09:00	13-SEP-19 09:00	0.25	96	hours	EHTR-FM
	3	10-SEP-19 10:00	13-SEP-19 09:00	0.25	71	hours	EHTR-FM
	4	09-SEP-19 12:33	13-SEP-19 09:00	0.25	92	hours	EHTR-FM
	5	10-SEP-19 11:00	13-SEP-19 09:00	0.25	70	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2346368 were received on 12-SEP-19 08:50.

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.

Teck

Page 1 of 1

COC ID:	**Regional Effects Program**	TURNAROUND TIME:	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/GHO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
Address	421 Pine Avenue		
City	Sparwood	Province	BC
Postal Code	V0B 2G0	Country	Canada
Phone Number	250-425-8202		

LABORATORY

Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
Email	Lyudmyla.Shvets@ALSGlobal.com		
Address	2559 29 Street NE		
City	Calgary	Province	AB
Postal Code	T1Y 7B5	Country	Canada
Phone Number	403-407-1800		

OTHER INFO

Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	X	X	X
Email 2:	carlie.meyer@teck.com	X	X	X
Email 3:	teckcoal@equisonline.com			X
Email 4:	jtester@minnow.ca	X	X	X
Email 5:				

PO number VPO00616180

SAMPLE DETAILS / **ANALYSIS REQUESTED** (Filtered? F: Field, L: Lab, FL: Field & Lab, N: None)

L2346368-COFC

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	HG-T-U-CVAF-VA	ALS_Package-DOC	ALS_Package-TKN/TOC	HG-D-CVAF-VA	TECKCOAL-MET-D-VA	TECKCOAL-MET-T-VA	TECKCOAL-ROUTINE-VA					
Filtered								N	N	N	N	N	N	N					
Preserved								NONE	NONE	H2SO4	NONE	NONE	HNO3	NONE					
RG_FBLANK_WS_2019-09-10_1100	RG_FBLANK	WS	No	10-Sep-19	11:00:00	G	7	1	①	1	1	1	1	1					
GH_ERSC4_WS_2019-09-10_0900	GH_ERSC4	WS	No	9-Sep-19	9:00:00	G	7	1	1	1	1	1	1	1					
RG_RIVER_WS_2019-09-10_1000	RG_RIVER	WS	No	10-Sep-19	10:00:00	G	7	1	1	1	1	1	1	1					
RG_ER1A_WS_2019-09-09_1233	RG_ER1A	WS	No	9-Sep-19	12:33:00	G	7	1	1	1	1	1	1	1					
RG_TRIP_WS_2019-09-10_1100	RG_TRIP	WS	No	10-Sep-19	11:00:00	G	7	1	1	1	1	1	1	1					

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS

VPO00616180

RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
Jennifer Ings/Minnow	September 10, 2019		9/12

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	**Jennifer Ings**	**Mobile #**	**519-500-3444**
Sampler's Signature		**Date/Time**	**September 10, 2019**

6°

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 14-SEP-19
Report Date: 24-SEP-19 17:22 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2347601

Project P.O. #:	VPO00616180
Job Reference:	REGIONAL EFFECTS PROGRAM
C of C Numbers:	REGIONAL EFFECTS
Legal Site Desc:	

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2347601-1	L2347601-2	L2347601-3		
	Description	WS	WS	WS		
	Sampled Date	12-SEP-19	12-SEP-19	11-SEP-19		
	Sampled Time	08:50	14:00	09:36		
	Client ID	RG_GH_SCW3_2019-09-12_0850	GH_ERSC2_2019-09-12_1400	RG_SCDTC_2019-09-12_0936		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (@ 25C) (uS/cm)	520	427	440		
	Hardness (as CaCO3) (mg/L)	339	237	246		
	pH (pH)	8.23	8.29	8.28		
	ORP (mV)	458	345	347		
	Total Suspended Solids (mg/L)	6.2	3.3	1.9		
	Total Dissolved Solids (mg/L)	353 DLHC	274 DLHC	274 DLHC		
	Turbidity (NTU)	1.23	0.72	0.39		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	146	146	148		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	146	146	148		
	Ammonia as N (mg/L)	0.0056	<0.0050	0.0057		
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050		
	Chloride (Cl) (mg/L)	1.98	1.25	1.32		
	Fluoride (F) (mg/L)	0.154	0.160	0.158		
	Ion Balance (%)	121	102	103		
	Nitrate (as N) (mg/L)	1.90	1.22	1.34		
	Nitrite (as N) (mg/L)	0.0026	0.0067	0.0012		
	Total Kjeldahl Nitrogen (mg/L)	0.360	0.329	0.309		
	Orthophosphate-Dissolved (as P) (mg/L)	0.0010	0.0010	0.0014		
	Phosphorus (P)-Total (mg/L)	0.0033	0.0033	<0.0020		
	Sulfate (SO4) (mg/L)	124	79.7	84.7		
	Anion Sum (meq/L)	5.69 RRV	4.70	4.87		
	Cation Sum (meq/L)	6.91	4.82	5.01		
	Cation - Anion Balance (%)	9.7	1.2	1.5		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	0.65	0.65	0.56		
	Total Organic Carbon (mg/L)	0.70	0.67	0.68		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0386	0.0274	0.0105		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00018	0.00013	0.00012		
	Barium (Ba)-Total (mg/L)	0.0524	0.0510	0.0481		
	Beryllium (Be)-Total (ug/L)	<0.020	<0.020	<0.020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010		
	Cadmium (Cd)-Total (ug/L)	0.0160	0.0132	0.0126		

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2347601-1	L2347601-2	L2347601-3		
	Description	WS	WS	WS		
	Sampled Date	12-SEP-19	12-SEP-19	11-SEP-19		
	Sampled Time	08:50	14:00	09:36		
	Client ID	RG_GH_SCW3_2019-09-12_0850	GH_ERSC2_2019-09-12_1400	RG_SCDTC_2019-09-12_0936		
Grouping	**Analyte**					
WATER						
Total Metals	Calcium (Ca)-Total (mg/L)	79.0	56.8	56.3		
	Chromium (Cr)-Total (mg/L)	0.00028	0.00025	0.00022		
	Cobalt (Co)-Total (ug/L)	<0.10	<0.10	<0.10		
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Iron (Fe)-Total (mg/L)	0.064	0.043	0.016		
	Lead (Pb)-Total (mg/L)	0.000058	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0071	0.0047	0.0051		
	Magnesium (Mg)-Total (mg/L)	34.1	20.8	21.1		
	Manganese (Mn)-Total (mg/L)	0.00371	0.00285	0.00118		
	Mercury (Hg)-Total (ug/L)	<0.00050	<0.00050	<0.00050		
	Molybdenum (Mo)-Total (mg/L)	0.00120	0.00110	0.00110		
	Nickel (Ni)-Total (mg/L)	0.00066	0.00053	0.00055		
	Potassium (K)-Total (mg/L)	0.688	0.533	0.533		
	Selenium (Se)-Total (ug/L)	22.0	9.48	9.99		
	Silicon (Si)-Total (mg/L)	2.14	1.92	1.90		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	2.61	1.49	1.51		
	Strontium (Sr)-Total (mg/L)	0.279	0.241	0.240		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010		
	Uranium (U)-Total (mg/L)	0.00142	0.000978	0.00102		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0035		
Dissolved Metals	Dissolved Mercury Filtration Location	LAB	LAB	LAB		
	Dissolved Metals Filtration Location	LAB	LAB	LAB		
	Aluminum (Al)-Dissolved (mg/L)	<0.0030	<0.0030	<0.0030		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00013	0.00012	0.00011		
	Barium (Ba)-Dissolved (mg/L)	0.0508	0.0486	0.0480		
	Beryllium (Be)-Dissolved (ug/L)	<0.020	<0.020	<0.020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Cadmium (Cd)-Dissolved (ug/L)	0.0090	0.0072	0.0065		
	Calcium (Ca)-Dissolved (mg/L)	80.2	61.0	63.2		
	Chromium (Cr)-Dissolved (mg/L)	0.00014	0.00020	0.00018		
	Cobalt (Co)-Dissolved (ug/L)	<0.10	<0.10	<0.10		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2347601-1	L2347601-2	L2347601-3		
	Description	WS	WS	WS		
	Sampled Date	12-SEP-19	12-SEP-19	11-SEP-19		
	Sampled Time	08:50	14:00	09:36		
	Client ID	RG_GH_SCW3_2019-09-12_0850	GH_ERSC2_2019-09-12_1400	RG_SCDTC_2019-09-12_0936		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Copper (Cu)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0073	0.0050	0.0055		
	Magnesium (Mg)-Dissolved (mg/L)	33.6	20.5	21.5		
	Manganese (Mn)-Dissolved (mg/L)	0.00111	0.00086	0.00026		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00122	0.00113	0.00117		
	Nickel (Ni)-Dissolved (mg/L)	0.00053	<0.00050	<0.00050		
	Potassium (K)-Dissolved (mg/L)	0.725	0.563	0.575		
	Selenium (Se)-Dissolved (ug/L)	22.8	10.2	10.6		
	Silicon (Si)-Dissolved (mg/L)	2.12	2.00	1.97		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	2.90	1.68	1.77		
	Strontium (Sr)-Dissolved (mg/L)	0.278	0.248	0.251		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Uranium (U)-Dissolved (mg/L)	0.00158	0.00112	0.00113		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		

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

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	Sample was Filtered and Preserved at the laboratory - DOC,Dissolved Metals, Dissolved Mercury are to be filtered and preserved in the lab; Filter codes added.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2347601-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2347601-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2347601-1, -2, -3
Matrix Spike	Aluminum (Al)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Iron (Fe)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Lithium (Li)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Nickel (Ni)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Potassium (K)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2347601-1, -2, -3
Matrix Spike	Uranium (U)-Total	MS-B	L2347601-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACIDITY-PCT-CL	Water	Acidity by Automatic Titration	APHA 2310 Acidity

This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-MAN-CL	Water	Alkalinity (Species) by Manual Titration	APHA 2320 ALKALINITY

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-CL	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-LOW-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by

Reference Information

subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

C-TOT-ORG-LOW-CL	Water	Total Organic Carbon	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-L-PCT-CL	Water	Electrical Conductivity (EC)	APHA 2510B

Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25C.

F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-U-CVAF-VA	Water	Total Mercury in Water by CVAFS (Ultra)	EPA 1631 REV. E

This analysis is carried out using procedures adapted from Method 1631 Rev. E. by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to a purge and trap concentration step and final reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry.

IONBALANCE-BC-CL	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL	Water	Ammonia, Total (as N)	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

ORP-CL	Water	Oxidation redution potential by elect.	ASTM D1498

This analysis is carried out in accordance with the procedure described in the "ASTM" method D1498 "Oxidation-Reduction Potential of Water" published by the American Society for Testing and Materials (ASTM). Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

P-T-L-COL-CL	Water	Phosphorus (P)-Total	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

PH-CL	Water	pH	APHA 4500 H-Electrode

pH is determined in the laboratory using a pH electrode. All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)

PO4-DO-L-COL-CL	Water	Orthophosphate-Dissolved (as P)	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-CL	Water	Total Dissolved Solids	APHA 2540 C

A well-mixed sample is filtered through a glass fibre filter paper. The filtrate is then evaporated to dryness in a pre-weighed vial and dried at 180 – 2 °C. The increase in vial weight represents the total dissolved solids (TDS).

TECKCOAL-IONBAL-CL	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

TKN-L-F-CL	Water	Total Kjeldahl Nitrogen	APHA 4500-NORG (TKN)

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-L-CL	Water	Total Suspended Solids	APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** 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:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

REGIONAL EFFECTS

Reference Information

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: L2347601 Report Date: 24-SEP-19

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ACIDITY-PCT-CL	**Water**							
Batch R4819063								
WG3164951-8 LCS								
Acidity (as CaCO3)			102.6		%		85-115	17-SEP-19
WG3164951-7 MB								
Acidity (as CaCO3)			1.5		mg/L		2	17-SEP-19
ALK-MAN-CL	**Water**							
Batch R4819050								
WG3164969-8 LCS								
Alkalinity, Total (as CaCO3)			103.5		%		85-115	17-SEP-19
WG3164969-7 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	17-SEP-19
BE-D-L-CCMS-VA	**Water**							
Batch R4819490								
WG3164492-2 LCS								
Beryllium (Be)-Dissolved			93.7		%		80-120	18-SEP-19
WG3164492-1 MB		**LF**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	18-SEP-19
BE-T-L-CCMS-VA	**Water**							
Batch R4818289								
WG3164328-2 LCS								
Beryllium (Be)-Total			100.5		%		80-120	18-SEP-19
WG3164328-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	18-SEP-19
C-DIS-ORG-LOW-CL	**Water**							
Batch R4822478								
WG3166371-6 LCS								
Dissolved Organic Carbon			99.0		%		80-120	18-SEP-19
WG3166371-5 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	18-SEP-19
Batch R4826948								
WG3168026-2 LCS								
Dissolved Organic Carbon			93.6		%		80-120	19-SEP-19
WG3168026-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	19-SEP-19
Batch R4827010								
WG3168037-2 LCS								
Dissolved Organic Carbon			106.8		%		80-120	19-SEP-19
WG3168037-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-LOW-CL	**Water**							
Batch R4827010								
WG3168037-1 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	19-SEP-19
C-TOT-ORG-LOW-CL	**Water**							
Batch R4822478								
WG3166371-6 LCS								
Total Organic Carbon			110.0		%		80-120	18-SEP-19
WG3166371-5 MB								
Total Organic Carbon			<0.50		mg/L		0.5	18-SEP-19
Batch R4826948								
WG3168026-2 LCS								
Total Organic Carbon			99.4		%		80-120	19-SEP-19
WG3168026-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	19-SEP-19
Batch R4827010								
WG3168037-2 LCS								
Total Organic Carbon			113.5		%		80-120	19-SEP-19
WG3168037-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	19-SEP-19
EC-L-PCT-CL	**Water**							
Batch R4819050								
WG3164969-8 LCS								
Conductivity (@ 25C)			101.4		%		90-110	17-SEP-19
WG3164969-7 MB								
Conductivity (@ 25C)			<2.0		uS/cm		2	17-SEP-19
HG-D-CVAA-VA	**Water**							
Batch R4817791								
WG3164741-3 DUP		**L2347601-1**						
Mercury (Hg)-Dissolved		<0.0000050	<0.000005	RPD-NA	mg/L	N/A	20	18-SEP-19
WG3164741-2 LCS								
Mercury (Hg)-Dissolved			99.5		%		80-120	18-SEP-19
WG3164741-1 MB		**LF**						
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	18-SEP-19
HG-T-U-CVAF-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-T-U-CVAF-VA	**Water**							
Batch R4825368								
WG3167345-5 DUP		**L2347601-1**						
Mercury (Hg)-Total		<0.00050	<0.00050	RPD-NA	ug/L	N/A	20	19-SEP-19
WG3167345-2 LCS								
Mercury (Hg)-Total			95.1		%		80-120	19-SEP-19
WG3167345-1 MB								
Mercury (Hg)-Total			<0.00050		ug/L		0.0005	19-SEP-19
WG3167345-6 MS		**L2347601-3**						
Mercury (Hg)-Total			84.3		%		70-130	19-SEP-19
MET-D-CCMS-VA	**Water**							
Batch R4819490								
WG3164492-2 LCS								
Aluminum (Al)-Dissolved			104.1		%		80-120	18-SEP-19
Antimony (Sb)-Dissolved			97.9		%		80-120	18-SEP-19
Arsenic (As)-Dissolved			97.3		%		80-120	18-SEP-19
Barium (Ba)-Dissolved			98.3		%		80-120	18-SEP-19
Bismuth (Bi)-Dissolved			97.9		%		80-120	18-SEP-19
Boron (B)-Dissolved			90.3		%		80-120	18-SEP-19
Cadmium (Cd)-Dissolved			99.8		%		80-120	18-SEP-19
Calcium (Ca)-Dissolved			93.8		%		80-120	18-SEP-19
Chromium (Cr)-Dissolved			99.97		%		80-120	18-SEP-19
Cobalt (Co)-Dissolved			99.7		%		80-120	18-SEP-19
Copper (Cu)-Dissolved			97.7		%		80-120	18-SEP-19
Iron (Fe)-Dissolved			101.3		%		80-120	18-SEP-19
Lead (Pb)-Dissolved			97.4		%		80-120	18-SEP-19
Lithium (Li)-Dissolved			95.8		%		80-120	18-SEP-19
Magnesium (Mg)-Dissolved			100.5		%		80-120	18-SEP-19
Manganese (Mn)-Dissolved			99.0		%		80-120	18-SEP-19
Molybdenum (Mo)-Dissolved			94.2		%		80-120	18-SEP-19
Nickel (Ni)-Dissolved			97.8		%		80-120	18-SEP-19
Potassium (K)-Dissolved			100.5		%		80-120	18-SEP-19
Selenium (Se)-Dissolved			99.3		%		80-120	18-SEP-19
Silicon (Si)-Dissolved			103.1		%		60-140	18-SEP-19
Silver (Ag)-Dissolved			93.0		%		80-120	18-SEP-19
Sodium (Na)-Dissolved			105.7		%		80-120	18-SEP-19
Strontium (Sr)-Dissolved			94.1		%		80-120	18-SEP-19
Thallium (Tl)-Dissolved			98.5		%		80-120	18-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4819490								
WG3164492-2 LCS								
Tin (Sn)-Dissolved			95.5		%		80-120	18-SEP-19
Titanium (Ti)-Dissolved			98.5		%		80-120	18-SEP-19
Uranium (U)-Dissolved			102.2		%		80-120	18-SEP-19
Vanadium (V)-Dissolved			99.5		%		80-120	18-SEP-19
Zinc (Zn)-Dissolved			94.8		%		80-120	18-SEP-19
WG3164492-1 MB		**LF**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	18-SEP-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	18-SEP-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	18-SEP-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	18-SEP-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	18-SEP-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	18-SEP-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	18-SEP-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	18-SEP-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	18-SEP-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	18-SEP-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	18-SEP-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	18-SEP-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	18-SEP-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	18-SEP-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	18-SEP-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	18-SEP-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	18-SEP-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	18-SEP-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	18-SEP-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	18-SEP-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	18-SEP-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	18-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R4819490								
WG3164492-1 MB		**LF**						
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	18-SEP-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	18-SEP-19
MET-T-CCMS-VA	**Water**							
Batch R4818289								
WG3164328-2 LCS								
Aluminum (Al)-Total			106.9		%		80-120	18-SEP-19
Antimony (Sb)-Total			101.8		%		80-120	18-SEP-19
Arsenic (As)-Total			103.8		%		80-120	18-SEP-19
Barium (Ba)-Total			112.7		%		80-120	18-SEP-19
Bismuth (Bi)-Total			100.7		%		80-120	18-SEP-19
Boron (B)-Total			102.4		%		80-120	18-SEP-19
Cadmium (Cd)-Total			104.4		%		80-120	18-SEP-19
Calcium (Ca)-Total			99.7		%		80-120	18-SEP-19
Chromium (Cr)-Total			107.1		%		80-120	18-SEP-19
Cobalt (Co)-Total			103.5		%		80-120	18-SEP-19
Copper (Cu)-Total			102.5		%		80-120	18-SEP-19
Iron (Fe)-Total			102.0		%		80-120	18-SEP-19
Lead (Pb)-Total			104.9		%		80-120	18-SEP-19
Lithium (Li)-Total			101.9		%		80-120	18-SEP-19
Magnesium (Mg)-Total			108.3		%		80-120	18-SEP-19
Manganese (Mn)-Total			103.9		%		80-120	18-SEP-19
Molybdenum (Mo)-Total			102.4		%		80-120	18-SEP-19
Nickel (Ni)-Total			104.2		%		80-120	18-SEP-19
Potassium (K)-Total			106.7		%		80-120	18-SEP-19
Selenium (Se)-Total			100.3		%		80-120	18-SEP-19
Silicon (Si)-Total			99.6		%		80-120	18-SEP-19
Silver (Ag)-Total			106.1		%		80-120	18-SEP-19
Sodium (Na)-Total			103.1		%		80-120	18-SEP-19
Strontium (Sr)-Total			105.1		%		80-120	18-SEP-19
Thallium (Tl)-Total			103.6		%		80-120	18-SEP-19
Tin (Sn)-Total			101.6		%		80-120	18-SEP-19
Titanium (Ti)-Total			96.9		%		80-120	18-SEP-19
Uranium (U)-Total			100.9		%		80-120	18-SEP-19
Vanadium (V)-Total			105.5		%		80-120	18-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R4818289								
WG3164328-2 LCS								
Zinc (Zn)-Total			106.6		%		80-120	18-SEP-19
WG3164328-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	18-SEP-19
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Arsenic (As)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Barium (Ba)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	18-SEP-19
Boron (B)-Total			<0.010		mg/L		0.01	18-SEP-19
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	18-SEP-19
Calcium (Ca)-Total			<0.050		mg/L		0.05	18-SEP-19
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Copper (Cu)-Total			<0.00050		mg/L		0.0005	18-SEP-19
Iron (Fe)-Total			<0.010		mg/L		0.01	18-SEP-19
Lead (Pb)-Total			<0.000050		mg/L		0.00005	18-SEP-19
Lithium (Li)-Total			<0.0010		mg/L		0.001	18-SEP-19
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	18-SEP-19
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	18-SEP-19
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	18-SEP-19
Potassium (K)-Total			<0.050		mg/L		0.05	18-SEP-19
Selenium (Se)-Total			<0.000050		mg/L		0.00005	18-SEP-19
Silicon (Si)-Total			<0.10		mg/L		0.1	18-SEP-19
Silver (Ag)-Total			<0.000010		mg/L		0.00001	18-SEP-19
Sodium (Na)-Total			<0.050		mg/L		0.05	18-SEP-19
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	18-SEP-19
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	18-SEP-19
Tin (Sn)-Total			<0.00010		mg/L		0.0001	18-SEP-19
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	18-SEP-19
Uranium (U)-Total			<0.000010		mg/L		0.00001	18-SEP-19
Vanadium (V)-Total			<0.00050		mg/L		0.0005	18-SEP-19
Zinc (Zn)-Total			<0.0030		mg/L		0.003	18-SEP-19
NH3-L-F-CL	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-L-F-CL	**Water**							
Batch R4832624								
WG3169161-14 LCS								
Ammonia as N			111.0		%		85-115	21-SEP-19
WG3169161-13 MB								
Ammonia as N			<0.0050		mg/L		0.005	21-SEP-19
ORP-CL	**Water**							
Batch R4812091								
WG3163281-2 CRM		**CL-ORP**						
ORP			225		mV		210-230	16-SEP-19
P-T-L-COL-CL	**Water**							
Batch R4827695								
WG3167957-14 LCS								
Phosphorus (P)-Total			117.1		%		80-120	20-SEP-19
WG3167957-13 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	20-SEP-19
PH-CL	**Water**							
Batch R4819050								
WG3164969-8 LCS								
pH			7.01		pH		6.9-7.1	17-SEP-19
PO4-DO-L-COL-CL	**Water**							
Batch R4807774								
WG3161867-10 LCS								
Orthophosphate-Dissolved (as P)			102.5		%		80-120	14-SEP-19
WG3161867-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	14-SEP-19
SOLIDS-TDS-CL	**Water**							
Batch R4823505								
WG3164467-2 LCS								
Total Dissolved Solids			105.4		%		85-115	18-SEP-19
WG3164467-1 MB								
Total Dissolved Solids			<10		mg/L		10	18-SEP-19
TKN-L-F-CL	**Water**							
Batch R4830469								
WG3169047-2 LCS								
Total Kjeldahl Nitrogen			103.4		%		75-125	21-SEP-19
WG3169047-1 MB								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-L-F-CL	**Water**							
Batch R4830469								
WG3169047-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	21-SEP-19
TSS-L-CL	**Water**							
Batch R4823272								
WG3164429-8 LCS								
Total Suspended Solids			93.8		%		85-115	18-SEP-19
WG3164429-7 MB								
Total Suspended Solids			<1.0		mg/L		1	18-SEP-19
TURBIDITY-CL	**Water**							
Batch R4809298								
WG3162274-11 LCS								
Turbidity			96.0		%		85-115	14-SEP-19
WG3162274-10 MB								
Turbidity			<0.10		NTU		0.1	14-SEP-19

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
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Oxidation redution potential by elect.							
	1	12-SEP-19 08:50	16-SEP-19 11:00	0.25	98	hours	EHTR-FM
	2	12-SEP-19 14:00	16-SEP-19 11:00	0.25	93	hours	EHTR-FM
	3	11-SEP-19 09:36	16-SEP-19 11:00	0.25	121	hours	EHTR-FM
pH							
	1	12-SEP-19 08:50	17-SEP-19 10:00	0.25	121	hours	EHTR-FM
	2	12-SEP-19 14:00	17-SEP-19 10:00	0.25	116	hours	EHTR-FM
	3	11-SEP-19 09:36	17-SEP-19 10:00	0.25	144	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2347601 were received on 14-SEP-19 09:55.

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.

Teck

Page 1 of 1

COC ID:	Regional Effects Program	TURNAROUND TIME:	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/GHO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
Address	421 Pine Avenue		
City	Sparwood	Province	BC
Postal Code	V0B 2G0	Country	Canada
Phone Number	250-425-8202		

LABORATORY

Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
Email	Lyudmyla.Shvets@ALSGlobal.com		
Address	2559 29 Street NE		
City	Calgary	Province	AB
Postal Code	T1Y 7B5	Country	Canada
Phone Number	403-407-1800		

OTHER INFO

Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	X	X	X
Email 2:	carlie.meyer@teck.com	X	X	X
Email 3:	teckcoal@equisonline.com			X
Email 4:	llester@minnow.ca	X	X	X
Email 5:				
PO number	VPO00616180			

L2347601-COFC

SAMPLE DETAILS / ANALYSIS REQUESTED

								N	N	N	N	N	N	N
								NONE	NONE	H2SO4	NONE	NONE	HNO3	NONE
Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	HG-T-U-CVAF-VA	ALS_Package-DOC	ALS_Package-TKN/TOC	HG-D-CVAF-VA	TECKCOAL-MET-D-VA	TECKCOAL-MET-T-VA	TECKCOAL-ROUTINE-VA
RG_GH_SCW3_WS_2019-09-12_0850	RG_GH_SCW3	WS	No	12-Sep-19	8:50:00	G	7	1	1	1	1	1	1	1
GH_ERSC2_WS_2019-09-12_1400	GH_ERSC2	WS	No	12-Sep-19	14:00:00	G	7	1	1	1	1	1	1	1
RG_SCDTC_WS_2019-09-11_0936	RG_SCDTC	WS	No	11-Sep-19	9:36:00	G	7	1	1	1	1	1	1	1

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS

VPO00616180

RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
Jennifer Ings/Minnow	September 13, 2019	DM	09/14/19 9:55AM

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	Jennifer Ings	Mobile #	519-500-3444
Sampler's Signature		Date/Time	September 13, 2019

9.7°C.

DATA COLLECTED CONCURRENT WITH SEPTEMBER BIOLOGICAL SAMPLES

Laboratory Sediment Data

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received: 14-SEP-19
Report Date: 23-SEP-19 16:44 (MT)
Version: FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #: L2347939
Project P.O. #: VPO00616180
Job Reference: REGIONAL EFFECTS PROGRAM
C of C Numbers: REGIONAL EFFECTS
Legal Site Desc:

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2347939-1	L2347939-2	L2347939-3		
	Description	SE	SE	SE		
	Sampled Date	05-SEP-19	05-SEP-19	05-SEP-19		
	Sampled Time	10:20	10:55	11:24		
	Client ID	RG_ELUGH_SE-1_2019-09-05_1020	RG_ELUGH_SE-2_2019-09-05_1055	RG_ELUGH_SE-3_2019-09-05_1124		
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	48.1	49.1	37.4		
	pH (1:2 soil:water) (pH)	8.25	8.36	8.43		
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0		
	% Sand (2.00mm - 1.00mm) (%)	2.5	4.9	<1.0		
	% Sand (1.00mm - 0.50mm) (%)	3.8	8.4	<1.0		
	% Sand (0.50mm - 0.25mm) (%)	15.2	16.3	4.7		
	% Sand (0.25mm - 0.125mm) (%)	19.4	23.9	16.5		
	% Sand (0.125mm - 0.063mm) (%)	16.6	16.3	42.0		
	% Silt (0.063mm - 0.0312mm) (%)	16.9	12.3	18.8		
	% Silt (0.0312mm - 0.004mm) (%)	19.9	13.5	14.1		
	% Clay (<4um) (%)	4.9	3.8	3.3		
	Texture	Sandy loam	Loamy sand	Sandy loam / Loamy sand		
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.6	2.50	2.18		
Metals	Aluminum (Al) (mg/kg)	6580	4970	5210		
	Antimony (Sb) (mg/kg)	0.51	0.46	0.42		
	Arsenic (As) (mg/kg)	5.09	4.72	4.45		
	Barium (Ba) (mg/kg)	124	106	97.3		
	Beryllium (Be) (mg/kg)	0.49	0.41	0.39		
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20		
	Boron (B) (mg/kg)	8.3	5.6	5.4		
	Cadmium (Cd) (mg/kg)	0.780	0.613	0.566		
	Calcium (Ca) (mg/kg)	59200	61500	49600		
	Chromium (Cr) (mg/kg)	16.1	12.2	12.3		
	Cobalt (Co) (mg/kg)	3.96	3.43	3.30		
	Copper (Cu) (mg/kg)	9.92	7.97	7.18		
	Iron (Fe) (mg/kg)	11500	10600	9630		
	Lead (Pb) (mg/kg)	6.18	7.19	5.14		
	Lithium (Li) (mg/kg)	9.7	7.5	7.5		
	Magnesium (Mg) (mg/kg)	12700	11500	12000		
	Manganese (Mn) (mg/kg)	459	358	351		
	Mercury (Hg) (mg/kg)	0.0331	0.0257	0.0244		
	Molybdenum (Mo) (mg/kg)	1.34	1.13	1.10		
	Nickel (Ni) (mg/kg)	18.3	14.8	14.2		
	Phosphorus (P) (mg/kg)	1170	1130	1150		
	Potassium (K) (mg/kg)	1780	1220	1230		
	Selenium (Se) (mg/kg)	0.93	0.61	0.57		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2347939-1	L2347939-2	L2347939-3		
	Description	SE	SE	SE		
	Sampled Date	05-SEP-19	05-SEP-19	05-SEP-19		
	Sampled Time	10:20	10:55	11:24		
	Client ID	RG_ELUGH_SE-1_2019-09-05_1020	RG_ELUGH_SE-2_2019-09-05_1055	RG_ELUGH_SE-3_2019-09-05_1124		
Grouping	**Analyte**					
SOIL						
Metals	Silver (Ag) (mg/kg)	0.17	0.14	0.12		
	Sodium (Na) (mg/kg)	86	77	74		
	Strontium (Sr) (mg/kg)	103	99.9	82.1		
	Sulfur (S) (mg/kg)	<1000	<1000	<1000		
	Thallium (Tl) (mg/kg)	0.176	0.138	0.137		
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0		
	Titanium (Ti) (mg/kg)	28.2	19.5	20.2		
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50		
	Uranium (U) (mg/kg)	0.984	0.877	0.838		
	Vanadium (V) (mg/kg)	28.8	23.6	23.1		
	Zinc (Zn) (mg/kg)	79.5	67.7	64.0		
	Zirconium (Zr) (mg/kg)	1.2	<1.0	<1.0		
Polycyclic Aromatic Hydrocarbons	Acenaphthene (mg/kg)	<0.0050	<0.0050	<0.0050		
	Acenaphthylene (mg/kg)	<0.0050	<0.0050	<0.0050		
	Acridine (mg/kg)	<0.010	<0.010	<0.010		
	Anthracene (mg/kg)	<0.0040	<0.0040	<0.0040		
	Benz(a)anthracene (mg/kg)	<0.010	<0.020 DLCI	<0.010		
	Benzo(a)pyrene (mg/kg)	<0.010	<0.010	<0.010		
	Benzo(b&j)fluoranthene (mg/kg)	0.011	0.017	<0.010		
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015	0.019	<0.015		
	Benzo(e)pyrene (mg/kg)	<0.010	0.015	<0.010		
	Benzo(g,h,i)perylene (mg/kg)	<0.010	<0.010	<0.010		
	Benzo(k)fluoranthene (mg/kg)	<0.010	<0.010	<0.010		
	Chrysene (mg/kg)	0.031	0.056	0.014		
	Dibenz(a,h)anthracene (mg/kg)	<0.0050	<0.0050	<0.0050		
	Fluoranthene (mg/kg)	<0.010	0.013	<0.010		
	Fluorene (mg/kg)	<0.010	<0.010	<0.010		
	Indeno(1,2,3-c,d)pyrene (mg/kg)	<0.010	<0.010	<0.010		
	1-Methylnaphthalene (mg/kg)	0.067	0.126	0.020		
	2-Methylnaphthalene (mg/kg)	0.079	0.153	0.023		
	Naphthalene (mg/kg)	0.035	0.081	<0.010		
	Perylene (mg/kg)	<0.010	0.011	<0.010		
	Phenanthrene (mg/kg)	0.107	0.222	0.037		
	Pyrene (mg/kg)	0.010	0.017	<0.010		
	Quinoline (mg/kg)	<0.010	<0.010	<0.010		
	Surrogate: d10-Acenaphthene (%)	92.9	81.7	65.4		

* 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**	L2347939-1 SE 05-SEP-19 10:20 RG_ELUGH_SE-1_2019-09-05_1020	L2347939-2 SE 05-SEP-19 10:55 RG_ELUGH_SE-2_2019-09-05_1055	L2347939-3 SE 05-SEP-19 11:24 RG_ELUGH_SE-3_2019-09-05_1124		
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	Surrogate: d12-Chrysene (%)	101.8	90.4	76.2		
	Surrogate: d8-Naphthalene (%)	81.9	76.0	58.7		
	Surrogate: d10-Phenanthrene (%)	101.5	91.1	77.3		
	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020		
	IACR (CCME)	0.16	0.22	<0.15		

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

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.

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/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-CL	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)

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**
PH-1:2-CL	Soil	pH in soil (1:2 Soil:Water Extraction)	CSSS Ch. 16

Soil and de-ionized water (by volume) are mixed in a defined ratio. The slurry is allowed to stand, shaken, and then allowed to stand again prior to taking measurements. After equilibration, the pH of the liquid portion of the extract is measured by a pH meter. Field Measurement is recommended where accurate pH measurements are required, due to the 15 minute recommended hold time.

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.

** 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:

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

Chain of Custody Numbers:

REGIONAL EFFECTS

Reference Information

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: L2347939 Report Date: 23-SEP-19

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R4834199								
WG3164535-4 IRM		**08-109_SOIL**						
Inorganic Carbon			105.2		%		80-120	23-SEP-19
WG3164535-2 LCS		**0.5**						
Inorganic Carbon			92.0		%		80-120	23-SEP-19
WG3164535-3 MB								
Inorganic Carbon			<0.050		%		0.05	23-SEP-19
C-TOT-LECO-SK	**Soil**							
Batch R4830063								
WG3164456-7 IRM		**08-109_SOIL**						
Total Carbon by Combustion			96.7		%		80-120	19-SEP-19
WG3164456-5 LCS		**SULFADIAZINE**						
Total Carbon by Combustion			102.2		%		90-110	19-SEP-19
WG3164456-4 MB								
Total Carbon by Combustion			<0.05		%		0.05	19-SEP-19
HG-200.2-CVAA-CL	**Soil**							
Batch R4815730								
WG3164056-9 CRM		**TILL-1**						
Mercury (Hg)			94.3		%		70-130	17-SEP-19
WG3164056-8 LCS								
Mercury (Hg)			90.1		%		80-120	17-SEP-19
WG3164056-6 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	17-SEP-19
MET-200.2-CCMS-CL	**Soil**							
Batch R4815669								
WG3164056-9 CRM		**TILL-1**						
Aluminum (Al)			102.6		%		70-130	17-SEP-19
Antimony (Sb)			99.9		%		70-130	17-SEP-19
Arsenic (As)			98.9		%		70-130	17-SEP-19
Barium (Ba)			102.4		%		70-130	17-SEP-19
Beryllium (Be)			97.2		%		70-130	17-SEP-19
Bismuth (Bi)			93.7		%		70-130	17-SEP-19
Boron (B)			2.9		mg/kg		0-8.2	17-SEP-19
Cadmium (Cd)			96.5		%		70-130	17-SEP-19
Calcium (Ca)			101.6		%		70-130	17-SEP-19
Chromium (Cr)			103.1		%		70-130	17-SEP-19
Cobalt (Co)			93.5		%		70-130	17-SEP-19
Copper (Cu)			98.9		%		70-130	17-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4815669								
WG3164056-9 CRM		**TILL-1**						
Iron (Fe)			100.5		%		70-130	17-SEP-19
Lead (Pb)			96.0		%		70-130	17-SEP-19
Lithium (Li)			95.3		%		70-130	17-SEP-19
Magnesium (Mg)			103.8		%		70-130	17-SEP-19
Manganese (Mn)			103.6		%		70-130	17-SEP-19
Molybdenum (Mo)			99.3		%		70-130	17-SEP-19
Nickel (Ni)			100.6		%		70-130	17-SEP-19
Phosphorus (P)			95.2		%		70-130	17-SEP-19
Potassium (K)			112.2		%		70-130	17-SEP-19
Selenium (Se)			0.30		mg/kg		0.11-0.51	17-SEP-19
Silver (Ag)			0.24		mg/kg		0.13-0.33	17-SEP-19
Sodium (Na)			119.5		%		70-130	17-SEP-19
Strontium (Sr)			110.6		%		70-130	17-SEP-19
Thallium (Tl)			0.119		mg/kg		0.077-0.18	17-SEP-19
Tin (Sn)			1.1		mg/kg		0-3.1	17-SEP-19
Titanium (Ti)			104.0		%		70-130	17-SEP-19
Tungsten (W)			0.14		mg/kg		0-0.66	17-SEP-19
Uranium (U)			90.0		%		70-130	17-SEP-19
Vanadium (V)			101.3		%		70-130	17-SEP-19
Zinc (Zn)			103.9		%		70-130	17-SEP-19
Zirconium (Zr)			1.1		mg/kg		0-1.8	17-SEP-19
WG3164056-8 LCS								
Aluminum (Al)			103.3		%		80-120	17-SEP-19
Antimony (Sb)			109.8		%		80-120	17-SEP-19
Arsenic (As)			104.8		%		80-120	17-SEP-19
Barium (Ba)			99.9		%		80-120	17-SEP-19
Beryllium (Be)			99.1		%		80-120	17-SEP-19
Bismuth (Bi)			103.8		%		80-120	17-SEP-19
Boron (B)			92.6		%		80-120	17-SEP-19
Cadmium (Cd)			103.5		%		80-120	17-SEP-19
Calcium (Ca)			99.8		%		80-120	17-SEP-19
Chromium (Cr)			104.0		%		80-120	17-SEP-19
Cobalt (Co)			97.0		%		80-120	17-SEP-19
Copper (Cu)			95.5		%		80-120	17-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4815669								
WG3164056-8 LCS								
Iron (Fe)			104.9		%		80-120	17-SEP-19
Lead (Pb)			103.5		%		80-120	17-SEP-19
Lithium (Li)			94.5		%		80-120	17-SEP-19
Magnesium (Mg)			107.1		%		80-120	17-SEP-19
Manganese (Mn)			103.3		%		80-120	17-SEP-19
Molybdenum (Mo)			110.0		%		80-120	17-SEP-19
Nickel (Ni)			104.0		%		80-120	17-SEP-19
Potassium (K)			107.8		%		80-120	17-SEP-19
Selenium (Se)			98.9		%		80-120	17-SEP-19
Silver (Ag)			106.0		%		80-120	17-SEP-19
Sodium (Na)			105.3		%		80-120	17-SEP-19
Strontium (Sr)			103.3		%		80-120	17-SEP-19
Sulfur (S)			95.3		%		80-120	17-SEP-19
Thallium (Tl)			101.3		%		80-120	17-SEP-19
Tin (Sn)			105.0		%		80-120	17-SEP-19
Titanium (Ti)			103.5		%		80-120	17-SEP-19
Tungsten (W)			96.3		%		80-120	17-SEP-19
Uranium (U)			93.1		%		80-120	17-SEP-19
Vanadium (V)			105.9		%		80-120	17-SEP-19
Zinc (Zn)			106.4		%		80-120	17-SEP-19
Zirconium (Zr)			109.1		%		80-120	17-SEP-19
WG3164056-6 MB								
Aluminum (Al)			<50		mg/kg		50	17-SEP-19
Antimony (Sb)			<0.10		mg/kg		0.1	17-SEP-19
Arsenic (As)			<0.10		mg/kg		0.1	17-SEP-19
Barium (Ba)			<0.50		mg/kg		0.5	17-SEP-19
Beryllium (Be)			<0.10		mg/kg		0.1	17-SEP-19
Bismuth (Bi)			<0.20		mg/kg		0.2	17-SEP-19
Boron (B)			<5.0		mg/kg		5	17-SEP-19
Cadmium (Cd)			<0.020		mg/kg		0.02	17-SEP-19
Calcium (Ca)			<50		mg/kg		50	17-SEP-19
Chromium (Cr)			<0.50		mg/kg		0.5	17-SEP-19
Cobalt (Co)			<0.10		mg/kg		0.1	17-SEP-19
Copper (Cu)			<0.50		mg/kg		0.5	17-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4815669								
WG3164056-6 MB								
Iron (Fe)			<50		mg/kg		50	17-SEP-19
Lead (Pb)			<0.50		mg/kg		0.5	17-SEP-19
Lithium (Li)			<2.0		mg/kg		2	17-SEP-19
Magnesium (Mg)			<20		mg/kg		20	17-SEP-19
Manganese (Mn)			<1.0		mg/kg		1	17-SEP-19
Molybdenum (Mo)			<0.10		mg/kg		0.1	17-SEP-19
Nickel (Ni)			<0.50		mg/kg		0.5	17-SEP-19
Phosphorus (P)			<50		mg/kg		50	17-SEP-19
Potassium (K)			<100		mg/kg		100	17-SEP-19
Selenium (Se)			<0.20		mg/kg		0.2	17-SEP-19
Silver (Ag)			<0.10		mg/kg		0.1	17-SEP-19
Sodium (Na)			<50		mg/kg		50	17-SEP-19
Strontium (Sr)			<0.50		mg/kg		0.5	17-SEP-19
Sulfur (S)			<1000		mg/kg		1000	17-SEP-19
Thallium (Tl)			<0.050		mg/kg		0.05	17-SEP-19
Tin (Sn)			<2.0		mg/kg		2	17-SEP-19
Titanium (Ti)			<1.0		mg/kg		1	17-SEP-19
Tungsten (W)			<0.50		mg/kg		0.5	17-SEP-19
Uranium (U)			<0.050		mg/kg		0.05	17-SEP-19
Vanadium (V)			<0.20		mg/kg		0.2	17-SEP-19
Zinc (Zn)			<2.0		mg/kg		2	17-SEP-19
Zirconium (Zr)			<1.0		mg/kg		1	17-SEP-19
MOISTURE-CL	**Soil**							
Batch R4818059								
WG3164039-3 DUP		**L2347939-1**						
Moisture		48.1	41.6		%	14	20	18-SEP-19
WG3164039-2 LCS								
Moisture			99.6		%		90-110	18-SEP-19
WG3164039-1 MB								
Moisture			<0.25		%		0.25	18-SEP-19
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4823484								
WG3166769-4 DUP		**L2347939-1**						
Acenaphthene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	18-SEP-19
Acenaphthylene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	18-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4823484								
WG3166769-4 DUP		**L2347939-1**						
Acridine		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Anthracene		<0.0040	<0.0040	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benz(a)anthracene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benzo(a)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benzo(b&j)fluoranthene		0.011	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benzo(g,h,i)perylene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benzo(k)fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Benzo(e)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Chrysene		0.031	0.025		mg/kg	19	50	18-SEP-19
Dibenz(a,h)anthracene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	18-SEP-19
Fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Fluorene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Indeno(1,2,3-c,d)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
1-Methylnaphthalene		0.067	0.070		mg/kg	5.1	50	18-SEP-19
2-Methylnaphthalene		0.079	0.082		mg/kg	3.9	50	18-SEP-19
Naphthalene		0.035	0.042		mg/kg	18	50	18-SEP-19
Perylene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
Phenanthrene		0.107	0.104		mg/kg	3.1	50	18-SEP-19
Pyrene		0.010	0.012		mg/kg	16	50	18-SEP-19
Quinoline		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	18-SEP-19
WG3166769-2 IRM		**ALS PAH RM2**						
Acenaphthene			104.6		%		65-130	18-SEP-19
Acenaphthylene			81.1		%		65-130	18-SEP-19
Acridine			110.5		%		65-130	18-SEP-19
Anthracene			83.7		%		65-130	18-SEP-19
Benz(a)anthracene			103.8		%		65-130	18-SEP-19
Benzo(a)pyrene			110.8		%		65-130	18-SEP-19
Benzo(b&j)fluoranthene			108.8		%		65-130	18-SEP-19
Benzo(g,h,i)perylene			100.1		%		65-130	18-SEP-19
Benzo(k)fluoranthene			103.1		%		65-130	18-SEP-19
Benzo(e)pyrene			106.5		%		65-130	18-SEP-19
Chrysene			109.7		%		65-130	18-SEP-19
Dibenz(a,h)anthracene			100.3		%		65-130	18-SEP-19
Fluoranthene			109.9		%		65-130	18-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4823484								
WG3166769-2 IRM		**ALS PAH RM2**						
Fluorene			95.6		%		65-130	18-SEP-19
Indeno(1,2,3-c,d)pyrene			114.2		%		65-130	18-SEP-19
1-Methylnaphthalene			88.7		%		65-130	18-SEP-19
2-Methylnaphthalene			91.2		%		65-130	18-SEP-19
Naphthalene			91.3		%		65-130	18-SEP-19
Perylene			78.0		%		65-130	18-SEP-19
Phenanthrene			108.6		%		65-130	18-SEP-19
Pyrene			106.5		%		65-130	18-SEP-19
WG3166769-1 LCS								
Acenaphthene			85.8		%		60-130	18-SEP-19
Acenaphthylene			80.5		%		60-130	18-SEP-19
Acridine			99.5		%		60-130	18-SEP-19
Anthracene			84.3		%		60-130	18-SEP-19
Benz(a)anthracene			102.8		%		60-130	18-SEP-19
Benzo(a)pyrene			95.9		%		60-130	18-SEP-19
Benzo(b&j)fluoranthene			94.6		%		60-130	18-SEP-19
Benzo(g,h,i)perylene			106.2		%		60-130	18-SEP-19
Benzo(k)fluoranthene			96.3		%		60-130	18-SEP-19
Benzo(e)pyrene			98.2		%		60-130	18-SEP-19
Chrysene			105.5		%		60-130	18-SEP-19
Dibenz(a,h)anthracene			101.1		%		60-130	18-SEP-19
Fluoranthene			95.5		%		60-130	18-SEP-19
Fluorene			83.7		%		60-130	18-SEP-19
Indeno(1,2,3-c,d)pyrene			95.3		%		60-130	18-SEP-19
1-Methylnaphthalene			87.5		%		60-130	18-SEP-19
2-Methylnaphthalene			85.0		%		60-130	18-SEP-19
Naphthalene			83.8		%		50-130	18-SEP-19
Perylene			100.3		%		60-130	18-SEP-19
Phenanthrene			87.8		%		60-130	18-SEP-19
Pyrene			98.0		%		60-130	18-SEP-19
Quinoline			81.0		%		60-130	18-SEP-19
WG3166769-3 MB								
Acenaphthene			<0.0050		mg/kg		0.005	18-SEP-19
Acenaphthylene			<0.0050		mg/kg		0.005	18-SEP-19
Acridine			<0.010		mg/kg		0.01	18-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4823484								
WG3166769-3 MB								
Anthracene			<0.0040		mg/kg		0.004	18-SEP-19
Benz(a)anthracene			<0.010		mg/kg		0.01	18-SEP-19
Benzo(a)pyrene			<0.010		mg/kg		0.01	18-SEP-19
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	18-SEP-19
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	18-SEP-19
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	18-SEP-19
Benzo(e)pyrene			<0.010		mg/kg		0.01	18-SEP-19
Chrysene			<0.010		mg/kg		0.01	18-SEP-19
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	18-SEP-19
Fluoranthene			<0.010		mg/kg		0.01	18-SEP-19
Fluorene			<0.010		mg/kg		0.01	18-SEP-19
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	18-SEP-19
1-Methylnaphthalene			<0.010		mg/kg		0.01	18-SEP-19
2-Methylnaphthalene			<0.010		mg/kg		0.01	18-SEP-19
Naphthalene			<0.010		mg/kg		0.01	18-SEP-19
Perylene			<0.010		mg/kg		0.01	18-SEP-19
Phenanthrene			<0.010		mg/kg		0.01	18-SEP-19
Pyrene			<0.010		mg/kg		0.01	18-SEP-19
Quinoline			<0.010		mg/kg		0.01	18-SEP-19
Surrogate: d8-Naphthalene			73.0		%		50-130	18-SEP-19
Surrogate: d10-Acenaphthene			78.3		%		60-130	18-SEP-19
Surrogate: d10-Phenanthrene			82.1		%		60-130	18-SEP-19
Surrogate: d12-Chrysene			94.7		%		60-130	18-SEP-19
PH-1:2-CL	**Soil**							
Batch R4826509								
WG3166771-1 IRM		**SAL-STD10**						
pH (1:2 soil:water)			7.78		pH		7.4-8	19-SEP-19
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R4828948								
WG3165101-1 DUP		**L2347939-1**						
% Gravel (>2mm)		<1.0	<1.0	RPD-NA	%	N/A	5	20-SEP-19
% Sand (2.00mm - 1.00mm)		2.5	1.6	J	%	0.9	5	20-SEP-19
% Sand (1.00mm - 0.50mm)		3.8	3.3	J	%	0.4	5	20-SEP-19
% Sand (0.50mm - 0.25mm)		15.2	14.2	J	%	1.0	5	20-SEP-19

Quality Control Report

Workorder: L2347939 Report Date: 23-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R4828948								
WG3165101-1 DUP		**L2347939-1**						
% Sand (0.25mm - 0.125mm)		19.4	18.0	J	%	1.4	5	20-SEP-19
% Sand (0.125mm - 0.063mm)		16.6	17.2	J	%	0.6	5	20-SEP-19
% Silt (0.063mm - 0.0312mm)		16.9	18.4	J	%	1.5	5	20-SEP-19
% Silt (0.0312mm - 0.004mm)		19.9	21.4	J	%	1.5	5	20-SEP-19
% Clay (<4um)		4.9	5.0	J	%	0.1	5	20-SEP-19
WG3165101-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			2.7		%		0-7.6	20-SEP-19
% Sand (1.00mm - 0.50mm)			3.6		%		0-8.9	20-SEP-19
% Sand (0.50mm - 0.25mm)			9.8		%		5.3-15.3	20-SEP-19
% Sand (0.25mm - 0.125mm)			14.8		%		10-20	20-SEP-19
% Sand (0.125mm - 0.063mm)			13.4		%		7.3-17.3	20-SEP-19
% Silt (0.063mm - 0.0312mm)			15.1		%		9.9-19.9	20-SEP-19
% Silt (0.0312mm - 0.004mm)			22.8		%		17.6-27.6	20-SEP-19
% Clay (<4um)			17.7		%		13.4-23.4	20-SEP-19

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

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.

Teck

Page 1 of 1

COC ID:	**Regional Effects Program**	**TURNAROUND TIME:**	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/GHO LAEMP
Project Manager	Cait Good
Email	cait.good@teck.com
Address	421 Pine Avenue
City	Sparwood
Province	BC
Postal Code	V0B 2G0
Country	Canada
Phone Number	250-425-8202

LABORATORY

Lab Name	ALS Calgary
Lab Contact	Lyuda Shvets
Email	Lyudmyla.Shvets@ALSGlobal.com
Address	2559 29 Street NE
City	Calgary
Province	AB
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Country	Canada
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OTHER INFO

Report Format / Distribution		Excel	PDF	EDD
Email 1:	cait.good@teck.com	x	x	x
Email 2:	carlie.meyer@teck.com	x	x	x
Email 3:	teckcoal@equisonline.com			x
Email 4:	jtester@minnow.ca	x	x	x
Email 5:				

PO number VPO00616180

L2347939-COFC

SAMPLE DETAILS / **ANALYSIS REQUESTED**

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	C-TOC-SK	MET-CCME+FULL-CL	MOISTURE-CL - % Moisture	PSA-PIPET-DETAIL-SK Particle Size	PAH-TMB-D/A-MS-CL-PAHs							
								N	N	N	N	N	N	N					
								NONE	NONE	NONE	NONE	NONE							
RG_ELUGH_SE-1_2019-09-05_1020	RG_ELUGH	SE	No	5-Sep-19	10:20:00	G	2	x	x	x	x	x							
RG_ELUGH_SE-2_2019-09-05_1055	RG_ELUGH	SE	No	5-Sep-19	10:55:00	G	2	x	x	x	x	x							
RG_ELUGH_SE-3_2019-09-05_1124	RG_ELUGH	SE	No	5-Sep-19	11:24:00	G	2	x	x	x	x	x							
								x	x	x	x	x							
								x	x	x	x	x							

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
VPO00616180	Jennifer Ings/Minnow	September 13, 2019	DM	09/14/19 9:55AM

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	**Jennifer Ings**	**Mobile #**	**519-500-3444**
Sampler's Signature		**Date/Time**	**September 13, 2019**

56 °C

Teck Coal Ltd.
ATTN: Cait Good
421 Pine Avenue
Sparwood BC V0B 2G0

Date Received:	17-SEP-19
Report Date:	02-OCT-19 17:02 (MT)
Version:	FINAL

Client Phone: 250-425-8202

Certificate of Analysis

Lab Work Order #:	L2349793
Project P.O. #:	VPO00616180
Job Reference:	REGIONAL EFFECTS PROGRAM
C of C Numbers:	Regional
Legal Site Desc:	

Lyudmyla Shvets, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2349793-1	L2349793-2	L2349793-3	L2349793-4	L2349793-5
	Description	SE	SE	SE	SE	SE
	Sampled Date	08-SEP-19	08-SEP-19	08-SEP-19	08-SEP-19	08-SEP-19
	Sampled Time	08:50	09:40	09:50	10:00	12:15
	Client ID	RG_EL20_SE-1_2019-09-08_0850	RG_EL20_SE-2_2019-09-08_0940	RG_EL20_SE-3_2019-09-08_0950	RG_EL20_SE-4_2019-09-08_1000	GH_EL20_SE-5_2019-09-08_1215
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	53.2	34.4	34.0	49.0	57.7
	pH (1:2 soil:water) (pH)	7.60	7.74	7.86	7.93	7.56
Particle Size	% Gravel (>2mm) (%)	<1.0	7.8	<1.0	<1.0	1.3
	% Sand (2.00mm - 1.00mm) (%)	<1.0	3.5	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	1.3	5.2	<1.0	<1.0	<1.0
	% Sand (0.50mm - 0.25mm) (%)	8.1	14.4	<1.0	<1.0	2.5
	% Sand (0.25mm - 0.125mm) (%)	12.3	15.4	7.7	7.8	9.1
	% Sand (0.125mm - 0.063mm) (%)	17.0	17.5	44.5	43.8	21.5
	% Silt (0.063mm - 0.0312mm) (%)	25.2	15.6	24.8	24.7	27.9
	% Silt (0.0312mm - 0.004mm) (%)	29.8	16.7	18.4	19.0	30.4
	% Clay (<4um) (%)	6.1	3.9	3.8	3.8	5.4
	Texture	Silt loam	Sandy loam	Sandy loam	Sandy loam	Silt loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	6.95	3.5	2.06	1.93	4.57
Metals	Aluminum (Al) (mg/kg)	6630	6620	4980	6130	7190
	Antimony (Sb) (mg/kg)	0.46	0.47	0.37	0.40	0.47
	Arsenic (As) (mg/kg)	5.48	5.97	4.68	5.33	5.97
	Barium (Ba) (mg/kg)	141	140	121	137	161
	Beryllium (Be) (mg/kg)	0.55	0.56	0.41	0.49	0.60
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	8.0	7.3	5.0	5.9	8.4
	Cadmium (Cd) (mg/kg)	0.913	0.866	0.598	0.701	0.966
	Calcium (Ca) (mg/kg)	69700	87800	56200	62700	62900
	Chromium (Cr) (mg/kg)	17.5	17.9	12.7	15.1	18.2
	Cobalt (Co) (mg/kg)	4.04	4.02	3.31	3.84	4.50
	Copper (Cu) (mg/kg)	12.8	12.0	8.39	9.40	13.1
	Iron (Fe) (mg/kg)	11900	13400	10300	11700	13100
	Lead (Pb) (mg/kg)	6.88	6.80	5.71	6.50	7.40
	Lithium (Li) (mg/kg)	9.8	9.9	8.2	9.3	11.2
	Magnesium (Mg) (mg/kg)	15400	18400	16100	17600	15800
	Manganese (Mn) (mg/kg)	383	434	402	464	591
	Mercury (Hg) (mg/kg)	0.0285	0.0236	0.0204	0.0223	0.0364
	Molybdenum (Mo) (mg/kg)	1.17	1.25	1.03	1.17	1.32
	Nickel (Ni) (mg/kg)	19.5	19.5	15.1	17.3	21.7
	Phosphorus (P) (mg/kg)	1390	1600	1320	1460	1360
	Potassium (K) (mg/kg)	1510	1440	1000	1240	1570
	Selenium (Se) (mg/kg)	1.15	0.97	0.50	0.63	1.11

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2349793-6	L2349793-7	L2349793-8	L2349793-9	L2349793-10
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_GH_SCW3_SE-1_2019-09-12_0850	RG_GH_SCW3_SE-2_2019-09-12_0910	RG_GH_SCW3_SE-3_2019-09-12_0923	RG_GH_SCW3_SE-4_2019-09-12_0946	RG_GH_SCW3_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	45.3	54.1	51.1	40.0	29.8
	pH (1:2 soil:water) (pH)	7.52	7.56	7.55	7.84	7.83
Particle Size	% Gravel (>2mm) (%)	2.9	<1.0	<1.0	<1.0	1.9
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	1.5	2.2	1.4	<1.0	<1.0
	% Sand (0.50mm - 0.25mm) (%)	7.3	5.3	5.0	<1.0	1.3
	% Sand (0.25mm - 0.125mm) (%)	16.0	10.0	11.5	9.2	7.5
	% Sand (0.125mm - 0.063mm) (%)	20.0	17.8	18.6	29.8	34.4
	% Silt (0.063mm - 0.0312mm) (%)	21.5	26.2	25.1	26.4	25.8
	% Silt (0.0312mm - 0.004mm) (%)	24.7	31.4	30.4	27.9	23.7
	% Clay (<4um) (%)	5.7	7.0	7.9	6.0	4.5
	Texture	Sandy loam	Silt loam	Silt loam	Silt loam	Sandy loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.97	5.08	5.06	3.34	3.17
Metals	Aluminum (Al) (mg/kg)	7930	8880	7050	7330	6270
	Antimony (Sb) (mg/kg)	0.54	0.58	0.44	0.40	0.36
	Arsenic (As) (mg/kg)	6.88	6.40	5.29	4.94	4.45
	Barium (Ba) (mg/kg)	155	170	136	134	121
	Beryllium (Be) (mg/kg)	0.63	0.68	0.56	0.53	0.45
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	8.0	10.7	8.4	8.7	7.6
	Cadmium (Cd) (mg/kg)	1.06	1.14	0.849	0.758	0.655
	Calcium (Ca) (mg/kg)	69500	65500	52100	54700	51100
	Chromium (Cr) (mg/kg)	19.2	20.9	16.3	16.7	14.5
	Cobalt (Co) (mg/kg)	5.00	4.97	3.89	3.69	3.17
	Copper (Cu) (mg/kg)	14.3	14.9	11.6	10.2	8.57
	Iron (Fe) (mg/kg)	15300	14800	12000	11200	10100
	Lead (Pb) (mg/kg)	8.68	8.78	6.87	6.43	5.77
	Lithium (Li) (mg/kg)	12.4	13.0	10.4	10.5	9.1
	Magnesium (Mg) (mg/kg)	19100	15900	13200	15000	14600
	Manganese (Mn) (mg/kg)	443	486	382	419	321
	Mercury (Hg) (mg/kg)	0.0377	0.0449	0.0397	0.0345	0.0248
	Molybdenum (Mo) (mg/kg)	1.33	1.36	1.06	1.04	0.91
	Nickel (Ni) (mg/kg)	23.5	24.2	18.6	17.4	14.8
	Phosphorus (P) (mg/kg)	1670	1470	1170	1240	1210
	Potassium (K) (mg/kg)	1720	2120	1570	1680	1400
	Selenium (Se) (mg/kg)	2.64	1.70	1.19	0.97	0.99

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	Sample ID	L2349793-11	L2349793-12	L2349793-13	L2349793-14	L2349793-15
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_RIVER_SE-1_2019-09-12_0850	RG_RIVER_SE-2_2019-09-12_0910	RG_RIVER_SE-3_2019-09-12_0923	RG_RIVER_SE-4_2019-09-12_0946	RG_RIVER_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	49.6	58.1	53.2	40.1	35.1
	pH (1:2 soil:water) (pH)	7.70	7.82	7.72	7.88	7.80
Particle Size	% Gravel (>2mm) (%)	2.6	<1.0	<1.0	<1.0	1.8
	% Sand (2.00mm - 1.00mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (1.00mm - 0.50mm) (%)	1.1	2.0	1.5	<1.0	1.0
	% Sand (0.50mm - 0.25mm) (%)	4.7	5.6	5.2	<1.0	1.5
	% Sand (0.25mm - 0.125mm) (%)	13.7	11.7	13.1	10.1	8.0
	% Sand (0.125mm - 0.063mm) (%)	20.0	19.8	20.4	28.8	34.4
	% Silt (0.063mm - 0.0312mm) (%)	23.4	23.3	22.3	26.9	24.8
	% Silt (0.0312mm - 0.004mm) (%)	27.7	29.3	28.6	27.7	23.2
	% Clay (<4um) (%)	5.9	8.3	8.4	5.7	5.1
	Texture	Silt loam	Silt loam	Silt loam / Sandy loam	Silt loam	Sandy loam
Organic / Inorganic Carbon	Total Organic Carbon (%)	4.49	5.04	4.98	3.58	3.37
Metals	Aluminum (Al) (mg/kg)	6640	5770	6170	4370	6230
	Antimony (Sb) (mg/kg)	0.44	0.38	0.47	0.35	0.38
	Arsenic (As) (mg/kg)	5.01	4.70	5.32	4.22	4.86
	Barium (Ba) (mg/kg)	120	119	135	104	128
	Beryllium (Be) (mg/kg)	0.51	0.42	0.50	0.41	0.44
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	9.1	5.5	5.6	<5.0	6.2
	Cadmium (Cd) (mg/kg)	0.840	0.790	0.897	0.644	0.705
	Calcium (Ca) (mg/kg)	49700	44900	52200	47100	54700
	Chromium (Cr) (mg/kg)	15.8	13.9	15.1	11.7	15.0
	Cobalt (Co) (mg/kg)	3.86	3.58	4.06	3.13	3.51
	Copper (Cu) (mg/kg)	11.5	10.9	12.4	8.93	9.85
	Iron (Fe) (mg/kg)	11300	10800	12100	9540	10900
	Lead (Pb) (mg/kg)	6.76	5.96	7.24	5.60	6.01
	Lithium (Li) (mg/kg)	10.1	8.1	9.6	8.3	8.9
	Magnesium (Mg) (mg/kg)	13400	12300	13600	13000	15500
	Manganese (Mn) (mg/kg)	355	347	377	364	355
	Mercury (Hg) (mg/kg)	0.0446	0.0386	0.0428	0.0329	0.0294
	Molybdenum (Mo) (mg/kg)	1.07	0.92	1.14	0.90	0.96
	Nickel (Ni) (mg/kg)	18.4	17.2	19.6	14.6	16.5
	Phosphorus (P) (mg/kg)	1140	1110	1180	1090	1300
	Potassium (K) (mg/kg)	1530	1220	1220	940	1350
	Selenium (Se) (mg/kg)	2.27	1.05	1.28	0.78	1.03

	Sample ID	L2349793-1	L2349793-2	L2349793-3	L2349793-4	L2349793-5
	Description	SE	SE	SE	SE	SE
	Sampled Date	08-SEP-19	08-SEP-19	08-SEP-19	08-SEP-19	08-SEP-19
	Sampled Time	08:50	09:40	09:50	10:00	12:15
	Client ID	RG_EL20_SE-1_2019-09-08_0850	RG_EL20_SE-2_2019-09-08_0940	RG_EL20_SE-3_2019-09-08_0950	RG_EL20_SE-4_2019-09-08_1000	GH_EL20_SE-5_2019-09-08_1215
Grouping	**Analyte**					
SOIL						
Metals	Silver (Ag) (mg/kg)	0.19	0.17	0.13	0.14	0.20
	Sodium (Na) (mg/kg)	95	111	84	94	92
	Strontium (Sr) (mg/kg)	103	123	77.1	85.4	99.5
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.196	0.191	0.146	0.167	0.206
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	14.3	15.7	11.7	10.7	13.1
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.15	1.22	0.862	0.964	1.09
	Vanadium (V) (mg/kg)	30.7	30.7	22.7	27.1	31.3
	Zinc (Zn) (mg/kg)	81.3	84.2	66.7	75.6	89.8
	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	<0.0050	<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)	<0.0040	<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)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015	<0.015	<0.015	<0.015	<0.015
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	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)	0.028	0.011	0.011	0.014	0.026
	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)	<0.010	<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)	0.072	0.017	0.021	0.030	0.065
	2-Methylnaphthalene (mg/kg)	0.093	0.023	0.027	0.037	0.082
	Naphthalene (mg/kg)	0.048	0.010	0.011	0.016	0.037
	Perylene (mg/kg)	0.010	<0.010	<0.010	<0.010	<0.010
	Phenanthrene (mg/kg)	0.107	0.029	0.038	0.050	0.100
	Pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	77.4	72.6	66.9	69.9	64.4

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	Sample ID	L2349793-6	L2349793-7	L2349793-8	L2349793-9	L2349793-10
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_GH_SCW3_SE-1_2019-09-12_0850	RG_GH_SCW3_SE-2_2019-09-12_0910	RG_GH_SCW3_SE-3_2019-09-12_0923	RG_GH_SCW3_SE-4_2019-09-12_0946	RG_GH_SCW3_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Metals	Silver (Ag) (mg/kg)	0.22	0.25	0.19	0.17	0.14
	Sodium (Na) (mg/kg)	117	97	82	88	82
	Strontium (Sr) (mg/kg)	97.5	111	83.5	84.4	73.1
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.217	0.256	0.194	0.180	0.158
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	13.8	14.7	13.3	13.9	12.4
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.31	1.30	0.984	0.949	0.893
	Vanadium (V) (mg/kg)	35.5	37.4	29.6	30.5	26.3
	Zinc (Zn) (mg/kg)	105	101	79.5	75.5	65.7
	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	<0.0050	<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)	<0.0040	<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)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015	<0.015	<0.015	<0.015	<0.015
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	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)	0.016	0.018	0.021	0.015	0.019
	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)	<0.010	<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)	0.033	0.038	0.051	0.021	0.030
	2-Methylnaphthalene (mg/kg)	0.050	0.049	0.064	0.030	0.039
	Naphthalene (mg/kg)	0.018	0.020	0.027	0.011	0.017
	Perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Phenanthrene (mg/kg)	0.047	0.053	0.071	0.037	0.049
	Pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	74.7	72.1	74.4	68.5	72.4

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	Sample ID	L2349793-11	L2349793-12	L2349793-13	L2349793-14	L2349793-15
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_RIVER_SE-1_2019-09-12_0850	RG_RIVER_SE-2_2019-09-12_0910	RG_RIVER_SE-3_2019-09-12_0923	RG_RIVER_SE-4_2019-09-12_0946	RG_RIVER_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Metals	Silver (Ag) (mg/kg)	0.17	0.16	0.20	0.14	0.15
	Sodium (Na) (mg/kg)	91	72	75	69	87
	Strontium (Sr) (mg/kg)	75.5	72.4	82.7	71.4	88.0
	Sulfur (S) (mg/kg)	<1000	<1000	<1000	<1000	<1000
	Thallium (Tl) (mg/kg)	0.189	0.156	0.186	0.139	0.164
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	11.2	8.6	8.0	8.5	12.1
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	1.05	0.832	1.01	0.783	0.897
	Vanadium (V) (mg/kg)	28.7	24.8	26.7	20.6	26.9
	Zinc (Zn) (mg/kg)	76.7	73.3	83.5	64.6	72.1
	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	<0.0050	<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)	<0.0040	<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)	<0.010	<0.010	<0.010	<0.010	<0.010
	Benzo(b+j+k)fluoranthene (mg/kg)	<0.015	<0.015	<0.015	<0.015	<0.015
	Benzo(e)pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	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)	0.019	0.020	0.027	<0.010	<0.010
	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)	<0.010	<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)	0.031	0.048	0.065	0.013	0.015
	2-Methylnaphthalene (mg/kg)	0.043	0.060	0.082	0.017	0.020
	Naphthalene (mg/kg)	0.015	0.026	0.033	<0.010	<0.010
	Perylene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Phenanthrene (mg/kg)	0.053	0.065	0.096	0.027	0.021
	Pyrene (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Quinoline (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Surrogate: d10-Acenaphthene (%)	70.2	75.4	67.2	68.2	68.5

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2349793-1 SE 08-SEP-19 08:50 RG_EL20_SE-1_2019-09-08_0850	L2349793-2 SE 08-SEP-19 09:40 RG_EL20_SE-2_2019-09-08_0940	L2349793-3 SE 08-SEP-19 09:50 RG_EL20_SE-3_2019-09-08_0950	L2349793-4 SE 08-SEP-19 10:00 RG_EL20_SE-4_2019-09-08_1000	L2349793-5 SE 08-SEP-19 12:15 GH_EL20_SE-5_2019-09-08_1215
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	Surrogate: d12-Chrysene (%)	89.0	86.5	86.3	88.1	91.7
	Surrogate: d8-Naphthalene (%)	68.6	63.9	58.7	64.1	57.7
	Surrogate: d10-Phenanthrene (%)	84.6	82.4	78.9	79.5	82.0
	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME)	<0.15	<0.15	<0.15	<0.15	<0.15

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2349793-6	L2349793-7	L2349793-8	L2349793-9	L2349793-10
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_GH_SCW3_SE-1_2019-09-12_0850	RG_GH_SCW3_SE-2_2019-09-12_0910	RG_GH_SCW3_SE-3_2019-09-12_0923	RG_GH_SCW3_SE-4_2019-09-12_0946	RG_GH_SCW3_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	Surrogate: d12-Chrysene (%)	80.5	82.8	81.6	83.1	85.6
	Surrogate: d8-Naphthalene (%)	69.5	62.4	69.0	59.6	65.2
	Surrogate: d10-Phenanthrene (%)	80.7	78.3	83.5	72.8	78.2
	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME)	<0.15	<0.15	<0.15	<0.15	<0.15

	Sample ID	L2349793-11	L2349793-12	L2349793-13	L2349793-14	L2349793-15
	Description	SE	SE	SE	SE	SE
	Sampled Date	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19	12-SEP-19
	Sampled Time	08:50	09:10	09:23	09:46	10:00
	Client ID	RG_RIVER_SE-1_2019-09-12_0850	RG_RIVER_SE-2_2019-09-12_0910	RG_RIVER_SE-3_2019-09-12_0923	RG_RIVER_SE-4_2019-09-12_0946	RG_RIVER_SE-5_2019-09-12_1000
Grouping	**Analyte**					
SOIL						
Polycyclic Aromatic Hydrocarbons	Surrogate: d12-Chrysene (%)	83.2	77.2	87.5	71.3	77.7
	Surrogate: d8-Naphthalene (%)	64.1	67.6	57.0	61.5	57.3
	Surrogate: d10-Phenanthrene (%)	87.6	79.1	79.2	93.3	78.1
	B(a)P Total Potency Equivalent (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	IACR (CCME)	<0.15	<0.15	<0.15	<0.15	<0.15

Reference Information

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.

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)

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.

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.

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/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

MOISTURE-CL	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)

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

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.

PH-1:2-CL	Soil	pH in soil (1:2 Soil:Water Extraction)	CSSS Ch. 16

Soil and de-ionized water (by volume) are mixed in a defined ratio. The slurry is allowed to stand, shaken, and then allowed to stand again prior to taking measurements. After equilibration, the pH of the liquid portion of the extract is measured by a pH meter. Field Measurement is recommended where accurate pH measurements are required, due to the 15 minute recommended hold time.

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.

** 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:

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

Chain of Custody Numbers:

Regional

Reference Information

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: L2349793 Report Date: 02-OCT-19

Client: Teck Coal Ltd.
421 Pine Avenue
Sparwood BC V0B 2G0
Contact: Cait Good

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R4851644								
WG3168529-1 DUP		**L2349793-9**						
Inorganic Carbon		1.45	1.44		%	1.3	20	01-OCT-19
WG3168529-4 IRM		**08-109_SOIL**						
Inorganic Carbon			89.0		%		80-120	01-OCT-19
WG3168529-2 LCS		**0.5**						
Inorganic Carbon			90.4		%		80-120	01-OCT-19
WG3168529-3 MB								
Inorganic Carbon			<0.050		%		0.05	01-OCT-19
C-TOT-LECO-SK	**Soil**							
Batch R4845919								
WG3168973-1 DUP		**L2349793-9**						
Total Carbon by Combustion		4.79	4.89		%	2.1	20	25-SEP-19
WG3168973-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			99.9		%		80-120	25-SEP-19
WG3168973-4 LCS		**SULFADIAZINE**						
Total Carbon by Combustion			100.2		%		90-110	25-SEP-19
WG3168973-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	25-SEP-19
HG-200.2-CVAA-CL	**Soil**							
Batch R4837249								
WG3169643-19 CRM		**TILL-1**						
Mercury (Hg)			88.9		%		70-130	25-SEP-19
WG3169643-24 CRM		**TILL-1**						
Mercury (Hg)			106.0		%		70-130	25-SEP-19
WG3169643-25 DUP		**L2349793-7**						
Mercury (Hg)		0.0449	0.0411		mg/kg	9.0	40	25-SEP-19
WG3169643-18 LCS								
Mercury (Hg)			96.7		%		80-120	25-SEP-19
WG3169643-23 LCS								
Mercury (Hg)			93.6		%		80-120	25-SEP-19
WG3169643-16 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	25-SEP-19
WG3169643-21 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	25-SEP-19
MET-200.2-CCMS-CL	**Soil**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-19 CRM		**TILL-1**						
Aluminum (Al)			112.6		%		70-130	25-SEP-19
Antimony (Sb)			90.0		%		70-130	25-SEP-19
Arsenic (As)			101.5		%		70-130	25-SEP-19
Barium (Ba)			114.9		%		70-130	25-SEP-19
Beryllium (Be)			98.7		%		70-130	25-SEP-19
Bismuth (Bi)			82.9		%		70-130	25-SEP-19
Boron (B)			3.1		mg/kg		0-8.2	25-SEP-19
Cadmium (Cd)			97.8		%		70-130	25-SEP-19
Calcium (Ca)			105.8		%		70-130	25-SEP-19
Chromium (Cr)			108.6		%		70-130	25-SEP-19
Cobalt (Co)			92.8		%		70-130	25-SEP-19
Copper (Cu)			102.4		%		70-130	25-SEP-19
Iron (Fe)			105.3		%		70-130	25-SEP-19
Lead (Pb)			96.6		%		70-130	25-SEP-19
Lithium (Li)			96.5		%		70-130	25-SEP-19
Magnesium (Mg)			110.4		%		70-130	25-SEP-19
Manganese (Mn)			112.3		%		70-130	25-SEP-19
Molybdenum (Mo)			90.8		%		70-130	25-SEP-19
Nickel (Ni)			104.8		%		70-130	25-SEP-19
Phosphorus (P)			101.9		%		70-130	25-SEP-19
Potassium (K)			105.4		%		70-130	25-SEP-19
Selenium (Se)			0.31		mg/kg		0.11-0.51	25-SEP-19
Silver (Ag)			0.24		mg/kg		0.13-0.33	25-SEP-19
Sodium (Na)			105.1		%		70-130	25-SEP-19
Strontium (Sr)			113.4		%		70-130	25-SEP-19
Thallium (Tl)			0.129		mg/kg		0.077-0.18	25-SEP-19
Tin (Sn)			1.1		mg/kg		0-3.1	25-SEP-19
Titanium (Ti)			117.3		%		70-130	25-SEP-19
Tungsten (W)			0.14		mg/kg		0-0.66	25-SEP-19
Uranium (U)			87.5		%		70-130	25-SEP-19
Vanadium (V)			107.3		%		70-130	25-SEP-19
Zinc (Zn)			102.9		%		70-130	25-SEP-19
Zirconium (Zr)			0.7		mg/kg		0-1.8	25-SEP-19
WG3169643-24 CRM		**TILL-1**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-24 CRM		**TILL-1**						
Aluminum (Al)			106.1		%		70-130	25-SEP-19
Antimony (Sb)			92.9		%		70-130	25-SEP-19
Arsenic (As)			98.9		%		70-130	25-SEP-19
Barium (Ba)			112.9		%		70-130	25-SEP-19
Beryllium (Be)			96.6		%		70-130	25-SEP-19
Bismuth (Bi)			84.2		%		70-130	25-SEP-19
Boron (B)			3.1		mg/kg		0-8.2	25-SEP-19
Cadmium (Cd)			100.5		%		70-130	25-SEP-19
Calcium (Ca)			98.5		%		70-130	25-SEP-19
Chromium (Cr)			103.3		%		70-130	25-SEP-19
Cobalt (Co)			90.5		%		70-130	25-SEP-19
Copper (Cu)			100.2		%		70-130	25-SEP-19
Iron (Fe)			101.4		%		70-130	25-SEP-19
Lead (Pb)			96.4		%		70-130	25-SEP-19
Lithium (Li)			93.4		%		70-130	25-SEP-19
Magnesium (Mg)			103.5		%		70-130	25-SEP-19
Manganese (Mn)			106.3		%		70-130	25-SEP-19
Molybdenum (Mo)			92.6		%		70-130	25-SEP-19
Nickel (Ni)			102.0		%		70-130	25-SEP-19
Phosphorus (P)			102.2		%		70-130	25-SEP-19
Potassium (K)			92.7		%		70-130	25-SEP-19
Selenium (Se)			0.28		mg/kg		0.11-0.51	25-SEP-19
Silver (Ag)			0.23		mg/kg		0.13-0.33	25-SEP-19
Sodium (Na)			92.8		%		70-130	25-SEP-19
Strontium (Sr)			103.0		%		70-130	25-SEP-19
Thallium (Tl)			0.122		mg/kg		0.077-0.18	25-SEP-19
Tin (Sn)			1.0		mg/kg		0-3.1	25-SEP-19
Titanium (Ti)			101.5		%		70-130	25-SEP-19
Tungsten (W)			0.15		mg/kg		0-0.66	25-SEP-19
Uranium (U)			85.2		%		70-130	25-SEP-19
Vanadium (V)			101.7		%		70-130	25-SEP-19
Zinc (Zn)			100.5		%		70-130	25-SEP-19
Zirconium (Zr)			0.7		mg/kg		0-1.8	25-SEP-19
WG3169643-25 DUP		**L2349793-7**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-25 DUP		**L2349793-7**						
Aluminum (Al)		8880	9300		mg/kg	4.7	40	25-SEP-19
Antimony (Sb)		0.58	0.56		mg/kg	2.3	30	25-SEP-19
Arsenic (As)		6.40	6.64		mg/kg	3.6	30	25-SEP-19
Barium (Ba)		170	177		mg/kg	4.2	40	25-SEP-19
Beryllium (Be)		0.68	0.72		mg/kg	6.3	30	25-SEP-19
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	25-SEP-19
Boron (B)		10.7	12.1		mg/kg	13	30	25-SEP-19
Cadmium (Cd)		1.14	1.12		mg/kg	2.5	30	25-SEP-19
Calcium (Ca)		65500	67100		mg/kg	2.5	30	25-SEP-19
Chromium (Cr)		20.9	21.9		mg/kg	4.8	30	25-SEP-19
Cobalt (Co)		4.97	5.02		mg/kg	0.9	30	25-SEP-19
Copper (Cu)		14.9	15.0		mg/kg	0.7	30	25-SEP-19
Iron (Fe)		14800	15200		mg/kg	2.6	30	25-SEP-19
Lead (Pb)		8.78	8.89		mg/kg	1.2	40	25-SEP-19
Lithium (Li)		13.0	13.7		mg/kg	5.5	30	25-SEP-19
Magnesium (Mg)		15900	16700		mg/kg	4.6	30	25-SEP-19
Manganese (Mn)		486	499		mg/kg	2.5	30	25-SEP-19
Molybdenum (Mo)		1.36	1.41		mg/kg	3.9	40	25-SEP-19
Nickel (Ni)		24.2	24.3		mg/kg	0.5	30	25-SEP-19
Phosphorus (P)		1470	1460		mg/kg	0.7	30	25-SEP-19
Potassium (K)		2120	2450		mg/kg	14	40	25-SEP-19
Selenium (Se)		1.70	1.62		mg/kg	5.2	30	25-SEP-19
Silver (Ag)		0.25	0.25		mg/kg	2.0	40	25-SEP-19
Sodium (Na)		97	105		mg/kg	8.0	40	25-SEP-19
Strontium (Sr)		111	114		mg/kg	2.4	40	25-SEP-19
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	25-SEP-19
Thallium (Tl)		0.256	0.262		mg/kg	2.1	30	25-SEP-19
Tin (Sn)		<2.0	<2.0	RPD-NA	mg/kg	N/A	40	25-SEP-19
Titanium (Ti)		14.7	17.9		mg/kg	19	40	25-SEP-19
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	25-SEP-19
Uranium (U)		1.30	1.29		mg/kg	0.7	30	25-SEP-19
Vanadium (V)		37.4	40.1		mg/kg	7.0	30	25-SEP-19
Zinc (Zn)		101	103		mg/kg	2.4	30	25-SEP-19
Zirconium (Zr)		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	25-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-18 LCS								
Aluminum (Al)			106.3		%		80-120	25-SEP-19
Antimony (Sb)			104.8		%		80-120	25-SEP-19
Arsenic (As)			99.6		%		80-120	25-SEP-19
Barium (Ba)			106.6		%		80-120	25-SEP-19
Beryllium (Be)			103.4		%		80-120	25-SEP-19
Bismuth (Bi)			100.1		%		80-120	25-SEP-19
Boron (B)			97.5		%		80-120	25-SEP-19
Cadmium (Cd)			107.3		%		80-120	25-SEP-19
Calcium (Ca)			99.5		%		80-120	25-SEP-19
Chromium (Cr)			103.3		%		80-120	25-SEP-19
Cobalt (Co)			92.1		%		80-120	25-SEP-19
Copper (Cu)			101.5		%		80-120	25-SEP-19
Iron (Fe)			108.8		%		80-120	25-SEP-19
Lead (Pb)			117.8		%		80-120	25-SEP-19
Lithium (Li)			105.1		%		80-120	25-SEP-19
Magnesium (Mg)			111.3		%		80-120	25-SEP-19
Manganese (Mn)			103.6		%		80-120	25-SEP-19
Molybdenum (Mo)			90.2		%		80-120	25-SEP-19
Nickel (Ni)			103.4		%		80-120	25-SEP-19
Potassium (K)			105.7		%		80-120	25-SEP-19
Selenium (Se)			97.7		%		80-120	25-SEP-19
Silver (Ag)			105.1		%		80-120	25-SEP-19
Sodium (Na)			108.3		%		80-120	25-SEP-19
Strontium (Sr)			105.9		%		80-120	25-SEP-19
Sulfur (S)			91.3		%		80-120	25-SEP-19
Thallium (Tl)			115.2		%		80-120	25-SEP-19
Tin (Sn)			104.8		%		80-120	25-SEP-19
Titanium (Ti)			99.7		%		80-120	25-SEP-19
Tungsten (W)			99.8		%		80-120	25-SEP-19
Uranium (U)			89.6		%		80-120	25-SEP-19
Vanadium (V)			105.9		%		80-120	25-SEP-19
Zinc (Zn)			101.0		%		80-120	25-SEP-19
Zirconium (Zr)			99.5		%		80-120	25-SEP-19
WG3169643-23 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-23 LCS								
Aluminum (Al)			101.3		%		80-120	25-SEP-19
Antimony (Sb)			108.2		%		80-120	25-SEP-19
Arsenic (As)			99.5		%		80-120	25-SEP-19
Barium (Ba)			99.4		%		80-120	25-SEP-19
Beryllium (Be)			102.4		%		80-120	25-SEP-19
Bismuth (Bi)			97.4		%		80-120	25-SEP-19
Boron (B)			101.5		%		80-120	25-SEP-19
Cadmium (Cd)			104.7		%		80-120	25-SEP-19
Calcium (Ca)			96.2		%		80-120	25-SEP-19
Chromium (Cr)			100.8		%		80-120	25-SEP-19
Cobalt (Co)			88.7		%		80-120	25-SEP-19
Copper (Cu)			97.1		%		80-120	25-SEP-19
Iron (Fe)			106.4		%		80-120	25-SEP-19
Lead (Pb)			114.9		%		80-120	25-SEP-19
Lithium (Li)			102.4		%		80-120	25-SEP-19
Magnesium (Mg)			105.4		%		80-120	25-SEP-19
Manganese (Mn)			98.8		%		80-120	25-SEP-19
Molybdenum (Mo)			90.8		%		80-120	25-SEP-19
Nickel (Ni)			99.4		%		80-120	25-SEP-19
Potassium (K)			102.1		%		80-120	25-SEP-19
Selenium (Se)			100.0		%		80-120	25-SEP-19
Silver (Ag)			102.0		%		80-120	25-SEP-19
Sodium (Na)			102.8		%		80-120	25-SEP-19
Strontium (Sr)			102.0		%		80-120	25-SEP-19
Sulfur (S)			90.7		%		80-120	25-SEP-19
Thallium (Tl)			113.3		%		80-120	25-SEP-19
Tin (Sn)			106.9		%		80-120	25-SEP-19
Titanium (Ti)			98.1		%		80-120	25-SEP-19
Tungsten (W)			100.2		%		80-120	25-SEP-19
Uranium (U)			86.3		%		80-120	25-SEP-19
Vanadium (V)			101.8		%		80-120	25-SEP-19
Zinc (Zn)			98.2		%		80-120	25-SEP-19
Zirconium (Zr)			101.5		%		80-120	25-SEP-19
WG3169643-16 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-16 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-19
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-19
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-19
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-19
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-19
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-19
Boron (B)			<5.0		mg/kg		5	25-SEP-19
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-19
Calcium (Ca)			<50		mg/kg		50	25-SEP-19
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-19
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-19
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-19
Iron (Fe)			<50		mg/kg		50	25-SEP-19
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-19
Lithium (Li)			<2.0		mg/kg		2	25-SEP-19
Magnesium (Mg)			<20		mg/kg		20	25-SEP-19
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-19
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-19
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-19
Phosphorus (P)			<50		mg/kg		50	25-SEP-19
Potassium (K)			<100		mg/kg		100	25-SEP-19
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-19
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-19
Sodium (Na)			<50		mg/kg		50	25-SEP-19
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-19
Sulfur (S)			<1000		mg/kg		1000	25-SEP-19
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-19
Tin (Sn)			<2.0		mg/kg		2	25-SEP-19
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-19
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-19
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-19
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-19
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-19
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-CL	**Soil**							
Batch R4831551								
WG3169643-21 MB								
Aluminum (Al)			<50		mg/kg		50	25-SEP-19
Antimony (Sb)			<0.10		mg/kg		0.1	25-SEP-19
Arsenic (As)			<0.10		mg/kg		0.1	25-SEP-19
Barium (Ba)			<0.50		mg/kg		0.5	25-SEP-19
Beryllium (Be)			<0.10		mg/kg		0.1	25-SEP-19
Bismuth (Bi)			<0.20		mg/kg		0.2	25-SEP-19
Boron (B)			<5.0		mg/kg		5	25-SEP-19
Cadmium (Cd)			<0.020		mg/kg		0.02	25-SEP-19
Calcium (Ca)			<50		mg/kg		50	25-SEP-19
Chromium (Cr)			<0.50		mg/kg		0.5	25-SEP-19
Cobalt (Co)			<0.10		mg/kg		0.1	25-SEP-19
Copper (Cu)			<0.50		mg/kg		0.5	25-SEP-19
Iron (Fe)			<50		mg/kg		50	25-SEP-19
Lead (Pb)			<0.50		mg/kg		0.5	25-SEP-19
Lithium (Li)			<2.0		mg/kg		2	25-SEP-19
Magnesium (Mg)			<20		mg/kg		20	25-SEP-19
Manganese (Mn)			<1.0		mg/kg		1	25-SEP-19
Molybdenum (Mo)			<0.10		mg/kg		0.1	25-SEP-19
Nickel (Ni)			<0.50		mg/kg		0.5	25-SEP-19
Phosphorus (P)			<50		mg/kg		50	25-SEP-19
Potassium (K)			<100		mg/kg		100	25-SEP-19
Selenium (Se)			<0.20		mg/kg		0.2	25-SEP-19
Silver (Ag)			<0.10		mg/kg		0.1	25-SEP-19
Sodium (Na)			<50		mg/kg		50	25-SEP-19
Strontium (Sr)			<0.50		mg/kg		0.5	25-SEP-19
Sulfur (S)			<1000		mg/kg		1000	25-SEP-19
Thallium (Tl)			<0.050		mg/kg		0.05	25-SEP-19
Tin (Sn)			<2.0		mg/kg		2	25-SEP-19
Titanium (Ti)			<1.0		mg/kg		1	25-SEP-19
Tungsten (W)			<0.50		mg/kg		0.5	25-SEP-19
Uranium (U)			<0.050		mg/kg		0.05	25-SEP-19
Vanadium (V)			<0.20		mg/kg		0.2	25-SEP-19
Zinc (Zn)			<2.0		mg/kg		2	25-SEP-19
Zirconium (Zr)			<1.0		mg/kg		1	25-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MOISTURE-CL	**Soil**							
Batch R4830131								
WG3168227-3 DUP		**L2349793-1**						
Moisture		53.2	54.9		%	3.2	20	21-SEP-19
WG3168227-2 LCS								
Moisture			95.6		%		90-110	21-SEP-19
WG3168227-1 MB								
Moisture			<0.25		%		0.25	21-SEP-19
Batch R4843312								
WG3171343-2 LCS								
Moisture			97.4		%		90-110	26-SEP-19
WG3171343-1 MB								
Moisture			<0.25		%		0.25	26-SEP-19
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-4 DUP		**L2349793-1**						
Acenaphthene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	25-SEP-19
Acenaphthylene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	25-SEP-19
Acridine		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Anthracene		<0.0040	<0.0040	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benz(a)anthracene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benzo(a)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benzo(b&j)fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benzo(g,h,i)perylene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benzo(k)fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Benzo(e)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Chrysene		0.028	0.024		mg/kg	15	50	25-SEP-19
Dibenz(a,h)anthracene		<0.0050	<0.0050	RPD-NA	mg/kg	N/A	50	25-SEP-19
Fluoranthene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Fluorene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Indeno(1,2,3-c,d)pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
1-Methylnaphthalene		0.072	0.071		mg/kg	1.7	50	25-SEP-19
2-Methylnaphthalene		0.093	0.089		mg/kg	5.0	50	25-SEP-19
Naphthalene		0.048	0.046		mg/kg	2.6	50	25-SEP-19
Perylene		0.010	0.011		mg/kg	1.9	50	25-SEP-19
Phenanthrene		0.107	0.098		mg/kg	9.2	50	25-SEP-19
Pyrene		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19
Quinoline		<0.010	<0.010	RPD-NA	mg/kg	N/A	50	25-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-2 IRM		**ALS PAH RM2**						
Acenaphthene			103.7		%		65-130	25-SEP-19
Acenaphthylene			79.6		%		65-130	25-SEP-19
Acridine			110.2		%		65-130	25-SEP-19
Anthracene			78.2		%		65-130	25-SEP-19
Benz(a)anthracene			93.6		%		65-130	25-SEP-19
Benzo(a)pyrene			99.3		%		65-130	25-SEP-19
Benzo(b&j)fluoranthene			94.9		%		65-130	25-SEP-19
Benzo(g,h,i)perylene			102.2		%		65-130	25-SEP-19
Benzo(k)fluoranthene			99.5		%		65-130	25-SEP-19
Benzo(e)pyrene			93.4		%		65-130	25-SEP-19
Chrysene			99.6		%		65-130	25-SEP-19
Dibenz(a,h)anthracene			93.8		%		65-130	25-SEP-19
Fluoranthene			102.2		%		65-130	25-SEP-19
Fluorene			90.2		%		65-130	25-SEP-19
Indeno(1,2,3-c,d)pyrene			109.8		%		65-130	25-SEP-19
1-Methylnaphthalene			87.7		%		65-130	25-SEP-19
2-Methylnaphthalene			91.1		%		65-130	25-SEP-19
Naphthalene			86.9		%		65-130	25-SEP-19
Perylene			70.8		%		65-130	25-SEP-19
Phenanthrene			103.5		%		65-130	25-SEP-19
Pyrene			98.8		%		65-130	25-SEP-19
WG3173943-6 IRM		**ALS PAH RM2**						
Acenaphthene			96.4		%		65-130	25-SEP-19
Acenaphthylene			79.0		%		65-130	25-SEP-19
Acridine			97.2		%		65-130	25-SEP-19
Anthracene			70.7		%		65-130	25-SEP-19
Benz(a)anthracene			90.0		%		65-130	25-SEP-19
Benzo(a)pyrene			93.5		%		65-130	25-SEP-19
Benzo(b&j)fluoranthene			90.6		%		65-130	25-SEP-19
Benzo(g,h,i)perylene			98.0		%		65-130	25-SEP-19
Benzo(k)fluoranthene			96.0		%		65-130	25-SEP-19
Benzo(e)pyrene			90.7		%		65-130	25-SEP-19
Chrysene			98.8		%		65-130	25-SEP-19
Dibenz(a,h)anthracene			92.7		%		65-130	25-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-6 IRM		**ALS PAH RM2**						
Fluoranthene			97.5		%		65-130	25-SEP-19
Fluorene			82.2		%		65-130	25-SEP-19
Indeno(1,2,3-c,d)pyrene			116.5		%		65-130	25-SEP-19
1-Methylnaphthalene			83.6		%		65-130	25-SEP-19
2-Methylnaphthalene			85.7		%		65-130	25-SEP-19
Naphthalene			86.7		%		65-130	25-SEP-19
Perylene			66.5		%		65-130	25-SEP-19
Phenanthrene			93.6		%		65-130	25-SEP-19
Pyrene			93.9		%		65-130	25-SEP-19
WG3173943-1 LCS								
Acenaphthene			88.4		%		60-130	25-SEP-19
Acenaphthylene			81.5		%		60-130	25-SEP-19
Acridine			92.3		%		60-130	25-SEP-19
Anthracene			81.8		%		60-130	25-SEP-19
Benz(a)anthracene			92.3		%		60-130	25-SEP-19
Benzo(a)pyrene			87.8		%		60-130	25-SEP-19
Benzo(b&j)fluoranthene			87.2		%		60-130	25-SEP-19
Benzo(g,h,i)perylene			93.4		%		60-130	25-SEP-19
Benzo(k)fluoranthene			94.2		%		60-130	25-SEP-19
Benzo(e)pyrene			91.5		%		60-130	25-SEP-19
Chrysene			93.9		%		60-130	25-SEP-19
Dibenz(a,h)anthracene			93.0		%		60-130	25-SEP-19
Fluoranthene			92.1		%		60-130	25-SEP-19
Fluorene			85.5		%		60-130	25-SEP-19
Indeno(1,2,3-c,d)pyrene			87.2		%		60-130	25-SEP-19
1-Methylnaphthalene			82.0		%		60-130	25-SEP-19
2-Methylnaphthalene			84.4		%		60-130	25-SEP-19
Naphthalene			85.5		%		50-130	25-SEP-19
Perylene			95.2		%		60-130	25-SEP-19
Phenanthrene			87.8		%		60-130	25-SEP-19
Pyrene			93.8		%		60-130	25-SEP-19
Quinoline			82.9		%		60-130	25-SEP-19
WG3173943-5 LCS								
Acenaphthene			78.7		%		60-130	25-SEP-19
Acenaphthylene			72.7		%		60-130	25-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-5 LCS								
Acridine			83.6		%		60-130	25-SEP-19
Anthracene			73.7		%		60-130	25-SEP-19
Benz(a)anthracene			86.8		%		60-130	25-SEP-19
Benzo(a)pyrene			75.7		%		60-130	25-SEP-19
Benzo(b&j)fluoranthene			77.7		%		60-130	25-SEP-19
Benzo(g,h,i)perylene			89.7		%		60-130	25-SEP-19
Benzo(k)fluoranthene			82.8		%		60-130	25-SEP-19
Benzo(e)pyrene			81.0		%		60-130	25-SEP-19
Chrysene			90.0		%		60-130	25-SEP-19
Dibenz(a,h)anthracene			88.5		%		60-130	25-SEP-19
Fluoranthene			87.1		%		60-130	25-SEP-19
Fluorene			68.6		%		60-130	25-SEP-19
Indeno(1,2,3-c,d)pyrene			78.1		%		60-130	25-SEP-19
1-Methylnaphthalene			73.9		%		60-130	25-SEP-19
2-Methylnaphthalene			71.6		%		60-130	25-SEP-19
Naphthalene			72.6		%		50-130	25-SEP-19
Perylene			82.0		%		60-130	25-SEP-19
Phenanthrene			77.4		%		60-130	25-SEP-19
Pyrene			88.7		%		60-130	25-SEP-19
Quinoline			71.2		%		60-130	25-SEP-19
WG3173943-3 MB								
Acenaphthene			<0.0050		mg/kg		0.005	25-SEP-19
Acenaphthylene			<0.0050		mg/kg		0.005	25-SEP-19
Acridine			<0.010		mg/kg		0.01	25-SEP-19
Anthracene			<0.0040		mg/kg		0.004	25-SEP-19
Benz(a)anthracene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(a)pyrene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(e)pyrene			<0.010		mg/kg		0.01	25-SEP-19
Chrysene			<0.010		mg/kg		0.01	25-SEP-19
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	25-SEP-19
Fluoranthene			<0.010		mg/kg		0.01	25-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-3 MB								
Fluorene			<0.010		mg/kg		0.01	25-SEP-19
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	25-SEP-19
1-Methylnaphthalene			<0.010		mg/kg		0.01	25-SEP-19
2-Methylnaphthalene			<0.010		mg/kg		0.01	25-SEP-19
Naphthalene			<0.010		mg/kg		0.01	25-SEP-19
Perylene			<0.010		mg/kg		0.01	25-SEP-19
Phenanthrene			<0.010		mg/kg		0.01	25-SEP-19
Pyrene			<0.010		mg/kg		0.01	25-SEP-19
Quinoline			<0.010		mg/kg		0.01	25-SEP-19
Surrogate: d8-Naphthalene			69.7		%		50-130	25-SEP-19
Surrogate: d10-Acenaphthene			73.3		%		60-130	25-SEP-19
Surrogate: d10-Phenanthrene			79.8		%		60-130	25-SEP-19
Surrogate: d12-Chrysene			87.9		%		60-130	25-SEP-19
WG3173943-7 MB								
Acenaphthene			<0.0050		mg/kg		0.005	25-SEP-19
Acenaphthylene			<0.0050		mg/kg		0.005	25-SEP-19
Acridine			<0.010		mg/kg		0.01	25-SEP-19
Anthracene			<0.0040		mg/kg		0.004	25-SEP-19
Benz(a)anthracene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(a)pyrene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	25-SEP-19
Benzo(e)pyrene			<0.010		mg/kg		0.01	25-SEP-19
Chrysene			<0.010		mg/kg		0.01	25-SEP-19
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	25-SEP-19
Fluoranthene			<0.010		mg/kg		0.01	25-SEP-19
Fluorene			<0.010		mg/kg		0.01	25-SEP-19
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	25-SEP-19
1-Methylnaphthalene			<0.010		mg/kg		0.01	25-SEP-19
2-Methylnaphthalene			<0.010		mg/kg		0.01	25-SEP-19
Naphthalene			<0.010		mg/kg		0.01	25-SEP-19
Perylene			<0.010		mg/kg		0.01	25-SEP-19
Phenanthrene			<0.010		mg/kg		0.01	25-SEP-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4845089								
WG3173943-7 MB								
Pyrene			<0.010		mg/kg		0.01	25-SEP-19
Quinoline			<0.010		mg/kg		0.01	25-SEP-19
Surrogate: d8-Naphthalene			66.2		%		50-130	25-SEP-19
Surrogate: d10-Acenaphthene			70.3		%		60-130	25-SEP-19
Surrogate: d10-Phenanthrene			70.7		%		60-130	25-SEP-19
Surrogate: d12-Chrysene			85.6		%		60-130	25-SEP-19
Batch R4849204								
WG3175293-2 IRM		**ALS PAH RM2**						
Acenaphthene			95.0		%		65-130	26-SEP-19
Acenaphthylene			70.9		%		65-130	26-SEP-19
Acridine			95.4		%		65-130	26-SEP-19
Anthracene			70.3		%		65-130	26-SEP-19
Benz(a)anthracene			86.6		%		65-130	26-SEP-19
Benzo(a)pyrene			80.2		%		65-130	26-SEP-19
Benzo(b&j)fluoranthene			86.7		%		65-130	26-SEP-19
Benzo(g,h,i)perylene			91.1		%		65-130	26-SEP-19
Benzo(k)fluoranthene			83.9		%		65-130	26-SEP-19
Benzo(e)pyrene			84.8		%		65-130	26-SEP-19
Chrysene			93.7		%		65-130	26-SEP-19
Dibenz(a,h)anthracene			87.0		%		65-130	26-SEP-19
Fluoranthene			95.5		%		65-130	26-SEP-19
Fluorene			86.1		%		65-130	26-SEP-19
Indeno(1,2,3-c,d)pyrene			97.3		%		65-130	26-SEP-19
1-Methylnaphthalene			85.0		%		65-130	26-SEP-19
2-Methylnaphthalene			86.9		%		65-130	26-SEP-19
Naphthalene			88.7		%		65-130	26-SEP-19
Perylene			65.1		%		65-130	26-SEP-19
Phenanthrene			94.5		%		65-130	26-SEP-19
Pyrene			92.3		%		65-130	26-SEP-19
WG3175293-1 LCS								
Acenaphthene			82.3		%		60-130	26-SEP-19
Acenaphthylene			76.4		%		60-130	26-SEP-19
Acridine			79.8		%		60-130	26-SEP-19
Anthracene			72.3		%		60-130	26-SEP-19
Benz(a)anthracene			81.3		%		60-130	26-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4849204								
WG3175293-1 LCS								
Benzo(a)pyrene			75.5		%		60-130	26-SEP-19
Benzo(b&j)fluoranthene			76.7		%		60-130	26-SEP-19
Benzo(g,h,i)perylene			80.9		%		60-130	26-SEP-19
Benzo(k)fluoranthene			80.2		%		60-130	26-SEP-19
Benzo(e)pyrene			79.3		%		60-130	26-SEP-19
Chrysene			82.9		%		60-130	26-SEP-19
Dibenz(a,h)anthracene			81.2		%		60-130	26-SEP-19
Fluoranthene			80.9		%		60-130	26-SEP-19
Fluorene			71.0		%		60-130	26-SEP-19
Indeno(1,2,3-c,d)pyrene			78.1		%		60-130	26-SEP-19
1-Methylnaphthalene			77.3		%		60-130	26-SEP-19
2-Methylnaphthalene			75.1		%		60-130	26-SEP-19
Naphthalene			75.3		%		50-130	26-SEP-19
Perylene			81.1		%		60-130	26-SEP-19
Phenanthrene			76.3		%		60-130	26-SEP-19
Pyrene			82.5		%		60-130	26-SEP-19
Quinoline			74.4		%		60-130	26-SEP-19
WG3175293-7 LCS								
Acenaphthene			87.6		%		60-130	27-SEP-19
Acenaphthylene			82.7		%		60-130	27-SEP-19
Acridine			96.3		%		60-130	27-SEP-19
Anthracene			85.0		%		60-130	27-SEP-19
Benz(a)anthracene			90.3		%		60-130	27-SEP-19
Benzo(a)pyrene			75.4		%		60-130	27-SEP-19
Benzo(b&j)fluoranthene			75.0		%		60-130	27-SEP-19
Benzo(g,h,i)perylene			75.3		%		60-130	27-SEP-19
Benzo(k)fluoranthene			77.7		%		60-130	27-SEP-19
Benzo(e)pyrene			81.1		%		60-130	27-SEP-19
Chrysene			90.0		%		60-130	27-SEP-19
Dibenz(a,h)anthracene			86.9		%		60-130	27-SEP-19
Fluoranthene			83.1		%		60-130	27-SEP-19
Fluorene			78.6		%		60-130	27-SEP-19
Indeno(1,2,3-c,d)pyrene			79.9		%		60-130	27-SEP-19
1-Methylnaphthalene			82.1		%		60-130	27-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4849204								
WG3175293-7 LCS								
2-Methylnaphthalene			80.5		%		60-130	27-SEP-19
Naphthalene			76.7		%		50-130	27-SEP-19
Perylene			77.6		%		60-130	27-SEP-19
Phenanthrene			87.2		%		60-130	27-SEP-19
Pyrene			85.0		%		60-130	27-SEP-19
Quinoline			84.8		%		60-130	27-SEP-19
WG3175293-3 MB								
Acenaphthene			<0.0050		mg/kg		0.005	26-SEP-19
Acenaphthylene			<0.0050		mg/kg		0.005	26-SEP-19
Acridine			<0.010		mg/kg		0.01	26-SEP-19
Anthracene			<0.0040		mg/kg		0.004	26-SEP-19
Benz(a)anthracene			<0.010		mg/kg		0.01	26-SEP-19
Benzo(a)pyrene			<0.010		mg/kg		0.01	26-SEP-19
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	26-SEP-19
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	26-SEP-19
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	26-SEP-19
Benzo(e)pyrene			<0.010		mg/kg		0.01	26-SEP-19
Chrysene			<0.010		mg/kg		0.01	26-SEP-19
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	26-SEP-19
Fluoranthene			<0.010		mg/kg		0.01	26-SEP-19
Fluorene			<0.010		mg/kg		0.01	26-SEP-19
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	26-SEP-19
1-Methylnaphthalene			<0.010		mg/kg		0.01	26-SEP-19
2-Methylnaphthalene			<0.010		mg/kg		0.01	26-SEP-19
Naphthalene			<0.010		mg/kg		0.01	26-SEP-19
Perylene			<0.010		mg/kg		0.01	26-SEP-19
Phenanthrene			<0.010		mg/kg		0.01	26-SEP-19
Pyrene			<0.010		mg/kg		0.01	26-SEP-19
Quinoline			<0.010		mg/kg		0.01	26-SEP-19
Surrogate: d8-Naphthalene			67.9		%		50-130	26-SEP-19
Surrogate: d10-Acenaphthene			74.2		%		60-130	26-SEP-19
Surrogate: d10-Phenanthrene			78.9		%		60-130	26-SEP-19
Surrogate: d12-Chrysene			82.1		%		60-130	26-SEP-19
WG3175293-5 MB								
Acenaphthene			<0.0050		mg/kg		0.005	27-SEP-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-TMB-D/A-MS-CL	**Soil**							
Batch R4849204								
WG3175293-5 MB								
Acenaphthylene			<0.0050		mg/kg		0.005	27-SEP-19
Acridine			<0.010		mg/kg		0.01	27-SEP-19
Anthracene			<0.0040		mg/kg		0.004	27-SEP-19
Benz(a)anthracene			<0.010		mg/kg		0.01	27-SEP-19
Benzo(a)pyrene			<0.010		mg/kg		0.01	27-SEP-19
Benzo(b&j)fluoranthene			<0.010		mg/kg		0.01	27-SEP-19
Benzo(g,h,i)perylene			<0.010		mg/kg		0.01	27-SEP-19
Benzo(k)fluoranthene			<0.010		mg/kg		0.01	27-SEP-19
Benzo(e)pyrene			<0.010		mg/kg		0.01	27-SEP-19
Chrysene			<0.010		mg/kg		0.01	27-SEP-19
Dibenz(a,h)anthracene			<0.0050		mg/kg		0.005	27-SEP-19
Fluoranthene			<0.010		mg/kg		0.01	27-SEP-19
Fluorene			<0.010		mg/kg		0.01	27-SEP-19
Indeno(1,2,3-c,d)pyrene			<0.010		mg/kg		0.01	27-SEP-19
1-Methylnaphthalene			<0.010		mg/kg		0.01	27-SEP-19
2-Methylnaphthalene			<0.010		mg/kg		0.01	27-SEP-19
Naphthalene			<0.010		mg/kg		0.01	27-SEP-19
Perylene			<0.010		mg/kg		0.01	27-SEP-19
Phenanthrene			<0.010		mg/kg		0.01	27-SEP-19
Pyrene			<0.010		mg/kg		0.01	27-SEP-19
Quinoline			<0.010		mg/kg		0.01	27-SEP-19
Surrogate: d8-Naphthalene			61.1		%		50-130	27-SEP-19
Surrogate: d10-Acenaphthene			69.9		%		60-130	27-SEP-19
Surrogate: d10-Phenanthrene			73.0		%		60-130	27-SEP-19
Surrogate: d12-Chrysene			86.0		%		60-130	27-SEP-19
PH-1:2-CL	**Soil**							
Batch R4837391								
WG3171196-3 IRM		**SAL-STD10**						
pH (1:2 soil:water)			7.67		pH		7.4-8	24-SEP-19
WG3171196-5 IRM		**SAL-STD10**						
pH (1:2 soil:water)			7.75		pH		7.4-8	24-SEP-19
PSA-PIPET-DETAIL-SK	**Soil**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-PIPET-DETAIL-SK	**Soil**							
Batch R4855848								
WG3168391-1 DUP		**L2349793-1**						
% Gravel (>2mm)		<1.0	<1.0	RPD-NA	%	N/A	5	02-OCT-19
% Sand (2.00mm - 1.00mm)		<1.0	<1.0	RPD-NA	%	N/A	5	02-OCT-19
% Sand (1.00mm - 0.50mm)		1.3	1.2	J	%	0.1	5	02-OCT-19
% Sand (0.50mm - 0.25mm)		8.1	8.6	J	%	0.4	5	02-OCT-19
% Sand (0.25mm - 0.125mm)		12.3	11.8	J	%	0.5	5	02-OCT-19
% Sand (0.125mm - 0.063mm)		17.0	17.3	J	%	0.2	5	02-OCT-19
% Silt (0.063mm - 0.0312mm)		25.2	25.3	J	%	0.2	5	02-OCT-19
% Silt (0.0312mm - 0.004mm)		29.8	29.5	J	%	0.2	5	02-OCT-19
% Clay (<4um)		6.1	6.0	J	%	0.1	5	02-OCT-19
WG3168391-2 IRM		**2017-PSA**						
% Sand (2.00mm - 1.00mm)			2.8		%		0-7.6	02-OCT-19
% Sand (1.00mm - 0.50mm)			4.1		%		0-8.9	02-OCT-19
% Sand (0.50mm - 0.25mm)			9.7		%		5.3-15.3	02-OCT-19
% Sand (0.25mm - 0.125mm)			14.7		%		10-20	02-OCT-19
% Sand (0.125mm - 0.063mm)			13.5		%		7.3-17.3	02-OCT-19
% Silt (0.063mm - 0.0312mm)			14.5		%		9.9-19.9	02-OCT-19
% Silt (0.0312mm - 0.004mm)			22.6		%		17.6-27.6	02-OCT-19
% Clay (<4um)			18.1		%		13.4-23.4	02-OCT-19

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.

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COC ID:	**Regional Effects Program**	**TURNAROUND TIME:**	Regular

Facility Name / Job#	Regional Effects Program/GHO LAEMP		
Project Manager	Cait Good		
Email	cait.good@teck.com		
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City	Sparwood	Province	BC
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Lab Name	ALS Calgary		
Lab Contact	Lyuda Shvets		
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City	Calgary	Province	AB
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Email 4:	jtester@minnow.ca	X	X	X
Email 5:				
PO number	VPO00616180			

SAMPLE DETAILS / **ANALYSIS REQUESTED**

L2349793-COFC

Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	C-TOC-SK	MET-CCME+FULL-CL	MOISTURE-CL - % Moisture	PSA-PIPET-DETAIL-SK Particle Size	PAH-TMB-D/A-MS-CL-PAHs		
								N	N	N	N	N	N	N
								NONE	NONE	NONE	NONE	NONE		
RG_EL20_SE-1_2019-09-08_0850	RG_EL20	SE	No	8-Sep-19	8:50:00	G	2	x	x	x	x	x		
RG_EL20_SE-2_2019-09-08_0940	RG_EL20	SE	No	8-Sep-19	9:40:00	G	2	x	x	x	x	x		
RG_EL20_SE-3_2019-09-08_0950	RG_EL20	SE	No	8-Sep-19	9:50:00	G	2	x	x	x	x	x		
RG_EL20_SE-4_2019-09-08_1000	RG_EL20	SE	No	8-Sep-19	10:00:00	G	2	x	x	x	x	x		
GH_EL20_SE-5_2019-09-08_1215	RG_EL20	SE	No	8-Sep-19	12:15:00	G	2	x	x	x	x	x		
RG_GH_SCW3_SE-1_2019-09-12_0850	RG_GH-SCW3	SE	No	12-Sep-19	8:50:00	G	2	x	x	x	x	x		
RG_GH_SCW3_SE-2_2019-09-12_0910	RG_GH-SCW3	SE	No	12-Sep-19	9:10:00	G	2	x	x	x	x	x		
RG_GH_SCW3_SE-3_2019-09-12_0923	RG_GH-SCW3	SE	No	12-Sep-19	9:23:00	G	2	x	x	x	x	x		
RG_GH_SCW3_SE-4_2019-09-12_0946	RG_GH-SCW3	SE	No	12-Sep-19	9:46:00	G	2	x	x	x	x	x		
RG_GH_SCW3_SE-5_2019-09-12_1000	RG_GH-SCW3	SE	No	12-Sep-19	10:00:00	G	2	x	x	x	x	x		

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
VPO00616180	Jennifer Ings/Minnow	September 16, 2019		9/17 9:10

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	**Jennifer Ings**	**Mobile #**	**519-500-3444**
Sampler's Signature		**Date/Time**	**September 16, 2019**

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COC ID:	**Regional Effects Program**	**TURNAROUND TIME:**	Regular

PROJECT/CLIENT INFO

Facility Name / Job#	Regional Effects Program/GHO LAEMP		
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LABORATORY

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Lab Contact	Lyuda Shvets		
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Email 4:	jtester@minnow.ca	x	x	x
Email 5:				
PO number	*VPO00616180*			

SAMPLE DETAILS / **ANALYSIS REQUESTED** Filtered - F: Field, L: Lab, FL: Field & Lab, N: None

L2349793-COFC

								Filtered	N	N	N	N	N	N	N
								PRESERVED	NONE	NONE	NONE	NONE	NONE		
Sample ID	Sample Location (sys_loc_code)	Field Matrix	Hazardous Material (Yes/No)	Date	Time (24hr)	G=Grab C=Comp	# Of Cont.	ANALYSIS	C-TOC-SK	MET-CCME+FULL-CL	MOISTURE-CL - % Moisture	PSA-PIPET-DETAIL-SK Particle Size	PAH-TMB-D/A-MS-CL-PAHs		
RG_RIVER_SE-1_2019-09-12_0850	RG_GH-SCW3	SE	No	12-Sep-19	8:50:00	G	2		x	x	x	x	x		
RG_RIVER_SE-2_2019-09-12_0910	RG_GH-SCW3	SE	No	12-Sep-19	9:10:00	G	2		x	x	x	x	x		
RG_RIVER_SE-3_2019-09-12_0923	RG_GH-SCW3	SE	No	12-Sep-19	9:23:00	G	2		x	x	x	x	x		
RG_RIVER_SE-4_2019-09-12_0946	RG_GH-SCW3	SE	No	12-Sep-19	9:46:00	G	2		x	x	x	x	x		
RG_RIVER_SE-5_2019-09-12_1000	RG_GH-SCW3	SE	No	12-Sep-19	10:00:00	G	2		x	x	x	x	x		

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS

VPO00616180

RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
Jennifer Ings/Minnow	September 16, 2019		

SERVICE REQUEST (rush - subject to availability)

Regular (default)	X
Priority (2-3 business days) - 50% surcharge	
Emergency (1 Business Day) - 100% surcharge	
For Emergency <1 Day, ASAP or Weekend - Contact ALS	

Sampler's Name	**Jennifer Ings**	**Mobile #**	**519-500-3444**
Sampler's Signature		**Date/Time**	**September 16, 2019**