SCIENCE INTEGRITY KNOWLEDGE

HUMAN HEALTH RISK ASSESSMENT OF SEDIMENT, SURFACE WATER, AND FISH FROM BARRY'S RUN, HALIFAX REGIONAL MUNICIPALITY

Completed as part of the Nova Scotia Lands Montague Mines Tailings Areas Conceptual Closure Plan currently being conducted by Intrinsik, Wood, EcoMetrix and Klohn Crippen Berger

FINAL REPORT

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Prepared For:

Donnie Burke
Executive Director
Nova Scotia Lands Inc.
Harbourside Place
45 Wabana Court
Sydney, NS

Summary

In spring of 2019, Halifax Regional Municipality (HRM) commissioned an Environmental Site Assessment (ESA) of municipally owned property known as Barry's Run, located in at Port Wallace in Dartmouth as part of the assessment of a proposed residential housing development application. This area includes a watercourse, which starts upstream of Barry's Run as Mitchell's Brook, and a marshy area, known as a fen, along the sides of the watercourse. Upstream of Barry's Run, on provincially owned lands, is the former Montague Mines site which ceased operations in 1940, and which is currently undergoing assessment for the purposes of developing a final closure plan. Mitchell's Brook runs alongside the former mine site, travels through Barry's Run, and exits into Lake Charles.

The purpose of the ESA was to confirm whether contaminants were present on the HRM property, to understand if sediments and surface waters had been impacted by historic mining activities upstream from the site, or other sources/activities in the area. The ESA included sediment and surface water sampling and determined that elevated concentrations of metals, most notably arsenic, were present in sediments within the main channel of the brook and the run. As a result of this study, and the use of the lands for recreational activities such as swimming and fishing, HRM issued a Risk Advisory for Barry's Run (https://www.halifax.ca/about-halifax/energy-environment/lakes-rivers/barrys-run-risk-advisory). The advisory notifies site users that high levels of arsenic have been found in the sediments, and that further studies were underway to better understand this issue and determine next steps. Residents were warned to avoid disturbing the sediments or eating fish from Barry's Run until further notice.

In response to the results of the 2019 study and risk advisory, an additional study was commissioned by Nova Scotia Lands Inc (NS Lands), which is the provincial Crown Corporation that manages remediation projects and provides asset management for some provincial lands. NS Lands is leading a mine closure project for the historical mine site at Montague Mines. This report provides the results of additional data collection and assessment for Barry's Run, which included sediment, surface water and fish tissue sampling and analysis, as well as a human health risk assessment study (HHRA) to assess the potential risks related to people using Barry's Run for recreational activities such as swimming, hiking or fishing.

The focus of this study was on sediments, surface waters, fish tissues, and soils from the fen area, and whether the measured concentrations of contaminants could pose a risk to people using the area. Arsenic and mercury were identified as the chemicals of concern. Both occur naturally in the environment ; however, are present in higher concentrations in some materials at historic mining areas, due to ore processing and mineral concentration (in the case of arsenic), or imported and released to the environment during historical gold recovery techniques (in the case of mercury). Arsenic is markedly elevated in Barry's Run relative to naturally occurring concentrations in the area, whereas mercury was only found to be elevated in a limited number of sediment samples (not in surface water); however, mercury can accumulate in fish tissues and hence was included in the study for completeness.

The methods used to conduct the study followed widely accepted sampling and analysis methods, as well as Human Health Risk Assessment (HHRA) methods developed by Health Canada. Some speciality analysis of sediments and fish tissues were conducted, following Health Canada guidance, to determine the availability of arsenic within these media, as arsenic

can bind tightly to sediment particles or tissues, which can reduce exposure potential when ingested. In addition, fish tissues were analyzed to determine what species or form of arsenic is present, as the toxicity of arsenic varies depending on the form present.

The HHRA used a series of assumptions related to how frequently people might use the area for various activities, including hiking along the fen, paddle boarding, kayaking, or swimming and wading. These activities could result in people coming into contact with sediments with elevated concentrations of arsenic or mercury, or arsenic in surface waters. In addition, people were assumed to fish in Barry's Run and consume fish frequently.

The results of the assessment were as follows:

- Infrequent swimming in Barry's Run and Mitchell's Brook within the Study area boundary (< 20 times/year) is estimated to have negligible risk levels for both arsenic and mercury, as long as sediment exposure is minimized. Negligible risk means that the exposures are so low they are considered to have an insignificant impact on human health.

- Sediment contact related to wading or swimming activities within Barry's Run and Mitchell's Brook was predicted to have negligible risk related to mercury. While sediment exposures for arsenic are associated with marginally increased risk levels relative to acceptable levels, it is uncertain whether the exposure assumptions used in the assessment reflect current or possible future land use patterns. Therefore, it is recommended that sediment contact be minimized until exposure assumptions can be further adjusted based on improved knowledge of public usage and as future land use in and around Barry's Run is more defined. Ultimately, clear statements related to site usage and risk management should be provided for area residents, and the assessment should reflect input from local land users related to exposure assumptions.

- Contact with soils along the fen was predicted to be associated with negligible risk levels, with the exception of the high hiking frequency scenario (which assumed 26 hikes or walking events per year, over a 56 year timeframe), wherein risks related to arsenic were marginally elevated.

- Fish consumption risks due to mercury levels in Brook trout and Smallmouth bass are negligible, as long as consumption rates are in keeping with the current Provincial fish consumption advisory. Risks related to arsenic in Brook trout and Smallmouth bass tissues marginally exceed acceptable risk levels for both species of fish, based on the assumption that all the fish people consume comes from Barry's Run, and that fish consumption rates equal those cited in the Provincial consumption advisory. These assumptions likely overestimate the amount and frequency of fish consumption from Barry's Run. Hence, a fish consumption advisory is unlikely to be needed, but input from the local fishing population, Nova Scotia Department of Health and Nova Scotia Department of Fisheries and Aquaculture should be sought prior to finalizing decisions related to the need for a consumption advisory.

Given the current levels of arsenic in sediments within Barry's Run and based on the assumptions related to current usage and exposure, risks are considered low, as the predicted exceedances are marginal using relatively high exposure scenarios which are likely conservative assumptions. Risk management is currently being implemented through public health warning signage, which instructs people to avoid disturbing the sediments, swimming, or

consuming fish, until further notice. It is recommended that input be obtained on the exposure assumptions, so that the assessment can be refined to reflect intended use, for the purposes of finalizing risk management needs. Based on the results of this assessment, there is no need for additional risk management at this time, and the existing risk management approach (signage) should remain in place, in order to reduce the potential for sediment disturbance and mobilization downstream while a final closure plan for Montague Mines is being completed. In addition, the final closure project currently underway for the Montague Mines site is expected to further reduce concentrations of arsenic (and mercury) in surface waters, and suspended sediment deposition in the study area. Additional study and design are currently underway on this closure plan.

The fen is likely acting as a sink for arsenic impacted sediments from upstream areas. Future land development involving release of storm waters to this area, or disturbance of sediments by public land users (through ATV usage in upgradient stream areas or dirt biking on exposed tailings at the Montague Mines site), has the potential to mobilize sediments in these areas and transport them further downstream into Lake Charles, if not properly managed.

HUMAN HEALTH RISK ASSESSMENT OF SEDIMENT, SURFACE WATER AND FISH FROM BARRY'S RUN, HALIFAX REGIONAL MUNICIPALITY

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1.0 INTRODUCTION

In spring of 2019, Dillon Consulting Limited (Dillon) was retained by the Halifax Regional Municipality (HRM) to conduct a Phase I/II Environmental Site Assessment (ESA) along Mitchell's Brook and Barry's Run, for property which is owned by HRM. This watercourse is located at Port Wallace in Dartmouth, and the site and adjacent lands are being considered for future residential development. According to Nova Scotia Property Online (accessed May 2019), the subject property is comprised of one land parcel zoned as resource (PID No. 41376898) and one land parcel without zoning (PID No. 41301789). The purpose of the ESA was to confirm whether contaminants were present in these two land parcels, and if sediments and surface waters have been impacted as a result of historic mining activities upgradient from the site, or other sources/activities.

The ESA included sediment and surface water sampling within the boundaries of the HRM property and determined that elevated concentrations of metals were present in sediments within the main channel of the brook and the run. Most notably, arsenic, which is associated with the historic Montague Gold Mine site, was found to be elevated in all sediment samples, relative to the Nova Scotia Tier 1 environmental quality standards (NS EQS) for protection of ecological health. Since no sediment guidelines exist for the protection of human health, the sediment data was compared to soil quality guidelines established for protection of human health. This comparison identified exceedances in all samples for arsenic (Dillon, 2019). Mercury, which is also associated with historic mine activities, was found to be elevated relative to ecological sediment quality guidelines in all samples but was only elevated in a single sample when compared to soil quality guidelines (Dillon, 2019). This suggests that human health risks related to mercury in sediments are low; however, mercury has the potential to biomagnify in fish tissues, even if sediment levels are low. Hence, mercury could pose a concern for human health due to exposure pathways such as fish consumption, even if sediment concentrations are low. No comparisons of surface water quality data to human health standards was conducted, as the waters within Mitchell's Brook and Barry's Run are not a potable water source. With respect to ecological health, comparison of surface water data to guidelines protective of freshwater aquatic life indicated that several samples exceeded the guideline for aluminium (total and dissolved) and arsenic (total). All other parameters met NS EQS for protection of aquatic life. Several metals exceeded sediment quality guidelines protective of aquatic life, most notably, arsenic and mercury.

Dillon (2019) indicated that current and/or future site users could be involved in the following activities:

- Children playing in the bog/fen in Barry's Run;
- Children playing in the shallow portion of Mitchell's Brook/Barry's Run; and,
- Fishing in both Barry's Run and Mitchell's Brook.

The assessment indicated that until further information was available related to potential risks to human and ecological receptors, the degree of uncontrolled recreational use and fishing should be carefully evaluated. No data were available with respect to fish tissue concentrations. HRM made an announcement in August, 2019 for a Barry's Run Risk Advisory (https://www.halifax.ca/about-halifax/energy-environment/lakes-rivers/barrys-run-risk-advisory) to notify site users that high levels of arsenic had been found in the sediments, and that further studies were underway to better understand this issue and determine next steps. Residents

were warned to avoid disturbing the sediments or eating fish until further notice. The HRM website provides the ESA report, advisory signage wording, and frequently asked questions, as well as a contact number. On the day of the announcement, signs were posted along the Barry's Run area to ensure site users were aware of the advisory.

Nova Scotia Lands Inc. (NS Lands) is in the process of developing a mine closure plan related to the historic Montague Mines. The Study Team awarded the conceptual mine closure contract includes Intrinsik Corp., Wood, EcoMetrix Limited, and Klohn Crippen Berger. A conceptual closure plan for Crown land areas associated with the Montague Mines site was developed in 2019 (Intrinsik et al, 2019), and is currently being refined through additional assessment and study. As part of the conceptual closure project, the Study team was directed by NS Lands to conduct a Human Health Risk Assessment (HHRA) of the HRM lands within Barry's Run and Mitchell's Brook areas potentially affected by historic releases from the Montague Mines site, or other lands or sources upgradient of the HRM property. The objective of this HHRA is to provide further assessment of the issues, focusing on the questions related to potential human health risks associated with current and future use of the Barry's Run and Mitchell's Brook areas. As part of this study, additional sampling was conducted by Dillon Consultants, under contract to NS Lands, to provide supplementary information for the HHRA. This field work was conducted in September through to December 2019, and provided additional information on the following:

- Fish tissue concentrations of arsenic and mercury from fish captured in Barry's Run;
- Additional sediment chemistry assessment of the fen, and sediments in Mitchell's Brook and Barry's Run, focusing mostly on arsenic and mercury;
- Bioaccessibility testing of arsenic in sediments and fish tissues to determine how available arsenic is in these media;
- Speciation analysis of arsenic in fish tissue to determine what forms of arsenic are present in fish tissues; and,
- Surface water sampling at the top of Mitchell's Brook (eastern edge of site) as well as at the bottom of Barry's Run (western most end of Barry's Run) at three (3) separate sampling intervals to gather additional data on arsenic concentrations in surface water, Total Suspended particulate matter in water, and to enable a calculation of sediment flux through this area.

This report provides a summary of the two field programs (spring 2019 as presented in Dillon 2019, and fall 2019, which can be found in Appendix A of this report), as well as the methodology used to conduct the HHRA and the results of the HHRA for the lands owned by HRM in the Barry's Run and Mitchell's Brook areas (the Site).

2.0 SITE CHARACTERIZATION AND FIELD INVESTIGATIONS

The location of Barry's Run, relative to the historic Montague Mines, is provided in Figure 2-1. The area is within the City of Dartmouth, Nova Scotia. Considerable environmental research on this site has been conducted, largely focused on arsenic (e.g., Parsons et al, 2012a and b; DeSisto (2014); DeSisto et al, 2017). The main tailings area of the Historic Montague mines is partially located in Mitchell's Brook, which flows downstream into Barry's Run. Barry's Run subsequently exits into Lake Charles, the shoreline of which contains residential homes, with recreational water usage.

Figure 2-1 Location of Barry's Run and Mitchell's Brook

2.1 Phase I/II Environmental Site Assessment (Dillon, 2019)

A detailed description of the Barry's Run site is provided in Dillon (2019), with the Phase I ESA outcomes being presented in Section 3, and the Phase II ESA methodology and outcomes being presented in Section 4 of that report. The site is vacant, and includes undeveloped forested land, with Mitchell's Brook and Barry's Run flowing through the centre of the property. There is a former flow control structure at the downstream end of Barry's Run, near the discharge point to Lake Charles. The channel may have been dammed historically by this structure. There are a number of paths through the forested part of the site, as well as the wetland, and there is evidence of all-terrain vehicle usage in the area, as well as hiking. The area surrounding Barry's Run and the Mitchell's Brook area is a bog/fen complex. Figure 2-2 provides a closer view of the Study Area, which includes Barry's Run, with the fen clearly visible, and Mitchell's Brook, upgradient of Barry's Run.

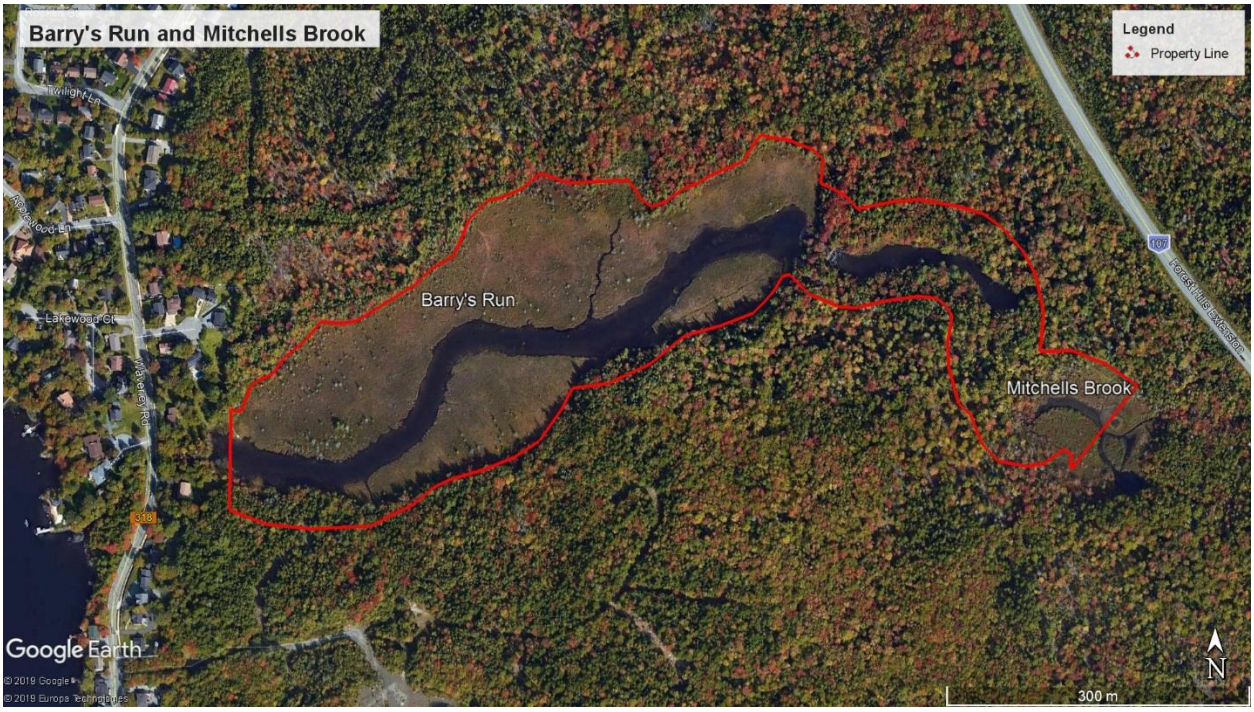

Figure 2-2 Study Area of Barry's Run and Mitchell's Brook, with Fen Area Visible

Since the Intrinsik study team was already working on the conceptual closure plan for the Montague Mines site prior to the commencement of the ESA, Dillon sought input from the Intrinsik team prior to commencing sampling of the Barry's Run study area. Sampling of the Barry's Run area was conducted in April 2019, and included the following:

- Thirteen sediment cores along Barry's Run were collected to gather data on sediment and pore water chemistry (5 samples only) in the aquatic part of the study area;
- Fourteen manual boreholes were taken from the fen surrounding the channel of Barry's Run; and,
- Nine surface water samples were taken along Barry's Run and Mitchell's Brook.

Samples were analyzed for metals, sulphide and sulphur species, benzene, toluene, ethylbenzene, and xylene (BTEX), cyanide, and petroleum hydrocarbons, and general water chemistry. Particle size analysis was also conducted on sediment samples.

The main results of the sampling indicated the following:

- Sediments:
  - Comparisons of metals concentrations to NS Tier 1 EQS for residential soil (non-potable groundwater usage and coarse-grained soil) indicated that arsenic, aluminum, antimony, cobalt, iron, mercury, vanadium exceeded Tier 1 standards in either all (arsenic) or some samples. Aluminium, iron and vanadium were concluded to be within background ranges and were not considered further. Antimony exceedances were limited to 2 samples, whereas cobalt exceedances occurred in 8 samples. Arsenic concentrations had the most pronounced exceedances over NS Tier 1 EQS;

    - Comparisons of metals concentrations to NS Tier 1 EQS for sediment quality protective of aquatic life indicated that arsenic, iron, lead mercury, manganese, nickel, zinc and selenium were present at concentrations exceeding the standards;
    - BTEX and petroleum hydrocarbon concentrations were below NS Tier 1 EQS for soil and sediment in the samples submitted for analysis;
    - Cyanide was either not detected or detected at concentrations below NS Tier 1 EQS in sediments; and,
    - Pore water analysis indicated a number of metals exceeded either NS Tier 1 EQS for freshwater aquatic life or US EPA dissolved water quality guidelines set for protection of aquatic life (arsenic, aluminum, manganese, cobalt, copper, iron, lead and mercury). Pore water specific guidelines are not available. The amount of metals in pore water were considered to be low, relative to the sediment concentrations, and suggest a stable phase of leaching.
- Surface waters:
    - Comparisons of metal concentrations to NS Tier 1 EQS for freshwater aquatic life indicated that aluminium and arsenic exceeded these standards;
    - Comparisons of dissolved data were also made to US EPA dissolved freshwater aquatic life criteria, since dissolved criteria are generally not available in Canada. Arsenic and mercury in surface water were less than the dissolved criteria;
    - Cyanide was non-detect in 2 surface water samples; and,
    - BTEX and petroleum hydrocarbons were below the relevant NS Tier 1 EQS protection of aquatic life.

The sediment arsenic and mercury data are presented in Figure 2-3, with surface water and pore water data for arsenic and mercury provided in Figure 2-4 (Dillon, 2019).

As part of the Dillon (2019) study, Dr. Ian Spooner of Acadia University conducted a study to investigate the historic deposition of arsenic in sediments within Barry's Run, and in Lake Charles. This study indicated that sediment history dating back 200 years can be assessed in the top 300 mm layer of sediments sampled from Lake Charles, which is downgradient from Barry's Run. The arsenic concentrations in shallower profiles of Lake Charles follow an expected trend in which a distinctive depositional period occurred in the 1900s, and then gradually returned to pre-1900 levels over the intervening years. Barry's Run cores taken by Dr. Spooner do not show the same degree of recovery in more recent years of sediment deposition. Dr. Spooners' work suggests that the sediments in Barry's Run were recovering and showed reduced concentrations over the past 20- to 30-year time interval, but the more recently deposited sediments suggest continued contributions from upgradient sources. The reasons behind this are unknown but could be related to a number of factors, such as upstream development, off-road vehicle use on the main tailings site or downstream of that site in Mitchell's Brook, and/or increased erosion due to storm events, etc.

The Dillon (2019) report recommends further study of potential human health and ecological risks related to elevated levels of metals in sediment and surface waters.

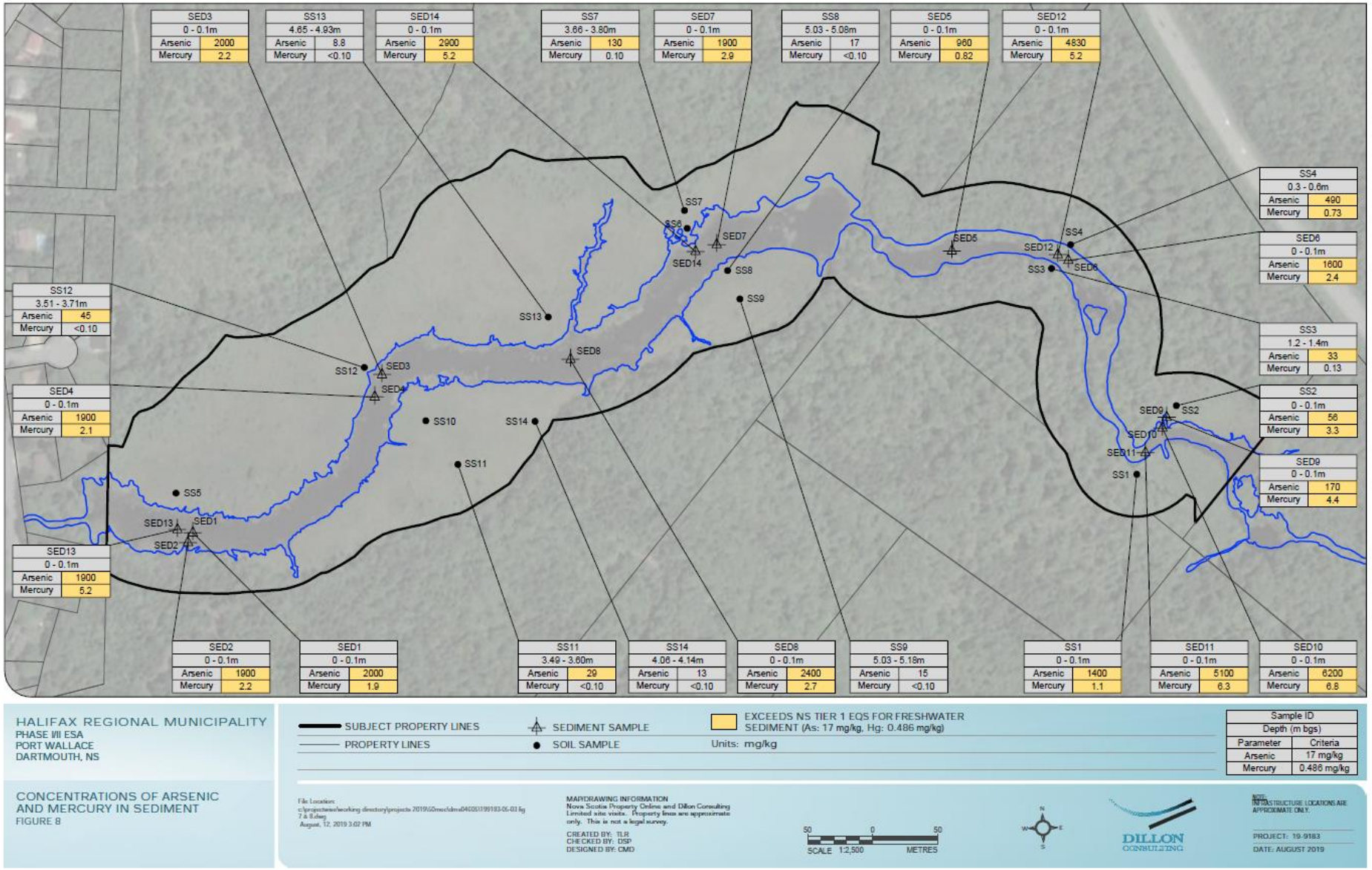

Figure 2-3 Concentration of Arsenic and Mercury in Sediment

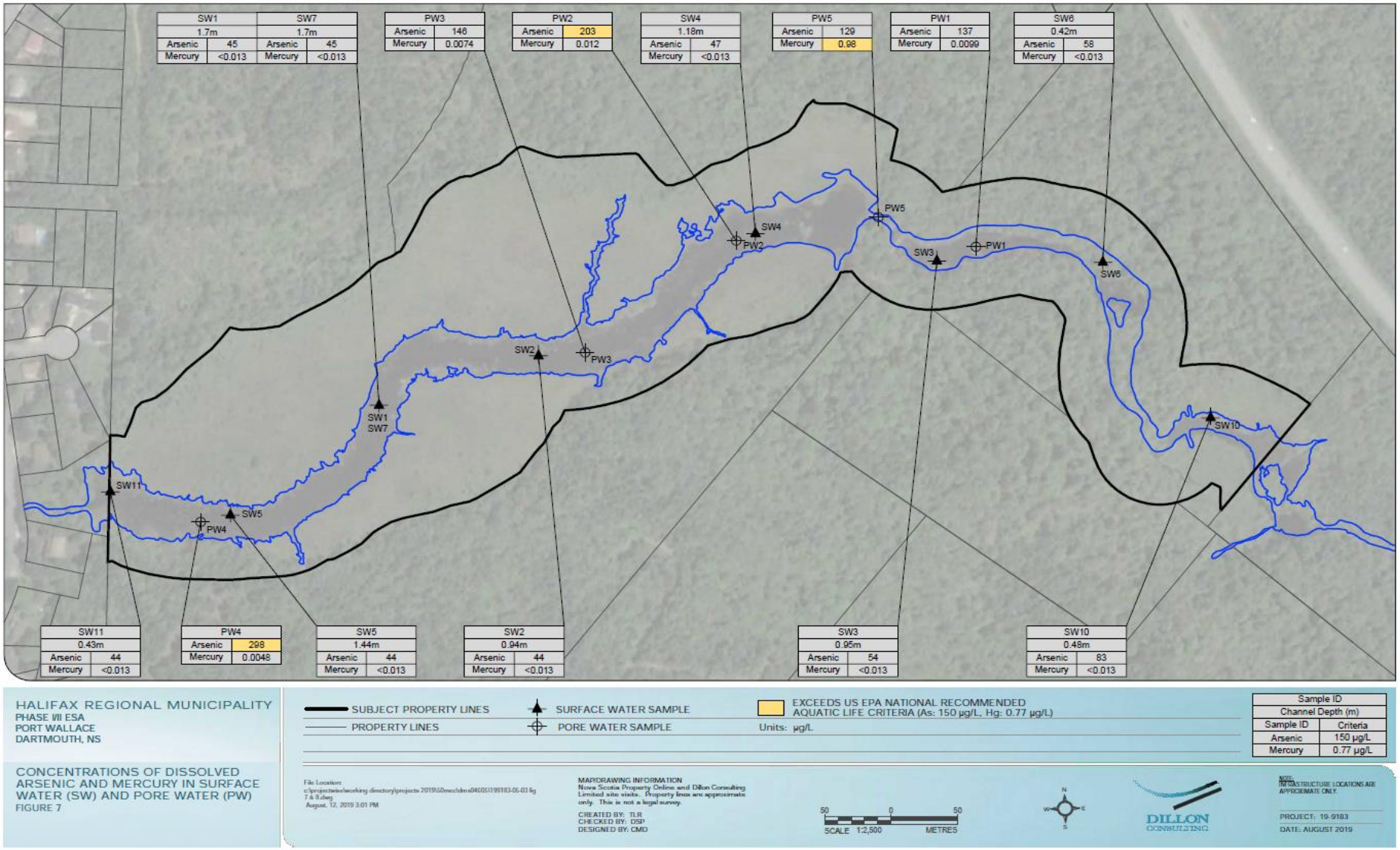

Figure 2-4 Concentration of Dissolved Arsenic and Mercury in Surface Water and Pore Water

2.2 Summary of Fall 2019 Field Program (Appendix A)

Dillon (2020 – see Appendix A), completed additional field work in the fall of 2019 to support the data needs of the HHRA, and the field program included advice from the Intrinsik team prior to implementation. This sampling included the following:

- Fish tissue concentrations of arsenic and mercury from fish captured in Barry's Run;
- Additional sediment chemistry assessment of the fen, and sediments in Mitchell's Brook and Barry's Run, focusing mostly on arsenic and mercury;
- *In vitro* bioaccessibility testing of arsenic in sediments and fish tissues to determine how available arsenic is in these media;
- Speciation analysis of arsenic in fish tissue to determine what form of arsenic is present in fish tissues, since toxicity of arsenic varies with the form present; and,
- Surface water sampling at the top of Mitchell's Brook (eastern edge of site) as well as at the bottom of Barry's Run (western most end of Barry's Run) at three (3) separate sampling intervals to gather additional data on arsenic concentrations in surface water, Total Suspended Solids (TSS) in water, and to enable a calculation of sediment flux through this area.

The details of the sampling methods and locations, field observations, field photographs and raw data are presented in Appendix A, with screening relative to NS Tier 1 EQS provided in Appendix B and discussed in Section 4.1. Briefly, six (6) sediment samples were taken in Barry's Run and Mitchell's Brook, in areas which could be used for recreational purposes. Samples were analyzed for arsenic and mercury at Bureau Veritas (Bedford, NS), and five (5) of these samples were submitted to Royal Military College for arsenic bioaccessibility testing. In addition, 16 samples were taken on the fen area which boarders Barry's Run, and submitted to Bureau Veritas for ICP metals analysis, including mercury. Surface water samples were collected at the eastern edge of the site (Mitchell's Brook) as well as at the bottom of Barry's Run (western edge of the site), on three (3) separate intervals (September 25; November 13 and December 3, 2019). Rain events occurred on the day before the November 13th and December 3rd sampling events. Samples were submitted to Bureau Veritas for general chemistry, total and dissolved metals including mercury, dissolved organic carbon (DOC), and Total Suspended Solids (TSS).

The results of the sediment chemistry data for mercury and arsenic are provided in Figure 2-5, whereas the surface water sampling results are provided in Figure 2-6. All data are provided in Appendix A.

Bioavailability is the extent and rate to which a chemical can be absorbed into the systemic circulation of an organism, and potentially produce an adverse effect (Hrudey et al., 1996; Kelly et al., 2002). A particularly important determinant of oral bioavailability is the bioaccessibility of the contaminant of potential concern (COPC). Bioaccessibility refers to the fraction of the COPC which can be biologically extracted from the exposure media (i.e., soils or sediments) and solubilized within the gastrointestinal tract so that it is available for absorption through the intestinal wall into the blood stream (Kelly et al., 2002). In other words, bioaccessibility sets an upper limit on bioavailability, and the two processes are positively correlated. This is especially relevant when evaluating the degree to which substances bound to soil can be absorbed into the body. Since the early 1990s, an extensive amount of literature and regulatory guidance has been published and developed in relation to soil bioaccessibility of metals and metalloids. These studies and documents provide a wealth of information on the various test methods, the

results of soil bioaccessibility testing of a wide range of soils and other soil-like materials such as sediments, mine tailings, slag, etc., the interpretation and application of soil bioaccessibility data, and the various issues, limitations and uncertainties related to soil bioaccessibility of metals. A considerable amount of work has been completed to characterize the bioaccessibility of arsenic within tailings samples at Montague Mines as well as several other historic tailings sites in Nova Scotia (e.g., Royal Roads University, 2007; Laird et al., 2007; ESG, 2009; Walker et al., 2009; Meunier et al., 2010; Meunier et al., 2011a; 2011b; as well as other publications). The percentage of bioaccessible arsenic varied from less than 1% to 49% at the tested historic gold districts, with a median of 7.3%. Specific results for Montague tailings ranged from 1.1% to 25% bioaccessible arsenic.

Arsenic in the study area sediments may originate from a variety of different anthropogenic and natural sources which can result in substantial differences in arsenic bioaccessibility and/or bioavailability. An understanding of the site-specific bioaccessibility of arsenic in the Study area sediments is critical to the assessment of potential risks associated with exposures. A number of sediment samples were submitted to the Environmental Sciences Group (ESG) at the Royal Military College in Kingston, ON, for in vitro bioaccessibility (IVBA) testing for the purposes of determining the site-specific bioavailability of arsenic in sediments. The bioaccessibility testing followed Health Canada guidance (Health Canada, 2017a) for testing of this nature. The arsenic sediment bioaccessibility results are provided in Appendix A and summarized in Section 6.1.

Fish were collected between September 18 to 26, 2019, along the shoreline of Barry's Run and Mitchell's Brook using both angling and fly-fishing techniques. Seven (7) smallmouthed bass and 13 brook trout were collected. Fish tissues were processed, and fillet samples were submitted to Bureau Veritas (Burnaby, BC) for arsenic and mercury analyses. Fish skin was included with the fillet, and some compositing of samples was required. Five of the fish fillet samples were submitted to ESG at the Royal Military College in Kingston, ON, for arsenic bioaccessibility and speciation analysis. These data were used to estimate the amount of bioaccessible arsenic in the gut following ingestion, and the forms of arsenic within that bioaccessible fraction. Arsenic toxicity varies widely depending on the speciation, and relative non-toxic forms of arsenic are known to occur in fish and seafood, and hence the interest in conducting this type of analysis on fish tissues. The ESG report can be found in Appendix A, and the results are summarized in Section 6.1.

The data from both field programs were considered acceptable for use in the HHRA.

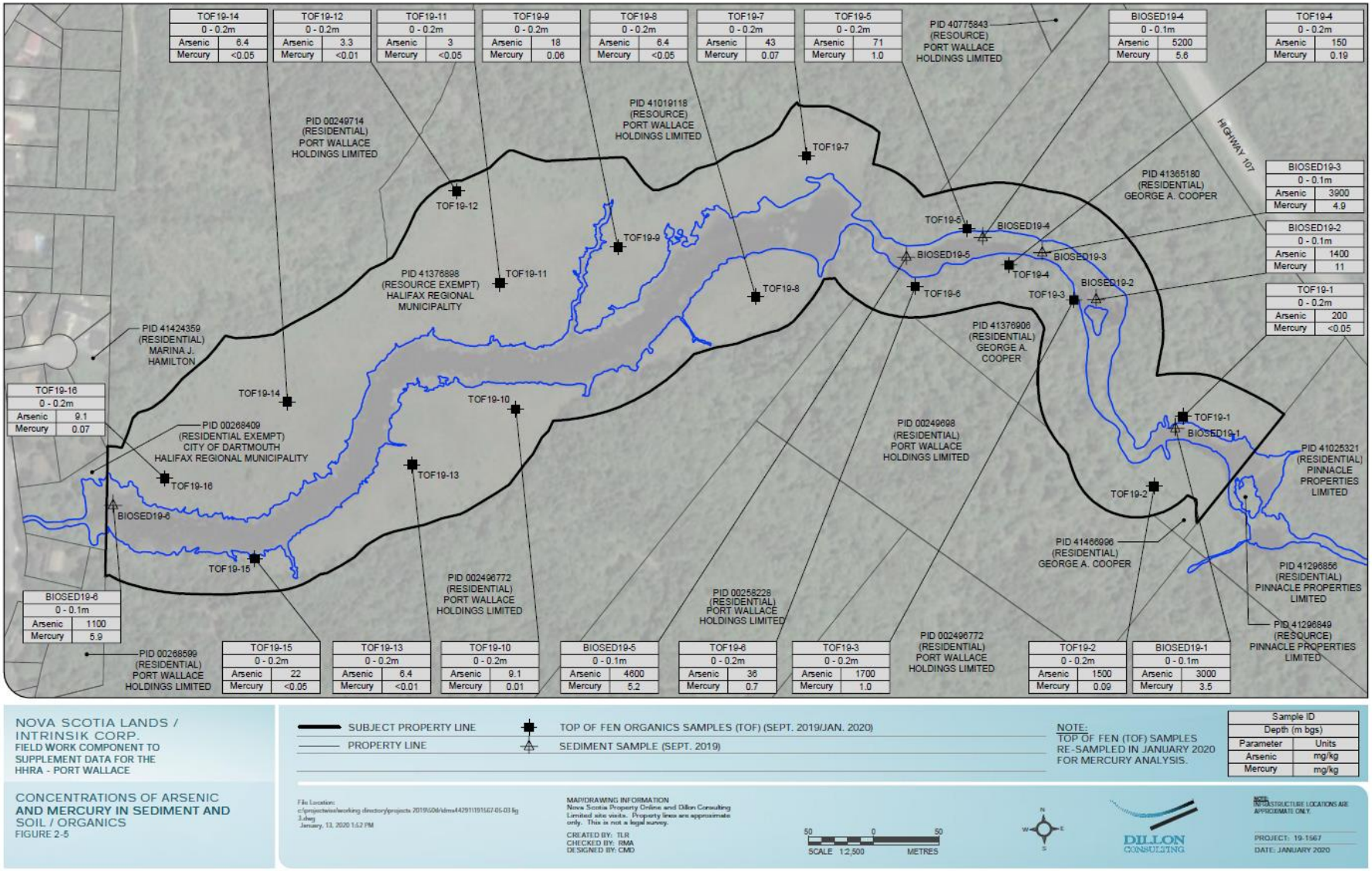

Figure 2-5 Concentration of Arsenic and Mercury in Sediment and Soil/Organics

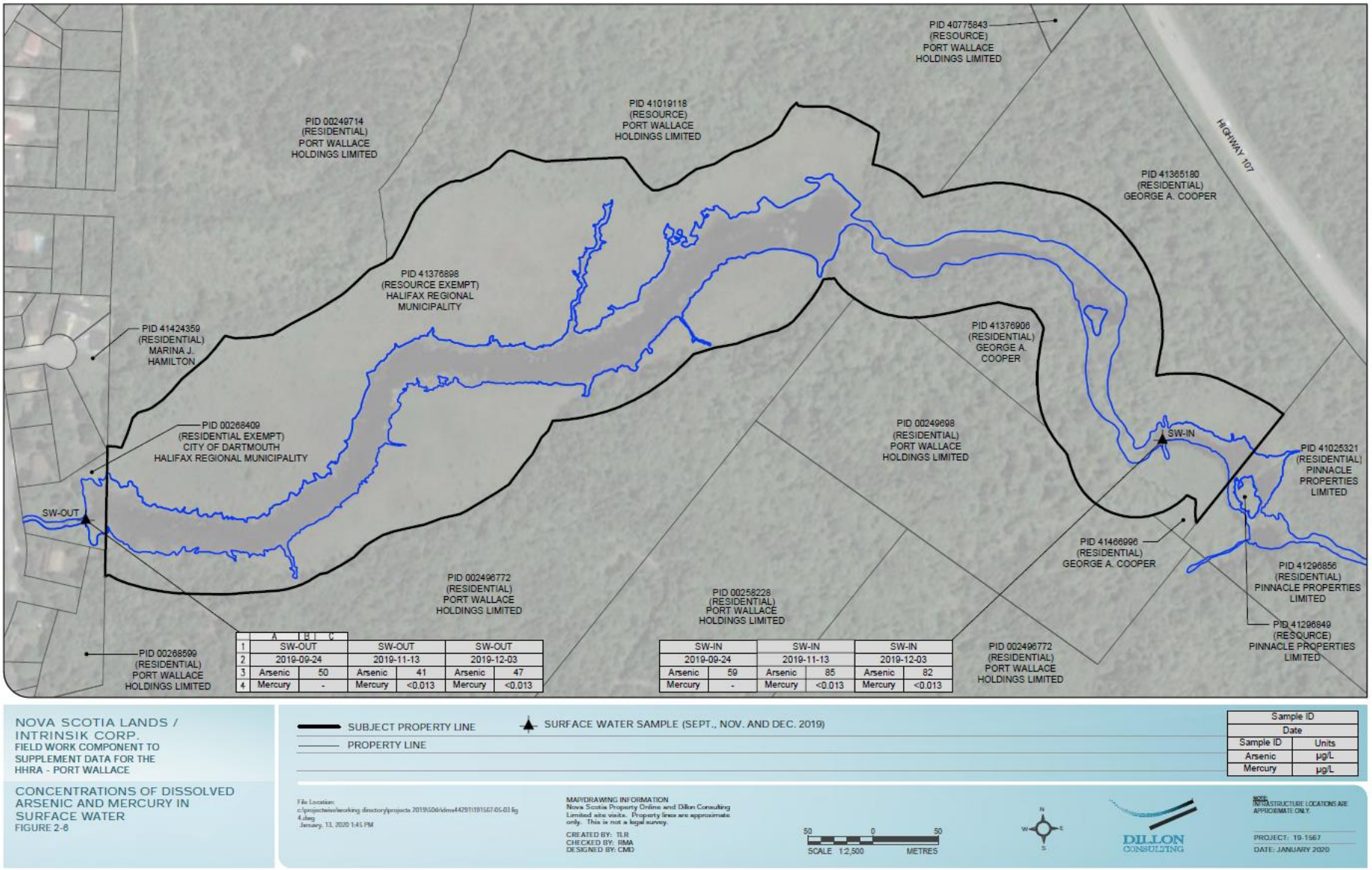

Figure 2-6 Concentration of Arsenic and Mercury in Surface Water

3.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

An HHRA is a scientific study that evaluates the potential for the occurrence of adverse health effects from exposures of people (receptors) to Chemicals of Potential Concern (COPCs) present in surrounding environmental media under existing or predicted exposure conditions. HHRA procedures are based on the fundamental dose-response principle of toxicology. The response of an individual to a chemical exposure increases in proportion to the internal dose. The dose is determined by the degree of exposure, which is proportional to the chemical concentrations in the environment where the receptor resides, works or visits.

The HHRA is based on a conventional risk assessment paradigm developed by such regulatory agencies as Health Canada, the Canadian Council of Ministers of the Environment (CCME) and the United States Environmental Protection Agency (U.S. EPA). This approach is recognized in Canada and worldwide and involves four (4) primary components (Figure 3-1).

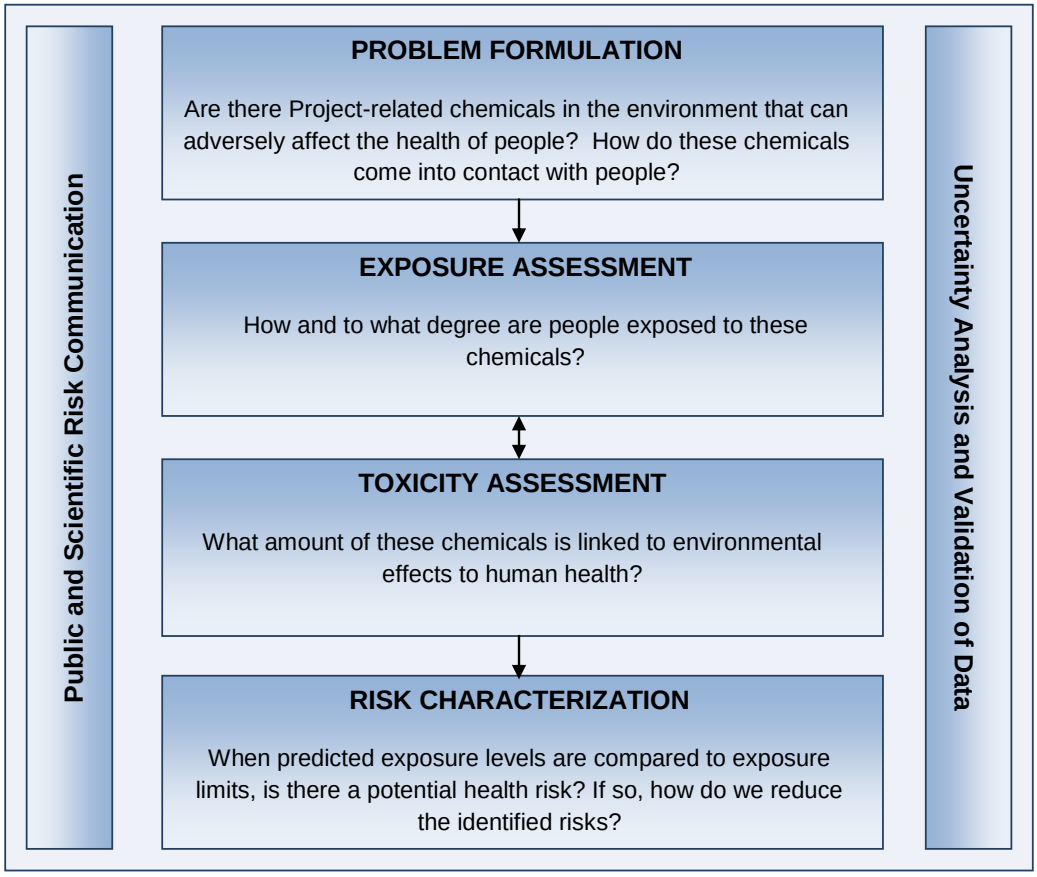

Figure 3-1 Standard Risk Assessment Framework

Since this project involves chemicals (i.e., metals) and exposure pathways (i.e., fish consumption; sediment contact) that are not generally captured in the Atlantic RBCA (Risk Based Corrective Action) model typically used to assess contaminated sites in Nova Scotia, the assessment considered guidance from Health Canada to conduct the HHRA:

- Preliminary Quantitative Risk Assessment Guidance; Health Canada, 2012;
- Detailed Quantitative Risk Assessment Guidance; Health Canada, 2010;
- Supplemental Guidance on Human Health Risk Assessment for Oral Bioavailability of Substances in Soil and Soil-Like Media; Health Canada, 2017a;
- Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathways; Health Canada, 2017b; and,
- Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption; Health Canada, 2007.

The methods for each of the steps in the HHRA are generally described below, with specific details being provided in later sections of the report.

Problem Formulation

The Problem Formulation Phase of the HHRA is an information gathering and interpretation stage that plans and focuses the study on critical areas of concern for the situation being evaluated. The problem formulation defines the nature and scope of the work to be conducted, permits practical boundaries to be placed on the overall scope of work, and ensures that the assessment is directed at the key areas and issues of concern. This step typically involves the following tasks:

- Screening and identification of chemicals of potential concern (COPCs);
- Identification and description of potential human receptors;
- Identification of operable exposure pathways;
- Development of a Conceptual Site Model (CSM).

The outcome of the Problem Formulation Phase forms the basis of the approach to be taken in the HHRA. The Problem Formulation is presented in Section 4.0.

Exposure Assessment

In the Exposure Assessment, the mechanisms by which the receptors are exposed to COPCs are characterized and the magnitude of these exposures are quantified or categorized.

The types of exposure data needed to evaluate risks to the receptors are determined in the exposure assessment and can include the following:

- On-site contaminant concentrations;
- Physical characteristics of the receptors;
- Exposure frequency and duration for each receptor; and,
- Estimation of total doses (*i.e.*, total contaminant intake from all exposure pathways).

The Exposure Assessment is presented in Section 5.0.

Toxicity Assessment

The toxicity assessment involves identifying and understanding potential health outcomes that could result from exposure to each of the COPCs and the conditions under which the outcomes might be observed. The toxicity assessment methodology is based on the fundamental dose-response principle. That is, the response of biological systems to chemical exposures increases in proportion to the concentration of a chemical in critical target tissues where adverse health outcomes may occur.

Two basic and quite different chemical categories are commonly recognized by regulatory agencies depending on a compound's mode of toxic action when estimating toxicological criteria for humans. The threshold approach (or the no-observed-adverse-effect levels [NOAELs]/benchmark dose with extrapolation/uncertainty factor approach) is typically used to evaluate non-carcinogens, and the non-threshold approach (or the mathematical model-unit risk estimation approach), is typically used for carcinogenic compounds.

Threshold Response Chemicals: For most effects, it is thought that there is a dose-response threshold below which no adverse effects would be expected to occur. This relationship is true for all chemicals that do not cause cancer by altering genetic material. Thresholds are generally assumed for non-carcinogenic effects because, for these types of effects, it is generally believed that homeostatic, compensating, and adaptive mechanisms must be overcome before toxicity is manifested.

Non-threshold Response Chemicals: This means that any exposure greater than zero is assumed to have a non-zero probability of causing some type of response or damage. This relationship is typically used for chemicals that can cause cancer by damaging genetic material. Under a "non-threshold" assumption, any exposure has some potential to cause damage, so it is necessary to define an "acceptable" level of risk associated with these types of exposures.

The approach used to identify the values used in the Toxicity Assessment, known as Toxicity Reference Values (TRVs), as well as the selected values, are provided in Section 6.0.

Risk Characterization

Risk characterization for chemicals with a threshold-type dose-response consists of a comparison between the toxicological criteria (*i.e.*, the rate of exposure that would not produce adverse effects) against the total estimated exposure. This comparison is expressed as an Exposure Ratio (ER) for oral and dermal exposures. These ratios are calculated by dividing the predicted exposure by the TRV, as indicated in the following equation:

$$Expsoure\ Ratio = \frac{Estimated\ Exposure\ (\mu g/kg/day)}{TRV\ (\mu g/kg/day)}$$

For the current assessment, it is assumed that there would be limited opportunity for receptors to be exposed to COPCs in surface water and sediments *via* inhalation. None of the COPCs are sufficiently volatile to warrant assessment *via* the inhalation of vapours, and impacted sediments are not anticipated to be exposed for long enough periods to allow them to become sufficiently dry to become available for inhalation of airborne particulates. Therefore, the current assessment only evaluated exposures *via* oral and dermal pathways.

If the total exposure to a chemical is equal to or less than the exposure limit, then the ER would be 1.0 or less, and no adverse health effects would be expected. For human exposures to non-carcinogens, the TRV represents the level of total exposure derived from multi-source and multimedia exposures, which would not result in adverse health effects, regardless of the source or route of exposure.

In cases where the total exposure has been estimated from both background and site sources, it would be valid to compare the estimated exposure to the entire exposure limit, and an acceptable ER level would be 1.0. If the HHRA addresses risks associated with a single source and a limited number of environmental pathways, the selection of an ER of 1.0 as a benchmark to indicate that exposure does not exceed the TRV is not valid. In an attempt to address this problem, Health Canada (2012) has apportioned 20% of the total exposure to any one environmental medium. ER values for non-carcinogens that are less than 0.20 are considered to represent a situation in which media-related exposures account for less than 20% of the TRV, and no adverse health effects are expected to be associated with the estimated level of exposure. Risks of this magnitude are considered negligible, which means exposures are estimated to be so low that they are considered to have an insignificant impact on human health. For some COPCs, such as methyl mercury, since exposures are predominantly from a single pathway, apportionment is not required and an ER of 1.0 is considered acceptable.

Risk characterization for chemicals with a non-threshold-type dose response (*i.e.*, carcinogens) consists of calculating an Incremental Lifetime Cancer Risk (ILCR). ILCR levels represent the predicted incremental risk of cancer over a lifetime to an individual member of a population of a given size and are expressed as a risk level. For example, if the ILCR is 0.1 (representing 1 person per 10), the predicted incremental risk of any individual developing cancer would be higher than if the ILCR is 0.001 (1 per 1,000). ILCRs are evaluated by comparing predicted ILCR levels to a benchmark risk level considered to be acceptable by regulatory agencies. For example, negligible or *de minimis* cancer risk levels are generally considered to range from $1x10^{-4}$ to $1x10^{-6}$. Health Canada (2012) and the Province of Nova Scotia consider $1x10^{-5}$ (one in one hundred thousand) an acceptable risk level. The following equation provides the method whereby the ILCR estimates are calculated:

$$ILCR = Estimated\ Exposure\ ((\mu g/kg)/day) x q_1^*\ (\mu g/kg/day)$$

ERs and ILCRs are effective tools for expressing potential adverse health effects from exposures to COPCs in that they help simplify the presentation of the HHRA results so that the reader may have a clear understanding of the significance of these results and an appreciation of their significance.

Details of the Risk Characterization are provided in Section 7.0.

By convention, the uncertainty associated with the prediction of potential health risks is accommodated, in part, through the use of reasonable worst-case assumptions, which embrace a sizable degree of conservatism. Using this approach, health risks identified in the assessment are unlikely to be understated but may be considerably overstated. Thus, it is important that the uncertainties and assumptions underlying the potential health risks be known and understood. The assessment uncertainties and the assumptions used in the HHRA are documented in the risk characterization (Section 7.0).

4.0 PROBLEM FORMULATION

The key tasks requiring evaluation within the problem formulation step included the following:

- Identification of the COPCs to be assessed within the HHRA based on environmental sampling data;
- Identification of receptors of concern, which include those persons with the greatest probability of exposure to COPCs from the Site and those with the greatest sensitivity to these chemicals; and,
- Identification of exposure pathways and scenarios considering the various factors that can influence how receptors come into contact with COPCs present in the environment, including: chemical-specific parameters, such as solubility and volatility; characteristics of the Site, such as physical geography, geology, and hydrogeology; as well as the physiology and behavioral patterns of receptors.

Each of these tasks are presented in Figure 4-1 and are used to develop a Conceptual Model (Figure 4-2).

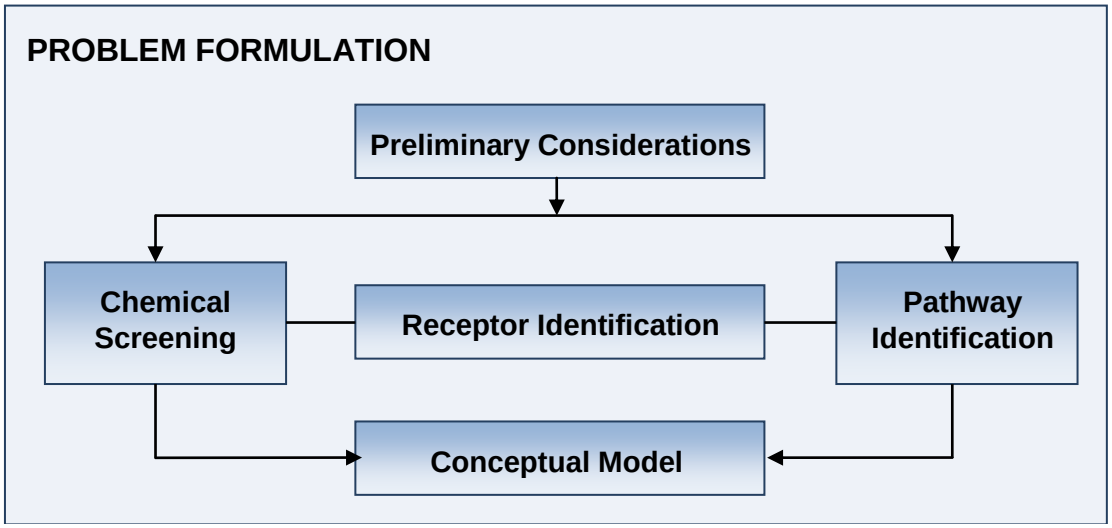

Figure 4-1 Components of the Problem Formulation Stage

4.1 Identification of Contaminants of Potential Concern (COPCs) for the HHRA

As discussed in Section 1, the predominant land use for this area is occasional recreational activities, such as swimming (which would involve sediment and surface water contact and incidental ingestion), as well as fishing. To identify which substances merited further assessment in the HHRA, a screening procedure was undertaken as follows:

- Sediment Data:
  - Comparison of measured sediment concentrations to NS Tier 1 EQS for soil (residential, non-potable land use), since sediment guidelines for protection of human health are not currently available. This approach is in keeping with Health Canada (2017b) guidance.

- Where substances exceeded NS Tier 1 EQS for residential soil, comparisons to background soil data for Nova Scotia (based on White et al, 2014), since metals are naturally occurring elements. Comparisons to background data for naturally occurring substances is in keeping with NSE (2014) guidance and assists in focusing the assessment on substances that are elevated over background and associated with historic/site activities.
- COPCs selection was based on consideration of both frequency and degree of exceedance over NS Tier 1 EQS and background, as well as inherent toxicity.

- Surface Water:
  - Comparison of measured surface water concentrations to NS Tier 1 EQS for potable groundwater, since surface water quality guidelines for protection of incidental ingestion of surface water during swimming activities are not available. This is a highly conservative approach, since potable groundwater standards are based on chronic daily exposure.

Appendix B presents the details of the COPC screening, including the site data for both sediments and surface waters from Barry's Run and Mitchell's Brook, and the outcome of the comparisons to the various guidelines and standards outlined above.

Based on the screening conducted, arsenic and mercury were carried forward into the HHRA as COPCs in sediment, whereas only arsenic was identified as meriting further assessment in surface waters.

No formal screening for fish tissues and fish consumption was conducted. The historic mining activities upgradient of the site have been associated with arsenic and mercury releases, and previously conducted fish surveys in lakes associated with historic mining activities by the Province (Leblanc and Halfyard, 2010) have focused on mercury and arsenic tissue levels in fish. Pore water data presented in Dillon (2019) suggests low availability of most metals in sediment pore water, which suggests limited ability of most metals to accumulate in benthos and food chains. While it is possible that some other metals could accumulate in local fish tissues, the degree of exceedance of arsenic in both sediments and surface waters (relative to available guidelines), and the widely known ability of mercury to bio-magnify in aquatic food chains, supports the selection of these two elements as COPCs in fish tissue. Mercury in fish tissues were assessed relative to the Health Canada (2007) limit of 0.5 mg/kg. A limit of 3.5 mg/kg arsenic in fish protein is available (https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/contaminants-adulterating-substances-foods.html) and while all fish tissue from the Study area were less than this value, it does not account for speciation of arsenic in fish tissues, and hence arsenic was considered in the assessment.

Therefore, both arsenic and mercury were selected as COPCs, and were assessed for all exposure pathways, including fish consumption.

4.2 Identification of Potential Human Receptors

A human receptor is a hypothetical person (*e.g.*, infant, toddler, child, adolescent, adult) who may reside or work in the area being investigated and is, or could potentially be, exposed to the COPCs. General physical and behavioural characteristics specific to the receptor type (*e.g.*, body weight, breathing rate, soil ingestion rate, *etc*.) are often used to determine the amount of

chemical exposure received by each receptor. Due to differences in these characteristics between receptors of different age classes, predicted exposure will vary on a receptor-by-receptor basis. Consequently, the potential risks associated with exposure to COPCs may differ depending on the receptor chosen for evaluation.

It is critical that the assessment is sufficiently comprehensive to ensure that overall risks have been adequately addressed. However, it is not feasible to consider all humans that may potentially be exposed to chemicals from the Site. As a result, it is important to select those human receptors that may be subject to the greatest potential risk. These will be people with the greatest probability of exposure to the chemicals detected on-site and those that have the greatest sensitivity to these chemicals.

For chemicals considered to be carcinogenic, it is common to assess exposure over a lifetime, as development of cancer is a long-term process that may take many years to manifest. For this reason, a special type of receptor called a "lifetime" or "composite" receptor is often selected for evaluation of potential carcinogenic risks. This receptor is a "composite" of all relevant life stages for which exposure will be evaluated. However, given that the adult life-stage represents the majority of the total lifespan (typically 56 years of the assumed 76-year total life expectancy), the characteristics of the lifetime composite receptor are generally consistent with those of the adult. Therefore, the assessment of carcinogenic risks was based on the adult.

Health risks associated with exposure to carcinogenic compounds are usually expressed as an estimate of excess or incremental lifetime cancer risk (ILCR) for a population resulting from exposure to a particular source. Thus, risks associated with carcinogenic compounds are predicted using the average daily dose over a human receptor's entire life span.

For non-carcinogens, the toddler is typically the most sensitive receptor for estimating exposure and risk as a result of an elevated soil ingestion rate during this life stage. The toddler (7 months to 4 years) and the child (5 to 11 years) life stages were included in the current assessment to assess risks associated with non-carcinogenic endpoints.

In order to evaluate potential exposures, it is necessary to characterize the physiological and behavioural characteristics of each receptor group. Several published resources were considered in the selection of these parameters, including:

- Health Canada. 2017b. Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathway. Federal Contaminated Site Risk Assessment in Canada. March 2017b.
- Health Canada. 2012. Federal Contaminated Sites Risk Assessment in Canada. PART I: Guidance on Human Health Risk Preliminary Quantitative Risk Assessment (PQRA), Version 2.0.
- Richardson. 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment. O'Connor Associates Environmental Inc.
- US EPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540//R/99/005. July 2004.

These sources have been used in numerous HHRAs that have been critically reviewed and accepted by regulatory agencies across Canada and the United States. Both the Compendium

of Canadian Human Exposure Factors for Risk Assessment (Richardson, 1997) and Health Canada (2012) rely on data from published and reliable Canadian sources, such as Health Canada, Statistics Canada, and the Canadian Fitness and Lifestyles Research Institute. Where insufficient data are available in these sources to appropriately characterize relevant activity patterns and/or behavioural/physiological characteristics of a certain receptor group, other appropriate sources were used. For fish consumption rates, there is a province-wide fish consumption advisory based on mercury concentrations in fish tissues (Province of Nova Scotia, 2019). This advisory cites a daily serving size of 75 grams of fish, based on Canada's Food Guide. This serving size was used in the exposure calculations for fish consumption, along with the advisory guidance related to number of servings per week or month for a given fish type/size and receptor age class. In addition to the published resources listed above, site-specific information gathered as part of past and current programs were used to characterize receptor parameters.

4.3 Identification of Exposure Scenarios and Operable Exposure Pathways

The means by which a person comes into contact with a chemical in an environmental medium are referred to as exposure pathways. The means by which a chemical enters the body from the environmental medium are referred to as exposure routes. There are three (3) major exposure routes through which chemicals can enter the body: inhalation; ingestion; and dermal absorption (*i.e.*, uptake through the skin). Exposure pathways may require direct contact between receptors and the environmental media of concern (*e.g.*, incidental ingestion of sediment, dermal contact, etc.), or may be indirect requiring the movement of the chemical from one environmental medium to another.

Barry's Run and Mitchell's Brook are located adjacent to a residential neighbourhood. Therefore, there is the potential for residents from the adjacent neighbourhoods to be exposed to impacted sediment and surface water should they venture into Barry's Run or Mitchell's Brook areas for recreational purposes. In addition, areas on the fen, which is a wide grassy area adjacent to the brook and run, could be accessed by locals for either walking/hiking or fishing. The fen is more soil-like, then sediment (see Photo 3 in Appendix A).

The primary exposure pathways of concern for receptors using the area include:

- Incidental ingestion of shoreline or bedded sediment from watercourses or soils from fen;
- Incidental ingestion of suspended sediment in surface water;
- Incidental ingestion of surface water while swimming;
- Dermal absorption from sediments or soils adhering to skin;
- Dermal absorption from surface water; and,
- Ingestion of fish harvested from Barry's Run and/or Mitchell's Brook.

Four (4) exposure scenarios were selected to address potential risks to receptors utilizing the area for recreational purposes. As a conservative approach, a cancer amortization was not applied in the assessment of carcinogenic risks in any of the exposure scenarios. This essentially assumes that receptors will be exposed to COPCs in sediment, surface water, and fish from the area over an entire lifetime. Although this is considered to overestimate the duration of exposure, this approach was taken to ensure that the assessment was sufficiently

protective of exposure during early life stages rather than amortizing cancer risks per life stage and applying an age-dependent adjustment factor (ADAF).

a) Recreational High Contact - Low Frequency Scenario

This scenario is considered to be reflective of members of the general public that may occasionally be involved in recreational activities within Barry's Run/Mitchell's Brook. In particular, it is anticipated to be protective of receptors utilizing the upper stretch of Barry's Run (closer to Mitchell's Brook) where access to this area is generally limited. This scenario assumes that receptors will have the opportunity for exposure to COPCs in shoreline/bedded sediments, to COPCs in sediments suspended in surface water, and to COPCs dissolved in surface water. Receptors were assumed to have high rates of contact with sediment, resulting in dermal absorption of COPCs through the adherence of shoreline/bedded sediment to the hands, feet, forearms, and lower legs. Incidental ingestion of shoreline/bedded sediment was assumed to occur *via* hand to mouth activity. While swimming, receptors were assumed to ingest suspended sediment within the water column as well as surface water containing dissolved COPCs. Dermal absorption of dissolved COPCs in water was also assumed to occur across the entire surface area of the body. Consistent with recommendations provided by Health Canada (2012, 2017b), the toddler was selected as the critical receptor for non-carcinogenic threshold substances and an adult was selected as the critical receptor for carcinogenic substances. Receptors were assumed to be involved in recreational activities six (6) times per year. Exposure estimates were not adjusted for less than lifetime exposures; rather, it was assumed that exposure behaviours will occur throughout the entire lifetime of a receptor.

b) Recreational Low Contact - High Frequency Scenario

This scenario is considered to be reflective of members of the general public or residents with homes located along the lower stretch of Barry's Run (western end of Study area) that may be involved in more frequent recreational activities within the water course that generally involve lower contact with sediment. This includes swimming, boating (e.g., kayaking; paddleboarding), and fishing which could result in incidental contact with sediments, primarily suspended within the water column as well as along the shoreline while entering or exiting the water. Receptors were assumed to have lower rates of contact with sediment, resulting in dermal absorption of COPCs through the adherence of shoreline/bedded sediment to the hands and feet, but higher frequency of swimming. Incidental ingestion of shoreline/bedded sediment was assumed to occur *via* hand to mouth activity. While swimming, receptors were assumed to ingest suspended sediment within the water column as well as surface water containing dissolved COPCs. Dermal absorption of dissolved COPCs in water was also assumed to occur across the entire surface area of the body. Due to the nature of these activities, the child was selected as the critical receptor for non-carcinogenic threshold substances over the toddler, and an adult was selected as the critical receptor for carcinogenic substances. Receptors were assumed to be involved in recreational activities two (2) times per week for 13 weeks (July, August, September). Exposure estimates were not adjusted for less than lifetime exposures; rather, it was assumed that exposure behaviours will occur throughout the entire lifetime of a receptor.

c) Fen Scenario

This scenario considers the possibility that members of the general public or residents with homes located along the lower stretch of Barry's Run may spend time on areas of the fen while accessing the watercourse for recreational activities. It is also possible that receptors spend time hiking/walking and biking on parts of the fen. These receptors could have incidental contact with COPCs in the fen material resulting in dermal absorption through the adherence of this material to the hands and feet. Incidental ingestion of fen material was also assumed to occur via hand to mouth activity. Due to the nature of these activities, the child was selected as the critical receptor for non-carcinogenic threshold substances over the toddler, and an adult was selected as the critical receptor for carcinogenic substances. Receptors were assumed to be involved in recreational activities two (2) times per week for 13 weeks (July, August, September. Exposure estimates were not adjusted for less than lifetime exposures; rather, it was assumed that exposure behaviours will occur throughout the entire lifetime of a receptor.

d) Recreational Fishing - Consumption of Local Fish

This scenario is considered to be reflective of people that catch fish for consumption within Barry's Run and/or Mitchell's Brook. it was assumed that fishing is done wearing waders, thereby limiting exposures to COPCs in surface water and sediment while fishing. If this is not the case, and fishing takes place in bare feet or shoes, these exposures would be similar to those addressed within scenarios a) and b) above. Potential exposures in the fen area during fishing are captured in the fen scenario (c) above. The recreational fishing scenario only assesses exposure *via* the consumption of fish caught within the water course. Human receptors were assumed to consume smallmouth bass and brook trout, since these were the only species captured in the fish survey. Based on the consumption advisory related to mercury in fish for Nova Scotia, a serving size of 75 grams was used to represent a typical serving (Province of Nova Scotia, 2019). Additional details on frequency of consumption are provided in Section 5.2.3, based on the consumption advisory.

e) Combined Exposure Scenario

It is possible that exposures could occur through swimming, sediment exposure and fen soil exposure while fishing. Hence, all scenarios were combined in a combined exposure scenario to consider this possibility.

4.4 Conceptual Model

The conceptual model for the site is critical to understanding the sources from which the COPC originate, the pathways through which the COPCs travel and the receptors that are potentially exposed to the COPCs. The objective of the conceptual model is to understand the components that contribute to the potential risks associated with the sources of COPCs, as well as to identify strategies that will mitigate the sources and/or connections between the sources and receptors. A schematic of the conceptual site model is shown in Figure 4-2.

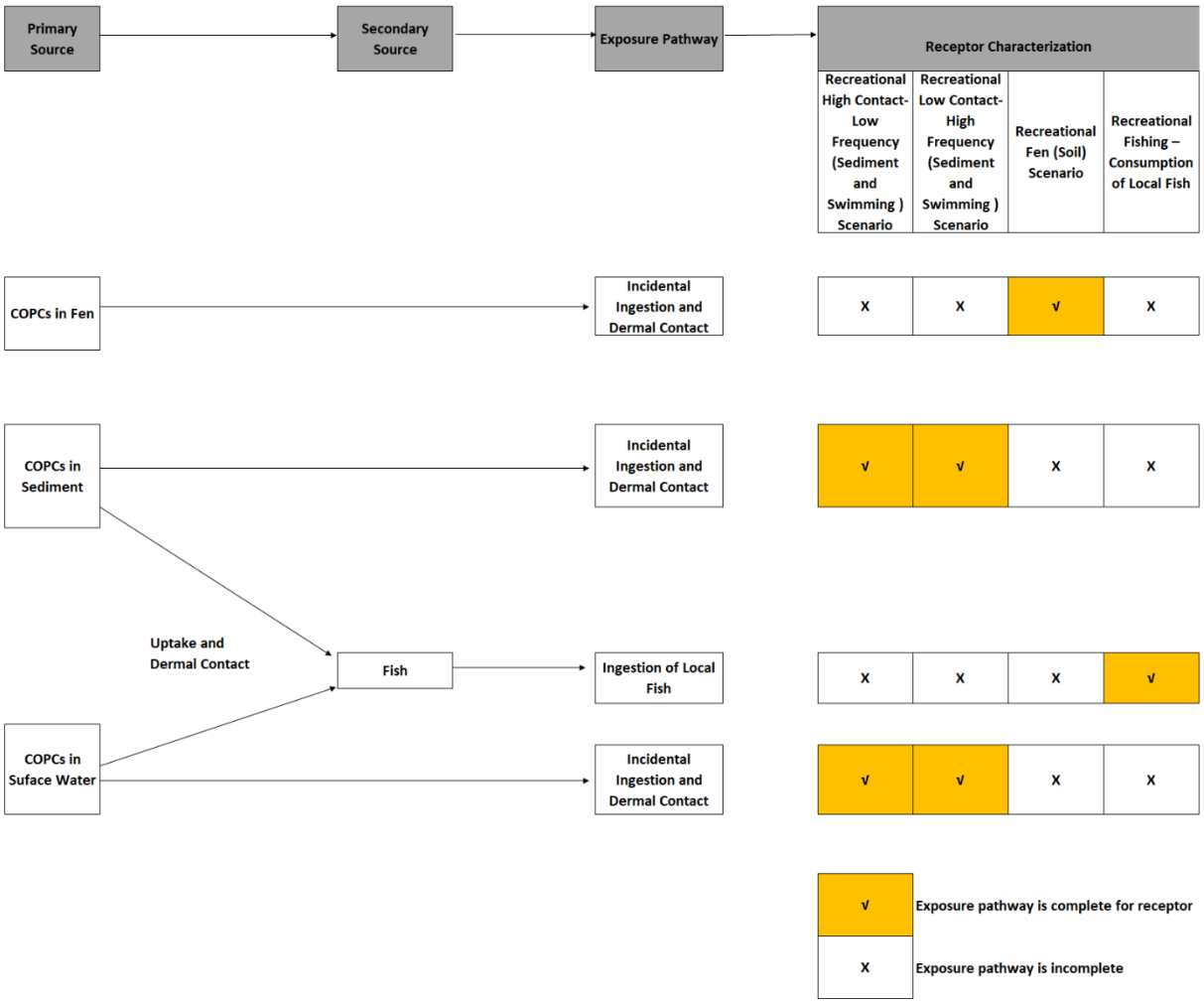

Figure 4-2 Human Health Conceptual Model

5.0 EXPOSURE ASSESSMENT

The exposure assessment evaluates data related to all COPCs, receptors, and exposure pathways identified during the problem formulation phase of the HHRA. The exposure assessment takes into account all potential exposure to COPCs from the different sources or media (*i.e*., sediment and surface water) which receptors could come in contact with as part of their daily activities.

The primary objective of the exposure assessment is to predict, using site-specific data and a series of conservative assumptions, the rate of exposure (*i.e*., the quantity of chemical and the rate at which that quantity is received) of the selected receptors to COPCs *via* the various exposure scenarios and pathways identified in the problem formulation step. The rate of exposure to chemicals from the various pathways is usually expressed as the amount of chemical taken in per body weight per unit time (*e.g*., µg chemical/kg body weight/day).

The degree of exposure of receptors to chemicals in the environment depends on the interactions of a number of parameters, including:

- The concentrations of COPC in various environmental media;
- The physical-chemical characteristics of the COPC which affect their environmental fate and transport and determine such factors as efficiency of absorption into the body of a given external exposure;
- The influence of site-specific environmental characteristics, such as geology, soil type, topography, hydrology, hydrogeology, local meteorology and climatology etc. on a chemical's behaviour within environmental media; and,
- The physiological and behavioural characteristics of the receptors (*e.g*., respiration rate, soils/dust intake, time spent at various activities and in different areas).

The derivation of the exposure point concentrations (EPCs) for COPCs used to assess exposure is described in Section 5.1.

5.1 Derivation of Exposure Point Concentrations

The derivation of an appropriate EPC (*i.e*., the concentration of a chemical in any environmental medium to which a receptor could reasonably be expected to be exposed over an extended period of time) is important to the overall exposure assessment. The US EPA Risk Assessment Guidance for Superfund (US EPA, 1989), recommends that the upper 95% confidence interval on the arithmetic mean of the data set (*i.e*., the 95% UCLM) should be used to represent the EPC. This is considered to be a reasonable estimate of the concentration to which a receptor might be exposed over a significant amount of time. When enough data are present, the 95% UCLM incorporates the central tendency (*i.e*., the arithmetic mean) and the uncertainty surrounding the arithmetic mean. This is also consistent with Health Canada's (2017b) guidance on HHRAs for contaminated sediments.

EPCs were developed for each COPC in sediment and surface water. All data that were less than the method detection limit (MDL) were assumed to be present at one half the MDL value unless otherwise indicated. The 95% UCLM concentrations were calculated using ProUCL, software (Version 5.1) developed by Lockheed Martin under contract with the US EPA. ProUCL tests the data set for normality, lognormality, and gamma distributions using parametric and non-parametric methods to calculate a conservative and stable 95% UCLM (US EPA, 2015).

The U.S. EPA has peer reviewed this software and endorses its use as a tool in contaminated site risk assessments.

5.1.1 Sediment/Fen Exposure Point Concentrations

The sediment arsenic and mercury data from the two sampling programs were evaluated statistically. The data are presented in Figures 2-3 and 2-5. For the scenarios considered in the assessment, the sediment EPC values varied as follows:

- Recreational high contact – Low frequency scenario: The sediment samples from within Barry's Run and Mitchell's Brook (identified as samples named either SED or BIOSED in Figures 2-3 and 2-5) were used to characterize exposure in this scenario. The 95th UCLM was used to represent the EPC. The statistical summary of the data is presented in Table 5-1.

- Recreational low contact - High frequency scenario: This scenario considers exposures that may occur in the western end of Barry's Run, near the exit to Lake Charles. Therefore, sediment samples from this area were used to characterize exposure. There were four (4) samples taken in this part of the study area, and the maximum of these data points was used as the EPC. As per the data presented in Figures 2-3 and 2-5, the maximum arsenic concentration in sediment was 2,000 mg/kg; the maximum mercury concentration was 5.9 mg/kg. These values were used in the modelling.

- Recreational contact with Fen: An additional scenario involving contact with soils on the fen was also assessed. The data presented in Figure 2-5 identified as TOF (Top of Fen) samples were used to characterize exposure. Data presented on Figure 2-3 as surface soil samples (identified by symbols SS) are at depth (> 3 metres deep), and hence there is no exposure potential related to these samples. The EPC used for this scenario is the 95th UCLM of arsenic and mercury data presented in Table 5-2.

Table 5-1 Descriptive Statistics for Arsenic and Mercury in Sediment

Metal	Descriptive Statistics (mg/kg DW)				
	n	Min	Max	Mean	95th UCLM
Arsenic	19	170	6,200	2,638	3,287
Mercury	19	0.82	11	4.27	5.224

Table 5-2 Descriptive Statistics for Arsenic and Mercury in Fen Samples (mg/kg DW)

Metal	Descriptive Statistics				
	n	Min	Max	Mean	95th UCLM
Arsenic	16	3	1,700	237	1,571
Mercury	14	0.025	1	0.237	0.67

5.1.2 Surface Water Exposure Point Concentrations

The surface water data from the two sampling programs were evaluated statistically and are presented in Figures 2-4 and 2-5. Pore water samples were not used in the HHRA, as there is limited plausible exposure to these concentrations. The dissolved data were used to characterize potential risk, with suspended sediments also being considered in the HHRA (from an oral and dermal exposure perspective). The statistical summary of the dissolved surface water data for arsenic and mercury is presented in Table 5-3. The mercury data was non-detect in all samples, and ½ of the detection limit was used in all cases of non-detect data. The 95th UCLM was used to characterize the EPC.

Table 5-3 Descriptive Statistics for Arsenic and Mercury in Surface Water

Metal	Descriptive Statistics (mg/l)				
	n	Min	Max	Mean	95th UCLM
Arsenic (Dissolved)	15	0.041	0.085	0.055	0.0625
Mercury (Dissolved)	13	0.0000065	0.0000065	0.0000065	0.0000065

5.1.3 Fish Tissue Concentrations

Mercury and arsenic concentrations (mg/kg ww) and fish size parameters [i.e., total fish length (cm) and total weight (g)] were obtained for brook trout and smallmouth bass collected from Barry's Run in 2019. A summary of these data are provided in Table 5-4. No available comparative data for fish from control lakes were obtained in this study. To provide additional context, mercury concentration and fish size parameters for brook trout collected between July 2006 and November 2007 from two morphologically similar lakes in Nova Scotia not associated with historic mining activities (i.e., control lakes) (LeBlanc and Halfyard, 2010) were compared to the data from Barry's Run. These data are also presented in Table 5-4. Comparison data for smallmouth bass from control lakes in Nova Scotia were not available in LeBlanc and Halfyard (2010). Raw fish data for both Barry's Run/Mitchell's Brook and the two (2) control lakes are provided in Table B-8 within Appendix B.

Given the small sample sizes for brook trout and smallmouth bass collected from Barry's Run/Mitchell's Brook, regression analysis between fish size and mercury concentration was not conducted. Mercury concentrations in brook trout from Barry's Run (mean=0.191 mg/kg, SD=0.093 mg/kg, n=9) were comparable or lower to mercury concentrations in brook trout from Dollar Lake (mean=0.397 mg/kg, SD=0.447 mg/kg, n=11) and Northeast Lake (mean=0.357 mg/kg, SD=0.289 mg/kg, n=6). However, it is important to note that mercury data from the two control lakes were obtained in 2006-2007; therefore, time could be a confounding factor when comparing metal concentrations from Barry's Run to metal concentrations from the two control lakes. When compared to the Canadian human health guideline for consumption of mercury in fish (0.5 mg/kg)(Health Canada, 2007), mercury concentrations in all brook trout (100%) were below this guideline and the median mercury concentration was more than 2-fold lower than this guideline (Figure 5-1). Given the available data, mercury is not considered to pose a risk to consumers of brook trout from Barry's Run, but was included in the modelling effort for completeness.

Table 5-4 Summary of Fish Statistics

Location	Species	Mean ±SD (range) [N]			
		Total Length (cm)	Total Weight (g)	Total Hg (mg/kg ww)	Total As (mg/kg ww)
Barry's Run/Mitchell's Brook	Brook Trout	21.4 ± 4.6 (12.2-29.5) [13]	103 ± 57.5 (30.0-231) [12[a]]	0.191 ± 0.093 (0.048-0.352) [9[b]]	0.704 ± 0.282 (0.324-1.13) [9[b]]
	Smallmouth Bass	24.4 ± 3.0 (21.1-30.5) [7]	147 ± 35.6 (113-194) [5[c]]	0.610 ± 0.242 (0.325-1.03) [7]	2.67 ± 0.084 (2.54-2.78) [7]
Dollar Lake	Brook Trout	25.7 ± 4.8 (18.5-34.4) [11]	168 ± 106 (48.0-418) [11]	0.397 ± 0.447 (0.100-1.34) [11]	NDA
Northeast Lake	Brook Trout	23.6 ± 4.4 (18.5-30.7) [6]	174 ± 81.3 (80.0-305) [6]	0.357 ± 0.289 (0.170-0.940) [6]	NDA

a. Fish weight was not evaluated in one fish.
b. Three composite samples were used which were made up of 2 to 3 fish subsamples in order to have sufficient tissue for metal analysis.
c. Fish weight was not evaluated in two fish.

NDA=no data available (lake specific data was not available)
Notes: Mercury and arsenic concentrations are presented on a mg/kg ww basis and were not normalized to measures of length or weight.

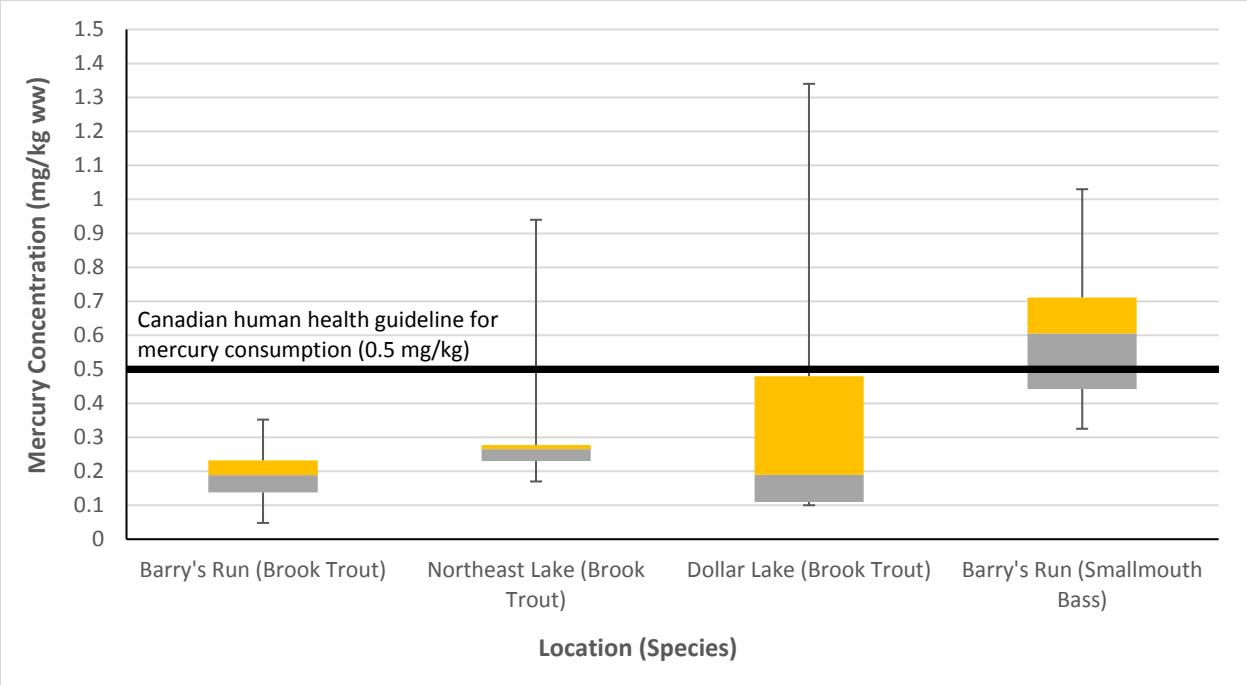

Figure 5-1 Mercury Concentrations in Brook Trout and Smallmouth Bass

Figure Notes: Mercury and arsenic concentrations are presented on a mg/kg ww basis and were not normalized to measures of length or weight. The components of the boxplot from bottom to top are as follows: 1) the lower whisker represents the minimum mercury concentration, 2) the grey square represents the lower quartile (25th percentile), 3) the intersection between the grey and yellow rectangles represents the median mercury concentration, 4) the yellow rectangle represents the upper quartile (75th percentile), and 5) the upper whisker presents the maximum mercury concentration.

Mercury concentrations in smallmouth bass from Barry's Run were approximately 3-fold greater than mercury concentrations measured in brook trout from Barry's Run (Figure 5-1). When compared to the Canadian human health guideline for consumption of mercury in fish (0.5 mg/kg), mean mercury in smallmouth bass (mean=0.610 mg/kg, SD=0.242 mg/kg, n=7) was greater than the guideline and 57% of the fish sampled had mercury concentrations exceeding this guideline.

Based on the available data, mercury was retained for further evaluation in the HHRA and potential risks associated with mercury following the consumption of smallmouth bass were evaluated using the consumption rates outlined in the Nova Scotia consumption advisory (NSE, 2019). Brook trout mercury data were also assessed, for completeness. The EPC used in the modelling was the 95th UCLM mercury concentration from each species, following consideration of fish size (as per the consumption advisory), with the exception of where sample sizes were limited (n = 3), wherein the maximum value was used (see Table 5-5).

With respect to arsenic, comparative data from the Leblanc and Halfyard (2010) study were not available. Arsenic fish tissue concentrations were included in the HHRA modelling. The EPC used for the arsenic fish tissue were the 95th ULCM concentrations of each species, with consideration of fish size (as per the consumption advisory), with the exception of where sample sizes were limited (n = 3), wherein the maximum value was used (see Table 5-3). Arsenic tissue concentrations were subsequently adjusted for bioaccessibility and speciation (see Section 6.1 for discussion of the bioaccessibility and speciation data).

Table 5-5 Exposure Point Concentrations for Fish

Location	Species	Size (cm)	Total Hg (mg/kg ww)					Total As (mg/kg ww)			
			n	Min	Max	Mean	95% UCLM	Min	Max	Mean	95% UCLM
Barry's Run	Brook Trout	<25	6	0.084	0.266	0.188	0.243	0.324	1.130	0.732	0.972
Barry's Run	Brook Trout	>25	3	0.048	0.352	0.196	*	0.432	1.010	0.647	*
Barry's Run	Smallmouth Bass	<35	7	0.325	1.030	0.610	0.787	2.540	2.780	2.674	2.736
Barry's Run	Smallmouth Bass	>35	0	-	-	-	-	-	-	-	-

*calculated UCLMs exceed maximum values (due to the small sample size); these UCLMs are considered invalid and maximum values are used for assessment purposes

5.2 Exposure Estimates

The primary objective of the exposure assessment is to predict, using site-specific data and a series of conservative assumptions, the rate of exposure (*i.e.*, the quantity of chemical and the rate at which that quantity is received) of the selected receptors to the COPC *via* the various exposure scenarios and pathways identified in the problem formulation.

Receptors were assumed to move in a random fashion and, over time, come into contact with the EPC of the COPCs in each environmental media. The EPC for any given environmental media (e.g., sediment, fen, surface water, and fish) was defined as the 95% UCLM, except where data were limited, as discussed previously. The rate of exposure to each COPC from

each exposure pathway was expressed as the amount of chemical taken in per body weight per unit time (*e.g.*, µg chemical/kg body weight/day) as a result of exposure to COPC in sediment, surface water, and local fish.

Receptor characteristics were selected for use in the HHRA. A list of parameters and assumptions describing the physiological and behavioural characteristics of each receptor evaluated in the HHRA are provided in Table 5-6. For the sediment exposure scenarios, guidance from health Canada (2017b) was used to derive the exposure characteristics. Some site-specific adjustments were made, since many of the assumptions in the Health Canada guidance relate to exposures of children to a tidal flat scenario (with exposed sediments). The sediment exposures in the Study Area are more related to bedded (underwater) sediments, and hence, some adjustments were made to account for the likelihood that sediment would not remain adhered to feet as someone leaves the water. Fen was assumed to consist of a soil-like material and exposures to fen was assumed to be occur in a manner similar to that defined by Health Canada (2012) for soils.

For fish consumption, the Province of Nova Scotia (2019) identified specific consumption rates for specific species, based on size. Grams/day quantities were calculated based on the Provincial guidance of 75 grams/serving and number of servings per week or month as indicated in the advisory. These consumption rates were used based on the assumption that people consuming fish in the Province should adhere to the guidance provided, which is established to protect against mercury exposures in fish tissues, which result from long range transport of mercury emissions from other areas and naturally occurring levels in the environment. Consumption estimates are provided in Table 5-7.

Table 5-6 Summary of Exposure Assumptions and Receptor-Specific Parameters

Description	*Units*	*Recreational – High Contact-Low Frequency*		*Recreational – Low Contact-High Frequency*		*Recreational Fishing*	*Reference*
		Toddler	*Adult*	*Child*	*Adult*	*Adult*	
Surface area of hands	m^2	0.0430	0.089	0.0590	0.089	-	Health Canada (2012,2017); Richardson (1997)
Surface area of feet	m^2	0.0430	0.119	0.0720	0.119	-	Health Canada (2017); Richardson (1997)
Surface area of lower legs[a]	m^2	0.169	0.572	-	-	-	Health Canada (2012,2017); Richardson (1997)
Surface area of forearms	m^2	0.0445	0.125	-	-	-	Health Canada (2012,2017); Richardson (1997)
Whole body surface area – swimming	m^2	0.613	1.760	1.010	1.760	-	Health Canada (2012,2017); Richardson (1997)
Dermal loading of sediment to hands	kg/m^2-event	0.00490	0.00490	0.00490	0.0049	-	Shoaf *et al*. (2005); Golder (2010); Health Canada (2017)
Dermal loading of sediment to feet[b]	kg/m^2-event	0.021	0.021	0.021	0.021	-	Shoaf *et al*. (2005); Golder (2010)
Dermal loading of sediment to legs	kg/m^2-event	0.00700	0.00700	-	-	-	Shoaf *et al*. (2005); Golder (2010); Health Canada (2017)
Dermal loading of sediment to arms	kg/m^2-event	0.00170	0.00170	-	-	-	Shoaf *et al*. (2005); Golder (2010); Health Canada (2017)
Dermal loading of soil (fen) to hands	kg/m^2-event	1.00E-03	1.00E-03	1.00E-03	1.00E-03		Health Canada (2012)
Dermal loading of soil (fen) to other surfaces	kg/m^2-event	1.00E-04	1.00E-04	1.00E-04	1.00E-04		Health Canada (2012)
Exposure Frequency	events/day	1	1	1	1	-	Assumed
Exposure Frequency	days/year	6	6	26	26	-	Assumed
Exposure Frequency - swimming	hours/event	1	1	1	1		Assumed
Sediment Ingestion Rate – shoreline sediment[c]	kg/d	0.000072	0.00002	0.000057	0.00002	-	Health Canada (2017); Wilson *et al*. (2015)
Sediment Ingestion Rate – suspended sediment[c]	kg/d	0.0000077	0.0000077	0.0000077	0.0000077		Health Canada (2017); Wilson *et al*. (2015)
Soil (fen) Ingestion Rate	kg/day	0.00008	0.00002	0.00002	0.00002		Health Canada (2012)
Ingestion Rate – surface water	L/hour	0.05	0.05	0.05	0.05		U.S. EPA (1989)
Body weight	kg	16.5	70.7	32.9	70.7		Health Canada (2012,2017)
Fish Consumption Rate		-	-	-	-	See Table 5-6	

Note: Fen scenario is the same as the sediment scenarios – soil ingestion rates dermal loadings as per Health Canada (2012) guidance for soils

[a]surface area the lower legs was assumed to be one half of the surface areas of the legs (upper and lower)

[b]dermal loading to feet was adjusted to reflect the nature of the site; a 10-fold rinsing factor was applied to values cited by Health Canada (2017b)

[c]Ingestion rates recommended by Wilson *et al*. (2015) are mg per hour. For the current assessment, it was assumed that the ingestion rate is event driven with one event occurring per day.

Table 5-7 Fish Consumption Rates (from Province of Nova Scotia, 2019)

		CONSUMPTION LIMIT BASED ON NUMBER OF SERVINGS[a]					CONSUMPTION RATE BASED ON MERCURY CONSUMPTION LIMITS				
Species	**Fish Length (measured nose to tail fork)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**
Brook Trout	Under 25 cm (9.8 in)	2 servings per week	1 serving per week	1½ servings per month	3/4 serving per month	½ serving per month	21.4[b] g/day	10.7 g/day	3.7 g/day	1.8 g/day	1.2 g/day
Brook Trout	Over 25 cm (9.8 in)	1 serving per week	1 serving per month	Avoid	Avoid	Avoid	10.7 g/day	2.5 g/day	Avoid	Avoid	Avoid
Smallmouth Bass	Under 35 cm (13.8 in)	3 servings per month	1 serving per month	1½ servings per month	Avoid	Avoid	7.4 g/day	2.5 g/day	3.7 g/day	Avoid	Avoid
Smallmouth Bass	Over 35 cm (13.8 in)	2 servings per month	Avoid	Avoid	Avoid	Avoid	4.9 g/day	Avoid	Avoid	Avoid	Avoid

[a]fish consumption rates were based on the information provided in the Nova Scotia fish advisory for mercury that cites a daily serving size of 75 grams of fish, based on Canada's Food Guide, as well as fish species and size specific ingestion restrictions.
[b]Consumption rates were calculated as follows: 75 g x 2 servings per week/7 days

5.2.1 Exposure to COPCs in Sediment/Fen

Exposure to COPCs in sediment is assumed to occur *via* incidental ingestion of shoreline/bedded sediment and suspended sediment in the water column, and dermal absorption through exposed skin. Fen is assumed to be soil like material, and exposures are assumed to occur via incidental ingestion and dermal absorption. The methods used to assess exposure to sediment differ from those used for soils as a result of differences in factors such as the frequency of exposure, the amount of exposed skin, and adherence of wet sediment to hands and other body parts (Health Canada, 2012; 2017b).

Incidental Ingestion

Sediment/fen ingestion can occur through hand to mouth contact with material adhered to the skin. Sediment exposure can also occur through the ingestion of water containing suspended sediment. Exposure will be dependent on the ingestion rate, exposure frequency and COPC concentration in the shoreline and suspended sediment.

The effective intake of COPCs is dependent upon the amount of chemical released from sediment/fen during digestion (referred to as the bioaccessible fraction). Only the fraction of COPCs that is released in soluble form from sediment/fen into the stomach or intestines during digestion is considered to be available for uptake. The fraction that is not released from sediment/fen is excreted in the feces and does not have the opportunity to cause adverse health effects. Therefore, in assessing exposure and potential human health risks from sediment/fen ingestion, it is necessary to consider the amount of chemical that is actually released from the sediment/fen into the gut and small intestine, and not just the total amount that is ingested with the sediment/fen. A site-specific bioaccessibility study was conducted to determine the bioaccessibility of arsenic from sediment relative to the medium used to derive the toxicological criterion (referred to as the relative absorption factor (RAF_{oral})). The bioaccessibility results are provided in Appendix A and summarized in Section 6.1. An RAF_{oral} for mercury of 1.0 was assumed. Fen samples were not tested for bioaccessibility. As such, the same value as that used for sediment was used for the fen.

The following equation (Health Canada, 2012; 2017b) was used to predict exposure *via* ingestion of sediment:

Ingestion of Sediment

$$EXP_{Oral} = \frac{C_{sed/fen} * IR * RAF_{oral} * EF}{BW * DPY}$$

where:

EXP_{Oral}=		daily oral exposure *via* ingestion of sediment/fen (mg/kg/day)
IR	=	sediment/fen ingestion rate (either shoreline sediment or suspended sediment) (kg/d)
RAF_{oral}	=	relative absorption factor from the gastrointestinal tract (unitless)
EF	=	exposure frequency (days/year)
BW	=	body weight (kg)
DPY	=	days per year (365 days/year)

Dermal Exposure

To estimate exposure *via* dermal contact with shoreline/bedded sediment/fen, it is assumed that a single dermal exposure event occurs for every day that a receptor is involved in recreational activities that results in contact with sediment/fen in Barry's run. Exposure is a function of the surface area of exposed skin and the sediment adherence to this skin. This will produce an estimate of the mass of COPC adhered to the skin on a daily basis. Since route-specific Toxicity Reference Values (TRVs) are not available for dermal exposure, the dermal exposure must be compared to the oral TRV. The insoluble nature of most metals in sediment/fen limits their potential for uptake through the skin. Available data on dermal uptake of metals indicate that uptake rates are low (Paustenbach, 2000). Since dermal absorption of the COPC are low relative to oral absorption, the dermal exposure was adjusted by applying a relative dermal absorption factor (RAF_{Dermal}) to account for the relative difference in absorption between the oral and dermal routes. Therefore, the estimated mass value is multiplied by a chemical-specific RAF_{Dermal} to yield the sediment/fen dermal exposure estimate in mg/kg body weight/day. The RAF_{Dermal} were those recommended by Lowney *et al*. (2007) for arsenic (0.005) and by Moody et al (2009) for mercury (0.466).

The following equation was used to predict exposure *via* dermal contact with sediment, based on Health Canada (2012; 2017b):

Ingestion of Sediment

$$EXP_{Dermal} = \frac{C_{sed/fen} * [\sum(SA_i * SL_i)] * RAF_{Dermal} * EF_1 * EF_2}{BW * DPY}$$

where:

EXP_{Dermal}	=	daily dermal exposure via contact with sediment/fen (mg/kg/day)
SAi	=	surface area of body part exposed for sediment loading (m^2)
SLi	=	sediment loading rate to exposed skin of body part (kg/m^2-event)
RAF_{Dermal}	=	relative absorption factor through skin (unitless)
EF_1	=	exposure frequency (days/year)
EF_2	=	exposure frequency (events/day)
BW	=	body weight (kg)
DPY	=	days per year (365 days/year)

5.2.2 Exposure to COPCs in Surface Water

Exposure was assumed to occur *via* incidental ingestion of dissolved COPCs in surface water as well as dermal contact of surface water with all skin. The method used to predict dermal absorption was that recommended by the U.S. EPA Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment) (U.S. EPA, 2004). In this method, the absorption of chemicals from water is a function of the thickness of the outer layer of the skin (known as the stratum corneum) and the duration of the exposure event. This model assumes that absorption continues after the exposure event has ended. The final absorbed dose (DA_{event}) considers the net fraction available for absorption on the stratum corneum after the exposure event. Since the length of the daily exposure events are relatively short (1 hour), it was assumed that a steady-state would not be reached and that neither the viable epidermis nor the cutaneous blood flow would limit

the dermal absorption of the COPC (U.S. EPA, 2004). The following equations were used to predict exposure *via* incidental ingestion and dermal contact with surface water:

Dermal Exposure While Swimming

$$EXP_{DermSW} = \frac{DA_{event} * SA * EV * EF * CF}{BW * DPY}$$

where:

$EXP_{Derm\ SW}$	=	daily dermal exposure *via* direct contact with surface water (mg/kg/day)
DA_{event}	=	absorbed dose per event (µg/cm^2-event)
SA	=	exposed surface area (cm^2)
EV	=	event frequency (event/day)
EF	=	exposure frequency (days/year)
BW	=	body weight (kg)
DPY	=	days per year (365 days/year)
CF	=	conversion factor (0.001 mg/µg)

In the above equation, the DA_{event} term was calculated as follows:

$$DA_{event} = K_P * C_{SW} * CF_1 * t_{event} * CF_2$$

where:

DA_{event}	=	absorbed dose per event (µg/cm^2-event)
K_p	=	dermal permeability coefficient of COPC in water (cm/hr)
C_{sw}	=	COPC concentration in surface water (µg/L)
CF_1	=	conversion factor for µg/L to mg/cm^3 (1.0x10^{-6})
t_{event}	=	duration of swimming event (hr event)
CF_2	=	conversion factor for mg/cm^2-event to µg/cm^2-event

The dermal permeability coefficient (Kp) for each COPC was 0.001 cm/hr (U.S. EPA, 2004).

Incidental Ingestion of Surface Water While Swimming

$$EXP_{oralSW} = \frac{IR_{SW} * C_{SW} * ED * EF * CF}{BW * AT}$$

where:

$EXP_{Oral\ SW}$	=	daily oral exposure *via* incidental ingestion of surface water (mg/kg/day)
IR_{SW}	=	incidental ingestion rate of surface water while swimming (L/hour)
C_{SW}	=	concentration in surface water (µg/L)
ED	=	event duration (hours/day)
EF	=	exposure frequency (days/year)
BW	=	body weight (kg)
DPY	=	days per year (365 days/year)
CF	=	conversion factor (0.001 mg/µg)

5.2.3 Exposure to COPCs in Local Fish

For the current assessment it was assumed that receptors would consume local fish an average rate as outlined in Table 5-7. The relative absorption factor for arsenic was determined through a bioaccessibility study for fish tissue similar to that described for sediment. Additionally, since arsenic toxicity varies widely depending on the form or species of arsenic in the fish tissue, and relatively non-toxic forms of arsenic are known to occur in fish and seafood (ATSDR, 2007), a speciation analysis was conducted on fish tissues to determine the proportion of inorganic and organic arsenic. The bioaccessibility and speciation results are provided in Appendix A and summarized in Section 6.1. For mercury, absorption within the gut *via* consumption of local fish was assumed to be 100%. Furthermore, all mercury was assumed to be in a methylated (organic) form within fish tissues, based on Health Canada (2007). Methylmercury has been found to represent a large percentage of total mercury measured in fish tissue, but the relative proportion varies with species. Health Canada (2007) recommends that in the absence of site-specific data, fish tissue mercury levels should be assumed to equal 100% methylmercury.

Ingestion of Local Fish

$$EXP_{LF} = \frac{CR_{LF} * C_{LF} * EF * RAF_{ORAL} * SP_{inorganic/organic}}{BW * DPY}$$

where:

EXP_{LF}	=	daily exposure to COPC from ingestion of local fish (mg/kg/day)
CR_{LF}	=	consumption rate of local fish (g/day)
EF	=	exposure frequency (365 days/year)
RAF_{ORAL}	=	relative absorption factor for ingestion of COPC (unitless)
$SP_{inorganic/organic}$	=	fraction of arsenic in fish tissue in as inorganic/organic species
C_{LF}	=	concentration of COPC in local fish tissue (mg/kg ww)
BW	=	body weight (kg)
DPY	=	days per year (365 days/year)

5.3 Exposure Assessment Results

All exposure estimates were calculated in an Excel® based exposure model. Model printouts, including exposure assessment results, are included as Appendix C.

6.0 TOXICITY ASSESSMENT

6.1 Bioaccessibility and Speciation

One of the most important factors in determining exposure of target tissues to a substance, and the body's ultimate response, is bioavailability. Bioavailability is the fraction of the total amount of a substance to which an organism has been exposed that successfully enters the blood stream. The bioavailability of a substance is dependent on the chemical form, the environmental medium, the route of exposure, physiological characteristics of the organism at time of exposure (e.g., ingested substances may be absorbed to different extents depending on whether the stomach is full or empty) as well as the tissues/organs with which the substance must interact as it passes from the point of entry to target tissues. As discussed in Section 2.2, bioaccessibility refers to the fraction of the COPC which can be biologically extracted from the exposure media (*i.e.*, soils or sediments) and solubilized within the gastrointestinal tract so that it is available for absorption through the intestinal wall into the blood stream (Kelly *et al*., 2002). In other words, bioaccessibility sets an upper limit on bioavailability, and the two processes are positively correlated. This is especially relevant when evaluating the degree to which substances bound to soil can be absorbed into the body.

Bioaccessibility testing was conducted by ESG of Royal Military College in Kingston, ON, on sediments and fish tissues for the current project (see ESG, 2019; Appendix A). As summarized in ESG (2019), to obtain the bioaccessible arsenic for the humans exposed to soil/sediment, the United States Environmental Protection Agency (U.S. EPA) OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017) was employed. Each dried and sieved sample (< 150 µm fraction) was extracted in 100 mL extraction vessels with a 0.4 M glycine solution adjusted to pH 1.5 in a liquid-to-(dry) solid ratio of 100:1. The extraction was carried out with end-over-end mixing at body temperature (37^{o}C) for 1 hour and liquid was separated from solids through the use of 0.45 µm filtration. All extracts were analyzed for arsenic concentrations by ICP-MS, and total concentrations of arsenic in sediment samples were obtained by aqua regia digestion and analysis using ICP-MS. Drying, sieving and extraction were carried out in the ESG laboratory. Analysis of extracts and sediments was carried out at the Analytical Services Unit at Queen's University, a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA). The methods used for analysis (metals in solids by ICP-MS and metals in water by ICP-MS) are listed on ASU's scope of accreditation. All Quality Assurance results were considered acceptable (see ESG, 2019; Appendix A). Table 6-1 provides the results of sediment bioaccessibility testing on 5 submitted samples.

Table 6-1 Bioaccessible Arsenic Concentrations in Sediment

SAMPLE ID	Bioaccessible Concentration of Arsenic (mg/kg)	Total Arsenic Sediment Concentration (mg/kg)	% Bioaccessible Arsenic*
	As	As	As
Biosed 19-1 2/2	310	4500	6.9
Biosed 19-2 2/2	199	990	20
Biosed 19-4 2/2	255	3200	8.0
Biosed 19-5 2/2	281	4000	7.0
Biosed 19-6 2/2	61.2	200	31

*Results are reported on a dry weight basis, for the <150 um fraction of soil

Based on the results presented in Table 6-2, bioaccessibility of arsenic in sediments ranged from 6.9% to 31% in the submitted samples, with a mean value of 14.6 %. Biosed 19-6 had the highest percent bioaccessibility. This sample was taken near the outflow of Barry's Run (towards Lake Charles) and had high level of organic material present in the sample. The measured total arsenic concentration in the sample (200 mg/kg) was noticeably lower than that reported in other samples, which is likely a function of deposited organic matter overlying the sediments. Samples Biosed 19-1, 19-4 and 19-5 have lower bioaccessible arsenic, ranging from 6.9 to 8.0 %, and these samples also have higher total arsenic concentrations (ranging from 3200 to 4500 mg/kg), relative to other samples. These samples could contain less organic depositional material and be more representative of tailings, which, based on bioaccessibility testing of the main tailings area at the historic Montague Mines site, was found to have low bioaccessibility (95 UCLM of data: 11.5 %, N= 19; ESG, 2009).

For the HHRA, the mean value of 14.6% was selected to represent the bioaccessibility of arsenic in sediments, based on the pretense that areas containing tailings have elevated arsenic concentrations and would be represented by lower bioaccessible arsenic concentrations. Fen samples were not tested for bioaccessibility. As such, the same value as that used for sediment was used for the fen. The mean sediment bioaccessibility value was adjusted using the following equation, which relates the bioaccessibility results with relative bioavailability results (RBA), which is recommended by Health Canada (2017a):

$$\text{Relative Bioavailability}_{\text{arsenic}}(\%) = 0.79 \times \text{IVBA}\ (\%) + 3.0$$

The resultant value used in the modelling was 14.5%.

For fish tissues, arsenic bioaccessibility testing was also conducted, along with arsenic speciation testing. As discussed in ESG (2019; see Appendix A), to obtain the bioaccessible fraction of arsenic in the fish tissue samples, the United States Environmental Protection Agency (U.S. EPA) OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017) was used to conduct the analysis, with modifications for to account for food content in the stomach. Each dried and ground fish tissue sample was extracted in 50 mL extraction vessels with a liquid-to-(dry) solid ratio of approximately 40:1. This was equal to a liquid-to-(wet) solid ratio of approximately 10:1, which was designed to be physiologically representative of ratios during meals. The samples were extracted with a 0.4 M glycine solution adjusted to pH 1.5 with end-over-end mixing at body temperature (37^{o}C) for 1 hour and liquid was separated from solids through the use of 0.45 µm filtration. All extracts were analyzed for total arsenic concentrations by ICP-MS, and total concentrations of arsenic in fish samples were obtained by acid digestion and analysis using ICP-MS. Drying, grinding, and extraction were carried out in the ESG laboratory. Analysis of extracts and fish tissues was carried out at the Analytical Services Unit at Queen's University, a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA). The methods used for analysis (metals in solids by ICP-MS and metals in water by ICP-MS) are listed on ASU's scope of accreditation.

Speciation analysis was carried out in the ESG laboratory on the extracts by high performance liquid chromatography (HPLC)-ICP-MS. The HPLC methods were anion exchange and cation exchange chromatography. The following species (as standards) could be separated by the methods used: arsenobetaine (AB), dimethylarsinic acid (DMA), monomethylarsonic acid (MMA), arsenosugars, trimethylarsine oxide (TMAO), arsenocholine, and tetramethylarsonium ion. Challenges with instrument performance caused delays in the analysis of inorganic AsIII and AsV in the sample extract matrix, and hence, some of the analysis was conducted by ALS

laboratories, to avoid delays in reporting (See Appendix A; ESG, 2019). Quality Assurance reporting from both labs was considered acceptable. Tables 6-2 and 6-3 present the bioaccessibility and speciation data, respectively, for the brook trout and smallmouth bass samples submitted for analysis.

Table 6-2 Bioaccessibile Arsenic Concentrations in Fish Tissue (wet weight)

SAMPLE ID	Bioaccessible Concentration	Fish Tissue Concentration	% Bioaccessible Arsenic
	As	As	As
F19-01 (brook trout < 25 cm)	0.66	1.1	62%
F19-02 (brook trout > 25 cm)	0.69	0.88	78%
F19-03 (small mouth bass < 35 cm)	1.4	2.4	57%
F19-07 (brook trout < 25 cm)	0.83	1.3	62%
F19-14 (small mouth bass < 35 cm)	0.97	2.1	46%

The maximum bioaccessibility values for each fish species/size range was used to characterize the bioaccessibility of arsenic in each species, due to the small number of samples within each size category.

It is important to understand how arsenic is metabolized in the body following ingestion, since different forms, or species, of arsenic have different toxicological potency. As discussed in ATSDR (2007), the primary method of metabolism of inorganic arsenic in humans is methylation. Arsenic V is reduced to arsenic III, and a portion of this is subsequently methylated to MMA and DMA. These metabolic pathways are presented in Figure 6-1. The main route of arsenic excretion is in the urine, and people exposed to arsenic excrete a combination of inorganic arsenic and its methylated metabolites in the urine. Based on the metabolic biotransformation pathways of inorganic arsenic to organic methylated arsenic (see Figure 6-1), and information related to the toxicity of the different species of arsenic detected, the arsenic species were grouped, where appropriate (see Table 6-3). The various groups were as follows:

- Inorganic arsenic [As (III) and As(V)] were not combined with other forms of arsenic, since these forms are highly toxic, relative to other forms of arsenic (see ATSDR, 2007). Separate TRVs are not available for these two species, and hence, these two inorganic species are combined to enable a conservative assessment of risk.
- Methylated organic forms of arsenic, MMA and DMA, were identified separately in the speciation analysis, along with trimethylarsine oxide (TMAO). As summarized by ATSDR (2007), DMA undergoes additional methylation, which results in the formation of TMAO in some species. Since MMA was not detected in any tissues (see Table 6-3), it was not grouped with other arsenic species, and it was not considered further. Since TMAO is formed from DMA, and there are inadequate toxicity data to characterize the toxicity of TMAO on its own (ATSDR, 2007), it was combined with DMA in Table 6-3, such that the toxicity was assumed to equal that of DMA.
- Another organic arsenic compound, arsenobetaine (AB), was also identified separately in the speciation analysis (see Table 6-3). This compound is commonly found in fish and seafoods and is considered relatively benign from a toxicity perspective (see ATSDR, 2007). They are not assessed further from a human health perspective.

Table 6-3 Arsenic Speciation in Fish Tissue (wet weight)

Sample ID	AsV	AsIII	DMA	MMA	AB	TMAO	SOS	Percent inorganic	Percent DMA/MMA/TMAO	Percent AB
F19-01	0.040	0.011	0.036	<0.009	0.12	0.53	0.73	7%	77%	16%
F19-02	0.030	0.009	<0.009	<0.009	0.14	0.62	0.80	5%	78%	18%
F19-03	0.11	0.013	1.2	<0.01	0.11	<0.01	1.5	8%	84%	8%
F19-07	0.071	0.012	0.020	<0.01	0.11	0.77	0.97	9%	81%	11%
F19-14	0.092	0.017	0.75	<0.01	0.21	<0.01	1.1	10%	70%	19%

AsIII = arsenite, AsV = arsenate, MMA = monomethylarsonic acid; DMA = dimethylarsinic acid; AB = arsenobetaine; TMAO = trimethylarsine oxide
SOS = sum of species = AsIII + AsV + MMA + DMA + TMAO + AB

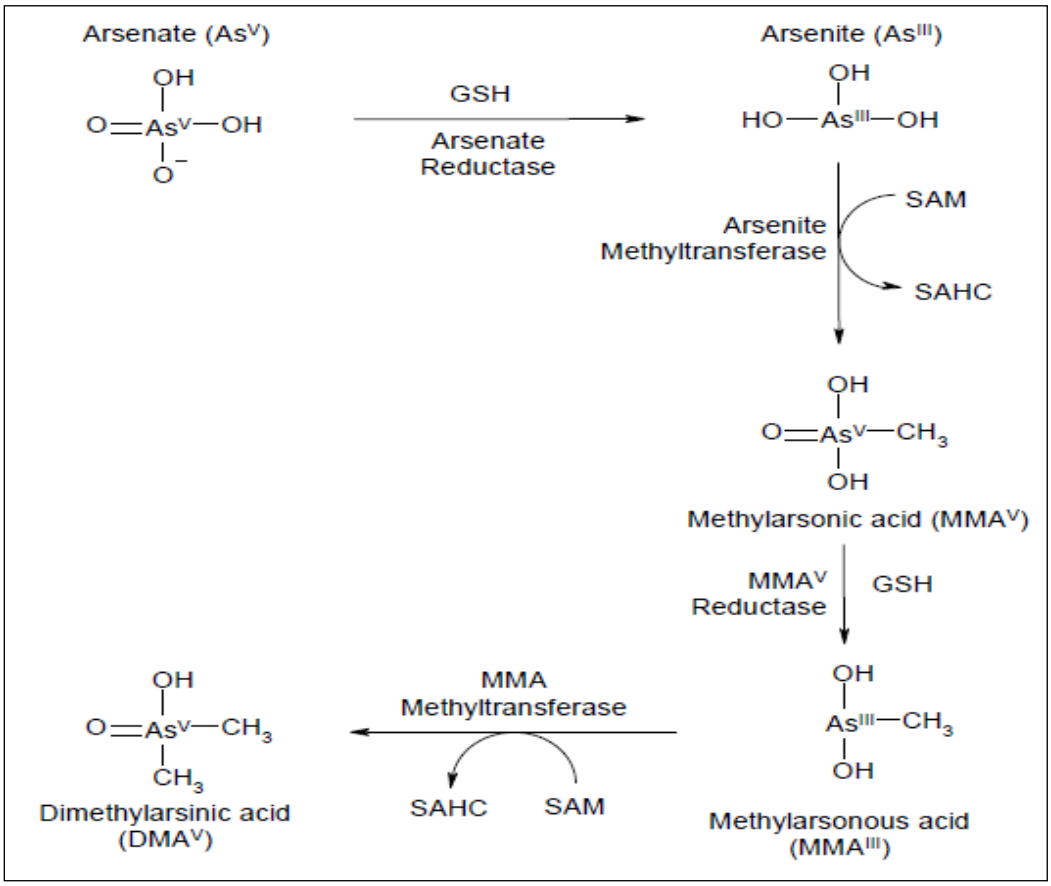

Figure 6-1 Metabolic Biotransformation Pathways for Arsenic (from ATSDR, 2007)

6.2 Selection of Toxicity Reference Values (TRVs)

To evaluate potential risks to human health from exposure to the COPC, oral TRVs were used in the assessment. The priority for selecting TRVs was given to those available from Health Canada (2010). If TRVs were not available from Health Canada (2010), a TRV was selected from other regulatory or recognized scientific agencies, according to Health Canada (2012) guidance, including:

- United States Environmental Protection Agency (US EPA);
- World Health Organization;
- Netherlands National Institute of Public Health and the Environment (RIVM);
- Agency for Toxic Substances and Disease Registry; and,
- California Environmental Protection Agency.

Table 6-4 provides the TRVs selected for this assessment. No TRV was identified for TMAO. The toxicity of this compound was assumed to be represented by that of DMA. Arsenobetaine was also identified in speciation analysis, but was concluded by ATSDR (2007) to be relatively non-toxic and not meriting further assessment in HHRAs.

Table 6-4 Human Health Oral Toxicity Reference Values Used in the HHRA

Chemical of Potential Concern	***TRV***		***Critical Effect***	***Reference***
	Non-Cancer (mg/kg bw/day)	*Cancer* (mg/kg bw/day)$^{-1}$		
Arsenic-inorganic (As (III) and As(V))	0.0003	–	Hyperpigmentation, keratosis, possible vascular complications	US EPA 2016
	–	1.8	Bladder, lung and liver cancer	Health Canada 2010
Arsenic-organic (DMA)	0.02		Bladder effects	ATSDR, 2007
Mercury (inorganic)	0.0003	–	Nephrotoxicity	Health Canada 2010
Mercury (methyl)	0.00047 (general adult population); 0.0002 (women of child-bearing age and children< 12 years)	-	Neurotoxicity	Health Canada 2010

7.0 RISK CHARACTERIZATION

The fundamental purpose of an HHRA is to estimate whether people living at, working at or visiting a given location are being exposed, or will be exposed, to concentrations of chemicals that have the potential to result in adverse health effects. The assessment of potential occurrences of adverse health effects from chemical exposure is based on the dose-response concept that is fundamental to the responses of biological systems to chemicals, whether they are therapeutic drugs, naturally-occurring substances, or man-made chemicals in the environment. Thus, an HHRA evaluates the likelihood (or risk) of adverse health effects following chemical exposures. It requires consideration of the toxic properties of the chemicals, the presence of receptors, and the existence of exposure pathways to the receptors. When all three factors are present (*i.e.*, chemicals, receptors and exposure pathways), there is a potential for adverse health effects to occur if exposures to the chemicals are elevated above acceptable levels (Figure 7-1)

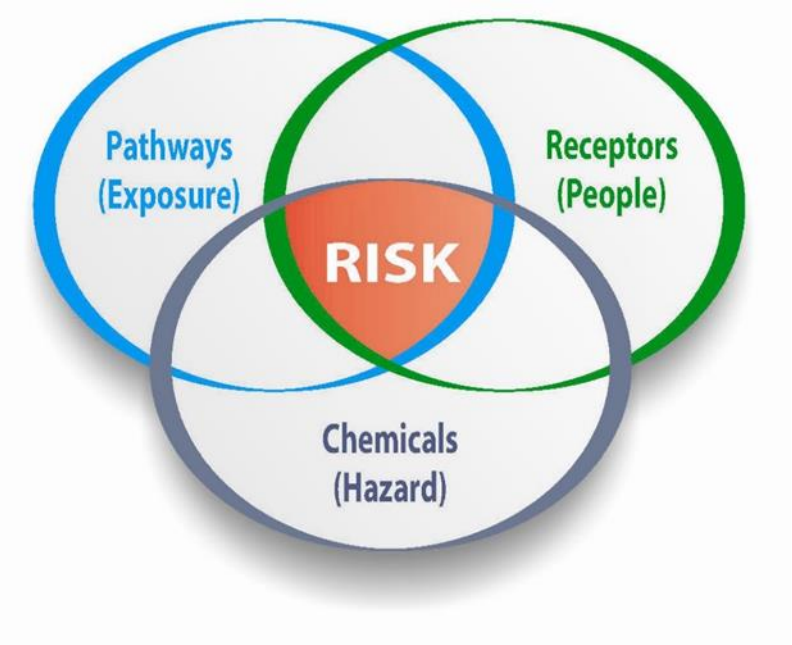

Figure 7-1 Factors Required for a Risk of Health Effects

The following subsections describe the results of the risk characterization phase. ERs and ILCRs were approximated for all COPCs associated with both non-cancer (threshold dose-response mechanisms) and cancer endpoints (non-threshold dose response mechanisms), respectively. ER and ILCR values have been presented for each exposure scenario.

Under typical ambient environmental exposure conditions, humans are exposed to complex mixtures of chemicals, rather than individual compounds. There can be a variety of types of interactions between chemicals in environmental mixtures that can alter the overall absorption, toxicokinetics, toxicodynamics, and toxicity of metals in humans and animals. Additivity of chemical toxicity occurs when chemicals have a similar mode or toxicological mechanism of action. The effect of a mixture of chemicals can be estimated from the sum of the exposure levels (weighted for potency), or the effects of the individual components. Since the COPCs at this site are inorganics and inorganic compounds tend to act via independent and unique modes of action, mixture effects were not considered.

For COPCs assessed in the HHRA, oral TRVs were used to predict risks associated with dermal exposure routes due to a lack of pathway-specific values. Therefore, oral and dermal risk estimates were summed to produce a total oral+dermal ER for threshold COPCs and a total oral+dermal ILCR for non-threshold COPCs.

7.1 Results of Sediment and Surface Water Exposure Assessment

Modelling outputs are provided in Appendix C, and include EPCs, receptor specific exposure estimates and ERs or ILCRs by pathway. Table 7-1 provides a summary of the ERs and ILCRs by pathway and COPC for swimming exposures, whereas Table 7-2 provides a summary of risks from sediment exposures. The assessment results are based on the data collected to date for the Study Area and exposure assumptions used in the assessment.

Table 7-1 Risks Related to Surface Water Exposure from Swimming

COPCs and Scenario	ER				ILCR			
	Oral Exposure (surface water)	Oral Exposure (suspended sediment)	Dermal Exposure	Total ER – Surface Water	Oral Exposure (surface water)	Oral Exposure (suspended sediment)	Dermal Exposure	Total ILCR – Surface Water
High Contact – Low Frequency								
Arsenic – Toddler	0.011	0.013	0.0013	0.025	-	-	-	-
Mercury - Toddler	1.08E-6	0.00013	1.31E-7	0.00013	-	-	-	-
Arsenic - Adult	-	-	-	-	1.3E-06	1.5E-06	4.4E-07	3.2E-06
Low Contact – High Frequency								
Arsenic – Child	0.023	0.016	0.0046	0.044	-	-	-	-
Mercury - Child	2.35E-6	0.00033	4.78E-7	0.00033	-	-	-	-
Arsenic – Adult	-	-	-	-	5.7E-06	4.1E-06	1.9E-06	**1.2E-05**

Bolded values exceed the acceptable ER of 0.2 or ILCR of 1E-05

Table 7-2 Risks Related to Sediment Exposure

COPCs and Scenario	ER			ILCR		
	Oral Exposure (hand to mouth)	Dermal Exposure	Total ER – Sediment	Oral Exposure (hand to mouth)	Dermal Exposure	Total ILCR – Sediment
High Contact – Low Frequency						
Arsenic – Toddler	0.11	0.10	**0.22**	-	-	-
Mercury - Toddler	0.0012	0.01	0.02	-	-	-
Arsenic - Adult	-	-	-	4.0E-06	**3.5E-05**	**3.8E-05**
Low Contact – High Frequency						
Arsenic – Child	0.12	0.13	**0.27**	-	-	-
Mercury - Child	0.0024	0.04	0.04	-	-	-
Arsenic – Adult	-	-	-	**1.1E-05**	**5.3E-05**	**6.4E-05**

Bolded values exceed the acceptable ER of 0.2 or ILCR of 1E-05

Risks Related to Swimming (surface water and suspended sediment ingestion and dermal absorption):

- Non-cancer risks related to surface water dermal contact or ingestion through swimming activities are negligible for both mercury and arsenic, in both the low frequency and high frequency scenarios. Negligible risk means that the exposures are so low they are considered to have an insignificant impact on human health. Incremental cancer risk related to arsenic is negligible for the low frequency scenario but is marginally above the acceptable level of 1.0E-05, at 1.2E-05 for the high frequency scenario. The assumptions in the high frequency scenario assume 26 swimming events per year, over a 56 year timeframe (assumed lifespan of adult), and assume ingestion of a mouthful (total of 50 ml) of water in each swimming event, in conjunction with incidental ingestion of suspended sediments and dermal exposure.

Risk Related to Sediment Exposures (incidental ingestion and dermal contact)

- Risks related to sediment contact or ingestion through wading or playing activities are negligible for mercury in both scenarios.
- Risks related to arsenic through sediment contact or ingestion marginally exceed an ER of 0.2, and also exceed the acceptable benchmark of 1E-05, in both scenarios. The assumptions in the high frequency scenario assume 26 sediment contact events per year, over a 56 year timeframe (assumed lifespan of adult), whereas the low frequency scenario assumes 6 sediment contact events per year (over a lifetime). Due to the tendency of sediments to adhere to skin, exposures (and hence risks) related to dermal contact with sediments are higher than other pathways.

7.2 Results of Fen Exposure Assessment

The results of the fen exposure assessment are presented in Table 7-3.

Table 7-3 Risks Related to Exposure to Fen Soils

COPCs and Scenario	ER			ILCR		
	Oral Exposure (hand to mouth)	Dermal Exposure	Total ER – Fen	Oral Exposure (hand to mouth)	Dermal Exposure	Total ILCR – Fen
High Contact – Low Frequency						
Arsenic – Toddler	0.061	1.79E-03	0.0623	-	-	-
Mercury - Toddler	0.0002	7.13E-05	0.000249	-	-	-
Arsenic - Adult	-	-	-	1.9E-06	5.6E-07	2.47E-06
Low Contact – High Frequency						
Arsenic – Child	0.033	3.6E-03	0.037	-	-	-
Mercury - Child	0.0001	1.43E-04	0.00024	-	-	-
Arsenic – Adult	-	-	-	8.3E-06	2.4E-06	**1.07E-05**

Bolded values exceed the acceptable ER of 0.2 or ILCR of 1E-05

Risk Related to Fen Exposures (incidental ingestion and dermal contact)

- Non-cancer risks related to dermal contact or ingestion of fen soils through hiking, walking or biking activities are negligible for both mercury and arsenic, in both the low frequency and high frequency scenarios. Incremental cancer risk related to arsenic is negligible for the low frequency scenario but is marginally above the acceptable level of 1.0E-05, at 1.07E-05 for the high frequency scenario. The assumptions in the high frequency scenario assume 26 hiking or walking events per year, over a 56 year timeframe (assumed lifespan of adult), and assume incidental ingestion of soils and dermal exposure. The fen has low arsenic concentrations in most areas, with the exception of the eastern part of the property near Mitchell's Brook, where some elevated concentrations are present (see Figure 2-5).

7.3 Fish Consumption Assessment

Risks related to consumption of fish from the Study area are presented in Table 7-4.

Table 7-4 Risks Related to Fish Consumption

Fish Species	Fish Length	General Public (> 12 yrs)	Women who are of may be pregnant and/or breast feeding	Child (age 5 – 12)	Child (age 1-4)	Infants (< 1 year)
Mercury						
Brook Trout	< 25 cm	0.16	0.18	0.14	0.14	0.18
	>25 cm	0.11	0.06	Avoid	Avoid	Avoid
Smallmouth Bass	<35cm	0.18	0.14	0.44	Avoid	Avoid
Arsenic – Non Cancer (inorganic)						
Brook Trout	<25 cm	0.05	0.03	0.02	0.02	0.03
	>25 cm	0.02	0.005	Avoid	Avoid	Avoid
Smallmouth Bass	<35 cm	0.06	0.02	0.06	Avoid	Avoid
Arsenic – Organic (DMA+MMA+TMAO)						
Brook Trout	<25 cm	0.0055	0.0028	0.002	0.002	0.0027
	>25 cm	0.003	0.0007	Avoid	Avoid	Avoid
Smallmouth Bass	<35 cm	0.0067	0.15	**0.48**		
Arsenic - Cancer						
Brook Trout	<25 cm	**2.79E-05**	**1.4 E-05**	**1.04E-05**	**1.03 E-05**	**1.35E-05**
	>25 cm	**1.05E-05**	2.46E-06	Avoid	Avoid	Avoid
Smallmouth Bass	<35 cm	**3.00E-05**	9.99E-06	**3.22E-05**	Avoid	Avoid

Bolded values exceed the acceptable ER of 1.0 for mercury, or 0.2 for arsenic or ILCR of 1E-05; where “avoid” is indicated, it is based on the Provincial consumption advisory (Province of Nova Scotia, 2019)

Risks Related to Fish Consumption:

- Risk related to mercury in fish tissue of either Brook Trout or Smallmouth bass are negligible, as long as consumption rates are in keeping with the current Provincial consumption advisory.
- Risks related to arsenic marginally exceed the acceptable risk level of 1E-05 for both Brook Trout and Smallmouth bass for some age categories, based on the assumption that all fish consumed comes from the Barry’s Run area, and that consumption rates equal those cited in the Provincial consumption advisory.

7.4 Risks Related to Combined Exposures

It is possible that exposures could occur through swimming and sediment exposure and fen soil exposure. Hence, these scenarios were combined in Table 7-5 to consider this issue. The risks based on these added exposures increase slightly but are not markedly increased over those previously presented.

Table 7-5 Risks related to Surface water, Sediment and Fen Combined

COPCs and Scenario	ER				ILCR			
	Total ER (surface water)	Total ER (sediment)	Total ER (fen)	Total ER	Total ILCR (surface water)	Total ILCR (sediment)	Total ILCR (fen)	Total ILCR –
High Contact – Low Frequency								
Arsenic – Toddler	0.025	0.21	0.062	**0.29**	-	-	-	-
Mercury - Toddler	0.00013	0.01	0.00025	0.01	-	-	-	-
Arsenic - Adult	-	-	-	-	3.2E-06	**3.8E-05**	2.5E-06	**4.4E-05**
Low Contact – High Frequency								
Arsenic – Child	0.044	**0.25**	0.037	**0.33**	-	-	-	-
Mercury - Child	0.00033	0.04	0.00025	0.04	-	-	-	-
Arsenic – Adult	-	-	-	-	**1.2E-05**	**6.4E-05**	**1.07E-05**	**8.7E-05**

Bolded values exceed the acceptable ER of 0.2 or ILCR of 1E-05

7.5 Risks Related to Sediment Mobilization

Another important factor to consider, with respect to risks related to this Study area, is that disturbance of the sediments (through recreational activities, or storm water release or flow) can result in mobilization of arsenic contaminated sediments to down stream areas. This is an important factor that must be considered in risk management of this area, which is unrelated to actual risks to site users of Barry's Run, but links to site users further downstream. This factor should drive risk management measures until further information is available in the Conceptual Closure Plan for the Montague Mines site.

8.0 UNCERTAINTIES

There is no prescribed “off the shelf” model or single approach to conduct a HHRA such as the current assessment developed to evaluate health risks in the Barry’s Run area. As such, many decisions are made during the course of the assessment that can influence the outcome of the assessment. The quantitative, or numerical, risk assessment requires the input of large amounts of data and numerical variables. Some of these input variables can be obtained from the general published literature, while other information must be area-specific and were obtained through our understanding of the area and its current use. It must be realized that the goal of quantitative exposure assessment is to produce a conservative model to ensure that risks are not underestimated.

Each of the decisions and input variables contain some element of variability and uncertainty and can affect the outcome of the assessment to some degree. This leads to some amount of “uncertainty” with the final results and conclusions. Risk managers need to know the uncertainties surrounding the study conclusions so that they can make recommendations accordingly (e.g., recommend additional experimentation or monitoring and/or risk management).

A summary of key uncertainties and limitations of the assessment include the following:

- Exposure assumptions related to frequency and duration of swimming, fen use, and sediment exposures considered input from field personnel and some local knowledge based on observations but may not adequately capture actual usage frequency by local residents, or future land users. Public consultation and input would be important for refinement of assumptions related to both past, and potential future land use, in order to finalize possible risk management needs.
- Swimmers were assumed to ingest a mouthful of water during every swimming event. This is likely an overestimate.
- The selection of COPCs, arsenic and mercury, is considered appropriate. As discussed in Appendix B, some other metals exceeded NS Tier 1 EQS, most of which were within background ranges, and hence, not considered to merit further study. Cobalt was above background ranges, and above NS Tier 1 EQS, but based on the conclusions of the assessment related to arsenic (which was more predominantly and frequently over NS Tier 1 EQS than cobalt), the presence of cobalt in sediments is not expected to alter the conclusions of the assessment.
- The number of sediment and surface water samples were adequately comprehensive to characterize exposure potential, but some fluctuations of surface water concentrations may occur during storm events. It is considered unlikely that swimming would occur in storm events, and hence, markedly increased exposures related to surface water concentrations are not anticipated. The fish data were limited, when considered on a fish size basis for some size categories. There were only 3 Brook trout > 25 cm, and no Smallmouth bass > 35 cm. Therefore, conclusions related to these size groups in particular are uncertain.
- Surface waters, sediments and fish tissues were only analyzed for total mercury, rather than inorganic and methyl mercury. All mercury in fish tissues was assumed to be methylated, which is a conservative assumption. All mercury in sediments and surface waters was assumed to be inorganic. Some authors indicated that surface water could contain 5.6% methyl mercury (Krabbenhoft et al, 1999) and sediments 2% methyl mercury (US EPA 2005). Estimates of this magnitude would not have a substantial effect

on risk conclusions. It is plausible that methyl mercury could represent a high percentage of total mercury in either medium, but based on the low concentrations of mercury in surface waters (non-detect) and sediments (less than NS Tier 1 residential soil guidelines in almost all samples), it is unlikely that risk conclusions would change dramatically.

- The sampling data from Bureau Veritas (BV) was used to characterize exposures, whereas the analytical data from ESG was used to characterize bioaccessibility for both sediments and fish tissues, as well as fish tissue speciation. This was considered an appropriate approach, as the BV sediment analysis followed standard environmental analytical procedures used for environmental site characterization (sieving to 2 mm size fraction), whereas the ESG dataset required sieving to 150 microns for bioaccessibility testing.
- Sediment adherence factors were characterized based on Health Canada (2017b). The scientific literature supporting these assumptions are based on a tidal flat exposure scenario, which differs from the characteristics of the Study area. There is no tidal influence at this site, exposing large areas of wetted sediments, which could result in higher sediment exposures and adherence during play activities. Adjustments were made based on consideration of this issue, such that a 10-fold “rinsing” factor was applied to the sediment adherence on feet. The risks would increase if this rinsing factor were removed, but the conclusions of the assessment for mercury would remain unchanged, whereas cancer risk related to arsenic would increase by a factor of 5-fold.
- Sediments 19-4 and 19-6 were located in depositional zones, wherein a layer of organic matter (0.1 to 0.2 m deep) was deposited over sediments (see Appendix A). This layer could act as a protective layer, further minimizing exposure to tailings, if present in underlain sediments.
- Oral bioaccessibility data for sediments included 5 samples. This number of samples is limited and hence associated with some degree of uncertainty, but consideration of the bioaccessibility data from the main tailings area (ESG, 2009; n = 19), and the similarities between the datasets suggests that the sediments with high arsenic concentrations (which likely contain tailings) are associated with low arsenic bioaccessibility, and hence the data are considered adequately representative.
- Oral bioaccessibility analysis for fen samples was not conducted. The data from the sediment bioaccessibility testing was assumed to adequately characterize the fen samples. Oral exposure risks are low, and the application of higher bioaccessibility assumptions is unlikely to significantly change conclusions.
- Dermal bioavailability for arsenic was characterized by Lowney et al, 2009. This paper pertains to arsenic pesticide contaminated soils, which may have higher dermal bioaccessibility than those in the current study. Therefore, this assumption is considered to be conservative.
- Some compositing of fish tissues was required in order to obtain enough tissue mass for the various analyses (see Appendix A). F-01, F-07 and F-10 were composite samples. In all cases, fish from the same area (reach) were composited (as opposed to fish from differing reaches, wherein exposures could have varied more). Fish size was within the provincial guidance (< or > 25 cm) for composites F-07 and F-10. For F-01, 3 fish were composited, two of which were < 25 cm, and 1 of which was slightly above 25 cm, at 25.4 cm. This was not considered to have a bearing on the risk results.
- Fish speciation and bioaccessibility was also limited in terms of sample size. Therefore, there is uncertainty related to conclusions associated with speciation and bioaccessibility. A larger dataset would assist in reducing these uncertainties. Maximum speciation and bioaccessibility results were used, where sample sizes were limited.

- Fish consumption risks were based on the assumption that all fish consumed came from Barry's Run. This is considered conservative, as fishing could be occurring in any number of lakes and streams. In addition, it is uncertain how long fish were resident in Barry's Run prior to being caught, and whether fish caught in other seasons may have differing exposures. Additional data collection could reduce uncertainties related to this issue. In addition, the smallmouth bass fish may largely be catch and release, and hence, theoretical risk calculations may be overstated, relative to actual consumption.
- In the derivation of limits by regulatory agencies, large uncertainty factors (i.e., 100-fold or greater) were used in the estimation of the reference dose (RfD) for threshold-type chemicals. These uncertainty factors were applied to exposure levels from studies where no adverse effects are observed (i.e., to the NOAEL). Thus, exceeding the toxicological criterion does not mean that adverse effects would occur. Exposures greater than the calculated toxicological criterion may also be without risk (i.e., below the threshold for adverse effects in humans), but this could not be, or was not, determined by the agency which derived the toxicological criterion. Humans were assumed to be the most sensitive species with respect to toxic effects of chemical. However, for obvious reasons, toxicity assays are not generally conducted on humans, so toxicological data from the most sensitive laboratory species were used in the estimation of toxicological criteria for humans.
- In the case of arsenic, there is agreement in the published literature that the methods used to estimate the oral toxic potency of arsenic based on exposures of Taiwanese populations to arsenic in drinking water would significantly overestimate cancer risks at lower levels of exposures, such as that experienced by the general North American population. The use of such data would thus result in an overestimation of cancer risk for the populations within the study area.
- TRVs, because of their inherent conservatism, are widely considered protective of sensitive subgroups and lifestages. However, risk assessment, and TRV's and environmental quality guidelines for that matter, can only protect most of the people, most of the time. There can always be those individuals that are hypersensitive, and those situations require special consideration. But risk assessments do not investigate these situations unless there is clear evidence that such a situation exists in the study area. There is no such evidence of this in the study area.
- An ecological risk assessment was outside the scope of the current assessment but will be conducted as part of the Stage 2 Conceptual Closure project for the historic Montague Mines site.

9.0 SUMMARY OF CONCLUSIONS AND RISK MANAGEMENT NEEDS

Based on the data and assumptions used in the assessment, the following conclusions can be drawn:

- Infrequent swimming in Barry's Run and Mitchell's Brook within the Study area boundary (< 20 times/year) is estimated to have negligible risk levels for both arsenic and mercury, as long as sediment exposure is minimized. Negligible risk means that the exposures are so low they are considered to have an insignificant impact on human health.

- Sediment contact related to wading or swimming activities within Barry's Run and Mitchell's Brook was predicted to have negligible risk related to mercury. While sediment exposures for arsenic are associated with marginally increased risk levels relative to acceptable levels, it is uncertain whether the exposure assumptions used in the assessment reflect current or possible future land use patterns. Therefore, it is recommended that sediment contact be minimized until exposure assumptions can be further adjusted based on improved knowledge of public usage and as future land use in and around Barry's Run is more defined. Ultimately, clear statements related to site usage and risk management should be provided for area residents, and the assessment should reflect input from local land users related to exposure assumptions.

- Contact with soils along the fen was predicted to be associated with negligible risk levels, with the exception of the high hiking frequency scenario (which assumed 26 hikes or walking events per year, over a 56 year timeframe), wherein risks related to arsenic were marginally elevated.

- Fish consumption risks due to mercury levels in Brook trout and Smallmouth bass are negligible, as long as consumption rates are in keeping with the current Provincial fish consumption advisory. Risks related to arsenic in Brook trout and Smallmouth bass tissues marginally exceed acceptable risk levels for both species of fish, based on the assumption that all the fish people consume comes from Barry's Run, and that fish consumption rates equal those cited in the Provincial consumption advisory. These assumptions likely overestimate the amount and frequency of fish consumption from Barry's Run. Hence, a fish consumption advisory is unlikely to be needed, but input from the local fishing population, Nova Scotia Department of Health and Nova Scotia Department of Fisheries and Aquaculture should be sought prior to finalizing decisions related to the need for a consumption advisory.

Given the current levels of arsenic in sediments within Barry's Run and based on the assumptions related to current usage and exposure, risks are considered low, as the predicted exceedances are marginal using relatively high exposure scenarios which are likely conservative assumptions. Risk management is currently being implemented through public health warning signage, which instructs people to avoid disturbing the sediments, swimming, or consuming fish, until further notice. It is recommended that input be obtained on the exposure assumptions, so that the assessment can be refined to reflect intended use, for the purposes of finalizing risk management needs. Based on the results of this assessment, there is no need for additional risk management at this time, and the existing risk management approach (signage) should remain in place, in order to reduce the potential for sediment disturbance and mobilization downstream while a final closure plan for Montague Mines is being completed. In addition, the final closure project currently underway for the Montague Mines site is expected to

further reduce concentrations of arsenic (and mercury) in surface waters, and suspended sediment deposition in the study area. Additional study and design are currently underway on this closure plan.

The fen is likely acting as a sink for arsenic impacted sediments from upstream areas. Future land development involving release of storm waters to this area, or disturbance of sediments by public land users (through ATV usage in upgradient stream areas or dirt biking on exposed tailings at the Montague Mines site), has the potential to mobilize sediments in these areas and transport them further downstream into Lake Charles, if not properly managed.

10.0 DOCUMENT SIGN-OFF

Intrinsik Corp. (Intrinsik) has provided this report to NS Lands solely for the purpose stated in the report. The information contained in this report was prepared and interpreted exclusively for NS Lands, and may not be used in any manner by any other party. Intrinsik does not accept any responsibility for the use of this report for any purpose other than as specifically intended by NS Lands. Intrinsik does not have, and does not accept, any responsibility or duty of care whether based in negligence or otherwise, in relation to the use of this report in whole or in part by any third party. Any alternate use, including that by a third party, or any reliance on or decision made based on this report, are the sole responsibility of the alternative user or third party. Intrinsik does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The HHRA has been performed in accordance with accepted practice and usual standards of thoroughness and competence for the profession of toxicology and human health risk assessment. Any information or facts provided by others, and referred to or utilized in the preparation of this report, is believed to be accurate without any independent verification or confirmation by Intrinsik. The information, opinions and recommendations provided within the aforementioned report have been developed using reasonable and responsible practices, and the report was completed to the best of our knowledge and ability.

Intrinsik Corp.

Christine Moore, M.Sc.
Senior Scientist

Elliot Sigal, B.Sc. (Hon.), QPRA, UKRT, ERT
Vice President/Senior Toxicologist

wood.

Chris Elliot, P.Eng.
Principal Environmental Engineer; Site Professional

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NOVA SCOTIA LANDS/INTRINSIK CORP.

Field Work Component in Support of Human Health Risk Assessment

Port Wallace, Dartmouth, NS

January 2020 - 19-1567

January 13, 2020

NOVA SCOTIA LANDS
Harbourside Place
Harbourside Commercial Park
45 Wabana Court
Sydney, NS
B1P 0B9

Attention: Mr. Donnie Burke

Report on Field Work Component in Support of Human Health Risk Assessment of Recreational Exposure Scenarios, Port Wallace, Dartmouth, Nova Scotia

Dillon Consulting Limited (Dillon) is pleased to present the following report detailing field work components in support of the Human Health Risk Assessment of Recreational Exposure Scenarios for the Halifax Regional Municipality (HRM) properties along Mitchell's Brook and Barry's Run (the site) which are located at Port Wallace within Dartmouth, Nova Scotia, with parcel identification designations (PID No.) 413071789 and 41376898, respectively.

Dillon would like to thank Nova Scotia Lands and Intrinsik Corp. for the opportunity to work together on this project. If you have any questions or comments regarding this report, please to not hesitate to contact the undersigned.

Sincerely,

DILLON CONSULTING LIMITED

Rebecca Appleton, P.Eng.
Project Manager

Lisa Marshall, PBD, MES
Senior Technical Review

RMA:jes
cc: Christine Moore, Intrinsik Corp.

Our file: 19-1567-1000

DILLON CONSULTING

137 Chain Lake Drive
Suite 100
Halifax
Nova Scotia
Canada
B3S 1B3
Telephone
902.450.4000
Fax
902.450.2008

Dillon Consulting Limited

Table of Contents

Figures

Appendices

References

1.0 Introduction

Dillon Consulting Limited (Dillon) is pleased to present the following report detailing field work components in support of the Human Health Risk Assessment (HHRA) for the Halifax Regional Municipality (HRM) properties along Mitchell's Brook and Barry's Run (the Site). The properties are located at Port Wallace within Dartmouth, Nova Scotia, with parcel identification designations (PID No.) 413071789 and 41376898, respectively. Dillon's Phase I/II ESA (Dillon, 2019) identified arsenic and mercury impacts at the Site from historical mining activities at the upstream former Montague Mines site. A site location map is presented on Figure 1.

Parts of Mitchell's Brook and Barry's Run are currently used for recreational purposes such as fishing and swimming. Given the degree of chemical impact identified in Mitchell's Brook and Barry's Run during the Phase I/II ESA (Dillon, 2019), the current recreational use of the area and its proposed future residential development, an assessment of potential human health risks associated with recreational exposures from the Site was initiated by the Province (through Nova Scotia Lands). The assessment of potential human health risks is being completed by Intrinsik Corp. (as part of the Mine Closure team which includes Wood, EcoMetrix and Klohn Crippen Berger) for the overall area, including the Site, in addition to the former Montague Mine site. Dillon was retained to collect additional data from the Site to be used by Intrinsik Corp. in their completion of an HHRA for the area and the site.

This report details the methodology, field observations and analytical results from the field work components in support of the HHRA being completing on the Site.

1.1 Objectives

The objectives of this project were as follows:

1. Further delineate metals surface soils/organics contamination in the fen immediately adjacent to Barry's Run and Mitchell's Brook;
2. Determine the in vitro bioaccessibility (IVBA) of arsenic in site sediments;
3. Determine arsenic (including speciation) and total mercury concentrations of arsenic in fish tissue from areas of the site where recreational fishing occurs;
4. Examine arsenic and mercury concentrations and sediment flux in surface water entering and leaving the Site through monthly surface water sampling; and,
5. Provide analytical results to the Nova Scotia Lands/Intrinsik Corp. team.

NOVA SCOTIA LANDS / INTRINSIK CORP.

FIELD WORK COMPONENT TO SUPPLEMENT DATA FOR THE HHRA - PORT WALLACE

SITE LOCATION MAP
FIGURE 1

DILLON CONSULTING

MAP/DRAWING INFORMATION
National Topographic System Mapsheet 11D/12.

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CHECKED BY: RMA
DESIGNED BY: SMG

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PROJECT: 19-1567

DATE: JANUARY 2020

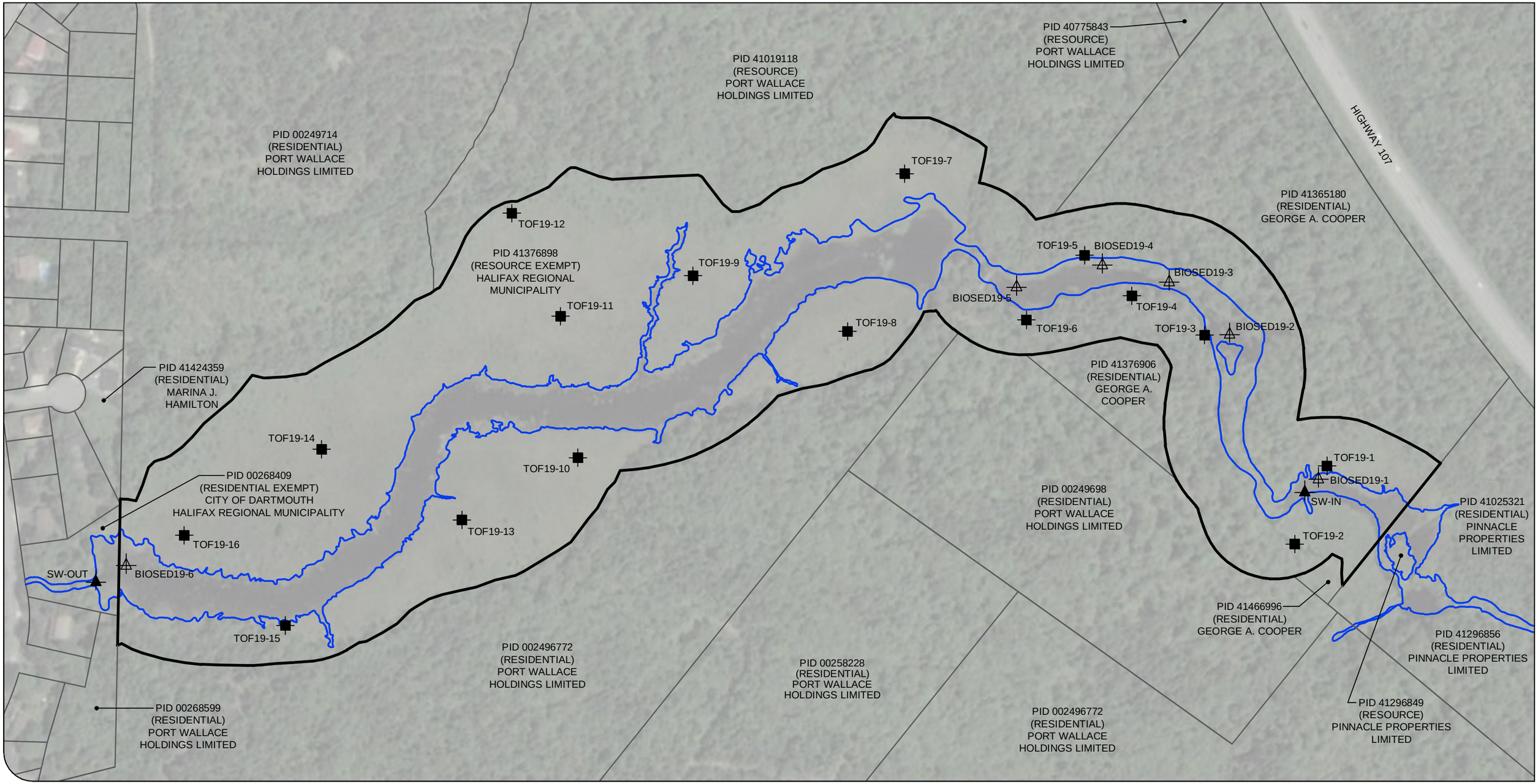
2.0 Field Work Components in Support of the Human Health Risk Assessment

2.1 Sediment and Surface Soil/Organics Sample Collection

On September 24, 2019, Dillon field personnel waded into the Barry's Run and Mitchell's Brook waterways and collected sediment samples from the bottom of the channel with a spade shovel in six sample locations (BIOSED19-1 to BIOSED19-6), which based on visual observations, appeared to contain minerogenic material believed to be mine tailings originating from the former Montague Mine site upstream. Upon completion, each sample was drained of excess water and then placed into a laboratory supplied container as a bulk sample. The samples were submitted to Bureau Veritas in Bedford, NS for total arsenic and total mercury analysis. Sample locations are presented on Figure 2. Upon receipt of analytical results from Bureau Veritas, five of the sediment samples (BIOSED19-1, 19-2, 19-4, 19-5 and 19-6) were submitted to the Royal Military College of Canada (RMC) Laboratory in Kingston, Ontario for total arsenic and bioaccessibility analysis. The five sediment samples sent to RMC were chosen to ensure a range of concentrations and areas of the Site were represented.

On September 24, 2019, Dillon field personnel collected surface soil/organics within the top 0.20 meters of the fen immediately adjacent to the Barry's Run and Mitchell's Brook waterways with a spade shovel in sixteen sample locations (TOF19-1 to TOF19-16). Upon completion, each sample was placed into a large zip lock bag as a bulk sample. The samples were submitted to Bureau Veritas in Bedford, NS for metals (including mercury) analysis. Sample locations are presented on Figure 2. Locations were strategically placed to achieve horizontal coverage across the two HRM land parcels which make up the Site.

Upon receipt of the laboratory analysis from Bureau Veritas, it was identified that Bureau Veritas did not analyze the surface soil / organics samples collected from the top of the fen for mercury. Since Bureau Veritas did not have adequate sample remaining to analyze for mercury, Dillon re-sampled the surface soil / organics in the same sixteen sampling locations within the top 0.20 meters of the fen immediately adjacent to the Barry's Run and Mitchell's Brook waterways on January 6, 2020. Two blind field duplicate samples (TOF20-FD1 and TOF20-FD2) were also collected and submitted to Bureau Veritas for mercury analysis.



NOVA SCOTIA LANDS / INTRINSIK CORP.

FIELD WORK COMPONENT TO SUPPLEMENT DATA FOR THE HHRA - PORT WALLACE

SAMPLING PLAN

FIGURE 2

SUBJECT PROPERTY LINE

PROPERTY LINE

TOP OF FEN SOIL / ORGANICS SAMPLES (TOF) (SEPT. 2019)

SURFACE WATER SAMPLE (SEPT., NOV. AND DEC. 2019)

SEDIMENT SAMPLE (SEPT. 2019)

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MAP/DRAWING INFORMATION
Nova Scotia Property Online and Dillon Consulting Limited site visits. Property lines are approximate only. This is not a legal survey.

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NOTE:
INFRASTRUCTURE LOCATIONS ARE APPROXIMATE ONLY.

PROJECT: 19-1567

DATE: JANUARY 2020

2.2 Surface Water Sample Collection

Dillon field personnel collected surface water samples at two locations, SW-IN located at the top of Mitchell's Brook and SW-OUT located at the bottom of Barry's Run (Figure 2) for three consecutive sampling events (September 25, November 13, and December 3, 2019 respectively). During the December 3, 2019 event, surface water samples were collected at the end of a rain event to capture potential variance associated with an influx of rainwater to the waterways. Significant precipitation (rain) fell the day prior to the November 13, 2019 surface water sampling event. Less than 5 mm of rain was recorded on November 13, 2019.

Surface water samples were collected and placed into laboratory supplied containers. Each sample was submitted to Bureau Veritas in Bedford, Nova Scotia (NS) for laboratory analysis of general chemistry, total and dissolved metals including mercury, dissolved organic carbon (DOC) and total suspended solids (TSS).

2.3 Fish Tissue Sample Collection

Between September 18 and 26, 2019, fish were caught from the shoreline of Barry's Run and Mitchell's Brook within the Site, using various techniques, including angling and fly-fishing. Twenty fish were collected in total; seven smallmouth bass and 13 brook trout. Sample lengths and whole fish weights were measured and recorded (See Appendix B, Table 3). The fish samples were de-headed and gutted and weighed. These weights represent the processed weight. The processed weights were used to create 16 fish fillet tissue samples. When required, fish of the same species collected from the same area of the site were composited to make up the required sample weight for one sample (i.e., samples F19-01, F19-07 and F19-10). Fish tissue samples (i.e., fillets) were stored on ice in a cooler in the field and placed in a freezer upon return to Dillon's office. The sixteen samples were submitted to Bureau Veritas laboratory in Burnaby, BC, for total arsenic and total mercury analysis. The Burnaby lab was selected as it was able to provide lower detection limits for the tissue samples than the Halifax lab.

Upon receipt of analytical results from Bureau Veritas, five of the fish fillet samples (F19-01, F19-02, F19-03, F19-07 and F19-14) were submitted to the RMC Laboratory in Kingston, Ontario for total arsenic, arsenic speciation and arsenic bioaccessibility analysis. The five samples sent to RMC were chosen based on the following considerations to ensure representative samples:

- Total arsenic (based on analytical results received from Bureau Veritas for the 16 fish tissue samples collected);
- Size of the fish (to represent those which would be more likely be consumed by humans);
- Type of fish so that, where available, both species observed on the Site were represented; and,
- Location where fish were caught to confirm fish caught in both Barry's Run and Mitchell's Brook were represented.

3.0 Findings

3.1 Field Observations

3.1.1 Sediment and Surface Soil/Organic Sample Collection

Field observations of the sediment (minerogenic material) sampled during field activities are presented in Table 1 in Appendix B. Five of the six samples were collected from the Mitchell's Brook portion of the site (BIOSED19-1 to BIOSED19-5). The sediment within Mitchell's Brook collected from samples BIO19-1, BIOSED19-2, BIOSED19-3 and BIOSED19-5 consisted of grey, dense, fine-grained minerogenic material that was visually observed from water surface along the bottom of the channel in areas where organic matter had been scoured out by turbulent water. It is assumed that the minerogenic material is mine tailings originating from the former Montague mine located upstream of the Site. In areas where sediment was not visually observed from water surface (sample location BIOSED19-4 and BIOSED19-6), sediment was identified below 0.1 to 0.2 meters of organic matter.

Field observations of the surface soil/organic samples collected from the fen during field activities are presented in Table 1 in Appendix B. The soil/organics within the top 0.2 meters of the fen adjacent to Barry's Run and Mitchell's Brook consisted of organic-rich material comprised mainly of sphagnum and grass-like sedges root mass and dark brown hydric soil.

3.1.2 Surface Water Sample Collection

Field parameters measured from surface water quality during field activities are presented in Table 2 in Appendix B. Surface water was clear with light tannin staining during all three sampling events. During the first two sampling events (September 25, and November 13, 2019) there were no visual signs of suspended organics at both SW-IN and SW-OUT. During the third sampling event (December 3, 2019) there was visual signs of suspended organic matter at SW-IN.

3.1.3 Fish Tissue Sample Collection

Field observations from the fish tissue sample collection field activities are presented in Table 3 in Appendix B. Twenty fish were collected in total; seven smallmouth bass and 13 brook trout. Sixteen fish were caught in Barry's Run and four fish were caught in Mitchell's Brook. Both brook trout and smallmouth bass were caught in Barry's Run. Brook trout were also caught in Mitchell's Brook; however, no smallmouth bass were caught in Mitchell's Brook. Eight of the fish were observed to be female fish with eggs.

3.2 Laboratory Analytical Results

3.2.1 Sediment

3.2.1.1 Arsenic and Mercury in Sediment

Laboratory analytical results for arsenic and mercury in sediment are presented in Table 1 in Appendix C and Figure 3. Laboratory analytical certificates are attached in Appendix D.

3.2.1.2 Bioaccessibility and Total Arsenic in Sediment

Laboratory analytical results for bioaccessibility and total arsenic in sediment are presented in Appendix D. Bioaccessibility ranged from 6.9% in BIOSED19-1 to 31% in BIOSED19-6.

3.2.2 Metals in Surface Soils/Organics

Laboratory analytical results for metals in the surface soil/organic samples collected from the top of fen are presented in Table 1 in Appendix C and Figure 3 (for arsenic and mercury only). Laboratory analytical certificates are attached in Appendix D.

3.2.2.1 Field QA/QC Results

As previously discussed, the surface soil / organics was re-sampled in the sixteen sample locations on January 6, 2020 and submitted for mercury analysis. Two blind field duplicate samples were collected and submitted to Bureau Veritas for mercury analysis; one at sample location TOF19-5 (TOF20-FD1) and one at sample location TOF19-8 (TOF20-FD2). The analytical results are presented in Table 1 in Appendix C.

Acceptable quality assurance relative percent difference (RPD) ranges for blind field duplicate samples are less than 40% at concentrations greater than five times the detection limit. Mercury was not detected above the detection limit in sample TOF19-8 or the field duplicate collected at this location (both results were reported as <0.05 mg/kg). The concentration of mercury in sample TOF19-5 (1.0 mg/kg) is less than five times the detection limit (detection limit of 0.3 mg/kg). A such, RPD calculations could not be performed on these samples.

3.2.3 Surface Water

Laboratory analytical results for general chemistry parameters, metals, total suspended solids and dissolved organic carbon in surface water are presented in Table 2 in Appendix C. The results of arsenic and mercury in surface water are summarized on Figure 4. Laboratory analytical certificates are attached in Appendix D.

3.2.3.1 Sediment Flux

The scope of work for this project included examining the monthly surface water analytical data to estimate sediment flux of arsenic and mercury entering Mitchell's Brook and leaving Barry's Run at the boundaries of the Site. The goal was to understand the level of suspended particulate being transported into and out of the Site to provide baseline information. The estimation of sediment flux is dependent on the concentration of Total Suspended Solids (TSS) in surface water. The analytical results showed that TSS was not detected in any of the surface water samples submitted and as such, it was not possible to estimate sediment flux.

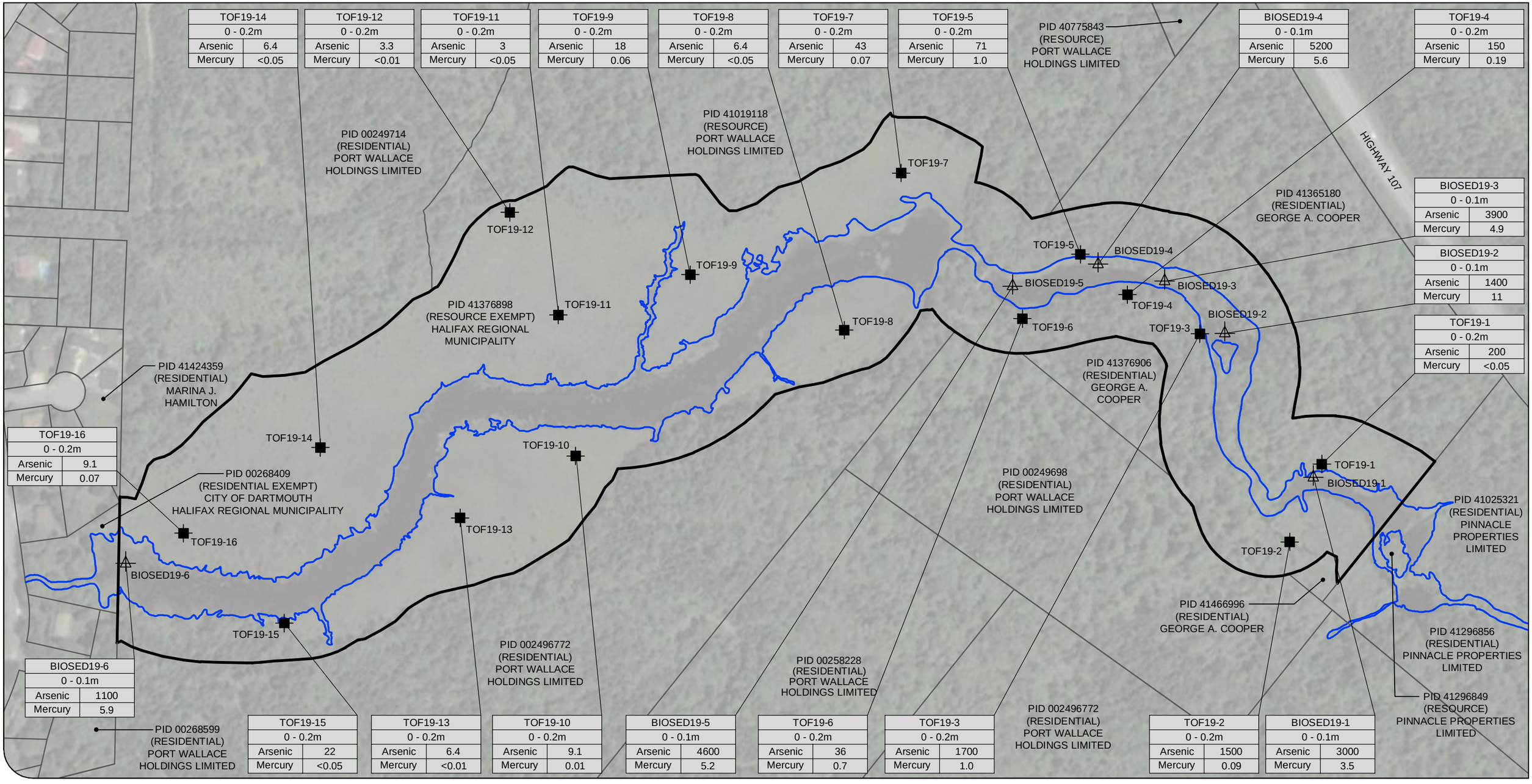
3.2.4 Fish Tissue

3.2.4.1 Arsenic and Mercury in Fish Tissue

Laboratory analytical results for total arsenic and total mercury in fish tissue are presented in Table 3 in Appendix C.

3.2.4.2 Arsenic Speciation and Total Arsenic in Fish Tissue

Laboratory analytical results for arsenic speciation and total arsenic in fish tissue are presented in Appendix D.



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FIELD WORK COMPONENT TO SUPPLEMENT DATA FOR THE HHRA - PORT WALLACE

CONCENTRATIONS OF ARSENIC AND MERCURY IN SEDIMENT AND SOIL / ORGANICS

FIGURE 3

SUBJECT PROPERTY LINE

PROPERTY LINE

TOP OF FEN ORGANICS SAMPLES (TOF) (SEPT. 2019/JAN. 2020)

SEDIMENT SAMPLE (SEPT. 2019)

NOTE:
TOP OF FEN (TOF) SAMPLES RE-SAMPLED IN JANUARY 2020 FOR MERCURY ANALYSIS.

Sample ID	
Depth (m bgs)	
Parameter	Units
Arsenic	mg/kg
Mercury	mg/kg

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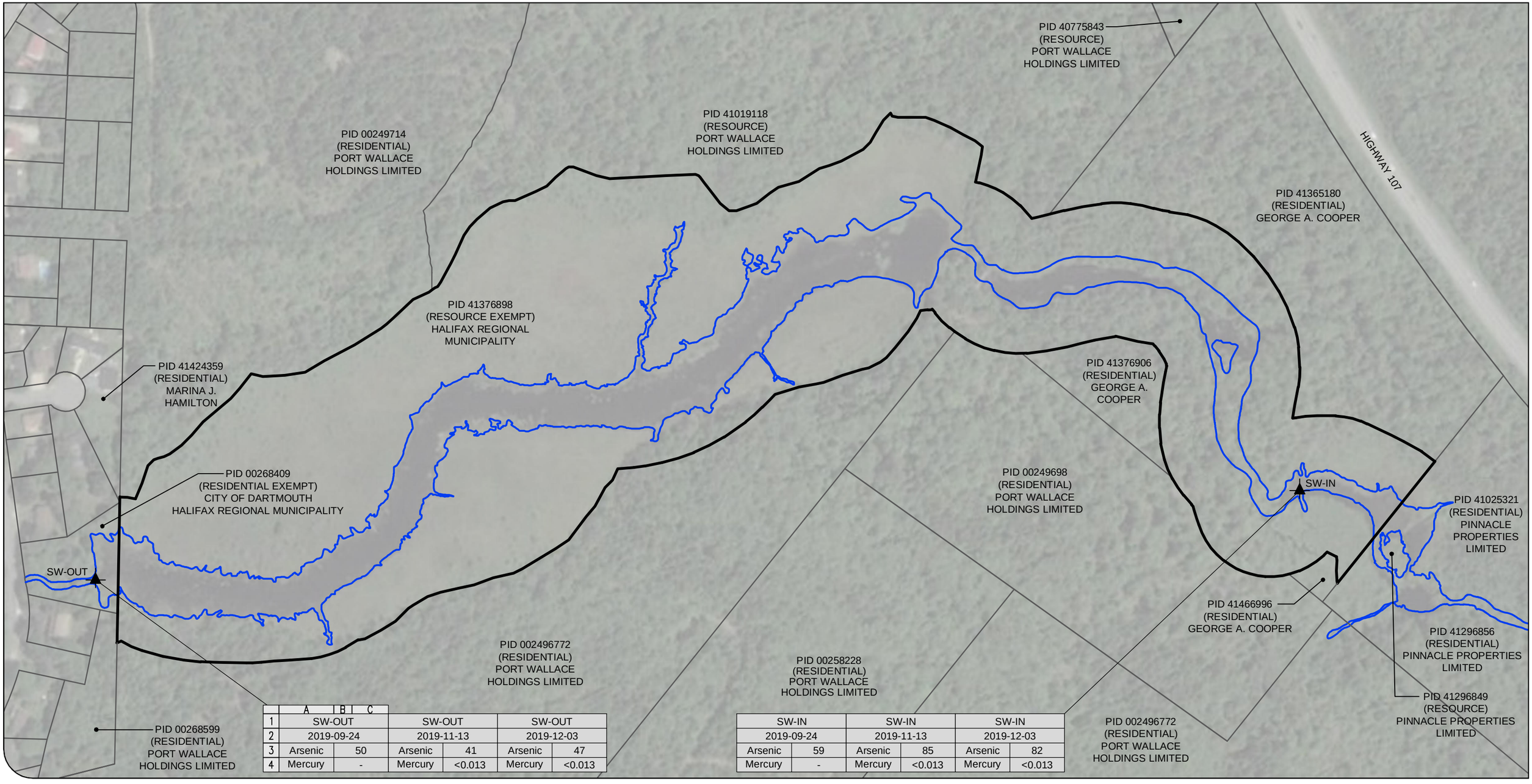

	A	B	C			
1	SW-OUT		SW-OUT		SW-OUT	
2	2019-09-24		2019-11-13		2019-12-03	
3	Arsenic	50	Arsenic	41	Arsenic	47
4	Mercury	-	Mercury	<0.013	Mercury	<0.013

SW-IN		SW-IN		SW-IN	
2019-09-24		2019-11-13		2019-12-03	
Arsenic	59	Arsenic	85	Arsenic	82
Mercury	-	Mercury	<0.013	Mercury	<0.013

NOVA SCOTIA LANDS / INTRINSIK CORP.

FIELD WORK COMPONENT TO SUPPLEMENT DATA FOR THE HHRA - PORT WALLACE

CONCENTRATIONS OF DISSOLVED ARSENIC AND MERCURY IN SURFACE WATER

FIGURE 4

SUBJECT PROPERTY LINE

PROPERTY LINE

SURFACE WATER SAMPLE (SEPT., NOV. AND DEC. 2019)

Sample ID	
Date	
Sample ID	Units
Arsenic	µg/L
Mercury	µg/L

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PROJECT: 19-1567
DATE: JANUARY 2020

Appendix A

Site Photographs

Photo 1: Barry's Run, facing east (December 3, 2019).

Photo 2: Stream at the junction of Mitchell's Brook and Barry's Run post-rain event, facing west (December 3, 2019).

Photo 3: Fish harvesting technique on Barry's Run, facing west (September 18, 2019).

Photo 4: Fish Species: Brook Trout, Fish ID: F3, Sample ID: F19_02 Fish (September 18, 2019).

Photo 5: Fish Species: Brook Trout, Fish ID: F14, Sample ID: F19_10 Fish (September 20, 2019).

Photo 6: Fish Species: Smallmouth Bass, Fish ID: F15, Sample ID: F19_11 Fish (September 20, 2019).

Photo 7: Surface soil / organics sample collected from the top of fen adjacent to Mitchell's Brook (September 24, 2019).

Photo 8: Surface soil / organics sample collected from the top of fen adjacent to Barry's Run (September 24, 2019).

Photo 9: Surface soil / organics sample collected from the top of fen adjacent to Barry's Run (September 24, 2019).

Photo 10: Sediment sample collected in Mitchell's Brook (September 24, 2019).

Photo 11: Sediment sample BIOSED19-5 collected in Mitchell's Brook (September 24, 2019).

Photo 12: Sediment sample BIOSED 19-4 collected in Mitchell's Brook with organics on top (September 24, 2019).

Photo 13: Visual of sediment on channel bottom of Mitchell's Brook with disturbed turbid cloud of sediment on the left following disturbance (September 24, 2019).

Photo 14: Up-gradient of Mitchell's Brook in the vicinity of SW-IN location, facing west (September 24, 2019).

Appendix B

Field Observations

Table 1: Field Observations from Sediment and Surface Soil / Organics (Top of Fen) Sampling Program (September 2019)
Field Work Component in Support of the Human Health Risk Assessment - Port Wallace, Dartmouth , NS
19-1567

Sample ID	Coordinates	Matrix	Sample Depth (mbgs)	Description	Notes
BIOSED19-1	N44 43.022, W63 32.023	Sediment	0 - 0.1	Grey, dense, fine grained minerogenic material	Sample Submitted for Bioaccessibility
BIOSED19-2	N44 43.076, W63 32.069	Sediment	0 - 0.1	Grey, dense, fine grained minerogenic material. Approximately 3" of grey tailings observed, followed by organic sediments beneath.	Sample Submitted for Bioaccessibility
BIOSED19-3	N44 43.094, W63 32.104	Sediment	0 - 0.1	Grey, dense, fine grained minerogenic material	
BIOSED19-4	N44 43.102, W63 32.134	Sediment	0 - 0.1	Brownish grey, dense, fine grained minerogenic material. Approximately 5 cm of organics was present above the sediment.	Sample Submitted for Bioaccessibility
BIOSED19-5	N44 43.094, W63 32.179	Sediment	0 - 0.1	Grey, dense, fine grained minerogenic material	Sample Submitted for Bioaccessibility
BIOSED19-6	N44 42.995, W63 32.641	Sediment	0 - 0.1	Brownish grey, dense, fine grained minerogenic material. Approximately 10 cm of organics was present above the sediment.	Sample Submitted for Bioaccessibility
TOF19-1	N44 43.027, W63 32.019	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-2	N44 43.033, W63 32.407	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-3	N44 43.086, W63 32.415	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-4	N44 43.124, W63 32.440	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-5	N44 43.011, W63 32.467	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-6	N44 43.037, W63 32.540	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-7	N44 42.973, W63 32.559	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-8	N44 43.007, W63 32.611	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-9	N44 42.998, W63 32.036	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-10	N44 43.076, W63 32.082	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-11	N44 43.100, W63 32.119	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-12	N44 43.106, W63 32.143	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-13	N44 43.088, W63 32.168	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-14	N44 43.137, W63 32.235	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-15	N44 43.079, W63 32.266	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	
TOF19-16	N44 43.100,W63 32.346	Organics	0 - 0.2	Grass-like sedge and sphagnum moss root mass with dark brown hydric soil	

Notes

BIOSED: Sediment Sample Collected in the Waterway

TOF: Top of Fen Organics Sample Collected in the Fen

Sample depth: samples were collected at surface of sediment / water interface. Sample depth represents depth of sediment from top of sediment in the channel.

For samples BIOSED19-4 and BIOSED19-6, a small layer of organics was present above the sediment. The organics were removed prior to sampling.

Table 2: Field Observations from Surface Water Sampling Program (September, November and December 2019)
Field Work Component in Support of the Human Health Risk Assessment - Port Wallace, Dartmouth , NS
19-1567

	EVENT #1		EVENT #2		EVENT #3	
Sample ID	SW-IN	SW-OUT	SW-IN	SW-OUT	SW-IN	SW-OUT
Date	2019-09-25		2019-11-13		2019-12-03	
Approximate Flow Rate (m/s)	-	-	0.03	0.14	0.07	0.25
Temperature (°C)	15.6	19.5	5.0	4.9	2.1	2.3
pH*	6.52	6.45	6.90	6.91	6.28	6.13
Conductivity (us/cm)	271	246	252	141	190	174
Stream water observations	clear / light yellow	clear / light yellow	clear / light yellow	clear / light yellow	light yellow / mainly clear with some organic particulate	clear / light yellow
Approximate Precipitation in 24 hours leading up to sampling event	~2 mm		~35 mm		~15 mm	

Notes

SW-IN	N44 43.019, W63 32.025
SW-OUT	N44 42.995, W63 32.657
*	lab pH reported for the November 2019 sampling event due to calibration issue with field pH meter

Flow rate not measured during September 2019 sampling event

Table 3: Field Observations from Fish Sample Collection Program (September 2019)
Field Work Component in Support of the Human Health Risk Assessment - Port Wallace, Dartmouth , NS
19-1567

Sample ID	Fish ID	Species	Date Collected	Length (inches)	Total Weight[1] (g)	Processed Weight[2] (g)	General Sample Area	Additional Observations	Notes[3]
F19_01	F1	Brook Trout	09/18/2019	7.5	66	43	Mitchell's Brook	female with eggs	Sample Submitted to RMC
	F2	Brook Trout	09/18/2019	6.625	45	33	Mitchell's Brook		
	F4	Brook Trout	09/18/2019	7	49	36	Mitchell's Brook		
F19_02	F3	Brook Trout	09/18/2019	10	157	96	Mitchell's Brook	female with eggs	Sample Submitted to RMC
F19_03	F5	Smallmouth Bass	09/18/2019	10	194	141	Barry's Run		Sample Submitted to RMC
F19_04	F6	Brook Trout	09/18/2019	11.5	231	84	Barry's Run		
F19_05	F7	Smallmouth Bass	09/18/2019	8.625	118	83	Barry's Run		
F19_06	F8	Smallmouth Bass	09/18/2019	8.25	113	80	Barry's Run		
F19_07	F9	Brook Trout	09/19/2019	7.5	63	43	Barry's Run	female with eggs	Sample Submitted to RMC
	F10	Brook Trout	09/19/2019	4.75	30	22	Barry's Run		
F19_08	F11	Brook Trout	09/20/2019	9.25	125	91	Barry's Run	female with eggs	
F19_09	F12	Brook Trout	09/20/2019	8.75	111	81	Barry's Run		
F19_10	F13	Brook Trout	09/20/2019	8.5	98	65	Barry's Run	female with eggs	
	F14	Brook Trout	09/20/2019	9.25	121	84	Barry's Run	female with eggs	
F19_11	F15	Smallmouth Bass	09/20/2019	9.5	174	123	Barry's Run		
F19_12	F16	Brook Trout	09/20/2019	9.75	143	101	Barry's Run		
F19_13	F17	Smallmouth Bass	09/20/2019	9	136	93	Barry's Run		
F19_14	F18	Smallmouth Bass	09/26/2019	12	-	187	Barry's Run		Sample Submitted to RMC
F19_15	F19	Smallmouth Bass	09/26/2019	9.5	-	125	Barry's Run	female with eggs	
F19_16	F20	Brook Trout	09/26/2019	8.75	-	73	Barry's Run	female with eggs	

Notes

1. Total Weight - Weight of fish

2. Processed Weight - Weight of fish cleaned and gutted

3. Sample submitted to RMC: following receipt of analytical resuls from Bureau Veritas, five samples were submitted to RMC for total arsenic and arsenic speciation analysis

Appendix C

Analytical Results Tables

DILLON CONSULTING

Table 1: Metals Analytical Results - Sediment and Soil / Organics (Port Wallace, Dartmouth, NS) - Samples Collected September 2019 and January 2020

			Metals																										
			Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Mercury[2]			Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Uranium	Vanadium	Zinc
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
RDL (Reportable Detection Limit)			10	2	2	5	2	5	0.3	2	1	2	50	0.5	2	2	0.1	[1]		2	2	2	0.5	5	0.1	0.1	2	5
Sample ID	Coordinates	Depth (m)																											
BIOSED19-1	N44 43.022, W63 32.023	0 - 0.1	-	-	3000	-	-	-	-	-	-	-	-	-	-	-	3.5			-	-	-	-	-	-	-	-	-
BIOSED19-2	N44 43.076, W63 32.069	0 - 0.1	-	-	1400	-	-	-	-	-	-	-	-	-	-	-	11			-	-	-	-	-	-	-	-	-
BIOSED19-3	N44 43.094, W63 32.104	0 - 0.1	-	-	3900	-	-	-	-	-	-	-	-	-	-	-	4.9			-	-	-	-	-	-	-	-	-
BIOSED19-4	N44 43.102, W63 32.134	0 - 0.1	-	-	5200	-	-	-	-	-	-	-	-	-	-	-	5.6			-	-	-	-	-	-	-	-	-
BIOSED19-5	N44 43.094, W63 32.179	0 - 0.1	-	-	4600	-	-	-	-	-	-	-	-	-	-	-	5.2			-	-	-	-	-	-	-	-	-
BIOSED19-6	N44 42.995, W63 32.641	0 - 0.1	-	-	1100	-	-	-	-	-	-	-	-	-	-	-	5.9			-	-	-	-	-	-	-	-	-
TOF19-1	N44 43.027, W63 32.019	0 - 0.2	8200	2.2	200	74	<2	<5	0.51	7.3	3.9	18	6300	69	3.1	320	-	<0.05	**	<2	13	<2	<0.5	46	<0.1	0.91	27	32
TOF19-2	N44 42.998, W63 32.036	0 - 0.2	14,000	2.1	1500	240	<2	5.2	2.3	9.1	98	37	23,000	58	3.9	14,000	-	0.09	*	3.5	57	2.9	<0.5	41	0.43	0.77	72	160
TOF19-3	N44 43.076, W63 32.082	0 - 0.2	18,000	2	1700	140	<2	<5	1.2	15	83	40	34,000	79	19	3500	-	1.0	****	<2	37	<2	<0.5	20	0.35	1.1	50	160
TOF19-4	N44 43.100, W63 32.119	0 - 0.2	5600	<2	150	66	<2	<5	<0.3	5.6	3.3	17	7600	110	3.2	110	-	0.19	**	<2	12	<2	<0.5	27	<0.1	0.36	18	26
TOF19-5	N44 43.106, W63 32.143	0 - 0.2	7100	<2	71	83	<2	<5	1.1	7	3.5	18	6500	260	4.3	160	-	1.0	***	<2	13	<2	<0.5	59	<0.1	0.82	23	59
TOF20-FD1 (Field Dup of TOF19-5)		0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	**	-	-	-	-	-	-	-	-	-
TOF19-6	N44 43.088, W63 32.168	0 - 0.2	4100	<2	37	46	<2	<5	<0.3	4.3	3.4	11	4700	110	<2	150	-	0.7	***	<2	7.9	<2	<0.5	16	<0.1	0.36	17	20
TOF19-7	N44 43.137, W63 32.235	0 - 0.2	7700	<2	43	38	<2	<5	<0.3	6.6	1.3	16	2800	71	<2	36	-	0.07	**	<2	8.6	<2	<0.5	7.7	<0.1	0.43	30	16
TOF19-8	N44 43.079, W63 32.266	0 - 0.2	2700	<2	6.4	67	<2	<5	0.31	2.9	1.4	7.3	4100	22	<2	220	-	<0.05	**	<2	7.8	<2	<0.5	38	<0.1	0.27	16	28
TOF20-FD2 (Field Dup of TOF19-8)		0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	**	-	-	-	-	-	-	-	-	-
TOF19-9	N44 43.100,W63 32.346	0 - 0.2	6400	<2	18	64	<2	<5	0.61	4.1	7	10	8900	61	<2	430	-	0.06	**	<2	12	<2	<0.5	43	<0.1	0.86	42	22
TOF19-10	N44 43.033, W63 32.407	0 - 0.2	3100	<2	9.1	78	<2	<5	0.41	3	2.6	6.4	2500	39	<2	200	-	0.01	*	<2	11	<2	<0.5	27	<0.1	0.26	14	25
TOF19-11	N44 43.086, W63 32.415	0 - 0.2	1600	<2	3	38	<2	<5	0.36	3.4	1.8	4.6	4400	38	<2	79	-	<0.05	**	<2	10	<2	<0.5	20	<0.1	<0.1	8.1	27
TOF19-12	N44 43.124, W63 32.440	0 - 0.2	4500	<2	3.3	31	<2	<5	<0.3	3	1.1	7.4	2700	42	<2	42	-	<0.01	*	<2	7.9	<2	<0.5	11	<0.1	<0.1	31	18
TOF19-13	N44 43.011, W63 32.467	0 - 0.2	3400	<2	6.4	110	<2	<5	0.65	2.6	2.2	7.4	2000	53	<2	130	-	<0.01	*	<2	14	<2	<0.5	44	<0.1	0.31	34	28
TOF19-14	N44 43.037, W63 32.540	0 - 0.2	3200	<2	6.4	56	<2	<5	<0.3	3.4	1.7	8.7	2600	76	<2	29	-	<0.05	**	<2	16	<2	<0.5	19	<0.1	0.33	34	25
TOF19-15	N44 42.973, W63 32.559	0 - 0.2	11,000	<2	22	10	<2	<5	0.73	2.9	5.4	15	4400	110	<2	38	-	<0.05	**	<2	20	<2	<0.5	<5	<0.1	0.16	18	17
TOF19-16	N44 43.007, W63 32.611	0 - 0.2	2500	<2	9.1	40	<2	<5	0.35	3.5	1.6	6.7	2200	73	<2	17	-	0.07	**	<2	8	<2	<0.5	23	<0.1	0.23	23	12

Notes:

[1] * / ** / *** / **** : RDLs of 0.01 / 0.05 / 0.3 / 0.5 for top of fen mercury results

[2] Top of fen surface soil / organics samples re-sampled in January 2020 for mercury analysis

Table 2: General Chemistry and Metals Analytical Results - Surface Water (Port Wallace, Dartmouth, NS)

			Sample ID	SW-IN			SW-OUT		
			Coordinates	N44 43.019, W63 32.025			N44 42.995, W63 32.657		
			Date Sampled	2019-09-24	2019-11-13	2019-12-03	2019-09-24	2019-11-13	2019-12-03
Method	Parameter	Unit	EQL						
Calculated Parameters	Langelier Index (@ 4C)	-		-1.99	-2.95	-2.91	-2.22	-2.96	-2.79
	Langelier Index (@20C)	-		-1.74	-2.7	-2.65	-1.97	-2.71	-2.54
	Saturation pH (@ 20C)	-		9.08	9.6	9.55	9.15	9.62	9.35
	Saturation pH (@ 4C)	-		9.33	9.85	9.81	9.41	9.87	9.6
	Nitrate (as N)	mg/L	0.05	<0.05	<0.05	0.086	<0.05	<0.05	0.14
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1	21	10	11	18	10	18
	Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<1	<1	<1	<1	<1
	Ionic Balance	%		0.21	6.37	5.81	1.2	6.22	8.16
	Anions Total	meq/L		2.35	1.42	1.82	2.05	1.28	1.79
	Cations Total	meq/L		2.36	1.25	1.62	2.1	1.13	1.52
	Hardness as CaCO3	mg/L	1	30	17	19	29	16	19
	Total Dissolved Solids (TDS) - Calculated	mg/L	1	140	82	100	120	75	100
Inorganics	Alkalinity (total) as CaCO3	mg/L	5	21	10	11	18	10	18
	Ammonia (as N)	mg/L	0.05	<0.05	0.051	<0.05	<0.05	<0.05	<0.05
	Nitrate + Nitrite (as N)	mg/L	0.05	<0.05	<0.05	0.086	<0.05	<0.05	0.14
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.02[#1]	<0.01	<0.01	<0.02[#1]
	Phosphate	mg/L	0.01	0.016	0.021	0.02	0.014	0.013	0.013
	Phosphorus	ug/L	100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phosphorus (Dissolved)	ug/L	100	<0.1	<0.1	<100	<0.1	<0.1	<100
	Electrical conductivity (lab)	µS/cm	1	240	150	190	230	130	180
	Chloride (Filtered)	mg/L	1	63	36	50	53	32	44
	Dissolved Organic Carbon (Filtered)	mg/L	0.5	3.1	6.4	4	3.4	8.4	4.6
	Total Organic Carbon (TOC)	mg/L	0.5	3.1	6.4	4.2	3.5	8.4	4.5
	pH (Lab)	pH Unit		7.35	6.9	6.9	7.19	6.91	6.81
	Silica as SiO2	mg/L	0.5	3.1	3.1	2	3	3.3	2.5
	Sulphate (SO4) (Filtered)	mg/L	2	8.2	8.7	8.8	10	8.4	9
	Total Suspended Solids (TSS)	mg/L	1	<1	<1	<1	<1	<1	<1
	Turbidity	NTU	0.1	0.72	0.84	0.52	0.82	0.52	0.56
	Colour	TCU	5	9.2	37	17	13	57	23
Metals	Aluminium	mg/L	0.005	0.017	0.097	0.047	0.023	0.14	0.064
	Aluminium (Dissolved)	mg/L	0.005	0.02	0.076	0.04	0.018	0.11	0.056
	Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Antimony (Dissolved)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Arsenic	mg/L	0.001	0.065	0.093	0.091	0.055	0.046	0.049
	Arsenic (Dissolved)	mg/L	0.001	0.059	0.085	0.082	0.05	0.041	0.047
	Barium	mg/L	0.001	0.0082	0.0046	0.0038	0.0066	0.0053	0.004
	Barium (Dissolved)	mg/L	0.001	0.008	0.0049	0.0034	0.0068	0.0049	0.004
	Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Beryllium (Dissolved)	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Bismuth	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Bismuth (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Boron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Boron (Dissolved)	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

			Sample ID	SW-IN			SW-OUT		
			Coordinates	N44 43.019, W63 32.025			N44 42.995, W63 32.657		
			Date Sampled	2019-09-24	2019-11-13	2019-12-03	2019-09-24	2019-11-13	2019-12-03
Method	Parameter	Unit	EQL						
Metals	Cadmium	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Cadmium (Dissolved)	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Calcium	mg/L	0.1	9.5	5.2	5.6	8.7	5.1	5.7
	Calcium (Dissolved)	mg/L	0.1	9.3	5.2	5.5	8.8	4.9	5.6
	Chromium Total (III+VI)	mg/L	0.001	<0.001	0.0012	<0.001	<0.001	0.0012	<0.001
	Chromium Total (III+VI) (Dissolved)	mg/L	0.001	<0.001	<0.001	<0.001	0.0011	0.0011	<0.001
	Cobalt	mg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
	Cobalt (Dissolved)	mg/L	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
	Copper	mg/L	0.0005	0.0008	0.00078	0.001	0.0031	0.00084	0.0013
	Copper (Dissolved)	mg/L	0.0005	0.00066	0.0019	0.00083	0.00054	0.00089	0.00075
	Iron	mg/L	0.05	0.077	0.13	0.053	0.12	0.15	0.073
	Iron (Dissolved)	mg/L	0.05	<0.05	0.084	<0.05	0.074	0.11	0.051
	Lead	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Lead (Dissolved)	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Magnesium	mg/L	0.1	1.7	1.1	1.2	1.6	1.1	1.2
	Magnesium (Dissolved)	mg/L	0.1	1.7	1	1.2	1.7	0.96	1.1
	Manganese	mg/L	0.002	0.14	0.052	0.018	0.12	0.047	0.02
	Manganese (Dissolved)	mg/L	0.002	0.13	0.023	0.012	0.11	0.028	0.017
	Mercury	mg/L	0.000013	--	0.000013	<0.000013	--	<0.000013	<0.000013
	Mercury (Dissolved)	mg/L	0.000013	--	<0.000013	<0.000013	--	<0.000013	<0.000013
	Molybdenum	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Molybdenum (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Nickel	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Nickel (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Potassium	ug/L	100	1200	910	0.88	1000	960	0.88
	Potassium (Dissolved)	ug/L	100	1200	960	910	1000	980	880
	Selenium	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Selenium (Dissolved)	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Silver (Dissolved)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Sodium	mg/L	0.1	40	21	29	32	19	26
	Sodium (Dissolved)	mg/L	0.1	40	20	28	34	18	26
	Strontium	mg/L	0.002	0.035	0.019	0.019	0.032	0.018	0.018
	Strontium (Dissolved)	mg/L	0.002	0.031	0.019	0.018	0.031	0.018	0.018
	Thallium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Thallium (Dissolved)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Tin	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Tin (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Titanium	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Titanium (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Uranium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Uranium (Dissolved)	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Vanadium	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Vanadium (Dissolved)	mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Zinc (Dissolved)	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Notes
#1 Elevated reporting limit due to method blank performance.

Table 3: Fish Parameters and Analytical Results (Total Arsenic and Total Mercury) for Fish Tissue - Samples Submitted to Bureau Veritas, Burnaby, BC
Field Work Component in Support of the Human Health Risk Assessment - Port Wallace, Dartmouth , NS
19-1567

Sample ID	Fish ID	Species	Date Collected	Length (inches)	Total Weight[1] (g)	Processed Weight[2] (g)	General Sample Area	Additional Observations	Total As (mg/kg ww)	Total Hg (mg/kg ww)	Notes[3]
F19_01	F1	Brook Trout	09/18/2019	7.5	66	43	Mitchell's Brook	female with eggs	0.989	0.183	Sample Submitted to RMC
	F2	Brook Trout	09/18/2019	6.625	45	33	Mitchell's Brook				
	F4	Brook Trout	09/18/2020	10	49	36	Mitchell's Brook				
F19_02	F3	Brook Trout	09/18/2021	10	157	96	Mitchell's Brook	female with eggs	1.01	0.048	Sample Submitted to RMC
F19_03	F5	Smallmouth Bass	09/18/2022	10	194	141	Barry's Run		2.72	0.606	Sample Submitted to RMC
F19_04	F6	Brook Trout	09/18/2023	11.5	231	84	Barry's Run		0.432	0.189	
Lab-Dup of F19_04	--	--	--	--	--	--	--	--	0.427	0.184	--
F19_05	F7	Smallmouth Bass	09/18/2024	8.625	118	83	Barry's Run		2.71	0.325	
F19_06	F8	Smallmouth Bass	09/18/2025	8.25	113	80	Barry's Run		2.54	0.44	
F19_07	F9	Brook Trout	09/19/2019	7.5	63	43	Barry's Run	female with eggs	1.13	0.232	Sample Submitted to RMC
	F10	Brook Trout	09/19/2019	4.75	30	22	Barry's Run				
F19_08	F11	Brook Trout	09/20/2019	9.25	125	91	Barry's Run	female with eggs	0.324	0.0836	
F19_09	F12	Brook Trout	09/20/2019	8.75	111	81	Barry's Run		0.708	0.138	
F19_10	F13	Brook Trout	09/20/2019	8.5	98	65	Barry's Run	female with eggs	0.682	0.266	
	F14	Brook Trout	09/20/2019	9.25	121	84	Barry's Run	female with eggs			
F19_11	F15	Smallmouth Bass	09/20/2019	9.5	174	123	Barry's Run		2.66	0.62	
F19_12	F16	Brook Trout	09/20/2019	9.75	143	101	Barry's Run		0.498	0.352	
F19_13	F17	Smallmouth Bass	09/20/2019	9	136	93	Barry's Run		2.59	0.444	
F19_14	F18	Smallmouth Bass	09/26/2019	12	-	187	Barry's Run		2.78	1.03	Sample Submitted to RMC
F19_15	F19	Smallmouth Bass	09/26/2019	9.5	-	125	Barry's Run	female with eggs	2.72	0.803	
F19_16	F20	Brook Trout	09/26/2019	8.75	-	73	Barry's Run	female with eggs	0.561	0.223	

Notes

1. Total Weight - Weight of fish

2. Processed Weight - Weight of fish cleaned and gutted

3. Sample submitted to RMC: following receipt of analytical resuls from Bureau Veritas, five samples were submitted to RMC for total arsenic and arsenic speciation analysis

Appendix D

Laboratory Analytical Certificates

DILLON CONSULTING

Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D 36950, D 36951

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/10/25
Report #: R5936194
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R7076
Received: 2019/10/02, 16:56

Sample Matrix: Tissue
Samples Received: 16

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Elements by CRC ICPMS - Tissue Wet Wt (1)	8	2019/10/10	2019/10/22	BBY7SOP-00021,	EPA 6020b R2 m
Elements by CRC ICPMS - Tissue Wet Wt (1)	8	2019/10/10	2019/10/23	BBY7SOP-00021,	EPA 6020b R2 m
Moisture in Tissue (Subcontracted) (1, 2)	16	2019/10/17	2019/10/17	BBY8SOP-00017	BCMOE BCLM Dec2000 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bedford to Burnaby - Offsite
(2) Offsite analysis requires that subcontracted moisture be reported.

Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D 36950, D 36951

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/10/25
Report #: R5936194
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R7076
Received: 2019/10/02, 16:56

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Heather Macumber, Senior Project Manager
Email: Heather.MACUMBER@bvlabs.com
Phone# (902)420-0203 Ext:226

==========

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

BV Labs Job #: B9R7076
Report Date: 2019/10/25

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: CJK

RESULTS OF ANALYSES OF TISSUE

BV Labs ID		KYE034	KYE035	KYE036	KYE037			KYE037		
Sampling Date		2019/09/18	2019/09/18	2019/09/18	2019/09/18			2019/09/18		
COC Number		D 36950	D 36950	D 36950	D 36950			D 36950		
	UNITS	F19-01	F19-02	F19-03	F19-04	RDL	QC Batch	F19-04 Lab-Dup	RDL	QC Batch
Metals										
Total (Wet Wt) Arsenic (As)	mg/kg	0.989	1.01	2.72	0.432	0.0040	6402822	0.427	0.0040	6402822
Total (Wet Wt) Mercury (Hg)	mg/kg	0.183	0.0480	0.606	0.189	0.0020	6402822	0.184	0.0020	6402822
PHYSICAL PROPERTIES										
Moisture-Subcontracted	%	76	80	78	74	0.30	6402823			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

BV Labs ID		KYE038	KYE039	KYE040	KYE041	KYE042	KYE043	KYE044		
Sampling Date		2019/09/18	2019/09/18	2019/09/19	2019/09/20	2019/09/20	2019/09/20	2019/09/20		
COC Number		D 36950	D 36950	D 36950	D 36950	D 36950	D 36950	D 36951		
	UNITS	F19-05	F19-06	F19-07	F19-08	F19-09	F19-10	F19-11	RDL	QC Batch
Metals										
Total (Wet Wt) Arsenic (As)	mg/kg	2.71	2.54	1.13	0.324	0.708	0.682	2.66	0.0040	6402822
Total (Wet Wt) Mercury (Hg)	mg/kg	0.325	0.440	0.232	0.0836	0.138	0.266	0.620	0.0020	6402822
PHYSICAL PROPERTIES										
Moisture-Subcontracted	%	73	74	76	76	75	78	79	0.30	6402823

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KYE045	KYE046	KYE047	KYE048	KYE049			KYE049		
Sampling Date		2019/09/20	2019/09/20	2019/09/26	2019/09/26	2019/09/26			2019/09/26		
COC Number		D 36951	D 36951	D 36951	D 36951	D 36951			D 36951		
	UNITS	F19-12	F19-13	F19-14	F19-15	F19-16	RDL	QC Batch	F19-16 Lab-Dup	RDL	QC Batch
Metals											
Total (Wet Wt) Arsenic (As)	mg/kg	0.498	2.59	2.78	2.72	0.561	0.0040	6402822			
Total (Wet Wt) Mercury (Hg)	mg/kg	0.352	0.444	1.03	0.803	0.223	0.0020	6402822			
PHYSICAL PROPERTIES											
Moisture-Subcontracted	%	76	75	66	76	76	0.30	6402823	74	0.30	6402823

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

BV Labs Job #: B9R7076
Report Date: 2019/10/25

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: CJK

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.7°C

Results relate only to the items tested.

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BV Labs Job #: B9R7076
Report Date: 2019/10/25

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: CJK

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6402822	JLP	Matrix Spike [KYE047-01]	Total (Wet Wt) Arsenic (As)	2019/10/23		NC	%	75 - 125
			Total (Wet Wt) Mercury (Hg)	2019/10/23		NC	%	75 - 125
6402822	JLP	QC Standard	Total (Wet Wt) Arsenic (As)	2019/10/22		98	%	75 - 125
			Total (Wet Wt) Mercury (Hg)	2019/10/22		91	%	75 - 125
6402822	JLP	Spiked Blank	Total (Wet Wt) Arsenic (As)	2019/10/22		94	%	75 - 125
			Total (Wet Wt) Mercury (Hg)	2019/10/22		94	%	75 - 125
6402822	JLP	Method Blank	Total (Wet Wt) Arsenic (As)	2019/10/22	<0.0040		mg/kg	
			Total (Wet Wt) Mercury (Hg)	2019/10/22	<0.0020		mg/kg	
6402822	JLP	RPD	Total (Wet Wt) Arsenic (As)	2019/10/22	NC		%	40
			Total (Wet Wt) Mercury (Hg)	2019/10/22	NC		%	40
6402822	JLP	RPD [KYE037-01]	Total (Wet Wt) Arsenic (As)	2019/10/22	1.2		%	40
			Total (Wet Wt) Mercury (Hg)	2019/10/22	2.9		%	40
6402823	éCE	Method Blank	Moisture-Subcontracted	2019/10/17	<0.30		%	
6402823	éCE	RPD [KYE049-01]	Moisture-Subcontracted	2019/10/17	2.5		%	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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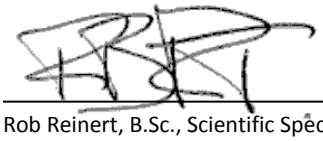
BV Labs Job #: B9R7076
Report Date: 2019/10/25

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: CJK

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Rob Reinert, B.Sc., Scientific Specialist

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Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D36948, D36947, D36949

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/10/15
Report #: R5921757
Version: 3 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R0093
Received: 2019/09/26, 14:31

Sample Matrix: Sediment
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Metals Solids Acid Extr. ICPMS	5	2019/09/30	2019/10/04	ATL SOP 00058	EPA 6020B R2 m
Metals Solids Acid Extr. ICPMS	1	2019/09/30	2019/10/07	ATL SOP 00058	EPA 6020B R2 m

Sample Matrix: Solid
Samples Received: 16

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Metals in Terrestrial Biota	14	2019/10/11	2019/10/11	ATL SOP 00058	EPA 6020B R3 m
Metals in Terrestrial Biota	2	2019/10/11	2019/10/15	ATL SOP 00058	EPA 6020B R3 m

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Carbonate, Bicarbonate and Hydroxide	2	N/A	2019/10/03	N/A	SM 23 4500-CO2 D
Alkalinity	2	N/A	2019/10/05	ATL SOP 00013	EPA 310.2 R1974 m
Chloride	2	N/A	2019/10/03	ATL SOP 00014	SM 23 4500-Cl- E m
Colour	2	N/A	2019/10/03	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (1)	2	N/A	2019/10/05	ATL SOP 00203	SM 23 5310B m
Conductance - water	2	N/A	2019/10/02	ATL SOP 00004	SM 23 2510B m
Hardness (calculated as CaCO3)	2	N/A	2019/10/01	ATL SOP 00048	Auto Calc
Metals Water Diss. MS (as rec'd)	2	N/A	2019/10/02	ATL SOP 00058	EPA 6020B R2 m
Metals Water Total MS	2	2019/09/30	2019/09/30	ATL SOP 00058	EPA 6020B R2 m
Ion Balance (% Difference)	2	N/A	2019/10/07	N/A	Auto Calc.
Anion and Cation Sum	2	N/A	2019/10/04	N/A	Auto Calc.
Nitrogen Ammonia - water	2	N/A	2019/10/03	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	2	N/A	2019/10/04	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	2	N/A	2019/10/02	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	2	N/A	2019/10/07	ATL SOP 00018	ASTM D3867-16
pH (2)	2	N/A	2019/10/02	ATL SOP 00003	SM 23 4500-H+ B m
Phosphorus - ortho	2	N/A	2019/10/03	ATL SOP 00021	SM 23 4500-P E m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/10/07	ATL SOP 00049	Auto Calc.
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/10/07	ATL SOP 00049	Auto Calc.

Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D36948, D36947, D36949

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/10/15
Report #: R5921757
Version: 3 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R0093
Received: 2019/09/26, 14:31

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Reactive Silica	2	N/A	2019/10/02	ATL SOP 00022	EPA 366.0 m
Sulphate	2	N/A	2019/10/02	ATL SOP 00023	ASTM D516-16 m
Total Dissolved Solids (TDS calc)	2	N/A	2019/10/07	N/A	Auto Calc.
Organic carbon - Total (TOC) (1)	2	N/A	2019/10/05	ATL SOP 00203	SM 23 5310B m
Total Suspended Solids	2	2019/10/01	2019/10/02	ATL SOP 00007	SM 23 2540D m
Turbidity	2	N/A	2019/10/05	ATL SOP 00011	EPA 180.1 R2 m

Remarks:

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Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.
(2) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.

Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D36948, D36947, D36949

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/10/15
Report #: R5921757
Version: 3 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9R0093
Received: 2019/09/26, 14:31

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Heather Macumber, Senior Project Manager
Email: Heather.MACUMBER@bvlabs.com
Phone# (902)420-0203 Ext:226

==========

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BV Labs Job #: B9R0093
Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (SEDIMENT)

BV Labs ID		KWQ711	KWQ712	KWQ713		KWQ714		
Sampling Date		2019/09/24	2019/09/24	2019/09/24		2019/09/24		
COC Number		D36948	D36948	D36948		D36948		
	UNITS	BIOSED19-1 0-0.1M	BIOSED19-2 0-0.1M	BIOSED19-3 0-0.1M	RDL	BIOSED19-4 0-0.1M	RDL	QC Batch
Metals								
Acid Extractable Arsenic (As)	mg/kg	3000	1400	3900	20	5200	200	6359706
Acid Extractable Mercury (Hg)	mg/kg	3.5	11	4.9	0.10	5.6	0.10	6359706

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KWQ715	KWQ716		
Sampling Date		2019/09/24	2019/09/24		
COC Number		D36948	D36948		
	UNITS	BIOSED19-5 0-0.1M	BIOSED19-6 0-0.1M	RDL	QC Batch
Metals					
Acid Extractable Arsenic (As)	mg/kg	4600	1100	20	6359706
Acid Extractable Mercury (Hg)	mg/kg	5.2	5.9	0.10	6359706

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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BV Labs Job #: B9R0093
Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		KWQ717	KWQ717		KWQ718	KWQ719		KWQ720	KWQ726		
Sampling Date		2019/09/24	2019/09/24		2019/09/24	2019/09/24		2019/09/24	2019/09/24		
COC Number		D36948	D36948		D36948	D36948		D36948	D36947		
	UNITS	TOF19-1	TOF19-1 Lab-Dup	RDL	TOF19-2	TOF19-3	RDL	TOF19-4	TOF19-5	RDL	QC Batch
Metals											
Acid Extractable Aluminum (Al)	mg/kg	8200	8000	10	14000	18000	10	5600	7100	10	6382132
Acid Extractable Antimony (Sb)	mg/kg	2.2	2.4	2.0	2.1	2.0	2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Arsenic (As)	mg/kg	200	200	2.0	1500	1700	20	150	71	2.0	6382132
Acid Extractable Barium (Ba)	mg/kg	74	72	5.0	240	140	5.0	66	83	5.0	6382132
Acid Extractable Beryllium (Be)	mg/kg	<2.0	<2.0	2.0	<2.0	<2.0	2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Boron (B)	mg/kg	<5.0	<5.0	5.0	5.2	<5.0	5.0	<5.0	<5.0	5.0	6382132
Acid Extractable Cadmium (Cd)	mg/kg	0.51	0.50	0.30	2.3	1.2	0.30	<0.30	1.1	0.30	6382132
Acid Extractable Chromium (Cr)	mg/kg	7.3	7.3	2.0	9.1	15	2.0	5.6	7.0	2.0	6382132
Acid Extractable Cobalt (Co)	mg/kg	3.9	3.8	1.0	98	83	1.0	3.3	3.5	1.0	6382132
Acid Extractable Copper (Cu)	mg/kg	18	18	2.0	37	40	2.0	17	18	2.0	6382132
Acid Extractable Iron (Fe)	mg/kg	6300	6200	50	23000	34000	50	7600	6500	50	6382132
Acid Extractable Lead (Pb)	mg/kg	69	68	0.50	58	79	0.50	110	260	0.50	6382132
Acid Extractable Lithium (Li)	mg/kg	3.1	3.1	2.0	3.9	19	2.0	3.2	4.3	2.0	6382132
Acid Extractable Manganese (Mn)	mg/kg	320	320	2.0	14000	3500	2.0	110	160	2.0	6382132
Acid Extractable Molybdenum (Mo)	mg/kg	<2.0	<2.0	2.0	3.5	<2.0	2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Nickel (Ni)	mg/kg	13	14	2.0	57	37	2.0	12	13	2.0	6382132
Acid Extractable Selenium (Se)	mg/kg	<2.0	<2.0	2.0	2.9	<2.0	2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Silver (Ag)	mg/kg	<0.50	<0.50	0.50	<0.50	<0.50	0.50	<0.50	<0.50	0.50	6382132
Acid Extractable Strontium (Sr)	mg/kg	46	45	5.0	41	20	5.0	27	59	5.0	6382132
Acid Extractable Thallium (Tl)	mg/kg	<0.10	<0.10	0.10	0.43	0.35	0.10	<0.10	<0.10	0.10	6382132
Acid Extractable Uranium (U)	mg/kg	0.91	0.89	0.10	0.77	1.1	0.10	0.36	0.82	0.10	6382132
Acid Extractable Vanadium (V)	mg/kg	27	26	2.0	72	50	2.0	18	23	2.0	6382132
Acid Extractable Zinc (Zn)	mg/kg	32	33	5.0	160	160	5.0	26	59	5.0	6382132

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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BV Labs Job #: B9R0093
Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		KWQ727	KWQ728	KWQ729	KWQ730	KWQ731	KWQ732		
Sampling Date		2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/24		
COC Number		D36947	D36947	D36947	D36947	D36947	D36947		
	UNITS	TOF19-6	TOF19-7	TOF19-8	TOF19-9	TOF19-10	TOF19-11	RDL	QC Batch
Metals									
Acid Extractable Aluminum (Al)	mg/kg	4100	7700	2700	6400	3100	1600	10	6382132
Acid Extractable Antimony (Sb)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Arsenic (As)	mg/kg	37	43	6.4	18	9.1	3.0	2.0	6382132
Acid Extractable Barium (Ba)	mg/kg	46	38	67	64	78	38	5.0	6382132
Acid Extractable Beryllium (Be)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Boron (B)	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	6382132
Acid Extractable Cadmium (Cd)	mg/kg	<0.30	<0.30	0.31	0.61	0.41	0.36	0.30	6382132
Acid Extractable Chromium (Cr)	mg/kg	4.3	6.6	2.9	4.1	3.0	3.4	2.0	6382132
Acid Extractable Cobalt (Co)	mg/kg	3.4	1.3	1.4	7.0	2.6	1.8	1.0	6382132
Acid Extractable Copper (Cu)	mg/kg	11	16	7.3	10	6.4	4.6	2.0	6382132
Acid Extractable Iron (Fe)	mg/kg	4700	2800	4100	8900	2500	4400	50	6382132
Acid Extractable Lead (Pb)	mg/kg	110	71	22	61	39	38	0.50	6382132
Acid Extractable Lithium (Li)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Manganese (Mn)	mg/kg	150	36	220	430	200	79	2.0	6382132
Acid Extractable Molybdenum (Mo)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Nickel (Ni)	mg/kg	7.9	8.6	7.8	12	11	10	2.0	6382132
Acid Extractable Selenium (Se)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Silver (Ag)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	6382132
Acid Extractable Strontium (Sr)	mg/kg	16	7.7	38	43	27	20	5.0	6382132
Acid Extractable Thallium (Tl)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	6382132
Acid Extractable Uranium (U)	mg/kg	0.36	0.43	0.27	0.86	0.26	<0.10	0.10	6382132
Acid Extractable Vanadium (V)	mg/kg	17	30	16	42	14	8.1	2.0	6382132
Acid Extractable Zinc (Zn)	mg/kg	20	16	28	22	25	27	5.0	6382132

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (SOLID)

BV Labs ID		KWQ733	KWQ734	KWQ735	KWQ753	KWQ754		
Sampling Date		2019/09/24	2019/09/24	2019/09/24	2019/09/24	2019/09/24		
COC Number		D36947	D36947	D36947	D36949	D36949		
	UNITS	TOF19-12	TOF19-13	TOF19-14	TOF19-15	TOF19-16	RDL	QC Batch
Metals								
Acid Extractable Aluminum (Al)	mg/kg	4500	3400	3200	11000	2500	10	6382132
Acid Extractable Antimony (Sb)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Arsenic (As)	mg/kg	3.3	6.4	6.4	22	9.1	2.0	6382132
Acid Extractable Barium (Ba)	mg/kg	31	110	56	10	40	5.0	6382132
Acid Extractable Beryllium (Be)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Boron (B)	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	6382132
Acid Extractable Cadmium (Cd)	mg/kg	<0.30	0.65	<0.30	0.73	0.35	0.30	6382132
Acid Extractable Chromium (Cr)	mg/kg	3.0	2.6	3.4	2.9	3.5	2.0	6382132
Acid Extractable Cobalt (Co)	mg/kg	1.1	2.2	1.7	5.4	1.6	1.0	6382132
Acid Extractable Copper (Cu)	mg/kg	7.4	7.4	8.7	15	6.7	2.0	6382132
Acid Extractable Iron (Fe)	mg/kg	2700	2000	2600	4400	2200	50	6382132
Acid Extractable Lead (Pb)	mg/kg	42	53	76	110	73	0.50	6382132
Acid Extractable Lithium (Li)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Manganese (Mn)	mg/kg	42	130	29	38	17	2.0	6382132
Acid Extractable Molybdenum (Mo)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Nickel (Ni)	mg/kg	7.9	14	16	20	8.0	2.0	6382132
Acid Extractable Selenium (Se)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	6382132
Acid Extractable Silver (Ag)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	6382132
Acid Extractable Strontium (Sr)	mg/kg	11	44	19	<5.0	23	5.0	6382132
Acid Extractable Thallium (Tl)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	6382132
Acid Extractable Uranium (U)	mg/kg	<0.10	0.31	0.33	0.16	0.23	0.10	6382132
Acid Extractable Vanadium (V)	mg/kg	31	34	34	18	23	2.0	6382132
Acid Extractable Zinc (Zn)	mg/kg	18	28	25	17	12	5.0	6382132

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Dillon Consulting Limited
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RESULTS OF ANALYSES OF WATER

BV Labs ID		KWQ755		KWQ756		
Sampling Date		2019/09/24		2019/09/24		
COC Number		D36949		D36949		
	UNITS	SW-IN	QC Batch	SW-OUT	RDL	QC Batch
Calculated Parameters						
Anion Sum	me/L	2.35	6356238	2.05	N/A	6356238
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	21	6356229	18	1.0	6356229
Calculated TDS	mg/L	140	6356250	120	1.0	6356250
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	6356229	<1.0	1.0	6356229
Cation Sum	me/L	2.36	6356238	2.10	N/A	6356238
Hardness (CaCO3)	mg/L	30	6356234	29	1.0	6356234
Ion Balance (% Difference)	%	0.210	6356236	1.20	N/A	6356236
Langelier Index (@ 20C)	N/A	-1.74	6356246	-1.97		6356246
Langelier Index (@ 4C)	N/A	-1.99	6356248	-2.22		6356248
Nitrate (N)	mg/L	<0.050	6356240	<0.050	0.050	6356240
Saturation pH (@ 20C)	N/A	9.08	6356246	9.15		6356246
Saturation pH (@ 4C)	N/A	9.33	6356248	9.41		6356248
Inorganics						
Total Alkalinity (Total as CaCO3)	mg/L	21	6364921	18	5.0	6364921
Dissolved Chloride (Cl-)	mg/L	63	6364928	53	1.0	6364928
Colour	TCU	9.2	6364936	13	5.0	6364936
Nitrate + Nitrite (N)	mg/L	<0.050	6364940	<0.050	0.050	6364940
Nitrite (N)	mg/L	<0.010	6364956	<0.010	0.010	6364956
Nitrogen (Ammonia Nitrogen)	mg/L	<0.050	6364378	<0.050	0.050	6364378
Dissolved Organic Carbon (C)	mg/L	3.1	6369507	3.4	0.50	6369507
Total Organic Carbon (C)	mg/L	3.1	6369499	3.5	0.50	6369495
Orthophosphate (P)	mg/L	0.016	6364939	0.014	0.010	6364939
pH	pH	7.35	6364217	7.19	N/A	6364217
Reactive Silica (SiO2)	mg/L	3.1	6364934	3.0	0.50	6364934
Total Suspended Solids	mg/L	<1.0	6361914	<1.0	1.0	6361914
Dissolved Sulphate (SO4)	mg/L	8.2	6364931	10	2.0	6364931
Turbidity	NTU	0.72	6369763	0.82	0.10	6369763
Conductivity	uS/cm	240	6369710	230	1.0	6369710

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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ELEMENTS BY ICP/MS (WATER)

BV Labs ID		KWQ755	KWQ756		
Sampling Date		2019/09/24	2019/09/24		
COC Number		D36949	D36949		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Metals					
Dissolved Aluminum (Al)	ug/L	20	18	5.0	6359671
Total Aluminum (Al)	ug/L	17	23	5.0	6359400
Dissolved Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6359671
Total Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6359400
Dissolved Arsenic (As)	ug/L	59	50	1.0	6359671
Total Arsenic (As)	ug/L	65	55	1.0	6359400
Dissolved Barium (Ba)	ug/L	8.0	6.8	1.0	6359671
Total Barium (Ba)	ug/L	8.2	6.6	1.0	6359400
Dissolved Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6359671
Total Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6359400
Dissolved Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6359671
Total Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6359400
Dissolved Boron (B)	ug/L	<50	<50	50	6359671
Total Boron (B)	ug/L	<50	<50	50	6359400
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6359671
Total Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6359400
Dissolved Calcium (Ca)	ug/L	9300	8800	100	6359671
Total Calcium (Ca)	ug/L	9500	8700	100	6359400
Dissolved Chromium (Cr)	ug/L	<1.0	1.1	1.0	6359671
Total Chromium (Cr)	ug/L	<1.0	<1.0	1.0	6359400
Dissolved Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6359671
Total Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6359400
Dissolved Copper (Cu)	ug/L	0.66	0.54	0.50	6359671
Total Copper (Cu)	ug/L	0.80	3.1	0.50	6359400
Dissolved Iron (Fe)	ug/L	<50	74	50	6359671
Total Iron (Fe)	ug/L	77	120	50	6359400
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	0.50	6359671
Total Lead (Pb)	ug/L	<0.50	<0.50	0.50	6359400
Dissolved Magnesium (Mg)	ug/L	1700	1700	100	6359671
Total Magnesium (Mg)	ug/L	1700	1600	100	6359400
Dissolved Manganese (Mn)	ug/L	130	110	2.0	6359671
Total Manganese (Mn)	ug/L	140	120	2.0	6359400
Dissolved Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6359671
Total Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6359400

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

ELEMENTS BY ICP/MS (WATER)

BV Labs ID		KWQ755	KWQ756		
Sampling Date		2019/09/24	2019/09/24		
COC Number		D36949	D36949		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Dissolved Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6359671
Total Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6359400
Dissolved Phosphorus (P)	ug/L	<100	<100	100	6359671
Total Phosphorus (P)	ug/L	<100	<100	100	6359400
Dissolved Potassium (K)	ug/L	1200	1000	100	6359671
Total Potassium (K)	ug/L	1200	1000	100	6359400
Dissolved Selenium (Se)	ug/L	<0.50	<0.50	0.50	6359671
Total Selenium (Se)	ug/L	<0.50	<0.50	0.50	6359400
Dissolved Silver (Ag)	ug/L	<0.10	<0.10	0.10	6359671
Total Silver (Ag)	ug/L	<0.10	<0.10	0.10	6359400
Dissolved Sodium (Na)	ug/L	40000	34000	100	6359671
Total Sodium (Na)	ug/L	40000	32000	100	6359400
Dissolved Strontium (Sr)	ug/L	31	31	2.0	6359671
Total Strontium (Sr)	ug/L	35	32	2.0	6359400
Dissolved Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6359671
Total Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6359400
Dissolved Tin (Sn)	ug/L	<2.0	<2.0	2.0	6359671
Total Tin (Sn)	ug/L	<2.0	<2.0	2.0	6359400
Dissolved Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6359671
Total Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6359400
Dissolved Uranium (U)	ug/L	<0.10	<0.10	0.10	6359671
Total Uranium (U)	ug/L	<0.10	<0.10	0.10	6359400
Dissolved Vanadium (V)	ug/L	<2.0	<2.0	2.0	6359671
Total Vanadium (V)	ug/L	<2.0	<2.0	2.0	6359400
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6359671
Total Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6359400

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs Job #: B9R0093
Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	6.3°C
Package 2	5.0°C
Package 3	5.7°C

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6359400	BAN	Matrix Spike	Total Aluminum (Al)	2019/09/30		97	%	80 - 120
			Total Antimony (Sb)	2019/09/30		104	%	80 - 120
			Total Arsenic (As)	2019/09/30		97	%	80 - 120
			Total Barium (Ba)	2019/09/30		NC	%	80 - 120
			Total Beryllium (Be)	2019/09/30		100	%	80 - 120
			Total Bismuth (Bi)	2019/09/30		97	%	80 - 120
			Total Boron (B)	2019/09/30		101	%	80 - 120
			Total Cadmium (Cd)	2019/09/30		97	%	80 - 120
			Total Calcium (Ca)	2019/09/30		NC	%	80 - 120
			Total Chromium (Cr)	2019/09/30		95	%	80 - 120
			Total Cobalt (Co)	2019/09/30		96	%	80 - 120
			Total Copper (Cu)	2019/09/30		97	%	80 - 120
			Total Iron (Fe)	2019/09/30		100	%	80 - 120
			Total Lead (Pb)	2019/09/30		98	%	80 - 120
			Total Magnesium (Mg)	2019/09/30		100	%	80 - 120
			Total Manganese (Mn)	2019/09/30		97	%	80 - 120
			Total Molybdenum (Mo)	2019/09/30		104	%	80 - 120
			Total Nickel (Ni)	2019/09/30		99	%	80 - 120
			Total Phosphorus (P)	2019/09/30		102	%	80 - 120
			Total Potassium (K)	2019/09/30		97	%	80 - 120
			Total Selenium (Se)	2019/09/30		95	%	80 - 120
			Total Silver (Ag)	2019/09/30		100	%	80 - 120
			Total Sodium (Na)	2019/09/30		93	%	80 - 120
			Total Strontium (Sr)	2019/09/30		NC	%	80 - 120
			Total Thallium (Tl)	2019/09/30		101	%	80 - 120
			Total Tin (Sn)	2019/09/30		103	%	80 - 120
			Total Titanium (Ti)	2019/09/30		100	%	80 - 120
			Total Uranium (U)	2019/09/30		104	%	80 - 120
			Total Vanadium (V)	2019/09/30		100	%	80 - 120
			Total Zinc (Zn)	2019/09/30		96	%	80 - 120
6359400	BAN	Spiked Blank	Total Aluminum (Al)	2019/09/30		99	%	80 - 120
			Total Antimony (Sb)	2019/09/30		102	%	80 - 120
			Total Arsenic (As)	2019/09/30		96	%	80 - 120
			Total Barium (Ba)	2019/09/30		101	%	80 - 120
			Total Beryllium (Be)	2019/09/30		99	%	80 - 120
			Total Bismuth (Bi)	2019/09/30		100	%	80 - 120
			Total Boron (B)	2019/09/30		102	%	80 - 120
			Total Cadmium (Cd)	2019/09/30		99	%	80 - 120
			Total Calcium (Ca)	2019/09/30		102	%	80 - 120
			Total Chromium (Cr)	2019/09/30		97	%	80 - 120
			Total Cobalt (Co)	2019/09/30		99	%	80 - 120
			Total Copper (Cu)	2019/09/30		99	%	80 - 120
			Total Iron (Fe)	2019/09/30		102	%	80 - 120
			Total Lead (Pb)	2019/09/30		100	%	80 - 120
			Total Magnesium (Mg)	2019/09/30		103	%	80 - 120
			Total Manganese (Mn)	2019/09/30		101	%	80 - 120
			Total Molybdenum (Mo)	2019/09/30		104	%	80 - 120
			Total Nickel (Ni)	2019/09/30		101	%	80 - 120
			Total Phosphorus (P)	2019/09/30		102	%	80 - 120
			Total Potassium (K)	2019/09/30		100	%	80 - 120
			Total Selenium (Se)	2019/09/30		95	%	80 - 120
			Total Silver (Ag)	2019/09/30		100	%	80 - 120
			Total Sodium (Na)	2019/09/30		98	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Strontium (Sr)	2019/09/30		103	%	80 - 120
			Total Thallium (Tl)	2019/09/30		102	%	80 - 120
			Total Tin (Sn)	2019/09/30		102	%	80 - 120
			Total Titanium (Ti)	2019/09/30		99	%	80 - 120
			Total Uranium (U)	2019/09/30		104	%	80 - 120
			Total Vanadium (V)	2019/09/30		101	%	80 - 120
			Total Zinc (Zn)	2019/09/30		99	%	80 - 120
6359400	BAN	Method Blank	Total Aluminum (Al)	2019/09/30	<5.0		ug/L	
			Total Antimony (Sb)	2019/09/30	<1.0		ug/L	
			Total Arsenic (As)	2019/09/30	<1.0		ug/L	
			Total Barium (Ba)	2019/09/30	<1.0		ug/L	
			Total Beryllium (Be)	2019/09/30	<1.0		ug/L	
			Total Bismuth (Bi)	2019/09/30	<2.0		ug/L	
			Total Boron (B)	2019/09/30	<50		ug/L	
			Total Cadmium (Cd)	2019/09/30	<0.010		ug/L	
			Total Calcium (Ca)	2019/09/30	<100		ug/L	
			Total Chromium (Cr)	2019/09/30	<1.0		ug/L	
			Total Cobalt (Co)	2019/09/30	<0.40		ug/L	
			Total Copper (Cu)	2019/09/30	<0.50		ug/L	
			Total Iron (Fe)	2019/09/30	<50		ug/L	
			Total Lead (Pb)	2019/09/30	<0.50		ug/L	
			Total Magnesium (Mg)	2019/09/30	<100		ug/L	
			Total Manganese (Mn)	2019/09/30	<2.0		ug/L	
			Total Molybdenum (Mo)	2019/09/30	<2.0		ug/L	
			Total Nickel (Ni)	2019/09/30	<2.0		ug/L	
			Total Phosphorus (P)	2019/09/30	<100		ug/L	
			Total Potassium (K)	2019/09/30	<100		ug/L	
			Total Selenium (Se)	2019/09/30	<0.50		ug/L	
			Total Silver (Ag)	2019/09/30	<0.10		ug/L	
			Total Sodium (Na)	2019/09/30	<100		ug/L	
			Total Strontium (Sr)	2019/09/30	<2.0		ug/L	
			Total Thallium (Tl)	2019/09/30	<0.10		ug/L	
			Total Tin (Sn)	2019/09/30	<2.0		ug/L	
			Total Titanium (Ti)	2019/09/30	<2.0		ug/L	
			Total Uranium (U)	2019/09/30	<0.10		ug/L	
			Total Vanadium (V)	2019/09/30	<2.0		ug/L	
			Total Zinc (Zn)	2019/09/30	<5.0		ug/L	
6359400	BAN	RPD	Total Aluminum (Al)	2019/09/30	5.7		%	20
6359671	AFM	Matrix Spike	Dissolved Aluminum (Al)	2019/10/02		99	%	80 - 120
			Dissolved Antimony (Sb)	2019/10/02		98	%	80 - 120
			Dissolved Arsenic (As)	2019/10/02		97	%	80 - 120
			Dissolved Barium (Ba)	2019/10/02		99	%	80 - 120
			Dissolved Beryllium (Be)	2019/10/02		102	%	80 - 120
			Dissolved Bismuth (Bi)	2019/10/02		95	%	80 - 120
			Dissolved Boron (B)	2019/10/02		NC	%	80 - 120
			Dissolved Cadmium (Cd)	2019/10/02		96	%	80 - 120
			Dissolved Calcium (Ca)	2019/10/02		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/10/02		96	%	80 - 120
			Dissolved Cobalt (Co)	2019/10/02		97	%	80 - 120
			Dissolved Copper (Cu)	2019/10/02		94	%	80 - 120
			Dissolved Iron (Fe)	2019/10/02		102	%	80 - 120
			Dissolved Lead (Pb)	2019/10/02		96	%	80 - 120
			Dissolved Magnesium (Mg)	2019/10/02		NC	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Manganese (Mn)	2019/10/02		NC	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/10/02		106	%	80 - 120
			Dissolved Nickel (Ni)	2019/10/02		96	%	80 - 120
			Dissolved Phosphorus (P)	2019/10/02		102	%	80 - 120
			Dissolved Potassium (K)	2019/10/02		100	%	80 - 120
			Dissolved Selenium (Se)	2019/10/02		98	%	80 - 120
			Dissolved Silver (Ag)	2019/10/02		86	%	80 - 120
			Dissolved Sodium (Na)	2019/10/02		97	%	80 - 120
			Dissolved Strontium (Sr)	2019/10/02		NC	%	80 - 120
			Dissolved Thallium (Tl)	2019/10/02		100	%	80 - 120
			Dissolved Tin (Sn)	2019/10/02		103	%	80 - 120
			Dissolved Titanium (Ti)	2019/10/02		101	%	80 - 120
			Dissolved Uranium (U)	2019/10/02		104	%	80 - 120
			Dissolved Vanadium (V)	2019/10/02		102	%	80 - 120
			Dissolved Zinc (Zn)	2019/10/02		99	%	80 - 120
6359671	AFM	Spiked Blank	Dissolved Aluminum (Al)	2019/10/02		104	%	80 - 120
			Dissolved Antimony (Sb)	2019/10/02		99	%	80 - 120
			Dissolved Arsenic (As)	2019/10/02		96	%	80 - 120
			Dissolved Barium (Ba)	2019/10/02		97	%	80 - 120
			Dissolved Beryllium (Be)	2019/10/02		98	%	80 - 120
			Dissolved Bismuth (Bi)	2019/10/02		98	%	80 - 120
			Dissolved Boron (B)	2019/10/02		101	%	80 - 120
			Dissolved Cadmium (Cd)	2019/10/02		95	%	80 - 120
			Dissolved Calcium (Ca)	2019/10/02		103	%	80 - 120
			Dissolved Chromium (Cr)	2019/10/02		96	%	80 - 120
			Dissolved Cobalt (Co)	2019/10/02		98	%	80 - 120
			Dissolved Copper (Cu)	2019/10/02		96	%	80 - 120
			Dissolved Iron (Fe)	2019/10/02		103	%	80 - 120
			Dissolved Lead (Pb)	2019/10/02		97	%	80 - 120
			Dissolved Magnesium (Mg)	2019/10/02		107	%	80 - 120
			Dissolved Manganese (Mn)	2019/10/02		98	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/10/02		102	%	80 - 120
			Dissolved Nickel (Ni)	2019/10/02		98	%	80 - 120
			Dissolved Phosphorus (P)	2019/10/02		107	%	80 - 120
			Dissolved Potassium (K)	2019/10/02		103	%	80 - 120
			Dissolved Selenium (Se)	2019/10/02		97	%	80 - 120
			Dissolved Silver (Ag)	2019/10/02		96	%	80 - 120
			Dissolved Sodium (Na)	2019/10/02		102	%	80 - 120
			Dissolved Strontium (Sr)	2019/10/02		97	%	80 - 120
			Dissolved Thallium (Tl)	2019/10/02		101	%	80 - 120
			Dissolved Tin (Sn)	2019/10/02		102	%	80 - 120
			Dissolved Titanium (Ti)	2019/10/02		102	%	80 - 120
			Dissolved Uranium (U)	2019/10/02		102	%	80 - 120
			Dissolved Vanadium (V)	2019/10/02		101	%	80 - 120
			Dissolved Zinc (Zn)	2019/10/02		102	%	80 - 120
6359671	AFM	Method Blank	Dissolved Aluminum (Al)	2019/10/02	<5.0		ug/L	
			Dissolved Antimony (Sb)	2019/10/02	<1.0		ug/L	
			Dissolved Arsenic (As)	2019/10/02	<1.0		ug/L	
			Dissolved Barium (Ba)	2019/10/02	<1.0		ug/L	
			Dissolved Beryllium (Be)	2019/10/02	<1.0		ug/L	
			Dissolved Bismuth (Bi)	2019/10/02	<2.0		ug/L	
			Dissolved Boron (B)	2019/10/02	<50		ug/L	
			Dissolved Cadmium (Cd)	2019/10/02	<0.010		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Calcium (Ca)	2019/10/02	<100		ug/L	
			Dissolved Chromium (Cr)	2019/10/02	<1.0		ug/L	
			Dissolved Cobalt (Co)	2019/10/02	<0.40		ug/L	
			Dissolved Copper (Cu)	2019/10/02	<0.50		ug/L	
			Dissolved Iron (Fe)	2019/10/02	<50		ug/L	
			Dissolved Lead (Pb)	2019/10/02	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2019/10/02	<100		ug/L	
			Dissolved Manganese (Mn)	2019/10/02	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2019/10/02	<2.0		ug/L	
			Dissolved Nickel (Ni)	2019/10/02	<2.0		ug/L	
			Dissolved Phosphorus (P)	2019/10/02	<100		ug/L	
			Dissolved Potassium (K)	2019/10/02	<100		ug/L	
			Dissolved Selenium (Se)	2019/10/02	<0.50		ug/L	
			Dissolved Silver (Ag)	2019/10/02	<0.10		ug/L	
			Dissolved Sodium (Na)	2019/10/02	<100		ug/L	
			Dissolved Strontium (Sr)	2019/10/02	<2.0		ug/L	
			Dissolved Thallium (Tl)	2019/10/02	<0.10		ug/L	
			Dissolved Tin (Sn)	2019/10/02	<2.0		ug/L	
			Dissolved Titanium (Ti)	2019/10/02	<2.0		ug/L	
			Dissolved Uranium (U)	2019/10/02	<0.10		ug/L	
			Dissolved Vanadium (V)	2019/10/02	<2.0		ug/L	
			Dissolved Zinc (Zn)	2019/10/02	<5.0		ug/L	
6359671	AFM	RPD	Dissolved Aluminum (Al)	2019/10/02	13		%	20
			Dissolved Antimony (Sb)	2019/10/02	NC		%	20
			Dissolved Arsenic (As)	2019/10/02	NC		%	20
			Dissolved Barium (Ba)	2019/10/02	3.8		%	20
			Dissolved Beryllium (Be)	2019/10/02	NC		%	20
			Dissolved Bismuth (Bi)	2019/10/02	NC		%	20
			Dissolved Boron (B)	2019/10/02	0.58		%	20
			Dissolved Cadmium (Cd)	2019/10/02	2.0		%	20
			Dissolved Calcium (Ca)	2019/10/02	0.41		%	20
			Dissolved Chromium (Cr)	2019/10/02	NC		%	20
			Dissolved Cobalt (Co)	2019/10/02	NC		%	20
			Dissolved Copper (Cu)	2019/10/02	NC		%	20
			Dissolved Iron (Fe)	2019/10/02	NC		%	20
			Dissolved Lead (Pb)	2019/10/02	NC		%	20
			Dissolved Magnesium (Mg)	2019/10/02	0.53		%	20
			Dissolved Manganese (Mn)	2019/10/02	0.72		%	20
			Dissolved Molybdenum (Mo)	2019/10/02	2.4		%	20
			Dissolved Nickel (Ni)	2019/10/02	NC		%	20
			Dissolved Phosphorus (P)	2019/10/02	NC		%	20
			Dissolved Potassium (K)	2019/10/02	5.7		%	20
			Dissolved Selenium (Se)	2019/10/02	NC		%	20
			Dissolved Silver (Ag)	2019/10/02	NC		%	20
			Dissolved Sodium (Na)	2019/10/02	0.46		%	20
			Dissolved Strontium (Sr)	2019/10/02	0.18		%	20
			Dissolved Thallium (Tl)	2019/10/02	NC		%	20
			Dissolved Tin (Sn)	2019/10/02	NC		%	20
			Dissolved Titanium (Ti)	2019/10/02	NC		%	20
			Dissolved Uranium (U)	2019/10/02	2.6		%	20
			Dissolved Vanadium (V)	2019/10/02	NC		%	20
			Dissolved Zinc (Zn)	2019/10/02	NC		%	20
6359706	BAN	Matrix Spike	Acid Extractable Arsenic (As)	2019/10/04		NC	%	75 - 125

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Mercury (Hg)	2019/10/04		NC	%	75 - 125
6359706	BAN	Spiked Blank	Acid Extractable Arsenic (As)	2019/10/04		103	%	75 - 125
			Acid Extractable Mercury (Hg)	2019/10/04		105	%	75 - 125
6359706	BAN	Method Blank	Acid Extractable Arsenic (As)	2019/10/03	<2.0		mg/kg	
			Acid Extractable Mercury (Hg)	2019/10/03	<0.10		mg/kg	
6359706	BAN	RPD	Acid Extractable Arsenic (As)	2019/10/04	11		%	35
			Acid Extractable Mercury (Hg)	2019/10/04	11		%	35
6361914	AM6	QC Standard	Total Suspended Solids	2019/10/02		95	%	80 - 120
6361914	AM6	Method Blank	Total Suspended Solids	2019/10/02	<1.0		mg/L	
6361914	AM6	RPD	Total Suspended Solids	2019/10/02	2.6		%	20
6364217	KMC	QC Standard	pH	2019/10/02		100	%	97 - 103
6364217	KMC	RPD	pH	2019/10/02	0.16		%	N/A
6364378	MCN	Matrix Spike	Nitrogen (Ammonia Nitrogen)	2019/10/03		85	%	80 - 120
6364378	MCN	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2019/10/03		101	%	80 - 120
6364378	MCN	Method Blank	Nitrogen (Ammonia Nitrogen)	2019/10/03	<0.050		mg/L	
6364378	MCN	RPD	Nitrogen (Ammonia Nitrogen)	2019/10/03	0.19		%	20
6364921	MCN	Matrix Spike	Total Alkalinity (Total as CaCO3)	2019/10/05		NC	%	80 - 120
6364921	MCN	Spiked Blank	Total Alkalinity (Total as CaCO3)	2019/10/05		108	%	80 - 120
6364921	MCN	Method Blank	Total Alkalinity (Total as CaCO3)	2019/10/05	<5.0		mg/L	
6364921	MCN	RPD	Total Alkalinity (Total as CaCO3)	2019/10/05	11		%	25
6364928	MCN	Matrix Spike	Dissolved Chloride (Cl-)	2019/10/03		NC	%	80 - 120
6364928	MCN	Spiked Blank	Dissolved Chloride (Cl-)	2019/10/03		100	%	80 - 120
6364928	MCN	Method Blank	Dissolved Chloride (Cl-)	2019/10/03	<1.0		mg/L	
6364928	MCN	RPD	Dissolved Chloride (Cl-)	2019/10/03	0.33		%	25
6364931	MCN	Matrix Spike	Dissolved Sulphate (SO4)	2019/10/02		87	%	80 - 120
6364931	MCN	Spiked Blank	Dissolved Sulphate (SO4)	2019/10/02		101	%	80 - 120
6364931	MCN	Method Blank	Dissolved Sulphate (SO4)	2019/10/02	<2.0		mg/L	
6364931	MCN	RPD	Dissolved Sulphate (SO4)	2019/10/02	0.59		%	25
6364934	MCN	Matrix Spike	Reactive Silica (SiO2)	2019/10/02		95	%	80 - 120
6364934	MCN	Spiked Blank	Reactive Silica (SiO2)	2019/10/02		97	%	80 - 120
6364934	MCN	Method Blank	Reactive Silica (SiO2)	2019/10/02	<0.50		mg/L	
6364934	MCN	RPD	Reactive Silica (SiO2)	2019/10/02	1.3		%	25
6364936	MCN	Spiked Blank	Colour	2019/10/03		100	%	80 - 120
6364936	MCN	Method Blank	Colour	2019/10/03	<5.0		TCU	
6364936	MCN	RPD	Colour	2019/10/03	NC		%	20
6364939	MCN	Matrix Spike	Orthophosphate (P)	2019/10/03		98	%	80 - 120
6364939	MCN	Spiked Blank	Orthophosphate (P)	2019/10/03		104	%	80 - 120
6364939	MCN	Method Blank	Orthophosphate (P)	2019/10/03	<0.010		mg/L	
6364939	MCN	RPD	Orthophosphate (P)	2019/10/03	2.7		%	25
6364940	MCN	Matrix Spike	Nitrate + Nitrite (N)	2019/10/04		101	%	80 - 120
6364940	MCN	Spiked Blank	Nitrate + Nitrite (N)	2019/10/04		92	%	80 - 120
6364940	MCN	Method Blank	Nitrate + Nitrite (N)	2019/10/04	<0.050		mg/L	
6364940	MCN	RPD	Nitrate + Nitrite (N)	2019/10/04	4.0		%	25
6364956	MCN	Matrix Spike	Nitrite (N)	2019/10/02		99	%	80 - 120
6364956	MCN	Spiked Blank	Nitrite (N)	2019/10/02		99	%	80 - 120
6364956	MCN	Method Blank	Nitrite (N)	2019/10/02	<0.010		mg/L	
6364956	MCN	RPD	Nitrite (N)	2019/10/02	NC		%	20
6369495	SSI	Matrix Spike	Total Organic Carbon (C)	2019/10/05		100	%	85 - 115
6369495	SSI	Spiked Blank	Total Organic Carbon (C)	2019/10/05		101	%	80 - 120
6369495	SSI	Method Blank	Total Organic Carbon (C)	2019/10/05	<0.50		mg/L	
6369495	SSI	RPD	Total Organic Carbon (C)	2019/10/05	NC		%	15
6369499	SSI	Matrix Spike	Total Organic Carbon (C)	2019/10/05		102	%	85 - 115
6369499	SSI	Spiked Blank	Total Organic Carbon (C)	2019/10/05		102	%	80 - 120

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6369499	SSI	Method Blank	Total Organic Carbon (C)	2019/10/05	<0.50		mg/L	
6369499	SSI	RPD	Total Organic Carbon (C)	2019/10/05	NC		%	15
6369507	SSI	Matrix Spike	Dissolved Organic Carbon (C)	2019/10/05		101	%	85 - 115
6369507	SSI	Spiked Blank	Dissolved Organic Carbon (C)	2019/10/05		101	%	80 - 120
6369507	SSI	Method Blank	Dissolved Organic Carbon (C)	2019/10/05	<0.50		mg/L	
6369507	SSI	RPD	Dissolved Organic Carbon (C)	2019/10/05	0.69		%	15
6369710	SSI	QC Standard	Conductivity	2019/10/04		99	%	80 - 120
6369710	SSI	Method Blank	Conductivity	2019/10/04	<1.0		uS/cm	
6369710	SSI	RPD	Conductivity	2019/10/04	0.43		%	10
6369763	KMC	QC Standard	Turbidity	2019/10/05		101	%	80 - 120
6369763	KMC	Spiked Blank	Turbidity	2019/10/05		100	%	80 - 120
6369763	KMC	Method Blank	Turbidity	2019/10/05	<0.10		NTU	
6369763	KMC	RPD	Turbidity	2019/10/05	2.3		%	20
6382132	BAN	Matrix Spike [KWQ717-01]	Acid Extractable Antimony (Sb)	2019/10/11		103	%	75 - 125
			Acid Extractable Arsenic (As)	2019/10/11		NC	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/11		NC	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/11		114	%	75 - 125
			Acid Extractable Boron (B)	2019/10/11		106	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/11		109	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/11		109	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/11		108	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/11		105	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/11		NC	%	75 - 125
			Acid Extractable Lithium (Li)	2019/10/11		119	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/11		NC	%	75 - 125
			Acid Extractable Molybdenum (Mo)	2019/10/11		117	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/11		109	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/11		109	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/11		105	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/11		112	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/11		112	%	75 - 125
			Acid Extractable Uranium (U)	2019/10/11		110	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/11		110	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/11		112	%	75 - 125
6382132	BAN	Spiked Blank	Acid Extractable Antimony (Sb)	2019/10/11		107	%	75 - 125
			Acid Extractable Arsenic (As)	2019/10/11		102	%	75 - 125
			Acid Extractable Barium (Ba)	2019/10/11		104	%	75 - 125
			Acid Extractable Beryllium (Be)	2019/10/11		103	%	75 - 125
			Acid Extractable Boron (B)	2019/10/11		104	%	75 - 125
			Acid Extractable Cadmium (Cd)	2019/10/11		98	%	75 - 125
			Acid Extractable Chromium (Cr)	2019/10/11		97	%	75 - 125
			Acid Extractable Cobalt (Co)	2019/10/11		100	%	75 - 125
			Acid Extractable Copper (Cu)	2019/10/11		97	%	75 - 125
			Acid Extractable Lead (Pb)	2019/10/11		102	%	75 - 125
			Acid Extractable Lithium (Li)	2019/10/11		104	%	75 - 125
			Acid Extractable Manganese (Mn)	2019/10/11		101	%	75 - 125
			Acid Extractable Molybdenum (Mo)	2019/10/11		105	%	75 - 125
			Acid Extractable Nickel (Ni)	2019/10/11		98	%	75 - 125
			Acid Extractable Selenium (Se)	2019/10/11		104	%	75 - 125
			Acid Extractable Silver (Ag)	2019/10/11		99	%	75 - 125
			Acid Extractable Strontium (Sr)	2019/10/11		103	%	75 - 125
			Acid Extractable Thallium (Tl)	2019/10/11		102	%	75 - 125

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QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Uranium (U)	2019/10/11		101	%	75 - 125
			Acid Extractable Vanadium (V)	2019/10/11		101	%	75 - 125
			Acid Extractable Zinc (Zn)	2019/10/11		99	%	75 - 125
6382132	BAN	Method Blank	Acid Extractable Aluminum (Al)	2019/10/11	<10		mg/kg	
			Acid Extractable Antimony (Sb)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Arsenic (As)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Barium (Ba)	2019/10/11	<5.0		mg/kg	
			Acid Extractable Beryllium (Be)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Boron (B)	2019/10/11	<5.0		mg/kg	
			Acid Extractable Cadmium (Cd)	2019/10/11	<0.30		mg/kg	
			Acid Extractable Chromium (Cr)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Cobalt (Co)	2019/10/11	<1.0		mg/kg	
			Acid Extractable Copper (Cu)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Iron (Fe)	2019/10/11	<50		mg/kg	
			Acid Extractable Lead (Pb)	2019/10/11	<0.50		mg/kg	
			Acid Extractable Lithium (Li)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Manganese (Mn)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Molybdenum (Mo)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Nickel (Ni)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Selenium (Se)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Silver (Ag)	2019/10/11	<0.50		mg/kg	
			Acid Extractable Strontium (Sr)	2019/10/11	<5.0		mg/kg	
			Acid Extractable Thallium (Tl)	2019/10/11	<0.10		mg/kg	
			Acid Extractable Uranium (U)	2019/10/11	<0.10		mg/kg	
			Acid Extractable Vanadium (V)	2019/10/11	<2.0		mg/kg	
			Acid Extractable Zinc (Zn)	2019/10/11	<5.0		mg/kg	
6382132	BAN	RPD [KWQ717-01]	Acid Extractable Aluminum (Al)	2019/10/11	3.0		%	35
			Acid Extractable Antimony (Sb)	2019/10/11	8.8		%	35
			Acid Extractable Arsenic (As)	2019/10/11	0.80		%	35
			Acid Extractable Barium (Ba)	2019/10/11	3.2		%	35
			Acid Extractable Beryllium (Be)	2019/10/11	NC		%	35
			Acid Extractable Boron (B)	2019/10/11	NC		%	35
			Acid Extractable Cadmium (Cd)	2019/10/11	2.1		%	35
			Acid Extractable Chromium (Cr)	2019/10/11	0.33		%	35
			Acid Extractable Cobalt (Co)	2019/10/11	2.2		%	35
			Acid Extractable Copper (Cu)	2019/10/11	1.3		%	35
			Acid Extractable Iron (Fe)	2019/10/11	0.86		%	35
			Acid Extractable Lead (Pb)	2019/10/11	1.5		%	35
			Acid Extractable Lithium (Li)	2019/10/11	2.2		%	35
			Acid Extractable Manganese (Mn)	2019/10/11	1.3		%	35
			Acid Extractable Molybdenum (Mo)	2019/10/11	NC		%	35
			Acid Extractable Nickel (Ni)	2019/10/11	1.1		%	35
			Acid Extractable Selenium (Se)	2019/10/11	NC		%	35
			Acid Extractable Silver (Ag)	2019/10/11	NC		%	35
			Acid Extractable Strontium (Sr)	2019/10/11	2.2		%	35
			Acid Extractable Thallium (Tl)	2019/10/11	NC		%	35
			Acid Extractable Uranium (U)	2019/10/11	2.5		%	35
			Acid Extractable Vanadium (V)	2019/10/11	1.4		%	35

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Acid Extractable Zinc (Zn)	2019/10/11	3.8		%	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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BV Labs Job #: B9R0093
Report Date: 2019/10/15

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: JAM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eric Dearman, Scientific Specialist

Mike MacGillivray, Scientific Specialist (Inorganics)

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

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ATL FCD 00149 / 22

CHAIN OF CUSTODY RECORD

COC #: D 36949 Page 3 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Dillon Consulting	Company Name:	Quotation #:	✓ Regular TAT (5 business days) Most analyses
Contact Name: Rebecca Appleton	Contact Name:	P.O. #:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 137 Chain Lake Dr. HFX	Address:	Project #: 19-1567-1000	IF RUSH please specify date (Surcharges will be applied)
Postal Code:	Postal Code:	Site Location: Port Wallace	DATE REQUIRED:
Phone: 450-4000 Fax: 450-2008	Phone: Fax:	Site #:	
Email: rappleton@dillon.ca	Email:	Sampled By: JAM/NCB	

Laboratory Use Only

CUSTODY SEAL Present	CUSTODY SEAL Intact	COOLER TEMPERATURES	COOLER TEMPERATURES
		12.0, 7	
		7.3, 5	
		5.3, 89	

COOLING MEDIA PRESENT Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED &PRESERVED	LAB FILTRATION REQUIRED	RCAP-MS (Total Metals) Well / Surface water	RCAP-MS (Dissolved Metals) Ground waters	Metals (Water): Total Digest (Default Method) for well water & surface water	Metals (Water): Dissolved for ground water	Metals (Water): Mercury (CIRCLE) TOTAL / DISSOLVED	Metals (Soil): Metals & Mercury Default Acid Extractable (Available) Digest	Metals (Soil): Metals Total Digest -for Ocean sediments (HNO3/HF/HClO4)	Metals (Soil): Mercury Low level by Cold Vapour AA	Metals (Soil): Hot Water Soluble Boron (required for CCME Agricultural/ Landfill)	RBCA Hydrocarbons (BTEX, C6-C32)	Hydrocarbons Soil (Potable), NS Fuel Oil Spill Policy Low Level BTEX ,C6-C32	CCME Hydrocarbons (CWS-PHC F1/BTEX, F2-F4)	NB Potable Water BTEX, VPH; Low level T.E.H	PAHs (Default for water/soil)	PAHs (FWAL /CCME Sediment)	~~PCBs~~ TSS	~~VOCs~~ DOC	Total Coliform/E.coli (Presence/Absence)	Total Coliform/E.Coli (Count)		HOLD- DO NOT ANALYZE	Regulatory Requirements (Specify) / COMMENTS
1	TOF19-15	Sept 24/19		ORG	1								✓																
2	TOF19-16	Sept 24/19		ORG	1								✓																
3	SW-IN	Sept 25/19		H_2O	6			✓		✓	✓													✓	✓				Total Metals bottle marked on cap "T.M."
4	SW-OUT	Sept 24/19		H_2O	6			✓		✓	✓													✓	✓				
5																													
6																													
7																													
8																													
9																													
10																													

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY:(Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
	9/26/19	2:30				B9R0093

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ATL FCD 00149 / 22

CHAIN OF CUSTODY RECORD

COC #: D 36948 Page 1 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Dillon Consulting	Company Name:	Quotation #:	✓ Regular TAT (5 business days) Most analyses
Contact Name: Rebecca Appleton	Contact Name:	P.O. #:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 137 Chain Lake Dr HFX	Address:	Project #: 19-1567-1000	IF RUSH please specify date (Surcharges will be applied)
Postal Code:	Postal Code:	Site Location: Port Wallace	DATE REQUIRED:
Phone: 450-4000 Fax: 450-2008	Phone: Fax:	Site #:	
Email: rappleton@dillon.ca	Email:	Sampled By: JAM/NCB	

Laboratory Use Only

CUSTODY SEAL Present	CUSTODY SEAL Intact	COOLER TEMPERATURES	COOLER TEMPERATURES
		12, 8, 7	
		7, 3, 5	
		5, 3, 9	

COOLING MEDIA PRESENT Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED &PRESERVED	LAB FILTRATION REQUIRED	RCAP-MS [Total Metals] Well / Surface water	RCAP-MS [Dissolved Metals] Ground waters	Metals (Water): Total Digest (Default Method) for well water & surface water	Metals (Water): Dissolved for ground water	Metals (Water): Mercury (CIRCLE) TOTAL / DISSOLVED	Metals (Soil): Metals & Mercury Default Acid Extractable (Available) Digest	Metals (Soil): Metals Total Digest - for Ocean sediments (HNO3/HF/HClO4)	Metals (Soil): Mercury Low level by Cold Vapour AA	Metals (Soil): Hot Water Soluble Boron (required for CCME Agricultural/ Landfill)	RBCA Hydrocarbons (BTEX, C6-C32)	Hydrocarbons Soil (Potable), NS Fuel Oil Spill Policy Low Level BTEX, C6-C32	CCME Hydrocarbons (CWS-PHC F1/BTEX, F2-F4)	NB Potable Water BTEX, VPH; Low level T.E.H	PAHs (Default for water/soil)	PAHs (FWAL /CCME Sediment)	PCBs	VOCs	Total Coliform/E.coli (Presence/Absence)	Total Coliform/E.Coli (Count)	Total Arsenic/Total Hg	HOLD- DO NOT ANALYZE	Regulatory Requirements (Specify)
1	BIOSED19-1 0-0.1m	Sept24/19		SED	1																						✓	
2	BIOSED19-2 0-0.1m				1																						✓	
3	BIOSED19-3 0-0.1m				1																						✓	
4	BIOSED19-4 0-0.1m				1																						✓	
5	BIOSED19-5 0-0.1m				1																						✓	
6	BIOSED19-6 0-0.1m				1																						✓	
7	TOF19-1	Sept24/19		ORG	1								✓															
8	TOF19-2				1								✓															
9	TOF19-3				1								✓															
10	TOF19-4				1								✓															

Regulatory Requirements (Specify)

COMMENTS: 1 of 2 / 1 Being held by Dillon

SEP 26 1431

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY:(Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
JM-M	9/26/19	2:30				B9R0093
JMacMaster						

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CHAIN OF CUSTODY RECORD

COC #: D36947 Page 2 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: Dillon Consulting	Company Name:	Quotation #:	✓ Regular TAT (5 business days) Most analyses
Contact Name: Rebecca Appleton	Contact Name:	P.O. #:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 137 Chain Lake Dr HFX	Address:	Project #: 19-1567-1000	IF RUSH please specify date (Surcharges will be applied)
Postal Code:	Postal Code:	Site Location: Port Wallace	DATE REQUIRED:
Phone: 450-4000 Fax: 450-2038	Phone: Fax:	Site #:	
Email: rappleton@dillon.ca	Email:	Sampled By: JAM/NCB	

Laboratory Use Only

CUSTODY SEAL Present	CUSTODY SEAL Intact	COOLER TEMPERATURES	COOLER TEMPERATURES
		12, 0, 7	
		7, 3, 5	
		5, 3, 9	

COOLING MEDIA PRESENT Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED &PRESERVED	LAB FILTRATION REQUIRED	RCAP-MS [Total Metals] Well / Surface water	RCAP-MS [Dissolved Metals] Ground waters	Metals (Water): Total Digest (Default Method) for well water & surface water	Metals (Water): Dissolved for ground water	Metals (Water): Mercury (CIRCLE) TOTAL / DISSOLVED	Metals (Soil): Metals & Mercury Default Acid Extractable (Available) Digest	Metals (Soil): Metals Total Digest -for Ocean sediments (HNO3/HF/HClO4)	Metals (Soil): Mercury Low level by Cold Vapour AA	Metals (Soil): Hot Water Soluble Boron (required for CCME Agricultural/ Landfill)	RBCA Hydrocarbons (BTEX, C6-C32)	Hydrocarbons Soil (Potable), NS Fuel Oil Spill Policy Low Level BTEX ,C6-C32	CCME Hydrocarbons (CWS-PHC F1/BTEX, F2-F4)	NB Potable Water BTEX, VPH, Low level T.E.H	PAHs (Default for water/soil)	PAHs (FWAL /CCME Sediment)	PCBs	VOCs	Total Coliform/E.coli (Presence/Absence)	Total Coliform/E.Coli (Count)		HOLD- DO NOT ANALYZE	Regulatory Requirements (Specify) / COMMENTS
1	TOF19-5	Sept 24/19		GRC	1								✓															
2	TOF19-6				1								✓															
3	TOF19-7				1								✓															
4	TOF19-8				1								✓															SIF SEP 26 14:31
5	TOF19-9				1								✓															
6	TOF19-10				1								✓															
7	TOF19-11				1								✓															
8	TOF19-12				1								✓															
9	TOF19-13				1								✓															
10	TOF19-14				1								✓															

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY:(Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
J.M. MacMaster	9/26/19	2:30				B4R0093

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Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D37846

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/12/02
Report #: R5988044
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B9W0593
Received: 2019/11/13, 15:36

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Carbonate, Bicarbonate and Hydroxide	1	N/A	2019/11/18	N/A	SM 23 4500-CO2 D
Carbonate, Bicarbonate and Hydroxide	1	N/A	2019/11/19	N/A	SM 23 4500-CO2 D
Alkalinity	2	N/A	2019/11/19	ATL SOP 00013	EPA 310.2 R1974 m
Chloride	2	N/A	2019/11/20	ATL SOP 00014	SM 23 4500-Cl- E m
Colour	2	N/A	2019/11/20	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (1)	2	N/A	2019/11/18	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2019/11/18	ATL SOP 00004	SM 23 2510B m
Conductance - water	1	N/A	2019/11/19	ATL SOP 00004	SM 23 2510B m
Hardness (calculated as CaCO3)	2	N/A	2019/11/18	ATL SOP 00048	Auto Calc
Mercury - Dissolved (CVAA,LL)	2	2019/11/28	2019/11/29	ATL SOP 00026	EPA 245.1 R3 m
Mercury - Total (CVAA,LL)	2	2019/11/28	2019/11/29	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Diss. MS (as rec'd)	2	N/A	2019/11/15	ATL SOP 00058	EPA 6020B R2 m
Metals Water Total MS	2	2019/11/18	2019/11/18	ATL SOP 00058	EPA 6020B R2 m
Ion Balance (% Difference)	2	N/A	2019/11/20	N/A	Auto Calc.
Anion and Cation Sum	2	N/A	2019/11/20	N/A	Auto Calc.
Nitrogen Ammonia - water	2	N/A	2019/11/20	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	2	N/A	2019/11/19	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	2	N/A	2019/11/20	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	2	N/A	2019/11/20	ATL SOP 00018	ASTM D3867-16
pH (2)	1	N/A	2019/11/18	ATL SOP 00003	SM 23 4500-H+ B m
pH (2)	1	N/A	2019/11/19	ATL SOP 00003	SM 23 4500-H+ B m
Phosphorus - ortho	2	N/A	2019/11/20	ATL SOP 00021	SM 23 4500-P E m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/11/20	ATL SOP 00049	Auto Calc.
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/11/20	ATL SOP 00049	Auto Calc.
Reactive Silica	2	N/A	2019/11/19	ATL SOP 00022	EPA 366.0 m
Sulphate	2	N/A	2019/11/20	ATL SOP 00023	ASTM D516-16 m
Total Dissolved Solids (TDS calc)	2	N/A	2019/11/20	N/A	Auto Calc.
Organic carbon - Total (TOC) (1)	1	N/A	2019/11/18	ATL SOP 00203	SM 23 5310B m
Organic carbon - Total (TOC) (1)	1	N/A	2019/11/19	ATL SOP 00203	SM 23 5310B m
Total Suspended Solids	2	2019/11/15	2019/11/19	ATL SOP 00007	SM 23 2540D m
Turbidity	2	N/A	2019/11/15	ATL SOP 00011	EPA 180.1 R2 m

Your Project #: 19-1567-1000
Site Location: PORT WALLACE
Your C.O.C. #: D37846

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/12/02
Report #: R5988044
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B9W0593
Received: 2019/11/13, 15:36

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.
(2) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Heather Macumber, Senior Project Manager
Email: Heather.MACUMBER@bvlabs.com
Phone# (902)420-0203 Ext:226
==========
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BV Labs Job #: B9W0593
Report Date: 2019/12/02

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: NCB

RESULTS OF ANALYSES OF WATER

BV Labs ID		LHN561			LHN561			LHN562		
Sampling Date		2019/11/13 09:45			2019/11/13 09:45			2019/11/13 10:15		
COC Number		D37846			D37846			D37846		
	UNITS	SW-IN	RDL	QC Batch	SW-IN Lab-Dup	RDL	QC Batch	SW-OUT	RDL	QC Batch
Calculated Parameters										
Anion Sum	me/L	1.42	N/A	6441797				1.28	N/A	6441797
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	10	1.0	6441791				10	1.0	6441791
Calculated TDS	mg/L	82	1.0	6441807				75	1.0	6441807
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	1.0	6441791				<1.0	1.0	6441791
Cation Sum	me/L	1.25	N/A	6441797				1.13	N/A	6441797
Hardness (CaCO3)	mg/L	17	1.0	6441793				16	1.0	6441793
Ion Balance (% Difference)	%	6.37	N/A	6441795				6.22	N/A	6441795
Langelier Index (@ 20C)	N/A	-2.70		6441803				-2.71		6441803
Langelier Index (@ 4C)	N/A	-2.95		6441805				-2.96		6441805
Nitrate (N)	mg/L	<0.050	0.050	6441799				<0.050	0.050	6441799
Saturation pH (@ 20C)	N/A	9.60		6441803				9.62		6441803
Saturation pH (@ 4C)	N/A	9.85		6441805				9.87		6441805
Inorganics										
Total Alkalinity (Total as CaCO3)	mg/L	10	5.0	6449591				10	5.0	6449591
Dissolved Chloride (Cl-)	mg/L	36	1.0	6449598				32	1.0	6449598
Colour	TCU	37	5.0	6449610				57	25	6449610
Nitrate + Nitrite (N)	mg/L	<0.050	0.050	6449612				<0.050	0.050	6449612
Nitrite (N)	mg/L	<0.010	0.010	6449613				<0.010	0.010	6449613
Nitrogen (Ammonia Nitrogen)	mg/L	0.051	0.050	6449794				<0.050	0.050	6449794
Dissolved Organic Carbon (C)	mg/L	6.4	0.50	6444176	6.4	0.50	6444176	8.4	0.50	6444176
Total Organic Carbon (C)	mg/L	6.4	0.50	6444181				8.4	0.50	6444181
Orthophosphate (P)	mg/L	0.021	0.010	6449611				0.013	0.010	6449611
pH	pH	6.90	N/A	6444118				6.91	N/A	6447426
Reactive Silica (SiO2)	mg/L	3.1	0.50	6449608				3.3	0.50	6449608
Total Suspended Solids	mg/L	<1.0	1.0	6444665				<1.0	1.0	6444665
Dissolved Sulphate (SO4)	mg/L	8.7	2.0	6449601				8.4	2.0	6449601
Turbidity	NTU	0.84	0.10	6444228				0.52	0.10	6444228
Conductivity	uS/cm	150	1.0	6444120				130	1.0	6447428

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

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BV Labs Job #: B9W0593
Report Date: 2019/12/02

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: NCB

RESULTS OF ANALYSES OF WATER

BV Labs ID		LHN562		
Sampling Date		2019/11/13 10:15		
COC Number		D37846		
	UNITS	SW-OUT Lab-Dup	RDL	QC Batch
Inorganics				
Total Organic Carbon (C)	mg/L	8.1	0.50	6444181

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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Sampler Initials: NCB

MERCURY BY COLD VAPOUR AA (WATER)

BV Labs ID		LHN561	LHN562		
Sampling Date		2019/11/13 09:45	2019/11/13 10:15		
COC Number		D37846	D37846		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Metals					
Dissolved Mercury (Hg)	ug/L	<0.013 (1)	<0.013 (1)	0.013	6468190
Total Mercury (Hg)	ug/L	0.013 (2)	<0.013 (2)	0.013	6468155

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
(1) Dissolved mercury analysis performed on a nitric acid preserved sample aliquot.
(2) Total mercury analysis performed on a nitric acid preserved sample aliquot.

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Report Date: 2019/12/02

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: NCB

ELEMENTS BY ICP/MS (WATER)

BV Labs ID		LHN561	LHN562		
Sampling Date		2019/11/13 09:45	2019/11/13 10:15		
COC Number		D37846	D37846		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Metals					
Dissolved Aluminum (Al)	ug/L	76	110	5.0	6444466
Total Aluminum (Al)	ug/L	97	140	5.0	6447335
Dissolved Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6444466
Total Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6447335
Dissolved Arsenic (As)	ug/L	85	41	1.0	6444466
Total Arsenic (As)	ug/L	93	46	1.0	6447335
Dissolved Barium (Ba)	ug/L	4.9	4.9	1.0	6444466
Total Barium (Ba)	ug/L	4.6	5.3	1.0	6447335
Dissolved Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6444466
Total Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6447335
Dissolved Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6444466
Total Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Boron (B)	ug/L	<50	<50	50	6444466
Total Boron (B)	ug/L	<50	<50	50	6447335
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6444466
Total Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6447335
Dissolved Calcium (Ca)	ug/L	5200	4900	100	6444466
Total Calcium (Ca)	ug/L	5200	5100	100	6447335
Dissolved Chromium (Cr)	ug/L	<1.0	1.1	1.0	6444466
Total Chromium (Cr)	ug/L	1.2	1.2	1.0	6447335
Dissolved Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6444466
Total Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6447335
Dissolved Copper (Cu)	ug/L	1.9	0.89	0.50	6444466
Total Copper (Cu)	ug/L	0.78	0.84	0.50	6447335
Dissolved Iron (Fe)	ug/L	84	110	50	6444466
Total Iron (Fe)	ug/L	130	150	50	6447335
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	0.50	6444466
Total Lead (Pb)	ug/L	<0.50	<0.50	0.50	6447335
Dissolved Magnesium (Mg)	ug/L	1000	960	100	6444466
Total Magnesium (Mg)	ug/L	1100	1100	100	6447335
Dissolved Manganese (Mn)	ug/L	23	28	2.0	6444466
Total Manganese (Mn)	ug/L	52	47	2.0	6447335
Dissolved Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6444466

RDL = Reportable Detection Limit
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Dillon Consulting Limited
Client Project #: 19-1567-1000
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Sampler Initials: NCB

ELEMENTS BY ICP/MS (WATER)

BV Labs ID		LHN561	LHN562		
Sampling Date		2019/11/13 09:45	2019/11/13 10:15		
COC Number		D37846	D37846		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Total Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6444466
Total Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Phosphorus (P)	ug/L	<100	<100	100	6444466
Total Phosphorus (P)	ug/L	<100	<100	100	6447335
Dissolved Potassium (K)	ug/L	960	980	100	6444466
Total Potassium (K)	ug/L	910	960	100	6447335
Dissolved Selenium (Se)	ug/L	<0.50	<0.50	0.50	6444466
Total Selenium (Se)	ug/L	<0.50	<0.50	0.50	6447335
Dissolved Silver (Ag)	ug/L	<0.10	<0.10	0.10	6444466
Total Silver (Ag)	ug/L	<0.10	<0.10	0.10	6447335
Dissolved Sodium (Na)	ug/L	20000	18000	100	6444466
Total Sodium (Na)	ug/L	21000	19000	100	6447335
Dissolved Strontium (Sr)	ug/L	19	18	2.0	6444466
Total Strontium (Sr)	ug/L	19	18	2.0	6447335
Dissolved Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6444466
Total Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6447335
Dissolved Tin (Sn)	ug/L	<2.0	<2.0	2.0	6444466
Total Tin (Sn)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6444466
Total Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Uranium (U)	ug/L	<0.10	<0.10	0.10	6444466
Total Uranium (U)	ug/L	<0.10	<0.10	0.10	6447335
Dissolved Vanadium (V)	ug/L	<2.0	<2.0	2.0	6444466
Total Vanadium (V)	ug/L	<2.0	<2.0	2.0	6447335
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6444466
Total Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6447335

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Revised Report: Total and Dissolved Mercury addded to both samples as per request from Rebecca. HWS Nov 26/19

Sample LHN561 [SW-IN] : RCAp Ion Balance acceptable. Anion/cation agreement within 0.2 meq/L.
Dissolved versus Total Metals (Cu): Re-analysis of new aliquots from client supplied bottles confirmed original results.

Sample LHN562 [SW-OUT] : RCAp Ion Balance acceptable. Anion/cation agreement within 0.2 meq/L.

Results relate only to the items tested.

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Dillon Consulting Limited
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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6444118	SHW	QC Standard	pH	2019/11/19		101	%	97 - 103
6444118	SHW	RPD	pH	2019/11/19	3.0		%	N/A
6444120	SHW	Spiked Blank	Conductivity	2019/11/19		101	%	80 - 120
6444120	SHW	Method Blank	Conductivity	2019/11/19	1.2, RDL=1.0		uS/cm	
6444120	SHW	RPD	Conductivity	2019/11/19	0.25		%	10
6444176	MGN	Matrix Spike [LHN561-02]	Dissolved Organic Carbon (C)	2019/11/18		101	%	85 - 115
6444176	MGN	Spiked Blank	Dissolved Organic Carbon (C)	2019/11/18		97	%	80 - 120
6444176	MGN	Method Blank	Dissolved Organic Carbon (C)	2019/11/18	<0.50		mg/L	
6444176	MGN	RPD [LHN561-02]	Dissolved Organic Carbon (C)	2019/11/18	0.97		%	15
6444181	MGN	Matrix Spike [LHN562-02]	Total Organic Carbon (C)	2019/11/18		92	%	85 - 115
6444181	MGN	Spiked Blank	Total Organic Carbon (C)	2019/11/15		99	%	80 - 120
6444181	MGN	Method Blank	Total Organic Carbon (C)	2019/11/15	<0.50		mg/L	
6444181	MGN	RPD [LHN562-02]	Total Organic Carbon (C)	2019/11/18	2.8		%	15
6444228	SHW	QC Standard	Turbidity	2019/11/15		111	%	80 - 120
6444228	SHW	Spiked Blank	Turbidity	2019/11/15		98	%	80 - 120
6444228	SHW	Method Blank	Turbidity	2019/11/15	<0.10		NTU	
6444228	SHW	RPD	Turbidity	2019/11/15	1.6		%	20
6444466	MLB	Matrix Spike	Dissolved Aluminum (Al)	2019/11/15		96	%	80 - 120
			Dissolved Antimony (Sb)	2019/11/15		100	%	80 - 120
			Dissolved Arsenic (As)	2019/11/15		96	%	80 - 120
			Dissolved Barium (Ba)	2019/11/15		99	%	80 - 120
			Dissolved Beryllium (Be)	2019/11/15		101	%	80 - 120
			Dissolved Bismuth (Bi)	2019/11/15		101	%	80 - 120
			Dissolved Boron (B)	2019/11/15		96	%	80 - 120
			Dissolved Cadmium (Cd)	2019/11/15		99	%	80 - 120
			Dissolved Calcium (Ca)	2019/11/15		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/11/15		95	%	80 - 120
			Dissolved Cobalt (Co)	2019/11/15		97	%	80 - 120
			Dissolved Copper (Cu)	2019/11/15		95	%	80 - 120
			Dissolved Iron (Fe)	2019/11/15		98	%	80 - 120
			Dissolved Lead (Pb)	2019/11/15		100	%	80 - 120
			Dissolved Magnesium (Mg)	2019/11/15		97	%	80 - 120
			Dissolved Manganese (Mn)	2019/11/15		94	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/11/15		103	%	80 - 120
			Dissolved Nickel (Ni)	2019/11/15		95	%	80 - 120
			Dissolved Phosphorus (P)	2019/11/15		104	%	80 - 120
			Dissolved Potassium (K)	2019/11/15		101	%	80 - 120
			Dissolved Selenium (Se)	2019/11/15		101	%	80 - 120
			Dissolved Silver (Ag)	2019/11/15		93	%	80 - 120
			Dissolved Sodium (Na)	2019/11/15		91	%	80 - 120
			Dissolved Strontium (Sr)	2019/11/15		100	%	80 - 120
			Dissolved Thallium (Tl)	2019/11/15		103	%	80 - 120
			Dissolved Tin (Sn)	2019/11/15		105	%	80 - 120
			Dissolved Titanium (Ti)	2019/11/15		95	%	80 - 120
			Dissolved Uranium (U)	2019/11/15		108	%	80 - 120
			Dissolved Vanadium (V)	2019/11/15		95	%	80 - 120
			Dissolved Zinc (Zn)	2019/11/15		96	%	80 - 120
6444466	MLB	Spiked Blank	Dissolved Aluminum (Al)	2019/11/15		102	%	80 - 120
			Dissolved Antimony (Sb)	2019/11/15		91	%	80 - 120
			Dissolved Arsenic (As)	2019/11/15		94	%	80 - 120
			Dissolved Barium (Ba)	2019/11/15		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/11/15		99	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Bismuth (Bi)	2019/11/15		94	%	80 - 120
			Dissolved Boron (B)	2019/11/15		91	%	80 - 120
			Dissolved Cadmium (Cd)	2019/11/15		96	%	80 - 120
			Dissolved Calcium (Ca)	2019/11/15		104	%	80 - 120
			Dissolved Chromium (Cr)	2019/11/15		94	%	80 - 120
			Dissolved Cobalt (Co)	2019/11/15		95	%	80 - 120
			Dissolved Copper (Cu)	2019/11/15		95	%	80 - 120
			Dissolved Iron (Fe)	2019/11/15		106	%	80 - 120
			Dissolved Lead (Pb)	2019/11/15		98	%	80 - 120
			Dissolved Magnesium (Mg)	2019/11/15		106	%	80 - 120
			Dissolved Manganese (Mn)	2019/11/15		95	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/11/15		93	%	80 - 120
			Dissolved Nickel (Ni)	2019/11/15		96	%	80 - 120
			Dissolved Phosphorus (P)	2019/11/15		109	%	80 - 120
			Dissolved Potassium (K)	2019/11/15		108	%	80 - 120
			Dissolved Selenium (Se)	2019/11/15		98	%	80 - 120
			Dissolved Silver (Ag)	2019/11/15		98	%	80 - 120
			Dissolved Sodium (Na)	2019/11/15		100	%	80 - 120
			Dissolved Strontium (Sr)	2019/11/15		100	%	80 - 120
			Dissolved Thallium (Tl)	2019/11/15		94	%	80 - 120
			Dissolved Tin (Sn)	2019/11/15		98	%	80 - 120
			Dissolved Titanium (Ti)	2019/11/15		94	%	80 - 120
			Dissolved Uranium (U)	2019/11/15		106	%	80 - 120
			Dissolved Vanadium (V)	2019/11/15		92	%	80 - 120
			Dissolved Zinc (Zn)	2019/11/15		94	%	80 - 120
6444466	MLB	Method Blank	Dissolved Aluminum (Al)	2019/11/15	<5.0		ug/L	
			Dissolved Antimony (Sb)	2019/11/15	<1.0		ug/L	
			Dissolved Arsenic (As)	2019/11/15	<1.0		ug/L	
			Dissolved Barium (Ba)	2019/11/15	<1.0		ug/L	
			Dissolved Beryllium (Be)	2019/11/15	<1.0		ug/L	
			Dissolved Bismuth (Bi)	2019/11/15	<2.0		ug/L	
			Dissolved Boron (B)	2019/11/15	<50		ug/L	
			Dissolved Cadmium (Cd)	2019/11/15	<0.010		ug/L	
			Dissolved Calcium (Ca)	2019/11/15	<100		ug/L	
			Dissolved Chromium (Cr)	2019/11/15	<1.0		ug/L	
			Dissolved Cobalt (Co)	2019/11/15	<0.40		ug/L	
			Dissolved Copper (Cu)	2019/11/15	<0.50		ug/L	
			Dissolved Iron (Fe)	2019/11/15	<50		ug/L	
			Dissolved Lead (Pb)	2019/11/15	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2019/11/15	<100		ug/L	
			Dissolved Manganese (Mn)	2019/11/15	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2019/11/15	<2.0		ug/L	
			Dissolved Nickel (Ni)	2019/11/15	<2.0		ug/L	
			Dissolved Phosphorus (P)	2019/11/15	<100		ug/L	
			Dissolved Potassium (K)	2019/11/15	<100		ug/L	
			Dissolved Selenium (Se)	2019/11/15	<0.50		ug/L	
			Dissolved Silver (Ag)	2019/11/15	<0.10		ug/L	
			Dissolved Sodium (Na)	2019/11/15	<100		ug/L	
			Dissolved Strontium (Sr)	2019/11/15	<2.0		ug/L	
			Dissolved Thallium (Tl)	2019/11/15	<0.10		ug/L	
			Dissolved Tin (Sn)	2019/11/15	<2.0		ug/L	
			Dissolved Titanium (Ti)	2019/11/15	<2.0		ug/L	
			Dissolved Uranium (U)	2019/11/15	<0.10		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Vanadium (V)	2019/11/15	<2.0		ug/L	
			Dissolved Zinc (Zn)	2019/11/15	<5.0		ug/L	
6444466	MLB	RPD	Dissolved Aluminum (Al)	2019/11/15	2.1		%	20
			Dissolved Antimony (Sb)	2019/11/15	NC		%	20
			Dissolved Arsenic (As)	2019/11/15	2.2		%	20
			Dissolved Barium (Ba)	2019/11/15	0.31		%	20
			Dissolved Beryllium (Be)	2019/11/15	NC		%	20
			Dissolved Bismuth (Bi)	2019/11/15	NC		%	20
			Dissolved Boron (B)	2019/11/15	NC		%	20
			Dissolved Cadmium (Cd)	2019/11/15	0.15		%	20
			Dissolved Calcium (Ca)	2019/11/15	0.78		%	20
			Dissolved Chromium (Cr)	2019/11/15	NC		%	20
			Dissolved Cobalt (Co)	2019/11/15	NC		%	20
			Dissolved Copper (Cu)	2019/11/15	3.4		%	20
			Dissolved Iron (Fe)	2019/11/15	NC		%	20
			Dissolved Lead (Pb)	2019/11/15	NC		%	20
			Dissolved Magnesium (Mg)	2019/11/15	0.48		%	20
			Dissolved Manganese (Mn)	2019/11/15	2.5		%	20
			Dissolved Molybdenum (Mo)	2019/11/15	NC		%	20
			Dissolved Nickel (Ni)	2019/11/15	NC		%	20
			Dissolved Phosphorus (P)	2019/11/15	NC		%	20
			Dissolved Potassium (K)	2019/11/15	4.7		%	20
			Dissolved Selenium (Se)	2019/11/15	NC		%	20
			Dissolved Silver (Ag)	2019/11/15	NC		%	20
			Dissolved Sodium (Na)	2019/11/15	0.71		%	20
			Dissolved Strontium (Sr)	2019/11/15	1.5		%	20
			Dissolved Thallium (Tl)	2019/11/15	NC		%	20
			Dissolved Tin (Sn)	2019/11/15	NC		%	20
			Dissolved Titanium (Ti)	2019/11/15	NC		%	20
			Dissolved Uranium (U)	2019/11/15	3.8		%	20
			Dissolved Vanadium (V)	2019/11/15	NC		%	20
			Dissolved Zinc (Zn)	2019/11/15	1.4		%	20
6444665	DME	QC Standard	Total Suspended Solids	2019/11/19		99	%	80 - 120
6444665	DME	Method Blank	Total Suspended Solids	2019/11/19	<1.0		mg/L	
6444665	DME	RPD	Total Suspended Solids	2019/11/19	12		%	20
6447335	MLB	Matrix Spike	Total Aluminum (Al)	2019/11/18		103	%	80 - 120
			Total Antimony (Sb)	2019/11/18		100	%	80 - 120
			Total Arsenic (As)	2019/11/18		100	%	80 - 120
			Total Barium (Ba)	2019/11/18		98	%	80 - 120
			Total Beryllium (Be)	2019/11/18		101	%	80 - 120
			Total Bismuth (Bi)	2019/11/18		100	%	80 - 120
			Total Boron (B)	2019/11/18		102	%	80 - 120
			Total Cadmium (Cd)	2019/11/18		98	%	80 - 120
			Total Calcium (Ca)	2019/11/18		104	%	80 - 120
			Total Chromium (Cr)	2019/11/18		100	%	80 - 120
			Total Cobalt (Co)	2019/11/18		99	%	80 - 120
			Total Copper (Cu)	2019/11/18		98	%	80 - 120
			Total Iron (Fe)	2019/11/18		104	%	80 - 120
			Total Lead (Pb)	2019/11/18		99	%	80 - 120
			Total Magnesium (Mg)	2019/11/18		106	%	80 - 120
			Total Manganese (Mn)	2019/11/18		104	%	80 - 120
			Total Molybdenum (Mo)	2019/11/18		102	%	80 - 120
			Total Nickel (Ni)	2019/11/18		102	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Phosphorus (P)	2019/11/18		105	%	80 - 120
			Total Potassium (K)	2019/11/18		103	%	80 - 120
			Total Selenium (Se)	2019/11/18		101	%	80 - 120
			Total Silver (Ag)	2019/11/18		99	%	80 - 120
			Total Sodium (Na)	2019/11/18		NC	%	80 - 120
			Total Strontium (Sr)	2019/11/18		103	%	80 - 120
			Total Thallium (Tl)	2019/11/18		102	%	80 - 120
			Total Tin (Sn)	2019/11/18		103	%	80 - 120
			Total Titanium (Ti)	2019/11/18		102	%	80 - 120
			Total Uranium (U)	2019/11/18		106	%	80 - 120
			Total Vanadium (V)	2019/11/18		101	%	80 - 120
			Total Zinc (Zn)	2019/11/18		101	%	80 - 120
6447335	MLB	Spiked Blank	Total Aluminum (Al)	2019/11/18		103	%	80 - 120
			Total Antimony (Sb)	2019/11/18		100	%	80 - 120
			Total Arsenic (As)	2019/11/18		101	%	80 - 120
			Total Barium (Ba)	2019/11/18		99	%	80 - 120
			Total Beryllium (Be)	2019/11/18		104	%	80 - 120
			Total Bismuth (Bi)	2019/11/18		103	%	80 - 120
			Total Boron (B)	2019/11/18		106	%	80 - 120
			Total Cadmium (Cd)	2019/11/18		96	%	80 - 120
			Total Calcium (Ca)	2019/11/18		105	%	80 - 120
			Total Chromium (Cr)	2019/11/18		102	%	80 - 120
			Total Cobalt (Co)	2019/11/18		100	%	80 - 120
			Total Copper (Cu)	2019/11/18		99	%	80 - 120
			Total Iron (Fe)	2019/11/18		106	%	80 - 120
			Total Lead (Pb)	2019/11/18		100	%	80 - 120
			Total Magnesium (Mg)	2019/11/18		108	%	80 - 120
			Total Manganese (Mn)	2019/11/18		104	%	80 - 120
			Total Molybdenum (Mo)	2019/11/18		103	%	80 - 120
			Total Nickel (Ni)	2019/11/18		104	%	80 - 120
			Total Phosphorus (P)	2019/11/18		107	%	80 - 120
			Total Potassium (K)	2019/11/18		107	%	80 - 120
			Total Selenium (Se)	2019/11/18		100	%	80 - 120
			Total Silver (Ag)	2019/11/18		99	%	80 - 120
			Total Sodium (Na)	2019/11/18		104	%	80 - 120
			Total Strontium (Sr)	2019/11/18		103	%	80 - 120
			Total Thallium (Tl)	2019/11/18		102	%	80 - 120
			Total Tin (Sn)	2019/11/18		105	%	80 - 120
			Total Titanium (Ti)	2019/11/18		105	%	80 - 120
			Total Uranium (U)	2019/11/18		108	%	80 - 120
			Total Vanadium (V)	2019/11/18		103	%	80 - 120
			Total Zinc (Zn)	2019/11/18		103	%	80 - 120
6447335	MLB	Method Blank	Total Aluminum (Al)	2019/11/18	<5.0		ug/L	
			Total Antimony (Sb)	2019/11/18	<1.0		ug/L	
			Total Arsenic (As)	2019/11/18	<1.0		ug/L	
			Total Barium (Ba)	2019/11/18	<1.0		ug/L	
			Total Beryllium (Be)	2019/11/18	<1.0		ug/L	
			Total Bismuth (Bi)	2019/11/18	<2.0		ug/L	
			Total Boron (B)	2019/11/18	<50		ug/L	
			Total Cadmium (Cd)	2019/11/18	<0.010		ug/L	
			Total Calcium (Ca)	2019/11/18	<100		ug/L	
			Total Chromium (Cr)	2019/11/18	<1.0		ug/L	
			Total Cobalt (Co)	2019/11/18	<0.40		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Copper (Cu)	2019/11/18	<0.50		ug/L	
			Total Iron (Fe)	2019/11/18	<50		ug/L	
			Total Lead (Pb)	2019/11/18	<0.50		ug/L	
			Total Magnesium (Mg)	2019/11/18	<100		ug/L	
			Total Manganese (Mn)	2019/11/18	<2.0		ug/L	
			Total Molybdenum (Mo)	2019/11/18	<2.0		ug/L	
			Total Nickel (Ni)	2019/11/18	<2.0		ug/L	
			Total Phosphorus (P)	2019/11/18	<100		ug/L	
			Total Potassium (K)	2019/11/18	<100		ug/L	
			Total Selenium (Se)	2019/11/18	<0.50		ug/L	
			Total Silver (Ag)	2019/11/18	<0.10		ug/L	
			Total Sodium (Na)	2019/11/18	<100		ug/L	
			Total Strontium (Sr)	2019/11/18	<2.0		ug/L	
			Total Thallium (Tl)	2019/11/18	<0.10		ug/L	
			Total Tin (Sn)	2019/11/18	<2.0		ug/L	
			Total Titanium (Ti)	2019/11/18	<2.0		ug/L	
			Total Uranium (U)	2019/11/18	<0.10		ug/L	
			Total Vanadium (V)	2019/11/18	<2.0		ug/L	
			Total Zinc (Zn)	2019/11/18	<5.0		ug/L	
6447335	MLB	RPD	Total Lead (Pb)	2019/11/18	NC		%	20
6447426	SHW	QC Standard	pH	2019/11/18		101	%	97 - 103
6447426	SHW	RPD	pH	2019/11/18	1.9		%	N/A
6447428	SHW	Spiked Blank	Conductivity	2019/11/18		101	%	80 - 120
6447428	SHW	Method Blank	Conductivity	2019/11/18	<1.0		uS/cm	
6447428	SHW	RPD	Conductivity	2019/11/18	1.2		%	10
6449591	MCN	Matrix Spike	Total Alkalinity (Total as CaCO3)	2019/11/19		95	%	80 - 120
6449591	MCN	Spiked Blank	Total Alkalinity (Total as CaCO3)	2019/11/19		101	%	80 - 120
6449591	MCN	Method Blank	Total Alkalinity (Total as CaCO3)	2019/11/19	<5.0		mg/L	
6449591	MCN	RPD	Total Alkalinity (Total as CaCO3)	2019/11/19	NC		%	25
6449598	MCN	Matrix Spike	Dissolved Chloride (Cl-)	2019/11/20		94	%	80 - 120
6449598	MCN	Spiked Blank	Dissolved Chloride (Cl-)	2019/11/20		97	%	80 - 120
6449598	MCN	Method Blank	Dissolved Chloride (Cl-)	2019/11/20	<1.0		mg/L	
6449598	MCN	RPD	Dissolved Chloride (Cl-)	2019/11/20	1.2		%	25
6449601	MCN	Matrix Spike	Dissolved Sulphate (SO4)	2019/11/20		95	%	80 - 120
6449601	MCN	Spiked Blank	Dissolved Sulphate (SO4)	2019/11/20		94	%	80 - 120
6449601	MCN	Method Blank	Dissolved Sulphate (SO4)	2019/11/20	<2.0		mg/L	
6449601	MCN	RPD	Dissolved Sulphate (SO4)	2019/11/20	2.7		%	25
6449608	MCN	Matrix Spike	Reactive Silica (SiO2)	2019/11/19		96	%	80 - 120
6449608	MCN	Spiked Blank	Reactive Silica (SiO2)	2019/11/19		98	%	80 - 120
6449608	MCN	Method Blank	Reactive Silica (SiO2)	2019/11/20	<0.50		mg/L	
6449608	MCN	RPD	Reactive Silica (SiO2)	2019/11/19	0.30		%	25
6449610	MCN	Spiked Blank	Colour	2019/11/20		95	%	80 - 120
6449610	MCN	Method Blank	Colour	2019/11/20	<5.0		TCU	
6449610	MCN	RPD	Colour	2019/11/20	7.1		%	20
6449611	MCN	Matrix Spike	Orthophosphate (P)	2019/11/20		88	%	80 - 120
6449611	MCN	Spiked Blank	Orthophosphate (P)	2019/11/20		92	%	80 - 120
6449611	MCN	Method Blank	Orthophosphate (P)	2019/11/20	<0.010		mg/L	
6449611	MCN	RPD	Orthophosphate (P)	2019/11/20	NC		%	25
6449612	MCN	Matrix Spike	Nitrate + Nitrite (N)	2019/11/19		87	%	80 - 120
6449612	MCN	Spiked Blank	Nitrate + Nitrite (N)	2019/11/19		97	%	80 - 120
6449612	MCN	Method Blank	Nitrate + Nitrite (N)	2019/11/19	<0.050		mg/L	
6449612	MCN	RPD	Nitrate + Nitrite (N)	2019/11/19	NC		%	25
6449613	MCN	Matrix Spike	Nitrite (N)	2019/11/20		99	%	80 - 120

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BV Labs Job #: B9W0593
Report Date: 2019/12/02

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: NCB

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6449613	MCN	Spiked Blank	Nitrite (N)	2019/11/20		103	%	80 - 120
6449613	MCN	Method Blank	Nitrite (N)	2019/11/20	<0.010		mg/L	
6449613	MCN	RPD	Nitrite (N)	2019/11/20	NC		%	20
6449794	MCN	Matrix Spike	Nitrogen (Ammonia Nitrogen)	2019/11/20		105	%	80 - 120
6449794	MCN	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2019/11/19		104	%	80 - 120
6449794	MCN	Method Blank	Nitrogen (Ammonia Nitrogen)	2019/11/19	<0.050		mg/L	
6449794	MCN	RPD	Nitrogen (Ammonia Nitrogen)	2019/11/20	NC		%	20
6468155	NHU	Matrix Spike	Total Mercury (Hg)	2019/11/29		106	%	80 - 120
6468155	NHU	Spiked Blank	Total Mercury (Hg)	2019/11/29		105	%	80 - 120
6468155	NHU	Method Blank	Total Mercury (Hg)	2019/11/29	<0.013		ug/L	
6468155	NHU	RPD	Total Mercury (Hg)	2019/11/29	NC		%	20
6468190	NHU	Matrix Spike	Dissolved Mercury (Hg)	2019/11/29		106	%	80 - 120
6468190	NHU	Spiked Blank	Dissolved Mercury (Hg)	2019/11/29		106	%	80 - 120
6468190	NHU	Method Blank	Dissolved Mercury (Hg)	2019/11/29	<0.013		ug/L	
6468190	NHU	RPD	Dissolved Mercury (Hg)	2019/11/29	NC		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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BV Labs Job #: B9W0593
Report Date: 2019/12/02

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: PORT WALLACE
Sampler Initials: NCB

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Eric Dearman, Scientific Specialist

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Your Project #: 19-1567-1000
Site#: Port Wallace
Site Location: Port Wallace
Your C.O.C. #: 750543-01-01

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/12/11
Report #: R6000824
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9Y1228
Received: 2019/12/03, 16:20

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Carbonate, Bicarbonate and Hydroxide	2	N/A	2019/12/10	N/A	SM 23 4500-CO2 D
Alkalinity	2	N/A	2019/12/10	ATL SOP 00013	EPA 310.2 R1974 m
Chloride	2	N/A	2019/12/11	ATL SOP 00014	SM 23 4500-Cl- E m
Colour	2	N/A	2019/12/10	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (as rec'd) (1)	2	N/A	2019/12/09	ATL SOP 00203	SM 23 5310B m
Conductance - water	2	N/A	2019/12/10	ATL SOP 00004	SM 23 2510B m
Hardness (calculated as CaCO3)	2	N/A	2019/12/06	ATL SOP 00048	Auto Calc
Mercury - Dissolved (CVAA,LL)	2	2019/12/09	2019/12/10	ATL SOP 00026	EPA 245.1 R3 m
Mercury - Total (CVAA,LL)	2	2019/12/09	2019/12/10	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Diss. MS (as rec'd)	2	N/A	2019/12/06	ATL SOP 00058	EPA 6020B R2 m
Metals Water Total MS	2	2019/12/10	2019/12/10	ATL SOP 00058	EPA 6020B R2 m
Ion Balance (% Difference)	2	N/A	2019/12/11	N/A	Auto Calc.
Anion and Cation Sum	2	N/A	2019/12/11	N/A	Auto Calc.
Nitrogen Ammonia - water	2	N/A	2019/12/10	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	2	N/A	2019/12/10	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	2	N/A	2019/12/10	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	2	N/A	2019/12/11	ATL SOP 00018	ASTM D3867-16
pH (2)	2	N/A	2019/12/10	ATL SOP 00003	SM 23 4500-H+ B m
Phosphorus - ortho	2	N/A	2019/12/10	ATL SOP 00021	SM 23 4500-P E m
Sat. pH and Langelier Index (@ 20C)	2	N/A	2019/12/11	ATL SOP 00049	Auto Calc.
Sat. pH and Langelier Index (@ 4C)	2	N/A	2019/12/11	ATL SOP 00049	Auto Calc.
Reactive Silica	2	N/A	2019/12/10	ATL SOP 00022	EPA 366.0 m
Sulphate	2	N/A	2019/12/10	ATL SOP 00023	ASTM D516-16 m
Total Dissolved Solids (TDS calc)	2	N/A	2019/12/11	N/A	Auto Calc.
Organic carbon - Total (TOC) (3)	1	N/A	2019/12/09	ATL SOP 00203	SM 23 5310B m
Organic carbon - Total (TOC) (3)	1	N/A	2019/12/10	ATL SOP 00203	SM 23 5310B m
Total Suspended Solids	2	2019/12/05	2019/12/06	ATL SOP 00007	SM 23 2540D m
Turbidity	2	N/A	2019/12/09	ATL SOP 00011	EPA 180.1 R2 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used

Your Project #: 19-1567-1000
Site#: Port Wallace
Site Location: Port Wallace
Your C.O.C. #: 750543-01-01

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2019/12/11
Report #: R6000824
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9Y1228
Received: 2019/12/03, 16:20

by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC
(2) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.
(3) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Heather Macumber, Senior Project Manager
Email: Heather.MACUMBER@bvlabs.com
Phone# (902)420-0203 Ext:226

==========

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BV Labs Job #: B9Y1228
Report Date: 2019/12/11

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: Port Wallace

RESULTS OF ANALYSES OF WATER

BV Labs ID		LMD218		LMD219			LMD219		
Sampling Date		2019/12/03 14:30		2019/12/03 15:30			2019/12/03 15:30		
COC Number		750543-01-01		750543-01-01			750543-01-01		
	UNITS	SW-IN	QC Batch	SW-OUT	RDL	QC Batch	SW-OUT Lab-Dup	RDL	QC Batch
Calculated Parameters									
Anion Sum	me/L	1.82	6477852	1.79	N/A	6477852			
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	11	6477847	18	1.0	6477847			
Calculated TDS	mg/L	100	6477860	100	1.0	6477860			
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	6477847	<1.0	1.0	6477847			
Cation Sum	me/L	1.62	6477852	1.52	N/A	6477852			
Hardness (CaCO3)	mg/L	19	6477850	19	1.0	6477850			
Ion Balance (% Difference)	%	5.81	6477851	8.16	N/A	6477851			
Langelier Index (@ 20C)	N/A	-2.65	6477856	-2.54		6477856			
Langelier Index (@ 4C)	N/A	-2.91	6477858	-2.79		6477858			
Nitrate (N)	mg/L	0.086	6477853	0.14	0.050	6477853			
Saturation pH (@ 20C)	N/A	9.55	6477856	9.35		6477856			
Saturation pH (@ 4C)	N/A	9.81	6477858	9.60		6477858			
Inorganics									
Total Alkalinity (Total as CaCO3)	mg/L	11	6488072	18	5.0	6488072			
Dissolved Chloride (Cl-)	mg/L	50	6488078	44	1.0	6488078			
Colour	TCU	17	6488091	23	5.0	6488091			
Nitrate + Nitrite (N)	mg/L	0.086	6488094	0.14	0.050	6488094			
Nitrite (N)	mg/L	<0.020 (1)	6488096	<0.020 (1)	0.020	6488096			
Nitrogen (Ammonia Nitrogen)	mg/L	<0.050	6488294	<0.050	0.050	6488294	<0.050	0.050	6488294
Dissolved Organic Carbon (C)	mg/L	4.0	6482912	4.6	0.5	6482912			
Total Organic Carbon (C)	mg/L	4.2	6482903	4.5	0.50	6487950			
Orthophosphate (P)	mg/L	0.020	6488092	0.013	0.010	6488092			
pH	pH	6.90	6487879	6.81	N/A	6487876			
Reactive Silica (SiO2)	mg/L	2.0	6488084	2.5	0.50	6488084			
Total Suspended Solids	mg/L	<1.0	6480274	<1.0	1.0	6480274			
Dissolved Sulphate (SO4)	mg/L	8.8	6488079	9.0	2.0	6488079			
Turbidity	NTU	0.52	6485966	0.56	0.10	6485966			
Conductivity	uS/cm	190	6487880	180	1.0	6487878			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Elevated reporting limit due to method blank performance.

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MERCURY BY COLD VAPOUR AA (WATER)

BV Labs ID		LMD218	LMD219		
Sampling Date		2019/12/03 14:30	2019/12/03 15:30		
COC Number		750543-01-01	750543-01-01		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Metals					
Dissolved Mercury (Hg)	ug/L	<0.013	<0.013	0.013	6486342
Total Mercury (Hg)	ug/L	<0.013	<0.013	0.013	6486328

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

ELEMENTS BY ICP/MS (WATER)

BV Labs ID		LMD218	LMD219		
Sampling Date		2019/12/03 14:30	2019/12/03 15:30		
COC Number		750543-01-01	750543-01-01		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Metals					
Dissolved Aluminum (Al)	ug/L	40	56	5.0	6480654
Total Aluminum (Al)	ug/L	47	64	5.0	6487928
Dissolved Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6480654
Total Antimony (Sb)	ug/L	<1.0	<1.0	1.0	6487928
Dissolved Arsenic (As)	ug/L	82	47	1.0	6480654
Total Arsenic (As)	ug/L	91	49	1.0	6487928
Dissolved Barium (Ba)	ug/L	3.4	4.0	1.0	6480654
Total Barium (Ba)	ug/L	3.8	4.0	1.0	6487928
Dissolved Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6480654
Total Beryllium (Be)	ug/L	<1.0	<1.0	1.0	6487928
Dissolved Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6480654
Total Bismuth (Bi)	ug/L	<2.0	<2.0	2.0	6487928
Dissolved Boron (B)	ug/L	<50	<50	50	6480654
Total Boron (B)	ug/L	<50	<50	50	6487928
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6480654
Total Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	6487928
Dissolved Calcium (Ca)	ug/L	5500	5600	100	6480654
Total Calcium (Ca)	ug/L	5600	5700	100	6487928
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	6480654
Total Chromium (Cr)	ug/L	<1.0	<1.0	1.0	6487928
Dissolved Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6480654
Total Cobalt (Co)	ug/L	<0.40	<0.40	0.40	6487928
Dissolved Copper (Cu)	ug/L	0.83	0.75	0.50	6480654
Total Copper (Cu)	ug/L	1.0	1.3	0.50	6487928
Dissolved Iron (Fe)	ug/L	<50	51	50	6480654
Total Iron (Fe)	ug/L	53	73	50	6487928
Dissolved Lead (Pb)	ug/L	<0.50	<0.50	0.50	6480654
Total Lead (Pb)	ug/L	<0.50	<0.50	0.50	6487928
Dissolved Magnesium (Mg)	ug/L	1200	1100	100	6480654
Total Magnesium (Mg)	ug/L	1200	1200	100	6487928
Dissolved Manganese (Mn)	ug/L	12	17	2.0	6480654
Total Manganese (Mn)	ug/L	18	20	2.0	6487928
Dissolved Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6480654
Total Molybdenum (Mo)	ug/L	<2.0	<2.0	2.0	6487928

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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ELEMENTS BY ICP/MS (WATER)

BV Labs ID		LMD218	LMD219		
Sampling Date		2019/12/03 14:30	2019/12/03 15:30		
COC Number		750543-01-01	750543-01-01		
	UNITS	SW-IN	SW-OUT	RDL	QC Batch
Dissolved Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6480654
Total Nickel (Ni)	ug/L	<2.0	<2.0	2.0	6487928
Dissolved Phosphorus (P)	ug/L	<100	<100	100	6480654
Total Phosphorus (P)	ug/L	<100	<100	100	6487928
Dissolved Potassium (K)	ug/L	910	880	100	6480654
Total Potassium (K)	ug/L	880	880	100	6487928
Dissolved Selenium (Se)	ug/L	<0.50	<0.50	0.50	6480654
Total Selenium (Se)	ug/L	<0.50	<0.50	0.50	6487928
Dissolved Silver (Ag)	ug/L	<0.10	<0.10	0.10	6480654
Total Silver (Ag)	ug/L	<0.10	<0.10	0.10	6487928
Dissolved Sodium (Na)	ug/L	28000	26000	100	6480654
Total Sodium (Na)	ug/L	29000	26000	100	6487928
Dissolved Strontium (Sr)	ug/L	18	18	2.0	6480654
Total Strontium (Sr)	ug/L	19	18	2.0	6487928
Dissolved Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6480654
Total Thallium (Tl)	ug/L	<0.10	<0.10	0.10	6487928
Dissolved Tin (Sn)	ug/L	<2.0	<2.0	2.0	6480654
Total Tin (Sn)	ug/L	<2.0	<2.0	2.0	6487928
Dissolved Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6480654
Total Titanium (Ti)	ug/L	<2.0	<2.0	2.0	6487928
Dissolved Uranium (U)	ug/L	<0.10	<0.10	0.10	6480654
Total Uranium (U)	ug/L	<0.10	<0.10	0.10	6487928
Dissolved Vanadium (V)	ug/L	<2.0	<2.0	2.0	6480654
Total Vanadium (V)	ug/L	<2.0	<2.0	2.0	6487928
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6480654
Total Zinc (Zn)	ug/L	<5.0	<5.0	5.0	6487928

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.7°C

Sample LMD218 [SW-IN] : RCAp Ion Balance acceptable. Anion/cation agreement within 0.2 meq/L.

Sample LMD219 [SW-OUT] : Poor RCAp Ion Balance due to sample matrix.

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6480274	AM6	QC Standard	Total Suspended Solids	2019/12/06		98	%	80 - 120
6480274	AM6	Method Blank	Total Suspended Solids	2019/12/06	<1.0		mg/L	
6480274	AM6	RPD	Total Suspended Solids	2019/12/06	2.4		%	20
6480654	BAN	Matrix Spike	Dissolved Aluminum (Al)	2019/12/06		95	%	80 - 120
			Dissolved Antimony (Sb)	2019/12/06		99	%	80 - 120
			Dissolved Arsenic (As)	2019/12/06		96	%	80 - 120
			Dissolved Barium (Ba)	2019/12/06		97	%	80 - 120
			Dissolved Beryllium (Be)	2019/12/06		100	%	80 - 120
			Dissolved Bismuth (Bi)	2019/12/06		97	%	80 - 120
			Dissolved Boron (B)	2019/12/06		NC	%	80 - 120
			Dissolved Cadmium (Cd)	2019/12/06		91	%	80 - 120
			Dissolved Calcium (Ca)	2019/12/06		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/12/06		93	%	80 - 120
			Dissolved Cobalt (Co)	2019/12/06		93	%	80 - 120
			Dissolved Copper (Cu)	2019/12/06		93	%	80 - 120
			Dissolved Iron (Fe)	2019/12/06		97	%	80 - 120
			Dissolved Lead (Pb)	2019/12/06		97	%	80 - 120
			Dissolved Magnesium (Mg)	2019/12/06		92	%	80 - 120
			Dissolved Manganese (Mn)	2019/12/06		94	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/12/06		NC	%	80 - 120
			Dissolved Nickel (Ni)	2019/12/06		96	%	80 - 120
			Dissolved Phosphorus (P)	2019/12/06		101	%	80 - 120
			Dissolved Potassium (K)	2019/12/06		NC	%	80 - 120
			Dissolved Selenium (Se)	2019/12/06		87	%	80 - 120
			Dissolved Silver (Ag)	2019/12/06		79 (1)	%	80 - 120
			Dissolved Sodium (Na)	2019/12/06		NC	%	80 - 120
			Dissolved Strontium (Sr)	2019/12/06		NC	%	80 - 120
			Dissolved Thallium (Tl)	2019/12/06		99	%	80 - 120
			Dissolved Tin (Sn)	2019/12/06		101	%	80 - 120
			Dissolved Titanium (Ti)	2019/12/06		102	%	80 - 120
			Dissolved Uranium (U)	2019/12/06		104	%	80 - 120
			Dissolved Vanadium (V)	2019/12/06		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/12/06		96	%	80 - 120
6480654	BAN	Spiked Blank	Dissolved Aluminum (Al)	2019/12/06		98	%	80 - 120
			Dissolved Antimony (Sb)	2019/12/06		97	%	80 - 120
			Dissolved Arsenic (As)	2019/12/06		95	%	80 - 120
			Dissolved Barium (Ba)	2019/12/06		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/12/06		100	%	80 - 120
			Dissolved Bismuth (Bi)	2019/12/06		99	%	80 - 120
			Dissolved Boron (B)	2019/12/06		97	%	80 - 120
			Dissolved Cadmium (Cd)	2019/12/06		96	%	80 - 120
			Dissolved Calcium (Ca)	2019/12/06		100	%	80 - 120
			Dissolved Chromium (Cr)	2019/12/06		94	%	80 - 120
			Dissolved Cobalt (Co)	2019/12/06		94	%	80 - 120
			Dissolved Copper (Cu)	2019/12/06		96	%	80 - 120
			Dissolved Iron (Fe)	2019/12/06		99	%	80 - 120
			Dissolved Lead (Pb)	2019/12/06		98	%	80 - 120
			Dissolved Magnesium (Mg)	2019/12/06		99	%	80 - 120
			Dissolved Manganese (Mn)	2019/12/06		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/12/06		101	%	80 - 120
			Dissolved Nickel (Ni)	2019/12/06		98	%	80 - 120
			Dissolved Phosphorus (P)	2019/12/06		99	%	80 - 120
			Dissolved Potassium (K)	2019/12/06		97	%	80 - 120
			Dissolved Selenium (Se)	2019/12/06		94	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Silver (Ag)	2019/12/06		97	%	80 - 120
			Dissolved Sodium (Na)	2019/12/06		96	%	80 - 120
			Dissolved Strontium (Sr)	2019/12/06		101	%	80 - 120
			Dissolved Thallium (Tl)	2019/12/06		100	%	80 - 120
			Dissolved Tin (Sn)	2019/12/06		99	%	80 - 120
			Dissolved Titanium (Ti)	2019/12/06		98	%	80 - 120
			Dissolved Uranium (U)	2019/12/06		102	%	80 - 120
			Dissolved Vanadium (V)	2019/12/06		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/12/06		100	%	80 - 120
6480654	BAN	Method Blank	Dissolved Aluminum (Al)	2019/12/06	<5.0		ug/L	
			Dissolved Antimony (Sb)	2019/12/06	<1.0		ug/L	
			Dissolved Arsenic (As)	2019/12/06	<1.0		ug/L	
			Dissolved Barium (Ba)	2019/12/06	<1.0		ug/L	
			Dissolved Beryllium (Be)	2019/12/06	<1.0		ug/L	
			Dissolved Bismuth (Bi)	2019/12/06	<2.0		ug/L	
			Dissolved Boron (B)	2019/12/06	<50		ug/L	
			Dissolved Cadmium (Cd)	2019/12/06	<0.010		ug/L	
			Dissolved Calcium (Ca)	2019/12/06	<100		ug/L	
			Dissolved Chromium (Cr)	2019/12/06	<1.0		ug/L	
			Dissolved Cobalt (Co)	2019/12/06	<0.40		ug/L	
			Dissolved Copper (Cu)	2019/12/06	<0.50		ug/L	
			Dissolved Iron (Fe)	2019/12/06	<50		ug/L	
			Dissolved Lead (Pb)	2019/12/06	<0.50		ug/L	
			Dissolved Magnesium (Mg)	2019/12/06	<100		ug/L	
			Dissolved Manganese (Mn)	2019/12/06	<2.0		ug/L	
			Dissolved Molybdenum (Mo)	2019/12/06	<2.0		ug/L	
			Dissolved Nickel (Ni)	2019/12/06	<2.0		ug/L	
			Dissolved Phosphorus (P)	2019/12/06	<100		ug/L	
			Dissolved Potassium (K)	2019/12/06	<100		ug/L	
			Dissolved Selenium (Se)	2019/12/06	<0.50		ug/L	
			Dissolved Silver (Ag)	2019/12/06	<0.10		ug/L	
			Dissolved Sodium (Na)	2019/12/06	<100		ug/L	
			Dissolved Strontium (Sr)	2019/12/06	<2.0		ug/L	
			Dissolved Thallium (Tl)	2019/12/06	<0.10		ug/L	
			Dissolved Tin (Sn)	2019/12/06	<2.0		ug/L	
			Dissolved Titanium (Ti)	2019/12/06	<2.0		ug/L	
			Dissolved Uranium (U)	2019/12/06	<0.10		ug/L	
			Dissolved Vanadium (V)	2019/12/06	<2.0		ug/L	
			Dissolved Zinc (Zn)	2019/12/06	<5.0		ug/L	
6480654	BAN	RPD	Dissolved Aluminum (Al)	2019/12/06	0.37		%	20
			Dissolved Antimony (Sb)	2019/12/06	11		%	20
			Dissolved Arsenic (As)	2019/12/06	1.0		%	20
			Dissolved Barium (Ba)	2019/12/06	0.050		%	20
			Dissolved Beryllium (Be)	2019/12/06	NC		%	20
			Dissolved Bismuth (Bi)	2019/12/06	NC		%	20
			Dissolved Boron (B)	2019/12/06	1.5		%	20
			Dissolved Cadmium (Cd)	2019/12/06	NC (2)		%	20
			Dissolved Calcium (Ca)	2019/12/06	0.14		%	20
			Dissolved Chromium (Cr)	2019/12/06	2.4		%	20
			Dissolved Cobalt (Co)	2019/12/06	NC		%	20
			Dissolved Copper (Cu)	2019/12/06	NC		%	20
			Dissolved Iron (Fe)	2019/12/06	NC		%	20
			Dissolved Lead (Pb)	2019/12/06	NC		%	20
			Dissolved Magnesium (Mg)	2019/12/06	0.50		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Manganese (Mn)	2019/12/06	0.030		%	20
			Dissolved Molybdenum (Mo)	2019/12/06	0.020		%	20
			Dissolved Nickel (Ni)	2019/12/06	NC		%	20
			Dissolved Phosphorus (P)	2019/12/06	NC		%	20
			Dissolved Potassium (K)	2019/12/06	0.81		%	20
			Dissolved Selenium (Se)	2019/12/06	19		%	20
			Dissolved Silver (Ag)	2019/12/06	NC		%	20
			Dissolved Sodium (Na)	2019/12/06	0.55		%	20
			Dissolved Strontium (Sr)	2019/12/06	0.099		%	20
			Dissolved Thallium (Tl)	2019/12/06	NC		%	20
			Dissolved Tin (Sn)	2019/12/06	NC		%	20
			Dissolved Titanium (Ti)	2019/12/06	NC		%	20
			Dissolved Uranium (U)	2019/12/06	9.1		%	20
			Dissolved Vanadium (V)	2019/12/06	1.1		%	20
			Dissolved Zinc (Zn)	2019/12/06	NC		%	20
6482903	SSI	Matrix Spike	Total Organic Carbon (C)	2019/12/09		99	%	85 - 115
6482903	SSI	Spiked Blank	Total Organic Carbon (C)	2019/12/09		98	%	80 - 120
6482903	SSI	Method Blank	Total Organic Carbon (C)	2019/12/09	<0.50		mg/L	
6482903	SSI	RPD	Total Organic Carbon (C)	2019/12/09	2.1		%	15
6482912	SSI	Matrix Spike	Dissolved Organic Carbon (C)	2019/12/09		96	%	85 - 115
6482912	SSI	Spiked Blank	Dissolved Organic Carbon (C)	2019/12/09		99	%	80 - 120
6482912	SSI	Method Blank	Dissolved Organic Carbon (C)	2019/12/09	<0.5		mg/L	
6482912	SSI	RPD	Dissolved Organic Carbon (C)	2019/12/09	NC		%	15
6485966	SHW	QC Standard	Turbidity	2019/12/09		103	%	80 - 120
6485966	SHW	Spiked Blank	Turbidity	2019/12/09		101	%	80 - 120
6485966	SHW	Method Blank	Turbidity	2019/12/09	<0.10		NTU	
6485966	SHW	RPD	Turbidity	2019/12/09	NC		%	20
6486328	NHU	Matrix Spike	Total Mercury (Hg)	2019/12/10		104	%	80 - 120
6486328	NHU	Spiked Blank	Total Mercury (Hg)	2019/12/10		105	%	80 - 120
6486328	NHU	Method Blank	Total Mercury (Hg)	2019/12/10	<0.013		ug/L	
6486328	NHU	RPD	Total Mercury (Hg)	2019/12/10	NC		%	20
6486342	NHU	Matrix Spike	Dissolved Mercury (Hg)	2019/12/10		105	%	80 - 120
6486342	NHU	Spiked Blank	Dissolved Mercury (Hg)	2019/12/10		105	%	80 - 120
6486342	NHU	Method Blank	Dissolved Mercury (Hg)	2019/12/10	<0.013		ug/L	
6486342	NHU	RPD	Dissolved Mercury (Hg)	2019/12/10	NC		%	20
6487876	SHW	QC Standard	pH	2019/12/10		100	%	97 - 103
6487876	SHW	RPD	pH	2019/12/10	0.95		%	N/A
6487878	SHW	Spiked Blank	Conductivity	2019/12/10		100	%	80 - 120
6487878	SHW	Method Blank	Conductivity	2019/12/10	<1.0		uS/cm	
6487878	SHW	RPD	Conductivity	2019/12/10	0.93		%	10
6487879	SHW	QC Standard	pH	2019/12/10		101	%	97 - 103
6487879	SHW	RPD	pH	2019/12/10	0.57		%	N/A
6487880	SHW	Spiked Blank	Conductivity	2019/12/10		102	%	80 - 120
6487880	SHW	Method Blank	Conductivity	2019/12/10	<1.0		uS/cm	
6487880	SHW	RPD	Conductivity	2019/12/10	0.98		%	10
6487928	BAN	Matrix Spike	Total Aluminum (Al)	2019/12/10		99	%	80 - 120
			Total Antimony (Sb)	2019/12/10		104	%	80 - 120
			Total Arsenic (As)	2019/12/10		101	%	80 - 120
			Total Barium (Ba)	2019/12/10		100	%	80 - 120
			Total Beryllium (Be)	2019/12/10		102	%	80 - 120
			Total Bismuth (Bi)	2019/12/10		101	%	80 - 120
			Total Boron (B)	2019/12/10		101	%	80 - 120
			Total Cadmium (Cd)	2019/12/10		96	%	80 - 120
			Total Calcium (Ca)	2019/12/10		103	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Chromium (Cr)	2019/12/10		100	%	80 - 120
			Total Cobalt (Co)	2019/12/10		101	%	80 - 120
			Total Copper (Cu)	2019/12/10		98	%	80 - 120
			Total Iron (Fe)	2019/12/10		104	%	80 - 120
			Total Lead (Pb)	2019/12/10		100	%	80 - 120
			Total Magnesium (Mg)	2019/12/10		106	%	80 - 120
			Total Manganese (Mn)	2019/12/10		102	%	80 - 120
			Total Molybdenum (Mo)	2019/12/10		101	%	80 - 120
			Total Nickel (Ni)	2019/12/10		102	%	80 - 120
			Total Phosphorus (P)	2019/12/10		105	%	80 - 120
			Total Potassium (K)	2019/12/10		106	%	80 - 120
			Total Selenium (Se)	2019/12/10		99	%	80 - 120
			Total Silver (Ag)	2019/12/10		99	%	80 - 120
			Total Sodium (Na)	2019/12/10		101	%	80 - 120
			Total Strontium (Sr)	2019/12/10		99	%	80 - 120
			Total Thallium (Tl)	2019/12/10		101	%	80 - 120
			Total Tin (Sn)	2019/12/10		101	%	80 - 120
			Total Titanium (Ti)	2019/12/10		106	%	80 - 120
			Total Uranium (U)	2019/12/10		106	%	80 - 120
			Total Vanadium (V)	2019/12/10		104	%	80 - 120
			Total Zinc (Zn)	2019/12/10		97	%	80 - 120
6487928	BAN	Spiked Blank	Total Aluminum (Al)	2019/12/10		101	%	80 - 120
			Total Antimony (Sb)	2019/12/10		101	%	80 - 120
			Total Arsenic (As)	2019/12/10		102	%	80 - 120
			Total Barium (Ba)	2019/12/10		100	%	80 - 120
			Total Beryllium (Be)	2019/12/10		102	%	80 - 120
			Total Bismuth (Bi)	2019/12/10		101	%	80 - 120
			Total Boron (B)	2019/12/10		101	%	80 - 120
			Total Cadmium (Cd)	2019/12/10		96	%	80 - 120
			Total Calcium (Ca)	2019/12/10		104	%	80 - 120
			Total Chromium (Cr)	2019/12/10		102	%	80 - 120
			Total Cobalt (Co)	2019/12/10		103	%	80 - 120
			Total Copper (Cu)	2019/12/10		102	%	80 - 120
			Total Iron (Fe)	2019/12/10		107	%	80 - 120
			Total Lead (Pb)	2019/12/10		101	%	80 - 120
			Total Magnesium (Mg)	2019/12/10		107	%	80 - 120
			Total Manganese (Mn)	2019/12/10		105	%	80 - 120
			Total Molybdenum (Mo)	2019/12/10		102	%	80 - 120
			Total Nickel (Ni)	2019/12/10		104	%	80 - 120
			Total Phosphorus (P)	2019/12/10		104	%	80 - 120
			Total Potassium (K)	2019/12/10		104	%	80 - 120
			Total Selenium (Se)	2019/12/10		99	%	80 - 120
			Total Silver (Ag)	2019/12/10		101	%	80 - 120
			Total Sodium (Na)	2019/12/10		104	%	80 - 120
			Total Strontium (Sr)	2019/12/10		102	%	80 - 120
			Total Thallium (Tl)	2019/12/10		101	%	80 - 120
			Total Tin (Sn)	2019/12/10		101	%	80 - 120
			Total Titanium (Ti)	2019/12/10		105	%	80 - 120
			Total Uranium (U)	2019/12/10		105	%	80 - 120
			Total Vanadium (V)	2019/12/10		107	%	80 - 120
			Total Zinc (Zn)	2019/12/10		100	%	80 - 120
6487928	BAN	Method Blank	Total Aluminum (Al)	2019/12/10	<5.0		ug/L	
			Total Antimony (Sb)	2019/12/10	<1.0		ug/L	
			Total Arsenic (As)	2019/12/10	<1.0		ug/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Barium (Ba)	2019/12/10	<1.0		ug/L	
			Total Beryllium (Be)	2019/12/10	<1.0		ug/L	
			Total Bismuth (Bi)	2019/12/10	<2.0		ug/L	
			Total Boron (B)	2019/12/10	<50		ug/L	
			Total Cadmium (Cd)	2019/12/10	<0.010		ug/L	
			Total Calcium (Ca)	2019/12/10	<100		ug/L	
			Total Chromium (Cr)	2019/12/10	<1.0		ug/L	
			Total Cobalt (Co)	2019/12/10	<0.40		ug/L	
			Total Copper (Cu)	2019/12/10	<0.50		ug/L	
			Total Iron (Fe)	2019/12/10	<50		ug/L	
			Total Lead (Pb)	2019/12/10	<0.50		ug/L	
			Total Magnesium (Mg)	2019/12/10	<100		ug/L	
			Total Manganese (Mn)	2019/12/10	<2.0		ug/L	
			Total Molybdenum (Mo)	2019/12/10	<2.0		ug/L	
			Total Nickel (Ni)	2019/12/10	<2.0		ug/L	
			Total Phosphorus (P)	2019/12/10	<100		ug/L	
			Total Potassium (K)	2019/12/10	<100		ug/L	
			Total Selenium (Se)	2019/12/10	<0.50		ug/L	
			Total Silver (Ag)	2019/12/10	<0.10		ug/L	
			Total Sodium (Na)	2019/12/10	<100		ug/L	
			Total Strontium (Sr)	2019/12/10	<2.0		ug/L	
			Total Thallium (Tl)	2019/12/10	<0.10		ug/L	
			Total Tin (Sn)	2019/12/10	<2.0		ug/L	
			Total Titanium (Ti)	2019/12/10	<2.0		ug/L	
			Total Uranium (U)	2019/12/10	<0.10		ug/L	
			Total Vanadium (V)	2019/12/10	<2.0		ug/L	
			Total Zinc (Zn)	2019/12/10	<5.0		ug/L	
6487928	BAN	RPD	Total Aluminum (Al)	2019/12/10	0.57		%	20
			Total Iron (Fe)	2019/12/10	NC		%	20
			Total Manganese (Mn)	2019/12/10	1.4		%	20
			Total Zinc (Zn)	2019/12/10	1.5		%	20
6487950	SSI	Matrix Spike	Total Organic Carbon (C)	2019/12/10		96	%	85 - 115
6487950	SSI	Spiked Blank	Total Organic Carbon (C)	2019/12/10		97	%	80 - 120
6487950	SSI	Method Blank	Total Organic Carbon (C)	2019/12/10	<0.50		mg/L	
6487950	SSI	RPD	Total Organic Carbon (C)	2019/12/10	3.4		%	15
6488072	EMT	Matrix Spike	Total Alkalinity (Total as CaCO3)	2019/12/10		102	%	80 - 120
6488072	EMT	Spiked Blank	Total Alkalinity (Total as CaCO3)	2019/12/10		107	%	80 - 120
6488072	EMT	Method Blank	Total Alkalinity (Total as CaCO3)	2019/12/10	<5.0		mg/L	
6488072	EMT	RPD	Total Alkalinity (Total as CaCO3)	2019/12/10	NC		%	25
6488078	EMT	Matrix Spike	Dissolved Chloride (Cl-)	2019/12/11		91	%	80 - 120
6488078	EMT	Spiked Blank	Dissolved Chloride (Cl-)	2019/12/11		95	%	80 - 120
6488078	EMT	Method Blank	Dissolved Chloride (Cl-)	2019/12/11	<1.0		mg/L	
6488078	EMT	RPD	Dissolved Chloride (Cl-)	2019/12/11	24		%	25
6488079	EMT	Matrix Spike	Dissolved Sulphate (SO4)	2019/12/10		110	%	80 - 120
6488079	EMT	Spiked Blank	Dissolved Sulphate (SO4)	2019/12/10		108	%	80 - 120
6488079	EMT	Method Blank	Dissolved Sulphate (SO4)	2019/12/10	<2.0		mg/L	
6488079	EMT	RPD	Dissolved Sulphate (SO4)	2019/12/10	NC		%	25
6488084	EMT	Matrix Spike	Reactive Silica (SiO2)	2019/12/10		96	%	80 - 120
6488084	EMT	Spiked Blank	Reactive Silica (SiO2)	2019/12/10		99	%	80 - 120
6488084	EMT	Method Blank	Reactive Silica (SiO2)	2019/12/10	<0.50		mg/L	
6488084	EMT	RPD	Reactive Silica (SiO2)	2019/12/10	6.2		%	25
6488091	EMT	Spiked Blank	Colour	2019/12/10		104	%	80 - 120
6488091	EMT	Method Blank	Colour	2019/12/10	<5.0		TCU	
6488091	EMT	RPD	Colour	2019/12/10	11		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6488092	EMT	Matrix Spike	Orthophosphate (P)	2019/12/10		86	%	80 - 120
6488092	EMT	Spiked Blank	Orthophosphate (P)	2019/12/10		91	%	80 - 120
6488092	EMT	Method Blank	Orthophosphate (P)	2019/12/10	<0.010		mg/L	
6488092	EMT	RPD	Orthophosphate (P)	2019/12/10	NC		%	25
6488094	EMT	Matrix Spike	Nitrate + Nitrite (N)	2019/12/10		87	%	80 - 120
6488094	EMT	Spiked Blank	Nitrate + Nitrite (N)	2019/12/10		96	%	80 - 120
6488094	EMT	Method Blank	Nitrate + Nitrite (N)	2019/12/10	<0.050		mg/L	
6488094	EMT	RPD	Nitrate + Nitrite (N)	2019/12/10	NC		%	25
6488096	EMT	Matrix Spike	Nitrite (N)	2019/12/11		100	%	80 - 120
6488096	EMT	Spiked Blank	Nitrite (N)	2019/12/11		108	%	80 - 120
6488096	EMT	Method Blank	Nitrite (N)	2019/12/11	0.012, RDL=0.010		mg/L	
6488096	EMT	RPD	Nitrite (N)	2019/12/11	NC (3)		%	20
6488294	EMT	Matrix Spike [LMD219-09]	Nitrogen (Ammonia Nitrogen)	2019/12/10		97	%	80 - 120
6488294	EMT	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2019/12/10		101	%	80 - 120
6488294	EMT	Method Blank	Nitrogen (Ammonia Nitrogen)	2019/12/10	<0.050		mg/L	
6488294	EMT	RPD [LMD219-09]	Nitrogen (Ammonia Nitrogen)	2019/12/10	NC		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery is within QC acceptance limits. < 10 % of compounds in multi-component analysis in violation.

(2) Elevated reporting limit due to sample matrix.

(3) Elevated reporting limit due to method blank performance.

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BV Labs Job #: B9Y1228
Report Date: 2019/12/11

Dillon Consulting Limited
Client Project #: 19-1567-1000
Site Location: Port Wallace

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Mike MacGillivray, Scientific Specialist (Inorganics)

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

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Your Project #: 19-1567-2000
Site Location: PORT WALLACE
Your C.O.C. #: D36959, D36960

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2020/01/10
Report #: R6032999
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C003411
Received: 2020/01/07, 10:56

Sample Matrix: Biota
Samples Received: 18

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Mercury in Vegetation by CVAA (1)	4	2020/01/09	2020/01/10	CAM SOP-00453	Health Canada Method
Mercury in Sludge by CVAA (1)	14	2020/01/09	2020/01/09	CAM SOP-00453	EPA 7470A m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bureau Veritas Laboratories Mississauga

Your Project #: 19-1567-2000
Site Location: PORT WALLACE
Your C.O.C. #: D36959, D36960

Attention: Rebecca Appleton

Dillon Consulting Limited
137 Chain Lake Dr
Suite 100
Halifax , NS
CANADA B3S 1B3

Report Date: 2020/01/10
Report #: R6032999
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C003411
Received: 2020/01/07, 10:56

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Heather Macumber, Senior Project Manager
Email: Heather.MACUMBER@bvlabs.com
Phone# (902)420-0203 Ext:226

==========

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BV Labs Job #: C003411
Report Date: 2020/01/10

Dillon Consulting Limited
Client Project #: 19-1567-2000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (BIOTA)

BV Labs ID		LSC611			LSC612			LSC613		LSC614		
Sampling Date		2020/01/06			2020/01/06			2020/01/06		2020/01/06		
COC Number		D36959			D36959			D36959		D36959		
	UNITS	TOF20-1	RDL	QC Batch	TOF20-2	RDL	QC Batch	TOF20-3	RDL	TOF20-4	RDL	QC Batch
Metals												
Mercury (Hg)	ug/g				0.09	0.01	6530320					
Acid Extractable Mercury (Hg)	ug/g	<0.05	0.05	6530120				1.0	0.5	0.19	0.05	6530120

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		LSC615	LSC616		LSC617	LSC618	LSC619		
Sampling Date		2020/01/06	2020/01/06		2020/01/06	2020/01/06	2020/01/06		
COC Number		D36959	D36959		D36959	D36959	D36959		
	UNITS	TOF20-5	TOF20-6	RDL	TOF20-7	TOF20-8	TOF20-9	RDL	QC Batch
Metals									
Acid Extractable Mercury (Hg)	ug/g	1.0	0.7	0.3	0.07	<0.05	0.06	0.05	6530120

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		LSC620			LSC628			LSC629	LSC630		
Sampling Date		2020/01/06			2020/01/06			2020/01/06	2020/01/06		
COC Number		D36959			D36960			D36960	D36960		
	UNITS	TOF20-10	RDL	QC Batch	TOF20-11	RDL	QC Batch	TOF20-12	TOF20-13	RDL	QC Batch
Metals											
Mercury (Hg)	ug/g	0.01	0.01	6530320				<0.01	<0.01	0.01	6530320
Acid Extractable Mercury (Hg)	ug/g				<0.05	0.05	6530120				

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		LSC630			LSC631	LSC632	LSC633	LSC633	LSC634		
Sampling Date		2020/01/06			2020/01/06	2020/01/06	2020/01/06	2020/01/06	2020/01/06		
COC Number		D36960			D36960	D36960	D36960	D36960	D36960		
	UNITS	TOF20-13 Lab-Dup	RDL	QC Batch	TOF20-14	TOF20-15	TOF20-16	TOF20-16 Lab-Dup	TOF20-FD1	RDL	QC Batch
Metals											
Mercury (Hg)	ug/g	<0.01	0.01	6530320							
Acid Extractable Mercury (Hg)	ug/g				<0.05	<0.05	0.07	<0.05	0.08	0.05	6530120

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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BV Labs Job #: C003411
Report Date: 2020/01/10

Dillon Consulting Limited
Client Project #: 19-1567-2000
Site Location: PORT WALLACE
Sampler Initials: JAM

ELEMENTS BY ATOMIC SPECTROSCOPY (BIOTA)

BV Labs ID		LSC635		
Sampling Date		2020/01/06		
COC Number		D36960		
	UNITS	**TOF20-FD2**	**RDL**	**QC Batch**
Metals				
Acid Extractable Mercury (Hg)	ug/g	<0.05	0.05	6530120

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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BV Labs Job #: C003411
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Dillon Consulting Limited
Client Project #: 19-1567-2000
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.3°C

Results relate only to the items tested.

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BV Labs Job #: C003411
Report Date: 2020/01/10

Dillon Consulting Limited
Client Project #: 19-1567-2000
Site Location: PORT WALLACE
Sampler Initials: JAM

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6530120	MEN	Matrix Spike [LSC633-01]	Acid Extractable Mercury (Hg)	2020/01/09		92	%	75 - 125
6530120	MEN	Spiked Blank	Acid Extractable Mercury (Hg)	2020/01/09		105	%	75 - 125
6530120	MEN	Method Blank	Acid Extractable Mercury (Hg)	2020/01/09	<0.05		ug/g	
6530120	MEN	RPD [LSC633-01]	Acid Extractable Mercury (Hg)	2020/01/09	28		%	35
6530320	MEN	Matrix Spike [LSC630-01]	Mercury (Hg)	2020/01/10		98	%	75 - 125
6530320	MEN	QC Standard	Mercury (Hg)	2020/01/10		96	%	70 - 130
6530320	MEN	Method Blank	Mercury (Hg)	2020/01/10	<0.01		ug/g	
6530320	MEN	RPD [LSC630-01]	Mercury (Hg)	2020/01/10	NC		%	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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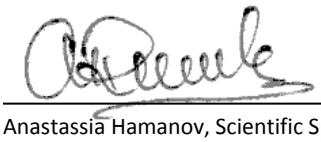
BV Labs Job #: C003411
Report Date: 2020/01/10

Dillon Consulting Limited
Client Project #: 19-1567-2000
Site Location: PORT WALLACE
Sampler Initials: JAM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

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ENVIRONMENTAL SCIENCES GROUP

Environmental Sciences Group

Royal Military College of Canada

P.O. Box 17000 Stn. Forces

Kingston, Ontario

K7K 7B4

ANALYSIS REPORT COVER NOTE

Report Number: RMC-AR-ESG-0005
Report Date: 17 December 2019
Sample(s) reported: 5
Issue Status: Final – amended 2
Analysis commenced on: 21 October 2019 (drying of sediments); 1 November 2019 (extraction)

The following data are reported in this report on a dry weight basis: total arsenic (Soil conc As), extracted arsenic (BA conc As) and percent bioaccessibility of arsenic (%BA As). Percent moisture is also reported.

Methods

Samples were on ice and contained in clear glass 250 mL jars with white plastic lids. The lid of BIODES19-1 was cracked on the side portion of lid, with a piece missing at the crack, and the lid of sample BIOSED19-5 was deeply scratched. Samples were mixed thoroughly before weighing subsamples (40–115 g) into plastic weigh boats. Water was not poured off. Samples were dried at room temperature (<40°C, as stipulated in the method, U.S. EPA 2017) in the weigh boats (covered) for up to 1 week with occasional mixing to prevent the formation of lumps. When dry, samples were sieved (<150 µm) prior to analysis.

To obtain the bioaccessible As for the human receptor exposed to soil, the United States Environmental Protection Agency (U.S. EPA) OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017) was employed. Each dried and sieved sample was extracted in 100 mL extraction vessels with a 0.4 M glycine solution adjusted to pH 1.5 in a liquid-to-(dry) solid ratio of 100:1. The extraction was carried out with end-over-end mixing at body temperature (37^{o}C) for 1 hour and liquid was separated from solids through the use of 0.45 µm filtration.

All extracts were analyzed for As concentrations by ICP-MS, and total concentrations of As in soil samples were obtained by aqua regia digestion and analysis using ICP-MS. Drying, sieving and extraction were carried out in the ESG laboratory. Analysis of extracts and soils was carried out at the Analytical Services Unit at Queen's University, a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA). The methods used for analysis (metals in solids by ICP-MS and metals in water by ICP-MS) are listed on ASU's scope of accreditation.

Quality Assurance and Quality Control (QA/QC)

The bioaccessibility of a standard reference material, NIST 2710a, was measured at the same time as the samples and NIST 2710a control limits are specified in the OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017).

Two types of fortified samples were included in the analysis, following the prescribed U.S. EPA OLEM 9200.2-164 QC/QC procedures: a laboratory control sample (LCS) and a matrix spike (MS). The LCS contained As in the extraction fluid (at a concentration of 10 mg/L) and was taken through the entire extraction procedure. The MS contained As (10 mg/L) and was prepared in the extraction fluid from a sample prior to analysis. A second MS with a different sample was prepared in the same way to ensure data quality.

The % recovery for As in the LCS was 97%, well within the prescribed limits for LCS (85–115% recovery). The % recovery for As in the first MS was 34%, which is outside the prescribed limit (75–125% recovery) (U.S. EPA 2017). The % recovery for As in the second MS was 86%, which was acceptable.

Blank results (method blank and reagent blank) were acceptable (less than the reporting limit, which was the lower of reporting limits specified in U.S. EPA 2017). Precision from the analytical duplicates was deemed acceptable with a relative percent difference (RPD) of 0.4%.

The QC results were reviewed for ASU reports and the results for duplicates, blanks, and water and soil controls (including CRMs) were all considered acceptable as follows. Duplicate RPDs were zero for all samples. Blanks were below reporting limits. CRMs and other laboratory controls were within 30% of certified and laboratory target values.

Acceptance limits were obtained from CCME 2016, unless otherwise indicated (i.e., for As bioaccessibility results, for which acceptance limits are from U.S. EPA 2017).

Data Interpretation and Limitations

The first MS sample is thought to have been prepared with a faulty pipette but the second MS sample gave acceptable results, suggesting the analysis was free of matrix effects.

An error in sample labeling in the report ASU 17226 As in Soil-1 prompted ASU to re-digest and reanalyze all sediment samples for total arsenic. Sample results from the second report (ASU 17226 As in Soil-1 Redigest) were used for the calculations of bioaccessibility in the present report.

For As, an equation relating bioaccessibility results with relative bioavailability (RBA) results are provided in U.S. EPA OLEM 9200.2-164 (U.S. EPA 2017) and is recommended by Health Canada (2017):

$RBA_{arsenic}(\%) = 0.79 \bullet IVBA(\%) + 3.0$ ($R^2 = 0.87$)

The use of this equation should be considered within the caveats and precautions discussed in Canadian guidance (Health Canada 2017).

Because of limitations with the current software used for reporting data, the number of significant figures quoted in the attached table may not be representative of the actual uncertainty. Data should be considered accurate to no more than two significant figures. This report is issued under final status.

The results given relate only to the items tested.

Report authorised by:

Iris Koch, Senior Analytical and Arsenic Research Manager, ESG

David J. Patch, Laboratory Technician, ESG

Date: 17 December 2019

References

Canadian Council of Ministers of the Environment (CCME) 2016. Guidance Manual For Environmental Site Characterization In Support Of Environmental And Human Health Risk Assessment, Volume 4 Analytical Methods.

Health Canada 2017. Federal Contaminated Site Risk Assessment in Canada. Supplemental Guidance on Human health Risk Assessment for Oral Bioavailability of Substances In Soil and Soil-Like Media. Prepared by Contaminated Sites Division.

U.S. EPA 2017. EPA OLEM 9200.2-164, April 20, 2017. Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead and Arsenic in Soil.

ESG Bioaccessibility Report - RMC-AR-ESG-0005 - Amended 2

Site:	Intrinsik sediments - Dillon	**# Samples:**	5
Analyst:	David Patch	**Reference Reports:**	ASU 17226 As Extracts-1
Extraction Date:	01-Nov-19		ASU 17226 As in Soil-1 Redigest
Method:	U.S. EPA OLEM 9200.2-164	**Report Date:**	17-Dec-19
Ratio:	100 to 1		

RESULTS

Results are reported on a dry weight basis, for the <150 um fraction of soil

SAMPLE ID	**BA conc (mg/kg)**	**Soil conc (mg/kg)**	**%BA**	**% Moisture**
	As	**As**	**As**	
Biosed 19-1 2/2	310	4500	6.9	31
Biosed 19-2 2/2	199	990	20	75
Biosed 19-4 2/2	255	3200	8.0	51
Biosed 19-5 2/2	281	4000	7.0	29
Biosed 19-6 2/2	61.2	200	31	34

Bioaccessibility Extraction QA/QC

Sample	**As**
BLANK	**Extract conc (mg/L)**
Method Blank	<0.005
Reagent Blank	<0.005
ACCEPTABLE?	Yes
CONTROL	**%BA**
NIST 2710A	34
Control Limits (U.S. EPA 2017)	**%BA**
NIST 2710A	32.9-49.1
Control Limits (ESG/CCME 2016)	**%BA**
NIST 2710A	28.7-53.3
ACCEPTABLE?	Yes
SPIKES	**% Recovery**
LCS	97
MS Method blank spiked	34
MS LC-22-14	86
ACCEPTABLE?	Yes; No; Yes
DUPLICATES	**%RPD**
LC-22-14	0.41
ACCEPTABLE?	Yes

Extract Analysis QA/QC (ASU)

Report:	ASU 17226 As Extracts-1
All concentrations in ug/L	
Sample	As
Blank (ug/L)	<2.0
Blank (ug/L)	<2.0
ACCEPTABLE?	Yes
Control 1	25
Control Target	25
% Recovery	100
ACCEPTABLE?	Yes
Control 2	25
Control Target	25
% Recovery	100
ACCEPTABLE?	Yes
1643e CRM 1	55
1643e Target	60
% Recovery	109
ACCEPTABLE?	Yes
1643e CRM 2	56
1643e Target	60
% Recovery	107
ACCEPTABLE?	Yes
EU-H CRM	690
EU-H Target	690
% Recovery	100
ACCEPTABLE?	Yes
Int-10	430
Int-10 Duplicate	430
AVERAGE	430
RPD (%)	0
ACCEPTABLE?	Yes
Spiked Blank	3400
Spiked Blank Duplicate	3400
AVERAGE	3400
RPD (%)	0
ACCEPTABLE?	Yes

Soil QAQC (ASU)

Report: ASU 17226 As in Soil-1 Redigest

Sample	As
Blank (mg/kg)	<1.0; <1.0
ACCEPTABLE?	Yes
Control 1 (ug/mL)	4
Control 1 Target (ug/mL)	4
% Recovery	100
ACCEPTABLE?	Yes
Mess-4 CRM (mg/kg) 1	17
Mess-4 CRM (mg/kg) 2	18
Mess-4 CRM target (mg/kg)	17
Arsenic certified (mg/kg)	21.7 ± 2.8
% Recovery (of target) 1	100
% Recovery (of target) 2	106
% Recovery (of certified) 1	78
% Recovery (of certified) 2	83
ACCEPTABLE?	Yes
Int-12 Soil (mg/kg)	220
Int-12 Soil Duplicate (mg/kg)	230
AVERAGE	225
RPD (%)	4
ACCEPTABLE?	Yes

Analytical Services Unit
School of Environmental Studies
Biosciences Complex, Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613 533-2642 Fax: 613 533-2897

ASU #	**17226**		Report ID:	ASU 17226 As Extracts-1
Client:	**ESG**		Date Submitted:	5-Nov-19
	19-045		Date Tested:	6-Nov-19
Site:	**RSA-RMC-13-Intrinsik**		Date:	7-Nov-19
Technique:	**ICP-MS**		Matrix:	Bioaccessibility Extracts
Report of Analysis of Extracts: all results in ng/ml				
Results relate only to the items tested				
	Int-1	**Int-2**	**Int-4**	**Int-5**
Arsenic	3100	2000	2600	2800
	Int-6	**Int-7**	**Int-8**	**Int-9**
Arsenic	610	590	700	530
	Int-10	**Int-10 Duplicate**	**Int-11**	**Int-12**
Arsenic	430	430	780	420
	Int-12D	**Int NIST 2710a**	**Int Method Blank**	**Reagent-B**
Arsenic	420	4800	3.1	2.0
	Int-LCS	**Spiked Blank**	**Spiked Blank Duplicate**	
Arsenic	9700	3400	3400	
Laboratory QA/QC				
	Blank	**Special Reporting Limit**		
Arsenic	<2.0; <2.0	<2.0		
	Control 1	**Control 1 Target**	**1643e CRM**	**1643e Target**
Arsenic	25; 25	25	55; 56	60
	EU-H CRM	**EU-H Target**		
Arsenic	690	690		
NOTES:	Scandium, Indium and Bismith were used as internal standards. Gas dilution (HMI) used: N.			
	All extracts were diluted x 10 prior to analysis.			
Prepared by:	.. 	Authorized by:		

ASU 17226 CHAIN OF CUSTODY/ ANALYTICAL REQUEST FORM

Project ID:	RSA-RMC-13-Intrinsik		
Request #:	Req #19-045	**Due Date:**	11-Nov
Requested By:	Iris Koch		
Sampled by:	David Patch/Iris Koch	**Date:**	04-Nov
Received by:		**Date:**	
Relinquished by:	Iris Koch	**Date:**	04-Nov
Received at lab by:	05 NOV 19	**Date:**	

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Sample Number	Date	Time	Matrix	Container	Analysis Request: Total arsenic			Analysis	Analysis	Comments	Cooler ID
Int-1 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-2 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-4 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-5 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-6 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-7 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-8 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-9 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-10 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-11 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-12 Soil	01-Nov	17:00	Soil/sediment	50 mL C-tube	X					Aqua regia digestion	1
Int-1	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-2	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-4	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-5	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-6	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-7	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-8	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-9	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-10	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-11	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-12	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int-12D	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int NIST 2710a	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Int Method Blank	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Reagent-B	01-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X						1
Int-LCS	01-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X					10 mg/L spike	1
Spiked Blank	01-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X					10 mg/L spike	1

Bioaccessibility extracts have no specified hold times but should be kept refrigerated until analysis.
Required detection limit is 10 - 25 ug/L in original extract.

Analytical Services Unit
School of Environmental Studies
Biosciences Complex, Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613 533-2642 Fax: 613 533-2897

ASU #	**17226**		Report ID:	ASU 17226 As in Soil-1 Redigest
Client:	**ESG**		Date Submitted:	5-Nov-19
	19-045		Date Tested:	13-Dec-19
	RSA-RMC-13-Intrinsik		Date:	16-Dec-19
Technique:	**ICP-OES**		Matrix:	Soil
Report of Analysis: all results in ug/g (unless otherwise noted)				
Results relate only to the items tested				
	Int-1 Soil	**Int-2 Soil**	**Int-4 Soil**	**Int-5 Soil**
Arsenic	4500	990	3200	4000
	Int-6 Soil	**Int-7 Soil**	**Int-8 Soil**	**Int-9 Soil**
Arsenic	200	470	510	520
	Int-10 Soil	**Int-11 Soil**	**Int-12 Soil**	**Int-12 Soil Duplicate**
Arsenic	540	600	220	230
Laboratory QA/QC				
	Blank			
Arsenic	<1.0; <1.0			
	Control 1 (ug/mL)	**Control 1 Target (ug/mL)**	**Mess-4 CRM**	**Mess-4 CRM target**
Arsenic	4.0	4.0	17; 18	17
Prepared by:		Authorized by:		

Analytical Services Unit
School of Environmental Studies
Biosciences Complex, Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613 533-2642 Fax: 613 533-2897

ASU #	**17245**		Report ID:	ASU 17245 As Extracts-1
Client:	**ESG**		Date Submitted:	19-Nov-19
	19-046		Date Tested:	21-Nov-19
Site:	**RSA-RMC-13-Intrinsik**		Date:	22-Nov-19
Technique:	**ICP-MS**		Matrix:	Bioaccessibility Extracts
Report of Analysis of Extracts: all results in ng/ml				
Results relate only to the items tested				
	CHP-3	**COMP 12**	**COMP 13**	**COMP 14**
Arsenic	130	36	9.6	19
	COMP 15	**COMP 16**	**COMP 17**	**COMP 17 Duplicate**
Arsenic	24	23	28	26
	F19-01	**F19-02**	**F19-03**	**F19-07**
Arsenic	71	80	130	87
	F19-14	**COMP 17D**	**Reagent-B**	**Method Blank**
Arsenic	93	25	<2.0	<2.0
	LCS	**NIST 2710a**	**Tuna CRM**	**Tuna CRM Duplicate**
Arsenic	10000	6900	87	87
	CHP-3 MS	**Int-12 MS**		
Arsenic	8500	9000		
Laboratory QA/QC				
	Blank	**Special Reporting Limit**		
Arsenic	<2.0; <2.0	<2.0		
	Control 1	**Control 1 Target**	**1643e CRM**	**1643e Target**
Arsenic	24; 23	25	51; 52	60
	EU-H CRM	**EU-H Target**		
Arsenic	670; 660	690		
NOTES:	Scandium, Indium and Bismith were used as internal standards. Gas dilution (HMI) used: N.			
	All extracts were diluted x 10 prior to analysis.			
Prepared by:		Authorized by:	Paula Whitley.	

ASU

CHAIN OF CUSTODY/ ANALYTICAL REQUEST FORM

Project ID:	RSA-RMC-13-Intrinsik		
Request #:	Req #19-046	**Due Date:**	27-Nov
Requested By:	Iris Koch		
Sampled by:	David Patch/Iris Koch	**Date:**	19-Nov
Received by:		**Date:**	
Relinquished by:	Iris Koch	**Date:**	19-Nov
Received at lab by:	P. Whitley	**Date:**	19 Nov

Analysis Request

Page ____1____ of 1

Sample Number	Date	Time	Matrix	Container	Total arsenic			Analysis	Analysis	Comments	Cooler ID
CHP-3	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 12	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 13	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 14	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 15	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 16	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 17	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-01	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-02	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-03	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-07	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-14	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 17D	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Reagent-B	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Method Blank	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
LCS	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X					10 mg/L spike	1
NIST 2710a	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Tuna CRM	15-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
CHP-3 MS	15-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X					10 mg/L spike	1
Int-12 MS	15-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X					10 mg/L spike	1
CHP-3	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 12	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 13	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 14	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 15	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 16	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 17	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-01	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-02	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-03	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-07	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-14	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1

Bioaccessibility extracts have no specified hold times but should be kept refrigerated until analysis.

ENVIRONMENTAL SCIENCES GROUP
CHAIN OF CUSTODY / REQUEST FORM

Client Contact:			**Christine Moore (Intrinsik) Rebecca Appleton (Dillon)**		Client email:	**cmoore@intrinsik.com / rappleton@dillon.ca**		**Analysis Request**				
ESG Contact:			Mike DeArruda: mike.dearruda@rmc.ca		Iris Koch: koch-i@rmc.ca			Ship to: Mike DeArruda/Iris Koch Environmental Sciences Group Royal Military College, 8 Verite Ave P.O. Box 17000 Station Forces Kingston, ON K7K 7B4 Phone: 613-541-6000 x6532 or 3735				
Cooler Identification:			small blue cooler with AGAT written on top									
Project Code:			19-1567 Port Wallace HHRA. **Contract #: 2019-013-RSA**									
Prepared By:			**R.Appleton**									
Signature/Date:			Rebecca Appleton		2019-10-10							
Relinquished By:			Rebecca Appleton									
Signature/Date:			Rebecca Appleton		2019-10-10							
Received By (Print Name):												
Signature/Date:					2019/__/__ (yyyymmdd)							
IN	Client ID	Storage Medium	Sample Matrix	Date Collected	Time Collected	Comments	ESG Comments	*Bioaccessibility*	*Total Arsenic*	*Arsenic Speciation*	*Other elements (specify)*	*Other (specify)*
	BIOSED19-1	250 mL glass jar	sediment	09/24/2019	9:00	on ice		x	x			
	BIOSED19-2	250 mL glass jar	sediment	09/24/2019	10:00	on ice		x	x			
	BIOSED19-4	250 mL glass jar	sediment	09/24/2019	10:45	on ice		x	x			
	BIOSED19-5	250 mL glass jar	sediment	09/24/2019	13:00	on ice		x	x			
	BIOSED19-6	250 mL glass jar	sediment	09/24/2019	15:00	on ice		x	x			
Notes: Other elements, sample issues, etc.												

Environmental Sciences Group

Royal Military College of Canada

P.O. Box 17000 Stn. Forces

Kingston, Ontario

K7K 7B4

ENVIRONMENTAL SCIENCES GROUP

ANALYSIS REPORT COVER NOTE

Report Number: RMC-AR-ESG-0008
Report Date: 18 December 2019
Sample(s) reported: 5
Issue Status: Final
Analysis commenced on: 7 November 2019 (drying of fish); 12 November 2019 (extraction)

The following data are reported in this report on a dry weight and wet weight basis: total arsenic (Fish conc As), extracted arsenic (BA conc As), arsenic species in extracts, and percent bioaccessibility of arsenic (%BA As). Percent moisture is also reported.

Methods

Samples were received on ice and consisted of cleaned fish tissue (including skin and bones) contained in Ziplocs. Samples were composited according to the labels on the bags and freeze-dried. When dry, samples were ground prior to analysis.

To obtain the bioaccessible As for the human receptor exposed to food, the United States Environmental Protection Agency (U.S. EPA) OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017) was employed with modifications for food content in the stomach. Each dried and ground sample was extracted in 50 mL extraction vessels with a liquid-to-(dry) solid ratio of approximately 40:1. This was equal to a liquid-to-(wet) solid ratio of approximately 10:1, which was designed to be physiologically representative of ratios during meals. Specifically, about 10-30% solid is estimated to be present during a meal, which is equal to a liquid-to-(wet) solid ratio ranging from 10:1 to 3:1; the ratio specifically used as the most conservative one was 10:1. The samples were extracted with a 0.4 M glycine solution adjusted to pH 1.5 with end-over-end mixing at body temperature (37^{o}C) for 1 hour and liquid was separated from solids through the use of 0.45 µm filtration.

All extracts were analyzed for total As concentrations by ICP-MS, and total concentrations of As in fish samples were obtained by acid digestion and analysis using ICP-MS. Drying, grinding, and extraction were carried out in the ESG laboratory. Analysis of extracts and fish tissues was carried out at the Analytical Services Unit at Queen's University, a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA). The methods used for analysis (metals in solids by ICP-MS and metals in water by ICP-MS) are listed on ASU's scope of accreditation.

Speciation analysis was carried out in the ESG laboratory on the extracts by high performance liquid chromatography (HPLC)-ICP-MS. The HPLC methods were anion exchange and cation exchange chromatography. The following species (as standards) could be separated by the methods used: arsenobetaine (AB), dimethylarsinic acid (DMA),

monomethylarsonic acid (MMA), arsenosugars, trimethylarsine oxide (TMAO), arsenocholine, and tetramethylarsonium ion. Challenges with instrument performance caused delays in the analysis of inorganic AsIII and AsV in the sample extract matrix.

These instrument delays in the ESG laboratory led to the decision to also have extracts analysed for arsenic species by HPLC-ICP-MS at ALS Environmental in Burnaby, BC, a laboratory accredited by CALA. The method used was arsenic species in water, which is listed on ALS's scope of accreditation. ALS reports only the following species: AsIII, AsV, DMA, MMA and AB.

Results from ALS were used for AsIII, AsV, DMA, MMA and AB, but were not available for TMAO, seen in the ESG analysis; results for this compound were obtained from the ESG analysis. Results for the sample extracted in duplicate were incomplete from ALS, and ESG results were used for this sample.

Quality Assurance and Quality Control (QA/QC)

Bioaccessibility and Total Arsenic

The bioaccessibility of a standard reference material, NIST 2710a, was measured at the same time as the samples and NIST 2710a control limits are specified in the OLEM 9200.2-164 (April 2017) method (U.S. EPA 2017). This sample was extracted according to the method (at a 100:1 liquid-to-solid ratio). The percent bioaccessibility for this sample was just outside the limits (50% measured vs. 49.1 % upper range value) but at 121% recovery, the result is within the 70–130 % recovery limits recommended by CCME for certified reference materials (CCME 2016), and was considered acceptable.

Two types of fortified samples were included in the analysis, following the prescribed U.S. EPA OLEM 9200.2-164 QC/QC procedures: a laboratory control sample (LCS) and a matrix spike (MS). The LCS contained As in the extraction fluid (at a concentration of 10 mg/L) and was taken through the entire extraction procedure. The MS contained As (10 mg/L) and was prepared in a fish extract sample prior to analysis. Results were acceptable.

Blank results (method blank and reagent blank) were acceptable (less than the reporting limit, which was the lower of reporting limits specified in U.S. EPA 2017). Precision from the analytical duplicates was deemed acceptable with a relative percent difference (RPD) of 9.7%.

The QC results were reviewed for ASU reports and the results for duplicates, blanks, and water and fish controls (including CRMs) were all considered acceptable.

Acceptance limits were obtained from CCME 2016, unless otherwise indicated (i.e., for As bioaccessibility results, for which acceptance limits are from U.S. EPA 2017).

Speciation Analysis

The column recovery (CR) was calculated as the sum of species (SOS) divided by the total arsenic in the extract (BA Conc). In the samples analyzed, % CRs were in the range 79–139%, indicating that column recovery is within the measurement error of the method and within recoveries recommended by CCME for control samples in other speciation analyses (for methylmercury, CCME 2016).

A standard reference material, BCR 627 (tuna fish tissue), was also included to monitor the speciation analysis. For the ALS analysis, results were within the certified range. For the ESG analysis, results were just outside the certified range but within 20% of the certified values (well within recoveries recommended by CCME for control samples in other speciation analyses i.e., for methylmercury, CCME 2016).

LCS recoveries (ALS and ESG analyses) and the recovery of a travel spike prepared by ESG and sent to ALS (containing the most prevalent species in the samples, DMA and AB) were acceptable. Blank results were acceptable.

As mentioned, results for the sample extracted in duplicate were incomplete from ALS (one of the duplicates was not included in the request form) and ESG results were used for this sample. RPDs of the two arsenic species in this sample were 10% and 36%, which are considered acceptable as they are within the range suggested by CCME for duplicates in other speciation analyses (for methylmercury, CCME 2016).

For the species that were detected and reported by both laboratories (DMA and AB), results were comparable, with an average RPD of 21%. For a few samples, the lower detection limits that could be obtained in the ALS laboratory resulted in DMA being detected by ALS but not ESG.

Data Interpretation and Limitations

Although speciation analysis was conducted at the ESG laboratory, difficulties with instrument performance meant that more delays would have been incurred while trying to troubleshoot these difficulties, which involved the detection of inorganic arsenic species in the sample extract matrix. Therefore ESG sub-contracted ALS to complete speciation analysis on extracts to ensure reporting of results in a timely manner. To ensure consistency of data, ALS results were used for all reported (by ALS) arsenic species.

One of the species detected and quantified in the ESG laboratory was TMAO, an arsenic species not included in the ALS analysis (although ALS confirmed that an additional peak was seen). Therefore the TMAO results from the ESG laboratory were included in this report to ensure complete speciation of the arsenic in the extracts.

Percent bioaccessibility values ranged from 46 to 78%, suggesting that not all the arsenic in the samples could be identified with respect to arsenic species. However, CR values averaging 112% suggests that species identification in the extracts was complete. In general,

arsenic that was not extracted (i.e. was not bioaccessible), while likely not of relevance when ingested, should not be assumed to be organic arsenic. Arsenic researchers have not yet determined the nature of unextracted tissue arsenic.

Of the organoarsenic species detected, only AB should be assumed to be non-toxic. DMA has been associated with carcinogenic activity (e.g., Cohen et al., 2001) and TMAO should also be considered potentially toxic since it is not well characterized with respect to its toxicity. No arsenosugars or arsenocholine were detected.

Because of limitations with the current software used for reporting data, the number of significant figures quoted in the attached table may not be representative of the actual uncertainty. Data should be considered accurate to no more than two significant figures. This report is issued under final status.

The results given relate only to the items tested.

Report authorised by:

Iris Koch, Senior Analytical and Arsenic Research Manager, ESG

David J. Patch, Laboratory Technician, ESG

Date: 18 December 2019

References

Canadian Council of Ministers of the Environment (CCME) 2016. Guidance Manual For Environmental Site Characterization In Support Of Environmental And Human Health Risk Assessment, Volume 4 Analytical Methods.

Cohen, S.M., Cano, M., St.John, M.K., Ryder, P.C., Uzvolgyi, E., Arnold, L.L. 2001. The carcinogenicity of dimethylarsinic acid (DMA) in rats. In Arsenic Exposure and Health Effects IV, Eds. W.R. Chappell, C.O. Abernathy, R.L. Calderon, Elsevier, Oxford, pp 277-283.

Health Canada 2017. Federal Contaminated Site Risk Assessment in Canada. Supplemental Guidance on Human health Risk Assessment for Oral Bioavailability of Substances In Soil and Soil-Like Media. Prepared by Contaminated Sites Division.

U.S. EPA 2017. EPA OLEM 9200.2-164, April 20, 2017. Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead and Arsenic in Soil.

ESG Bioaccessibility/Speciation Report - RMC-AR-ESG-0008

Site:	Intrinsik fish - Dillon	**# Samples:**	5
Analyst:	David Patch	**Reference Reports:**	ASU 17245 As Extracts-1
Extraction Date:	12-Nov-19		ASU 17245 As Tissue-1
Method:	Modified U.S. EPA OLEM		ALS L2389610
	9200.2-164	**Report Date:**	18-Dec-19
Ratio:	40 to 1		

RESULTS

Concentrations are in mg/kg, unless otherwise noted

AsIII = arsenite, AsV = arsenate, MMA = monomethylarsonic acid; DMA = dimethylarsinic acid; AB = arsenobetaine; TMAO = trimethylarsine oxide
SOS = sum of species = AsIII + AsV + MMA + DMA + TMAO + AB
% CR = column recovery = sum of species/BA conc x 100%
AsV, AsII, DMA, MMA and AB results are from ALS; TMAO results are from ESG. Exceptions are noted; see cover letter for details.

Dry weight concentrations

SAMPLE ID	BA conc	Fish conc	%BA	AsV	AsIII	DMA	MMA	AB	TMAO	SOS	% CR	% Moisture
	As	As	As	As	As	As	As	As	As	As	As	
F19-01	2.8	4.6	62	0.17	0.05	0.16	<0.04	0.50	2.3	3.2	111	77
F19-02	3.2	4.1	78	0.14	0.04	<0.04	<0.04	0.66	2.9	3.8	117	79
F19-03	5.2	9.1	57	0.41	0.05	4.6	<0.04	0.43	<0.04	5.5	106	74
F19-07	3.5	5.6	62	0.30	0.05	0.084	<0.04	0.44	3.2	4.1	117	76
F19-14	3.7	8.0	46	0.35	0.06	2.9	<0.04	0.80	<0.04	4.1	110	74

Wet weight concentrations

SAMPLE ID	BA conc	Fish conc	%BA	AsV	AsIII	DMA	MMA	AB	TMAO	SOS	% CR
	As	As	As	As	As	As	As	As	As	As	As
F19-01	0.66	1.1	62	0.040	0.011	0.036	<0.009	0.12	0.53	0.73	111
F19-02	0.69	0.88	78	0.030	0.009	<0.009	<0.009	0.14	0.62	0.80	117
F19-03	1.4	2.4	57	0.11	0.013	1.2	<0.01	0.11	<0.01	1.5	106
F19-07	0.83	1.3	62	0.071	0.012	0.020	<0.01	0.11	0.77	0.97	117
F19-14	0.97	2.1	46	0.092	0.017	0.75	<0.01	0.21	<0.01	1.1	110

NR = not reported (see cover letter)

Bioaccessibility Extraction QA/QC

Sample	As
BLANK	**Extract conc**
Method Blank	<0.002
Reagent Blank	<0.002
ACCEPTABLE?	Yes
CONTROL	**%BA**
NIST 2710A	50
Control Limits (U.S. EPA 2017)	**%BA**
NIST 2710A	32.9-49.1
Control Limits (ESG/CCME 2016)	**%BA**
NIST 2710A	28.7-53.3
ACCEPTABLE?	Yes
SPIKES	**% Recovery**
LCS	100
MS CHP-3	86
ACCEPTABLE?	Yes; Yes
DUPLICATES	**%RPD**
COMP 17	9.7
ACCEPTABLE?	Yes

Speciation QAQC (ALS)

Sample	AsV	AsIII	DMA	MMA	AB	TMAO	SOS	BA conc (ppm)	%CR
Blank (µg/L)	<0.020	<0.020	<0.020	<0.020	<0.050	NR	n/a	n/a	n/a
Method Blank (MBLANK) (µg/L)	<1.0	<1.0	<1.0	<1.0	<2.5	NR	n/a	n/a	n/a
ACCEPTABLE?	Yes; Yes	Yes; Yes	Yes; Yes	Yes; Yes	Yes; Yes	n/a	n/a	n/a	n/a
LCS % Recovery	110	111	100	108	112	NR	n/a	n/a	n/a
ACCEPTABLE?	Yes	Yes	Yes	Yes	Yes	n/a	Yes	Yes	Yes
CRM BCR-627 (Tuna) (mg/kg)	<0.04	<0.04	0.142	<0.04	3.9	NR	4.0	3.4	117
CRM BCR-627 (Tuna) certified values	n/a	n/a	0.15 ± 0.022	n/a	3.9 ± 0.22	n/a	n/a	n/a	n/a
CRM BCR-627 (Tuna) % Recovery	n/a	n/a	95	n/a	99	n/a	n/a	n/a	n/a
ACCEPTABLE?	Yes	Yes	Yes	Yes	Yes	n/a	n/a	n/a	Yes
Travel Spike (TSPIKE) % Recovery	n/a	n/a	119	n/a	102	n/a	n/a	n/a	n/a
ACCEPTABLE?	Yes	Yes	Yes	Yes	Yes	n/a	n/a	n/a	n/a

Speciation QAQC (ESG)

Sample	AsV	AsIII	DMA	MMA	AB	TMAO	SOS	BA conc (ppm)	%CR
Blank (µg/L)	<1	<1	<1	<1	<1	<1	n/a	n/a	n/a
Method Blank (µg/L)	<1	<1	<1	<1	<1	<1	n/a	n/a	n/a
ACCEPTABLE?	Yes; Yes	Yes; Yes	Yes; Yes	Yes; Yes	Yes; Yes	Yes; Yes	n/a	n/a	n/a
LCS 1 % Recovery (cation)	n/a	n/a	127	n/a	126	129	n/a	n/a	n/a
LCS 2 % Recovery (cation)	n/a	n/a	124	n/a	131	122	n/a	n/a	n/a
LCS 3 % Recovery (anion)	93	91	93	84	n/a	n/a	n/a	n/a	n/a
ACCEPTABLE?	Yes	Yes	Yes; Yes; Yes	Yes	Yes; Yes	Yes; Yes	n/a	n/a	n/a
CRM BCR-627 (Tuna) (mg/kg)	NR	NR	0.12	<0.04	3.4	<0.04	3.6	3.4	104
CRM BCR-627 (Tuna) Certified values	n/a	n/a	0.15 ± 0.022	n/a	3.9 ± 0.22	n/a	n/a	n/a	n/a
CRM BCR-627 (Tuna) % Recovery	n/a	n/a	81	n/a	88	n/a	n/a	n/a	n/a
ACCEPTABLE?	Yes	Yes	Yes	Yes	Yes	n/a	n/a	n/a	Yes
COMP 17 (mg/kg)	n/a	n/a	0.74	<0.04	0.28	<0.04	1.0	1.1	95
COMP 17D (mg/kg)	NR	NR	0.51	<0.04	0.26	<0.04	0.77	1.0	79
RPD (%)	NR	NR	36	both nd	10	both nd	29	10	19
ACCEPTABLE?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

n/a = not applicable; NR = not reported; nd = not detected

Extract QAQC (ASU)

Report: ASU 17245 As Extracts-1

All concentrations in ug/L

Sample	As
Blank	<2.0
Blank	<2.0
ACCEPTABLE?	Yes
Control 1	24
Control Target	25
% Recovery	104
ACCEPTABLE?	Yes
Control 2	23
Control Target	25
% Recovery	109
ACCEPTABLE?	Yes
1643e CRM 1	51
1643e Target	60
% Recovery	118
ACCEPTABLE?	Yes
1643e CRM 2	52
1643e Target	60
% Recovery	115
ACCEPTABLE?	Yes
EU-H CRM	670
EU-H Target	690
% Recovery	103
ACCEPTABLE?	Yes
EU-H CRM	660
EU-H Target	690
% Recovery	105
ACCEPTABLE?	Yes
COMP 17	28
COMP 17 Duplicate	26
AVERAGE	27
RPD (%)	7.4
ACCEPTABLE?	Yes
Tuna CRM	87
Tuna CRM Duplicate	87
AVERAGE	87
RPD (%)	0
ACCEPTABLE?	Yes

Fish Total Arsenic QAQC (ASU)

Report:	ASU 17245 As Tissue-1
Sample	As
Blank (mg/kg)	<0.5
ACCEPTABLE?	Yes
Control 1 (µg/mL)	25
Control 1 Target (ug/mL)	25
% Recovery	100
ACCEPTABLE?	Yes
Control 2 (µg/mL)	25
Control 2 Target (ug/mL)	25
% Recovery	100
ACCEPTABLE?	Yes
TORT-3 CRM (mg/kg)	58
TORT-3 CRM target (mg/kg)	59
Arsenic certified (mg/kg)	59.5 ± 3.8
% Recovery (of target)	98
% Recovery (of certified)	97
ACCEPTABLE?	Yes
COMP 14 (mg/kg)	2.1
COMP 14 Duplicate (mg/kg)	2.4
AVERAGE	2.25
RPD (%)	13
ACCEPTABLE?	Yes

Analytical Services Unit
School of Environmental Studies
Biosciences Complex, Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613 533-2642 Fax: 613 533-2897

ASU #	**17245**		Report ID:	ASU 17245 As Extracts-1
Client:	**ESG**		Date Submitted:	19-Nov-19
	19-046		Date Tested:	21-Nov-19
Site:	**RSA-RMC-13-Intrinsik**		Date:	22-Nov-19
Technique:	**ICP-MS**		Matrix:	Bioaccessibility Extracts
Report of Analysis of Extracts: all results in ng/ml				
Results relate only to the items tested				
	CHP-3	**COMP 12**	**COMP 13**	**COMP 14**
Arsenic	130	36	9.6	19
	COMP 15	**COMP 16**	**COMP 17**	**COMP 17 Duplicate**
Arsenic	24	23	28	26
	F19-01	**F19-02**	**F19-03**	**F19-07**
Arsenic	71	80	130	87
	F19-14	**COMP 17D**	**Reagent-B**	**Method Blank**
Arsenic	93	25	<2.0	<2.0
	LCS	**NIST 2710a**	**Tuna CRM**	**Tuna CRM Duplicate**
Arsenic	10000	6900	87	87
	CHP-3 MS	**Int-12 MS**		
Arsenic	8500	9000		
Laboratory QA/QC				
	Blank	**Special Reporting Limit**		
Arsenic	<2.0; <2.0	<2.0		
	Control 1	**Control 1 Target**	**1643e CRM**	**1643e Target**
Arsenic	24; 23	25	51; 52	60
	EU-H CRM	**EU-H Target**		
Arsenic	670; 660	690		
NOTES:	Scandium, Indium and Bismith were used as internal standards. Gas dilution (HMI) used: N.			
	All extracts were diluted x 10 prior to analysis.			
Prepared by:		Authorized by:	Paula Whitley.	

Analytical Services Unit
School of Environmental Studies
Biosciences Complex, Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613 533-2642 Fax: 613 533-2897

ASU #	**17245**		Report ID:	ASU 17245 As Tissue-1
Client:	**ESG**		Date Submitted:	20-Nov-19
	19-046		Date Tested:	22-Nov-19
Site:	**RSA-RMC-13-Intrinsik**		Date:	28-Nov-19
Technique:	**ICP-MS**		Matrix:	Tissue
Report of Analysis of Tissue: all results in ug/g (unless otherwise noted)				
Results relate only to the items tested				
	CHP-3	**COMP 12**	**COMP 13**	**COMP 14**
Arsenic	6.6	4.1	1.9	2.1
	COMP 14 Duplicate	**COMP 15**	**COMP 16**	**COMP 17**
Arsenic	2.4	3.4	3.7	4.7
	F19-01	**F19-02**	**F19-03**	**F19-07**
Arsenic	4.6	4.1	9.1	5.6
	F19-14			
Arsenic	8.0			
Laboratory QA/QC				
	Blank	**Normal Reporting Limit**		
Arsenic	<0.5	<0.5		
	Control 1 (ng/mL)	**Control 1 Target (ng/mL)**	**TORT-3 CRM**	**TORT-3 Target**
Arsenic	25; 25	25	58	59
NOTES:	Scandium, Indium and Bismith were used as internal standards. Gas dilution (HMI) used: Y (med)			
Prepared by:		Authorized by:		

ASU

CHAIN OF CUSTODY/ ANALYTICAL REQUEST FORM

Project ID:	RSA-RMC-13-Intrinsik		
Request #:	Req #19-046	**Due Date:**	27-Nov
Requested By:	Iris Koch		
Sampled by:	David Patch/Iris Koch	**Date:**	19-Nov
Received by:		**Date:**	
Relinquished by:	Iris Koch	**Date:**	19-Nov
Received at lab by:	P. Whitley	**Date:**	19 Nov

Analysis Request

Page ____1____ of 1

Sample Number	Date	Time	Matrix	Container	Total arsenic			Analysis	Analysis	Comments	Cooler ID
CHP-3	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 12	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 13	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 14	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 15	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 16	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 17	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-01	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-02	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-03	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-07	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
F19-14	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
COMP 17D	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Reagent-B	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Method Blank	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
LCS	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X					10 mg/L spike	1
NIST 2710a	14-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
Tuna CRM	15-Nov	17:00	Bioaccessibility extract	50 mL C-tube	X						1
CHP-3 MS	15-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X					10 mg/L spike	1
Int-12 MS	15-Nov	17:00	Bioaccessibility extract	15 mL C-tube	X					10 mg/L spike	1
CHP-3	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 12	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 13	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 14	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 15	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 16	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
COMP 17	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-01	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-02	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-03	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-07	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1
F19-14	14-Nov	17:00	Fish	125 mL plastic jar	X					Acid digestion	1

Bioaccessibility extracts have no specified hold times but should be kept refrigerated until analysis.

ROYAL MILITARY COLLEGE
ATTN: Iris Koch
Royal Military College of Canada
12 Verite Ave, P.O. Box 17000 Station Fo
Kingston ON K7K 7B4

Date Received: 29-NOV-19
Report Date: 16-DEC-19 11:44 (MT)
Version: FINAL

Client Phone: 613-541-6000

Certificate of Analysis

Lab Work Order #: L2389610

Project P.O. #: 4501 993 747
Job Reference: ROYAL MILITARY COLLEGE - SPECIATED ARSENIC
C of C Numbers:
Legal Site Desc: 19-036

Edward Ngai
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2389610-1	L2389610-2	L2389610-3	L2389610-4	L2389610-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	14-NOV-19	14-NOV-19	14-NOV-19	14-NOV-19	14-NOV-19
	Sampled Time	17:00	17:00	17:00	17:00	17:00
	Client ID	CHP-3	COMP12	COMP13	COMP14	COMP15
Grouping	**Analyte**					
WATER						
Speciated Metals	Arsenate (As V) (ug/L)	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Arsenite (As III) (ug/L)	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Dimethylarsinic Acid (DMA, as As) (ug/L)	4.3	39.5	8.0	12.5	21.3
	Monomethylarsonic Acid (MMA, as As) (ug/L)	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Arsenobetaine (AsB, as As) (ug/L)	176	9.0	2.9	7.0	7.0

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2389610-6 WATER 14-NOV-19 17:00 COMP16	L2389610-7 WATER 14-NOV-19 17:00 F19-01	L2389610-8 WATER 14-NOV-19 17:00 F19-02	L2389610-9 WATER 14-NOV-19 17:00 F19-03	L2389610-10 WATER 14-NOV-19 17:00 F19-07
WATER						
Speciated Metals	Arsenate (As V) (ug/L)	<1.0 DLM	4.3	3.5	10.3	7.4
	Arsenite (As III) (ug/L)	<1.0 DLM	1.2	1.1	1.2	1.3
	Dimethylarsinic Acid (DMA, as As) (ug/L)	21.8	3.9	<1.0 DLM	116	2.1
	Monomethylarsonic Acid (MMA, as As) (ug/L)	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Arsenobetaine (AsB, as As) (ug/L)	4.4	12.5	16.5	10.8	11.1

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2389610-11	L2389610-12	L2389610-13	L2389610-14	L2389610-15
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	14-NOV-19	14-NOV-19	14-NOV-19	14-NOV-19	14-NOV-19
	Sampled Time	17:00	17:00	17:00	17:00	17:00
	Client ID	F19-14	COMP17D	TUNA	MBLANK	TSPIKE
Grouping	**Analyte**					
WATER						
Speciated Metals	Arsenate (As V) (ug/L)	8.8	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Arsenite (As III) (ug/L)	1.6	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Dimethylarsinic Acid (DMA, as As) (ug/L)	72.0	19.0	3.6	<1.0 DLM	57.1
	Monomethylarsonic Acid (MMA, as As) (ug/L)	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM	<1.0 DLM
	Arsenobetaine (AsB, as As) (ug/L)	19.9	5.5	98.1	<2.5 DLM	46.1

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

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AS-SPEC-HPLC/CCMS-VA	Water	Arsenic Species in Water by HPLC/CCMS	USGS WRIR 02-4144

Speciated Arsenic (As) Analysis is by reverse phase HPLC-ICPMS. Sample handling, preservation and holding times outlined in USGS Report 02-4144 and AWWA Preservation of Arsenic Species, 2006. Instrumental analysis based on Afton et al, Journal of Chromatography A, 1208 (2008) 156-163 and Agilent Technologies application notes. Filtration is conducted prior to preservation. Results for unfiltered, preserved samples may be elevated due to extraction of arsenic species from particulate matter in the samples.
Elevated iron (~100+ ppm) concentrations or sulfidic water can introduce biases to the reported results for some arsenic species.

** 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
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Client: ROYAL MILITARY COLLEGE
Royal Military College of Canada 12 Verite Ave, P.O. Box 17000 Station Fo
Kingston ON K7K 7B4
Contact: Iris Koch

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
AS-SPEC-HPLC/CCMS-VA	**Water**							
Batch	**R4941480**							
WG3240847-2	**LCS**							
Arsenate (As V)			109.9		%		80-120	11-DEC-19
Arsenite (As III)			110.9		%		80-120	11-DEC-19
Dimethylarsinic Acid (DMA, as As)			100.1		%		80-120	11-DEC-19
Monomethylarsonic Acid (MMA, as As)			107.7		%		80-120	11-DEC-19
Arsenobetaine (AsB, as As)			111.7		%		80-120	11-DEC-19
WG3240847-1	**MB**							
Arsenate (As V)			<0.020		ug/L		0.02	11-DEC-19
Arsenite (As III)			<0.020		ug/L		0.02	11-DEC-19
Dimethylarsinic Acid (DMA, as As)			<0.020		ug/L		0.02	11-DEC-19
Monomethylarsonic Acid (MMA, as As)			<0.020		ug/L		0.02	11-DEC-19
Arsenobetaine (AsB, as As)			<0.050		ug/L		0.05	11-DEC-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

Hold Time Exceedances:

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

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

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

L2389610-COFC

COC Number: 19-036

Page 1 of 2

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Times (TATs) are not available for all tests)	
Company:	Environmental Sciences Group (ESG)	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	Regular [R]	☑ Standard TAT - if received by 3 pm - business days - no surcharges apply
Contact:	Mike DeArruda	☐ Criteria on Report - provide details below if box checked		PRIORITY (Business Days)	4 day [P4-20%] ☐ / 3 day [P3-25%] ☐ / 2 day [P2-50%] ☐
Address:	R36 - 8 Verite Ave. Kingston, ON K7K 7B4	Select Distribution:	☑ EMAIL ☑ MAIL ☐ FAX	EMERGENCY	1 Business day [E - 100%] ☐ Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
Phone:	613-541-6000 x6532 or 613-484-8540	Email 1	mike.dearruda@rmc.ca	Date and Time Required for all E&P TATs:	dd-mm-yy hh:mm
		Email 2	thomas.partridge@rmc.ca		
		Email 3	koch-i@rmc.ca		
Invoice To	Same as Report To ☑ Yes ☐ No	Email 4			
	Copy of Invoice with Report ☑ Yes ☐ No	Invoice Distribution			
Company:	Environmental Sciences Group (ESG)	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX		
Contact:	Mike DeArruda	Email 1	mike.dearruda@rmc.ca		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q75792	AFE/Cost Center	PO #
Job #:	Royal Military College - Speciated Arsenic	Major/Minor Code:	Routing Code:
PO / AFE:	4501 993 747	Requisitioner:	
LSD:	19-036	Location:	
ALS Lab Work Order # (lab use only):	L2389610	ALS Contact:	Sampler:

Analysis Request

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

NUMBER OF CONTAINERS: 15 | 25 | 25

WATER - AS-SPEC-HPLC/CGMS-VA | MISC - SAMPLE-DISPOSAL-VA

SAMPLES ON HOLD

ALS Sample #	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type				
	CHP-3	14-Nov-19	17:00	Water	R			
	COMP12	14-Nov-19	17:00	Water	R			
	COMP13	14-Nov-19	17:00	Water	R			
	COMP14	14-Nov-19	17:00	Water	R			
	COMP15	14-Nov-19	17:00	Water	R			
	COMP16	14-Nov-19	17:00	Water	R			
	F19-01	14-Nov-19	17:00	Water	R			
	F19-02	14-Nov-19	17:00	Water	R			
	F19-03	14-Nov-19	17:00	Water	R			
	F19-07	14-Nov-19	17:00	Water	R			
	F19-14	14-Nov-19	17:00	Water	R			
	COMP17D	14-Nov-19	17:00	Water	R			

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

Are samples taken from a Regulated DW System? ☐ Yes ☑ No

Are samples for human drinking water use? ☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | Ice packs ☑ | Cooling Initiated ☐

SIF Observations Yes ☐ No ☐

Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
	18.9

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: MIKE DeARRUDA	Date: Nov 28/19	Time:	Received by:	Date:	Time:	Received by:	Date: Nov 29/19	Time: 8:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v08 Front/03 October 2013

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

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

Th 3rd Dec 19 1°C 8:55 AM

Ice cubes

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

L2389610-COFC

COC Number: 19-036

Page 2 of 2

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Times (TATs) are not available for all tests)	
Company:	Environmental Sciences Group (ESG)	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	Regular [R]	☑ Standard TAT - if received by 3 pm - business days - no surcharges apply
Contact:	Mike DeArruda	☐ Criteria on Report - provide details below if box checked		PRIORITY (Business Days)	4 day [P4-20%] ☐
Address:	R36 - 8 Verite Ave. Kingston, ON K7K 7B4	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX		3 day [P3-25%] ☐
Phone:	613-541-6000 x6532 or 613-484-8540	Email 1	mike.dearruda@rmc.ca		2 day [P2-50%] ☐
		Email 2	Shari.Reed@rmc.ca	EMERGENCY	1 Business day [E - 100%] ☐
		Email 3			Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
		Email 4		Date and Time Required for all E&P TATs:	dd-mm-yy hh:mm

Invoice To	Same as Report To	Invoice Distribution	
	Copy of Invoice with Report	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Environmental Sciences Group (ESG)	Email 1	mike.dearruda@rmc.ca
Contact:	Mike DeArruda		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q75792	AFE/Cost Center	PO #
Job #:	Royal Military College - Speciated Arsenic	Major/Minor Code:	Routing Code:
PO / AFE:	4501 993 747	Requisitioner:	
LSD:	19-036	Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request

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

ALS Sample #	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS: WATER - AS-SPEC-HPLC/CCMS-V	MISC - SAMPLE-DISPOSAL-VA	####	SAMPLES ON HOLD
	TUNA	14-Nov-19	17:00	Water	R			
	MBLANK	14-Nov-19	17:00	Water	R			
	TSPIKE	14-Nov-19	17:00	Water	R			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System?	
Are samples for human drinking water use?	

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			18.7		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Mike DeArruda	Date: Nov 28/19	Time:	Received by:	Date:	Time:	Received by:	Date: 11/29/19	Time: 0830

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v08 Front/03 October 2013

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

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

TAT 3rd Dec 19 12 Noon AM

Ice cubes

ENVIRONMENTAL SCIENCES GROUP
CHAIN OF CUSTODY / REQUEST FORM

Client Contact:			Chrishne Moore / Rebecca Appleton			Client email:	cmoore@intrinsik.com rappleton@dillon.ca	**Analysis Request**					
ESG Contact:			Mike DeArruda: mike.dearruda@rmc.ca			Iris Koch: koch-i@rmc.ca		Ship to: Mike DeArruda/Iris Koch Environmental Sciences Group Royal Military College, 8 Verite Ave P.O. Box 17000 Station Forces Kingston, ON K7K 7B4 Phone: 613-541-6000 x6532 or 3735					
Cooler Identification:			Red small cooler - w/ Dillon Multiple 1966										
Project Code:			19-1567 Port Wallace HHRA. Contract #: 2019-013-RSA										
Prepared By:			N. Booth										
Signature/Date:						2019/10/31 (yyyymmdd)							
Relinquished By:													
Signature/Date:						2019/__/__ (yyyymmdd)							
Received By (Print Name):													
Signature/Date:						2019/__/__ (yyyymmdd)							
IN	Client ID	Storage Medium	Sample Matrix	Date Collected	Time Collected	Comments	ESG Comments	*Bioaccessibility*	*Total Arsenic*	*Arsenic Speciation*	*Other elements (specify)*	*Other (specify)*	
	Fig_01	Ziplock bag	Fish	9/18/19	9:00	On ICG		X	X	X			
	Fig_02	ziplock bag	↓	9/18/19	10:00	↓		X	X	X			
	Fig_03	ziplock bag		9/18/19	10:30			X	X	X			
	Fig_07	ziplock bag		9/19/19	8:30			X	X	X			
	Fig_14	ziplock bag	↓	9/26/19	9:00	↓		X	X	X			
	Add rows as needed												

Notes: Other elements, sample issues, etc.

Appendix E

Disclaimer

Dillon Consulting Limited (Dillon) has used the degree of care and skill ordinarily exercised under similar circumstances at the time the work was performed by reputable members of the environmental consulting profession practicing in Canada. Dillon assumes no responsibility for conditions it was not authorized to investigate or which were beyond its scope of work. There is no warranty expressed or implied by Dillon that the work will discover all potential contamination since it may not be possible, even with exhaustive sampling, testing and analysis, to document all potential contamination on the site.

This report was prepared by Dillon for the sole benefit of Nova Scotia Lands and Intrinsik Corp. The material in the report reflects Dillon's best judgment in light of the information available to Dillon at the time of preparation. Any use which a third party (i.e. a party other than Nova Scotia Lands and Intrinsik Corp.) makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

References

Dillon Consulting Limited, Phase I/II Environmental Site Assessment, Port Wallace, Dartmouth, Nova Scotia, Submitted to Halifax Regional Municipality, August 2019.

APPENDIX B

CHEMICALS OF POTENTIAL CONCERN – HUMAN HEALTH AND ECOLOGICAL SCREENING

APPENDIX B: CHEMICALS OF POTENTIAL CONCERN – HUMAN HEALTH AND ECOLOGICAL SCREENING

This assessment is a human health risk assessment study. Screening outcomes of COPCs for the HHRA are presented in this appendix. In addition, screening for ecological receptors was also completed, and is presented in this appendix. An Ecological Risk Assessment (ERA) has not yet been completed but will be conducted in a separate study.

B-1.0 HUMAN HEALTH SCREENING

B-1.1 Sediments

The Nova Scotia (NS) Environmental Quality Standards (EQS) for Contaminated Sites (NSE, 2014) were developed to provide numerical environmental quality standards for relevant environmental media typically evaluated at contaminated sites in Nova Scotia. Although standards protective of human health have been developed for soil and groundwater, health-based sediment and surface water criteria for incidental swimming exposure pathways have not been developed.

Two separate sampling campaigns have been conducted in Barry's Run between 2019 and 2020. The first set of sediment and surface water data were collected in April, 2019 (Dillon, 2019), whereas the second set was collected in September through December 2019 (see Appendix A), and included sediments, surface water, and fish tissues. As part of the second sampling campaign, sampling of sediment from the fen area ("TOF") was conducted in January, 2020 (see Appendix A for further details). This section of the screening appendix provides screening outcomes related to the comparison of the sediment and surface water data to human health NS EQS.

Given the lack of human health-based sediment criteria, Dillon (2019) compared the spring sediment data to NS Tier 1 residential soil standards (residential soils; non-potable groundwater usage; coarse-grained soils; NSE, 2014) as a surrogate for sediment guidance levels (see Table E4 from Dillon (2019), inserted below as Table B-1). A number of metals exceeded the Tier 1 soil standards, including aluminum, antimony, arsenic, cobalt, iron, mercury and vanadium.

Consideration of background environmental conditions is part of the standard screening process for substances which occur naturally in the environment, and the use of regional data is considered an accepted comparison approach (NSE, 2014; see Table B-1). Metals with concentrations in excess of the NS Tier 1 soil standards and typical Nova Scotian background soil concentrations were discussed further or retained as COPCs for further evaluation in the HHRA. Aluminium, iron and vanadium were concluded to be within background ranges by Dillon (2019; see Section 4.4.2.2), and do not merit further evaluation.

Antimony concentrations in sediments range from < 2 mg/kg to 9.5 mg/kg (see Table B-1), with the NS Tier 1 soil standard being 7.5 mg/kg. Only 2 of the 14 samples exceed the guideline. Background soil antimony concentrations provided in White et al (2014) range from 0.6 mg/kg to 0.8 mg/kg, which is lower than the analytical detection limit in the current study. Since only 2 samples exceed the NS EQS, antimony is considered to be unlikely to pose a risk, or drive remedial decision making at this site. Therefore, it was not considered further.

Table B-1 General Chemistry and Metals in Sediment (taken from Dillon, 2019)

				Sample ID	SED01	SED02	SED03	SED04	SED05	SED06	SED07	SED07B (Dup of SED07)	SED08	SED09	SED10	SED10 (Lab Dup - Maxxam Burnaby)	SED11	SED12	SED13	SED14
				Date	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-16	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2019-04-26	2019-04-26
				Sample Depth (mbgs)	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1
Parameter	**Units**	**EQL**	NS Tier 1 EQS Freshwater Sediment	**NS Tier 1 EQS Soil Residential Non-Potable Coarse**																
General Chemistry			-	-																
Phosphorus	mg/kg	10	-	-	-	-	-	-	-	-	-	-	-	-	-	731	-	694	-	-
Cyanide Anion	mg/kg	0.2	-	**29**	-	-	-	-	-	-	-	-	-	-	-	0.36	-	<0.4	-	-
Total Organic Carbon (TOC)	mg/kg	0.0005	-	-	170000	-	-	-	-	-	130000	-	-	-	1300	1300	-	8800	-	-
pH (aqueous extract)	pH Unit		-	-	-	-	-	-	-	-	-	-	-	-	-	5.81	-	6.19	-	-
Sulphate (SO4)	mg/kg	10	-	-	1500	-	-	-	-	-	2300	-	-	-	59	585	-	170	-	-
Sulphide	mg/kg	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	0.45	-	32.7	-	-
Metals			-	-																
Aluminium	mg/kg	10	-	**15400**	**17,000**	**18,000**	**20,000**	**18,000**	**27,000**	**22,000**	**25,000**	**22,000**	**23,000**	12,000	14,000	13,500	12,000	13,900	11,000	12,000
Antimony	mg/kg	0.1	25	**7.5**	<2	<2	<2	<2	<2	<2	2.4	2.3	2.3	<2	**9.5**	**9.36**	**8.1**	7.38	3.3	4.6
Arsenic	mg/kg	0.5	17	**31**	**2000**	**1900**	**2000**	**1900**	**960**	**1600**	**1900**	**1900**	**2400**	**170**	**6200**	**6480**	**5100**	**4830**	**1900**	**2900**
Barium	mg/kg	0.1	-	**10000**	150	250	230	250	160	150	230	240	260	84	58	54.5	70	64.4	74	91
Beryllium	mg/kg	0.2	-	**38**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	0.37	<2	0.42	<2	<2
Bismuth	mg/kg	0.1	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	0.89	<2	0.85	<2	<2
Boron	mg/kg	50	-	**4300**	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	-	<50	-	<50	<50
Cadmium	mg/kg	0.05	3.5	**14**	2.6	2.6	2.1	1.9	1.7	1.4	2.5	2.4	2.6	<0.3	<0.3	0.176	<0.3	0.268	<0.3	<0.3
Calcium	mg/kg	100	-	-	-	-	-	-	-	-	-	-	-	-	-	4810	-	3980	-	-
Chromium Total (III+VI)	mg/kg	1	90	**220**	12	14	15	14	21	19	17	16	17	13	15	15.9	14	15.9	12	13
Cobalt	mg/kg	0.3	-	**22**	**100**	**120**	**130**	**110**	**84**	**87**	**160**	**150**	**160**	4.1	16	18.5	17	17.9	8.1	15
Copper	mg/kg	0.5	197	**1100**	32	35	36	33	34	35	43	39	40	30	53	50.5	47	52.1	34	38
Iron	mg/kg	50	43766	**11000**	**40,000**	**40,000**	**54,000**	**44,000**	**41,000**	**36,000**	**45,000**	**42,000**	**54,000**	**17,000**	**31,000**	**33,600**	**27,000**	**32,100**	**18,000**	**23,000**
Lead	mg/kg	0.1	91.3	**140**	63	72	73	62	96	74	78	72	74	35	73	57.3	62	54	40	45
Lithium	mg/kg	2	-	-	12	16	16	15	25	22	21	19	20	24	25	-	24	-	22	23
Magnesium	mg/kg	100	-	-	-	-	-	-	-	-	-	-	-	-	-	9780	-	9090	-	-
Manganese	mg/kg	0.2	1100	-	4900	15,000	14,000	17,000	4800	7700	14,000	14,000	13,000	250	660	703	890	1210	280	930
Mercury	mg/kg	0.05	0.486	**6.6**	1.9	2.2	2.2	2.1	0.82	2.4	2.9	2.7	2.7	4.4	**6.8**	4.55	6.3	5.35	5.2	5.2
Molybdenum	mg/kg	0.1	-	**110**	<2	<2	<2	<2	2.2	<2	<2	<2	<2	<2	<2	0.23	<2	0.28	<2	<2
Nickel	mg/kg	0.8	75	**330**	86	76	53	48	38	41	75	65	67	12	34	38.5	29	35.6	17	25
Potassium	mg/kg	100	-	-	-	-	-	-	-	-	-	-	-	-	-	4520	-	4370	-	-
Rubidium	mg/kg	2	-	-	8.5	11	11	9.8	11	15	12	12	12	20	32	-	29	-	19	25
Selenium	mg/kg	0.5	2	**80**	1.7	1.9	2	1.8	2.7	2.5	2	2	2.2	<1	<1	<0.5	<1	<0.5	<1	<1
Silver	mg/kg	0.05	1	**77**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.157	<0.5	0.164	<0.5	<0.5
Sodium	mg/kg	100	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	-	<100	-	-
Strontium	mg/kg	0.1	-	**9400**	23	24	24	29	40	27	29	26	31	12	17	20.5	14	18.6	13	14
Sulphur (as S)	mg/kg	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2950	-	-
Thallium	mg/kg	0.05	-	**1**	0.29	0.34	0.37	0.32	0.34	0.36	0.43	0.4	0.48	0.16	0.28	0.304	0.26	0.327	0.2	0.26
Tin	mg/kg	0.1	-	**9400**	1.2	1.3	1.3	1.3	1.3	1.4	1.5	1.3	1.3	<1	<1	0.28	<1	0.36	<1	<1
Titanium	mg/kg	1	-	-	-	-	-	-	-	-	-	-	-	-	-	610	-	582	-	-
Uranium	mg/kg	0.1	-	**23**	0.85	1.2	1.1	1	2.5	1.4	1.3	1.2	1.2	1.1	1.1	-	1.1	-	1.1	1.1
Vanadium	mg/kg	2	-	**39**	**60**	**63**	**69**	**56**	**58**	**56**	**66**	**61**	**75**	16	15	16.4	14	16.8	12	15
Zinc	mg/kg	1	315	**5600**	260	270	250	230	200	180	330	290	320	58	120	119	100	135	64	94
Zirconium	mg/kg	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	29.3	-	22.8	-	-

				Sample ID	SS01	SS02	SS03	SS04	SS07	SS08	SS09	SS10	SS11	SS12	SS13	SS13B (Dup of SS13)	SS14
				Date	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2019-04-25	2018-04-25	2019-04-25	2019-04-25	2019-04-29	2019-04-29	2019-04-29
				Sample Depth (mbgs)	0-0.1	0-0.1	1.2-1.4	0.3-0.6	3.66-3.8	5.03-5.08	5.03-5.18	3.36-3.56	3.49-3.6	3.51-3.71	4.65-4.93	4.65-4.93	4.06-4.14
			NS Tier 1 EQS Freshwater Sediment	NS Tier 1 EQS Soil Residential Non-Potable Coarse													
Parameter	**Units**	**EQL**															
General Chemistry																	
Phosphorus	mg/kg	10	-	-	-	-	-	-	-	-	-	665	-	-	-	-	-
Cyanide Anion	mg/kg	0.2	-	**29**	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon (TOC)	mg/kg	0.0005	-	-	-	-	-	-	-	6800	-	2900	-	-	<500	-	-
pH (aqueous extract)	pH Unit		-	-	-	-	-	-	-	-	-	5.46	-	-	-	-	-
Sulphate (SO4)	mg/kg	10	-	-	-	-	-	-	-	11	-	<100	-	-	20	-	-
Sulphide	mg/kg	0.3	-	-	-	-	-	-	-	-	-	<0.3	-	-	-	-	-
Metals			-	-													
Aluminium	mg/kg	10	-	**15400**	-	-	-	-	8300	6000	6800	10,600	12,000	12,000	5600	5500	13,000
Antimony	mg/kg	0.1	25	**7.5**	-	-	-	-	<2	<2	<2	0.24	<2	<2	<2	<2	<2
Arsenic	mg/kg	0.5	17	**31**	**1400**	**56**	**33**	**490**	**130**	17	15	16.4	29	**45**	8.8	8.1	13
Barium	mg/kg	0.1	-	**10000**	-	-	-	-	23	20	20	25	32	30	11	9.5	35
Beryllium	mg/kg	0.2	-	**38**	-	-	-	-	<2	<2	<2	0.27	<2	<2	<2	<2	<2
Bismuth	mg/kg	0.1	-	-	-	-	-	-	<2	<2	<2	0.14	<2	<2	<2	<2	<2
Boron	mg/kg	50	-	**4300**	-	-	-	-	<50	<50	<50	-	<50	<50	<50	<50	<50
Cadmium	mg/kg	0.05	3.5	**14**	-	-	-	-	<0.3	<0.3	<0.3	0.075	<0.3	<0.3	<0.3	<0.3	<0.3
Calcium	mg/kg	100	-	-	-	-	-	-	-	-	-	2120	-	-	-	-	-
Chromium Total (III+VI)	mg/kg	1	90	**220**	-	-	-	-	14	9.7	11	17.1	19	19	8.7	8.8	21
Cobalt	mg/kg	0.3	-	**22**	-	-	-	-	9.3	5.8	6.4	10.4	12	13	5.5	5.9	12
Copper	mg/kg	0.5	197	**1100**	-	-	-	-	18	16	16	18	20	22	12	12	21
Iron	mg/kg	50	43766	**11000**	-	-	-	-	**15,000**	10,000	**13,000**	**20,500**	**23,000**	**25,000**	11,000	11,000	**23,000**
Lead	mg/kg	0.1	91.3	**140**	-	-	-	-	11	8.2	8.4	9.66	13	11	6.7	4.3	14
Lithium	mg/kg	2	-	-	-	-	-	-	18	11	13	-	23	23	11	12	25
Magnesium	mg/kg	100	-	-	-	-	-	-	-	-	-	6240	-	-	-	-	-
Manganese	mg/kg	0.2	1100	-	-	-	-	-	260	190	250	390	410	420	200	200	430
Mercury	mg/kg	0.05	0.486	**6.6**	1.1	3.3	0.13	0.73	0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	0.1	-	**110**	-	-	-	-	<2	<2	<2	0.45	<2	3.8	<2	<2	<2
Nickel	mg/kg	0.8	75	**330**	-	-	-	-	19	16	15	24.4	26	34	12	11	29
Potassium	mg/kg	100	-	-	-	-	-	-	-	-	-	700	-	-	-	-	-
Rubidium	mg/kg	2	-	-	-	-	-	-	5.9	4.4	4.4	-	7	6.6	2.6	2.6	7.3
Selenium	mg/kg	0.5	2	**80**	-	-	-	-	<1	<1	<1	<0.5	<1	<1	<1	<1	<1
Silver	mg/kg	0.05	1	**77**	-	-	-	-	<0.5	<0.5	<0.5	<0.05	<0.5	<0.5	<0.5	<0.5	<0.5
Sodium	mg/kg	100	-	-	-	-	-	-	-	-	-	<100	-	-	-	-	-
Strontium	mg/kg	0.1	-	**9400**	-	-	-	-	8.1	7.5	8.7	14.9	13	15	7.2	6.9	16
Sulphur (as S)	mg/kg	500	-	-	-	-	-	-	-	-	-	<500	-	-	-	-	-
Thallium	mg/kg	0.05	-	**1**	-	-	-	-	<0.1	<0.1	<0.1	0.055	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg	0.1	-	**9400**	-	-	-	-	<1	<1	<1	0.23	<1	<1	<1	<1	<1
Titanium	mg/kg	1	-	-	-	-	-	-	-	-	-	498	-	-	-	-	-
Uranium	mg/kg	0.1	-	**23**	-	-	-	-	1.3	1	0.82	-	1.2	2.1	0.52	0.52	3
Vanadium	mg/kg	2	-	**39**	-	-	-	-	13	8.2	9.3	14	16	14	8	8.3	17
Zinc	mg/kg	1	315	**5600**	-	-	-	-	48	37	41	51.8	61	67	26	26	66
Zirconium	mg/kg	0.5	-	-	-	-	-	-	-	-	-	6.06	-	-	-	-	-

Arsenic exceeded the soil standard in all 14 samples taken, whereas mercury only exceeded the soil standard in 1 sample. Both of these substances are associated with historic mining activities, and hence are carried forward for further evaluation in the human health risk assessment.

Cobalt concentrations ranged from 4.1 mg/kg to 160 mg/kg in sediments, relative to the NS Tier 1 standard of 22 mg/kg (see Table B-1) and exceeded the standard in 8 of the 14 sediment samples. Maximum concentrations were 7-fold above the standard. Background concentrations of cobalt in Nova Scotia soils also are above the standard, ranging from 23 to 29 mg/kg, depending on the depth profile of soils (White et al, 2014). When considered in conjunction with arsenic, the degree of exceedance for cobalt is unlikely to drive risks or remedial decision making at this site, as arsenic markedly exceeds the soil standard (see Table B-1).

A number of inorganic substances did not have NS Tier 1 EQS, such as bismuth, calcium, lithium, magnesium, manganese, potassium, rubidium, sodium, sulphur, titanium, and zirconium. Bismuth was largely below detection limits and is of low toxicity, whereas calcium, magnesium, potassium, sodium and sulphur are naturally occurring elements which are regulated by the body and hence, would not merit further study. Lithium, rubidium, titanium and zirconium are not anticipated to be associated with historic mining activities and are not considered to be drivers in terms of toxicity related to this site, and hence, were not considered further. While manganese is present at concentrations in sediments which are higher than background soil ranges cited by White et al (2014; 2,972 to 6,874 mg/kg), manganese is a naturally occurring element and would be associated with the natural geology of the area. It is an essential element for humans (IOM, 2001) and of reasonably low oral toxicity, relative to the primary COPC of interest, arsenic, and hence, was not considered to merit further evaluation in the risk assessment.

Dillon (2019) also analyzed sediments for BTEX and TPH (see Table E5 from Dillon, 2019, inserted below as Table B-2). These samples were all non-detect for BTEX lighter end TPH, and hence, did not merit further evaluation. Some heavier carbon TPH was detected, but upon further analyses it was concluded to be biogenic in nature, due to the presence of organic matter, and hence, was not considered to merit further study.

Therefore, only arsenic and mercury were considered to merit further study in the HHRA, based on the data presented in Dillon (2019).

The fall sediment data collected by Dillon (see Appendix A) were compared to the Tier 1 NS soil standards as a surrogate for sediment guidance levels. This is in keeping with guidance provided by Health Canada, related to human sediment exposures (Health Canada, 2017). Concentrations of aluminum, arsenic, cobalt, iron, lead, mercury and vanadium in one or more sediment samples exceeded the NS Tier 1 soil standards (Table B-3). As shown in Table B-3, soil standards were not available for lithium and manganese. While exposure to lithium and manganese is not anticipated to result in any unacceptable risks to human health, these two metals were considered further, in conjunction with those metals which exceeded the NS Tier 1 soil standards (aluminum, arsenic, cobalt, lead, iron, mercury and vanadium), based on the outcomes in Table B-3.

Table B-2 Petroleum Hydrocarbons in Sediment (taken from Dillon, 2019)

				Sample ID	SED10	SED10[1]	SED12	SED12[1]
				Date	2019-04-25	2019-04-25	2019-04-25	2019-04-25
				Sample Depth (mbgs)	0-0.1	0-0.1	0-0.1	0-0.1
Parameter	**Units**	**EQL**	NS Tier 1 EQS Freshwater Sediment	**NS Tier 1 EQS Soil Residential Non-Potable Coarse**				
BTEX			-	-				
Benzene	mg/kg	0.025	1.2	**0.099**	<0.025	-	<0.025	-
Toluene	mg/kg	0.05	1.4	**77**	<0.05	-	<0.05	-
Ethylbenzene	mg/kg	0.025	1.2	**30**	<0.025	-	<0.025	-
Xylenes Total	mg/kg	0.05	1.3	**8.8**	<0.05	-	<0.05	-
Petroleum Hydrocarbons (PHCs)								
C6-C10 - BTEX	mg/kg	2.5	-	-	<2.5	-	<2.5	-
>C10-C16	mg/kg	10	-	-	<10	<10	<10	<10
>C16-C21	mg/kg	10	-	-	18	15	23	20
>C21-C32	mg/kg	15	-	-	100	100	100	95
Modified TPH	mg/kg	15	15*|25**|43***	**74*|270**|1100*****	120***	120***	130***	110***
Resemblance					G	G	K,L, Possible G	K,L, Possible G

Note: Applicable Criteria Based on resemblance as indicated

[1]Silica Gel Treatment performed prior to analysis

Resemblance:

A - Gasoline Fraction	F - One Product in Fuel Range
B - Weathered Gasoline Fraction	G - Lube Oil Fraction
C - One Product in Gas Range	H -One Product In Lube Oil Range
D - Fuel Oil Fraction	I - No Resemblance
E - Weathered Fuel Oil Fraction	J - Unidentified Peaks in the C6-C10 Range
	K - Unidentified Peaks in the C10-C21 Range
	L - Unidentified Peaks in the C21-C32 Range

Table B-3 Comparison of Metal Concentrations in Sediment Samples to NS Tier 1 Soil Standards for Residential Land Use with Coarse Textured Soils (Fall Data)

		Metals																						
		Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL		10	2	2	5	2	5	0.3	2	1	2	50	0.5	2	2	0.1	2	2	2	0.5	5	0.1	0.1	2	5
NS Tier 1 EQS Soil Residential Non-Potable Coarse		*15400*	*7.5*	*31*	*10000*	*38*	*4300*	*14*	*220*	*22*	*1100*	*11000*	*140*	*NV*	*NV*	*6.6*	*110*	*330*	*80*	*77*	*9400*	*1*	*23*	*39*	*5600*
Sample ID	**Sample Depth (cm)**																								
BIOSED19-1	0 - 0.1	-	-	*3000*	-	-	-	-	-	-	-	-	-	-	-	3.5	-	-	-	-	-	-	-	-	-
BIOSED19-2	0 - 0.1	-	-	*1400*	-	-	-	-	-	-	-	-	-	-	-	*11*	-	-	-	-	-	-	-	-	-
BIOSED19-3	0 - 0.1	-	-	*3900*	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	-	-	-	-	-	-	-
BIOSED19-4	0 - 0.1	-	-	*5200*	-	-	-	-	-	-	-	-	-	-	-	5.6	-	-	-	-	-	-	-	-	-
BIOSED19-5	0 - 0.1	-	-	*4600*	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-	-	-	-	-	-
BIOSED19-6	0 - 0.1	-	-	*1100*	-	-	-	-	-	-	-	-	-	-	-	5.9	-	-	-	-	-	-	-	-	-
TOF19-1	0 - 0.2	8200	2.2	*200*	74	<2	<5	0.51	7.3	3.9	18	6300	69	3.1	320	-	<2	13	<2	<0.5	46	<0.1	0.91	27	32
TOF19-10	0 - 0.2	3100	<2	9.1	78	<2	<5	0.41	3	2.6	6.4	2500	39	<2	200	-	<2	11	<2	<0.5	27	<0.1	0.26	14	25
TOF19-11	0 - 0.2	1600	<2	3	38	<2	<5	0.36	3.4	1.8	4.6	4400	38	<2	79	-	<2	10	<2	<0.5	20	<0.1	<0.1	8.1	27
TOF19-12	0 - 0.2	4500	<2	3.3	31	<2	<5	<0.3	3	1.1	7.4	2700	42	<2	42	-	<2	7.9	<2	<0.5	11	<0.1	<0.1	31	18
TOF19-13	0 - 0.2	3400	<2	6.4	110	<2	<5	0.65	2.6	2.2	7.4	2000	53	<2	130	-	<2	14	<2	<0.5	44	<0.1	0.31	34	28
TOF19-14	0 - 0.2	3200	<2	6.4	56	<2	<5	<0.3	3.4	1.7	8.7	2600	76	<2	29	-	<2	16	<2	<0.5	19	<0.1	0.33	34	25
TOF19-15	0 - 0.2	11,000	<2	22	10	<2	<5	0.73	2.9	5.4	15	4400	110	<2	38	-	<2	20	<2	<0.5	<5	<0.1	0.16	18	17
TOF19-16	0 - 0.2	2500	<2	9.1	40	<2	<5	0.35	3.5	1.6	6.7	2200	73	<2	17	-	<2	8	<2	<0.5	23	<0.1	0.23	23	12
TOF19-2	0 - 0.2	14,000	2.1	*1500*	240	<2	5.2	2.3	9.1	*98*	37	*23,000*	58	3.9	14,000	-	3.5	57	2.9	<0.5	41	0.43	0.77	*72*	160
TOF19-3	0 - 0.2	*18,000*	2	*1700*	140	<2	<5	1.2	15	*83*	40	*34,000*	79	19	3500	-	<2	37	<2	<0.5	20	0.35	1.1	*50*	160
TOF19-4	0 - 0.2	5600	<2	*150*	66	<2	<5	<0.3	5.6	3.3	17	7600	110	3.2	110	-	<2	12	<2	<0.5	27	<0.1	0.36	18	26
TOF19-5	0 - 0.2	7100	<2	*71*	83	<2	<5	1.1	7	3.5	18	6500	*260*	4.3	160	-	<2	13	<2	<0.5	59	<0.1	0.82	23	59
TOF19-6	0 - 0.2	4100	<2	*37*	46	<2	<5	<0.3	4.3	3.4	11	4700	110	<2	150	-	<2	7.9	<2	<0.5	16	<0.1	0.36	17	20
TOF19-7	0 - 0.2	7700	<2	*43*	38	<2	<5	<0.3	6.6	1.3	16	2800	71	<2	36	-	<2	8.6	<2	<0.5	7.7	<0.1	0.43	30	16
TOF19-8	0 - 0.2	2700	<2	6.4	67	<2	<5	0.31	2.9	1.4	7.3	4100	22	<2	220	-	<2	7.8	<2	<0.5	38	<0.1	0.27	16	28
TOF19-9	0 - 0.2	6400	<2	18	64	<2	<5	0.61	4.1	7	10	8900	61	<2	430	-	<2	12	<2	<0.5	43	<0.1	0.86	*42*	22
TOF20-1	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-3	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
TOF20-4	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-
TOF20-5	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
TOF20-6	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-
TOF20-7	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-
TOF20-8	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-9	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-
TOF20-11	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-14	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-15	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-16	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-
TOF20-16_D	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-FD1 (Field Dup of TOF19-5)	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-
TOF20-FD2 (Field Dup of TOF19-8)	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-

Environmental Standards Comments

Italics/Underline Concentration exceeds Nova Scotia Environment Tier 1 Environmental Quality Standards (July 2013) for Soil at a Non-Potable Site (Residential, Coarse-grained)

NV Indicates that a standard was not provided by Nova Scotia Environment

Following this primary screening, the identified metals exceeding the soil standards (or lacking soil standards) were compared to background concentrations reported for Nova Scotian soils, based on White et al (2014). Metals with concentrations in excess of the NS Tier 1 soil standards and typical Nova Scotian background soil concentrations (as indicated by White et al, 2014) were discussed further or retained as COPCs for further evaluation in the HHRA. While it is recognized that Table B-4 compares soil background concentrations to sediments, in light of the lack of robust sediment background datasets, this approach was still considered reasonable (since natural geology would be reflected in both soils and sediments). Table B-4 provides a summary of maximum site concentrations of these metals in sediment, relative to the 98th percentile soil concentrations cited by White et al (2014). Although concentrations of aluminum, iron and vanadium exceeded the NS Tier 1 soil standards in one or more sediment samples, concentrations of these metals in all samples were below the 98th percentile background concentrations reported for these metals in Nova Scotian soils (White et al, 2014). Therefore, concentrations of aluminum, iron and vanadium in sediment were considered to be representative of typical background soil concentrations in Nova Scotia and these metals were not retained for further evaluation, similar to the findings of Dillon (2019), relative to that dataset.

Table B-4 Comparison of Maximum Concentrations of Metals in Sediment Exceeding NS Tier 1 Soil Standards to Typical Nova Scotia Soil Background Concentrations (from White et al, 2014)

Metal	Maximum Concentration in Sediment (mg/kg)	Background Soil 98th Percentiles (mg/kg)			
		PH-98th	A-98th	B-98th	C-98th
Aluminum	18,000	34,644	37,948	43,722	37,680
Arsenic	**5,200**	24	31	36	38
Cobalt	**98**	23	24	29	27
Iron	34,000	39,814	51,260	63,470	69,160
Lead	**260**	71	60	40	56
Lithium	19	NDA	NDA	NDA	NDA
Manganese	**14,000**	2,972	6,847	5,932	3,449
Mercury	**11**	0.4	0.2	0.2	0.1
Vanadium	72	124	138	124	104

BOLDED values in greyscale indicate that maximum measured concentration in Barry's Run sediment was greater than the Nova Scotia soil background concentrations reported in White et al (2014).
A=A soil horizon; B=B soil horizon; C=C soil horizon; PH=public health interval (0-5 cm); NDA: no data available

There was no available background data for lithium. Lithium is largely less than detection (<2 mg/kg; see Table B-3), is not anticipated to be associated with historic mining activities and is not considered to be a driver in terms of toxicity related to this site.

Both arsenic and mercury are associated with historic mining activities. Arsenic is markedly elevated relative to the NS Tier 1 soil standard in sediment samples taken in Barry's Run and Mitchells' Brook (see Table B-3; "biosed" samples), but many parts of the fen area ("TOF" samples; Table B-3) met the NS Tier 1 standard. Mercury only exceeds the soil standard in one sample in the area (see Table B-3) but has the potential to biomagnify in fish tissue. Therefore, both of these substances were carried forward into the HHRA for further assessment. Maximum cobalt concentrations are elevated relative to typical background concentrations (see Table B-4). Only two samples were found to have concentrations exceeding background ranges, with the remaining samples being well within the NS EQS. As discussed previously with the spring Dillon (2019) screening, cobalt is unlikely to be a significant risk driver, due to the degree of exceedance of arsenic over the NS EQS. Therefore, cobalt was not considered further in the HHRA.

With respect to lead, the maximum sediment concentration was elevated relative to the background data provided in Table B-4. However, only one of the sediment samples exceeded the NS Tier 1 soil standard and this exceedance was less than 2-fold of the standard, relative to the primary COPC, arsenic, wherein mean sediment concentrations were markedly above the NS Tier 1 soil standard. Lead has also not been reported to be associated with historic mining activities to any significant extent, and hence, lead was not considered further as a COPC.
The maximum sediment manganese concentration was elevated relative to background soil concentrations (Table B-4). Of the data presented in Table B-3, only the maximum data point was outside the background data cited in Table B-4 (second maxima is 3,500 mg/kg; see Tables B-3 and B-4). As discussed previously, manganese is a naturally occurring element and would be associated with the natural geology of the area. It is an essential element for humans (IOM, 2001) and of reasonably low oral toxicity, relative to the primary COPC of interest, arsenic, and hence, was not considered to merit further evaluation in the risk assessment.

In conclusion, only arsenic and mercury were retained as COPCs in sediment for further evaluation in the HHRA, based on consideration of both the spring (Dillon, 2019) and fall (Appendix A) datasets.

B-1.2 Surface Water

Given the lack of human health based surface water criteria for incidental ingestion scenarios such as that which might occur during swimming, the selection of COPCs in Barry's Run surface water was based on a comparison of the concentrations of metals measured in Barry's Run surface water during the spring and fall to the Nova Scotia Tier 1 potable groundwater drinking water standards (Table B-5). As shown in Table B-5, the concentration of aluminum, arsenic and manganese exceeded the NS Tier 1 potable groundwater drinking water standard in one or more surface water samples. As shown in Table B-5, the concentration of arsenic exceeded the NS Tier 1 potable groundwater drinking water standard in all surface water samples collected in both the spring and fall. Therefore, arsenic was retained as a COPC in surface water for further evaluation in the HHRA. Aluminum and manganese exceeded their NS Tier 1 potable groundwater drinking water standard in only one surface water sample collected in the spring, and the exceedances were marginal. The standard developed for aluminum is based on operational guidance (i.e., non-health based), and both of these guidelines are based on chronic life time daily drinking water exposure. Therefore, incidental consumption during swimming activities of these metals measured in surface waters from Barry's Run would not be associated with any health risks, and these substances were not considered further. Many substances lack health based drinking water standards. Of these, bismuth, phosphorus and titanium were non-detectable in all samples, and hence, would not be expected to pose a risk in an incidental surface water consumption exposure scenario. Metals that were detected, but lack drinking water guidelines included calcium (5.6 to 9.5 mg/L), magnesium (0.96 to 1.7 mg/L) and potassium (0.9 to 1.2 mg/L), all of which are ions that are essential elements, and would not be associated with any health risks.

In conclusion, only arsenic was retained as a COPC in surface water for further evaluation in the HHRA, based on consideration of both the spring (Dillon, 2019) and fall (Appendix A) datasets.

Table B-5 Comparison of Metal Concentrations in Surface Water Samples to NS Tier 1 Potable Groundwater Drinking Water Standards (Spring and Fall Data)

				Sample ID	KWQ755 (SW-IN)	LHN561 (SW-IN)	LMD218 (SW-IN)	KWQ756 (SW-OUT)	LHN562 (SW-OUT)	LMD219 (SW-OUT)	JPE946	JPE947	JPE947	JPE948	JPE949	JPE950	JPE951	JPE952	JPE953	JPE954
				Sampling Date	2019-09-24	2019-11-13	2019-12-03	2019-09-24	2019-11-13	2019-12-03	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19
				Code	NA	NA	NA	NA	NA	NA	2019SW1	2019SW2	2019SW2 Lab-Dup	2019SW3	2019SW4	2019SW5	2019SW6	2019SW10	2019SW11	2019SW7
Method	Parameter	Unit	EQL	NS Tier 1 Potable Groundwater Drinking Water Standards																
	Aluminium	mg/L	0.005	**0.1a**	0.017	0.097	0.047	0.023	**0.14**	0.064	0.081	0.071	0.073	0.063	0.070	0.079	0.057	0.046	0.086	0.080
	Aluminium (Filtered)	mg/L	0.005	**0.1a**	0.02	0.076	0.04	0.018	**0.11**	0.056	0.081	0.077	NDA	0.066	0.068	0.080	0.055	0.048	0.088	0.091
	Antimony	mg/L	0.001	**0.006**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Antimony (Filtered)	mg/L	0.001	**0.006**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Arsenic	mg/L	0.001	**0.01**	**0.065**	**0.093**	**0.091**	**0.055**	**0.046**	**0.049**	**0.045**	**0.047**	**0.048**	**0.054**	**0.050**	**0.046**	**0.059**	**0.086**	**0.045**	**0.046**
	Arsenic (Filtered)	mg/L	0.001	**0.01**	**0.059**	**0.085**	**0.082**	**0.05**	**0.041**	**0.047**	**0.045**	**0.044**	NDA	**0.054**	**0.047**	**0.044**	**0.058**	**0.083**	**0.044**	**0.045**
	Barium	mg/L	0.001	**1**	0.0082	0.0046	0.0038	0.0066	0.0053	0.004	0.0045	0.0041	0.0044	0.0041	0.0055	0.0045	0.0044	0.0045	0.0045	0.0046
	Barium (Filtered)	mg/L	0.001	**1**	0.008	0.0049	0.0034	0.0068	0.0049	0.004	0.0044	0.0043	NDA	0.0044	0.0044	0.0044	0.0044	0.0046	0.0047	0.0046
	Beryllium	mg/L	0.001	**0.004**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Beryllium (Filtered)	mg/L	0.001	**0.004**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Bismuth	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Bismuth (Filtered)	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Boron	mg/L	0.05	**5**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Boron (Filtered)	mg/L	0.05	**5**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NDA	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Cadmium	mg/L	0.00001	**0.005**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Cadmium (Filtered)	mg/L	0.00001	**0.005**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NDA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
	Calcium	mg/L	0.1	**NV**	9.5	5.2	5.6	8.7	5.1	5.7	5.7	5.7	5.7	5.7	5.9	5.6	5.9	6.2	5.7	5.7
	Calcium (Filtered)	mg/L	0.1	**NV**	9.3	5.2	5.5	8.8	4.9	5.6	5.8	5.8	NDA	5.8	5.6	5.7	6.0	6.2	5.7	5.7
	Chromium Total (III+VI)	mg/L	0.001	**0.05**	<0.001	0.0012	<0.001	<0.001	0.0012	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium Total (III+VI) (Filtered)	mg/L	0.001	**0.05**	<0.001	<0.001	<0.001	0.0011	0.0011	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Cobalt	mg/L	0.0004	**0.01**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
	Cobalt (Filtered)	mg/L	0.0004	**0.01**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	NDA	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
	Copper	mg/L	0.0005	**1b**	0.0008	0.00078	0.001	0.0031	0.00084	0.0013	0.00089	0.00087	0.00095	0.00130	0.00080	0.00092	0.00097	0.00098	0.00092	0.00097
	Copper (Filtered)	mg/L	0.0005	**1b**	0.00066	0.0019	0.00083	0.00054	0.00089	0.00075	0.00076	0.00076	NDA	0.00082	0.00076	0.00076	0.00086	0.00081	0.00080	0.00088
	Iron	mg/L	0.05	**0.3b**	0.077	0.13	0.053	0.12	0.15	0.073	0.073	0.055	0.057	<0.05	0.052	0.067	0.060	<0.05	0.070	0.075
	Iron (Filtered)	mg/L	0.05	**0.3b**	<0.05	0.084	<0.05	0.074	0.11	0.051	0.059	0.053	NDA	<0.05	<0.05	0.059	<0.05	<0.05	0.170	0.056
	Lead	mg/L	0.0005	**0.005 (revised value 2019)**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Lead (Filtered)	mg/L	0.0005	**0.005 (revised value 2019)**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	NDA	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Magnesium	mg/L	0.1	**NV**	1.7	1.1	1.2	1.6	1.1	1.2	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.1	1.1
	Magnesium (Filtered)	mg/L	0.1	**NV**	1.7	1	1.2	1.7	0.96	1.1	1.1	1.1	NDA	1.1	1.1	1.1	1.1	1.2	1.1	1.1
	Manganese	mg/L	0.002	**0.12 (revised value 2019)**	**0.14**	0.052	0.018	0.12	0.047	0.02	0.027	0.020	0.021	0.019	0.019	0.026	0.018	0.018	0.026	0.028
	Manganese (Filtered)	mg/L	0.002	**0.12 (revised value 2019)**	**0.13**	0.023	0.012	0.11	0.028	0.017	0.024	0.020	NDA	0.017	0.018	0.023	0.015	0.018	0.025	0.022
	Mercury	mg/L	0.000013	**0.001**	NDA	0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013 [1]	NDA	NDA	NDA	NDA	<0.000013 [1]	<0.000013 [1]	NDA	<0.000013 [1]	<0.000013 [1]
	Mercury (dissolved)	mg/L	0.000013	**0.001**	NDA	<0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013
	Molybdenum	mg/L	0.002	**0.07**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Molybdenum (Filtered)	mg/L	0.002	**0.07**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002
	Nickel	mg/L	0.002	**0.1**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Nickel (Filtered)	mg/L	0.002	**0.1**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Phosphorus	ug/L	100	**NV**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phosphorus (Filtered)	ug/L	100	**NV**	<0.1	<0.1	<100	<0.1	<0.1	<100	<100	<100	NDA	<100	<100	<100	<100	<100	<100	<100
	Potassium (K)	ug/L	100	**NV**	1200	910	880	1000	960	880	930	900	910	940	950	950	950	1000	930	960
	Potassium (K) (Filtered)	ug/L	100	**NV**	1200	960	910	1000	980	880	970	1000	NDA	980	980	980	990	1100	980	970
	Selenium	mg/L	0.0005	**0.05 (revised 2014)**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Selenium (Filtered)	mg/L	0.0005	**0.05 (revised 2014)**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Silver	mg/L	0.0001	**0.1**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Silver (Filtered)	mg/L	0.0001	**0.1**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Sodium	mg/L	0.1	**200b**	40	21	29	32	19	26	28.0	28.0	29.0	30.0	30.0	28.0	31.0	32.0	28.0	28.0
	Sodium (Filtered)	mg/L	0.1	**200b**	40	20	28	34	18	26	29.0	30.0	NDA	31.0	30.0	29.0	32.0	34.0	28.0	29.0
	Strontium	mg/L	0.002	**7.0 (revised 2019)**	0.035	0.019	0.019	0.032	0.018	0.018	0.019	0.019	0.020	0.020	0.021	0.020	0.021	0.022	0.020	0.019
	Strontium (Filtered)	mg/L	0.002	**7.0 (revised 2019)**	0.031	0.019	0.018	0.031	0.018	0.018	0.020	0.021	NDA	0.020	0.021	0.020	0.022	0.022	0.019	0.020
	Thallium	mg/L	0.0001	**0.002**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Thallium (Filtered)	mg/L	0.0001	**0.002**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Tin	mg/L	0.002	**4.4**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Tin (Filtered)	mg/L	0.002	**4.4**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Titanium	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Titanium (Filtered)	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Uranium	mg/L	0.0001	**0.02**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Uranium (Filtered)	mg/L	0.0001	**0.02**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Vanadium	mg/L	0.002	**0.0062**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Vanadium (Filtered)	mg/L	0.002	**0.0062**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Zinc	mg/L	0.005	**5b**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Zinc (Filtered)	mg/L	0.005	**5b**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0054	<0.005	NDA	<0.005	0.0065	<0.005	<0.005	0.0074	<0.005	<0.005

Environmental Standards Comments

Bold Concentration exceeds Nova Scotia Environment Tier 1 Potable Groundwater Drinking Water Standards
NV Indicates that the standards provided were aesthetic objectives, operational guidance or that a standard was not provided by Nova Scotia Environment
NA Not applicable
NDA No data available
Revised value indicates that Health Canada has updated the drinking water quality guideline since NS EQS were published; hence the updated value is provided and used in screening
[1] A mercury bottle was not received for Total Mercury analysis
a Indicates groundwater drinking water standard is an operational guidance (non-health based standard)
b Indicates groundwater drinking water standard is an aesthetic objective (non-health based standard)

B-1.3 References

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B-2.0 ECOLOGICAL SCREENING

While an Ecological Risk Assessment (ERA) is not currently part of the scope for the current project, ecological risk screening was completed to confirm the potential need for further ecological assessment of the Barry's Run receiving environment, based on comparisons to NSE EQS (NSE, 2014). The COPCs identified will be evaluated in an ERA, which will be conducted in conjunction with the mine closure project for the Historic Montague Mine site.
Both datasets from the two sampling campaigns were considered in the screening.

B-2.1 Sediments

Dillon (2019) compared the spring sediment data to NS Tier 1 freshwater sediment standards (see Table B-1 in Section B-1.1, which is Table E4 from Dillon, 2019). A number of metals exceeded the NS Tier 1 freshwater sediment standards, including arsenic, iron, lead, manganese, mercury, nickel, selenium and zinc. Iron was concluded to be within background ranges (See Section 4.4.2.2, Dillon, 2019), and does not merit further evaluation. Exceedances for all remaining metals were identified within the top 10 cm of sediment (sediment associated with greatest potential for exposure to freshwater aquatic organisms). Arsenic and mercury exceeded the sediment standards in 18 surface sediment (≤10 cm) samples. Both of these substances are associated with historic mine activities, and hence should be carried forward for further evaluation in the ERA. Although lead exceeded the applicable standards in one surface sediment (≤10 cm) sample, this exceedance was marginal (e.g., less than 1.1-fold) and lead has not been reported to be associated with historic mining activities to a significant extent, based on the existing site data from the main tailings area, where lead is only marginally elevated over human or ecological health standards in the main tailings area (see Appendix B-2; Intrinsik et al, 2019). Nickel and zinc exceedances were noted in two surface sediment samples and selenium exceeded the standards in three surface sediment samples. Similar to lead, these exceedances were marginal (i.e., 1.1 to 1.4-fold of each standard). Based on the limited and marginal exceedances in surface sediment samples noted for lead, nickel, selenium and zinc, these metals were considered unlikely to be major drivers of toxicity or remedial outcomes when compared to the exceedances noted for other metals. As such, lead, nickel, selenium and zinc were not retained for further evaluation in the ERA. Background sediment data could not be found in the literature reviewed for manganese and manganese is typically enriched in mining locations. Background soil manganese concentrations provided in Section B-1.1 (human health screening - sediment) indicate that manganese concentrations are elevated, relative to typical manganese levels in Nova Scotia soils. While manganese is unlikely to be a driver of toxicity based on the degree of exceedance, relative to sediment quality guidelines, it will be considered in the future ERA as a possible contributor to toxicity.

Dillon (2019) also analyzed sediments for BTEX and TPH (see Table B-2 in Section B-1.1). These samples were all non-detect for BTEX lighter end TPH, and hence, did not merit further evaluation. Some heavier carbon TPH was detected, but upon further analyses it was concluded to be biogenic in nature, due to the presence of organic matter, and hence, was not considered to merit further study.

Similar to the approach taken by Dillon (2019), the selection of COPCs in Barry's Run and Mitchells' Brook sediment and fen samples collected in September through January 2020 by Dillon (see Appendix A) was based on a comparison of the concentrations of metals measured in sediment samples to the NS Tier 1 freshwater sediment standards (Table B-6). Metals with concentrations in excess of the NS Tier 1 freshwater sediment standards were retained for further evaluation. As shown in Table B-6, the concentrations of arsenic, lead, manganese,

mercury and selenium exceeded the freshwater sediment standards in one or more sediment samples. Exceedances for all of these metals were identified at sample depths of 0-10 cm and/or 0-20 cm (sediment associated with potential for exposure to freshwater aquatic organisms). Selenium only exceeded the standards in a single sediment sample collected at a depth of 0-20 cm in the fen area (i.e., TOF sample) and this exceedance was marginal (e.g. less than 1.5-fold). Based on the marginal exceedance noted for selenium in this single sediment sample, this metal was considered unlikely to be a major driver of toxicity or remedial outcomes when compared to the exceedances noted for other metals and was not retained as COPC for further evaluation in the ERA. Lead exceeded the applicable standards and 98th percentile typical Nova Scotia soil background concentrations in four surface sediment samples (25% of samples) collected in the fen area. While it is not substantially linked to site activities up-gradient (Montague mines), it will be considered further in the ERA as a COPC. As noted previously, background sediment data could not be found in the literature reviewed for manganese and manganese is typically enriched in mining locations. While manganese is unlikely to be a driver of toxicity based on the degree of exceedance, relative to sediment quality guidelines, it will be considered in the future ERA as a possible contributor to toxicity. Arsenic and mercury exceeded the standards in 15 and 9 surface sediment samples, respectively. These metals are associated with historic mining activities, and hence are considered to be COPCs. Many other metals did not have sediment quality guidelines. All of these metals are naturally occurring substances, but some may have some additional association with historic mining activities. Based on the reported concentrations of arsenic and mercury in upstream environments, these two metalloids are expected to be the primary COPCs, and hence, the focus of any future ERA will largely be on these two substances, but can consider possible involvement of other metals or metalloids, as necessary.

In conclusion, arsenic, lead, mercury and manganese were retained as COPCs in sediment for further evaluation in the ERA.

Table B6 Comparison of Metal Concentrations in Sediment Samples to NS Tier 1 Environmental Quality Standards for Freshwater Sediment (Fall Data)

		Metals																							
		Aluminium	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Uranium	Vanadium	Zinc
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL		10	2	2	5	2	5	0.3	2	1	2	50	0.5	2	2	0.1	2	2	2	0.5	5	0.1	0.1	2	5
NS Tier 1 EQS Freshwater Sediment		**NV**	**25**	**17**	**NV**	**NV**	**NV**	**3.5**	**90**	**NV**	**197**	**43766**	**91.3**	**NV**	**1100**	**0.486**	**NV**	**75**	**2**	**1**	**NV**	**NV**	**NV**	**NV**	**315**
Sample ID	**Sample Depth (cm)**																								
BIOSED19-1	0 - 0.1	-	-	**3000**	-	-	-	-	-	-	-	-	-	-	-	**3.5**	-	-	-	-	-	-	-	-	-
BIOSED19-2	0 - 0.1	-	-	**1400**	-	-	-	-	-	-	-	-	-	-	-	**11**	-	-	-	-	-	-	-	-	-
BIOSED19-3	0 - 0.1	-	-	**3900**	-	-	-	-	-	-	-	-	-	-	-	**4.9**	-	-	-	-	-	-	-	-	-
BIOSED19-4	0 - 0.1	-	-	**5200**	-	-	-	-	-	-	-	-	-	-	-	**5.6**	-	-	-	-	-	-	-	-	-
BIOSED19-5	0 - 0.1	-	-	**4600**	-	-	-	-	-	-	-	-	-	-	-	**5.2**	-	-	-	-	-	-	-	-	-
BIOSED19-6	0 - 0.1	-	-	**1100**	-	-	-	-	-	-	-	-	-	-	-	**5.9**	-	-	-	-	-	-	-	-	-
TOF19-1	0 - 0.2	8200	2.2	**200**	74	<2	<5	0.51	7.3	3.9	18	6300	69	3.1	320	-	<2	13	<2	<0.5	46	<0.1	0.91	27	32
TOF19-10	0 - 0.2	3100	<2	9.1	78	<2	<5	0.41	3	2.6	6.4	2500	39	<2	200	-	<2	11	<2	<0.5	27	<0.1	0.26	14	25
TOF19-11	0 - 0.2	1600	<2	3	38	<2	<5	0.36	3.4	1.8	4.6	4400	38	<2	79	-	<2	10	<2	<0.5	20	<0.1	<0.1	8.1	27
TOF19-12	0 - 0.2	4500	<2	3.3	31	<2	<5	<0.3	3	1.1	7.4	2700	42	<2	42	-	<2	7.9	<2	<0.5	11	<0.1	<0.1	31	18
TOF19-13	0 - 0.2	3400	<2	6.4	110	<2	<5	0.65	2.6	2.2	7.4	2000	53	<2	130	-	<2	14	<2	<0.5	44	<0.1	0.31	34	28
TOF19-14	0 - 0.2	3200	<2	6.4	56	<2	<5	<0.3	3.4	1.7	8.7	2600	76	<2	29	-	<2	16	<2	<0.5	19	<0.1	0.33	34	25
TOF19-15	0 - 0.2	11,000	<2	**22**	10	<2	<5	0.73	2.9	5.4	15	4400	**110**	<2	38	-	<2	20	<2	<0.5	<5	<0.1	0.16	18	17
TOF19-16	0 - 0.2	2500	<2	9.1	40	<2	<5	0.35	3.5	1.6	6.7	2200	73	<2	17	-	<2	8	<2	<0.5	23	<0.1	0.23	23	12
TOF19-2	0 - 0.2	14,000	2.1	**1500**	240	<2	5.2	2.3	9.1	98	37	23,000	58	3.9	**14,000**	-	3.5	57	**2.9**	<0.5	41	0.43	0.77	72	160
TOF19-3	0 - 0.2	18,000	2	**1700**	140	<2	<5	1.2	15	83	40	34,000	79	19	**3500**	-	<2	37	<2	<0.5	20	0.35	1.1	50	160
TOF19-4	0 - 0.2	5600	<2	**150**	66	<2	<5	<0.3	5.6	3.3	17	7600	**110**	3.2	110	-	<2	12	<2	<0.5	27	<0.1	0.36	18	26
TOF19-5	0 - 0.2	7100	<2	**71**	83	<2	<5	1.1	7	3.5	18	6500	**260**	4.3	160	-	<2	13	<2	<0.5	59	<0.1	0.82	23	59
TOF19-6	0 - 0.2	4100	<2	**37**	46	<2	<5	<0.3	4.3	3.4	11	4700	**110**	<2	150	-	<2	7.9	<2	<0.5	16	<0.1	0.36	17	20
TOF19-7	0 - 0.2	7700	<2	**43**	38	<2	<5	<0.3	6.6	1.3	16	2800	71	<2	36	-	<2	8.6	<2	<0.5	7.7	<0.1	0.43	30	16
TOF19-8	0 - 0.2	2700	<2	6.4	67	<2	<5	0.31	2.9	1.4	7.3	4100	22	<2	220	-	<2	7.8	<2	<0.5	38	<0.1	0.27	16	28
TOF19-9	0 - 0.2	6400	<2	**18**	64	<2	<5	0.61	4.1	7	10	8900	61	<2	430	-	<2	12	<2	<0.5	43	<0.1	0.86	42	22
TOF20-1	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-3	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-	-	-
TOF20-4	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-
TOF20-5	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-	-	-	-	-	-	-
TOF20-6	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.7**	-	-	-	-	-	-	-	-	-
TOF20-7	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-
TOF20-8	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-9	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-
TOF20-11	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-14	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-15	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-16	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	-
TOF20-16_D	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-
TOF20-FD1 (Field Dup of TOF19-5)	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-	-	-	-
TOF20-FD2 (Field Dup of TOF19-8)	0 - 0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-

Environmental Standards Comments

Bold	Concentration exceeds Nova Scotia Environment Tier 1 Environmental Quality Standards (July 2013) for Freshwater Sediment
NV	Indicates that a standard was not provided by Nova Scotia Environment

B-2.2 Surface Water

The selection of COPCs in Barry's Run surface water was based on a comparison of the concentrations of metals measured in surface water samples collected during the spring and fall to the NS Tier 1 freshwater surface water standards (Table B-7). Following this primary screening, metals exceeding the freshwater surface water standards were compared to revised guidelines (based on site-specific water quality characteristics) or site-specific surface water quality guideline values. Metals with concentrations markedly greater than the NS Tier 1 freshwater surface water standards and revised guidelines or site-specific guideline values were retained as COPCs for further evaluation in the ERA.

As shown in Table B-7, the concentrations of aluminum and arsenic exceeded the NS Tier 1 freshwater surface water standards in all surface water samples and the concentration of copper exceeded the standards in a single surface water sample (i.e., SW-OUT collected in September of 2019). Although the concentrations of aluminum and copper in surface water samples exceeded the NS Tier 1 freshwater surface water standards, it is important to note that the toxicity of aluminum and copper are dependent on pH and water hardness, respectively. National water quality guideline values for the protection of aquatic life, which take pH and water hardness into consideration, have been developed for these metals by the Canadian Council of Ministers of the Environment (CCME). When taking into consideration the pH of surface water samples collected from Barry's Run (range: 6.81-7.35), the concentrations of aluminum in all samples were below the CCME (1987) water quality guideline for the protection of aquatic life (i.e., 0.1 mg/L assuming a pH of ≥6.5), with the exception of surface water sample SW-OUT collected in November of 2019. However, the exceedance noted for this single surface water sample was marginal (e.g., less than 1.5-fold). When taking into consideration the water hardness of surface water sample SW-OUT collected in September of 2019 (i.e., 29 mg/L $CaCO_3$), the concentration of copper in this surface water sample (i.e., 0.0031 mg/L) exceeded the CCME (1987) long-term freshwater water quality guideline value for the protection of aquatic life (i.e.,0.002 mg/L). However, this exceedance was marginal (e.g., less than 1.5-fold), and only occurred in a single sample. Based on the limited and marginal exceedances in surface water samples noted for aluminum and copper, these metals were considered unlikely to be major drivers of toxicity or remedial outcomes when compared to the exceedances noted for other metals and were not retained as COPCs for further evaluation in the ERA.

Concentrations of arsenic in all surface water samples exceeded the NS Tier 1 freshwater surface water standards, as well as the Site Specific Tier 2 SSD Guideline of 0.030 mg/L (Intrinsik et al., 2019). Therefore, based on the available information, arsenic was retained as a COPC in surface water for further evaluation in the ERA.

Several metals were lacking freshwater aquatic life guidelines. Many of these are salts which are naturally occurring and unlikely to be associated with any toxicity (e.g., calcium, potassium, sodium). Phosphorus, ammonia, and nitrate and nitrite are not associated with the mine site, and hence, are not considered further. Bismuth, chromium, tin and titanium are non-detect in all samples, and therefore are not considered further.

In conclusion, arsenic in surface water was retained as COPC for further evaluation in the ERA.

Table B7 Comparison of Metal Concentrations in Surface Water Samples to NS Tier 1 Environmental Quality Standards for Surface Water (Freshwater)

				Sample ID	KWQ755 (SW-IN)	LHN561 (SW-IN)	LMD218 (SW-IN)	KWQ756 (SW-OUT)	LHN562 (SW-OUT)	LMD219 (SW-OUT)	JPE946	JPE947	JPE947	JPE948	JPE949	JPE950	JPE951	JPE952	JPE953	JPE954	JPE954
				Sampling Date	2019-09-24	2019-11-13	2019-12-03	2019-09-24	2019-11-13	2019-12-03	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19	4/29/19
				Code	NA	NA	NA	NA	NA	NA	2019SW1	2019SW2	2019SW2 Lab-Dup	2019SW3	2019SW4	2019SW5	2019SW6	2019SW10	2019SW11	2019SW7	2019SW7 Lab-Dup
Method	**Parameter**	**Unit**	**EQL**	NS Tier 1 EQS Freshwater Surface Water																	
Calculated	Langelier Index (@ 4C)	-			-1.99	-2.95	-2.91	-2.22	-2.96	-2.79	-2.69	-2.86	NDA	-2.79	-2.81	-2.73	-2.75	-2.67	-2.87	-2.85	NDA
	Langelier Index (@20C)	-			-1.74	-2.7	-2.65	-1.97	-2.71	-2.54	-2.44	-2.61	NDA	-2.54	-2.56	-2.48	-2.50	-2.42	-2.62	-2.60	NDA
	Saturation pH (@ 20C)	-			9.08	9.6	9.55	9.15	9.62	9.35	9.54	9.54	NDA	9.55	9.57	9.54	9.54	9.53	9.57	9.54	NDA
	Saturation pH (@ 4C)	-			9.33	9.85	9.81	9.41	9.87	9.6	9.79	9.79	NDA	9.81	9.82	9.79	9.79	9.78	9.82	9.79	NDA
	Nitrate (as N)	mg/L	0.05		<0.05	<0.05	0.086	<0.05	<0.05	0.14	0.092	0.092	NDA	0.066	0.27	0.084	<0.050	<0.050	0.076	0.076	NDA
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1		21	10	11	18	10	18	11	11	NDA	11	11	11	11	11	10	11	NDA
	Alkalinity (Carbonate as CaCO3)	mg/L	1		<1	<1	<1	<1	<1	<1	<1.0	<1.0	NDA	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NDA
	Ionic Balance	%			0.21	6.37	5.81	1.2	6.22	8.16	2.03	3.43	NDA	3.60	3.66	3.24	1.88	1.82	2.96	2.89	NDA
	Anions Total	meq/L			2.35	1.42	1.82	2.05	1.28	1.79	1.76	1.81	NDA	1.87	1.84	1.75	1.90	1.96	1.74	1.78	NDA
	Cations Total	meq/L			2.36	1.25	1.62	2.1	1.13	1.52	1.69	1.69	NDA	1.74	1.71	1.64	1.83	1.89	1.64	1.68	NDA
	Hardness as CaCO3	mg/L	1		30	17	19	29	16	19	19	19	NDA	19	19	19	20	20	19	19	NDA
	Total Dissolved Solids (TDS) - Calculated	mg/L	1		140	82	100	120	75	100	100	100	NDA	110	110	100	110	110	100	100	NDA
Inorganics	Alkalinity (total) as CaCO3	mg/L	5		21	10	11	18	10	18	11	11	NDA	11	11	11	11	11	11	11	NDA
	Ammonia (as N)	mg/L	0.05		<0.05	0.051	<0.05	<0.05	<0.05	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NDA
	Nitrate + Nitrite (as N)	mg/L	0.05		<0.05	<0.05	0.086	<0.05	<0.05	0.14	0.092	0.092	NDA	0.066	0.27	0.084	<0.050	<0.050	0.076	0.076	NDA
	Nitrite (as N)	mg/L	0.01		<0.01	<0.01	<0.02[#1]	<0.01	<0.01	<0.02[#1]	<0.010	<0.010	NDA	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NDA
	Phosphate	mg/L	0.01		0.016	0.021	0.02	0.014	0.013	0.013	0.013	0.013	NDA	0.014	0.013	0.013	0.015	0.020	0.012	0.012	NDA
	Phosphorus	ug/L	100		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phosphorus (Dissolved)	ug/L	100		<0.1	<0.1	<100	<0.1	<0.1	<100	<100	<100	NDA	<100	<100	<100	<100	<100	<100	<100	NDA
	Electrical conductivity (lab)	µS/cm	1		240	150	190	230	130	180	200	200	200	210	210	200	220	230	200	200	200
	Chloride (Filtered)	mg/L	1		63	36	50	53	32	44	48	50	NDA	52	50	48	54	56	48	49	NDA
	Dissolved Organic Carbon (Filtered)	mg/L	0.5		3.1	6.4	4	3.4	8.4	4.6	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
	Total Organic Carbon (TOC)	mg/L	0.5		3.1	6.4	4.2	3.5	8.4	4.5	5.3	5.2	NDA	4.9	4.9	5.4	4.8	4.4	5.3	5.3	NDA
	pH (Lab)	pH Unit			7.35	6.9	6.9	7.19	6.91	6.81	7.10	6.93	6.97	7.02	7.01	7.06	7.04	7.11	6.95	6.94	6.98
	Silica as SiO2	mg/L	0.5		3.1	3.1	2	3	3.3	2.5	1.6	1.5	NDA	1.3	1.5	1.6	1.2	1.1	1.6	1.6	NDA
	Sulphate (SO4) (Filtered)	mg/L	2		8.2	8.7	8.8	10	8.4	9	8.4	8.5	NDA	8.4	9.0	8.3	8.4	8.5	8.9	8.4	NDA
	Total Suspended Solids (TSS)	mg/L	1		<1	<1	<1	<1	<1	<1	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
	Turbidity	NTU	0.1		0.72	0.84	0.52	0.82	0.52	0.56	0.25	0.26	NDA	0.31	0.27	0.24	0.33	<0.10	0.41	0.47	NDA
	Colour	TCU	5		9.2	37	17	13	57	23	33	28	NDA	28	27	32	25	24	31	31	NDA
Metals	Aluminium	mg/L	0.005	**0.005**	**0.017**	**0.097**	**0.047**	**0.023**	**0.14**	**0.064**	**0.081**	**0.071**	**0.073**	**0.063**	**0.070**	**0.079**	**0.057**	**0.046**	**0.086**	**0.080**	NDA
	Aluminium (Filtered)	mg/L	0.005	**0.005**	**0.02**	**0.076**	**0.04**	**0.018**	**0.11**	**0.056**	**0.081**	**0.077**	NDA	**0.066**	**0.068**	**0.080**	**0.055**	**0.048**	**0.088**	**0.091**	NDA
	Antimony	mg/L	0.001	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Antimony (Filtered)	mg/L	0.001	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Arsenic	mg/L	0.001	**0.005**	**0.065**	**0.093**	**0.091**	**0.055**	**0.046**	**0.049**	**0.045**	**0.047**	**0.048**	**0.054**	**0.050**	**0.046**	**0.059**	**0.086**	**0.045**	**0.046**	NDA
	Arsenic (Filtered)	mg/L	0.001	**0.005**	**0.059**	**0.085**	**0.082**	**0.05**	**0.041**	**0.047**	**0.045**	**0.044**	NDA	**0.054**	**0.047**	**0.044**	**0.058**	**0.083**	**0.044**	**0.045**	NDA
	Barium	mg/L	0.001	**1**	0.0082	0.0046	0.0038	0.0066	0.0053	0.004	0.0045	0.0041	0.0044	0.0041	0.0055	0.0045	0.0044	0.0045	0.0045	0.0046	NDA
	Barium (Filtered)	mg/L	0.001	**1**	0.008	0.0049	0.0034	0.0068	0.0049	0.004	0.0044	0.0043	NDA	0.0044	0.0044	0.0044	0.0044	0.0046	0.0047	0.0046	NDA
	Beryllium	mg/L	0.001	**0.0053**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Beryllium (Filtered)	mg/L	0.001	**0.0053**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Bismuth	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Bismuth (Filtered)	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Boron	mg/L	0.05	**1.2**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NDA
	Boron (Filtered)	mg/L	0.05	**1.2**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NDA	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NDA
	Cadmium	mg/L	0.00001	**0.00001**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NDA
	Cadmium (Filtered)	mg/L	0.00001	**0.00001**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NDA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NDA
	Calcium	mg/L	0.1	**NV**	9.5	5.2	5.6	8.7	5.1	5.7	5.7	5.7	5.7	5.7	5.9	5.6	5.9	6.2	5.7	5.7	NDA
	Calcium (Filtered)	mg/L	0.1	**NV**	9.3	5.2	5.5	8.8	4.9	5.6	5.8	5.8	NDA	5.8	5.6	5.7	6.0	6.2	5.7	5.7	NDA
	Chromium Total (III+VI)	mg/L	0.001	**NV**	<0.001	0.0012	<0.001	<0.001	0.0012	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Chromium Total (III+VI) (Filtered)	mg/L	0.001	**NV**	<0.001	<0.001	<0.001	0.0011	0.0011	<0.001	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Cobalt	mg/L	0.0004	**0.01**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	NDA
	Cobalt (Filtered)	mg/L	0.0004	**0.01**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	NDA	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	NDA
	Copper	mg/L	0.0005	**0.002**	0.0008	0.00078	0.001	**0.0031**	0.00084	0.0013	0.00089	0.00087	0.00095	0.00130	0.00080	0.00092	0.00097	0.00098	0.00092	0.00097	NDA
	Copper (Filtered)	mg/L	0.0005	**0.002**	0.00066	0.0019	0.00083	0.00054	0.00089	0.00075	0.00076	0.00076	NDA	0.00082	0.00076	0.00076	0.00086	0.00081	0.00080	0.00088	NDA
	Iron	mg/L	0.05	**0.3**	0.077	0.13	0.053	0.12	0.15	0.073	0.073	0.055	0.057	<0.05	0.052	0.067	0.060	<0.05	0.070	0.075	NDA
	Iron (Filtered)	mg/L	0.05	**0.3**	<0.05	0.084	<0.05	0.074	0.11	0.051	0.059	0.053	NDA	<0.05	<0.05	0.059	<0.05	<0.05	0.170	0.056	NDA
	Lead	mg/L	0.0005	**0.001**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	NDA
	Lead (Filtered)	mg/L	0.0005	**0.001**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	NDA	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	NDA
	Magnesium	mg/L	0.1	**NV**	1.7	1.1	1.2	1.6	1.1	1.2	1.1	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.1	1.1	NDA
	Magnesium (Filtered)	mg/L	0.1	**NV**	1.7	1	1.2	1.7	0.96	1.1	1.1	1.1	NDA	1.1	1.1	1.1	1.1	1.2	1.1	1.1	NDA
	Manganese	mg/L	0.002	**0.82**	0.14	0.052	0.018	0.12	0.047	0.02	0.027	0.020	0.021	0.019	0.019	0.026	0.018	0.018	0.026	0.028	NDA
	Manganese (Filtered)	mg/L	0.002	**0.82**	0.13	0.023	0.012	0.11	0.028	0.017	0.024	0.020	NDA	0.017	0.018	0.023	0.015	0.018	0.025	0.022	NDA
	Mercury	mg/L	0.000013	**0.000026**	NDA	0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013 [1]	NDA	NDA	NDA	NDA	<0.000013 [1]	<0.000013 [1]	NDA	<0.000013 [1]	<0.000013 [1]	NDA
	Mercury (dissolved)	mg/L	0.000013	**0.000026**	NDA	<0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013	<0.000013	NDA	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013	<0.000013	NDA
	Molybdenum	mg/L	0.002	**0.073**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Molybdenum (Filtered)	mg/L	0.002	**0.073**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Nickel	mg/L	0.002	**0.025**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Nickel (Filtered)	mg/L	0.002	**0.025**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Potassium (K)	ug/L	100	**NV**	1200	910	880	1000	960	880	930	900	910	940	950	950	950	1000	930	960	NDA
	Potassium (K) (Filtered)	ug/L	100	**NV**	1200	960	910	1000	980	880	970	1000	NDA	980	980	980	990	1100	980	970	NDA
	Selenium	mg/L	0.0005	**0.001**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Selenium (Filtered)	mg/L	0.0005	**0.001**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	NDA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NDA
	Silver	mg/L	0.0001	**0.0001**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Silver (Filtered)	mg/L	0.0001	**0.0001**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Sodium	mg/L	0.1	**NV**	40	21	29	32	19	26	28.0	28.0	29.0	30.0	30.0	28.0	31.0	32.0	28.0	28.0	NDA
	Sodium (Filtered)	mg/L	0.1	**NV**	40	20	28	34	18	26	29.0	30.0	NDA	31.0	30.0	29.0	32.0	34.0	28.0	29.0	NDA
	Strontium	mg/L	0.002	**21**	0.035	0.019	0.019	0.032	0.018	0.018	0.019	0.019	0.020	0.020	0.021	0.020	0.021	0.022	0.020	0.019	NDA
	Strontium (Filtered)	mg/L	0.002	**21**	0.031	0.019	0.018	0.031	0.018	0.018	0.020	0.021	NDA	0.020	0.021	0.020	0.022	0.022	0.019	0.020	NDA
	Thallium	mg/L	0.0001	**0.0008**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Thallium (Filtered)	mg/L	0.0001	**0.0008**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Tin	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Tin (Filtered)	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Titanium	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Titanium (Filtered)	mg/L	0.002	**NV**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Uranium	mg/L	0.0001	**0.3**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Uranium (Filtered)	mg/L	0.0001	**0.3**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NDA
	Vanadium	mg/L	0.002	**0.006**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Vanadium (Filtered)	mg/L	0.002	**0.006**	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	NDA
	Zinc	mg/L	0.005	**0.03**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NDA
	Zinc (Filtered)	mg/L	0.005	**0.03**	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0054	<0.005	NDA	<0.005	0.0065	<0.005	<0.005	0.0074	<0.005	<0.005	NDA

Environmental Standards Comments

Bold Concentration exceeds Nova Scotia Environment Tier 1 Environmental Quality Standards (July 2013) for Freshwater Surface Water

#1 Elevated reporting limit due to method blank performance.

[1] A mercury bottle was not received for Total Mercury analysis

NA Not applicable

NV Indicates that a standated was not provided by Nova Scotia Environment

B-2.3 References

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APPENDIX C

MODEL OUTPUTS FOR HUMAN HEALTH RISK ASSESSMENT

Exposure and Risk Calculations Related to Sediments in Barry's Run

		Oral Exposure - Shoreline Sediment Hand to Mouth		Dermal Exposure														
Chemical	**EPC (mg/kg)**	**Oral Exposure (mg/kg/day)**	**Risk (ER or ILCR)**	**Hands (mg/kg/day)**	**Feet (mg/kg/day)**	**Legs (mg/kg/day)**	**Arms (mg/kg/day)**	**Forearms (mg/kg/day)**	**Whole Body (mg/kg/day)**	**Total Dermal (mg/kg/day)**	**Risk (ER or ILCR)**		**Total Risk (ER or ILCR)**					
Non-Cancer Endpoints																		
High Contact-Low Frequency																		
Arsenic - Toddler	3287	3.4E-05	0.1147	3.4E-06	1.5E-05	9.7E-06	1.2E-06			2.9E-05	0.10		2.12E-01					
Mercury - Toddler	5.22	3.74E-07	0.0012	5.1E-07	2.2E-06	1.4E-06	1.8E-07			4.3E-06	0.01		1.56E-02					
Low-Contact-High Frequency																		
Arsenic - Child	2000	3.6E-05	0.1201	6.3E-06	3.3E-05					3.9E-05	0.13		2.50E-01					
Mercury - Child	5.9	7.3E-07	0.0024	1.7E-06	9.0E-06					1.1E-05	0.04		3.82E-02					
Cancer Endpoints																		
High Contact-Low Frequency																		
Arsenic - Adult	3287	2.2E-06	4.0E-06	1.7E-06	9.5E-06	7.7E-06	8.1E-07			2.0E-05	3.5E-05		3.94E-05					
Low-Contact-High Frequency																		
Arsenic - Adult	2000	5.9E-06	1.1E-05	4.4E-06	2.5E-05					3.0E-05	5.3E-05		6.38E-05					
				Arsenic	Mercury													
RfD		Oral Reference Dose [6]	mg/kg/day	3.00E-04	3.00E-04													
ILCR		Oral ILCR	$mg/kg/day^{-1}$	1.80E+00	-													
AF_G		Relative absorption factor for gut [7]	unitless	1.46E-01	1.00E+00	Mean arsenic bioaccessibility from ESG (2019)												
AF_S		Relative absorption factor for skin [1]	unitless	5.00E-03	4.66E-01	Arsenic value based on Lowney et al. 2007												
BSC		Background sediment concentration [4]	mg/kg	2.00E+02	3.74E-01	Arsenic value based on Spooner 2019												

RECEPTOR AND LAND-USE SPECIFIC PARAMETERS

Parameter		**Description**	**Units**	**Toddler**	**Adult**	**Child**	**Adult**	**Reference**
				High Contact	**High Contact**	**Low Contact**	**Low Contact**	
SA_H		Surface area of hands	m^2	4.30E-02	8.90E-02	5.90E-02	8.90E-02	HC (2017)
SA_F		Surface area of feet	m^2	4.30E-02	1.19E-01	7.20E-02	1.19E-01	HC (2017)
SA_L		Surface area of legs (lower)	m^2	8.45E-02	2.86E-01			HC (2017)
SA_A		Surface area of arms (upper and lower)	m^2	8.90E-02	2.50E-01	1.48E-01	2.50E-01	HC (2017)
SA_{FA}		Surface area of forearms[2]	m^2	4.45E-02	1.25E-01	7.40E-02	1.25E-01	HC (2017)
SA_{WB}		Whole body surface area	m^2	6.13E-01	1.76E+00			HC (2017)
SA_{HT}		Surface area of head and torso	m^2	3.54E-01				HC (2017)
DL_H		Dermal loading of sediment to hands	kg/m^2-event	4.90E-03	4.90E-03	4.90E-03	4.90E-03	Shoaf (2005); Golder (2010)
DL_F		Dermal loading of sediment to feet	kg/m^2-event	2.10E-02	2.10E-02	2.10E-02	2.10E-02	Shoaf (2005); Golder (2010)
DL_L		Dermal loading of sediment to legs	kg/m^2-event	7.00E-03	7.00E-03	7.00E-03	7.00E-03	Shoaf (2005); Golder (2010)
DL_A		Dermal loading of sediment to arms	kg/m^2-event	1.70E-03	1.70E-03	1.70E-03	1.70E-03	Shoaf (2005); Golder (2010)
DL_{FA}		Dermal loading of sediment to forearms	kg/m^2-event	1.70E-03	1.70E-03	1.70E-03	1.70E-03	Shoaf (2005); Golder (2010)
DL_{HT}		Dermal loading of sediment to head and torso [3]	kg/m^2-event	4.35E-03	4.35E-03	4.35E-03	4.35E-03	Shoaf (2005); Golder (2010)
EF		Exposure Frequency	events/d	1		1	1	CCME (2006)
EF		Exposure Frequency	days/year	6	6	26	26	
DPY		Days per year	days/year	365	365	365	365	
$SIR_{Shoreline}$		Sediment Ingestion rate - shoreline sediment [5]	kg/d	7.20E-05	2.00E-05	5.70E-05	2.00E-05	HC (2017)
SIR_{SS}		Sediment Ingestion rate - suspended sediment [5]	kg/d	7.70E-06	7.70E-06	7.70E-06	7.70E-06	
BW		Body weight	kg	16.5	70.7	32.9	70.7	CCME(2006)
		Cancer Amortization	unitless		1.00E+00		1.00E+00	

Comments

[1] As per the minutes of the Sediment Workshop, RAFs for soil should be used given the lack of dermal RAF data for sediments. RAF for skin is based on the average percent absorption of wet Colorado residential soil in Lowney et al. 2007

[2] Health Canada, as instructed by the Sediment Working Group, would like to assume that hands, feet and forearms are exposed under the recreational low contact scenario. No surface area data for forearms are presented in HC (2017), O'Connor (1997) or EPA (2008) for children. It has been assumed that 50% of the total arm (upper and lower) area would be representative of the forearm. It is noted that the US EPA (1997) EFH does provide forearm surface area data for adults, the value is approximately equal to 50% of the total arm surface area.

[3] Loading factor for head and torso represents the average of those values recommended by Shoaf (2005) and Golder (2010) for legs and arms.

[4] Where background sediment data were available (from individual CCME SQG doucments), these data were used.

[5] Sediment ingestion rates are from HC (2017) and represent the sum of the hand-to-mouth contact sediment ingestion rate and the suspended sediment contact sediment ingestion rate summed together and converted from mg/hour to kg/d assuming 1 hour of exposure per event

[6] The Toxicity Refernce Values for arsenic are the chronic RfD and oral slope factor from the US EPA (1993) and for mercury the chronic RfD is from WHO (2010)

[7] The mean arsenic bioaccessibility from Barry's Run samples was selected for use for the relative absorption factor for gut (ESG, 2019).

Exposure and Risk Calculations Related to Surface Water in Barry's Run

	Oral Exposure to Surface Water							Dermal Exposure to Surface Water										Oral Exposure to Suspended Sediment		
	Dissolved Surface Water Concentration	Daily Ingestion (ug/kg/day)		Exposure Limit/ q1*	Exposure Ratio/Cancer Risk			Dermal Permeability Coefficient	Absorbed Dose per Event	Daily Dermal (ug/kg/day)			Exposure Limit/ q1*	Exposure Ratio/ Cancer Risk			Total Risk from Surface Water			Sediment Concentration	Oral Exposure	Risk
Chemical	(ug/L)	Toddler	Child	(ug/kg/day)	Toddler	Child	Adult	(cm/hr)	(mg/cm2-event)	Toddler	Child	Adult	(ug/kg/day)	Toddler	Child	Adult	Toddler	Child	Adult	(mg/kg)	(mg/kg/day)	(ER or ILCR)
Non-Carcinogens																						
High Contact-Low Frequency																						
Arsenic - Toddler	6.3E+01	3.1E-03		3.0E-01	0.0105			1.0E-03	6.3E-08	3.8E-04			3.0E-01	0.00127			0.0117			3287	3.7E-06	0.01227
Mercury - Toddler	6.5E-03	3.2E-07		3.0E-01	0.000001			1.0E-03	6.5E-12	3.9E-08			3.0E-01	0.0000001			0.0000012			5.22	4.0E-08	0.000133
Low Contact-High Frequency																						
Arsenic - Child	6.3E+01		6.8E-03	3.0E-01		0.0227		1.0E-03	6.3E-08		1.4E-03		3.0E-01		0.00464			0.0274		2000	4.9E-06	0.0162
Mercury - Child	6.5E-03		7.0E-07	3.0E-01		0.0000		1.0E-03	6.5E-12		1.4E-07		3.0E-01		0.00000			0.0000		5.9	9.8E-08	0.000328
Carcinogens																						
High Contact-Low Frequency																						
Arsenic - Adult	6.30E+01			1.80E-03			1.3E-06	1.00E-03	6.3E-08			2.46E-04	1.80E-03			4.4E-07			1.8E-06	3287	8.6E-07	1.5E-06
Low-Contact-High Frequency																						
Arsenic - Adult	6.30E+01			1.80E-03			5.7E-06	1.00E-03	6.3E-08			1.07E-03	1.80E-03			1.9E-06			7.6E-06	2000	2.3E-06	4.1E-06
Reference Dose																						
Arsenic	0.3	ug/kg/day																				
Mercury	0.3	ug/kg/day																				
Oral Slope Factor																						
Arsenic	1.80E-03	$ug/kg/day^{-1}$																				
Receptor Parameters																						
Body Weight - Infant	8.2	kg																				
Body Weight - Toddler	16.5	kg																				
Body Weight - Child	32.9	kg																				
Body Weight - Teen	59.7	kg																				
Body Weight - Adult	70.7	kg																				
SW ingestion Rate - Infant	0.05	L/hour	US EPA (1989)																			
SW ingestion Rate - Toddler	0.05	L/hour	US EPA (1989)																			
SW ingestion Rate - Child	0.05	L/hour	US EPA (1989)																			
SW ingestion Rate - Teen	0.05	L/hour	US EPA (1989)																			
SW ingestion Rate - Adult	0.05	L/hour	US EPA (1989)																			
Exposed Skin Surface Area - Infant	3510	cm^2	Richardson (1997)																			
Exposed Skin Surface Area - Toddler	6050	cm^2	Richardson (1997)																			
Exposed Skin Surface Area - Child	10200	cm^2	Richardson (1997)																			
Exposed Skin Surface Area - Teen	15000	cm^2	Richardson (1997)																			
Exposed Skin Surface Area - Adult	16800	cm^2	Richardson (1997)																			
High Contact-Low Frequency																						
Hours per event Swimming	1	hours/event																				
Swimming events per day	1	events/day																				
Days per Year with Exposure to SW	6	days/year																				
Days per Year	365	days/year																				
Cancer Amortization	1.00E+00																					
Low Contact-High Frequency																						
Hours per event Swimming	1	hours/event																				
Swimming events per day	1	events/day																				
Days per Year with Exposure to SW	26	days/year																				
Days per Year	365	days/year																				
Cancer Amortization	1.00E+00																					
pi	3.14159																					
Conversion Factor	1000	cm3-kg/m3-g																				
Conversion Factor	1000	mg to ug																				
Conversion Factor	1000	L/m3																				
Conversion Factor	1.00E-06	ug/L to mg/cm3																				
SW Dermal Permeability Coefficient																						
Arsenic	1.00E-03	cm/hr																				
Mercury	1.00E-03	cm/hr																				
Suspended Sediment Gut RAF																						
Arsenic	0.146																					
Mercury	1																					
Suspended Sediment Ingestion Rate	7.70E-06	kg/d																				

Exposure and Risk Calculations Related to Soil (Fen) in Barry's Run

		Oral Exposure - Soil (fen)			Dermal Exposure						
Chemical	EPC (mg/kg)	Oral Exposure (mg/kg/day)	Risk (ER or ILCR)		Hands (mg/kg/day)	Other Surfaces (mg/kg/day)		Total Dermal (mg/kg/day)	Risk (ER or ILCR)		Total Risk (ER or ILCR)
Non-Cancer Endpoints											
High Contact-Low Frequency											
Arsenic - Toddler	1571	1.8E-05	0.06094		3.4E-07	2.0E-07		5.4E-07	1.79E-03		6.27E-02
Mercury - Toddler	0.67	5.34E-08	0.00018		1.3E-08	8.0E-09		2.1E-08	7.13E-05		2.49E-04
Low-Contact-High Frequency											
Arsenic - Child	1571	9.9E-06	0.0331		1.0E-06	7.7E-08		1.1E-06	3.60E-03		3.67E-02
Mercury - Child	0.67	2.9E-08	0.00010		4.0E-08	3.1E-09		4.3E-08	1.43E-04		2.40E-04
Cancer Endpoints											
High Contact-Low Frequency											
Arsenic - Adult	1571	1.1E-06	1.9E-06		1.6E-07	1.5E-07		3.1E-07	5.6E-07		2.48E-06
Low-Contact-High Frequency											
Arsenic - Adult	1571	4.6E-06	8.3E-06		7.0E-07	6.5E-07		1.4E-06	2.4E-06		1.08E-05

				Arsenic	Mercury						
RfD		Oral Reference Dose	mg/kg/day	3.00E-04	3.00E-04						
ILCR		Oral ILCR	$mg/kg/day^{-1}$	1.80E+00	-						
AF_G		Relative absorption factor for gut	unitless	1.46E-01	1.00E+00	Mean arsenic bioaccessibility from ESG (2019)					
AF_S		Relative absorption factor for skin	unitless	5.00E-03	4.66E-01	Arsenic value based on Lowney et al. 2007					
BSC		Background sediment concentration	mg/kg	2.00E+02	3.74E-01	Arsenic value based on Spooner 2019					

RECEPTOR AND LAND-USE SPECIFIC PARAMETERS

Parameter		Description	Units	Toddler	Adult	Child	Adult	Reference
				High Contact	High Contact	Low Contact	Low Contact	
SA_H		Surface area of hands	m^2	4.30E-02	8.90E-02	5.90E-02	8.90E-02	HC (2012)
SA_{OS}		Surface area of Other Surfaces	m^2	2.58E-01	8.22E-01	4.55E-02	8.22E-01	HC (2012)
DL_H		Dermal loading of soils to hands	kg/m^2-event	1.00E-03	1.00E-03	1.00E-03	1.00E-03	HC (2012)
DL_{OS}		Dermal loading of soil to other surfaces	kg/m^2-event	1.00E-04	1.00E-04	1.00E-04	1.00E-04	HC (2012)
EF		Exposure Frequency	events/d	1		1	1	CCME (2006)
EF		Exposure Frequency	days/year	6	6	26	26	
DPY		Days per year	days/year	365	365	365	365	
SIR_{fen}		Soil Ingestion rate - Fen	kg/d	8.00E-05	2.00E-05	2.00E-05	2.00E-05	HC (2012)
BW		Body weight	kg	16.5	70.7	32.9	70.7	CCME(2006)
		Cancer Amortization	unitless		1.00E+00		1.00E+00	

From Nova Scotia Environment Fish Consumption Advisory

https://novascotia.ca/nse/fish-consumption-advisory.asp

		MERCURY CONSUMPTION LIMIT					MERCURY CONSUMPTION LIMIT				
Species	**Fish Length < (measured nose to tail fork)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**
Brook Trout	Under 25 cm (9.8 in)	2 servings per week	1 serving per week	1½ servings per month	3/4 serving per month	½ serving per month	21.4 g/day	10.7 g/day	3.7 g/day	1.8 g/day	1.2 g/day
Brook Trout	Over 25 cm (9.8 in)	1 serving per week	1 serving per month	Avoid	Avoid	Avoid	10.7 g/day	2.5 g/day	Avoid	Avoid	Avoid
Smallmouth Bass	Under 35 cm (13.8 in)	3 servings per month	1 serving per month	1½ servings per month	Avoid	Avoid	7.4 g/day	2.5 g/day	3.7 g/day	Avoid	Avoid
Smallmouth Bass	Over 35 cm (13.8 in)	2 servings per month	Avoid	Avoid	Avoid	Avoid	4.9 g/day	Avoid	Avoid	Avoid	Avoid

1 serving = 75g or 2½oz or 125mL or ½cup of cooked fish (Canada's Food Guide)

if consumption advisory followed due to mercury, mercury and arsenic exposures and risks for fish in Barry's Run

		FISH CONSUMPTION					FISH CONCENTRATION	MERCURY EXPOSURE					TRV (ug/kg/day)	MERCURY FISH CONSUMPTION RISK				
Species	**Fish Length < (measured nose to tail fork)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**MERCURY TISSUE CONCENTRATION ug/g ww**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**Oral RfD (general pop)** / **Oral RfD (children and women bearing age)**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-12**	**Children age 1-4**	**Infants (less than 1 year of age)**
							receptor body weight	**70.7**	**70.7**	**32.9**	**16.5**	**8.2**						
Brook Trout	Under 25 cm (9.8 in)	21.4 g/day	10.7 g/day	3.7 g/day	1.8 g/day	1.2 g/day	0.243	0.07 ug/kg/day	0.04 ug/kg/day	0.03 ug/kg/day	0.03 ug/kg/day	0.04 ug/kg/day	0.47 / 0.2	0.16	0.18	0.14	0.14	0.18
Brook Trout	Over 25 cm (9.8 in)	10.7 g/day	2.5 g/day	Avoid	Avoid	Avoid	0.352	0.05 ug/kg/day	0.01 ug/kg/day	Avoid	Avoid	Avoid		0.11	0.06	Avoid	Avoid	Avoid
Smallmouth Bass	Under 35 cm (13.8 in)	7.4 g/day	2.5 g/day	3.7 g/day	Avoid	Avoid	0.787	0.08 ug/kg/day	0.03 ug/kg/day	0.09 ug/kg/day	Avoid	Avoid		0.18	0.14	0.44	Avoid	Avoid
Smallmouth Bass	Over 35 cm (13.8 in)	4.9 g/day	Avoid	Avoid	Avoid	Avoid		0.00 ug/kg/day	Avoid	Avoid	Avoid	Avoid		0.00	Avoid	Avoid	Avoid	Avoid

		FISH CONSUMPTION					FISH CONCENTRATION			ARSENIC EXPOSURE					TRV		ARSENIC FISH CONSUMPTION RISK			
Species	**Fish Length < (measured nose to tail fork)**	**General Public Over age 12**	**Women who are or may become preganant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**ARSENIC TISSUE CONCENTRATION ug/g ww**	**BIOACCESSIBILITY**	**INORGANIC FRACTION**	**General Public Over age 12**	**Women who are or may become preganant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**Oral RfD (ug/kg/day) oral ILCR (ug/kg/day)$^{-1}$**	**General Public Over age 12**	**Women who are or may become preganant and / or are breast feeding**	**Children age 5-12**	**Children age 1-4**	**Infants (less than 1 year of age)**
							receptor body weight			**70.7**	**70.7**	**32.9**	**16.5**	**8.2**						
Brook Trout	Under 25 cm (9.8 in)	21.4 g/day	10.7 g/day	3.7 g/day	1.8 g/day	1.2 g/day	0.972	62%	9%	0.02 ug/kg/day	0.01 ug/kg/day	0.01 ug/kg/day	0.01 ug/kg/day	0.01 ug/kg/day	0.30 1.80E-03	0.05 2.79E-05	0.03 1.40E-05	0.02 1.04E-05	0.02 1.03E-05	0.03 1.39E-05
Brook Trout	Over 25 cm (9.8 in)	10.7 g/day	2.5 g/day	Avoid	Avoid	Avoid	1.01	78%	5%	0.0058 ug/kg/day	0.0014 ug/kg/day	Avoid	Avoid	Avoid		0.02 1.05E-05	0.0045 2.46E-06	Avoid	Avoid	Avoid
Smallmouth Bass	Under 35 cm (13.8 in)	7.4 g/day	2.5 g/day	3.7 g/day	Avoid	Avoid	2.74	57%	10%	0.017 ug/kg/day	0.006 ug/kg/day	0.018 ug/kg/day	Avoid	Avoid		0.06 3.00E-05	0.02 9.99E-06	0.06 3.22E-05	Avoid	Avoid
Smallmouth Bass	Over 35 cm (13.8 in)	4.9 g/day	Avoid	Avoid	Avoid	Avoid		57%	10%	0.00 ug/kg/day	Avoid	Avoid	Avoid	Avoid		0.00 0.00E+00	Avoid	Avoid	Avoid	Avoid

	FISH CONCENTRATION			ARSENIC EXPOSURE					TRV		ARSENIC FISH CONSUMPTION RISK			
ARSENIC TISSUE CONCENTRATION ug/g ww	**BIOACCESSIBILITY**	**DMA/MMA/TMAO FRACTION**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-11**	**Children age 1-4**	**Infants (less than 1 year of age)**	**DMA MRL**	**General Public Over age 12**	**Women who are or may become pregnant and / or are breast feeding**	**Children age 5-12**	**Children age 1-4**	**Infants (less than 1 year of age)**
receptor body weight			**70.7**	**70.7**	**32.9**	**16.5**	**8.2**						
0.730	62%	81%	0.110 ug/kg/day	0.055 ug/kg/day	0.041 ug/kg/day	0.041 ug/kg/day	0.055 ug/kg/day	20	0.0055	0.0028	0.0020	0.0020	0.0027
0.65	78%	78%	0.060 ug/kg/day	0.014 ug/kg/day	Avoid	Avoid	Avoid		0.0030	0.0007	Avoid	Avoid	Avoid
2.67	57%	84%	0.134 ug/kg/day	0.045 ug/kg/day	0.144 ug/kg/day	Avoid	Avoid		0.0067	0.1488	0.4796	Avoid	Avoid
	57%	84%	0.000 ug/kg/day	Avoid	Avoid	Avoid	Avoid		0.0000	Avoid	Avoid	Avoid	Avoid