City of Hamilton
GENERAL ISSUES COMMITTEE
ADDENDUM

Meeting #: 20-006

Date: February 13, 2020

Time: IMMEDIATELY FOLLOWING THE GIC BUDGET MEETING

Location: Council Chambers, Hamilton City Hall
71 Main Street West

Stephanie Paparella, Legislative Coordinator (905) 546-2424 ext. 3993

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6. STAFF PRESENTATIONS

*6.1. Chedoke Creek Ministry Order Update (PW19008(g)/LS19004(f)) (City Wide)

Discussion of Appendix "B" of this report in Closed Session is subject to the following requirement(s) of the City of Hamilton's Procedural By-law and the *Ontario Municipal Act, 2001*:

- **Litigation or potential litigation, including matters before administrative tribunals, affecting the City;**
- **Advice that is subject to solicitor-client privilege, including communications necessary for that purpose; and,**
- **A position, plan, procedure, criteria or instruction to be applied to any negotiations carried on or to be carried on by or on behalf of the municipality or local board.**

DUE TO ITS SIZE, APPENDIX "A" TO THIS REPORT IS AVAILABLE ON-LINE ONLY.

CITY OF HAMILTON
PUBLIC WORKS DEPARTMENT
Hamilton Water Division
and
CITY MANAGER'S OFFICE
Legal and Risk Management Services Division

TO:	Mayor and Members General Issues Committee
COMMITTEE DATE:	February 13, 2020
SUBJECT/REPORT NO:	Chedoke Creek Ministry Order Update (PW19008(g)/LS19004(f)) (City Wide)
WARD(S) AFFECTED:	City Wide
PREPARED BY:	Cari Vanderperk (905) 546-2424 Ext. 3250 Larry Tansley (905) 546-2424 Ext. 3588
SUBMITTED BY: **SIGNATURE:**	Andrew Grice Director, Hamilton Water Public Works Department
SUBMITTED BY: **SIGNATURE:**	Nicole Auty City Solicitor Legal and Risk Management Services

Discussion of Appendix B of this report in closed session is subject to the following requirement(s) of the City of Hamilton's Procedural By-law and the *Ontario Municipal Act, 2001*:

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RECOMMENDATION(S)

(a) That Report PW19008(g)/LS19004(f) be received; and,

(b) That the Legal Opinion of Rosalind Cooper attached as Appendix “B” to Report PW19008(g)/LS19004(f) respecting the ongoing investigation and potential litigation remain confidential and not be released as a public document.

EXECUTIVE SUMMARY

This Report PW19008(g)/LS19004(f) contains information relating to the potential contamination of Chedoke Creek as a result of the discharge from the Main/King Combined Sewer Overflow (CSO) tank. More specifically it provides the following:

- An update on the status of the Director’s Order served on the City of Hamilton (City) by the Ministry of the Environment, Conservation and Parks (MECP);
- A summary of the consultant report, provided by SLR Consulting (Canada) Ltd. (SLR), titled “Ecological Risk Assessment, Chedoke Creek” required in the Director’s Order, outlining the results of Ecological Risk Assessment (ERA) for the specified study area of Chedoke Creek, attached as Appendix “A” to Report PW19008(g)/LS19004(f);
- The City’s decision on appropriate remedial actions, based on the results of the ERA that will be outlined in a letter that will be submitted to the MECP on February 14, 2020, as required in the Director’s Order;
- Privileged and confidential legal advice and an update relating to the investigation into this matter by the MECP’s Investigations and Enforcement Branch (IEB) that may potentially result in regulatory litigation if charges are laid against the City and/or City staff, attached as Appendix “B” to Report PW19008(g)/LS19004(f).

The City has been served Director’s Order No. 1-MRRCX (Director’s Order) by the MECP on November 28, 2019, pursuant to their authority under the *Environmental Protection Act* (*EPA*) and the *Ontario Water Resources Act* (*OWRA*).

The Director’s Order requires the City to, by February 14, 2020, submit a written report setting out the results of an ERA in regard to the impacts to Chedoke Creek (creek) from the Main/King CSO discharge that occurred between January 2014 and July 2018. It also requires a review and selection of preferred remedial option, with justification and associated implementation timelines.

The Director’s Order requires the City to, by May 1, 2020, submit a written report evaluating the impacts of the sewage discharge to Cootes Paradise, and any proposed remedial recommendations and actions with associated timelines.

Staff have worked closely with SLR to satisfy the requirements of the Director's Order and intend to submit a letter identifying the City's remedial option for Chedoke Creek to the MECP Director, with the SLR report appended, by the February 14, 2020 deadline.

The ERA was completed to assess whether metals, polycyclic aromatic hydrocarbons (PAHs), nutrients and bacteria (E. coli), collectively known as Contaminants of Potential Concern (COPC), found in Chedoke Creek pose unacceptable risks to aquatic life, amphibians and aquatic-dependent wildlife. The findings show that prior to and after the 2014 to 2018 discharge event, there were persistent elevated levels of COPC in the sediment. In surface water, nutrient and bacteria levels were higher during the discharge event, but decreased in the study area after the discharge, to levels at or below those observed prior to the discharge event. In addition, E. coli levels observed in 2018-2019, after the discharge, were lower in the study area than at some locations upstream of the Main/King CSO.

The ERA notes that given these findings along with disadvantages associated with direct removal (dredging), the requirement for remediation of the creek would appear unnecessary to address effects from the sewage discharge.

With regards to long term monitoring, Staff are working on an internal water quality program, in consultation with external stakeholders, that will improve our overall governance of urban watercourses that receive discharges from City infrastructure.

Alternatives for Consideration – Not applicable

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: There are costs associated with the regards to the development and implementation of an internal water quality program. The scope and timing of the program will be more accurately determined following the appropriate consultation process. A Full Time Equivalent (FTE) for Hamilton Water has already been approved by Council and recruitment is underway.

There are also potential costs associated with any charges that may be laid by the MECP against the City and/or its employees and any other litigation that may arise, which are reviewed under the Legal implications section below.

Staffing: There are no staffing implications at this time.

Legal: Legal and Risk Management Services staff will continue to provide legal assistance as this matter unfolds.

HISTORICAL BACKGROUND

Provincial Orders:

The City has been served three orders related to Chedoke Creek. Provincial Officer's Order No. 1-J25YB (1st Order) was served on the City of Hamilton (City) by the MECP on August 2, 2018; Provincial Officer's Order No. 1-J3XAY (2nd Order) was served on the City by the MECP on November 21, 2019, and the subsequent Director's Order No. 1-MRRCX (Director's Order) was served on the City by the MECP on November 28, 2019, pursuant to their authority under the *Environmental Protection Act* (*EPA*) and the *Ontario Water Resources Act* (*OWRA*).

As the Members of the General Issues Committee were advised verbally by Legal Services staff on November 20, 2019, and in Report PW19008(d)/LS1904(d) on November 27, 2019, the MECP issued the 2nd Order on November 14, 2019 that included requirements related to Cootes Paradise which was unexpected to the City and would require a significant extension to the timeline. The 1st Order issued to the City by the MECP and the consultant studies that followed had been restricted to the effect of the discharge on Chedoke Creek.

Accordingly, on November 21, 2019, the City filed a formal request that this 2nd Order be reviewed by the MECP, with the hope that the new language in relation to Cootes Paradise be removed, or the timeline for completion of work be extended. Appended to the City's request for review was an opinion from the City's technical consultant, SLR Consulting (Canada) Ltd. (SLR), regarding the constraints to the feasibility of the additional work.

The results of the review by the MECP were received by the City on November 28, 2019, in the form of a Director's Order which, in summary, maintains the intent of the 2nd Order with a deadline of February 14, 2020 for the report related to Chedoke Creek, and separates the requirements for Cootes Paradise, assigning a deadline of May 1, 2020.

The Director's order also requires the City to provide the MECP with written, biweekly progress updates. Bi-weekly meetings with the MECP are ongoing and the progress reports are being posted on the City's website.

Staff have worked closely with SLR to satisfy the requirements of the Director's Order and intend to submit a letter identifying the City's remedial option for Chedoke Creek to the MECP Director by the February 14, 2020 deadline. To assist with the response to the Director's Order, the City retained SLR to fill gaps identified in the peer review of the original assessment by Wood Environment and Infrastructure Solutions (Wood), which was submitted in response to the 1st Order. The Wood Report included information on the physical characteristics and the quality of the sediment found at the bottom of Chedoke Creek, the aquatic invertebrates living in this sediment, the fish living in or migrating to Chedoke Creek and the quality of the water in the creek. However, according to the peer review findings only sediment quality had been used to evaluate whether conditions in the creek potentially caused adverse effects to aquatic life. For this reason, SLR recommended re-analyzing the data presented in the Wood Report along with collection of additional data to fill in the identified data gaps for completion of an Ecological Risk Assessment (ERA) to determine and recommend appropriate remedial action(s) in Chedoke Creek.

POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

N/A

RELEVANT CONSULTATION

Hamilton Water staff have been working closely with Public Health Services, Legal and Risk Management and Corporate Communications staff regarding this matter. In addition, external legal counsel who is a specialist in environmental law, and has significant experience with environmental investigations and charges, has been retained to assist City staff as this matter progresses.

ANALYSIS AND RATIONALE FOR RECOMMENDATION(S)

Ecological Risk Assessment (ERA) Results:

SLR, in response to the MECP Director's Order, prepared an aquatic ERA to assess the environmental impacts to Chedoke Creek from the Main/King CSO discharge that occurred between January 2014 and July 2018. The subject area is defined as the lower section of Chedoke Creek, parallel to Highway 403 between Glen Road and Princess Point.

The objective of the ERA was to evaluate the potential risks to aquatic plants and invertebrates, fish, amphibians and aquatic-dependent wildlife associated with exposure to Contaminants of Potential Concern (COPC) in sediment and surface water in the study area. The COPC evaluated in the report included:

- Metals (in sediment and surface water)
- Polycyclic aromatic hydrocarbons, PAH (in sediment only)
- Nutrients (in sediment and surface water)

Fecal coliforms including E. coli were identified as uncertain COPC in surface water and sediment as there are no screening benchmarks for the protection of ecological receptors. E.coli levels were, however, assessed within the report as well, as they may indicate fecal contamination.

The risk assessment methods used were based on established procedures recommended by MECP and Environment Canada. Field sample results representing reasonable spatial coverage were used to determine current exposure to selected ecological receptor groups/species, which included:

- 22 sediment samples (collected by Wood in 2018 and SLR in 2019)
- 8 surface water samples (collected by SLR in 2019)

Relevant sediment and surface water data was used to discuss trends prior to and following the Main/King CSO discharge event. SLR produced a series of calculations and analyses to determine the degree to which aquatic ecological receptors were likely exposed to COPC and an evaluation of the adverse effects posed by the COPC. The results of the analyses indicated that potential risks to aquatic life and amphibians exposed to surface sediment were negligible for select nutrients and negligible to low for metals. The analyses also identified potential low, moderate or high risks, depending on the location in the creek, for aquatic life and amphibians exposed to select PAHs in surface sediment. PAHs were identified as the risk drivers among the COPC.

The findings of the ERA indicate that elevated concentrations of COPC (PAHs, metals, nutrients and bacteria) have been a persistent and ongoing issue in Chedoke Creek sediment and/or surface water prior to and after the 2014-2018 discharge event, including in areas upstream of the Main/King CSO. These observations are consistent with the fact that Chedoke Creek is predominantly an urbanized watershed that has been altered over time as a result of intense urban development and continues to be subject to numerous point source (e.g., CSOs, stormwater outfalls) and nonpoint source discharges (e.g., highway runoff, runoff from urban and industrial areas). Comparable conclusions were also made in a report completed by Wood (MECP Order # 1-J25YB Item 1b Chedoke Creek Natural Environment and Sediment Quality Assessment and Remediation Report, City of Hamilton, January 24, 2019).

For the above reasons, the ERA notes that it is not possible to target remediation to COPC and sediments solely associated with the 2014-2018 Main/King CSO discharge. However, SLR evaluated four feasible remediation options to address potential risks, which were originally provided in the Wood 2019 report:

- Physical capping – applying cover of clean material over contaminated sediment;
- Chemical inactivation – use of a chemical to bind with phosphorus in sediment to reduce the release of it from sediment into the water column;
- Direct removal – hydraulic dredging of organic sediment;
- No action.

A technical analysis of these options was completed. A detailed review of the direct removal option found that the disadvantages outweighed the advantages. Key disadvantages of direct removal include potential disruption of aquatic habitat (including for species of potential concern), and it only provides short term benefits as Chedoke Creek continues to operate as an urban watercourse.

Options to remediate and monitor the creek, per Item 1 of the Director's Order, were contingent on the assessment of impact. Information available for review in the ERA showed nutrient contamination and phosphorus loading typically associated with sewage discharge have reduced and are comparable to pre-discharge levels, indicating no apparent and persistent impacts in Chedoke Creek resulting from the sewage discharge spill event. Given these findings, the requirement for remediation of the creek would appear unnecessary to address the effects from the sewage discharge.

As a result of the findings of the ERA staff are supportive of consultant's recommendation to not remediate the creek as a direct result of the discharge from the Main/King CSO tank between January 2014 and July 2018. Staff intend to submit a letter identifying this decision to the MECP Director, with the SLR report appended, by the February 14, 2020 deadline.

With regards to long term monitoring, staff are working on an internal water quality program, that will improve our overall governance of urban watercourses that receive discharges from City infrastructure. Staff have reached out to representatives from stakeholders such as Hamilton Conservation Authority, HHRAP, Environment Hamilton and the RBG, in order to solicit feedback for this program, and to ensure communication lines between the City and our community partners remain open.

ALTERNATIVES FOR CONSIDERATION

Not applicable

ALIGNMENT TO THE 2016 – 2025 STRATEGIC PLAN

Community Engagement and Participation

Hamilton has an open, transparent and accessible approach to City government that engages with and empowers all citizens to be involved in their community.

Healthy and Safe Communities

Hamilton is a safe and supportive City where people are active, healthy, and have a high quality of life.

Clean and Green
Hamilton is environmentally sustainable with a healthy balance of natural and urban spaces.

Built Environment and Infrastructure
Hamilton is supported by state of the art infrastructure, transportation options, buildings and public spaces that create a dynamic City.

Our People and Performance
Hamiltonians have a high level of trust and confidence in their City government.

APPENDICES AND SCHEDULES ATTACHED

Appendix “A” – Ecological Risk Assessment, Chedoke Creek SLR Consulting (Canada) Ltd. (SLR)

Appendix “B” – Legal Opinion of Rosalind Cooper global environmental solutions

Ecological Risk Assessment

Chedoke Creek
Hamilton, Ontario

February 2020
SLR Project No.: 209.40666.00000

ECOLOGICAL RISK ASSESSMENT

CHEDOKE CREEK

HAMILTON, ONTARIO

SLR Project No.: 209.40666.00000

Prepared by

SLR Consulting (Canada) Ltd.
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Markham, ON L3R 5Z6

for

City of Hamilton
77 James Street North, Suite 400
Hamilton, ON L8R 2K3

February 12, 2020

Distribution: 1 copy – City of Hamilton
1 copy – SLR Consulting (Canada) Ltd.

EXECUTIVE SUMMARY

INTRODUCTION

SLR Consulting (Canada) Ltd. (**SLR**) was retained by the City of Hamilton to complete an Aquatic Ecological Risk Assessment (**ERA)** for the lower section of Chedoke Creek, parallel to Highway 403 between Glen Road and Princess Point (i.e., study area).

An accidental sewage discharge from the Main/King Combined Sewer Overflow (**CSO**) facility to Chedoke Creek occurred between January 28, 2014 and July 18, 2018.

On November 14 and 28, 2019, MECP issued a revised provincial order and Directors Order to the City, including a requirement for completing an ERA report for Chedoke Creek.

The purpose of the ERA was to evaluate the potential risks to aquatic plants and invertebrates, fish, amphibians and aquatic-dependent wildlife associated with exposure to contaminants of potential concern (**COPCs**) in sediment and surface water in the study area. The ERA was conducted in response to the sewage discharge. Specifically, the Order specified that the ERA should include an evaluation of the sewage remaining in the creek, identification of any on-going environmental impacts to the creek as a result of the sewage spill and a review of remediation options for the creek. Typical components of sewage discharge include nutrients and bacteria, with relatively small amounts of metals and polycyclic aromatic hydrocarbons (PAHs). However, because this is a CSO, metals and PAHs were also analyzed because these are components of CSO discharge.

ERA APPROACH

The methods used to conduct this ERA were based on risk assessment procedures recommended by the Ministry of Environment, Conservation and Parks (**MECP**) and Environment and Climate Change Canada (**ECCC**).

The study area considered in this ERA includes the lower section of Chedoke Creek running parallel to Highway 403. The upstream extent of the study area is defined by Glen Road at which point Chedoke Creek is channelized underground. The downstream limit of the study area is the Desjardin Recreational Trail Bridge at Princess Point (Drawing 1). The bridge at Princess Point marks the boundary of the Chedoke Creek subwatershed (Hamilton Conservation Authority - **HCA**, 2008).

The datasets used in this ERA included a total of twenty-two sediment samples collected by Wood in 2018 and by SLR in 2019, as well as a total of eight surface water samples obtained by SLR in 2019. Sediment and surface water samples obtained prior to the Main/King CSO discharge event were also used, when available, to evaluate whether concentrations have returned to conditions observed before the discharge event. The ERA focused on the shallow sediment dataset (collected entirely within the top 15 cm of sediment) following MECP guidance (MOE 2008) specifying that surficial sediments (to about 10 cm depth) are where most sediment-dwelling organisms live and should therefore be the focus of the sediment assessment. The 2019 sediment sampling locations in the study area were selected based on a review of the 2018 sediment results. The design of the sampling program was intended to provide a gradient of chemical concentrations in the resultant data and provide reasonable spatial coverage of the study area.

The first part of this ERA is the problem formulation. For there to be any possibility of risks to ecological health, aquatic receptors must be exposed to one or more stressors (i.e., one or more COPCs). This question was addressed systematically by identifying the COPCs, the ecological receptors of concern (**ROCs**) that might be exposed to the COPCs, and the specific pathways through which the ROCs might be exposed. The information was summarized in a conceptual site model (**CSM**). The CSM combines information on COPCs, potential receptors, and potential exposure pathways to provide an overall picture of interactions within the study area and identifies complete exposure pathways which are carried forward for risk characterization.

The next steps in the ERA were the calculation of the degree to which the ROCs were exposed to the COPCs (i.e., Exposure Assessment) and an evaluation of the adverse effects posed by the COPCs (i.e., Effects Assessment). The exposure assessment evaluated the spatial distribution of the COPC groups and quantified the concentrations of individual COPCs at the point of contact with a receptor (e.g., aquatic plants, aquatic invertebrates, fish and/or amphibians). The COPC concentration at the point of contact is also referred to as the exposure point concentration (**EPC**). As part of the Effects Assessment, toxicity reference values (**TRVs**) were compiled for each of the COPCs to assess the potential effects and characterize the potential risks. A TRV is a receptor-specific concentration of a chemical, above which adverse effects have the potential to occur, and below which there is a low likelihood that adverse effects will occur.

In the Risk Quantification, the EPC obtained as part of the Exposure Assessment were divided by the TRVs to calculate hazard quotients (**HQs**). The HQs were compared to MECP ecological risk-based targets to characterize risks. According to MECP guidance, HQs greater than 1 indicate potential risks are present, while HQs less than 1 indicate negligible risk. In addition to calculating HQs, additional lines of evidence (**LOEs**) were evaluated to further assess the risks for benthic invertebrates. The benthic invertebrate LOEs included toxicity tests and the assessment of benthic invertebrates living in the creek. These additional LOEs were used because concentrations of contaminants in sediment may exceed the applicable guidelines; however, contaminant concentrations are not necessarily strongly correlated to bioavailability and toxicity. Because relationships between concentrations of contaminants in sediment and their bioavailability are poorly understood, and vary on a site-specific basis, determining effects of contaminants in sediment on aquatic organisms often requires a combination of approaches, including biological observations, controlled toxicity tests and measures of effects on benthic communities inhabiting sediments.

PROBLEM FORMULATION FINDINGS

Which compounds have been retained as COPCs?

COPC screening benchmarks were used to identify substances that could cause negative effects to ecological receptors. Chemicals with concentrations exceeding the screening benchmarks were deemed to be final COPCs and were carried forward for evaluation in the ERA.

The sediment screening benchmarks included, in the following order of preference, the Provincial Sediment Quality Guidelines (**PSQGs**) Lowest Effect Level (**LEL**), the Canadian Sediment Quality Guidelines (**CCME**) freshwater Interim Sediment Quality Guidelines (**ISQGs**), or the background sediment concentrations for metals in the Great Lakes region.

The surface water screening benchmarks included, in the following order of preference, the Provincial Water Quality Objectives (**PWQOs**), MECP Aquatic Protection Values (**APVs**), CCME Water Quality Guidelines, and BC Approved WQG for the protection of freshwater aquatic life.

The surface water results were screened against values protective of aquatic life, and of wildlife or livestock to account for wildlife potentially using Chedoke Creek as a source of drinking water.

The final COPCs retained in the ERA are presented below.

COPC Group	Sediment (0-0.15)	Surface Water
Metals	Arsenic, cadmium, chromium, copper, lead, manganese, mercury and zinc	Aluminum and iron (total)
PAHs	Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene and total PAHs	None
Nutrients	Total Kjeldahl nitrogen (TKN) and total phosphorus	Nitrite and total phosphorus

Fecal coliforms including *E. coli* were identified as uncertain COPCs in surface water and sediment as there are no screening benchmarks for the protection of ecological receptors.

What species were identified as ROCs and how?

Numerous databases and reports were consulted to identify the ecological receptors potentially present in the study area. In addition, SLR biologists gathered information on aquatic plants and animals and their habitat while in the field. This information was used to compile a list of the species potentially present in the study area. It is standard practice in completing an ERA to select a subset of representative plant and animal species (surrogate receptors) to evaluate a reasonable number of receptors because it is impractical in terms of time and cost to conduct a risk assessment for every plant and animal species that might occur in a particular area. Provincial and federal agencies provide criteria to assist in the selection of surrogate receptors. These criteria were used to compile the final list of species considered in this ERA.

The following receptor groups and species were selected. Some species were selected to represent different feeding guilds.

- Aquatic plants
- Benthic aquatic invertebrates (community of organisms living in or on the sediment)
- Aquatic invertebrates (community of organisms living in the water column)
- Fish (benthivorous represented by the white sucker and piscivorous represented by the northern pike)
- Amphibians (represented by the leopard frog)
- Reptiles (represented by the northern water snake and snapping turtle)
- Herbivorous dabbling ducks (represented by the mallard)
- Omnivorous dabbling ducks (represented by American Black duck)
- Carnivorous birds (represented by the Great Blue heron)
- Piscivorous birds (represented by the osprey)
- Herbivorous mammals (represented by the muskrat)

How can the ecological ROCs come into contact with the COPCs and what was evaluated in the ERA?

The ecological ROCs can come into contact with the COPCs via several exposure pathways including:

- Direct contact with contaminated environmental media (e.g., sediment, surface water)
- Ingestion (consumption) of sediment and water
- Ingestion of contaminated prey items.

As per risk assessment guidance, only complete exposure pathways are carried forward for evaluation in the ERA. Complete exposure pathways require a receptor to contact an environmental medium where COPCs have been identified. Complete exposure pathways have varying levels of importance; consequently, the pathways that reflect the highest potential exposure of a ROC to a specific COPC or group of COPCs are generally identified.

Complete exposure pathways were identified for:

- Aquatic plants exposed to COPCs in sediment and surface water
- Aquatic invertebrates exposed to COPCs in sediment and surface water
- Fish exposed to COPC in sediment and surface water
- Amphibians exposed to COPC in sediment and surface water

COPC SEDIMENT DISTRIBUTION AND TRENDS

Nutrients

Nutrients are a component of raw sewage. Total Kjeldahl nitrogen (TKN[1]) and total phosphorus (TP) were the nutrients used to evaluate nutrients in sediment and surface water after the discharge event.

In 2018, both TKN and TP in surface sediment were above the PSQG LEL but below the PSQG SEL. In 2019, TKN decreased at all locations and all sediment samples had TKN in concentrations below the PSQG LEL. Concentrations of TP in surface sediment were comparable in 2018 and 2019. Studies that included historical sediment samples analyzed for TP in the study area were not found. However, sediment samples were collected in Cootes Paradise in 2006 and 2013, including two sediment samples from Chedoke Bay (CC-1 and CC-2). TP concentrations obtained from Chedoke Bay in 2006 and 2013 were comparable to concentrations obtained in 2018 and 2019.

Nutrients concentrations in the surface water samples obtained in 2019 were characteristics of waters influenced by organic inputs. TKN in the study area ranged from 500 to 1500 µg/L and indicates nutrients enrichment[2]. TP concentrations in 2019 (314 to 428 µg/L) exceeded the PWQO

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[1] TKN measures ammonia and organic nitrogen. In many wastewaters and effluents, organic nitrogen will convert to ammonia.

[2] There is no Ontario guideline for TKN; however, waters not influenced by excessive organic inputs typically range from 0.100 to 0.500 mg/l (Environment Canada 1979).

(30 µg/L) indicative of an excessive amount of TP in rivers. Elevated nutrients concentrations are a common occurrence in Chedoke Creek. In 1996, a mean TKN concentration of 2840 µg/L was reported for Chedoke Creek (Chow-Fraser 1996). The mean total phosphorus concentration in the same study was reported to be 375 µg/L. These concentrations are higher (TKN) or comparable (TP) to those obtained in 2019.

TP concentrations were measured in the study area (CP-11) before (2009 to 2013), during the discharge (May 2014 to July 2018) and after the discharge (August 2018 to October 2018) (HCA data as provided by City of Hamilton, 2019). The results show that TP concentrations were significantly higher in 2018 during the Gate 2 failure. After the discharge, TP concentrations returned to concentrations observed before the discharge event.

Chow-Fraser indicated that the high nutrient levels observed in 1996 in Chedoke Creek were probably linked to the several CSOs discharging into the creek. In addition, urban runoff has been recognized as a major nonpoint source of TP in the growing season, for example urban runoff has been identified as the second most important nonpoint loading source of TP to Cootes Paradise (Dong-Kyun et al 2016).

Bacteria

E. coli counts in surface water are commonly elevated throughout the Chedoke Creek watershed. *E coli* levels in water were measured in the study area and at three locations upstream of the Main/King CSO (CC-3, CC-7 and CC-9) in 2018, during and after the sanitary sewer discharge event. The results show that *E. coli* levels were significantly higher downstream of the King/Main CSO than in the upstream stations at CC-2, CC-7, and CC-9, during the discharge. After the discharge period, *E coli* downstream of the King/Main CSO decreased to levels lower than those observed at the upstream locations. This distribution pattern points to several sources of *E. coli* in Chedoke Creek subwatershed. In sediment, fecal coliforms were elevated after the discharges and have since decreased. Fecal coliforms are, however, still detectable in surface sediment downstream from the CSO and could be released to the water column when the sediment is stirred.

Metals

Metals in surface sediment reflect the various inputs present in an urban watershed such as Chedoke Creek subwatershed and are present in concentrations that are comparable to those in a composited sample obtained in the study area by Environment Canada in 2002.

Metals exceeding the PSQG LELs in one or more samples included arsenic, chromium, copper, lead, manganese, mercury and zinc. Copper was the only metal that exceeded the PSQG SEL (at locations C-3 West, C-4 West and C-5 East). The highest concentrations of metals in surface sediment were generally obtained at locations 3 West, C-4 West and C-5 East. This indicates that the storm sewers located immediately upstream of C3-West and C5-East may also contribute metals to the study area.

Polycyclic Aromatic Hydrocarbons (PAHs)

All surface sediment sampling locations except for one (G3) had one or more PAHs and total PAHs in concentrations exceeding the PSQG LELs in 2018 and 2019. Total PAHs were below the SEL in all samples in 2018 and 2019.

In all samples, fluoranthene was the dominant PAH, followed by pyrene and phenanthrene or chrysene. The similar distribution of individual PAHs in the samples across the study area points to a common source. A study on PAHs in Cootes Paradise Marsh and select tributaries completed by Chow-Fraser et al (1996) indicated that PAHs in sediment in Spencer, Borer's and Chedoke Creeks most likely originated from automobile exhaust and residual asphalt based on the high levels of fluoranthene and pyrene, which are derivatives of engine combustion.

In 2002, Environment Canada investigated PAH concentrations in the sediment of 131 tributaries draining into the Niagara River or Lake Ontario. A composited sediment sample was obtained upstream of the mouth of Chedoke Creek as part of the 2002 study. The results indicated that at the time, individual PAHs and total PAHs also exceeded the SQG LELs. Similar to the samples obtained in 2018 and 2019, pyrene, fluoranthene and phenanthrene were the dominant PAHs in the composited sample obtained in 2002. The Environment Canada study concluded that PAHs were widespread in the tributaries, with concentrations generally appearing to be higher in or near urbanized areas. Ten out of the 131 tributaries had concentrations of total PAHs greater than 10 mg/kg. These tributaries were located in the most densely populated portions of the basin, between Hamilton and Toronto, and included Chedoke Creek. Out of the ten tributaries, seven had higher concentrations of total PAHs than Chedoke Creek.

KEY FINDINGS OF THE ERA

The hazard quotients calculated as part of the risk characterization indicated that potential risks to aquatic life and amphibians exposed to surface sediment were negligible for nutrients and negligible to low for metals. This however does not preclude potential risks from exposure to nutrients for which TRVs are not available. Based on the hazard quotients for COPCs with available TRVs, potential risks were identified for aquatic life and amphibians exposed to PAHs in surface sediment. The potential risks were qualified as low, moderate or high depending on location. PAHs were identified as the risk drivers among the COPCs for which TRVs were available.

One mussel species of special conservation concern, Lilliput (*Toxolasma parvum*), has been observed in Cootes Paradise Marsh and Princess Point near the study area. For this reason, potential risks were conservatively assessed for this species although it is not known if it is present in the study area. The ERA found potential risks for this species at all sampling locations for metals and/or PAHs in sediment and nutrients in surface water.

Additional lines of evidence (LOEs) were used to evaluate potential risks to benthic invertebrates exposed to COPCs in sediment. The toxicity tests showed that the freshwater midge *Chironomus dilutus* was not significantly impacted after being exposed the sediment obtained from the study area. Adverse effects to amphipod (*Hyalella azteca*) growth and survival were observed in the toxicity tests. The benthic community in the study area comprised stress tolerant species consistent with those observed in urban streams draining areas of high percent impervious cover.

The results of the ERA indicate that the PAHs, metals and bacteria in the study area sediment, as well as the sediment oxygen demand resulting from the degradation of natural organic detritus and/or organic waste, likely restricts the benthic invertebrate community makeup to stress tolerant organisms. While the Main/King CSO discharge likely impacted the benthic invertebrates, the benthic community assemblage observed in the study area is consistent with that observed in streams in urban watersheds with a high percent of impervious cover and connectivity issues. The review of the COPCs distribution indicates that concentrations of PAHs, metals, nutrients and bacteria in sediment and/or surface water are comparable to concentrations measured prior to the discharge. The elevated concentrations of COPCs have been an ongoing issue in Chedoke Creek sediment and/or surface water prior to and after the 2014-2018 discharge event, including in areas upstream of the Main/King CSO. These observations are consistent with the fact that Chedoke Creek is predominantly an urbanized watershed that has been altered over time as a result of intense urban development within the Hamilton area, and the creek has been and continues to be subject to numerous point source (e.g., CSOs, storm water outfalls) and nonpoint source discharges (e.g., highway runoff, runoff from urban and industrial areas).

RECOMMENDATIONS

Item 1 of the Director's Order required "*an identification and evaluation of sewage remaining in the creek, anticipation of any ongoing environmental impacts to the creek as a result of the sewage spill, and a review of options designed to remediate the creek and monitor the environmental condition of the creek.*"

Recommendations proposed by Wood (2019) were reviewed by SLR based on information collected during 2019 (and not available to Wood) and findings in the current ERA. As a result of this review, none of the following recommendations considered in Wood (2019) – physical capping, chemical inactivation, or sediment removal by hydraulic dredge – are recommended at this time.

Options to remediate and monitor the creek were contingent on the assessment of impact. Monitoring the environmental condition of the creek as it relates to ongoing operations for the Main/King CSO is occurring. Information available for review in the ERA showed nutrient contamination and phosphorus loading typically associated with sewage discharge have reduced and are comparable to pre-discharge levels, indicating no apparent and persistent effects in Chedoke Creek resulting from the sewage discharge. Given these findings, the requirement for remediation of the creek as stated in the Director's Order would appear unnecessary to address effects from the sewage discharge, and the '**no action**' alternative is recommended.

TABLE OF CONTENTS

TABLES WITHIN TEXT

TABLES FOLLOWING TEXT

DRAWINGS

APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Area of Environmental Concern
ANOVA	Analysis of Variance
APVs	Aquatic Protection Values
ARCS	Assessment and Remediation of Contaminated Sediment
ATSDR	Agency for Toxic Substances and Disease Registry
AWF	Freshwater Aquatic Life
BC	British Columbia
BICS	Benthic Invertebrate Community Structure
BOD	Biochemical Oxygen Demand
BV	Bureau Veritas
CC	Chedoke Creek
CCME	Canadian Council of Ministers of the Environment
cfu/ml	Colony Forming Unit per Milliliter
cm	centimetre
COPC	Contaminants(s) of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CP	Cootes Paradise
CSAP	Contaminated Sites Approved Professionals Society
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
CUM	Cultural Meadow
CUS	Cultural Savana
DFO	Fisheries and Oceans Canada
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
$DQRA_{CHEM}$	Detailed Quantitative Risk Assessment for Chemicals
EC	Environment Canada
EC_{20}	Environmental Concentration where 20% Effect Occurs
EPC	Exposure Point Concentration
EPR	Environmental Project Report
EPS	Environmental Protection Series
EPT	Ephemeroptera, Plecoptera, Trichoptera
ERA	Ecological Risk Assessment
ESA	Environmental Sensitive Area
FCSAP	Federal Contaminated Sites Action Plan

FOD	Deciduous Forest
HBI	Hilsenhoff's Biotic Index
HCA	Hamilton Conservation Authority
HHRAP	Hamilton Harbour Remedial Action Plan
HQ	Hazard Quotient
HMW	High Molecular Weight
IBA	Important Bird Area
IMPARA	Important Reptile and Amphibian Area
ISQGs	Interim Sediment Quality Guidelines
km^2	square kilometers
L	Litre
LEL	Lowest Effect Level
LMW	Low Molecular Weight
LOE	Line of Evidence
LOEL	Lowest Observed Effect Level
LRT	Light Rail Transit
m	metre
MAC	Maximum Allowable Concentration
MAS	Shallow Marsh
MECP	Ministry of the Environment, Conservation and Parks
mg/kg	milligram per kilogram
mg/L	milligram per litre
MOE	Ministry of the Environment
NA	Not Applicable
na	not available
NAI	Natural Areas Inventory
NOAEL	No Observed Adverse Effect Level
O_2	Oxygen
OAO	Open water
OMNR	Ontario Ministry of Natural Resources
ON	Ontario
PAH	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PEC	Consensus-Based Probable Effect Concentration
PEL	Probable-Effect Level
POPs	Persistent Organic Pollutants
PWQO	Provincial Water Quality Objectives

PSQGs	Provincial Sediment Quality Guidelines
Q	Quotient
QA/QC	Quality Assurance and Quality Control
RBG	Royal Botanical Gardens
ROC	Receptor of Concern
SA	Shallow Aquatic
SAR	Species at Risk
SARA	Species at Risk Act
SedQC	Sediment Quality Criteria
SEL	Severe Effect Level
SLR	SLR Consulting (Canada) Ltd.
SOP	Standard Operating Procedure
SQG	Sediment Quality Guideline
TCEQ	Texas Commission on Environmental Quality
TKN	Total Kjeljdahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
UCLM	Upper Confidence Limit of the Mean
UNEP	United Nations Environmental Programme
US	United States
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VECs	Valued Ecosystem Components
WOE	Weight of Evidence
Wood	Wood Environmental & Infrastructure Solutions
WQG	Water Quality Guidelines
µg/L	micrograms per litre

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (**SLR**) was retained by the City of Hamilton to complete an Aquatic Ecological Risk Assessment (**ERA)** for the lower section of Chedoke Creek, parallel to Highway 403 (Drawing 1). The purpose of the ERA was to evaluate the potential risks to aquatic plants and invertebrates, fish, amphibians and aquatic-dependent wildlife associated with exposure to contaminants of potential concern (**COPCs**) in sediment and surface water in the study area. The ERA was conducted in response to the sewage discharge.

The ERA was carried out using data and information presented in the Wood Environmental & Infrastructure Solutions (**Wood**) report titled, *MECP Order # 1-J25YB Item 1b Chedoke Creek Natural Environment and Sediment Quality Assessment and Remediation Report, City of Hamilton*, dated January 24, 2019 as well as environmental data collected by SLR during the week of September 30, 2019.

1.1 Background

An accidental sewage discharge from the Main/King Combined Sewer Overflow (**CSO**) facility to Chedoke Creek occurred between January 28, 2014 and July 18, 2018.

On August 2, 2018, the Ministry of Environment, Conservation and Parks (**MECP**) issued Provincial Officer's Order #1-J25YB (the 2018 Order) to the City. The 2018 Order included requirements for an evaluation of the impacts of the sewage discharge to Chedoke Creek. To fulfil this requirement, the City retained Wood to complete a site assessment and an impact assessment, and to prepare a remedial plan, if required (Wood, 2019).

In the spring of 2019, the City asked SLR to provide peer review services related to the investigation and mitigation recommendations presented in the 2019 Wood Report. Findings of the peer review were provided in a memorandum dated May 15, 2019 and follow-up report entitled "*Peer Review Related Services and Environmental Technical Support*" dated June 7, 2019.

The findings of the peer review indicated that the 2019 Wood Report included information on the physical characteristics and the quality of the sediment found at the bottom of Chedoke Creek, the aquatic invertebrates living in this sediment, the fish living in or migrating to Chedoke Creek, and the quality of the water in the creek. However, only sediment quality compared to the Provincial Sediment Quality Guidelines had been used to evaluate whether conditions in the creek potentially caused adverse effects to aquatic life. For this reason, SLR recommended re-analyzing the data presented in the Wood Report in the context of an ERA to determine next steps for Chedoke Creek, including a data gap analysis and the development of a workplan to collect additional information where required.

Following a review of the data contained in the 2019 Wood Report and consultation with the City of Hamilton, a sediment and surface water sampling program was conducted in September 2019 by SLR to support the completion of a risk assessment report. Sediment sampling sites in Chedoke Creek were selected based on a review of the sediment chemistry data provided in the 2019 Wood Report. The sampling design was intended to provide a gradient of chemical concentrations in the resultant data and provide reasonable spatial coverage of the study area. Though every effort was made to include a local sediment reference location in a comparable urban creek (i.e., Red Hill Creek), no nearby location included fine sediments suitable for chemical or toxicological analyses.

The field program consisted of the collection of surface water and sediment samples from Lower Chedoke Creek for analytical chemistry evaluation. Two surface water samples were also collected upstream and downstream of the CSO at Red Hill Creek, a local urban stream. In addition to chemical analysis, select sediment samples were submitted for toxicological characterization (i.e., toxicity testing). Benthic invertebrate community structure (**BICS**) analysis was also conducted.

On November 14 and 28, 2019, MECP issued a revised provincial order and Directors Order (1-MRRCX) to the City, including a requirement for completing an ecological risk assessment report for Chedoke Creek as a result of the sewage discharge.

1.2 ERA Scope and Approach

The risk assessment presented in this report is an aquatic ecological risk assessment and considered ecological receptors including aquatic life (aquatic plants, aquatic invertebrates and fish), amphibians and aquatic-dependent reptiles, birds and mammals.

1.2.1 Spatial Scope

The study area considered in this ERA includes the lower section of Chedoke Creek running parallel to Highway 403. The upstream extent of the study area is defined by Glen Road at which point Chedoke Creek is channelized underground. The downstream limit of the study area is the Desjardin Recreational Trail Bridge at Princess Point (Drawing 1). The bridge at Princess Point marks the boundary of the Chedoke Creek subwatershed (Hamilton Conservation Authority - **HCA**, 2008; drawing provided in Appendix A). The outlet of the Main/King CSO facility is located at the upstream limit of the study area.

Some environmental samples were collected immediately downstream of the bridge in Chedoke Bay (also referred to as Chedoke Delta). Chedoke Bay is located in the south east corner of Cootes Paradise Marsh at the mouth of Chedoke Creek (Theijsmeijer and Bowman, 2016). These samples, while collected from within Cootes Paradise, are discussed in the ERA as they characterize the outlet area of Chedoke Creek.

Environmental samples obtained in Chedoke Creek upstream of the study area were also considered in this ERA. These samples provide information on conditions in sections of the creek not affected by the Main/King CSO. Finally, environmental samples obtained in Red Hill Creek were considered in this ERA. These samples provide information on environmental conditions in an urban creek draining a similar urban watershed.

As per the scope of work for this ERA, Cootes Paradise Marsh was not included in the ERA.

1.2.2 Temporal Scope

The ERA focuses on current environmental conditions in the study area. Therefore, environmental data collected prior to or during the Main/King CSO discharge were not included in the dataset used to evaluate the current exposure of ecological receptors (i.e., data obtained before July 18, 2018).

Environmental data obtained from Chedoke Creek prior to the CSO discharge were; however, considered in this report to support the discussion of environmental trends prior to and following the Main/King CSO discharge.

1.2.3 General Approach

The ERA was conducted in general accordance with the ecological risk assessment guidance available from the following sources:

- Ministry of the Environment (**MOE**[3]). 2008. Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario.
- MOE 2011a. Soil, ground water and sediment standards for use under Part XV.1 of the Environmental Protection Act.
- MOE 2011b. Rationale for the Development of the Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Ministry of the Environment Standards Development Branch. April 15, 2011.
- MECP. 2017. Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act. Published August 18, 2017, Updated May 15, 2019.
- Environment Canada (**EC**). 2012. Federal Contaminated Sites Action Plan (**FCSAP**) Ecological Risk Assessment Guidance. March 2012.

The first part of this ERA is the problem formulation. For there to be any possibility of a risk to ecological health, aquatic receptors must be exposed to one or more stressors (i.e., one or more COPCs). This question was addressed systematically by identifying the COPCs, the ecological receptors of concern (**ROCs**) that might be exposed to the COPCs, and the specific pathways through which the ROCs might be exposed. The information was summarized in a conceptual site model (**CSM**[4]) to determine the ROC-COPC combinations arising from complete exposure pathways that were carried forward for risk characterization.

The next steps were the calculation of the degree to which the ROCs were exposed to the COPCs (i.e., Exposure Assessment) and the toxicity of the COPC (i.e., Effects Assessment). Using these two factors, risk calculations were completed and the resulting hazard quotients (**HQs**) were compared to MECP ecological risk-based targets (i.e., Risk Characterization). According to MECP guidance, HQs greater than 1 indicate potential risks are present, while HQs less than 1 indicate negligible risk. In addition to calculating HQs to evaluate the risks, additional lines of evidence (**LOEs**) were evaluated to further assess the risks for benthic invertebrates. The benthic invertebrate LOEs included the evaluation of sediment toxicity to freshwater organisms in controlled laboratory conditions, and the assessment of benthic invertebrate living in the creek.

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[3] Now the Ministry of Environment Conservation and Parks (MECP)

[4] A CSM combines information on COPCs, potential receptors, and potential exposure pathways to provide an overall picture of interactions on a site and identifies complete exposure pathways which are carried forward for risk characterization (refers to Section 5.7).

1.3 Report Organization

The report is organized into the sections described in Table 1-1.

Table 1-1: Report Organization

Report Section	Content
Section 1 – Introduction	Outlines site objectives and scope.
Section 2 – Applicable Guidelines and/or Standards	Provides an overview of the standards and guidelines applied to the data to identify the COPCs
Section 3 – Summary of Previous Environmental Studies	Provides brief summaries of previous environmental studies relevant to the ERA.
Section 4 – Data Collected in Support of the ERA	Provides a summary of the field investigations completed by SLR to support the ERA.
Section 5 – Problem Formulation	Provides site information; describes characterization data and historical and current analytical results; presents the COPC screening process and identifies COPCs in affected media; screens potential ecological receptors; discusses relevant exposure pathways; presents the CSM identifying complete exposure pathways to be evaluated in the ERA.
Section 6 – Exposure Assessment	Discusses the distribution of the final COPCs and identifies exposure point concentrations (EPCs) for each medium, pathway and receptor pairing.
Section 7 – Effect Assessment	Provides toxicity reference values (TRVs) and discusses methods and results for toxicity tests, benthic invertebrate community structure and biological surveys.
Section 8 – Risk Characterization	Evaluates potential risks by combining the exposure information and TRVs to calculate HQs on a study area-wide basis. Presents the additional LOEs used in the evaluation of risks and integrates each LOEs into a final ERA weight of evidence (WOE).
Section 9 – Uncertainty Analysis	Identifies areas of greatest uncertainty and any assumptions that could affect the conclusions of the ERA
Section 10 – Summary and Conclusions	Provides a summary and conclusions of the ERA.
Section 11 – Recommendations	Provides a summary of the recommendations.
Section 12 – Statement of Limitations	Discusses obligations and responsibilities of SLR regarding this report.
Section 13 – References	Lists references used in the ERA.

2.0 APPLICABLE GUIDELINES AND/OR STANDARDS

The following subsections present the environmental guidelines and/or standards specifically used to identify the COPCs selected in the ERA (i.e., COPC screening benchmarks). The COPC identification process (or COPC screening) is further discussed in Section 5.4.

2.1 Sediment

The Provincial Sediment Quality Guidelines (**PSQGs**) Lowest Effect Levels (**LELs**) are the basis of the MECP Sediment Standards (MOE 2011a) and were used to identify sediment COPCs for aquatic life (macrophyte, benthic invertebrates and benthic fish) (MOE 2011b and MOE 2008). The PSQG LEL "*indicates a level of contamination that can be tolerated by the majority of sediment-dwelling organisms*. *Sediments meeting the LEL are considered clean to marginally polluted*" (MOE 2008).

The Canadian Sediment Quality Guidelines (Canadian Council of Ministers of the Environment - CCME 1999) freshwater Interim Sediment Quality Guidelines (**ISQGs**) were used as secondary values to identify COPCs for the parameters for which PSQG LELs have not been developed.

The background sediment concentrations for metals in the Great Lakes region (MOE, 2008) were also used as screening benchmarks, where available.

The selected COPC screening values for sediment are provided in Table 1 after the text.

2.2 Surface Water

The surface water results were compared to the guidelines/standards listed below to identify COPCs for aquatic life. Where provincial water quality objectives or values were unavailable, guidelines and standards from other jurisdictions were selected if methods and protection goals aligned with MECP approaches.

- Provincial Water Quality Objectives (**PWQOs**) and Interim PWQOs for the protection of aquatic life (MOE 1994 and updates);
- MECP Aquatic Protection Values (**APVs**) (MOE 2011b);
- CCME Water Quality Guidelines (**WQG**) for the protection of aquatic life (2008);
- BC Approved WQG for the protection of Freshwater Aquatic Life (**AWF**) Long-term Values (BC ENV, 2019); and
- BC Working WQGs for the protection of AWF Long-term Values (BC ENV 2018).

In addition to the guidelines listed above, the CCME WQG for the protection of livestock were used to identify COPCs for aquatic-dependent wildlife potentially using Chedoke Creek as a source of drinking water. In the absence CCME WQG for livestock, the BC Approved and Working WQG for wildlife and/or livestock were used. Finally, in the absence of WQG specific to wildlife or livestock, the MECP value protective of potable water (GW1) were conservatively applied to identify COPCs for wildlife ingesting surface water.

The selected COPC screening values for surface water are provided in Tables 2 and 3 after the text.

3.0 SUMMARY OF PREVIOUS ENVIRONMENTAL STUDIES

The following is a summary of recent environmental studies considered in this ERA.

3.1 Royal Botanical Gardens Water Quality Monitoring Program

The Royal Botanical Gardens (**RBG**) has been conducting an annual water quality monitoring program since the early 1970's in Cootes Paradise Marsh and Grindstone Marsh. The monitoring program focuses on the marshes, but also monitors inflowing waters including Chedoke Creek, Spencer Creek, Borer's Creek, and Grindstone Creek. One sampling location, CP11, is within Chedoke Creek in the study area. RBG records show that CP11 was monitored from June 1994 to May 2014.

Surface water samples were analyzed for bacteriology and nutrients (total ammonia, ammonia un-ionized, Total Kjeldahl Nitrogen (**TKN**), nitrate, nitrite, total nitrogen, and total phosphorus (**TP**)). In addition, temperature, conductivity, dissolved oxygen, pH, and turbidity were measured in the field. The sample locations are provided in Appendix A.

3.2 Hamilton Conservation Authority (HCA) Water Quality Monitoring Program

In 2014, HCA became responsible for the surface water sampling in Spencer Creek, Ancaster Creek, Borers Creek and Chedoke Creek, previously completed by RBG. This sampling program included biweekly grab samples was implemented under the Hamilton Harbour Remedial Action Plan (**HHRAP**) to gather information on inputs from nonpoint sources of nutrients, sediments and bacteria into Cootes Paradise Marsh and ultimately the Hamilton Harbour. The HCA monitoring program included one sampling location in Chedoke Creek, in the study area (CP-11). As part of the 2017/2018 sampling program, eight additional sampling locations were added in Chedoke Creek (CC-3. CC-5, CC-7, CC-9, CC-2, CC-5a, CC-10, CC11 Outlet). These samples locations were added in order to identify the sources of elevated levels of nutrients and bacteria that had been observed at CP-11. Sampling locations CP-11 and CC11 Outlet are within the study area. The other seven locations are upstream of the study area.

Samples obtained by HCA were analyzed for bacteriology and nutrients (ammonia + ammonium, nitrate, nitrite, TP, and o-Phosphate). In addition, temperature, conductivity, dissolved oxygen, pH, and turbidity were measured in the field. Sample locations are provided in Appendix A.

3.3 Sediment Quality in Canadian Lake Ontario Tributaries: Part One (West of the Bay of Quinte) Screening-Level Survey

In the summer of 2002, Environment Canada completed a screening-level survey of the quality of recently deposited sediment near the mouths of tributaries draining to the Niagara River and Lake Ontario as far east as the Bay of Quinte. Sampling method followed the United States Geological Survey (**USGS**) protocol and sub-samples were combined at each site to obtain one sample representative of the overall conditions in a given tributary. A total of 147 samples were obtained including 131 tributaries and 16 field duplicate samples (Dove et al 2003). One sample was obtained from lower Chedoke Creek and analyzed for metals, polycyclic aromatic hydrocarbons (**PAHs**), total polychlorinated biphenyls (**PCBs**) and organochlorine pesticides. Total PCBs and pesticides results were below the detection limits of the laboratory methods. Most individual PAHs and total PAHs in the Chedoke Creek sample were above the SQG LEL. In addition, phenanthrene, fluoranthene, pyrene and benz(a)anthracene were above the CCME probable effect level (**PEL**). Arsenic, cadmium, chromium, copper, mercury, manganese, lead and zinc were above the SQG LEL. Zinc was also above the CCME PEL.

The study concluded that PAHs were widespread in the tributaries, with concentrations generally appearing to be higher in or near urbanized areas. Ten of the tributaries had concentrations of total PAHs greater than 10 mg/kg. These tributaries were located in the most densely populated portion of the basin, between Hamilton and Toronto (Table 3-1).

Table 3-1: Total PAHs Concentrations in Ten Lake Ontario Tributaries

Tributary	Total PAH concentration (mg/kg)
Pioneer Creek	71.6
Stoney Creek	26.0
Rambo Creek	20.0
Applewood Creek	19.3
Shoreacres Creek	18.8
Wendigo Creek	17.0
Montgomery Creek	14.8
Chedoke Creek	14.5
Roseland Creek	12.6
Tuck Creek	11.7

The study also concluded that some metals commonly exceeded the SQG LEL, including cadmium (at 94 sites), copper (at 83 sites), manganese (at 87 sites), and zinc (at 64 sites).

3.4 Royal Botanical Gardens (RBG) Marsh Sediment Quality Assessment

In November 2013 sediment grab samples were obtained from Cootes Paradise Marsh and Grindstone Marsh areas as part of the sediment quality monitoring program completed by RBG (Bowman and Theijsmeijer, 2014). Sediment samples were obtained from ten locations. While the inflowing creeks were not sampled, two samples were obtained from Chedoke Bay (CC-1 and CC-2). The locations were selected based on results of the RBG 2006 sediment sampling program so that results could be compared to evaluate trends in sediment quality. Sediment samples were analyzed for nutrients and metals. Concentrations of TKN, TP, cadmium, copper, iron, manganese, lead, nickel and zinc exceeded the PSQG LEL but were below the SEL in Chedoke Bay. Metals exceeding the PSQGs LEL were observed at most locations in Cootes Paradise and Grindstone Marsh, with copper exceeding the LEL at all ten locations. Chedoke Bay and West Pond had the greatest number of metals exceeding the LEL (seven LEL exceedances for both stations). All stations exceeded the LEL for TKN and TP. In addition, TP exceeded the SEL at the Desjardins Canal sampling locations. The study concluded that the sediments of Cootes Paradise Marsh and Grindstone Marsh demonstrate low to moderate contamination of some heavy metals and nutrients, with the exception of TP in the Desjardin Canal. Sample locations are provided in Appendix A.

The study did not recommend additional monitoring for metals in sediment because concentrations "*were only slightly elevated above LEL's and include a number of naturally* *occurring metals sources from high contact with rock in the area*". The study recommended follow up monitoring for nutrients (specifically TP and TKN) in areas of concern including West Pond, Westdale Inlet, the Desjardins Canal, and Long Pond. Remediation of the Desjardins Canal sediment was identified as a priority.

3.5 Wood Environment and Infrastructure Solution (2019)

Wood completed a site assessment and impact assessment of Chedoke Creek downstream from the Main/King CSO facility (Wood, 2019). The study used several LOEs including sediment physical characteristics and analytical chemistry, benthic invertebrate community data, fish community data and surface water analytical chemistry to evaluate the environmental conditions in lower Chedoke Creek.

The sediment thickness characterization indicated that a greater accumulation of fine sediment was present along the west shoreline of the creek, with upstream sampling locations generally containing less soft sediment than downstream sampling locations.

Wood collected sediment core and/or grab samples from ten locations in Chedoke Creek. All locations were downstream of the Main/King CSO facility. Sediment samples were analysed for bacteria, nutrients, metals and PAHs. Analytical results were compared to the PSQG LELs and SELs. Porewater biochemical oxygen demand (**BOD**) was also measured. The highest level of BOD was observed at the downstream end of the creek immediately upstream of the Princess Point bridge and coincided with the highest level of organic matter observed in the creek. The highest fecal bacteria counts were obtained downstream of the Kay Drage Park bridge. The report noted that inputs/sources of fecal bacteria were ongoing in the creek (e.g., permitted CSO, wildlife, dogs). Nutrients concentrations exceeded the PSQG LEL, but were below the SEL. The report indicated that these results suggested that the "*sediments contain a level of contamination that can be tolerated by the majority of sediment-dwelling organisms, but not necessarily stress-intolerant taxa*". Metals exceeding the PSQG LELs included arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc. Exceedances of the LELs were observed at all locations. In surficial sediment (< 15 cm), copper was the only metal to exceed the PSQG SEL. In deeper sediment (>15 cm), cadmium, copper, nickel and zinc exceeded the PSQG SELs. The report indicated that several sources of metal contamination were present in the Chedoke Creek watershed (e.g., other CSOs and urban runoff) and added that isolating these sources from the Main/King CSO facility inputs was not considered feasible. Wood also reviewed sediment data provided in studies completed prior to the CSO event and indicated that the results suggested that legacy metals enrichment had occurred prior to the Main/King CSO facility event. One or more PAHs exceeded the PSQG LELs at all locations. Comparisons to the SELs were not provided. Similar to the metals-enrichment discussion, Wood reported that many historical and ongoing sources of PAHs were present in the Chedoke Watershed.

Wood collected seven sediment samples for BICS analysis. Results indicated that "*the community was made of taxa generally tolerant of poor water quality and environmental stress*". Sampling for benthic invertebrates in Chedoke Creek was not completed prior to 2018 to evaluate pre-discharge conditions. Wood noted that "*benthic macroinvertebrate community data provide a measurement of the existing conditions and do not solely represent impacts attributable to the discharge event. Other confounding factors such as other sources of contaminants (e.g., other CSOs and urban runoff) have likely contributed to the environmentally degraded state of the creek, however as noted earlier, establishing a clear distinction as to the attributable sources is not considered feasible with the available data*."

Wood did not implement field studies to evaluate fish in Chedoke Creek, and instead used fish community survey data provided by the RBG. The data interpretation showed "*changes typically indicative of environmental stresses during the discharge event time period; however, some recent (2018) data suggest improvement*". Wood added that monitoring would be required to confirm the apparent improving trend.

As with the evaluation of fish, Wood used existing surface water data in the impact assessment. The data included nutrient concentrations prior to, during and after the discharge. The Wood evaluation showed a decline in water quality during the discharge and a "*dramatic improvement in water quality*" after the discharge ceased. Wood recommended monitoring to confirm this apparent improving trend.

Wood recommended sediment dredging based on the degraded ecological conditions in the creek. Wood did note that these conditions likely existed "*long before the beginning of the spill event in 2014*". Wood also reported that "*future accumulation and pollutant loading is likely since multiple CSOs and stormwater outfalls exist upstream*".

4.0 ENVIRONMENTAL DATA COLLECTED IN SUPPORT OF THE ERA

During the week of September 30, 2019, SLR collected thirteen (13) surface water and nine (9) sediment samples (including one duplicate) from Lower Chedoke Creek. A surface water sample was also collected upstream and downstream of the Main/King CSO at Red Hill Creek, a local urban stream. The surface water samples were submitted to the City of Hamilton laboratory for analysis, while the sediment samples were submitted to Bureau Veritas Laboratories (**BV** - previously known as Maxxam). Target analytes for surface water and sediment are summarized below.

Table 4-1: Summary of SLR 2019 Surface Water and Sediment Analytes

Surface Water	Sediment
pH and hardness	Particle size
TOC and DOC	TOC and moisture
BOD	Bacteriology
TSS	Nutrients (total ammonia, TKN, total phosphorus)
Bacteriology	Metals including mercury
Nutrients (total phosphorus, dissolved ortho-phosphate, total ammonia, ammonia un-ionized, nitrate and nitrite)	BOD (porewater)
Metals including mercury	Hydrogen sulphide (porewater)
PAHs	PAHs

DOC - dissolved organic carbon
BOD – Biochemical oxygen demand (BOD)
PAH - Polycyclic aromatic hydrocarbons
TKN – Total Kjeldahl nitrogen (sum of organic nitrogen and ammonia/ammonium)
TSS - Total suspended solids
TOC - Total organic carbon

In addition, surface water pH, temperature, conductivity and dissolved oxygen were measured in the field.

Sediment sampling sites in Chedoke Creek were selected based on a review of the sediment chemistry data provided in the Wood Report. The design was intended to provide a gradient of chemical concentrations in the resultant data and provide reasonable spatial coverage of the study area. Though every effort was made to include a local sediment reference location in a comparable urban creek, i.e. Red Hill Creek, no location included sediments with grain size ranges suitable for chemical or toxicological analysis.

Grab sediment samples were collected by deploying and retrieving a Ponar dredge sampler. The sampling method was selected to be consistent with that used by Wood so that the sample results could be compared. Grab samples were collected side-by-side at each location until enough material was obtained for chemical characterization, toxicity testing, and BICS analysis.

Six (6) sediment samples obtained from the Study area were submitted to BV for toxicological characterization using the freshwater midge *Chironomus dilutus* and the freshwater amphipod *Hyalella azteca*.

Benthic invertebrate samples were collected, and field filtered at the same locations where sediments were collected. Samples from 10 locations (eight in the Study area, one in Chedoke Bay and one in Red Hill Creek), with three replicates at each location (for a total of 30 samples), were submitted to Entomogen for benthic invertebrate identification to the lowest practical level (species or genus). The sample in Red Hill Creek was used to provide qualitative information on benthic community assemblage in another urban stream with a similar watershed. Sediment could not be collected at this location due to the nature of the substrate (e.g., cobble), for this reason, this sample will not be used as a local reference for direct comparisons.

Laboratory analytical reports are provided in Appendix B.

5.0 PROBLEM FORMULATION

The problem formulation is considered the planning phase of the risk assessment. The steps include:

- Describing the study area;
- Screening the environmental data to identify COPCs;
- Evaluating the fate and transport of COPCs in environmental media;
- Identifying ecological receptors of concern; and
- Determining COPC and exposure pathway combinations considered to be complete.

The information herein will form the basis for developing the CSM, which will illustrate the applicable exposure pathways between sources of contamination and potential receptors evaluated in the ERA. Only complete exposure pathways are to be quantified in this ERA.

5.1 Chedoke Creek

Chedoke Creek watershed covers an area of 25.1 km^2, with the head waters located above the Niagara Escarpment. The watershed comprises six catchment basins, including, from the headwaters to the outlet: Chedoke West, Lang's Creek, Mid-Chedoke, Cliffview, Chedoke East, and Lower Chedoke Creek (HCA) (2008). Chedoke Creek flows eastward and aligns parallel with Highway 403, within its lower section, before outletting into the south shore of Cootes Paradise Marsh. Chedoke Creek combined with Ancaster Creek and Borer's Creek, two other creeks of similar size outletting in the marsh, account for 16% of the total watershed of the Cootes Paradise Marsh (Cootes Paradise Water Quality Group 2012).

The watershed is predominantly urbanized with more than 70% of impervious surface. HCA (2008) noted that "*much of the Chedoke Creek subwatershed has been altered over time as a result of intense urban development within the Hamilton area; subsequently the majority of the stream flow directly results from storm water input. Therefore, erosion, sedimentation and insufficient channel sizes occur at the outlet*". HCA (2008) inventories nineteen (19) stormwater outfalls/(CSOs) in Chedoke Creek, including four in Lower Chedoke Creek. Land use statistics provided by HCA (2008) are summarized in Table 5-1.

Table 5-1: Chedoke Creek Subwatershed Land Use Statistics (Source: HCA 2008)

Land Use/Descriptor	Area (km^2)
Area	25.1
Agricultural	0.001
Commercial	0.7
Industrial	0.6
Institutional	3.2
Open space	3.0
Residential	11.0
Transportation	5.5
Utility	1.1
Impervious area (%)	76

Water quality in Chedoke Creek indicates contamination with urban sewage and cross connections, and urban runoff with high levels of nitrate, phosphorus and bacteria (*E. coli* and total coliform) commonly observed (Vander Hout et al 2015). Chedoke Creek is generally considered to have degraded habitat conditions for aquatic life (SNC Lavalin 2017).

The waters of Chedoke Creek are reported to "bypass the majority of Cootes Paradise as it enters the marsh near the outlet to the harbour with minimal impact to the centre of the marsh" (Theÿsmeÿer as cited in Cootes Paradise Water Quality Group 2012).

5.1.1 Study Area

As indicated in Section 1.3.1, the study area includes the lower section of Chedoke Creek extending parallel to Highway 403, between Glen Road and the Desjardin Recreational Trail Bridge at Princess Point (Drawing 1). Chedoke Bay at the mouth of Chedoke Creek is also described in this section as it is the outlet area of Chedoke Creek.

The area of study of Chedoke Creek within the Cootes Paradise Environmental Sensitive Area (**ESA**) is a linear small riverine warmwater system and is part of the broader Spencer Creek Watershed and Management Area (Bowlby et al. 2009, HCA 2008). The vegetation communities along the shorelines reflect this whereby there are no wetland embayment communities (Photograph 1, Appendix C). The riparian bank slopes are moderate along the length of Chedoke Creek study area and comprise modified (armour stone) sections (Photograph 2, Appendix C).). Near the large box culvert, steep concrete banks occur (Photograph 3, Appendix C).). Two bridges and a pedestrian trail also occur along the banks. The trail fragments the creek from adjacent Deciduous Forest (**FOD**) and Cultural Savana (**CUS**) of the study area. Treed vegetation along the banks are composed mostly of Manitoba Maple (*Acer negundo*), Willow Species (*Salix*), and Sugar Maple (*Acer saccharum*) intermixed with Poplar (*Populus sp*), Ironwood (*Ostrya virginiana*), Black Walnut (*Juglans nigra*), Elm *(Ulmus sp*) and Ash (*Fraxinus* sp) (Photograph 4, Appendix C). These remnant creek valley slopes of floodplain forests have experienced significant degradation. Cultural Meadow (**CUM**) (Photograph 5, Appendix C).) almost exclusively occurs along the eastern banks and includes a suite of tolerant broad-leaf vegetation typical of old fields and disturbed areas. Efforts in recent years have focused on restoring these shoreline areas (Photograph 6, Appendix C).) and areas of Chedoke Bay.

The aquatic community is a mixture of mostly open water (OAO), with pockets of Mixed Shallow Aquatic (**SA**). Small areas of Shallow Marsh (**MAS**) occur at the northern end near sampling Station C5/G6 and in smaller pockets especially near sampling station G3. Water levels and flows fluctuate during spring freshets and rain events. During low flow periods, exposed flats occur along the banks and near the Main/King CSO. Submergent and emergent vegetation observed throughout the study area includes those species tolerant of dryer and or prolonged flooding periods. Broad-leaved and Narrow-leaved Cattail (*Typha latifolia / Typha angustifolia)* and Reed Canary Grass (*Phalaris arundinacea*) are common along the riparian banks, with Broad-leaved Arrowhead (*Sagittaria latifolia*) and Water Smartweed (*Persicaria amphibia*) occurring infrequently in smaller cluster areas. Invasive flora such as Eurasian Manna Grass (*Glyceria maxima*) occurs with pockets of Common Reed (*Phragmites australis*). Generally, the submergent and floating leaved community is lacking, but restoration efforts in recent years by the RBG (Chedoke Bay Project and Stream Habitat Improvement program) has seen a reintroduction of some species. In the summer duckweed species, Canada Waterweed (*Elodea canadensis*), Water Smartweed (*Polygonum amphibium*) and Pond Weed (*Stuckenia pectinata*) occur in small backwater areas. Photographs 7 and 8 (Appendix C). provide examples of these SA areas. The shallow vegetation communities provide refuge, foraging, spawning and nesting opportunities for a variety of fish and wildlife (Photographs 9 and 10, Appendix C).

5.2 Aquatic Receptors of Concern

As part of the problem formulation process, aquatic ecological receptors potentially exposed to COPCs are identified. The ecological receptors of potential concern (ROCs) in the study area include aquatic life (invertebrates, plants and fish) and aquatic dependent wildlife (e.g., mammals, waterfowl, amphibians and reptiles) that are confirmed within the study area, or potentially present in the study area based on the available habitat and therefore may potentially be exposed to COPCs through sediments or surface water. The aquatic life and wildlife receptor groups are briefly described in the sub-sections below. The ROCs selected in the ERA are presented in Section 5.2.4.

5.2.1 Aquatic Life

Aquatic life as defined in this report encompasses aquatic plants, aquatic invertebrates and fish. The confluence of Chedoke Creek with Cootes Paradise Marsh is unimpeded. The flora and fauna community in Cootes Paradise Marsh is diverse, owing to its position at the interface between Lake Ontario and the Spencer Creek watershed. However, the aquatic habitat communities of Chedoke Creek are limited due to the degraded habitat in the creek.

Aquatic plants largely consist of macrophytes, phytoplankton, and periphyton. Aquatic macrophyte is the general term applied to large vascular and non-vascular plants that grow in aquatic systems [including both submergent and emergent plants]. Phytoplankton are small non-vascular plants that are suspended in the water column and are comprised of several types of algae. Periphyton are typically larger non-vascular plants that grow on other aquatic plants, or on the bottom surface of the water body often encrusting large cobble and rocks.

Aquatic invertebrates include species that reside in the water column (zooplankton), in the sediment (infaunal) or on the sediment (epifaunal). Wood (2019) and SLR (2019) completed quantitative surveys of the aquatic invertebrates associated with the sediment in Chedoke Creek (i.e., benthic invertebrates). Species observed by Wood and SLR consisted mainly of stress tolerant organisms such as chironomids and oligochaetes. These species are typical of urban streams. Species observed in Chedoke Creek are provided as part of Entomogen Report in Appendix E.

Fish species in Chedoke Creek were documented in Bowlby et al (2009) and the Royal Botanical Gardens (RBG, 2001 thru 2018) and are summarized in Table 5-2. The fish assemblage in Chedoke Creek reflects a warm water system. Chedoke Creek is significantly groundwater fed; therefore in the summer it will draw in fish species that prefer cooler water from the habitats of Cootes Paradise (Tys Theijsmeijer personal communication 2018). In the reaches of Chedoke Creek (south of Main Street), Creek Chub (*Semotilus atromaculatus*), Brook Stickleback (*Culaea inconstans*) and Pumpkinseed (*Lepomis gibbosus*) have been observed. Movement of the warm water and cool water fish from Cootes Paradise is expected within the study area given unrestricted access at the confluence. For example, White Sucker (*Castostomus commersoni*), Brown Bullhead (*Ameiurus nebulosus*) Pumpkin Seed and Large Mouth Bass (*Micropterus salmoides*) dominate the fish community in Chedoke Creek. Foraging opportunities and habitat in the study area exists for other piscivores such as Northern Pike (*Esox Lucius*) and small community bait fish ((e.g., Emerald shiner (*Notropis atherinoides*), Spottail shiner (*Notropis hudsonius)*)).

Table 5-2: Native Fish Species Known to occur in Chedoke Creek

Species	Scientific	Observations and Abundances[5]	Observed by RBG, 2001 - 2018
Black Bullhead	*Ameiurus melas*	2	x
Black Crappie	*Pomoxis nigromaculatus*	3	x
Bluegill	*Lepomis macrochirus*		x
Bluntnose Minnow	*Pimephales notatus*	3	x
Bowfin	*Amia calva*	3	x
Brook Silverside	*Labidesthes sicculus*	3	
Brown Bullhead	*Ameiurus nebulosus*	4	x
Channel Catfish	*Ictalurus punctatus*	4	
Common Shiner	*Luxilus cornutus*	2	
Common White Sucker	*Castostomus commersoni*	4	x
Creek Chub	*Semotilus atromaculatus*	1	
Gizzard Shad	*Dorosoma cepedianum*		x
Emerald Shiner	*Notropis atherinoides*	4	x
Fathead Minnow	*Pimephales promelas*	3	x
Fresh Water Drum	*Aplodinotus grunniens*	4	
Golden Shiner	*Notemigonus crysoleucas*	2	x
Golden Redhorse	*Moxostoma erythrurum*	1	
Greater Redhorse	*Moxostoma valenciennesi*	1	
Green Sunfish	*Lepomis cyanellus*	3	x
Johnny Darter	*Etheostoma nigrum*	3	
Largemouth Bass	*Micropterus salmoides*	4	x
Longnose Dace	*Rhinichthys cataractae*	1	x
Longnose Gar	*Lepisosteus osseus*	2	
Logperch	*Percina sp.*		x
Northern Pike	*Esox lucius*	3	x
Pumpkinseed	*Lepomis gibbosus*	4	x
River Chub	*Nocomis micropogon*	1	
Rock Bass	*Ambloplites rupestris*	3	
Sand Shiner	*Notropis ludibundus*	1	
Shorthead Redhorse	*Moxostoma macrolepidotum*	2	
Silver Redhorse	*Moxostoma anisurum*	1	
Smallmouth Bass	*Micropterus dolomieu*	2	
Spottail Shiner	*Notropis hudsonius*	4	x
Spotted Gar	*Lepisosteus osseus*	1	
Tadpole Madtom	*Noturus gyrinus*	2	x
Walleye	*Sander vitreus*	2	x
White Bass	*Morone chrysops*	1	
White Crappie	*Pomoxis annularis*	1	
White Perch	*Morone americana*		x
Yellow Perch	*Perca flavescens*	4	x

*** Invaders (e.g. Goldfish, Carp, Rudd, Round Goby) occur but are excluded*

[5] Warm and Cool Recorded fish community observed in seining and electrofishing fish surveys since 1970. Data from the watersheds were obtained from over 600 unpublished studies and were compiled into databases by the Hamilton Conservation Authority and Conservation Halton. Data from electrofishing, and entrapment surveys by DFO, RBG, and OMNR. Abundance Levels are based on quartiles with “1” as the lowest, and “4” as the highest relative abundance as described by Bowlby et Al, 2009.

5.2.2 Aquatic Dependent Wildlife

Information on aquatic dependent wildlife potentially using the study area was gathered from the following sources:

- Nature Counts Natural Areas Inventory (NAI) (https://conservationhamilton.ca/natural-areas-inventory-nai/);
- Information from wildlife surveys completed in the Chedoke Watershed / Cootes Paradise by various organizations and/or consultants (Royal Ontario Botanical Gardens, Research and monitoring Cootes Paradise);
- Hamilton Naturalist Club Bird Counts;
- EBird, 2019 and Ontario Freshwater Fishes Life History Database;
- Environmental Review of Hendrie Valley. RBG Report No. 2019-6;
- Hamilton Harbour and Watershed Fisheries Management Plan (2009);
- City of Hamilton B-Line Light Rapid Transit - Draft Environmental Project Report, Appendix B.1 Natural Heritage Features, Prepared by SNC Lavalin (2010);
- Cootes Paradise Heritage Lands Management Plan, Inventory, Issues and Opportunities, May 2018;
- Hamilton Conservation Authority Chedoke Creek Subwatershed Stewardship Action Plan (2008);
- Chedoke Creek Watershed Fact Sheet (2018);
- Cootes Paradise Nature Sanctuary Lower Chedoke Creek Area Water Quality & Fisheries (RBG, 2001);
- Project Paradise (2017)
- Observations through field evaluations by SLR biologists during the September 30, 2019 field program.

In addition, the study area is near Cootes Paradise a Nationally Important Reptile and Amphibian Area (**IMPARA**) and known Nationally Important Bird Area (**IBA**) for migratory waterfowl staging and feeding[6].

SLR used the above information to compile a list of aquatic dependent wildlife ROCs relevant to the project study area (e.g., potentially exposed to sediment and surface water COPCs). These include birds, amphibians and mammals that potentially use the site during all or part of the year. Aquatic dependent groups and representative species are provided in Appendix C.

5.2.3 Species of Concern

Species that are listed either provincially under the Endangered Species Act, 2007 (Ontario Regulation 230/08) or federally by the Committee on the Status of Endangered Wildlife In Canada (**COSEWIC**) under the Species at Risk Act (s.c. 2002 c.29)[7] as special concern, threatened, or

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[6] Cootes Paradise has the highest biodiversity of plants per hectare in Canada and the highest biodiversity of plants in the Hamilton and Halton regions with 877 species (https://www.hamilton.ca/city-initiatives/our-harbour/cootes-paradise-marsh).

endangered collectively for the purpose of this assessment are referred to as Species at Risk. As per the Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act (MECP 2017) threatened and endangered species were considered for inclusion as valued ecosystem components [**VECs**].

Species at risk (**SAR**) were included as receptors of concern to be evaluated in the ERA if they were confirmed to be present within the study area or may occur based on habitat affinities. There are approximately 35 identified SAR species within the Cootes Paradise area, including several locally rare birds within the Hamilton Region. Not all these species are relevant, "aquatic dependent species". For this reason, the species list was refined to include those with a "riverine" habitat type – for example waterfowl, herons, gulls, terns, and sandpipers.

No SAR were observed during the 2019 sampling program conducted by SLR[8].

The SAR review identified one mussel, one reptile and three birds listed as either threatened or endangered in the area of Chedoke Creek. A summary of each SAR and its potential presence within the study area is included in Table 5-3, below.

Table 5-3: Summary of Species at Risk

Species	Provincial Designation	General Habitat Affinities	Potentially Present in Study Area?
Lilliput *(Toxolasma parvum)*	Threatened	*Variety of habitats, from small to large rivers to wetlands and the shallows of lakes, ponds and reservoirs. It prefers to burrow in soft substrates (river and lake bottoms) made of mud, sand, silt or fine gravel (COSEWIC, 2013)*	Yes – Recorded in Cootes Paradise, Chedoke Bay Hendrie Valley (RBG, 2019) DFO SAR Mapping, 2019
Blanding's Turtle *(Emydoidea blandingii)*	Threatened *General Habitat Defined	Primarily aquatic species; prefers shallow water rich in nutrients, organic soil and rich vegetation. Requires terrestrial basking and nesting sites and can nest in dry conifer forests up to 410 m from a body of water.	Yes – Recorded in Cootes Paradise, Chedoke Bay Hendrie Valley (RBG, 2019)
American White Pelican *(Pelecanus erythrorhynchos)*	Threatened	The White Pelican is a habitat generalist. Breeding occur on islands and shallow wetlands and rely on diet of mainly eat fish and occasionally crustaceans	Yes – Recorded in Cootes Paradise, Chedoke Bay Hendrie Valley (RBG, 2019)
Golden Eagle *(Aquila chrysaetos)*	Endangered	Golden Eagles breeding habitats typically include Northern Ontario but will migrate, overwinter and have been recently documented nesting in parts of Southern Ontario. They use variety of habitat throughout their range and are often observed foraging in managed wetlands and reservoirs for fish, reptiles and birds.	Yes – Recorded in Cootes Paradise, Chedoke Bay Hendrie Valley (RBG, 2019)
Red Knot *rufa* subspecies *(Calidris canutus rufa)*	Endangered	Only occurs in Ontario during migration, where the Red Knot *rufa* subspecies utilizes open and exposed mud flats, beach shoreline for staging where their primary diet consists of mollusks and crustaceans, other invertebrates.	Yes – Recorded in Cootes Paradise, Chedoke Bay Hendrie Valley (RBG, 2019)

[8] SLR recognizes work was conducted in late September early October. Work was not to complete targeted flora or fauna inventories, observations are incidental.

Blanding's Turtle was identified as potentially occurring within the study area due to confirmed presence within Cootes Paradise and marsh habitats of Hendrie Valley. Chedoke Creek lacks the typical wetland marsh communities preferred by this species. Therefore, occurrences are expected to be limited to vagrant individuals. Blanding's Turtle is unlikely to spend significant time within the study area.

Two endangered bird species were identified as potentially present within the study area (Golden Eagle and Red Knot *Rufa* Subspecies). The Golden Eagle prefers to forage in the larger open water habitats of Cootes Paradise and would be unlikely to spend significant time within the study area. Red Knot may utilize exposed shallow flats during low flow; however, the fluctuating water levels of Chedoke Creek are considered a limiting factor. The marsh communities and open areas of Cootes Paradise would be preferred. Occurrences are expected to be limited to vagrant individuals.

The Lilliput mussel was identified as potentially present within the study area. Based on the recent sightings of this invertebrate at the outlet of Chedoke Creek (Morris et al., 2015) and the lack of survey sites within Chedoke itself, this SAR species has been retained for further assessment.

In addition, several SAR fish and birds occur in the broader area, but no suitable habitat is found in the study site (e.g. extensive marshlands are not present). Other species have not been observed in the study area for more than 40 years and are considered historical (e.g. Lake Sturgeon, American Eel, Least Bittern, King Rail). These species were not retained as SAR species in this ERA.

5.2.4 Summary of Potential Ecological Receptors

Receptor refinement is conducted as it is not practical or necessary to characterize risks for all species belonging to the general receptor groups described above. Risk assessments must limit their focus to a smaller list of specific organisms, or receptors of concern, that might be present in the study area and come into contact with the COPCs. An ROC is an individual species chosen to serve as a surrogate for other species occupying a similar position in the food web; thus, results of the risk characterization for the surrogate receptor can be used to make inferences about risk to other species occupying a similar level in the food web. Surrogate ecological receptors were selected according to the following main criteria (CCME 1997; Environment Canada 2012):

- Species likely to be most exposed to contaminants;
- Species indigenous to the area;
- Species representative of the foraging guild or serve as a food item for higher trophic level species;
- Species recognized by the federal or territorial government as threatened, endangered, or of special concern;
- Species recognized as good indicators or surrogate species (i.e., representative of other similar organisms of a general type and feeding niche);
- Sedentary species or species with a small home range; and
- Species of aesthetic value or recreational value to the local human population.

The receptor groups and surrogate ecological ROCs selected for the problem formulation are provided in Table 5-4. Only the receptor group and/or surrogate receptors for which complete, and potentially significant exposure pathways were identified were carried forward in the risk assessment (Section 5.6).

Table 5-4: Ecological Receptor Selection

Receptor Group	Type	Surrogate Receptor	Primary Diet	Rationale for Selection or Exclusion of Receptor Group and/or Surrogate Receptor
Aquatic Plants	Submergent and Emergent	Community Level	-	Included – Directly exposed to sediment and/or surface water COPCs; important habitat item for fish, food items for herbivorous birds and mammals.
Aquatic Invertebrates	Benthic	Community and individual level (lilliput)	-	Included – Benthic invertebrates are directly exposed to sediment and/or surface water COPCs. Aquatic invertebrates are an important food item for fish, invertivorous birds and mammals. SAR (lilliput) may be present in the study area.
Fish	Herbivorous	None Selected.	Aquatic Plants	Not included – No herbivorous fish identified.
	Benthivorous, Carnivorous, & Omnivorous	White Sucker	Benthic forager; insect larvae, aquatic vegetation / macrophytes (invertivore/ detritivore)	Included – Exposed to surface water and/or sediment COPCs; eats mainly benthic macroinvertebrates with some vegetation. Consumed by larger fish, piscivorous birds, or wildlife. Widely distributed and common in both Chedoke Creek and Cootes Paradise. Open substratum and Litho-pelagophils spawners.
	Piscivorous	Northern Pike	Carnivore	Included – Exposed to surface water and/or sediment COPCs; consume smaller fish and are especially vulnerable to bioaccumulative COPCs. Fish in this group may be consumed by wildlife or piscivorous birds. Open substratum and phytophils spawners. Targeted by recreational and sustenance fishing. Known to occur in Cootes Paradise with unimpeded movement to habitats of Chedoke Creek which are suitable foraging, spawning and rearing of habitats young.
Amphibians	Herpetofauna	Leopard Frog	Terrestrial and aquatic invertebrates, including snails, small crayfish and a variety of insects	Included – Exposed to surface water and/or sediment COPCs; consume aquatic invertebrates. May hibernate in sediment of Chedoke Creek

Receptor Group	Type	Surrogate Receptor	Primary Diet	Rationale for Selection or Exclusion of Receptor Group and/or Surrogate Receptor
Reptiles	Herpetofauna Snakes	Northern Watersnake	Fish and amphibians	**Included** – Exposed to surface water and/or sediment COPCs; consume smaller fish, amphibians.
	Herpetofauna Turtles	Snapping Turtle	Omnivorous aquatic invertebrates and macrophytes	**Included** – Exposed to surface water and/or and sediment COPCs; consume smaller fish, amphibians.
Birds	Herbivorous Dabbling Ducks	Mallard	Aquatic macrophytes	**Included** – Exposed to surface water and/or sediment COPCs; consume leaves, seeds, roots of many types of pond weeds, aquatic vegetation, tubers and rhizomes.
	Omnivorous Dabbling Ducks	American Black Duck	Omnivorous aquatic invertebrates and plants	**Included** – Exposed to surface water and/or sediment COPCs; consume aquatic macrophytes (e.g. smartweeds, pondweeds, algae and duckweeds) as well as aquatic insects, mollusks and crustaceans.
	Carnivorous	Great Blue Heron	Small fish crustaceans, mollusks, aquatic insects, leeches, and frogs	**Included** – Exposed to surface water and/or sediment COPCs; consume mostly fish, invertebrates, mollusks, crustaceans and amphibians.
	Piscivorous	Osprey	Large fish	**Included** – Exposed to surface water COPCs only; consume larger fish. SAR (Golden eagle and White Pelican) identified in the area.
Mammals	Herbivorous	Muskrat	Tubers, leaves, aquatic macrophytes	**Included** – Exposed to surface water and/or sediment COPCs; consume aquatic macrophytes (e.g. tubers)
	Carnivorous/ Omnivorous	None	NA	**Not Included** – none identified.

5.3 Data Considered in the ERA

This section describes the datasets used in the ERA. The datasets represent current conditions in the study area (i.e., after the Main/King CSO discharge). All sample locations are illustrated in Drawing 2.

5.3.1 Sediment Chemistry Dataset

All sediment data collected in the study area by Wood in 2018 and by SLR in October 2019 were used to select sediment COPCs.

Two depth-specific sediment datasets were compiled for assessing exposure of aquatic receptors to COPCs: a shallow sediment dataset (collected entirely within the top 15 cm of sediment), and a deeper sediment dataset (collected at depths greater than 15 cm). The shallow dataset will be the focus of this ERA following MECP guidance (MOE 2008) specifying that surficial sediments (to about 10 cm depth) are where most sediment-dwelling organisms live and should therefore be the initial focus of the sediment assessment. The MOE (2008) guidance adds that deeper sediments should also be considered in the assessment as they may be relevant for evaluating potential future risks to aquatic receptors (i.e., risks that could exist in the future if subsurface sediments become exposed). Impacts to deeper sediment (15 cm+) are discussed in the uncertainty section (Section 9.0).

As indicated in Section 4.0, a suitable sediment reference location could not be sampled by SLR in 2019. Similarly, a reference location was not provided in Wood (2019).

The ERA sediment datasets used for COPC screening are presented in Appendix D.

The sediment samples obtained by RBG in 2013 and 2006 were used to evaluate trends in sediment quality (Section 6.1). Historical sediment samples were not used to select COPCs.

5.3.2 Surface Water Chemistry Dataset

The surface water samples (7 samples plus one duplicate) obtained by SLR from Chedoke Creek during the week of September 30, 2019 were included in the surface water dataset.

Historical water quality data collected pre- and post- discharge was reviewed by SLR; however, only data representing current water quality conditions was included in the surface water dataset for the assessment of current risks to aquatic life.

In addition, SLR obtained two surface water samples from Red Hill Creek to gather information from an urban creek located in a similar watershed. Historical water quality data provided by the City from Red Hill Creek since August 2018 was also included to compile a “reference” dataset for surface water quality.

5.3.3 Porewater Chemistry Dataset

Porewater extracted from the sediment samples collected in 2019 was analysed for hydrogen sulphide and biochemical oxygen demand (BOD) to support the interpretation of toxicity tests and effects.

5.3.4 Sediment Toxicity Dataset

Six sediment samples were obtained from the study area and submitted to BV for toxicity testing. The following freshwater sediment toxicity tests were conducted on the samples:

- 10-day survival and growth test with the freshwater midge, *Chironomus dilutus*
- 14-day survival and growth test with the freshwater amphipod, *Hyalella Azteca*

The BV report is provided in Appendix E.

5.3.5 Benthic Invertebrate Community Structure Dataset

Sediment samples for BICS analysis were collected at seven locations by Wood in 2018, and at eight location by SLR in 2019. Additionally, a BICS sample was taken immediately downstream from the study area in Chedoke Bay and one sample was collected from Red Hill Creek. The locations of the 2019 BICS samples are illustrated on Drawing 3 and the 2019 statistical analyses report by Entomogen is provided in Appendix E. Details on the BICS samples collected by Wood are available in Wood (2019).

5.3.6 Dataset Use

The surface water and sediment datasets were used to identify COPCs for the protection of aquatic life (e.g., aquatic plants, invertebrates and fish as well as amphibians) and aquatic-dependent wildlife consuming food items obtained from the study area. This was achieved through a bioaccumulation assessment as described in Section 5.4.3.

Surface water was also screened for the protection of wildlife consuming water as drinking water.

5.4 Contaminants of Potential Concern

COPCs are substances that occur at elevated concentrations in environmental media, typically because of anthropogenic activity. More specifically, COPCs are the chemicals that occur at concentrations high enough to potentially cause adverse effects to receptors. Substances deemed COPCs are further evaluated in the risk assessment process, whereas contaminants with a low probability of posing risks to receptors are not identified as COPCs and are not evaluated further Typical components of sewage discharge include nutrients and bacteria, with relatively small amounts of metals and polycyclic aromatic hydrocarbons (PAHs). However, because this is a CSO, metals and PAHs were also analyzed because these are components of CSO discharge.

5.4.1 COPC Screening Method

COPCs were selected by comparing maximum concentrations to screening benchmarks from the sources listed in Section 2.0. Media-specific screening methodologies are described in the sections below.

5.4.1.1 *Sediment*

For sediment, a parameter was retained as a COPC if the maximum concentration exceeded the applicable guideline, standard or background concentration described in Section 2.1. Where SQG or sediment background values were not available for a parameter, the MECP Table 1 Background Standards for Soil (MOE 2011a) were used as screening benchmarks. If no guideline was available for a parameter, it was retained as an uncertain COPC.

5.4.1.2 *Surface water*

<u>Aquatic Life</u>

For screening of surface water for aquatic life, a two-stage screening process was implemented. A parameter was identified as a preliminary COPC if the maximum concentration exceeded the PWQO or CCME WQG (where the PWQO was unavailable). To ensure the risk assessment focuses on evaluating the COPCs that represent potential risk drivers, a COPC refinement process was implemented for surface water preliminary COPCs. The COPC refinement process was intended to support the development of a list of final COPCs for evaluation in the risk assessment and consisted of comparing the maximum concentration to the MECP APVs.

The PWQOs are "*numerical and narrative ambient surface water quality criteria that represent a desirable level of water quality that the Ministry strives to maintain in the surface waters of the Province*" (MOE 2011b). Chedoke Creek is an urban watercourse which collects a combination of storm water runoff and discharges from the City's combined sewer overflow tanks during large

storm events. It is also located adjacent to other potential sources of impacts such as a major highway (highway 403) and a former landfill (City of Hamilton Website, 2019). According to the City of Hamilton, warning signs advising against recreational use of the creek (including swimming, wading, paddling, fishing) due to historically degraded water quality pre-date the Main/King CSO discharge, indicating that degraded conditions have been present historically within the creek. Based on these observations, the APVs were selected for final screening of water quality COPCs as more appropriate values representative of an urban watercourse environment. APVs were developed by the MECP to support the derivation of the Site Condition Standards (MOE 2011a) for contaminated sites. MOE 2011b indicates that while PWQOs are conservative values that are protective of all forms of aquatic life and aspects of the aquatic life cycle during indefinite exposure to the water, the APVs are "*designed to provide a scientifically defensible and reasonably conservative level of protection for most aquatic organisms".*
Based on the urban environment of the stream, the APVs were considered appropriate for final screening of surface water COPCs where available. Where neither an APV or PWQO was available for a specific parameter, water quality guidelines from other jurisdictions were reviewed and selected for final screening as listed in Section 2.2. Guidelines from other jurisdictions were selected if methods and protection goals aligned with MECP approaches. If no guideline was available for a parameter, it was retained as an uncertain COPC.

Wildlife

For screening of wildlife consuming surface water as drinking water, a parameter was retained as a COPC if the maximum concentration exceeded the applicable guideline or standard described in Section 2.2. Since no provincial water quality guidelines are available for this exposure pathway, the CCME WQG for protection of livestock was selected as the primary screening benchmark. Where a CCME guideline was unavailable, values protecting wildlife and livestock from other jurisdictions were selected (as listed in Section 2.2). If no wildlife or livestock-specific values were available, the MECP GW1 values protective of consumption of water as drinking water (MOE 2011b) were applied conservatively as screening values.

If no guideline was available for a parameter, it was retained as an uncertain COPC.

5.4.2 COPC Screening Results

The final COPC screening results are presented in the sections below. Tables 1 to 3, after the text, provide details on the parameters screened for sediment and surface water datasets, including the number of samples, the number of detectable concentrations, the maximum concentrations and the second highest concentrations. Applicable screening benchmarks along with the rationale for retaining or dismissing parameters as COPCs are also presented.

5.4.2.1 *Final Sediment COPCs*

The final COPC screening results for sediment are presented in the table below.

Table 5-5: Sediment COPC Summary

COPC Group	Sediment (0-0.15)
Metals	Arsenic, cadmium, chromium, copper, lead, manganese, mercury and zinc
PAHs	Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene and total PAHs
Nutrients	Total Kjeldahl nitrogen (TKN) and total phosphorus

5.4.2.2 *Final Surface Water COPCs*

Preliminary and final surface water COPCs are summarized in the table below.

Table 5-6: Surface Water COPC Summary

Receptor Group	COPC Group	Preliminary COPCs	Final COPCs
Aquatic Life	Metals	Aluminum, boron, iron (total), zinc	Aluminum and iron (total)
	PAHs	None	None
	Nutrients	Nitrite (As N) and total phosphorus	Nitrite (As N) and total phosphorus
Wildlife	Metals	-*	None
	PAHs	-*	
	Nutrients	-*	
	Bacteria	-*	

*Preliminary screening not completed for wildlife screening (see Section 5.4.1.2).

Total boron exceeded the PWQO (200 µg/L) at one location (206; C4-West). Dissolved boron exceeded the PWQO at three locations (maximum concentration: 211 µg/L; C3-Centre, C3-West and C4-West). The PWQO for boron is an interim objective set for emergency purposes based on the best information readily available and was not subject to peer review and formal publication (MOE 1994). All total and dissolved boron concentrations are less than the CCME long-term WQG for the protection of aquatic life of 1500 µg/L[9]. Boron was therefore not retained as a final COPC in surface water.

5.4.2.3 *Uncertain Sediment and Surface Water COPCs*

Uncertain COPCs are summarized in Table 5-7 and discussed in the Uncertainty Analysis (Section 9.1.2.2).

[9] The CCME WQG for boron was developed in 2009 following CCME protocol (CCME 2009).

Table 5-7: Uncertain COPC Summary

COPC Group	Sediment (0-0.15)	Surface Water	
		Aquatic Life	Wildlife
Metals	Aluminum, antimony, silver	None	Iron (total), manganese
PAHs	1-methylnaphthalene [10]	None	None
Nutrients[11]	Ammonia and ammonium (as N) ammonia as N nitrogen (total)	Kjeldahl nitrogen total silicon	Kjeldahl nitrogen total silicon
Bacteria	*E. coli;* fecal coliform	*E. coli*	-

5.4.2.4 *Innocuous Substances*

COPC screening benchmarks or regional background concentrations were not available for bismuth, calcium, lithium, magnesium, potassium, strontium, tungsten and zirconium. Although commonly included in routine chemical analysis, government agencies such as the MECP do not develop regulatory criteria for these naturally occurring innocuous parameters (HC 2010c). As many of these parameters are considered essential nutrients and/or occur naturally in southern Ontario, they were not identified as uncertain COPCs.

5.4.3 Bioaccumulation Screening

In addition to identifying COPCs that are present above relevant sediment screening benchmarks for ecological life, MOE 2008 recommends *"identifying substances that could biomagnify and affect the health of biological communities at higher trophic levels*". Since available SQGs do not evaluate biomagnification, initial (conservative) decisions regarding biomagnification potential are based on the presence or absence of quantifiable amounts of substances that may biomagnify (MOE 2008).

Biomagnifying substances were identified by reviewing substances listed in MOE 2008, as well as those listed in the United Nations Environmental Programme (UNEP) Stockholm Convention on Persistent Organic Pollutants (POPs). In addition, substances that bioaccumulative in sediment and water were also identified conservatively through review of the following documents:

- (UNEP) Stockholm Convention on Persistent Organic Pollutants (POPs);
- Texas Commission on Environmental Quality (TCEQ). 2018. Conducting Ecological Risk Assessments at Remediation Sites in Texas. Draft August 2018; and
- Contaminated Sites Approved Professionals Society (CSAP). 2015. Bioaccumulation Research Project.

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[10] No guidelines were available for benzo(b)fluoranthene and benzo(b+j)fluoranthene; however these were included in the calculation for total PAHs and therefore were not identified as uncertain COPCs.

[11] No guidelines were available for organic phosphorus or orthophosphate (PO_4-P) however these parameters were assessed as total Phosphorus and therefore were not identified as uncertain COPCs (CCME 2016).

A summary of bioaccumulating and biomagnifying COPCs in the aquatic environment based on the review of the above-noted documents is presented in the table below. PAH parameters in sediment were not included in the summary table and are discussed further in the following section.

Table 5-8: Bioaccumulation Potential of Preliminary COPCs

Preliminary COPC	Bioaccumulative Media		Bioaccumulation Potential	Biomagnifying?
	Sediment	Surface Water		
Aluminum	-	-	Not considered bioaccumulative	Not biomagnifying
Arsenic	x	-	Bioaccumulative (sediment)	Not biomagnifying
Boron	-	-	Not considered bioaccumulative	Not biomagnifying
Cadmium	x	-	Bioaccumulative (sediment)	Not biomagnifying
Chromium (III+VI)	-	-	Not considered bioaccumulative (sediment or water)	Not biomagnifying
Copper	x	-	Bioaccumulative (sediment)	Not biomagnifying
Iron (total)	-	-	Not considered bioaccumulative	Not biomagnifying
Lead	-	-	Not considered bioaccumulative (sediment or water)	Not biomagnifying
Manganese	-	-	Not considered bioaccumulative	Not biomagnifying
Mercury	x	x	Bioaccumulative (sediment and water)	Yes; as methylmercury (CCME 2000)
Zinc	x	-	Bioaccumulative (sediment)	Not biomagnifying
Nutrients (Ammonia, Nitrite (As N), phosphorus TKN)	-	-	Not considered bioaccumulative[12]	Not biomagnifying
Bacteria (Fecal Coliform, E.coli)	NA	NA	NA	NA

NA - not applicable to COPC group

As indicated above, arsenic, cadmium, copper, mercury and zinc are potentially bioaccumulative sediment parameters, however arsenic and mercury were not retained as bioaccumulative COPCs in this ERA based on the following:

- Based on a review of arsenic distribution in the study area, the bioaccumulation potential of arsenic is considered low. Arsenic was only measured above the PSQG LEL

[12] Nutrients such as nitrate and ammonia are naturally occurring compounds and key intermediates in the nitrogen cycle. It is continually recycled in the environment; therefore, bioaccumulation does not occur (ATSDR, 2004).

(0.4 mg/kg) at one sediment sample location (12 mg/kg at C-5 East) and was below the PWQO at all sample locations in surface water.
- Mercury was not retained as a potentially bioaccumulating and biomagnifying COPC for this ERA. Based on a review of mercury distribution in the study area, the bioaccumulating and biomagnifying potentials of mercury is considered to me low. Mercury was only measured above the PSQG LEL (0.2 mg/kg) at one sediment sample location (0.255 mg/kg at C-3 West) and was not detected in surface water.

5.4.3.1 *Bioaccumulation and Biomagnification of PAHs*

PAHs were also identified as COPCs but were not included in the bioaccumulation table above. PAHs may bioconcentrate in aquatic organisms and animals; however extensive metabolism of these compounds by high-trophic level consumers has been demonstrated, and food chain uptake does not appear to be a major source of exposure to PAHs for aquatic animals (Agency for Toxic Substances and Disease Registry **- ATSDR**, 1995).

A study by Bleeker and Verbruggen (2009) re-evaluated bioaccumulation in aquatic organisms and indicated that bioaccumulation of PAHs in aquatic organisms varies between low molecular weight (LMW) PAHs (e.g., acenaphthylene, acenaphthene, anthracene, fluorene, 2—methylnaphthalene, naphthalene and phenanthrene) and high molecular weight (HMW) PAHs (e.g., benz[a]anthracene, benzo[a]pyrene, chrysene, fluoranthene and pyrene). Phenanthrene and fluoranthene were not considered to be bioaccumulative in fish. HMW PAHs (four rings or more) were all found to potentially bioaccumulate in organisms lower in the food chain, but not in fish. LMW PAHs (2-3 rings) were noted to generally not bioaccumulate in fish or invertebrates. It has also been established that most vertebrates readily metabolize and excrete PAHs (Hylland, 2006). Tissue concentrations of PAHs do not increase (biomagnify) from the lowest to highest levels of food chains (Hylland, 2006). Therefore, direct effects of PAHs on invertebrates will be evaluated as part of this ERA but PAHs were not carried forward as bioaccumulating or biomagnifying COPCs for higher trophic levels.

5.5 Exposure Pathway Identification

Exposure pathways describe the movement of contaminants from sources such as sediment, to potential ecological receptors identified in Section 5.2. An exposure pathway is typically defined by the following four components:

- a source and mechanism of constituent release to the environment
- an environmental medium (e.g., sediment) for the released constituent(s)
- potential contact (exposure point) between a receptor and the affected environmental medium
- an exposure pathway (e.g., ingestion, dermal contact) at the exposure point.

The potential exposure pathways and the identified groups of ecological receptors of concern potentially exposed include:

- uptake of COPCs in sediment by aquatic plants
- direct contact with COPCs in sediment by benthic invertebrates
- direct contact with COPCs in sediment by benthic fish
- direct contact/dermal uptake of sediment and surface water COPCs by amphibians
- uptake of COPCs in surface water by aquatic plants
- direct contact with COPCs in surface water by aquatic invertebrates (e.g., zooplankton)

- direct contact with COPCs in surface water through skin or gills of fish
- ingestion of COPCs in sediment and prey items by benthic invertebrates
- ingestion of COPCs in food items and incidental ingestion of sediment by fish
- direct contact with, and incidental ingestion, of COPCs in sediment during feeding by aquatic-dependent wildlife
- ingestion of COPCs in surface water as drinking water for wildlife
- ingestion of bioaccumulating and/or biomagnifying COPCs in aquatic biota by aquatic dependent wildlife.

As per risk assessment guidance, only complete and potentially significant exposure pathways are carried forward for quantitative evaluation. Complete exposure pathways require a receptor to contact an environmental medium where COPCs have been identified. Complete exposure pathways have varying levels of importance; consequently, the pathways that reflect the highest exposure of a ROC to a specific COPC or group of COPCs are generally identified.

The significance of the exposure pathways listed above have been evaluated based on professional judgement, and have been categorized as follows:

- Exposure pathway is complete and potentially significant. Quantitative assessment of risk is recommended;
- Exposure pathway is complete but insignificant (no COPCs or limited exposure). Quantitative assessment of risk is not recommended; and
- Exposure pathway is incomplete. Quantitative assessment of risk is not recommended.

The following sections identify complete and potentially significant exposure pathways warranting further evaluation through quantitative ERA, as well as those exposure pathways that are incomplete or insignificant and are not considered to pose unacceptable risk.

5.5.1 Exposure to Sediment

Metals, PAHs and nutrients have been retained as the final groups of COPCs for the protection of aquatic life (benthic invertebrates, aquatic plants and fish). Complete and potentially significant exposure pathways for benthic invertebrates include direct contact with contaminated sediments, and ingestion of contaminated sediment (e.g., polychaetes that process sediment to obtain food). Direct contact with sediment and ingestion of sediment were also considered to be complete and potentially significant exposure pathways for fish. The uptake of COPCs through the root system was also considered to be a complete exposure pathway for some aquatic plants.

Direct contact with sediment is considered a complete and potentially significant exposure pathway for amphibians as some species may hibernate in the study area. Snakes and turtles may be directly exposed to COPCs in sediment via dermal contact and absorption through the skin as well as uptake through the food chain. Although these reptiles (including SAR) were identified as ROCs, based on their habitat affinities and availability of food in Cootes Paradise, turtles and snakes) are likely to use the more suitable habitat in Cootes Paradise, and are therefore unlikely to spend a significant amount of time within the study area.

Aquatic-dependent wildlife species (i.e., mammals and birds) may be directly exposed to COPCs in sediment via dermal contact. This exposure pathway was considered to be complete, but not a source of significant exposure as the integument of mammals and birds acts as a barrier to chemical exchange (BC MOE non-dated). Mammals and birds may also be exposed via uptake through the food chain, however based on the availability of food in Cootes Paradise, the home range size of species identified, the size of the site and quality of habitat compared to Cootes Paradise, and the urban setting of the study area, birds (including SAR) and mammals are not expected to be present for significant periods of time in Chedoke Creek compared to Cootes Paradise. Exposure via food chain uptake was not identified as a significant exposure pathway.

5.5.2 Exposure to Surface Water

Aquatic plants, aquatic invertebrates, fish and the larval stage of amphibians can be directly exposed to surface water COPCs (e.g., uptake of contaminants through the roots, gills and/or through the skin). Aluminum, iron, nitrite, TP and *E. coli* were retained as final COPCs in surface water for the protection of aquatic life; therefore, complete and potentially significant exposure pathways were identified for aquatic plants, aquatic invertebrates, fish and amphibians.

Reptiles such as turtles and snakes may be directly exposed to COPCs in surface water via dermal contact. Although these receptor groups (including SAR) were identified as ROCs, based on their habitat affinities and availability of food in Cootes Paradise, turtles and reptiles are unlikely to spend a significant amount of time within the study area.

Mammal and bird receptors can potentially use surface water within the study area as a source of drinking water. No substances were retained as final COPCs in surface water for the protection of wildlife; however, select metals, nutrients and bacterial parameters were identified as uncertain COPCs. Although direct ingestion of surface water is recognized as a pathway of exposure, protection for aquatic organisms living directly within the surface waters should provide a higher level of protection than is required for organisms merely drinking the water (MOE 2011b). Therefore, since no final COPCs were identified, the ingestion of surface water as drinking water by wildlife was not further assessed. Exposure to uncertain COPCs are discussed in Section 9.0.

The ingestion of contaminated food items and the incidental ingestion of contaminated sediment was identified as a complete but insignificant exposure pathway for aquatic-dependent wildlife based on the distribution of the COPCs and on the foraging ranges of the aquatic dependent wildlife ROCs. As per MOE (2008) the biomagnifying potential of the COPCs was qualitatively evaluated. Mercury was the only COPC identified as a biomagnifying COPC. As indicated in Section 5.3.3, mercury exceeded the SQG LEL in one sediment sample only, and was not detected in surface water.

5.6 Conceptual Site Model

CSMs combine information on COPCs, ROCs, and exposure pathways to provide an overall picture of site related exposures. The CSM for ecological receptors is presented in Drawing 4. Complete exposure pathways carried forward in the risk assessment were shaded green on the CSM drawing. Some exposure pathways were considered potentially complete but were associated with a low likelihood of significant exposure (i.e., exposure would be very infrequent or the dose from exposure would be very low). These pathways were shaded yellow on the CSM drawing. Incomplete pathways are those through which exposure does not occur and were not shaded in the CSM drawing. Only complete and significant exposure pathways were evaluated further in the ERA.

In addition to the flow-chart CSM, a summary of the complete and potentially significant exposure pathways to be quantified in the risk assessment is provided in Table 5-9, below. This summary is based on the environmental media investigated in the Study Area and the COPCs identified as final COPCs.

Table 5-9: Summary of Potential Exposure Pathways

Environmental Medium	Receptors of Concern	Exposure Pathway	Final COPCs	Further Qualitative or Quantitative Assessment of Risk in the ERA?
Sediment	Aquatic plants	Uptake	Arsenic, cadmium, chromium, copper, lead, manganese, mercury, zinc Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs, TKN, phosphorus	Yes, complete and potentially significant exposure pathway
Sediment	Benthic Invertebrates	Direct contact		Yes, complete and potentially significant exposure pathway
Sediment	Fish	Direct contact	Arsenic, cadmium, chromium, copper, lead, manganese, mercury, zinc Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs, TKN, phosphorus	Yes, complete and potentially significant exposure pathway
Sediment	Amphibians (frog)	Direct Contact	benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs, TKN, phosphorus	Yes, complete and potentially significant exposure pathway
Sediment	Reptile (turtles & snakes)	Direct contact	Arsenic, cadmium, chromium, copper, lead, manganese, mercury, zinc Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs, TKN, phosphorus	No, complete but insignificant exposure pathway
Sediment	Wildlife (birds and mammals)	Direct Contact	Arsenic, cadmium, chromium, copper, lead, manganese, mercury, zinc Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs, TKN, phosphorus	No, complete but insignificant exposure pathway

Environmental Medium	Receptors of Concern	Exposure Pathway	Final COPCs	Further Qualitative or Quantitative Assessment of Risk in the ERA?
	Amphibians (frog)	Direct Contact	Arsenic, cadmium, chromium, copper, lead, manganese, mercury, zinc Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene, total PAHs	Yes, complete and potentially significant exposure pathway
Surface Water	Aquatic Plants	Uptake	Aluminum, iron (total), nitrite (as N), phosphorus, *e.coli.*	Yes, complete and potentially significant exposure pathway
Surface Water	Zooplankton	Direct contact		Yes, complete and potentially significant exposure pathway
Surface Water	Benthic Invertebrates	Direct contact		Yes, complete and potentially significant exposure pathway
Surface Water	Fish	Direct contact	Aluminum, iron (total), nitrite (as N), phosphorus, *e.coli*.	Yes, complete and potentially significant exposure pathway
Surface Water	Reptile (turtles & snakes)	Direct Contact	Aluminum, iron (total), nitrite (as N), phosphorus, *e.coli.*	No, complete but insignificant exposure pathway
Surface Water	Amphibians (frog)	Direct Contact	Aluminum, iron (total), nitrite (as N), phosphorus, *e.coli.*	Yes, complete and potentially significant exposure pathway
Surface Water	Wildlife (birds and mammals)	Direct Contact, ingestion	None	No, no COPCs
Food Items	Fish	Ingestion	Cadmium, copper, and zinc *	No, complete but insignificant exposure pathway
Food Items	Amphibians	Ingestion	Cadmium, copper, and zinc	No, complete but insignificant exposure pathway
Food Items	Reptile (turtles & snakes)	Ingestion	Cadmium, copper, and zinc	No, complete but insignificant exposure pathway
Food Items	Wildlife	Ingestion	Cadmium, copper, and zinc	No, complete but insignificant exposure pathway

*Based on bioassessment; source of COPCs is sediment, no bioaccumulative COPCs identified in surface water.

5.7 ERA Risk Analysis Plan

The development of a risk analysis plan represents the final stage of the problem formulation process: it presents the overall implementation strategy of the ERA (EC 2012). An overview of the preliminary Risk Analysis Plan for the ERA is provided in this section, including selection of assessment and measurement endpoints and proposed methods to evaluate potential risks to aquatic plants, aquatic invertebrates, fish, amphibians and aquatic-dependent wildlife.

5.7.1 Assessment and Measurement Endpoints

Assessment endpoints define the values or attributes of the receptors which must be protected. The CCME (1996) defines an assessment endpoint as the "*characteristic of the risk assessment that is the focus of the risk assessment.*" Azimuth (2012) defines an assessment endpoint as "*an explicit expression of the environmental value to be protected*" and includes an entity (*a "thing" to be protected such as a receptor group*" and "*a specific property of that receptor (an attribute)*"). The selection of assessment endpoints is an essential element of the overall risk assessment process because it provides a means of focussing assessment activities on the key environmental values (e.g., survival of benthic invertebrates) that could be negatively affected by exposure to environmental contaminants.

Measurement endpoints are the criteria to measure the potential effects. Measurement endpoints can include measures of exposure such as concentrations of COPCs in environmental media, and measures of effects such as literature-based receptor-specific TRVs. The assessment and measurement endpoints which have been used in this ERA are outlined in Table 5-10 and pertain to the four receptor groups retained for assessment. As it would not be practical or possible to incorporate all possible measurement endpoints, the measurement endpoints that inform the assessment endpoints and provide the most useful information for evaluating the risks associated with exposure to the COPCs, have been identified.

Table 5-10: ERA Assessment and Measurement Endpoints

Receptor Group	Assessment Endpoint	Lines of Evidence		
		LOE	Measurement Endpoint	Overview of the Risk Evaluation Framework
Aquatic Plants	Structure and ecological function (i.e. food and habitat for invertebrates, fish, and wildlife)	Chemistry (surface water and sediment)	Final COPC concentrations	- HQs derived using literature-based TRVs - HQs ≤1.0 indicate negligible risks; HQs > 1.0 indicate potential risks - HQs distribution - Field observations
Aquatic Invertebrates*	Structure and ecological function (i.e. food for fish, and wildlife)	Chemistry (surface water and sediment)	Final COPC concentrations	- HQs derived using TRV based on site-specific and literature toxicity information - HQs ≤1.0 indicate negligible risks; HQs > 1.0 indicate potential risks - HQs distribution
		Toxicity test (sediment)	Survival, and growth	- Comparisons to laboratory control
		Biological assessment	Abundance and richness	- Comparisons among year and sampling locations
Fish	Viability of local fish populations (ability for the population to sustain itself over the long term)	Chemistry (surface water and sediment)	Final COPC concentrations	- HQs derived using TRV based on site-specific and literature toxicity information - HQs ≤1.0 indicate negligible risks; HQs > 1.0 indicate potential risks
Amphibian	Viability of local amphibian populations	Chemistry (surface water and sediment)	Final COPC concentrations	- HQs derived using TRV based on site-specific and literature toxicity information - HQs ≤1.0 indicate negligible risks; HQs > 1.0 indicate potential risks

*Listed species assessment endpoint will be protective of the individual as opposed to the viable population

6.0 EXPOSURE ASSESSMENT

Exposure is defined as the contact of a receptor with a chemical or a physical agent. The goal of the exposure assessment is to quantify complete exposure pathways identified in the problem formulation and summarized in the conceptual site model. In doing so, exposure point concentrations (EPCs) are defined for each COPC carried forward in the ERA.

The measure of exposure for aquatic life is generally not discussed in terms of specific exposure pathways, but rather as concentrations in the exposure media, in this case surface water and/or sediment. For this reason, EPCs representing the concentrations of individual COPCs at the point of contact with a receptor (aquatic plant, aquatic invertebrate, fish and/or amphibian), are provided in the exposure assessment for aquatic life. The EPC are based on the data obtained by Wood in 2018 and by SLR in 2019. The environmental studies considered in the ERA are described in Sections 3.0 and 4.0 and the data used in the exposure assessment are presented in Section 5.6.1. Exposure assessment uncertainties are discussed in Section 9.2.

6.1 COPCs Spatial Distribution and Trends

The following section discusses the spatial distribution of the COPC groups in the surficial sediment and/or surface water, as well as comparisons to MECP guidelines.

6.1.1 Metals

Metals in surface sediment reflect the various inputs present in an urban watershed such as Chedoke Creek. Arsenic, cadmium, chromium (III+VI), lead, manganese, mercury and zinc concentrations in sediment exceeded the PSQG LELs, but were below the SELs in all samples. Copper was the only metal to exceed the PSQG SEL. In surface water, aluminum, iron and zinc exceeded the PWQO for the protection of freshwater aquatic life. The spatial distribution of these COPCs is briefly described below (for each COPC).

In surface water, total aluminum ranged from 160 µg/L to 598 µg/L, which exceeded the PWQO of 75 µg/L. The lowest concentration was obtained immediately downstream of the King/Main CSO (C-1) and the highest concentration was obtained at the most downstream location (C5-East). Dissolved aluminum concentrations were significantly lower, ranging from non-detected (<2 µg/L) to 14 µg/L, indicating that total aluminum is mostly associated with particulates.

In surface water, total iron ranged from 202 µg/L to 1180 µg/L. The PWQO (300 µg/L) was exceeded in six out of eight samples. The highest concentration was observed at C5 East. Iron was not retained as a COPC in sediment as concentrations were less than the sediment background value published by MECP (MOE 2008).

Arsenic in sediment exceeded the PSQG LEL (6 mg/kg) in one out of twenty-two samples (12 mg/kg, C-5 East in September 2018). All arsenic concentrations were below the SEL (33 mg/kg). Arsenic concentrations in surface water were below the PWQO.

Cadmium in sediment exceeded the PSQG LEL (0.6 mg/kg) in thirteen out of twenty-samples. The highest cadmium concentrations were obtained at location C5-East (8.5 mg/kg) and C-4 West (6.1 mg/kg) in September 2018. All cadmium concentrations were below the SEL (10 mg/kg). Cadmium was not detected in surface water (<0.1 µg/L).

Chromium (III+VI) in sediment exceeded the PSQG LEL (26 mg/kg) in six out of twenty-samples. Chromium exceedances were seen at locations C-3, C-4 and C-5. The highest chromium concentrations were obtained at location C-4 West (41 mg/kg) and C5-East (37 mg/kg) in September 2018. All chromium concentrations were below the SEL (110 mg/kg). Chromium concentrations in surface water were below the CCME WQGs.

Copper in sediment exceeded the PSQG LEL (16 mg/kg) in all samples (n=15). Copper also exceeded the severe effect level (**SEL**) (110 mg/kg) at locations C-3 West (170 mg/kg) in September 2018, and C-4 West (125 mg/kg) in October 2019 and C-5 East (136 mg/kg) in September 2018. Copper concentrations in surface water were below the PWQO.

Lead in sediment exceeded the PSQG LEL (31 mg/kg) in eleven out of fifteen samples. The highest lead concentration was obtained at location C-3 West (87 mg/kg). All lead concentrations were below the SEL (250 mg/kg). Lead concentrations in surface water were below the PWQO.

Manganese in sediment exceeded the PSQG LEL (460 mg/kg) in five out of six samples. Manganese concentrations ranged from 390 mg/kg at G-6 Comp to 623 mg/kg at G-5 Comp. All manganese concentrations were below the SEL (1100 mg/kg). Manganese concentrations in surface water were below the PWQO.

Mercury in sediment exceeded the PSQG LEL (0.2 mg/kg) in one out of six samples (0.255 mg/kg; C3-West). All mercury concentrations were below the SEL (2 mg/kg). Mercury was not detected in surface water.

Zinc in sediment exceeded the PSQG LEL (120 mg/kg) in all samples (n=15). The highest zinc concentration was obtained at location C-4 West (532 mg/kg) in 2019. The second highest concentration (505 mg/kg) was obtained at C3-West in 2018. Zinc in surface water ranged from 15 to 22 µg/L. The maximum concentration exceeded the PWQO of 20 µg/L.

The concentrations of metal COPCs in sediment generally increased from upstream to downstream, with the highest concentrations typically observed at locations C5-East and C3-West. The metals distribution in sediment indicates that the storm sewers located immediately upstream of C3-West and C5-East may also contribute metals to the study area.

Generally, the concentrations of metals COPCs in the surficial sediments of Chedoke Creek and Chedoke Bay do not show an enrichment following the 2014-2018 discharge compared to historical results with the potential exception of copper. Environment Canada investigated metals concentrations in sediment in Chedoke Creek in 2002 (Dove et al 2003). Several surface (<5 cm) sediment sub-samples (e.g. mid-channel, left-bank, right-bank) were collected upstream of the mouth of Chedoke Creek The concentrations in the composited sediment sample obtained by Environment Canada in 2003 were compared to the range of concentrations obtained in 2018 and 2019 (Table 6-1). The results generally show comparable concentrations. In 2018 and 2019 combined, two out of fifteen samples had copper in higher concentrations than in 2002 and four out of 22 samples had cadmium in higher concentrations than in 2003. In 2018 and 2019, the samples with the highest concentrations of copper also had the highest concentrations of zinc and TP.

Table 6-1: Chedoke Creek COPC Concentrations in 2002, 2018 and 2019

COPC	2002*	2018**	2019**
Arsenic	11	3 - 12	3.56-5.76
Cadmium	1	0.27 - 8.5	0.601-1.32
Chromium	39	16 - 41	19.8-35.9
Copper	86	30 - 170	38.1-125
Lead	70	13 - 145	24.5-51.3
Manganese	547	na	390 - 623
Mercury	0.403	na	0.057 - 0.255
Zinc	551	167 - 505	214- 532

*one sample made up of several combined sub-samples representative of the overall conditions.
**min-max
na – not available
All concentrations are in mg/kg.

In addition to the samples collected in Chedoke Creek, four sediment samples were obtained from Chedoke Bay (C6 East, C6-Centre, and C6-West in 2018; G7 in 2019). Cadmium, chromium (III+VI), copper, lead, manganese, mercury and zinc concentration in sediment exceeded the SQG LELs, but were below the SELs in these samples.

Sediment samples were also collected from Chedoke Bay in 2006 (CC-1) and in 2013 (CC-2). Cadmium, copper, iron, manganese, lead, nickel and zinc exceeded the PSQG LELs, but were below the SELs in these samples (Bowman and Theÿsmeÿer, 2014). The 2013 sediment study showed that metals exceeding the PSQG LELs were observed at most locations in Cootes Paradise and Grindstone Marsh, with copper exceeding the LEL at all ten locations investigated (Bowman and Theÿsmeÿer, 2014). Comparison of metals concentrations obtained in 2006 and 2013 to concentrations obtained in 2018 and 2019 shows similar results, except for copper showing a possible increase (Table 6-2). Note that the maximum copper concentration in West Pond in 2013 was 90.5 mg/kg. A study on contaminant loadings and concentrations to Hamilton Harbour reported "*concerns about the concentration levels of copper in the sediments of Cootes Paradise and the Grindstone Creek Estuary*. *The Technical Team hypothesized that sources could include copper pipes and roofs in the area or residue from copper now used in brake pads instead of asbestos*" (Hamilton Harbour Remedial Action Plan Office 2018).

Table 6-2: Chedoke Bay Historical and Current Surface Sediment Metal Maximum COPC Concentrations

COPC	2006	2013	2018	2019
Cadmium	2.1	2.1	0.96	0.96
Copper	73	55	76	99.8
Manganese	-	630	-	537
Lead	69	50	63	61
Zinc	400	340	303	451

All concentrations are in mg/kg.

6.1.2 PAHs

PAHs were widespread in the study area. All sediment sampling locations except for G3 had one or more PAHs and total PAHs[13] in concentrations exceeding the SQG LELs. All individual PAHs except for pyrene in one sample (C1-West) are below the SELs adjusted to the lowest TOC level obtained in Chedoke Creek (2 percent). SLR re-sampled location C1-West in 2019. Pyrene was below the SEL in 2019. Total PAHs were below the SEL in all samples in 2018 and 2019. PAHs were not detected in surface water.

Total PAHs concentrations in 2018 ranged from 2.97 to 98.69 mg/kg (n=16) and total PAHs in 2019 ranged from 5.3 to 13 mg/kg (n=6). The maximum concentration of total PAHs was obtained in C1-West by Wood in 2018. SLR re-sampled this location in 2019 and measured a total PAH concentration of 6.7 mg/kg for this location.

The distribution of total PAHs shows variability among stations located within the same area. Generally, total PAHs were highest at the location downstream of the King/Main CSO, decreased at locations G3 and G4, and increased downstream of Macklin Street Bridge. Total PAHs concentrations between Macklin Street Bridge and Princess Point appeared similar (based on the geomean; Table 6-3).

In all samples, fluoranthene was the dominant PAH, followed by pyrene and phenanthrene or chrysene. Benz(a)anthracene and benzo(a)pyrene were the fifth or sixth most dominant PAHs, depending on the sample. The similar distribution of individual PAHs in the samples across the study area points to a common source. A study on PAHs in Cootes Paradise Marsh and select tributaries completed by Chow-Fraser et al (1996) indicated that PAHs in sediment of Spencer, Borer's and Chedoke Creeks most likely originated from automobile exhaust and residual asphalt based on the high levels of fluoranthene and pyrene which are derivatives of engine combustion.

Based on the 2018 and 2019 results, PAH concentrations do not seem to be correlated with nutrient levels. For example, in 2018 the sampling location with the highest total PAH concentrations was the only sampling location with TP concentration below the PSQG LEL. TKN was also below the LEL in that sample.

Environment Canada investigated PAH concentrations in sediment in Chedoke Creek in 2002 (Dove et al 2003). Most of the individual PAHs and total PAHs (14. 5 mg/kg) exceeded the SQG LELs in the sediment sample obtained in 2002. Similar to the samples obtained in 2018 and 2019, pyrene, fluoranthene, phenanthrene and benz(a)anthracene were the dominant PAHs in the sample.

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[13] PAH (total) is the sum of 16 PAH compounds: Acenaphthene, Acenaphthylene, Anthracene, Benzo[k]fluoranthene, Benzo[b]fluoranthene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[g,h,i]perylene, Chrysene, Dibenzo[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene, Phenanthrene, and Pyrene (MOE, 2008).

Table 6-3: Total PAHs Results in Chedoke Creek

Location	Date	Total PAHs Conc.	Geomean
G-1 Comp	9/18/2018	42.2	20.1
C-1 West	9/18/2018	98.7	
C-1 West	10/2/2019	6.7	
G-2 Comp	9/18/2018	5.1	
C-2 West	9/18/2018	23.0	
G-3 Comp	9/18/2018	3.0	3.0
G-4 Comp	9/18/2018	4.4	4.9
G-4 Comp	10/2/2019	5.3	
G-5 Comp	9/19/2018	8.2	9.0
G-5 Comp	10/2/2019	5.7	
C-3 West	9/18/2018	11.0	
C-3 West	10/2/2019	13.0	
C-3 Centre	9/18/2018	16.0	
C-3 East	9/18/2018	4.9	
C-4 West	9/19/2018	20.5	9.7
C-4 West	10/1/2019	7.8	
C-4 Centre	9/19/2018	8.9	
C-4 East	9/19/2018	6.2	
C-5 West	9/19/2018	6.5	7.9
C-5 Centre	9/19/2018	5.3	
C-5 East	9/19/2018	16.0	
G-6 Comp	10/1/2019	7.3	

6.1.3 Nutrients

Nutrients are a component of raw sewage. Nutrients were retained as COPCs in sediment (TKN and TP) and in surface water (nitrite and TP).

In sediment, TKN exceed the PSQG LEL (550 mg/kg) in twelve (600 to 1900 mg/kg) of twenty-two samples. TKN showed a decrease in concentrations in October 2019 and none of the samples had TKN concentrations above the LEL. The maximum TKN concentration in 2018 was 814 mg/kg obtained at C3-West and the maximum TKN concentration in 2019 was 330 mg/kg obtained at C-4 West. Ammonia also decreased between 2019 (maximum 400 mg/kg) and 2018 (maximum 130 mg/kg).

TP was widespread in the study area and exceeded the PSQG LEL (600 mg/kg) in twenty-one out of twenty-two sediment samples obtained in 2018 and 2019. The maximum TP concentration in 2018 was 1622 mg/kg obtained in sample C-3 West and the maximum TP concentration in 2019 was 1560 mg/kg obtained in sample C-4 West.

All samples had TKN and TP concentrations below the SELs (4800 and 2000 mg/kg, respectively).

Studies that included sediment samples analyzed for nutrients in Chedoke Creek before the Main/King CSO discharge were not found. However, sediment samples were collected in Cootes Paradise and Grindstone Marsh in 2006 and 2013, including two sediment samples from Chedoke Bay (CC-1 and CC-2) (Bowman and Theijsmeijer, 2014). These sediment samples were analyzed for TKN and TP and exceeded the LELs at all locations in Cootes Paradise and Grindstone Marsh. TP also exceeded the SEL in Desjardin Canal in 2006 and 2013 (Bowman and Theijsmeijer, 2014). Comparison of TP and TKN concentrations obtained from Chedoke Bay in 2006 and 2013 to concentrations obtained in 2018 and 2019 in sediment (within the top 15 cm of sediment) shows similar TP concentrations and a decrease in TKN concentrations (Table 6-4).

Table 6-4: Chedoke Bay Historical and Current Maximum Sediment TKN and TP Concentrations in Surface Sediment

COPC	2006	2013	2018	2019
TKN	1250	1390	814	120
TP	1100	1100	1000	1140

Unit in 2006 and 2013 are in µg/g and unit in 2018 and 2019 are in mg/kg; both are ppm.

In surface water, total nitrite exceeded the CCME long-term WQG (60 µg/L) at all 2019 study area sample locations, ranging from 70 to 220 µg/L. There is no PWQO for nitrite. The lowest concentration was obtained at the most downstream location (C5-East) and the highest concentration was obtained immediately downstream of the Main/King CSO outlet (C-1). TKN was retained as an uncertain COPC in surface water as no PWQO is available. Waters not influenced by excessive organic inputs typically range from 100 to 500 µg/L (Environment Canada 1979). Measured concentrations within the study area ranged from 500 to 1500 µg/L, with the highest concentration obtained at the most downstream location (C-5 East). It is noted that the concentrations measured in 2019 at Red Hill reference locations R-1 and R-2 were also below this range (300 and <200 µg/L, respectively).

TP concentrations exceeded PWQO (30 µg/L) to prevent excessive algae growth in river at all sample locations and were within a comparable range across the study area (314 to 428 µg/L). The maximum TP concentration was obtained in sample G-1 Comp West collected immediately downgradient of the CSO outlet, while the minimum was collected at the most downstream location (C5-East). Dissolved phosphorus concentrations were generally consistent with the total concentrations measured immediately downstream of the CSO outlet (C-1 and G-1) but were lower than the total concentrations measured at downstream locations. This indicates that particulates likely play a larger role in total phosphorus concentrations at downstream locations. TP was not detected in the Red Hill reference samples in 2019.

TP concentrations were measured in the study area (CP-11) before (2009 to 2013), during (May 2014 to July 2018) and after the discharge (August 2018 to October 2018) (HCA data as provided by City of Hamilton, 2019). The results show that TP concentrations were significantly higher in 2018 during the Gate 2 failure. After the discharge, TP concentrations returned to pre-discharge concentrations (Table 6-5).

Table 6-5: Surface Water TP Concentrations Before, During and After the Discharge

Period	Year	N	Range	Median
Pre-discharge	2009	12	84-271	194
Pre-discharge	2010	11	111-269	185
Pre-discharge	2011	11	100-469	195
Pre-discharge	2012	11	158-365	290
Discharge	2014	8	156-956	350
Discharge	2015	17	113-1250	369
Discharge	2016	19	226-1004	433
Discharge	2017	27	130-740	359
Discharge	2018 (until end of July)	16	276-2780	1130
Post-discharge	2018 (August-October)	10	195-935	233

Nutrients in Chedoke Creek surface water have been evaluated in several studies. Chow-Fraser reported a mean nutrient TKN concentration for May to September 1996 of 2840 µg/L for Chedoke Creek. The mean TP concentration in the same study was reported to be 375 µg/L. Chow-Fraser (1996) indicates that high nutrient levels in Chedoke Creek were probably linked to the several CSOs discharging into the creek. In addition, urban runoff has been recognized as a major nonpoint source of TP in the growing season, for example urban runoff has been identified as the second most important nonpoint loading source of TP to Cootes Paradise (Dong-Kyun et al 2016).

6.1.4 Bacteria

E. coli and fecal coliform were identified as an uncertain COPC in sediment and surface water based on the lack of guidelines specific to ecological receptors. While samples were also analyzed for fecal coliform, *E. coli* is a better indicator of bacterial fecal contamination. MOEE 1994 states that *E. coli* was selected for the guidelines for the protection of human health as "*studies have determined that, among bacteria of the coliform group, E. coli is the most suitable and specific indicator of fecal contamination*".

E. coli levels in sediment in 2019 ranged from 5,400 to 2,400 MPN/100g. *E coli* were not analyzed in sediment in 2018. Fecal coliforms in sediment were analyzed in both 2018 and 2019 and decreased from 2018 to 2019 at all sampling locations. Levels in 2018 ranged from 8,000 to 45,000 MPN/100g with a median concentration of 20,000 MPN/100g. In 2018, the highest levels were observed at C-3 West and C-3 East. Levels in 2019 ranged from 5,400 to 2,400 MPN/100g with a median concentration of 4450 MPN/100g. In 2018, the highest levels were observed at C-3 West, C-3 East and C-5 East.

E. coli levels in surface water in 2019 ranged from 390 to 4100 cfu/100 ml. E coli counts were higher at upstream location C1-West and lowest at downstream location C5-East. The 2019 median concentration was 1450 cfu/100 ml. Wood (2019) reported a median for *E. coli* during the discharge event of 12300 cfu/100 ml.

E. coli counts are elevated throughout the Chedoke Creek subwatershed. *E coli* levels were measured in the study area (CP-11) and at three locations upstream of the Main/King CSO (CC-3, CC-7 and CC-9; locations provided in Appendix A) in 2018. The results are provided in Table 6-6 for two time period, during the discharge (April to July 2018) and after the discharge (August to October 2018) (HCA data as provided by City of Hamilton, 2019). The results show that *E. coli* levels were significantly higher at station CP-11 than in the upstream stations at CC-2, CC-7, and CC-9, during the discharge. After the discharge, *E coli* decreased to levels lower than those observed at the upstream locations.

Table 6-6: Chedoke Creek E. Coli Levels in Surface Water Downstream and Upstream of Main/King CSO in 2018

	Downstream of Main/King CSO			Upstream of Main/King CSO								
	CP-11 (study area)			CC-3			CC-7			CC-9		
	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
2018 (April -July)	11	290000-4900000	1800000	8	590-104000	15900	8	570-6600	2800	8	590-18000	3200
2018 (August-October)	10	190-20000	3300	5	800-610000	6400	5	440-6000	1600	5	1630-9000	7100
2019		390-4100	1450	na	na	na	na	na	na	na	na	na

na - not available
Unit are in CFU/100ml
April-July 2018 – during discharge
August-October 2018 – after discharge
Samples collected on the same dates at all locations but location CC-11 included duplicate.
2018 dates during discharge: April:11 and 25; May: 9 and 23: June: 7 and 20; July 4 and 18
2018 dates after discharge: August:1, 15 and 29; September 11 and 27; October: 10.

6.1.5 Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO)

While BOD and DO were not selected as COPCs, the two parameters provide information on the potential indirect effect of natural organic detritus and/or organic waste. BOD is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions thus reducing available dissolved oxygen for fish and other aquatic biota (e.g., invertebrates) (Wood 2019). BOD in the 2019 sediment sample (measured in the porewater) ranged from 6.4 to 31 mg/L. The highest BOD was observed at C-4 West. BOD measured at C-1 West, downstream of the CSO, was 8.5 mg/L. DO was measured in surface water at each location in the field and ranged from 2.96 to 10.23 mg/L. The location with the highest DO level was C-1 West and the location with the lowest DO level was C5-East/G6. Both locations with the highest BOD (C-4 West: 31 mg/l and C5-East/G6: 17 mg/L) also showed the lowest DO (4.85 and 2.96 mg/L respectively). Sampling locations C-4 West and C5-East/G6 had DO levels lower than the CCME minimal DO guideline levels for the protection of warm water biota (6 mg/L). Surface water DO in the study area prior to the King/Main CSO discharge event ranged from 3 mg/L to 16 mg/L with the lowest DO levels observed in the summer.

Total organic carbon measured in sediment in 2019 ranged from 2.6% to 4.7% and was comparable to total organic carbon observed in the study area in 2002 (3.8% - Dove et al 2003).

6.2 Exposure Point Concentrations (EPC)

Aquatic plants and benthic invertebrates are sessile and thus, may be exposed to higher or lower concentrations in discrete area(s) of Chedoke Creek. For this reason, the concentrations of the individual sediment samples obtained in Chedoke Creek were used as EPCs.

EPCs for fish and amphibians are based on the calculated 95% UCLM concentrations because fish are mobile receptors and thus, may be exposed to the entire length of Chedoke Creek within the study area.

The EPCs for the individual samples and the 95% UCLM concentrations are presented in Table 4 after the text.

For surface water COPCs, the maximum concentrations were adopted as the EPCs for aquatic plant, invertebrates (benthic and zooplankton), fish and amphibians. The maximum concentrations were conservatively selected because surface water samples in the study area were only collected on one occasion (2019) from 8 locations, providing limited information on the temporal and spatial variations in surface water quality. The surface water EPCs are summarized below in Table 6-7.

The method followed to calculate the 95% UCLMs and the detailed results of the analyses are presented in Appendix F.

Table 6-7: Surface Water Exposure Point Concentrations

COPC	EPC	Unit	Statistic
Aluminum	598	µg/L	Maximum
Iron (total)	1340	µg/L	Maximum
Nitrite (as N)	280	µg/L	Maximum
Total Phosphorus	450	µg/L	Maximum
Total Phosphorus (Filtered)	420	µg/L	Maximum

The EPCs are carried forward to the risk characterization section of this ERA.

7.0 EFFECTS ASSESSMENT

Exposure to COPCs in sediment and surface water has the potential to negatively affect aquatic organisms. Toxicity reference values (**TRVs**) were compiled for each of the COPCs to assess the potential effects and characterize the potential risks. A TRV is a receptor-specific concentration of a chemical, above which adverse effects have the potential to occur, and below which there is a low likelihood that adverse effects will occur. The selected TRVs were then used to quantify the potential risks (Section 8.0).

Concentrations of contaminants in sediment may exceed the applicable guidelines; however, contaminant concentrations are not necessarily strongly correlated to bioavailability and toxicity. Because relationships between concentrations of contaminants in sediment and their bioavailability are poorly understood and vary on a site-specific basis, determining effects of contaminants in sediment on aquatic organisms often requires a combination of approaches, including biological observations, controlled toxicity tests and measures of effects on benthic communities inhabiting sediments (Ingersoll et al., 1997). The following information was compiled and presented as part of the effect assessment:

- Sediment toxicity testing was completed using benthic invertebrates exposed to sediments collected from impacted locations to identify whether exposure to the COPCs caused decreases in survival, reproduction and/or growth compared to a laboratory control;
- BICS analysis was conducted to assess the benthic community composition at various locations; and
- Both toxicity testing and BICS analysis rely upon site-specific information to assess whether potential effects are due to elevated chemical concentrations and/or other biological and physical stressors (e.g., particle size, competition/predation).

The effects assessment presents key information used in the risk characterization presented in Section 8.0. Effects assessment uncertainties are discussed in Section 9.3.

7.1 Literature-Based Toxicity Reference Values

The TRVs were selected in accordance with ERA guidance (EC 2012, MECP 2019) and are outlined in the subsection below.

7.1.1 Sediment TRVs for Aquatic Life

While screening-level sediment quality guidelines (i.e., lowest effect level-type SQGs) were used to identify the COPCs, aquatic life, probable-effect level (PEL) type SQGs were adopted as TRVs to assess risks to aquatic life associated with exposure to sediment COPCs for non listed species. This approach was adopted because the results of the reliability evaluations of various types of SQGs indicate that PEL-type SQGs tend to be more predictive of sediment toxicity than threshold effect level SQGs (Long et al. 1995; MacDonald et al. 2000, 2003). In addition, for non-listed species, the goal of the ERA was not to protect each individual from a toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained. More specifically, the following hierarchical approach was applied to select TRVs for aquatic life:

- MacDonald D.D., Ingersoll C.G. and Berger T.A. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Contamination and Toxicology 39(1). 20-31.
- Canadian SQGs for the protection of freshwater aquatic life (i.e., PELs; CCME 1999 and updates).
- USEPA Assessment and Remediation of Contaminated Sediment (ARCS) probable effect concentrations (PECs) (Ingersoll et al. 1996).
- Persaud D. R. Jaagumagi and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of Environment and Energy.

The consensus-based probable effect concentrations (**PECs**) developed by MacDonald *et al*. (2000) were developed by averaging probable effect-level concentrations from several guidelines to yield consensus-based PECs. The consensus-based PECs have been evaluated for their reliability in predicting toxicity in sediments by using matching sediment chemistry and toxicity data from field studies. The results of the reliability evaluation showed that most of the consensus-based values for individual contaminants provide an accurate basis for predicting the presence or absence of toxicity (MacDonald et al. 2000). The consensus-based PECs were adopted for all of the COPCs for which they were developed. The consensus-based PECs are lower than the PSQG SELs.

The CCME PEL represents the lower limit of the range of chemical concentrations that are usually or always associated with adverse biological effects. The PELs are calculated as the square root of the product (i.e., the geometric mean) of the 50th percentile concentration of the effect dataset and the 85th percentile concentration of the no-effect dataset (CCME 1999). The CCME PELs were adopted for those COPCs for which consensus-based PECs were not available. The CCME PEL based are lower than the PSQG SELs.

The PSQG SELs were selected as the TRV for COPCs for which consensus-based PECs or CCME PELs were not available.

As indicated in Section 5.2.3, aquatic life species of concern include freshwater mussels which have documented presence immediately downstream of the study area. While not observed in the study area, these species could potentially be present in Chedoke Creek. For this reason, lower-level SQGs from the above listed sources were used as TRV. The sediment background concentration (MOE 2008) was selected as the iron TRV.

As toxicity information for sediment COPCs relevant to aquatic plants, fish and amphibians is limited, the benthic invertebrate based TRVs have been applied to all aquatic life receptors. TRVs selected for aquatic life are summarized below in Table 7-1.

Table 7-1: Sediment Toxicity Reference Values for the Protection of Aquatic Life (mg/kg)

COPC	Non-Listed Species			Listed Species		
	TRV	Type	Source	TRV	Type	Source
Arsenic	33	PEC	Mac Donald et al (2000)	9.79	TEC	Mac Donald et al (2000)
Cadmium	4.98	PEC	Mac Donald et al (2000)	0.99	TEC	Mac Donald et al (2000)
Chromium (III+VI)	111	PEC	Mac Donald et al (2000)	43.3	TEC	Mac Donald et al (2000)
Copper	149	PEC	Mac Donald et al (2000)	31.6	TEC	Mac Donald et al (2000)
Iron	40000	SEL	Persaud (1993)	30000	Background	MOE 2008
Lead	128	PEC	Mac Donald et al (2000)	35.8	TEC	Mac Donald et al (2000)
Manganese	1100	SEL	Persaud (1993)	460	LEL	Persaud (1993)
Mercury	1.06	PEC	CCME PEL	0.18	TEC	Mac Donald et al (2000)
Silver	-	-		-	-	
Zinc	450	PEC	Mac Donald et al (2000)	121	TEC	Mac Donald et al (2003)
Acenaphthylene	0.128	PEL	CCME (1999)	0.01	ISQG	CCME (1999)
Acenaphthene	0.0889	PEL	CCME (1999)	0.006	ISQG	CCME (1999)
Anthracene	0.845	PEC	Mac Donald et al (2000)	0.22	LEL	Persaud (1993)
Benz(a)anthracene	1.05	PEC	Mac Donald et al (2000)	0.32	LEL	Persaud (1993)
benzo(g,h,i)perylene	6.40	SEL	Persaud (1993)	0.17	LEL	Persaud (1993)
benzo(k)fluoranthene	1.45	PEC	Mac Donald et al (2000)	0.24	LEL	MOE 2008
Benzo(a)pyrene	1.45	PEC	Mac Donald et al (2000)	0.37	LEL	Persaud (1993)
Chrysene	1.29	PEC	Mac Donald et al (2000)	0.34	LEL	Persaud (1993)
Dibenz(a,h)anthracene	0.135	PEC	Mac Donald et al (2000)	0.06	LEL	Persaud (1993)
Fluoranthene	2.223	PEC	Mac Donald et al (2000)	0.75	LEL	Persaud (1993)
Fluorene	0.536	PEC	Mac Donald et al (2000)	0.19	LEL	Persaud (1993)
Indeno(1,2,3-c,d)pyrene	6.40	SEL	Persaud (1993)	0.2	LEL	Persaud (1993)

COPC	Non-Listed Species			Listed Species		
	TRV	Type	Source	TRV	Type	Source
2- Methylnaphthalene	0.201	PEL	CCME (1999)	0.02	ISQG	CCME (1999)
Naphthalene	0.561	PEC	Mac Donald et al (2000)	0.176	TEC	Mac Donald et al (2003)
Phenanthrene	1.17	PEC	Mac Donald et al (2000)	0.56	LEL	Persaud (1993)
Pyrene	1.52	PEC	Mac Donald et al (2000)	0.49	LEL	Persaud (1993)
PAHs (sum of total)	22.8	PEC	Mac Donald et al (2000)	4	LEL	Persaud (1993)
Kjeldahl nitrogen total	4800	SEL	Persaud (1993)	550	LEL	Persaud (1993)
Phosphorus	2000	SEL	Persaud (1993)	600	LEL	Persaud (1993)

7.1.2 Surface Water TRVs for Aquatic Life

This section presents the selected TRVs for each of the selected surface water COPCs. The MECP has not developed aquatic protection values for the final surface water COPCs, therefore the PWQO rationale document and more recent literature sources were reviewed for the selection of TRVs. Sources reviewed included:

- MOE 1979. Rationale for the Establishment of the Provincial Water Quality Objectives. September 1979. Ontario Ministry of the Environment.
- MOE 1988. Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines. Aluminum. September 1988. Ontario Ministry of the Environment.
- Technical supporting documents published by CCME as part of the Canadian Environmental Quality Guidelines for the protection of aquatic life.
- Technical supporting documents published by BC MOE as part of the BC Approved WQG and Working WQG.

Preferences in TRV selection were given to chronic sublethal toxicity data for reproduction and growth for species representative of a warm water system, if available. For non-listed species, preferences were given to the lowest observed effect level (**LOEL**) or EC_{20}, where available. In the ERA the goal was not to protect each individual from any toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained. Therefore, LOELs or EC_{20}s were considered appropriate TRVs where available for non-listed species. To account for the potential presence of SAR (i.e. the Lilliput mussel) in the study area, a no observed adverse effect level (NOAEL) was also selected for invertebrates following MECP guidance (MECP 2019).

The selected TRVs for aquatic life are summarized in Table 7-2 and discussed Appendix G.

Table 7-2: Surface Toxicological Reference Values for the Protection of Aquatic Life (µg/L)

COPC	Invertebrates	Aquatic Plants	Fish	Amphibians
Aluminum	320 (non-listed) 100 (listed-species)[c]	460	200	320
Iron (total)	1740 (non-listed) 300 (listed-species)[c]	1740	300[a]	1740
Nitrite (as N)	60 (Listed and non-listed) [b]		5,000 (warm water)	60[a]
Phosphorus	30 µg/L (benchmark to prevent algal growth)[d]			

a- PWQO guideline retained as TRV due to limited toxicity information for amphibians
b- PWQO guideline retained as TRV due to limited ROC-specific toxicity information available
c- A NOAEL was selected, where available, to account for the potential presence of SAR (i.e. the Lilliput mussel) in the study area. If the NOAEL was below the provincial guideline, the guideline was retained as the TRV
d- No TRVs were available for phosphorus, a target benchmark of 30 µg/L was selected to prevent excessive algal growth.

7.2 Sediment Toxicity Tests

Select sediment samples were submitted to Bureau Veritas Laboratory[14] (BV) for toxicity tests. BV test methods and detailed results are presented in Appendix E. This section presents a summary of results.

Toxicity tests were completed using the freshwater midge *Chironomus dilutus* and the freshwater amphipod, *Hyalella azteca*. Both lethal (i.e., survival) and sublethal (i.e., growth endpoints) were measured. The tests were completed using the following testing protocols.

- Bureau Veritas Laboratories Standard Operating Procedure: *Chironomus dilutus* 10-Day Survival and Growth Test (BBY2SOP-00010) based on Environment Canada Biological Test Method: Test for Survival and Growth in Sediment Using the Larvae of Freshwater Midges (*Chironomus tentans* or *Chironomus riparius*) (Environmental Protection Series (EPS) 1/RM/32), and
- Bureau Veritas Laboratories SOP: *Hyalella azteca* 14-Day Survival and Growth Test (BBY2SOP-00011) based on the Environment Canada Biological Test Method: Test for Survival and Growth in Sediment and Water Using the Freshwater Amphipod *Hyalella azteca* (EPS 1/RM/33).

These two tests were selected as they are the two aquatic species that are the most highly recommended for most freshwater sediment quality assessments and have been used to evaluate sediment toxicity in Hamilton Harbour.

In addition to the toxicity tests, the overlying waters were analysed for ammonia (as N), hydrogen sulphide, temperature and pH at test initiation and completion to evaluate the potential influence on the toxicity test results (Appendix A of the BV Toxicity Testing Report).

[14] Maxxam Analytics changed their name to Bureau Veritas Laboratory (BVL) in June, 2019.

Toxicity testing response endpoints (survival and growth) were evaluated statistically by BV to determine whether the impacted sediments differed significantly from the laboratory control sediment. These results are presented in Appendix E and summarized in Table 7-3.

Table 7-3: Summary of *Chironomus dilutus* and *Hyalella azteca* Percent Difference

Sample	*Chironomus dilutus* Percent Decreased Compared to Lab Control		*Hyalella azteca* Toxicity Results Percent Decreased Compared to Lab Control	
	Mean Survival	Mean Weight	Mean Survival	Mean Weight
C-5 East / G6	6.3	140	61.2*	71.4*
C-4 West	18.8	116	98*	57.1*
C-3 West	2.1	148	51*	78.6*
C-3 Centre / G5	10.4	152	12.2	42.9*
G-4	12.5	150	34.7*	64.3*
C-1 West	16.7	148	8.4	28.6*

* Statistically significant decrease observed by BV compared to the laboratory control.

The toxicity tests completed with C. dilutus did not show any significant differences between the samples versus the negative control for either the survival or growth endpoints. Therefore, organism survival and growth were not significantly impacted by the presence of COPCs.

The toxicity tests completed with H. azteca shows that all samples except for C3 Centre/G5, G4 and C1 West had a statistically significant decrease in mean survival compared to the negative control. All samples showed a statistically significant decrease in mean dry weight compared to the negative control (Table 7-3). *H. azteca* survival and growth were negatively affected by the presence of COPCs.

7.3 Benthic Invertebrate Community Structure Analysis

A BICS analysis was completed to characterize the benthic invertebrate communities; and thus, to provide a direct measurement of potential COPC-related effects to the ecological integrity of the benthic community metrics under actual field conditions.

7.3.1 Benthic Invertebrate Community Structure Analysis Method

SLR obtained sediment samples for BICS analysis from 10 locations in 2019 (eight in the study area, one in Red Hill Creek and one in Chedoke Bay). The samples were submitted to Entomogen where they were sorted under a dissecting microscope and identified to the lowest practicable taxonomic level (typically species or genus).

Entomogen employed Excel and R version 6.1 (including *iNext*, *vegan*, *stats* and *SpadeR* packages) to evaluate similarities and differences in the metrics, listed below, of benthic invertebrate community structure. A description of these indices and the associated formulae to calculate them are provided in the Entomogen report in Appendix E.

Biologica evaluated the data to further assess changes in the benthic community over time. In doing so, Biologica conducted a two-way analysis of variance (**ANOVA**) to examine the effect of year and site on species richness and the Hilsenhoff's Biotic Index. Biologica also completed cluster analysis in PRIMER-E v. 6.0 to assess differences in community structure among the 2019 macroinvertebrate community stations.

Benthic invertebrate community metrics used to describe the health of the benthic invertebrate communities, included:

- Species Richness
- Hilsenhoff biotic index (HBI);
- Simpsons Diversity Index (1-D);
- Shannon-Weiner Diversity Index (H);
- Pielou's eveness (J');
- % Chironomidae; and
- % Ephemeroptera, Plecoptera, Trichoptera (EPT).

The assessment of BICS carried out by Entomogen, including assessment of overall ecological condition, was provided to SLR in a summary report (report included in Appendix E). In addition, Biologica provided further statistical analysis of the benthic invertebrate community between sampling sites and year over year (2018 and 2019).

7.3.2 Benthic Invertebrate Community Structure Analysis Results

Benthic invertebrate taxa that are tolerant to environmental stress dominated the species composition of all sites sampled in 2018 and 2019. No sensitive species (EPT *spp.*) were observed in 2018 or 2019. Although chironomids, oligochaetes and isopods are generally considered tolerant to pollution, each group contains species with varying tolerance levels. Dominant organisms often characterize sediment pollution (Lenat, Smock and Penrose 1980). In 2018, each location sampled in Chedoke Creek was dominated by tubificids and chironomids; species known to dominate areas of higher organic pollution (Brinkhurst and Gelder 1991). These same species also were observed in high relative proportions in 2019, with a noted increase in isopod % contribution at G5 and G1. Coles et al (2012) note that "*isopods are found in slower moving streams that have relatively low dissolved oxygen concentrations*". Leeches were also observed at G1 and C-3 Centre/G5. "*Leeches are most common in warm, protected shallows where stream velocities are relatively low*" (Coles 2012). The dominant genus of chironomids was *Chironomus* (for both 2018 and 2019) which has been shown to increase in density in watercourses with domestic sewage input (Oliveira, Martins, Alves 2010, Gower and Buckland 1978).

Grain size analysis was completed for all benthic invertebrate sampling locations, with the exception of G1 and R1, due to the coarseness of substrate. Entomogen found that "*sediment grain size data was not sufficient to describe variation in taxa at the sites and that other variables may be driving the system".* This statement does not include G1 and R1, since the grain size at G1 and R1 at these locations could not be analyzed by the laboratory.

As with 2018 results, the Hilsenhoff Biotic Index (HBI) scores calculated in 2019 are similar between sampling locations (Table 7-4). A two-way ANOVA indicated a statistically significant increase in Hilsenhoff HBI values between 2018 and 2019 but that HBI values between sample sites within each sampling year were not statistically different (i.e., HBI for G1 in 2019 is not statistically different from G6 in 2019). Biologica indicated that the observed increase in HBI values was due to an increase in the relative abundance of the more pollution tolerant taxa. Mean species richness increased at all sampling site in 2019 compared to 2018, with the exception of G1 (Table 7-4). A two-way ANOVA indicated a statistically significant increase in species richness between 2018 and 2019 and between sites within each year (i.e., G1 compared to G4 in 2019). Lower species richness observed at G1 is likely driven by differences in habitat (increased substrate coarseness).

Table 7-4: Mean Species Richness and Hilsenhoff's Biotic Index (HBI) in 2018 and 2019

Sampling Location	2018		2019	
	Richness	HBI	Richness	HBI
G1	3.00	6.19	3.33	8.18
G4	2.33	6.00	11.33	9.41
G5	2.33	6.00	6.67	9.37
G6	1.67	4.00	4.67	9.87

To assess differences in community structure among the 2019 benthic invertebrate sampling locations a cluster analysis was performed using the Bray-Curtis Similarity to evaluate variation in 2019 benthic community. This cluster analysis indicated that the invertebrate communities were not statistically distinguishable, except for the community at location G1. This observation should be interpreted with caution given: 1) chemistry and toxicity data are not available for the Red Hill Creek; 2) Substrate at G1 is larger/more course than at the other sampling stations; 3) consideration of hydrological effects on benthic communities has not been considered (i.e., differences of water level and velocity fluctuations experiences at each sampling location).

8.0 RISK CHARACTERIZATION

Risk characterization integrates the results of the exposure and effects assessments to identify potential unacceptable risks from exposure to COPCs. The first step within the risk characterization involves the evaluation of hazard quotients (HQs) on a study area-wide basis. Hazard quotients (HQs) relate the EPC with the TRV as follows:

- Hazard Quotient = Exposure Point Concentration (mg/kg or µg/L) / TRV (mg/kg or µg/L).

Hazard quotients greater than one indicate that potential risks are present; however, hazard quotients above 1.0 do not necessarily indicate that risks are likely or certain.

For sediment the HQs were calculated on an individual sample basis for sessile aquatic organisms (aquatic plants and invertebrates). HQs for aquatic plants and invertebrates were also calculated on a site-wide basis using EPCs (95% UCLM) representative of the entire study area. HQs for fish were calculated using 95% UCLM concentrations. The HQs based on the 95% UCLMs provide "*a conservative estimate of risk, particularly for a small site with relatively few environmental sampling points*" (Golder, 2006).

For surface water, the HQs were calculated using the maximum COPC concentrations. The HQs above are discussed below in Section 8.1.

SLR also implemented a WOE approach using a subset of samples that involved integrating the results for the following three key LOEs: sample specific HQs, benthic invertebrate toxicity testing and BICS analysis. The additional LOEs and WOE are presented in Section 8.2.

Risk Characterization uncertainties are discussed in Section 9.4.

8.1 Sediment HQ

8.1.1 Aquatic Plants and Benthic Invertebrates

SLR calculated HQs based on each sample to evaluate the risks to aquatic plants and benthic invertebrates. The sample-specific HQs also provide information on the spatial distribution of HQs. Sample-specific HQs are provided in Table 4 after the text.

Sample-specific HQs greater than 1.0 for aquatic plants, benthic invertebrates and fish assessed at the community level (non-listed species) are summarized in Table 8-1. These HQs indicates that, for the COPCs for which TRVs were available, PAHs contribute the most to the potential risks. In order to evaluate the relative degree of PAHs contamination of the sediment samples and to make comparisons among locations, a mean HQ quotient (mean HQ-Q) was also calculated for PAHs. The mean HQ-Q was calculated according to the general guidance for calculating mean concentration quotients (e.g. PEC-Qs) and SedQC-Q (ENV, non-dated). The mean HQ-Q for PAHs was calculated by summing the individual PAH HQs obtained with reliable TRV (PEC or PEL) and dividing this number by the number of individual PAHs included in the sum (n=11). The HQ-Qs are presented in Table 8-1. Since PAHs were identified as potential risk-drivers, the HQ-Qs were used to attribute risk categories to the individual samples. Risk categories and criteria used are presented in Table 8-2. HQs greater than 1.0 are furthers discussed after the tables.

Table 8-1: Summary of Sediment Samples with HQs > 1.0

ROCs	Location	Date	acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	fluoranthene	fluorene	methylnaphthalene, 2-	naphthalene	phenanthrene	pyrene	PAHs (sum of total)	PAHs HQ-Q	Cadmium	Copper	Lead	Zinc	Risk Categories
Aquatic plants and benthic invertebrates	G-1 Comp	9/18/2018		9.3	1.2	2.8		1.7	2.5	2.7	4.1	1.6	1.5	1.7	8.1	4.4	1.9	3.8					High
	C-1 West	9/18/2018		16.8	5.6	6.3	1.6	4.1	5.5	5.9	11.0	3.3			14.1	12.4	4.3	7.7					High
	C-2 West	9/18/2018		2.9		1.7		1.2	1.7	1.6	2.4				3.1	2.7	1.0	1.7					Moderate
	C-3 West	10/2/2019		3.0					1.2	1.2	1.4				2.1	1.5	0.6	1.3					Moderate
	C-3 West	9/18/2018									1.2					1.4	0.5	0.6		1.1		1.2	Low
	C-3 Centre	9/18/2018		3.0							1.7				2.8	1.8	0.7	1.3					Moderate
	C-4 West	10/1/2019								1.3						1.1	0.3	0.6				1.2	Low
	C-4 West	9/19/2018		2.8		1.6			1.6	1.5	2.0				2.8	2.3	0.9	1.7	1.2				Moderate
	C-4 Centre	9/19/2018														1.1	0.4	0.5					Low
	C-5 East	9/19/2018	1.4			1.9		1.2	1.4	1.9	1.3					1.9	0.7	1.0			1.6		Moderate*
Fish and amphibians	Study Area-Wide			3.8		1.7		1.2	1.7	1.8	3.1				3.8	3.3	1.2	2.1					Moderate

*A moderate risk ranking was provided because three HQs were close to 2.0 (1.9),seven individual PAHs had HQs>1.o and lead HQ >1.0

This table only present HQs>1.0. Sample-specific HQs are provided in Table 4 after the text.

Table 8-2: Risk Categories and Associated Criteria Used to Rank Sediment Samples Presented in Table 8-1 Based on Analytical Chemistry

Chemistry Risk Categories	Criteria
Low	Mean HQ-Q for PAHs < 1 and all HQ < 2;
Moderate	Mean HQ-Q for PAHs > 1 and at least one HQ ≥ 2 but < 5
High	Mean HQ-Q for PAHs > 1 and at least one HQ ≥ 5

For metals, HQs greater than 1.0 were obtained for cadmium, copper, lead and zinc, each in one sample only. These HQs were of low magnitude (1.1 to 1.6). An HQ of 1.2 was obtained for cadmium for sample C-4 West collected in September 2018. Note that SLR re-sampled location C-3 West and C-4 West in October 2019 and found that the HQs for copper and zinc were below 1.0 in this sample. Study area-wide HQs for metals were less than 1.0. indicating negligible risk based on the community level. Based on the above observations, metals in surface sediment are not considered to be risk drivers in the study area for non-SAR species.

The HQs obtained for nutrients (for which TRVs were available) were less than 1.0, indicating that direct risks from nutrients exposure were negligible.

HQs greater than 1.0 were obtained for one or more individual PAHs at several locations including: G-1 Comp, C-1 West, C-2 West, C-3 West and Centre, C-4 West and Centre, and C-5 East (Table 8-1). The HQs summarized in Table 8-1 indicate that potential risks are present in the study area for aquatic plants and benthic invertebrates exposed to PAHs in sediment. Generally, the magnitude of HQs and number of individual PAHs with HQs above 1.0 are highest at the upstream locations. HQs greater than 4 were only obtained at G-1 Comp and G-1 West in September 2018.

The individual PAH HQs presented in Table 8-1 were obtained by dividing individual PAH concentrations by the corresponding TRV. The resulting HQs show that the sediment samples have generally more than one PAH with an HQ greater than 1.0, and that the magnitudes of the HQs vary among individual PAHs and sampling locations. In addition, Table 8-1 shows that an HQ for total PAHs may be less than 1.0, while in the same sample several individual PAHs have HQs greater than 1.0. The PAHs HQ-Qs indicate that, based on chemistry only, location G-1 Comp and C-1 West (in 2018) contributed the most to the potential risks.

8.1.2 Fish and Amphibians

Study-area wide HQs greater than 1.0 for fish and amphibians were obtained for exposure to PAHs only (Table 8-1; Study Area wide HQs). These HQs indicates that there is a potential risk for fish and amphibians exposed to PAHs in sediment.

8.1.3 Invertebrates Species at risk

As indicated in Section 5.2.3, one SAR mussel species, Lilliput *(Toxolasma parvum),* has been observed in Cootes Paradise and Princes Point near the study area. For this reason, potential risks were conservatively assessed for SAR invertebrates based on lower-level TRVs. The resulting HQs are provided in Table 5 after the text. HQs above 1.0 were found at all sampling locations for most individual PAHs, metals and nutrients and indicated that risks to SAR invertebrates from exposure to sediment were likely.

8.2 Surface Water HQs

SLR calculated HQs based on the maximum concentration to evaluate the risk to aquatic plants, invertebrates, amphibians and fish. For invertebrates, HQs were calculated using TRVs protective of both the community as a whole and individual species, to account for the potential presence of SAR. HQs were also calculated on an individual sample-basis for COPC for which potential risks were identified on a study area wide basis. HQs for all final COPCs are provided in Table 6 following the text.

8.2.1 Invertebrates

The HQs for invertebrates (benthic and zooplankton) exposed to COPCs in surface water are presented in the table below. HQs greater than 1 for invertebrates on a community level were calculated for aluminum and nitrite (as N). HQs were above 1 for aluminum, nitrite (as N) and iron when calculated on an individual basis.

Table 8-3: Invertebrate Hazard Quotients (HQ) for Surface Water

COPC	EPC (µg/L)	TRV (µg/L)		HQ (EPC / TRV)	
		Community (Non-listed)	Individual (Listed)	Community (Non-listed)	Individual (Listed)
Aluminum	598	320	100	1.9	6.0
Iron (total)	1340	1740	300	0.8	4.5
nitrite (as N)	280	60	60	4.7	4.7

Bold HQ >1

On a sample-specific basis, six of seven samples had HQs above 1 for invertebrates exposed to iron (total) when calculated on an individual (SAR) level. All HQs were below 1 for invertebrates (community-level). HQs for nitrite (as N) were above 1.0 at all sample locations on both a community and individual level.

Four of seven samples had HQs above 1 for aluminum (total) for invertebrates (community level), while all sample locations had HQs > 1 when calculated on an individual (SAR) level. However, all HQs were below 1 when calculated using dissolved aluminum concentrations.

8.2.2 Aquatic Plants

The HQs for aquatic plants exposed to COPCs in surface water are presented in the table below. HQs greater than 1 for aquatic plants were calculated for aluminum and nitrite (as N).

Table 8-4: Aquatic Plant Hazard Quotients (HQ) for Surface Water

COPC	EPC (µg/L)	TRV (µg/L)	HQ (EPC / TRV)
Aluminum	598	460	1.3
Iron (total)	1340	1740	0.8
nitrite (as N)	280	60	4.7

Bold HQ >1

On a sample-specific basis, HQs greater than 1.0 were calculated for nitrite (as N) at all seven sample locations. HQs greater than 1.0 were also calculated for total aluminum (2 of 7 locations), however all HQs were below 1.0 when calculated using dissolved aluminum concentrations. HQs for iron (total) were below 1.0 for aquatic plants at all sample locations.

8.2.3 Fish

The HQs for fish exposed to COPCs in surface water are presented in the table below. HQs greater than 1 for fish were calculated for aluminum, iron and nitrite (as N).

Table 8-5: Fish Hazard Quotients (HQ) for Surface water

COPC	EPC (µg/L)	TRV (µg/L)	HQ (EPC / TRV)
Aluminum	598	200	3
Iron (total)	1340	300	4.5
nitrite (as N)	280	60	4.7

Bold HQ >1

On a sample-specific basis, six of seven samples had HQs above 1 for fish exposed to iron (total) in surface water. HQs > 1 were also calculated at 6 of 7 samples for aluminum (total), however all HQs were below 1 when calculated using dissolved aluminum concentrations. HQs were also below 1 for fish exposed to nitrite (as N) for all surface water samples.

8.2.4 Amphibians

The HQs for amphibians exposed to COPCs in surface water are presented in the table below. HQs greater than 1 for fish were calculated for aluminum and nitrite (as N).

Table 8-6: Amphibian Hazard Quotients (HQ) for Surface water

COPC	EPC (µg/L)	TRV (µg/L)	HQ (EPC / TRV)
Aluminum	598	320	1.9
Iron (total)	1340	1740	0.8
nitrite (as N)	280	60	4.7

Bold HQ >1

On a sample-specific basis, all seven samples had HQs above 1 for amphibians exposed to nitrite (as N) in surface water. HQs > 1 were also calculated at 4 of 7 samples for aluminum (total), however all HQs were below 1 when calculated using dissolved aluminum concentrations. HQs were also below 1 for amphibians exposed to iron (total) in all surface water samples.

8.2.5 Interpretation of Surface Water Results

Potential risks were identified for invertebrates (non-listed), aquatic plants and amphibians due to aluminum (total) and nitrite (as N) concentrations in surface water. Potential risks were also identified for fish and invertebrate SAR (if present) due to exposure to all final COPCs (aluminum, iron and nitrite (as N)).

HQs for aluminum in surface water were above 1 for total aluminum concentrations only. When using dissolved aluminum concentrations, calculated HQs were below or equal to 1 for all receptor groups. It is noted that most of the bio-reactive aluminum is likely to be in the dissolved fraction, and the dissolved aluminum concentration excludes particulate aluminum which is less likely to be biologically reactive (BC ENV 2001). Based on the HQs for dissolved aluminum, risks to aquatic receptors are considered negligible.

Although aluminum, iron (total) and nitrite were identified as final COPCs in surface water, with the exception of nitrite these parameters were not identified as COPCs in sediment. No final sediment COPCs were identified as final COPCs in surface water, indicating that sediment is likely acting as a contaminant sink rather than a source. As noted in Section 5.4.1, most of the stream flow directly results from storm water input (HC 2008), therefore surface water concentrations are likely to vary significantly between high and low-flow events. In addition, as noted in Section 6.1.3, Chow-Fraser (1996) documented historically high nutrient conditions in the creek (circa 1996) and linked the high nutrients levels in Chedoke Creek to the CSOs prior to the discharge event.

Although potential risks to select receptors were identified due to exposure to surface water, based on the COPCs present compared to those in sediment, the historical water quality conditions in Chedoke Creek and the variability in surface water concentrations, surface water is unlikely to be the risk-driver for aquatic life within the study area.

HQs were not calculated for phosphorus as no TRVs were available. Although phosphorus concentrations in surface water within the study area exceed the benchmark for excessive algal growth of 30 µg/L, surface water phosphorus levels are expected to be highly variable, and no algae blooms were observed within Chedoke Creek during the site visits.

8.3 Lines of Evidence (LOEs) for Select 2019 Sediment Samples

As indicated in Section 4.0, SLR collected several lines of evidences (LOEs) including, chemistry, toxicity and benthic invertebrate community structure data to assess potential risks to benthic invertebrates from sediment contamination.

Concentrations of contaminants in sediment may exceed the applicable guidelines; however, contaminant concentrations are not necessarily strongly correlated with bioavailability and toxicity. Because relationships between concentrations of contaminants in sediment and their bioavailability are poorly understood, determining effects of contaminants in sediment on aquatic organisms often requires a combination of approaches, including controlled toxicity tests and measures of effects on benthic communities inhabiting sediments (Ingersoll et al., 1997).

While individual measurement tools for assessing sediment contamination each have an inherent level of uncertainty associated with their application, the uncertainty associated with an overall risk assessment of sediment contamination is reduced by integrating these tools. The use of sediment chemistry, sediment toxicity, and benthic community data together establishes a weight of evidence linking contaminants in sediment to adverse biological effects (EC and MOE, 2008). The integration of multiple LOEs using a weight of evidence approach has the potential to substantially reduce uncertainty associated with risk assessment of contaminated sediments and will improve management decisions.

8.3.1 Approach

Additional assessment was conducted on a sub-set of locations in 2019 to obtain information from multiple LOEs for integration into a WOE analysis. The rationale for sample selection for the toxicity testing and BICS analysis LOEs is summarized below:

- Samples with a range of COPC concentrations were selected to represent the range detected across the study area; and
- Sediment samples were collected from areas noted to have the "worst-case" COPC concentrations based on previous sediment sampling events.

The locations that comprised the multiple LOEs assessment are presented below in Table 8-7.

Table 8-7: Summary of 2019 Sediment Samples with Additional Lines of Evidence

Location	Lines of Evidence		
	Chemistry	Toxicity	BICS
C-1 West	√	√	√
G1*	-	-	√
G4	√	√	√
C-3 West	√	√	√
C-3 Centre / G5	√	√	√
C-4 West	√	√	√
C-5 East / G6	√	√	√
R1 (Red Hill)	-	-	√

*substrate at G1 and R1 are comparable and consist of cobble/gravel which did not allow for chemistry or toxicity analysis

Toxicity tests were used as a line of evidence to evaluate sediment quality at AEC 5, consistent with the Canada-Ontario Decision-Making Framework for assessment of contaminated sediment (EC and MOE, 2008) and Federal Contaminated Sites Action Plan (FCSAP) Guidance (EC, 2012). These documents recommend toxicity testing when bulk chemistry indicates that adverse effects may occur such as when one or more sediment COPCs exceed the applicable guidelines and/or background concentrations.

BICS analysis considers site-specific information integrating the fact that the potential effects may be due to elevated chemistry but also to other biological and physical stressors (e.g., particle size, competition/predation).

The results of each of the LOEs are discussed independently below and integrated in a weight of evidence (WOE).

8.3.2 Chemistry Line of Evidence

The 2019 sampling program targeted the locations with highest PAHs concentrations. However, the 2019 results had lower PAHs concentrations than those obtained in 2018. Only two samples, C-3 West and C-4 West had HQs greater than 1.0 for individual PAHs (Table 4, after the text). The categories and criteria used to describe the risks potentially associated with the 2019 samples are presented in Table 8-2. The following risk categories were obtained for the 2019 sediment samples using these criteria.

Table 8-8: 2019 Sediment Samples Risk Categories

Location	Risk Category
C-1 West	Low – HQ-Q for PAHs was 0.6 and no HQs > 2
G1	Low – HQ-Q for PAHs was 0.6 and no HQs > 2
G4	Low – HQ-Q for PAHs was 0.6 and no HQs > 2
C-3 West	Moderate – HQ-Q for PAHs was 1.3 and 2 HQs ≥ 2 but < 5 (2.1 and 3.0)
C-3 Centre / G5	Low – HQ-Q for PAHs was 0.6 and no HQs > 2
C-4 West	Low – HQ-Q for PAHs was 0.6 and no HQs > 2
C-5 East / G6	Low – HQ-Q for PAHs was 0.6 and no HQs > 2

8.3.3 Toxicity Test Line of Evidence

The toxicity test LOE identifies risk categories based on the survival and growth results for the freshwater midge (*C. dilutus*) and the freshwater amphipod (*H. azteca),* as described in Section 7.2.

According to the framework provided by EC and MOE (2008), "*sediments with less than a 20% difference between controls and test/reference sediments are not considered to be toxic, even if the difference is statistically significant*". For this reason, the toxicity test results were further assessed using the typical approach in a sediment quality triad to interpret the magnitude of the response (McDonald 2003, EC and MOE, 2008). The toxicity tests results were categorized into one of three risk categories based on the adverse effect (toxic response) elicited, as shown below in Table 8-9.

Table 8-9: Risk Categories and Criteria for Toxicity LOE

Risk Categories	Criteria
Low	A reduction of less than 20% in all of the test endpoints is considered indicative of a negligible biological effect (e.g., more than 80% survival).
Moderate	A reduction greater than 20% but less than 50% in one or more of the test endpoints is considered indicative of a moderate biological effect (e.g., less than 80% survival but greater than 50% survival).
High	A reduction greater than 50% in one or more of the test endpoints is considered indicative of a severe biological effect (e.g., less than 50% survival).

HQ = hazard quotient

The resulting risk categories and a summary of the results used to assign the categories to each sample are presented in the table below.

Table 8-10: Risk Categories for the Toxicity Testing LOE

Sample	Risk Category (based on the magnitude of toxicity response relative to lab control)
C-1 West	Moderate - - no reduction in *C. dilutus* survival or growth; 8% decrease in *H. azteca* survival, 29% decrease in *H. azteca* growth
G1	-
G4	High - no reduction in *C. dilutus* survival or growth; 35% decrease in *H. azteca* survival, 64% decrease in *H. azteca* growth
C-3 West	High - no reduction in *C. dilutus* survival or growth; 51% decrease in *H. azteca* survival, 79% decrease in *H. azteca* growth
C-3 Centre / G5	Moderate - - no reduction *C. dilutus* survival or growth; 12% decrease in *H. azteca* survival, 43% decrease in *H. azteca* growth
C-4 West	High - no reduction in *C. dilutus* survival or growth; 98% decrease in *H. azteca* survival, 57% decrease in *H. azteca* growth
C-5 East / G6	High - no reduction in *C. dilutus* survival or growth; 39% decrease in *H. azteca* survival, 71% decrease in *H. azteca* growth

There were no differences (significant or greater than 20%) in *C. dilutus* survival and growth between any of the sample locations and the negative laboratory control. A low risk ranking is obtained for all samples based on the *C. dilutus* toxicity test. The moderate and high risks rankings are based on the *H. hazteca* toxicity test.

A review of the chemistry results was completed to identify the potential risk-drivers. The review focuses on the *H. azteca* survival endpoint. The sample with the greatest reduction in mean percent survival (98%) for *H. azteca* were C-4 West followed by C-5 East/G6 and C-3 West. A comparison of the chemistry results to the TRV indicated that 2 PAHs and zinc were above the TRVs in C4-West and that 6 PAHs were above the TRVs in C-3 West. PAHs and metals in all other samples were below the TRVs (Table 8-11). BV noted that a strong hydrocarbon odour was noticed in all replicates of sample C-4 West at the end of the test. The results indicated that PAHs likely contributed to the adverse effects seen in C-4 West and C-3 West. *H. azteca* difference in sensitivity to PAH mixtures in sediment appears to be two-fold compared to chironomids (Verrhiest et al. 2001). While TKN and phosphorus were below the sediment TRV, the highest level of TKN and phosphorus were obtained in C-4 West and C-3 West. In addition, the highest level of total ammonia in sediment and in the overlying water at the test initiation were obtained in C-4 West and C-5 East. Total ammonia decreased during the 14-day toxicity test, which indicates that it is linked to the study area and not an artifact of the tests. Total ammonia likely contributed to the observed adverse effects as *H. azteca* is more sensitive to ammonia than *C. dilutus*.

C-4 West, C-3 West and C-5 East/G6 also had the highest porewater BOD. The toxicity test procedure included aeration of the samples and dissolved oxygen, measured every second days, ranged from 8.2 mg/L to 8.6 mg/L. Environment Canada (2017) indicated that *H. azteca* can be exposed to low levels of oxygen for an extended period of time, with reported 96-h and 30-d LC50s less than 0.3 mg O_2/L. For this reason, in controlled laboratory conditions, dissolved oxygen levels are not considered to have contributed to the observed toxicity.

Table 8-11: COPCs above TRV in Samples Submitted for Toxicity Tests

Sample	PAHs	Metals	Nutrients
C-5 East / G6	<TRV	<TRV	<TRV
C-4 West	2 PAHs > TRV	Zinc >TRV	<TRV
C-3 West	6 PAHs > TRV	<TRV	<TRV
C-3 Centre / G5	<TRV	<TRV	<TRV
G-4	<TRV	<TRV	<TRV
C-1 West	<TRV	<TRV	<TRV

8.3.4 BICS Line of Evidence

The sediment samples were submitted for BICS analysis as described in Section 7.3. A reference location with a comparable substrate was not found during the 2019 field sampling program. For this reason, an evaluation of potential risks based on comparison to a reference site with soft sediment could not be completed.

The benthic community in the study area is dominated by taxa that are tolerant to environmental stress and urbanization. The cluster analysis completed to assess differences in community structure among the 2019 benthic invertebrate sampling locations indicated that the invertebrate communities were not statistically distinguishable, except for the community at location G1 which had a lower number of species and total specimens count. Based on these results, there was little support for classifying degrees of impairment among locations (except for G1). Therefore, a very poor impairment rating (based on the HBI) was assigned to all locations based on the presence of pollution stress-tolerant taxa in 2019.

8.3.5 Weight of Evidence

The final step within the benthic community assessment was to integrate the three LOEs (results of the chemistry, toxicity and BICS) into an overall weight of evidence (WOE) on a sample by sample basis. Each location was assigned a final risk ranking based on the integrated risk category results for the three LOEs.

The final WOE risk rankings were assigned as follows:

- **Negligible Risk Ranking** – risk category of low in the chemistry and toxicity LOEs; BICS does not show impairment.
- **Low Risk Ranking** – risk category is low in at least 2 of the 3 LOEs. None of the LOEs have a risk category of high; BICS shows minimal impairment (HBI very good to good).

- **Moderate Risk Ranking** - risk category of low or moderate in at least 2 of 3 LOEs. Only one LOE with a high LOE risk category if combined with at least one low LOE risk category.
- **High Risk Ranking** - risk category of high in 2 of 3 LOEs, or one high combined with two moderate LOE risk categories. Shows a severe level of effects (reduction greater than 50% in survival in one or more toxicological endpoints).

BICS data is usually considered as the strongest LOE and can be assigned more weight compared with the other LOEs; for example, EC and OMOE (2008) recommend that remediation decisions be based on biology (i.e., BICS results). However, there is a moderate level of uncertainty related to the results of the BICS analysis as an adequate reference could not be found for comparison. Therefore, equal weighting was assigned to both the toxicity and BICS LOEs, rather than weighting one over the other. In addition, the results of the toxicity tests and BICS were aligned in that there was no toxicity observed in the chironomid toxicity test and chironomids were observed to be the dominant species in the study area.

The LOE risk classifications assigned to the seven sediment locations are summarized in Table 8-12. Uncertainties related to the LOEs are discussed in Section 9.0.

Table 8-12: WOE Risk Rankings for Sediment Samples

Location	Risk Categories				WOE Risk Ranking
	Chemistry LOE	Toxicity LOE *C. dilutus*	Toxicity LOE *H. azteca*	BICS LOE	
C-1 West	Low	Low	Moderate	Impaired – HBI very poor	Moderate
G1	-	-	-	Impaired – HBI very poor	High (only one LOE high uncertainty)
G4	Low	Low	High (growth end point only)	Impaired – HBI very poor	High
C-3 West	Moderate	Low	High	Impaired – HBI very poor	High
C-3 Centre / G5	Low	Low	Moderate	Impaired – HBI very poor	Moderate
C-4 West	Low	Low	High	Impaired – HBI very poor	High
C-5 East / G6	Low	Low	High	Impaired – HBI very poor	High

9.0 UNCERTAINTY ANALYSIS

There are four broad types of uncertainty which parallel each of the main stages of a risk assessment, and their inherent assumptions. These types of uncertainty are listed below and briefly discussed in the context of the ERA in the remainder of this section.

- Problem formulation uncertainties
- Exposure assessment uncertainties
- Toxicity/effects assessment uncertainties
- Risk characterization uncertainties

9.1 Problem Formulation Uncertainties

9.1.1 Data Collection and Evaluation Uncertainties

Quantitative components within risk assessments are only as accurate as the accuracy of chemical characterization of media in both space and time. Data representative of current conditions to which receptors may be exposed have been considered in this risk assessment.

Risk assessments rely on the accuracy of the parameter characterization and analysis performed at a site. The data used in this report was collected by several agencies over the period of 2018 to 2019 and data used to analyze trends dated back to 2003. All of the data considered in the risk assessment is believed to be of good quality. The chemical analyses for the 2018 and 2019 data were performed by BV and the City of Hamilton laboratory. Both laboratories are accredited by the Canadian Association for Laboratory Accreditation. Laboratory Quality Assurance Quality Control (QA/QC) samples including blanks, duplicates, and matrix spikes are routinely run with analytical samples, and laboratory data meets all quality objectives prior to being released. SLR also has a standardized corporate QA/QC program which includes following SLR's standard operating procedures and standard industry practices, performing quality checks on historical data.

No PAHs were detected in surface water during the surface water sampling program, however the laboratory detection limits were above the PWQOs or CCME WQGs for select PAH parameters (anthracene, benz(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, perylene, phenanthrene and pyrene).

With the exception of phenanthrene, all of the PAH parameters with detection limits above criteria are high molecular weight (HMW) PAHs with low solubility. PAHs released into water bodies will strongly adsorb to sediments and suspended matter, and HMW PAHs tend to be less soluble than LMW PAHs, therefore HMW PAHs are unlikely to be present in surface water. Phenanthrene is a LMW PAH, and therefore has the potential to be in surface water. However, although the detection limit for phenanthrene is above the PWQO, it is below the CCME WQG, therefore uncertainty associated with phenanthrene concentrations in surface water is low.

Based on the comprehensive QA/QC protocols performed on the data by the laboratory and by SLR, the analytical data is considered to be of good quality and suitable for use in the ERA. Consequently, it is considered unlikely that the uncertainties associated with the laboratory analytical data may have significantly underestimated media concentrations so as to impact the identification of COPCs in the study area.

Though every effort was made to include a local sediment reference location in a comparable urban creek, i.e., Red Hill Creek, due to the nature of the substrate (i.e., cobble) no reference sediments suitable for chemical or toxicological analyses were identified.

9.1.2 COPC Screening Uncertainties

The COPC screening process is designed to be conservative to avoid inadvertently omitting substances which may adversely affect ecological receptor populations during the screening analysis. The conservative nature of the screening process is predicated on using the maximum concentrations from each dataset and using low level type screening values (e.g., PWGO or PSQG LELs).

9.1.2.1 *Depth-Specific COPC Screening*

As noted in Section 4.3.1, COPC screening was completed for the shallow sediment (0-0.15 m) dataset to assess risks where the majority of ecological life may be exposed (MOE 2008). Following MECP guidance, deeper sediment (i.e., greater than 0.15 m) has also been considered to determine whether significant depth-specific differences were present, and to evaluate uncertainties should surficial sediment be removed and deeper sediment exposed. The deep (>0.15 m) sediment dataset was provided in Appendix D, and the results of the COPC screening for the deep dataset is provided in Appendix H. A summary of the COPCs for the deep sediment dataset is provided in the table below. For comparison, the shallow COPC screening results are also provided.

Table 9-1: Depth-Specific Sediment COPC Summary

COPC Group	Sediment (0-0.15) (See Section 5.4.2.1)	Sediment (>0.15)
Metals	Arsenic, cadmium, chromium, copper, lead, manganese, mercury and zinc	Arsenic, cadmium, chromium (III+VI), copper, lead and zinc
PAHs	Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene and total PAHs	Acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene and total PAHs
Nutrients	Total Kjeldahl nitrogen (TKN) and phosphorus	Total Kjeldahl nitrogen (TKN) and phosphorus

As shown in Table 9-1, all shallow sediment COPCs were also identified as COPCs in the deep dataset (0.15+) with the exception of manganese, mercury and acenaphthylene. There is uncertainty associated with the concentrations of manganese and mercury in deep sediment, since these parameters were not analysed as part of the 2018 program. Acenaphthylene was not selected as a COPC since it was not detected in the deep sediment. Although the detection limit exceeded the screening benchmark (ISQG), uncertainty with the selection of this parameter as a COPC is low, since it is also assessed as part of total PAHs.

9.1.2.2 *Uncertain COPCs*

For sediment and surface water, a parameter was retained as a COPC if the maximum concentration exceeded the applicable screening benchmark described in Section 2.0. If no benchmark was available for a parameter, it was retained as an uncertain COPC. Uncertain COPCs retained in sediment and surface water are summarized in the table below.

Table 9-2 Uncertain COPC Summary

COPC Group	Uncertain COPC	Receptor Group (Exposure Pathway)	Uncertainty Level (Low/Medium/High)
Sediment			
Metals	Aluminum	Aquatic Life (Direct Contact)	Low; naturally occurring in aluminosilicate silts and clays, which are common in southern Ontario.
	Antimony		Low; 95%UCLM for antimony of 0.93 mg/kg is below the Table 1 background concentration for soil of 1 mg/kg (MOE 2011a).
	Silver		No aquatic TRVs available for sediment
PAHs	1-methylnaphthalene	Aquatic Life (Direct Contact)	Low; 2-methylnaphthalene assessed. No guidelines or toxicity values specific to 1-methylnaphthalene are available.
Nutrients	Ammonia and ammonium (as N) ammonia as N nitrogen (total)	Aquatic Life (Direct Contact)	Low; algae blooms not observed during site visits. Nutrients generally elevated in the watershed.
Bacteria	Fecal Coliforms	Aquatic Life (Direct Contact)	Low; *E. coli* is the most suitable and specific indicator of fecal contamination (MOE 1994).
Surface Water			
Metals	Iron (total), manganese	Wildlife (Ingestion of Drinking Water)	Low; below available human health drinking water guidelines[15]
PAHs	None	None	-
Nutrients	Kjeldahl nitrogen total silicon	Aquatic Life (Direct Contact) Wildlife (Ingestion of Drinking Water)	Low; algae blooms not observed during site visits. Nutrients generally elevated in the watershed. Other nutrients considered as COPCs in surface water based on available screening benchmark.
Bacteria	-	-	Low; addressed as sediment COPCs, main concern is human health

9.1.3 Receptor Identification Uncertainties

Aquatic plants were assessed at the community level. There are no documented aquatic plants at risk in the study area. The level of uncertainty associated with considering this receptor at the community level is considered to be low.

Aquatic invertebrates were assessed at the community level and at the individual level. There are no documented aquatic invertebrates at risk in the study area; however, one SAR mussel species

[15] Ontario human health drinking water values for iron and manganese are based on aesthetic objectives (, therefore the Health Canada maximum allowable concentration (MAC) was selected for manganese (120 µg/L). No MAC was available for iron, therefore BC Contaminated Sites Regulation drinking water value for iron (6500 µg/L) was selected.

has been documented in Cootes Paradise near the outlet of Chedoke Creek. Based on the lack of survey sites within Chedoke itself, this SAR species has been retained for further assessment. The level of uncertainty associated with considering aquatic invertebrates at the community and individual levels is low.

Aquatic-dependent wildlife receptors were selected by identifying the bird and mammal species potentially using the study area for all or parts of their life cycles. Field surveys were not conducted specifically to determine the occurrence of potential wildlife species thus SLR wildlife observations were incidental in nature and may have missed seasonal presence of some organisms. Information on aquatic-dependent wildlife receptors was gathered from specialised databases and past consultant reports, and a comprehensive list of species potentially present in the study area was developed. The level of uncertainty associated with the selection of receptors of concern is considered to be low.

9.1.4 Exposure Pathway Uncertainties

Only pathways considered to be complete and potentially significant were included for quantification in the ERA. Identification of a complete exposure pathway is based on a rigorous process. Pathways are considered complete if one or more constituents are present in a medium under consideration, and if a route of entry (i.e., direct contact) is present. The decision regarding whether a pathway is significant is based on several factors, including expected magnitude of exposure (e.g., contaminant concentration, frequency and duration of exposure, etc.), likelihood of exposure (e.g., based on site physical features, presence or absence of habitat), properties of a parameter in a given medium, and availability of methods to quantify exposure.

9.2 Exposure Assessment Uncertainties

9.2.1 Estimated Exposure Concentrations

Use of the selected EPCs (95% UCLM for sediment, maximum for surface water) is conservative and will tend to overestimate exposure. EPCs are not distributed evenly throughout the site. Therefore, sediment EPCs are expected to overestimate exposure to aquatic ecological receptors on a study area-wide basis.

Although there is uncertainty associated with a lack of seasonal data for surface water, the use of maximum concentrations is likely to result in an over estimation of risk within the study area.

9.2.1.1 *Depth-Specific EPCs*

To assess the differences between sediment EPCs for the shallow and deep dataset, 95 UCLMs were calculated for both datasets and compared. For PAHs, 13 of the 17 PAH parameters analysed in both datasets were lower in the deep dataset than the shallow dataset, including total PAHs, which was 27% lower in the deep dataset (26.4 mg/kg in shallow, 19.3 mg/kg in deep). The 95% UCLMs for the deep dataset were above the shallow dataset for acenaphthene, fluorene, 2-methylnaphthalene and naphthalene. Based on the 95%UCLM concentration for total PAHs in the shallow dataset vs. the deep dataset, higher risks to aquatic receptors due to PAH exposure are expected to result from exposure to shallow sediment, therefore uncertainty is expected to be low.

95% UCLMs for 7 of the 16 metals parameters analysed in both datasets were higher in the deep dataset than the shallow dataset (antimony, arsenic, barium, cadmium, chromium (total), lead and silver). Of these parameters, arsenic, cadmium, chromium (total) and lead were retained as final COPCs in shallow sediment, while antimony and silver were identified as uncertain COPCs. There is some uncertainty with the selection of EPCs for arsenic, cadmium, chromium (total) and lead as the 95%UCLM concentrations for the deep sediment dataset would have resulted in higher HQs for these parameters. However, since the shallow dataset represents the area where most sediment-dwelling organisms live, uncertainty under current conditions is considered low. For antimony uncertainty is low as the 95%UCLM for antimony is only marginally above the Table 1 Background Concentration for Soil (1.2 mg/kg vs. the Table 1 background concentration of 1 mg/kg). Uncertainty due to depth-specific differences in barium is also considered low as the 95%UCLM concentration for barium of 205 mg/kg in the deep dataset is below the Table 1 background concentration (210 mg/kg). The 95% UCLMs for the deep dataset were below the shallow dataset for beryllium, boron, copper, molybdenum, nickel, thallium, uranium, vanadium and zinc.

For nutrients, both the TKN and phosphorus 95% UCLM concentrations were higher in the deep sediment dataset than the shallow, however the concentrations were comparable to the historical ranges of TKN (120 to 1250 mg/kg) and TP (1000 to 1140 mg/kg) in sediment described in Section 6.1.3. Depth-specific uncertainty related to nutrients is considered low.

9.3 Effects Assessment Uncertainties

Toxicity information for many parameters is often limited. Consequently, there are varying degrees of uncertainty associated with the toxicity values used to determine risk estimates. These uncertainties may result in overestimates or underestimates of risk. PEL-type TRVs were selected for sediment for non-listed species and lower-level SQGs were selected for SAR invertebrates (based on the potential presence of the Lilliput mussel).

TRVs for aquatic plants, fish and amphibians in sediment were not available from the sources of information reviewed.

The PEC and PEL are developed based toxicity tests with benthic invertebrates as it is assumed that benthic invertebrates are generally the organisms most exposed to the sediment and the most sensitive of the aquatic life receptors. Based on this assumption, the uncertainty associated with applying TRVs for benthic invertebrates to evaluate the potential risk to aquatic life is considered to be low.

A TRV could not be identified for silver in sediment. Silver was retained as a COPC based on the maximum concentration (3.3. mg/kg) exceeding the ON Sediment Table 1 Background concentration of 0.5 mg/kg in eight out of the twenty-two sediment samples. The ERA indicated that metals were not the risk drivers in the study area. The level of uncertainty associated with the lack of a TRV for silver is expected to be low.

For surface water, LOAELs and NOAELs were selected from reputable agencies for listed and non-listed species, respectively. The use of PEL- type TRVs for non-listed species and LOAELs or NOAELs for listed species was considered a conservative approach since these values have been based on standardized approaches used by regulatory agencies using carefully scrutinized toxicity datasets. The use of these values as TRVs is not expected to lead to underestimates of risk.

Iron Precipitate

Toxicity values for iron were selected based on reviewed toxicological studies, rather than physical effects due to precipitation and creation of iron floc. The PWQO derivation document for iron (MOE 1979) indicated that while there is considerable variation in acceptable concentrations of iron, there is general agreement that the hydroxide precipitate interferes with respiration through the chorion in fish eggs and impairs gill function of gill-breathing organisms by occlusion of the lamellae. The PWQO for total iron was set at 300 µg/L to prevent the formation of ferric hydroxide precipitate or “floc”. Evidence of significant iron precipitate within the study area was not observed by SLR during the sit visits, therefore a toxicology based TRV was considered more appropriate for assessment of iron effects to aquatic life. Should signs of iron precipitate be observed in the future, further assessment may be required.

9.3.1 Toxicity Testing and BICS Analysis

Additional quantitative assessment was completed to assess risks to benthic invertebrates exposed to COPCs in sediment. Chronic sediment toxicity tests were completed using 10 and 14-day survival and growth tests for the freshwater midge, *C. dilutus* and freshwater amphipod, *H. azteca,* respectively. Testing evaluated significant differences between laboratory controls and impacted samples for either survival or growth endpoints. A total of six impacted samples in the study area were tested. The health histories of the test organisms used in the exposures were acceptable as organism mortality did not exceed 10% during shipping. The tests met all validity criteria outlined in the applicable reference methods. The level of uncertainty associated with the toxicity testing LOE is moderate. A relatively high number of sediment samples were submitted for toxicity testing based on the size of the study area; however, the sediment samples did not necessarily capture the elevated chemistry associated with the highest HQs. There is a high level of ecological relevance associated with this LOE as it assesses potential impacts using biologically relevant organisms under controlled laboratory conditions.

The level of uncertainty associated with the BICS LOE is high. The data suggest that there is an altered community structure due to past and ongoing point sources and nonpoint sources of pollution and urbanization, and an adequate reference location could not be identified. However, there is a high level of ecological relevance associated with this LOE as it directly measures site-specific benthic community impacts.

Measurement errors can also influence the results of the BICS analysis, for example, misidentification of benthic invertebrate species can affect the calculations of the metrics that are used to classify sediment samples as impaired or not impaired. Since 100% of each sample was identified (i.e. no sub sampling), measurement errors related to the BICS analyses are unlikely to influence the results of the risk evaluation.

9.4 Risk Characterization Uncertainties

A combination of tools was used in this risk assessment to qualitatively and quantitatively characterize risks to aquatic receptors. The derivation of a hazard quotient using a conservative TRV to assess risk is a quantitative estimate designed to result in overestimation of risks. Risk estimates attempt to address the variability in exposure point concentrations, or variability in toxicity amongst individuals, by using conservative estimates for these factors. In doing so, the deterministic approach generally overestimates risk, due to compounding/magnification of conservative decisions and assumptions a risk assessor will make in each step or value used in the risk assessment. In addition, the uses of multiple LOEs to characterize overall risk to the benthic invertebrates lowers the uncertainty.

10.0 SUMMARY AND CONCLUSIONS

The purpose of the ERA was to evaluate the potential risks to aquatic plants and invertebrates, fish, amphibians and aquatic-dependent wildlife associated with exposure to contaminants of potential concern (**COPCs**) in sediment and surface water in the study area. The ERA was conducted in response to the sewage discharge.

Sediment (22 samples) and surface water (8 samples) samples collected in 2018 and 2019 represent the water and sediment quality within the study area. The sediment samples used to assess risk in the ERA are located within the top 0 to 0.15 metres of sediment, which is most commonly inhabited by aquatic organisms.

The conceptual site model (CSM) developed in this ERA identified potential pathways by which aquatic life within the study area may be exposed to contaminants in sediment and surface water (termed “complete exposure pathways”). Those exposure pathways include the following:

- Aquatic life such as aquatic plants and algae, invertebrates, fish and amphibians may have direct contact with (i.e. ingest or absorb through skin contact) metals (arsenic, cadmium, chromium, copper, lead manganese, mercury and zinc), PAHs (acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene indeno(1,2,3-cd)pyrene, 2- methylnaphthalene, naphthalene, phenanthrene, pyrene and total PAHs) and nutrients (TKN and total phosphorus) in sediment; and
- Aquatic life such as aquatic plants and algae, invertebrates, fish and amphibians may have direct contact with (i.e. ingest or absorb through skin contact) metals (aluminum and iron) and nutrients (nitrite and total phosphorus) in surface water.

Mammals and birds are not expected to have significant contact with contaminants in sediment and surface water within the study area. Species in these groups are unlikely to spend significant time within the study area due to the lack of food-sources and habitat within the study area and the presence of more suitable habitat in nearby Cootes Paradise Marsh. In addition, based on the results of the ERA, contaminants in sediment and surface water within the study area are not likely to significantly accumulate in the food chain, and are therefore unlikely to pose a risk to higher trophic level wildlife (i.e. carnivorous birds, mammals and reptiles).

The ERA assessed risks by calculating risk estimates known as hazard quotients, (or “HQs”) and comparing to MECP recommended risk target levels. Risk estimates were calculated for both mobile wildlife (i.e. amphibians, reptile and fish) and less mobile communities (i.e. aquatic plants and invertebrates) by assessing exposure on a study wide, and on individual sample location basis. Potential risks to aquatic life due to direct contact with contaminants in surface water were calculated conservatively using the maximum measured concentration within the study area. Where a potential species at risk (SAR) was identified, more conservative values were used to calculate the risk estimate.

In summary, the risk estimate (i.e. HQ) evaluation identified the following:

- For the majority of aquatic life (i.e. non-species at risk), risks due to direct contact with metals in sediment and surface water were low to negligible.

- Risks were also negligible for non-SAR aquatic life and amphibians due to direct contact with nutrients in sediment, however toxicity information was limited for some species groups, so there is some uncertainty in the risk estimates for these receptors. Potential risks were identified for these aquatic life and amphibians for nitrite in surface water.
- Potential risks were identified for aquatic life and amphibians for direct contact with PAHs in sediment on a study-area basis. HQs greater than the risk target level were calculated for one or more individual PAHs at several locations including: G-1 Comp, C-1 West, C-2 West, C-3 West and Centre, C-4 West and Centre, and C-5 East. Generally, the magnitude of HQs and number of individual PAHs with HQs above 1.0 are highest at the upstream locations.
- One SAR mussel species, Lilliput *(Toxolasma parvum),* has been observed in Cootes Paradise Marsh and Princess Point near the study area. For this reason, potential risks were assessed more conservatively for SAR invertebrates using lower toxicity values protective of individuals rather than the overall community. HQs above the target level of 1.0 were found at all sampling locations for metals and/or PAHs in sediment and nutrients in surface water, indicating likely risks to SAR invertebrates from exposure to sediment and surface water.

The aquatic vegetation in the study area was qualitatively evaluated by SLR biologists during the 2019 field program. The aquatic plant life that was observed was consistent with what would be expected, considering the context of the study area (i.e., based on the physical features and water flow patterns of Chedoke Creek) and the surrounding urban landscape.

A weight of evidence (WOE) assessment was completed on a subset of sediment samples (seven in total) to further evaluate risks to benthic invertebrates. Based on the WOE results, there is a moderate to high potential for risks to benthic invertebrates inhabiting sediments in the study area. However, the benthic community observed in the study area is consistent with that observed in streams in similar urban watersheds (Coles et al, 2012). Urban development is often associated with a loss of sensitive species and an increasing percentage of pollution tolerant species due to a high percentage of impervious cover (i.e. concrete, asphalt, roof tops etc.) (Cole et al 2012).

The results of the ERA indicate that the contaminants in the study area sediment, as well as the sediment oxygen demand resulting from the degradation of natural organic detritus (plants, organisms etc.) and/or organic waste, likely limits the benthic invertebrate community makeup to stress tolerant organisms. Review of the contaminant distribution indicates that elevated levels of PAHs, certain metals, nutrients and bacteria have been an ongoing issue in Chedoke Creek sediment and/or surface water prior to and after the 2014-2018 discharge event, including in areas upstream of the Main/King CSO.

11.0 RECOMMENDATIONS

As indicated in the Introduction section this ERA was prepared in response to Director's Order Number 1-MRRCX. Item 1 of the Order required a written report to include: '*an evaluation of the environmental impact to the creek from sewage discharged by the City between January 28, 2014 and July 18, 2018, an identification and evaluation of sewage remaining in the creek, identification of any anticipated on-going environmental impacts to the creek as a result of the sewage spill, and a review of options designed to remediate the creek and monitor the environmental condition of the creek*.'

The findings of this ERA and Wood (2019) indicated that some of the COPCs within the study area sediment are likely associated with the 2014-2018 Main/King CSO discharge event. However, both this ERA and the Wood Report (2019) indicated that the COPCs, as well as sediment depositions within the study area, have many different point and nonpoint sources. In addition, the various CSO and stormwater outfalls in the Chedoke Creek sub-watershed have discharged sewage and stormwater prior to, during and subsequent to the 2014-2018 Main/King CSO discharge. Wood completed an analysis of sediment in the study area to support the design of remediation options and reported that "*the sediment characteristics from the prior discharge events are likely to be similar to, and indistinguishable from, the 2014-2018 Main/King CSO discharge event*" (Wood 2019). SLR agrees with this statement. In addition, the findings of the ERA indicate that elevated concentrations of COPCs have been a persistent and ongoing issue in Chedoke Creek sediment and/or surface water prior to and after the 2014-2018 discharge event, including in areas upstream of the Main/King CSO.

Remediation options discussed in the Wood Report (2019) targeted solids and TKN loading from the discharge. Wood (2019) indicated that approximately 90% of the total phosphorus mass load appeared to have already been solubilized or transported downstream immediately following taking corrective actions at the Main/King CSO tank overflow gate. Subsequent sediment sampling has shown that TKN in surface sediment was below the PSQG LEL in all sediment samples obtained in 2019. For the above reasons, it is not possible to target remediation to COPCs and sediments solely associated with the 2014-2018 Main/King CSO discharge.

Although effects may be related in part to storm water and urban runoff and sewage, based on the degraded conditions generally observed in the study area, and the fact that fecal bacteria are still found in sediment, remediation may be beneficial, nonetheless. The proposed remediation action plan (RAP) provided by Wood (2019) evaluated the following options:

- Physical Capping
- Chemical Inactivation
- Direct Removal
- No-Action Alternative

The above proposed remediation options and no-action alternative are described in Wood (2019) and briefly summarized and evaluated below using additional information not yet available when Wood (2019) was prepared.

<u>Physical Capping</u>

"*Physical capping is accomplished by applying a cover of clean material on top of the contaminated sediment to effectively eliminate or reduce biogeochemical and physical interaction with the overlying water column*" (Wood 2019).

Physical capping was not recommended by Wood (2019) based on the minimal water depth and high flows within the study area, which would limit the effectiveness of this method. In addition, the surface water sampling program completed in 2019 indicated that the metals and PAHs present in elevated concentrations in the sediment were not COPCs in surface water. Based on the findings of the ERA, physical capping is **not recommended**.

Chemical Inactivation

"*Chemical inactivation of sediment is utilized worldwide to reduce the release of phosphorus from sediments to the water column via processes such as diffusion and resuspension*" (Wood 2019).

Chemical inactivation only addresses phosphorus and 90 percent of the phosphorus load is no longer in the study area. The ERA indicates other sediment COPCs such as PAHs and certain metals likely are primary contributors to the degraded sediment quality observed within the study area. Chemical inactivation would not address these COPCs. Therefore, chemical inactivation is **not recommended**.

Direct Removal

Wood (2019) recommended physical removal of the organic sediment within the study area as it would "directly address the three primary sources of potential impairment including nutrient contamination, bacteriological contamination, and habitat loss". Hydraulic dredging was the recommended method as it provides "an efficient means to remove the target sediments down to a specific elevation without the need to disturb areas outside of the necessary dredge footprint". A conceptual dredge design is provided in Wood (2019).

While Wood (2019) identified the three primary sources of potential impairment as 'nutrient contamination, bacteriological contamination, and habitat loss', SLR would identify additional persistent COPCs such as PAHs, and certain metals. Hydraulic dredging would likely address the fecal coliform remaining in the surface sediment (<0.15 m). Except for one location (C3-West), fecal coliforms were not detected in deeper sediment in 2018. However, hydraulic dredging may not address nutrient contamination. Sediment results in 2019 indicated that TKN was below the LEL. In addition, most of the total phosphorus load is no longer in the study area and total phosphorus concentrations in sediment in Chedoke Bay were comparable to historical concentrations. Thus, removal of key parameters associated with sewage discharge by dredging may not be warranted as these parameters have not persisted subsequent to the Main/King CSO discharge event. However, hydraulic dredging may address other COPC such as PAHs and certain metals (e.g., copper) that are likely contributing to the adverse effects. In addition, dredged areas would be subject to re-contamination resulting in temporary benefits of sediment removal. For these reasons, advantages and disadvantages associated with dredging are shown in Table 11-1.

Table 11-1: Some Effects Associated with Sediment Removal by Dredge in Chedoke Creek.

Advantages	Disadvantages
• Improved sediment quality after removal of COPCs • The ongoing presence of fecal bacteria that are still found in sediment • Opportunity to enhance riparian and aquatic habitat in dredged areas (although habitat enhancement could occur even without dredging)	• Disruption of aquatic habitat in dredged areas including removal of benthic organisms and aquatic plants • Sediment removal may cause potential harm to a species at risk mussel • Short-term benefit given likelihood of re-contamination of sediments given persistent presence of COPCs in Chedoke Creek sediments, unless management of input water quality occurs • Temporary benefit may be shortened further if natural re-colonization of dredged area is delayed given the likely paucity of benthic invertebrate populations in the upstream concrete channel reaches to provide individuals to drift and re-populate lower reaches of the Creek • Low dissolved oxygen and continued inputs from upstream urban runoff may limit re-colonization by sensitive species • Nutrient contamination typically associated with sewage discharge have reduced to the extent that TKN concentration is below LEL and most of the total phosphorus load is no longer in the study area. Furthermore, total phosphorus concentrations in sediment in Chedoke Bay were comparable to historical concentrations, thus the rationale to address potential effects of the CSO discharge are largely abated.

Given the strength of the disadvantages associated with direct sediment removal (dredging), and that nutrients appear comparable to historical concentrations, this remedial activity is **not recommended** at this time.

No-Action Alternative

The ERA has shown that PAHs, certain metals, nutrients and bacteria in surface water and/or sediment have been an ongoing concern (above PSQG LELs or PWQOs) in Chedoke Creek and/or Chedoke Bay and that the benthic invertebrate community makeup is limited to stress tolerant organisms. In addition, toxicity tests completed in controlled laboratory conditions indicated that the sediment elicited adverse effects in the amphipod *H. azteca*. Finally, while fecal coliform concentrations have decreased since 2018, fecal coliforms are still detectable in surface sediment. Fecal bacteria in sediment can form a reservoir of viable organism that can enter the water column when the sediment is stirred (Mallin et al. 2007). However, these observed effects are associated with numerous upstream sources other than the Main/King CSO discharge.

As reported above, most of the total phosphorus load is no longer in the study area and total phosphorus concentrations in sediment in Chedoke Bay were comparable to historical concentrations in 2019. In addition, sediment samples show fecal coliform levels had decreased in October 2019 compared to September 2018 and TKN in surface sediment was below the PSQG LEL in all sediment samples obtained in 2019. These findings suggest no persistent, elevated levels of nutrients in Chedoke Creek downstream from the King/Main CSO.

The Director's Order required "*an identification and evaluation of sewage remaining in the creek, anticipation of any ongoing environmental impacts to the creek as a result of the sewage spill, and a review of options designed to remediate the creek and monitor the environmental condition of the creek.*"

Options to remediate and monitor the creek were contingent on the assessment of impact. Given that post-discharge levels of contaminants appear consistent with pre-discharge levels, no ongoing impacts to the creek as a result of the sewage spill persist. Monitoring the environmental condition of the creek as it relates to ongoing operations for the Main/King CSO is occurring. Thus, remediation would appear unnecessary to address effects from the sewage discharge that occurred from 2014 to 2018, and the '**no action**' alternative is recommended.

12.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for the City of Hamilton referred to as the “Client”. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

This report has been prepared for specific application to this site and conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR’s professional opinion based on limited investigations including visual observation of the study area, environmental investigation at discrete locations and depths, and laboratory analysis of specific parameters. The results cannot be extended to previous or future site conditions, portions of the site that were unavailable for direct investigation, subsurface locations which were not investigated directly, or parameters and materials that were not addressed. Substances other than those addressed by the investigation may exist within the study area; and substances addressed by the investigation may exist in areas of the creek not investigated in concentrations that differ from those reported. SLR does not warranty information from third party sources used in the development of investigations and subsequent reporting.

Nothing in this report is intended to constitute or provide a legal opinion. SLR expresses no warranty to the accuracy of laboratory methodologies and analytical results. SLR expresses no warranty with respect to the toxicity data presented in various references or the validity of toxicity studies on which it was based. Scientific models employed in the evaluations were selected based on accepted scientific methodologies and practices in common use at the time and are subject to the uncertainties on which they are based.

SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

The Client may submit this report to the Ministry of Environment Conservation and Parks and/or related Ontario environmental regulatory authorities or persons for review and comment purposes. These agencies may rely on the information contained in this report regarding the study area, as described in this report. These agencies may copy the report as required to fulfil regulatory obligations.

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TABLES

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

TABLE 1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR AQUATIC LIFE - SEDIMENT (0-0.15 mbss)

SEDIMENT CHARACTERIZATION															ECOLOGICAL HEALTH SCREENING		
			Maximum Concentration				Second Highest Concentration				95% UCLM	ProUCL	Background		Screening Benchmarks		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Method applied	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	COPC?
Shallow Depth (0 to 0.15 mbss)																	
Metals																	
Aluminum	6 (+0)	6 (+0)	13,200	C-4 West	0-0.15	10/1/2019	12200	C-3 West	0-0.15	10/2/2019	11987	95% BCA Bootstrap	-	-	-	-	Uncertain
Antimony	22 (+0)	7 (+0)	1.54	C-4 West	0-0.15	10/1/2019	1.3	C-5 East	0-0.15	9/19/2018	0.932	95% KM (BCA)	1.0	-	-	-	Uncertain
Arsenic	22 (+0)	22 (+0)	12	C-5 East	0-0.15	9/19/2018	5.76	C-4 West	0-0.15	10/1/2019	5.517	95% BCA Bootstrap	-	4.0	**6**	5.9	**Yes; maximum > LEL**
Barium	22 (+0)	22 (+0)	210	C-5 East	0-0.15	9/19/2018	141	C-4 West	0-0.15	9/19/2018	117.9	95% BCA Bootstrap	210.0	-	-	-	No; maximum < Table 1 background
Beryllium	22 (+0)	22 (+0)	0.67	C-4 West	0-0.15	10/1/2019	0.6	C-3 West	0-0.15	10/2/2019	0.477	95% BCA Bootstrap	2.5	-	-	-	
Boron	22 (+0)	15 (+0)	23.5	C-1 West	0-0.15	10/2/2019	23.4	C-4 West	0-0.15	10/1/2019	19	95% BCA Bootstrap	36.0	-	-	-	
Cadmium	22 (+0)	22 (+0)	8.5	C-5 East	0-0.15	9/19/2018	6.1	C-4 West	0-0.15	9/19/2018	2.427	95% BCA Bootstrap	-	1.0	**0.6**	0.6	**Yes; maximum > LEL**
Chromium (III+VI)	22 (+0)	22 (+0)	41	C-4 West	0-0.15	9/19/2018	37	C-5 East	0-0.15	9/19/2018	27.52	95% BCA Bootstrap	-	31.0	**26**	37.3	**Yes; maximum > LEL**
Copper	22 (+0)	15 (+0)	170	C-3 West	0-0.15	9/18/2018	145	C-4 West	0-0.15	9/18/2018	91.01	95% BCA Bootstrap	-	25.0	**16**	35.7	**Yes; maximum > LEL**
Iron	6 (+0)	6 (+0)	25,600	C-4 West	0-0.15	10/1/2019	24,800	C-3 West	0-0.15	10/2/2019	23967	95% BCA Bootstrap	-	30,000	**20,000**	-	No; maximum < background
Lead	22 (+0)	15 (+0)	145	C-5 East	0-0.15	9/19/2018	87	C-3 West	0-0.15	9/18/2018	57.90	95% BCA Bootstrap	-	23.0	**31**	35	**Yes; maximum > LEL**
Manganese	6 (+0)	6 (+0)	623	G-5 Comp	0-0.15	10/2/2019	594	C-4 West	0-0.15	10/1/2019	589	95% BCA Bootstrap	-	400.0	**460**	-	**Yes; maximum > LEL**
Mercury	6 (+0)	6 (+0)	0.255	C-3 West	0-0.15	10/2/2019	0.197	C-4 West	0-0.15	10/1/2019	0.187	95% BCA Bootstrap	-	0.1	**0.2**	0.17	**Yes; maximum > LEL**
Molybdenum	22 (+0)	22 (+0)	2.4	C-3 West	0-0.15	9/18/2018	2.34	C-4 West	0-0.15	10/1/2019	1.407	95% BCA Bootstrap	2.0	-	-	-	No; maximum < Table 1 background
Nickel	22 (+0)	15 (+0)	36	C-5 East	0-0.15	9/19/2018	32	C-4 West	0-0.15	9/19/2018	24.34	95% BCA Bootstrap	-	31.0	**16**	-	No; maximum within 20% of background
Selenium	22 (+0)	5 (+0)	1	C-3 West	0-0.15	9/18/2018	1	C-5 East	0-0.15	9/19/2018	NC	-	1.2	-	-	-	No; maximum < Table 1 background
Silver	22 (+0)	22 (+0)	3.3	C-4 West	0-0.15	9/19/2018	3	C-5 East	0-0.15	9/19/2018	1.126	95% BCA Bootstrap	-	**0.5**	-	-	Uncertain, maximum > background
Sodium	6 (+0)	6 (+0)	447	C-4 West	0-0.15	10/1/2019	363	C-1 West	0-0.15	10/2/2019	360.7	95% BCA Bootstrap	-	-	-	-	Uncertain
Thallium	22 (+0)	22 (+0)	0.263	C-4 West	0-0.15	10/1/2019	0.255	C-3 West	0-0.15	10/2/2019	0.177	95% BCA Bootstrap	1.0	-	-	-	No; maximum < Table 1 background
Tin	6 (+0)	6 (+0)	6.31	G-4 Comp	0-0.15	10/2/2019	5.05	C-4 West	0-0.15	10/1/2019	4.822	95% BCA Bootstrap	-	-	-	-	Uncertain
Titanium	6 (+0)	6 (+0)	150	C-4 West	0-0.15	10/1/2019	139	C-3 West	0-0.15	10/2/2019	137.3	95% BCA Bootstrap	-	-	-	-	Uncertain

TABLE 1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR AQUATIC LIFE - SEDIMENT (0-0.15 mbss)

SEDIMENT CHARACTERIZATION															ECOLOGICAL HEALTH SCREENING		
			Maximum Concentration				Second Highest Concentration				95% UCLM	ProUCL	Background		Screening Benchmarks		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Method applied	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	COPC?
Uranium	22 (+0)	22 (+0)	0.886	C-4 West	0-0.15	10/1/2019	0.88	C-3 West	0-0.15	9/18/2018	0.687	95% BCA Bootstrap	1.9	-	-	-	No; maximum < Table 1 background
Vanadium	22 (+0)	15 (+0)	28.7	C-4 West	0-0.15	10/1/2019	24.9	C-3 West	0-0.15	10/2/2019	21.05	95% BCA Bootstrap	86.0	-	-	-	No; maximum < Table 1 background
Zinc	22 (+0)	15 (+0)	532	C-4 West	0-0.15	10/1/2019	505	C-3 West	0-0.15	9/18/2018	349.3	95% BCA Bootstrap	-	65.0	**120**	123	**Yes; maximum > LEL**
PAHs																	
Acenaphthylene	22 (+0)	8 (+0)	0.18	C-5 East	0-0.15	9/19/2018	0.11	C-4 West	0-0.15	9/19/2018	0.0423	95% KM (BCA)	-	-	-	**0.00587**	**Yes; maximum > ISQG**
Acenaphthene	22 (+0)	11 (+0)	1.49	C-1 West	0-0.15	9/18/2018	0.83	G-1 Comp	0-0.1	9/18/2018	0.341	95% KM (BCA)	-	-	-	**0.00671**	**Yes; maximum > ISQG**
Anthracene	22 (+0)	16 (+0)	4.69	C-1 West	0-0.15	9/18/2018	0.99	G-1 Comp	0-0.1	9/18/2018	0.867	95% KM (BCA)	-	-	**0.22**	0.0469	**Yes; maximum > LEL**
Benz(a)anthracene	22 (+0)	22 (+0)	6.6	C-1 West	0-0.15	9/18/2018	2.96	G-1 Comp	0-0.1	9/18/2018	1.83	95% BCA Bootstrap	-	-	**0.32**	0.0317	**Yes; maximum > LEL**
Benzo[b]fluoranthene	22 (+0)	22 (+0)	8.37	C-1 West	0-0.15	9/18/2018	3.59	G-1 Comp	0-0.1	9/18/2018	2.517	95% BCA Bootstrap	0.3	-	-	-	No; assessed as total PAHs[b]
Benzo(b+j)fluoranthene	6 (+0)	6 (+0)	1.4	C-3 West	0-0.15	10/2/2019	1.3	C-4 West	0-0.15	10/1/2019	1.267	95% BCA Bootstrap	-	-	-	-	No; assessed as total PAHs[b]
benzo(g,h,i)perylene	22 (+0)	22 (+0)	4.36	C-1 West	0-0.15	9/18/2018	1.45	G-1 Comp	0-0.1	9/18/2018	1.236	95% BCA Bootstrap	-	-	**0.17**	-	**Yes; maximum > LEL**
benzo(k)fluoranthene	22 (+0)	17 (+0)	2.29	C-1 West	0-0.15	9/18/2018	1.37	G-1 Comp	0-0.1	9/18/2018	0.71	95% KM (BCA)	-	-	**0.24**	-	**Yes; maximum > LEL**
Benzo(a)pyrene	22 (+0)	22 (+0)	6.01	C-1 West	0-0.15	9/18/2018	2.4	G-1 Comp	0-0.1	9/18/2018	1.712	95% BCA Bootstrap	-	-	**0.37**	0.0319	**Yes; maximum > LEL**
Chrysene	22 (+0)	22 (+0)	7.15	C-1 West	0-0.15	9/18/2018	3.24	G-1 Comp	0-0.1	9/18/2018	2.155	95% BCA Bootstrap	-	-	**0.34**	0.0571	**Yes; maximum > LEL**
Dibenz(a,h)anthracene	22 (+0)	13 (+0)	0.79	C-1 West	0-0.15	9/18/2018	0.37	G-1 Comp	0-0.1	9/18/2018	0.242	95% KM (BCA)	-	-	**0.06**	0.00622	**Yes; maximum > LEL**
Fluoranthene	22 (+0)	22 (+0)	24.5	C-1 West	0-0.15	9/18/2018	9.08	G-1 Comp	0-0.1	9/18/2018	6.834	95% BCA Bootstrap	-	-	**0.75**	0.111	**Yes; maximum > LEL**
Fluorene	22 (+0)	13 (+0)	1.76	C-1 West	0-0.15	9/18/2018	0.84	G-1 Comp	0-0.1	9/18/2018	0.395	95% KM (BCA)	-	-	**0.19**	0.0212	**Yes; maximum > LEL**
indeno(1,2,3-cd)pyrene	22 (+0)	22 (+0)	3.45	C-1 West	0-0.15	9/18/2018	1.34	G-1 Comp	0-0.1	9/18/2018	0.997	95% BCA Bootstrap	-	-	**0.2**	-	**Yes; maximum > LEL**
Methylnaphthalene, 1-	16 (+0)	2 (+0)	0.2	G-1 Comp	0-0.1	9/18/2018	0.15	C-4 West	0-0.15	9/19/2018	NC	-	0.05	-	-	-	No; assessed as total PAHs[b]
Methylnaphthalene, 2-	22 (+0)	9 (+0)	0.3	C-4 West	0-0.15	9/19/2018	0.3	G-1 Comp	0-0.1	9/18/2018	0.0877	95% KM (BCA)	-	-	-	0.0202	**Yes; maximum > ISQG**
Naphthalene	22 (+0)	11 (+0)	0.98	G-1 Comp	0-0.1	9/18/2018	0.24	C-3 Centre	0-0.15	9/18/2018	0.191	95% KM (BCA)	-	-	-	0.0346	**Yes; maximum > ISQG**
Phenanthrene	22 (+0)	22 (+0)	16.5	C-1 West	0-0.15	9/18/2018	9.53	G-1 Comp	0-0.1	9/18/2018	4.336	95% BCA Bootstrap	-	-	**0.56**	0.0419	**Yes; maximum > LEL**
Pyrene	22 (+0)	22 (+0)	18.9	C-1 West	0-0.15	9/18/2018	6.75	G-1 Comp	0-0.1	9/18/2018	4.973	95% BCA Bootstrap	-	-	**0.49**	0.053	**Yes; maximum > LEL**
PAHs (sum of total)	6 (+0)	6 (+0)	13	C-3 West	0-0.15	10/2/2019	7.8	C-4 West	0-0.15	10/1/2019	26.41	95% BCA Bootstrap	-	-	**4**	-	**Yes; maximum > LEL**

TABLE 1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR AQUATIC LIFE - SEDIMENT (0-0.15 mbss)

SEDIMENT CHARACTERIZATION															ECOLOGICAL HEALTH SCREENING		
			Maximum Concentration				Second Highest Concentration				95% UCLM	ProUCL	Background		Screening Benchmarks		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Method applied	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	COPC?
Nutrients																	
ammonia and ammonium (as N)	16 (+0)	6 (+0)	400	C-3 West	0-0.15	9/18/2018	300	C-4 West	0-0.15	9/19/2018	NC	-	-	-	-	-	Uncertain
ammonia as N	6 (+0)	6 (+0)	190	C-4 West	0-0.15	10/1/2019	130	G-6 Comp	0-0.15	10/1/2019	122.7	95% BCA Bootstrap	-	-	-	-	Uncertain
kjeldahl nitrogen total	22 (+0)	22 (+0)	1,900	C-3 West	0-0.15	9/18/2018	1,600	C-4 West	0-0.15	9/19/2018	841.8	95% BCA Bootstrap	-	-	**550**	-	**Yes; maximum > LEL**
nitrogen (total)	6 (+0)	3 (+0)	4,000	C-4 West	0-0.15	10/1/2019	3,000	C-3 West	0-0.15	10/2/2019	NC	-	-	-	-	-	Uncertain
organic phosphorus	6 (+0)	5 (+0)	4.6	C-4 West	0-0.15	10/1/2019	3.1	C-3 West	0-0.15	10/2/2019	3.25	95% KM (BCA)	-	-	-	-	No; assessed as total phosphorus[c]
phosphorus total	22 (+0)	22 (+0)	1,622	C-3 West	0-0.15	9/18/2018	1,560	C-4 West	0-0.15	10/1/2019	1020	95% BCA Bootstrap	-	-	**600**	-	**Yes; maximum > LEL**
Fecal Coliforms	17 (+0)	16 (+0)	45,000	C-3 West	0-0.15	9/18/2018	43,000	C-3 Centre	0-0.15	9/18/2018	25529	95% KM (BCA)	-	-	-	-	Uncertain

Notes:
mg/kg - milligram per kilogram
mbss - metres below sediment surface
PWQO - Provincial Water Quality Objective
BC CSR - British Columbia Contaminated Site Regulation
COPC - Contaminant of Potential Concern
conc. - concentration
Dup - Duplicate
max. - maximum
UCLM - Upper Confidence Limit of the Mean
"-" No guideline available, or not selected, as provincial guideline is available.
Value selected for screening.
BOLD formatting indicates selected screening benchmark
a - Background sediment values from MOE 2008 (the great lakes basin) were preferentially selected where available.
b- total PAHs include Acenaphthylene, acenaphthene, anthracene, benz(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene
c- total phosphorus includes both organic and inorganic phosphorus

References:
MOE 2008. ON PSQG Background Concentrations:Ontario Provincial Sediment Quality Guideline - Table 3 and Table 4 Background Sediment Concentrations
ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level
MOE 2011. ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards
CCME SedQG Freshwater (ISQG):CCME Sediment Quality Guidelines for the Protection of Aquatic Life, Freshwater (Interim sediment quality guidelines)
CCME SedQG Freshwater (PEL):CCME Sediment Quality Guidelines for the Protection of Aquatic Life, Freshwater (Probable effects levels)

TABLE 2. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR AQUATIC LIFE - SURFACE WATER

SURFACE WATER CHARACTERIZATION									ECOLOGICAL HEALTH SCREENING						
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration			Second Highest Concentration			Screening Benchmarks					Preliminary COPC?	Final COPC?
			Conc.	Sample ID	Sample Date	Conc.	Sample ID	Sample Date	PWQO	CCME FWAL (long term)	APVs	BC AWF	BC WQG		
Metals (µg/L)															
Aluminium	7 (+1)	7 (+1)	598	C-5 East - G6	9/30/2019	489	C-4 West	9/30/2019	**75**	-	-	-	-	**Yes; maximum > PWQO**	**Yes; maximum > PWQO**
Barium	7 (+1)	7 (+1)	49.5	C-5 East - G6	9/30/2019	49.2	C-4 West	9/30/2019	-	-	2,300	-	-	**Uncertain**	No; maximum < APV
Barium (filtered)	7 (+1)	7 (+1)	48.6	C-4 West	9/30/2019	47.2	C-5 East - G6	9/30/2019	-	-	2,300	-	-	**Uncertain**	No; maximum < APV
Boron (total)	7 (+1)	7 (+1)	206	C-4 West	9/30/2019	197	C-3 Centre - G5	9/30/2019	**200**	**1500**	3550	-	-	**Yes; maximum > PWQO**	No; maximum < APV
Boron (filtered)	7 (+1)	7 (+1)	211	C-3 Centre - G5	9/30/2019	209	C-4 West	9/30/2019	**200**	**1500**	3550	-	-	**Yes; maximum > PWQO**	No; maximum < APV
Chromium (III+VI) total	7 (+1)	7 (+1)	1	C-5 East - G6	9/30/2019	0.8	C-4 West	9/30/2019	-	-	64	-	-	**Uncertain**	No; maximum < APV
Chromium (III+VI) Filtered	7 (+1)	2 (+0)	0.1	C-3 West	9/30/2019	0.1	G-1 Comp	9/30/2019	-	-	64	-	-	**Uncertain**	No; maximum < APV
Iron (total)	7 (+1)	7 (+1)	1180	C-5 East - G6	9/30/2019	990	C-4 West	9/30/2019	**300**	**300**	-	-	1,000	**Yes; maximum > PWQO**	**Yes; maximum < BC WQG**
Manganese	7 (+1)	7 (+1)	98.9	C-5 East - G6	9/30/2019	88.2	C-4 West	9/30/2019	-	320[a]	-	-	-	No; maximum < Draft CCME Guideline	No; maximum < BC WQG
Manganese (filtered)	7 (+1)	7 (+1)	76.2	C-5 East - G6	9/30/2019	63	C-4 West	9/30/2019	-	320[a]	-	-	-	No; maximum < Draft CCME Guideline	No; maximum < BC WQG
Sodium	7 (+1)	7 (+1)	87,900	G-4 Comp	9/30/2019	84,200	C-3 West	9/30/2019	-	-	180,000	-	-	**Uncertain**	No; maximum < APV
Sodium (filtered)	7 (+1)	7 (+1)	93,400	G-4 Comp	9/30/2019	89,800	C-3 West	9/30/2019	-	-	180,000	-	-	**Uncertain**	No; maximum < APV
titanium	7 (+1)	7 (+1)	11.2	C-5 East - G6	9/30/2019	9.2	C-4 West	9/30/2019	-	-	-	1,000	-	**Uncertain**	No; maximum < BC AWF
titanium (filtered)	7 (+1)	6 (+1)	0.3	C-1 West	9/30/2019	0.2	C-3 Centre - G5	9/30/2019	-	-	-	1,000	-	**Uncertain**	No; maximum < BC AWF
Zinc	7 (+1)	7 (+1)	22	C-1 West (Field Duplicate)	9/30/2019	21	C-3 West	9/30/2019	**20**	**7**	89	-	-	**Yes; maximum > PWQO**	No; maximum < APV
Nutrients (mg/L)															
kjeldahl nitrogen total	7 (+1)	7 (+1)	1.5	C-5 East - G6	9/30/2019	1.4	C-4 West	9/30/2019	-	-	-	-	-	**Uncertain**	Uncertain
nitrate (as N)	7 (+1)	7 (+1)	2.07	G-4 Comp	9/30/2019	1.95	C-1 West	9/30/2019	-	13[b]	-	-		No; maximum < interim guideline	-
nitrite (as N)	7 (+1)	7 (+1)	0.28	G-4 Comp	9/30/2019	0.22	C-1 West	9/30/2019	-	0.06	-	-	-	**Yes; maximum > CCME**	**Yes; maximum > CCME**
nitrate and nitrite (as N)	7 (+1)	7 (+1)	2.35	G-4 Comp	9/30/2019	2.17	C-1 West	9/30/2019	-	-	-	400	-	**Uncertain**	No; maximum < BC AWF
orthophosphate (PO4-P)	7 (+1)	7 (+1)	0.44	C-1 West	9/30/2019	0.44	G-1 Comp	9/30/2019	-	-	-	-	-	**Uncertain**	No; assessed as total phosphorus[c]
phosphorus total	7 (+1)	7 (+1)	0.45	C-1 West (Field Duplicate)	9/30/2019	0.428	G-1 Comp	9/30/2019	0.01	-	-	-	-	**Yes; maximum > PWQO**	**Yes; maximum > PWQO**

TABLE 2. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR AQUATIC LIFE - SURFACE WATER

SURFACE WATER CHARACTERIZATION									ECOLOGICAL HEALTH SCREENING						
			Maximum Concentration			Second Highest Concentration			Screening Benchmarks						
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Conc.	Sample ID	Sample Date	Conc.	Sample ID	Sample Date	PWQO	CCME FWAL (long term)	APVs	BC AWF	BC WQG	Preliminary COPC?	Final COPC?
phosphorus (Filtered)	7 (+1)	7 (+1)	0.42	G-1 Comp	9/30/2019	0.41	C-1 West (Field Duplicate)	9/30/2019	0.01	-	-	-	-	**Yes; maximum > PWQO**	**Yes; maximum > PWQO**
Silicon	7 (+1)	7 (+1)	3.71	C-5 East - G6	9/30/2019	3.62	C-3 West	9/30/2019	-	-	-	-	-	**Uncertain**	Uncertain
Silicon (filtered)	7 (+1)	7 (+1)	2.8	C-3 West	9/30/2019	2.79	G-4 Comp	9/30/2019	-	-	-	-	-	**Uncertain**	Uncertain
E.coli	7 (+1)	7 (+1)	4,100	C-1 West	9/30/2019	2800	G-1 Comp	9/30/2019	-	-	-	-	-	**Uncertain**	Uncertain

Notes:
mg/L - milligram per litre
µg/L - microgram per litre
mbg - metres below ground
PWQO - Provincial Water Quality Objective
BC CSR - British Columbia Contaminated Site Regulation
COPC - Contaminant of Potential Concern
conc. - concentration
Dup - Duplicate
max. - maximum
UCLM - Upper Confidence Limit of the Mean
"-" No guideline available, or not selected, as provincial guideline is available.
a - draft CCME guideline (2018)
b- interim CCME guideline (2003)
Value selected for screening.
BOLD formatting indicates selected screening benchmark

References:
ON PWQO:Ontario Provincial Water Quality Objectives, July 1994
CCME WQG Freshwater Aquatic Life (long term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Long-term)

TABLE 3. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR WILDLIFE - SURFACE WATER

SEDIMENT CHARACTERIZATION															
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration			Second Highest Concentration			Red Hill Max Value	Screening Benchmark					COPC?
			µg/L	Sample ID	Sample Date	µg/L	Sample ID	Sample Date		CCME WQG Agricultural (Livestock)	BC WQG Wildlife (Approved)	BC CSR LW (Approved)	BC CSR LW or WQG Wildlife (Working)	O.Reg 153/04 Standard - Potable Water (GW1 values)	
Metals (µg/L)															
Aluminum	7 (+1)	7 (+1)	598	C-5 East - G6	9/30/2019	489	C-4 West	9/30/2019	24	5000	5000	5000	-	-	No; maximum < CCME WQG
Barium	7 (+1)	7 (+1)	49.5	C-5 East - G6	9/30/2019	49.2	C-4 West	9/30/2019	62.6	-	-	-	-	1000	No; maximum < MECP GW1
Barium (filtered)	7 (+1)	7 (+1)	48.6	C-4 West	9/30/2019	47.2	C-5 East - G6	9/30/2019	62.4	-	-	-	-	1000	No; maximum < MECP GW1
Boron (total)	7 (+1)	7 (+1)	206	C-4 West	9/30/2019	197	C-3 Centre - G5	9/30/2019	131	5000	5000	5000	-	5000	No; maximum < CCME WQG
Boron (filtered)	7 (+1)	7 (+1)	211	C-3 Centre - G5	9/30/2019	209	C-4 West	9/30/2019	141	5000	5000	5000	-	5000	No; maximum < CCME WQG
Chromium (III+VI) total	7 (+1)	7 (+1)	1	C-5 East - G6	9/30/2019	0.8	C-4 West	9/30/2019	<0.1	-	-	-	50	50	No; maximum < BC LW/Wildlife
Chromium (III+VI) Filtered	7 (+1)	2 (+0)	0.1	C-3 West	9/30/2019	0.1	G-1 Comp	9/30/2019	<0.1	-	-	-	50	50	No; maximum < BC LW/Wildlife
Iron (total)	7 (+1)	7 (+1)	1180	C-5 East - G6	9/30/2019	990	C-4 West	9/30/2019	140	-	-	-	-	-	Uncertain
Manganese	7 (+1)	7 (+1)	98.9	C-5 East - G6	9/30/2019	88.2	C-4 West	9/30/2019	136	-	-	-	-	-	Uncertain
Manganese (filtered)	7 (+1)	7 (+1)	76.2	C-5 East - G6	9/30/2019	63	C-4 West	9/30/2019	106	-	-	-	-	-	Uncertain
Sodium	7 (+1)	7 (+1)	87,900	G-4 Comp	9/30/2019	84,200	C-3 West	9/30/2019	121000	-	-	-	-	200,000	No; maximum < MECP GW1
Sodium (filtered)	7 (+1)	7 (+1)	93,400	G-4 Comp	9/30/2019	89,800	C-3 West	9/30/2019	124000	-	-	-	-	200,000	No; maximum < MECP GW1
titanium	7 (+1)	7 (+1)	11.2	C-5 East - G6	9/30/2019	9.2	C-4 West	9/30/2019	1	-	-	-	100	-	No; maximum < BC LW/Wildlife
titanium (filtered)	7 (+1)	6 (+1)	0.3	C-1 West	9/30/2019	0.2	C-3 Centre - G5	9/30/2019	0.1	-	-	-	100	-	No; maximum < BC LW/Wildlife
Zinc	7 (+1)	7 (+1)	22	C-1 West (Field Duplicate)	9/30/2019	21	C-3 West	9/30/2019	5	-	-	2000	-	5000	No; maximum < BC LW
Nutrients (mg/L)															
kjeldahl nitrogen total	7 (+1)	7 (+1)	1.5	C-5 East - G6	9/30/2019	1.4	C-4 West	9/30/2019	0.3	-	-	-	-	-	Uncertain
nitrate (as N)	7 (+1)	7 (+1)	2.07	G-4 Comp	9/30/2019	1.95	C-1 West	9/30/2019	0.33	-	-	-	-	-	No; maximum of nitrate+nitrite < CCME WQG
nitrite (as N)	7 (+1)	7 (+1)	0.28	G-4 Comp	9/30/2019	0.22	C-1 West	9/30/2019	<0.05	10	10	10	-	-	No; maximum < CCME WQG

TABLE 3. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING FOR WILDLIFE - SURFACE WATER

SEDIMENT CHARACTERIZATION															
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration			Second Highest Concentration			Red Hill Max Value	Screening Benchmark					COPC?
			µg/L	Sample ID	Sample Date	µg/L	Sample ID	Sample Date		CCME WQG Agricultural (Livestock)	BC WQG Wildlife (Approved)	BC CSR LW (Approved)	BC CSR LW or WQG Wildlife (Working)	O.Reg 153/04 Standard - Potable Water (GW1 values)	
nitrate and nitrite (as N)	7 (+1)	7 (+1)	2.35	G-4 Comp	9/30/2019	2.17	C-1 West	9/30/2019	0.33	100	100	100	-	-	No; maximum < CCME WQG
orthophosphate (PO4-P)	7 (+1)	7 (+1)	0.44	C-1 West	9/30/2019	0.44	G-1 Comp	9/30/2019	<0.05	-	-	-	-	-	Uncertain
phosphorus	7 (+1)	7 (+1)	0.45	C-1 West (Field Duplicate)	9/30/2019	0.428	G-1 Comp	9/30/2019	<0.01	-	-	-	-	-	Uncertain
phosphorus (Filtered)	7 (+1)	7 (+1)	0.42	G-1 Comp	9/30/2019	0.41	C-1 West (Field Duplicate)	9/30/2019	<0.01	-	-	-	-	-	Uncertain
Silicon	7 (+1)	7 (+1)	3.71	C-5 East - G6	9/30/2019	3.62	C-3 West	9/30/2019	3.97	-	-	-	-	-	Uncertain
Silicon (filtered)	7 (+1)	7 (+1)	2.8	C-3 West	9/30/2019	2.79	G-4 Comp	9/30/2019	4.41	-	-	-	-	-	Uncertain
E.coli	7 (+1)	7 (+1)	4,100	C-1 West	9/30/2019	2800	G-1 Comp	9/30/2019	10	-	-	-	-	-	Uncertain

Notes:
mg/L - milligram per litre
µg/L - microgram per litre
mbg - metres below ground
PWQO - Provincial Water Quality Objective
BC CSR - British Columbia Contaminated Site Regulation
O.Reg 153/04 Standard - Potable Water: GW1 Component values from MOE 2011
COPC - Contaminant of Potential Concern
conc. - concentration
Dup - Duplicate
max. - maximum
UCLM - Upper Confidence Limit of the Mean
"-" No guideline available, or not selected, as provincial guideline is available.
a - draft CCME guideline (2018)
b- interim CCME guideline (2003)
Value selected for screening.
BOLD formatting indicates selected screening benchmark

References:
ON PWQO:Ontario Provincial Water Quality Objectives, July 1994
CCME WQG Freshwater Aquatic Life (long term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Long-term)
MOE 2011. Rationale for the Development of the Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Ministry of the Environment Standards Development Branch. April 15, 2011.

TABLE 4: SEDIMENT EPCS AND HQS – NO SAR

				Carbon	PAHs																														
				Total Organic Carbon	acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(g,h,i)perylene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	methylnaphthalene, 2-	naphthalene	phenanthrene	pyrene	PAHs (sum of total)	Mean PAH-Q	arsenic	cadmium	chromium	copper	iron	lead	manganese	mercury	silver	zinc	kjeldahl nitrogen total	phosphorus total
				µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g		µg/g	µg/g		µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
TRV (PEC, PEL or SEL)					0.128	0.0889	0.845	1.05	6.4	1.45	1.45	1.29	0.135	2.223	0.536	6.4	0.201	0.561	1.17	1.52	22.8		33	4.98	111	149	40000	91.3	1100	0.486		450	4800	2000
Monitoring_Zone	Location_Code	Sampled_Date_Time																																	
G-1	G-1 Comp	9/18/2018	Concentrations	-	<0.1	0.83	0.99	2.96	1.45	1.37	2.4	3.24	0.37	9.08	0.84	1.34	0.3	0.98	9.53	6.75	42.23		3.8	0.37	21	63	-	16	-	-	0.13	187	900	690
G-1	G-1 Comp	9/18/2018	HQs			9.3	1.2	2.8	0.2	0.9	1.7	2.5	2.7	4.1	1.6	0.2	1.5	1.7	8.1	4.4	1.9	3.8	0.1	0.1	0.2	0.4		0.2				0.4	0.2	0.3
C-1	C-1 West	10/2/2019	Concentrations	26,000	0.011	0.049	0.13	0.6	0.46	0.31	0.69	0.86	0.12	1.9	0.063	0.45	0.012	0.014	0.86	1.4	6.7		3.56	1.32	21.8	44.6	23,000	24.5	566	0.057	0.083	214	5.8	715
C-1	C-1 West	10/2/2019	HQs		0.1	0.6	0.2	0.6	0.1	0.2	0.5	0.7	0.9	0.9	0.1	0.1	0.1	0.0	0.7	0.9	0.3	0.5	0.1	0.3	0.2	0.3	0.6	0.3	0.5	0.1		0.5	0.0	0.4
C-1	C-1 West	9/18/2018	Concentrations	-	<0.1	1.49	4.69	6.6	4.36	2.29	6.01	7.15	0.79	24.5	1.76	3.45	<0.1	<0.1	16.5	18.9	98.69		3.6	0.41	22	30	-	20	-	-	0.11	215	500	598
C-1	C-1 West	9/18/2018	HQs			16.8	5.6	6.3	0.7	1.6	4.1	5.5	5.9	11.0	3.3	0.5			14.1	12.4	4.3	7.7	0.1	0.1	0.2	0.2		0.2				0.5	0.1	0.3
G-2	G-2 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	0.12	0.38	0.22	<0.2	0.36	0.45	<0.1	1.11	<0.1	0.19	<0.1	<0.1	0.73	0.85	5.11		3	0.27	21	50	-	13	-	-	0.1	167	400	628
G-2	G-2 Comp	9/18/2018	HQs				0.1	0.4	0.0		0.2	0.3		0.5		0.0			0.6		0.2	0.2	0.1	0.1	0.2	0.3		0.1				0.4	0.1	0.3
C-2	C-2 West	9/18/2018	Concentrations	-	<0.1	0.26	0.43	1.79	0.99	0.99	1.71	2.13	0.22	5.25	0.29	0.9	<0.1	0.22	3.63	4.06	22.97		4.6	0.58	19	51	-	34	-	-	0.19	244	1000	837
C-2	C-2 West	9/18/2018	HQs			2.9	0.5	1.7	0.2	0.7	1.2	1.7	1.6	2.4	0.5	0.1		0.4	3.1	2.7	1.0	1.7	0.1	0.1	0.2	0.3		0.4				0.5	0.2	0.4
G-3	G-3 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	<0.1	0.18	0.13	<0.2	0.18	0.26	<0.1	0.59	<0.1	0.11	<0.1	<0.1	0.25	0.47	2.97		3.9	0.56	20	81	-	50	-	-	0.48	311	600	795
G-3	G-3 Comp	9/18/2018	HQs					0.18	0.0		0.1	0.2		0.3		0.0			0.2	0.3	0.1	0.1	0.1	0.1	0.2	0.5		0.5				0.7	0.1	0.4
G-4	G-4 Comp	10/2/2019	Concentrations	31,000	0.013	0.03	0.08	0.45	0.43	0.25	0.57	0.79	0.11	1.5	0.047	0.39	0.014	0.014	0.6	1.1	5.3		4.13	0.623	25.7	64.9	22,600	39.6	550	0.104	0.387	332	47	993
G-4	G-4 Comp	10/2/2019	HQs		0.1	0.3	0.1	0.18	0.1	0.2	0.4	0.6	0.8	0.7	0.1	0.1	0.1	0.0	0.5	0.7	0.2	0.4	0.1	0.1	0.2	0.4	0.6	0.4	0.5	0.2		0.7	0.0	0.5
G-4	G-4 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	<0.1	0.34	0.2	<0.2	0.33	0.42	<0.1	0.96	<0.1	0.18	<0.1	<0.1	0.45	0.76	4.44		3.6	0.39	22	58	-	22	-	-	0.31	215	400	737
G-4	G-4 Comp	9/18/2018	HQs					0.18	0.0		0.2	0.3		0.4		0.0			0.4	0.5	0.2	0.2	0.1	0.1	0.2	0.4		0.2				0.5	0.1	0.4
G-5	G-5 Comp	10/2/2019	EPC	20,000	0.012	0.038	0.12	0.54	0.38	0.23	0.58	0.75	0.1	1.6	0.048	0.36	0.0096	0.0089	0.68	1.2	5.7		3.71	0.601	19.8	38.1	21,100	29.6	623	0.1	0.263	272	35	871
G-5	G-5 Comp	10/2/2019	HQs		0.1	0.4	0.1	0.18	0.1	0.2	0.4	0.6	0.7	0.7	0.1	0.1	0.0	0.0	0.6	0.8	0.3	0.4	0.1	0.1	0.2	0.3	0.5	0.3	0.6	0.2		0.6	0.0	0.4
G-5	G-5 Comp	9/19/2018	EPC	-	<0.1	<0.1	0.16	0.68	0.38	0.29	0.68	0.84	<0.1	1.91	<0.1	0.32	<0.1	<0.1	0.94	1.48	8.18		3.9	0.57	21	64	-	42	-	-	0.42	275	800	756
G-5	G-5 Comp	9/19/2018	HQs				0.2	0.18	0.1	0.2	0.5	0.7		0.9		0.1			0.8	1.0	0.4	0.4	0.1	0.1	0.2	0.6		0.4				0.6	0.2	
C-3	C-3 West	10/2/2019	EPC	39,000	0.016	0.27	0.43	1.1	0.57	0.41	0.94	1.5	0.16	3.2	0.31	0.54	0.067	0.13	2.5	2.3	13		4.97	0.753	31.5	85.7	24,800	44.9	588	0.255	0.607	427	95	1170
C-3	C-3 West	10/2/2019	HQs		0.1	3.0	0.5	1.0	0.1	0.3	0.6	1.2	1.2	1.4	0.6	0.1	0.3	0.2	2.1	1.5	0.6	1.3	0.2	0.2	0.3	0.6	0.6	0.5	0.5	0.5		0.9	0.0	0.6
C-3	C-3 West	9/18/2018	EPC	-	<0.1	<0.1	0.12	0.79	0.54	0.52	0.91	1.23	0.13	2.56	<0.1	0.54	<0.1	<0.1	1.13	2.09	10.96		4.7	0.81	31	170	-	87	-	-	1.6	505	1900	1622
C-3	C-3 West	9/18/2018	HQs				0.1	0.8	0.1	0.4	0.6	1.0	1.0	1.2		0.1			1.0	1.4	0.5	0.6	0.1	0.2	0.3	1.1		1.0				1.1	0.4	0.8
C-3	C-3 Centre	9/18/2018	EPC	-	<0.1	0.27	0.28	1.1	0.44	0.63	1.05	1.34	0.12	3.7	0.26	0.46	0.1	0.24	3.23	2.75	15.97		3.5	0.39	26	71	-	28	-	-	0.37	202	600	660
C-3	C-3 Centre	9/18/2018	HQs			3.0	0.3	1.0	0.1	0.4	0.7	1.0	0.9	1.7	0.5	0.1	0.5	0.4	2.8	1.8	0.7	1.3	0.1	0.1	0.2	0.5		0.3				0.4	0.1	0.3
C-3	C-3 East	9/18/2018	EPC	-	<0.1	<0.1	<0.1	0.38	0.23	<0.2	0.39	0.5	<0.1	1.1	<0.1	0.2	<0.1	<0.1	0.39	0.86	4.85		3.8	0.76	16	60	-	59	-	-	0.3	310	800	642
C-3	C-3 East	9/18/2018	HQs					0.4	0.0		0.3	0.4		0.5		0.0			0.3		0.2	0.2	0.1	0.2	0.1	0.4		0.6				0.7	0.2	0.3
C-4	C-4 West	10/1/2019	EPC	47,000	0.021	0.045	0.1	0.71	0.74	0.47	0.69	1.3	0.17	2.2	0.074	0.63	0.034	0.023	0.83	1.6	7.8		5.76	0.914	35.9	125	25,600	51.3	594	0.197	1.18	532	330	1560
C-4	C-4 West	10/1/2019	HQs		0.2	0.5	0.1	0.7	0.1	0.3	0.5	1.0	1.3	1.0	0.1	0.1	0.2	0.0	0.7	1.1	0.3	0.6	0.2	0.2	0.3	0.8	0.6	0.6	0.5	0.4		1.2	0.1	0.8
C-4	C-4 West	9/19/2018	EPC	-	0.11	0.25	0.69	1.69	0.77	0.7	1.5	2.01	0.2	4.5	0.47	0.65	0.3	0.14	3.32	3.48	20.48		5.5	6.1	41	145	-	72	-	-	3.3	472	1600	1260
C-4	C-4 West	9/19/2018	HQs		0.9	2.8	0.8	1.6	0.1	0.5	1.0	1.6	1.5	2.0	0.9	0.1	1.5	0.2	2.8	2.3	0.9	1.7	0.2	1.2	0.4	1.0		0.8				1.0	0.3	0.6
C-4	C-4 Centre	9/19/2018	EPC	-	<0.1	<0.1	0.15	0.71	0.41	0.3	0.69	0.89	<0.1	2.12	0.11	0.35	<0.1	<0.1	1.16	1.62	8.91		4.1	0.56	19	42	-	32	-	-	0.27	298	600	718
C-4	C-4 Centre	9/19/2018	HQs				0.2	0.7	0.1	0.2	0.5	0.7		1.0	0.2	0.1			1.0	1.1	0.4	0.5	0.1	0.1	0.2	0.3		0.4				0.7	0.1	0.4
C-4	C-4 East	9/19/2018	EPC	-	<0.1	<0.1	<0.1	0.44	0.37	0.23	0.48	0.66	<0.1	1.41	<0.1	0.27	<0.1	<0.1	0.6	1.13	6.19		4.3	0.74	22	72	-	28	-	-	0.58	215	1000	861
C-4	C-4 East	9/19/2018	HQs					0.4	0.1	0.2	0.3	0.5		0.6		0.0			0.5		0.3	0.2	0.1	0.1	0.2	0.5		0.3				0.5	0.2	0.4
C-5	C-5 West	9/19/2018	EPC	-	<0.1	<0.1	<0.1	0.46	0.38	0.25	0.5	0.68	<0.1	1.44	<0.1	0.27	<0.1	<0.1	0.72	1.16	6.46		5.7	3.1	32	97	-	56	-	-	1.3	428	1200	1120
C-5	C-5 West	9/19/2018	HQs					0.4	0.1	0.2	0.3	0.5		0.6		0.0			0.6	0.8	0.3	0.3	0.2	0.6	0.3	0.7		0.6				1.0	0.3	0.6
C-5	C-5 Centre	9/19/2018	EPC	-	<0.1	<0.1	<0.1	0.42	0.31	<0.2	0.39	0.47	<0.1	1.15	<0.1	0.25	<0.1	<0.1	0.58	0.92	5.29		3.7	0.86	20	66	-	49	-	-	0.53	244	500	781
C-5	C-5 Centre	9/19/2018	HQs					0.4	0.0		0.3	0.4		0.5		0.0			0.5	0.6	0.2	0.2	0.1	0.2	0.2	0.4		0.5				0.5	0.1	0.4
C-5	C-5 East	9/19/2018	EPC	-	0.18	<0.1	0.28	1.99	0.98	0.72	1.69	1.76	0.26	2.99	0.1	0.88	<0.1	0.15	0.93	2.94	15.95		12	8.5	37	136	-	145	-	-	3	414	900	978
C-5	C-5 East	9/19/2018	HQs		1.4		0.3	1.9	0.2	0.5	1.2	1.4	1.9	1.3	0.2	0.1			0.8	1.9	0.7	1.0	0.4	1.7	0.3	0.9		1.6				0.9	0.2	0.5
G-6	G-6 Comp	10/1/2019	EPC	39,000	0.02	0.084	0.12	0.61	0.63	0.34	0.75	1.1	0.13	2	0.087	0.54	0.027	0.029	0.89	1.5	7.3		4.29	0.609	22.6	64.1	18,800	46.1	390	0.104	0.342	339	180	904
G-6	G-6 Comp	10/1/2019	HQs		0.2	0.9	0.1	0.18	0.1	0.2	0.5	0.9	1.0	0.9	0.2	0.1	0.1	0.1	0.8	1.0	0.3	0.6	0.1	0.1	0.2	0.4	0.5	0.5	0.4	0.2		0.8	0.0	0.5
		95% UCLM	EPC		0.0423	0.341	0.867	1.83	1.236	0.71	1.712	2.155	0.242	6.834	0.395	0.997	0.0877	0.191	4.336	4.973	26.41		5.52	2.4	27.5	91	23967	57.9	589	0.187	1.126	349.3	841.8	1020
		95% UCLM	HQs		0.3	3.8	1.0	1.7	0.2	0.5	1.2	1.7	1.8	3.1	0.7	0.2	0.4	0.3	3.7	3.3	1.2	2.1	0.2	0.5	0.2	0.6	0.6	0.6	0.5	0.4	-	0.8	0.2	0.5

EPC - Exposure point concentration
HQs - Hazard quotients
TRV - Toxicity reference value
HQs are obtained by dividing the EPC by the TRV
HQs >1.0 indicate potential risk
The mean HQ-Q for PAHs was calculated by summing the individual PAH HQs obtained with reliable TRV (PEC or PEL) and dividing this number by the number of individual PAHs included in the sum.

TABLE 5: SEDIMENT EPCS AND HQS – SAR

Monitoring_Zone	Location_Code	Sampled_Date_Time		Carbon	PAHs																												
				Total Organic Carbon	acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(g,h,i)perylene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	methylnaphthalene, 2-	naphthalene	phenanthrene	pyrene	PAHs (sum of total)	arsenic	cadmium	chromium	copper	iron	lead	manganese	mercury	silver	zinc	kjeldahl nitrogen total	phosphorus total
				µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g		µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
TRV (TEL, LEL or ISQG)					0.01	0.0060	0.220	0.32	0.17	0.24	0.37	0.34	0.06	0.75	0.19	0.2	0.02	0.176	0.56	0.49	4	9.79	0.99	43.3	31.6	30000	35.8	460	0.18		121	550	600
G-1	G-1 Comp	9/18/2018	Concentrations	-	<0.1	0.83	0.99	2.96	1.45	1.37	2.4	3.24	0.37	9.08	0.84	1.34	0.3	0.98	9.53	6.75	42.23	3.8	0.37	21	63	-	16	-	-	0.13	187	900	690
G-1	G-1 Comp	9/18/2018	HQs			138.3	4.5	9.3	8.5	5.7	6.5	9.5	6.2	12.1	4.4	6.7	15.0	5.6	17.0	13.8	10.6	0.4	0.4	0.5	2.0		0.4				1.5	1.6	1.2
C-1	C-1 West	10/2/2019	Concentrations	26,000	0.011	0.049	0.13	0.6	0.46	0.31	0.69	0.86	0.12	1.9	0.063	0.45	0.012	0.014	0.86	1.4	6.7	3.56	1.32	21.8	44.6	23,000	24.5	566	0.057	0.083	214	5.8	715
C-1	C-1 West	10/2/2019	HQs		1.1	8.2	0.6	1.9	2.7	1.3	1.9	2.5	2.0	2.5	0.3	2.3	0.6	0.1	1.5	2.9	1.7	0.4	1.3	0.5	1.4	0.8	0.7	1.2	0.3		1.8	0.0	1.2
C-1	C-1 West	9/18/2018	Concentrations	-	<0.1	1.49	4.69	6.6	4.36	2.29	6.01	7.15	0.79	24.5	1.76	3.45	<0.1	<0.1	16.5	18.9	98.69	3.6	0.41	22	30	-	20	-	-	0.11	215	500	598
C-1	C-1 West	9/18/2018	HQs			248.3	21.3	20.6	25.6	9.5	16.2	21.0	13.2	32.7	9.3	17.3			29.5	38.6	24.7	0.4	0.4	0.5	0.9		0.6				1.8	0.9	1.0
G-2	G-2 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	0.12	0.38	0.22	<0.2	0.36	0.45	<0.1	1.11	<0.1	0.19	<0.1	<0.1	0.73	0.85	5.11	3	0.27	21	50	-	13	-	-	0.1	167	400	628
G-2	G-2 Comp	9/18/2018	HQs				0.5	1.2	1.3		1.0	1.3		1.5		1.0			1.3		1.3	0.3	0.3	0.5	1.6		0.4				1.4	0.7	1.0
C-2	C-2 West	9/18/2018	Concentrations	-	<0.1	0.26	0.43	1.79	0.99	0.99	1.71	2.13	0.22	5.25	0.29	0.9	<0.1	0.22	3.63	4.06	22.97	4.6	0.58	19	51	-	34	-	-	0.19	244	1000	837
C-2	C-2 West	9/18/2018	HQs			43.3	2.0	5.6	5.8	4.1	4.6	6.3	3.7	7.0	1.5	4.5		1.3	6.5	8.3	5.7	0.5	0.6	0.4	1.6		0.9				2.0	1.8	1.4
G-3	G-3 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	<0.1	0.18	0.13	<0.2	0.18	0.26	<0.1	0.59	<0.1	0.11	<0.1	<0.1	0.25	0.47	2.97	3.9	0.56	20	81	-	50	-	-	0.48	311	600	795
G-3	G-3 Comp	9/18/2018	HQs					0.18	0.8		0.5	0.8		0.8		0.6			0.4	1.0	0.7	0.4	0.6	0.5	2.6		1.4				2.6	1.1	1.3
G-4	G-4 Comp	10/2/2019	Concentrations	31,000	0.013	0.03	0.08	0.45	0.43	0.25	0.57	0.79	0.11	1.5	0.047	0.39	0.014	0.014	0.6	1.1	5.3	4.13	0.623	25.7	64.9	22,600	39.6	550	0.104	0.387	332	47	993
G-4	G-4 Comp	10/2/2019	HQs		1.3	5.0	0.4	0.18	2.5	1.0	1.5	2.3	1.8	2.0	0.2	2.0	0.7	0.1	1.1	2.2	1.3	0.4	0.6	0.6	2.1	0.8	1.1	1.2	0.6		2.7	0.1	1.7
G-4	G-4 Comp	9/18/2018	Concentrations	-	<0.1	<0.1	<0.1	0.34	0.2	<0.2	0.33	0.42	<0.1	0.96	<0.1	0.18	<0.1	<0.1	0.45	0.76	4.44	3.6	0.39	22	58	-	22	-	-	0.31	215	400	737
G-4	G-4 Comp	9/18/2018	HQs					0.18	1.2		0.9	1.2		1.3		0.9			0.8	1.6	1.1	0.4	0.4	0.5	1.8		0.6				1.8	0.7	1.2
G-5	G-5 Comp	10/2/2019	Concentrations	20,000	0.012	0.038	0.12	0.54	0.38	0.23	0.58	0.75	0.1	1.6	0.048	0.36	0.0096	0.0089	0.68	1.2	5.7	3.71	0.601	19.8	38.1	21,100	29.6	623	0.1	0.263	272	35	871
G-5	G-5 Comp	10/2/2019	HQs		1.2	6.3	0.5	0.18	2.2	1.0	1.6	2.2	1.7	2.1	0.3	1.8	0.5	0.1	1.2	2.4	1.4	0.4	0.6	0.5	1.2	0.7	0.8	1.4	0.6		2.2	0.1	1.5
G-5	G-5 Comp	9/19/2018	Concentrations	-	<0.1	<0.1	0.16	0.68	0.38	0.29	0.68	0.84	<0.1	1.91	<0.1	0.32	<0.1	<0.1	0.94	1.48	8.18	3.9	0.57	21	64	-	42	-	-	0.42	275	800	756
G-5	G-5 Comp	9/19/2018	HQs				0.7	0.18	2.2	1.2	1.8	2.5		2.5		1.6			1.7	3.0	2.0	0.4	0.6	0.5	2.0		1.3				8.7	1.5	
C-3	C-3 West	10/2/2019	Concentrations	39,000	0.016	0.27	0.43	1.1	0.57	0.41	0.94	1.5	0.16	3.2	0.31	0.54	0.067	0.13	2.5	2.3	13	4.97	0.753	31.5	85.7	24,800	44.9	588	0.255	0.607	427	95	1170
C-3	C-3 West	10/2/2019	HQs		1.6	45.0	2.0	3.4	3.4	1.7	2.5	4.4	2.7	4.3	1.6	2.7	3.4	0.7	4.5	4.7	3.3	0.5	0.8	0.7	2.7	0.8	1.3	1.3	1.4		3.5	0.2	2.0
C-3	C-3 West	9/18/2018	Concentrations	-	<0.1	<0.1	0.12	0.79	0.54	0.52	0.91	1.23	0.13	2.56	<0.1	0.54	<0.1	<0.1	1.13	2.09	10.96	4.7	0.81	31	170	-	87	-	-	1.6	505	1900	1622
C-3	C-3 West	9/18/2018	HQs				0.5	2.5	3.2	2.2	2.5	3.6	2.2	3.4		2.7			2.0	4.3	2.7	0.5	0.8	0.7	5.4		2.4					3.5	2.7
C-3	C-3 Centre	9/18/2018	Concentrations	-	<0.1	0.27	0.28	1.1	0.44	0.63	1.05	1.34	0.12	3.7	0.26	0.46	0.1	0.24	3.23	2.75	15.97	3.5	0.39	26	71	-	28	-	-	0.37	202	600	660
C-3	C-3 Centre	9/18/2018	HQs			45.0	1.3	3.4	2.6	2.6	2.8	3.9	2.0	4.9	1.4	2.3	5.0	1.4	5.8	5.6	4.0	0.4	0.4	0.6	2.2		0.8					1.1	1.1
C-3	C-3 East	9/18/2018	Concentrations	-	<0.1	<0.1	<0.1	0.38	0.23	<0.2	0.39	0.5	<0.1	1.1	<0.1	0.2	<0.1	<0.1	0.39	0.86	4.85	3.8	0.76	16	60	-	59	-	-	0.3	310	800	642
C-3	C-3 East	9/18/2018	HQs					1.2	1.4		1.1	1.5		1.5		1.0			0.7		1.2	0.4	0.8	0.4	1.9		1.6				2.6	1.5	1.1
C-4	C-4 West	10/1/2019	Concentrations	47,000	0.021	0.045	0.1	0.71	0.74	0.47	0.69	1.3	0.17	2.2	0.074	0.63	0.034	0.023	0.83	1.6	7.8	5.76	0.914	35.9	125	25,600	51.3	594	0.197	1.18	532	330	1560
C-4	C-4 West	10/1/2019	HQs		2.1	7.5	0.5	2.2	4.4	2.0	1.9	3.8	2.8	2.9	0.4	3.2	1.7	0.1	1.5	3.3	2.0	0.6	0.9	0.8	4.0	0.9	1.4	1.3	1.1		4.4	0.6	2.6
C-4	C-4 West	9/19/2018	Concentrations	-	0.11	0.25	0.69	1.69	0.77	0.7	1.5	2.01	0.2	4.5	0.47	0.65	0.3	0.14	3.32	3.48	20.48	5.5	6.1	41	145	-	72	-	-	3.3	472	1600	1260
C-4	C-4 West	9/19/2018	HQs		11.0	41.7	3.1	5.3	4.5	2.9	4.1	5.9	3.3	6.0	2.5	3.3	15.0	0.8	5.9	7.1	5.1	0.6	6.2	0.9	4.6		2.0				3.9	2.9	2.1
C-4	C-4 Centre	9/19/2018	Concentrations	-	<0.1	<0.1	0.15	0.71	0.41	0.3	0.69	0.89	<0.1	2.12	0.11	0.35	<0.1	<0.1	1.16	1.62	8.91	4.1	0.56	19	42	-	32	-	-	0.27	298	600	718
C-4	C-4 Centre	9/19/2018	HQs				0.7	2.2	2.4	1.3	1.9	2.6		2.8	0.6	1.8			2.1	3.3	2.2	0.4	0.6	0.4	1.3		0.9				2.5	1.1	1.2
C-4	C-4 East	9/19/2018	Concentrations	-	<0.1	<0.1	<0.1	0.44	0.37	0.23	0.48	0.66	<0.1	1.41	<0.1	0.27	<0.1	<0.1	0.6	1.13	6.19	4.3	0.74	22	72	-	28	-	-	0.58	215	1000	861
C-4	C-4 East	9/19/2018	HQs					1.4	2.2	1.0	1.3	1.9		1.9		1.4			1.1		1.5	0.4	0.7	0.5	2.3		0.8				1.8	1.8	1.4
C-5	C-5 West	9/19/2018	Concentrations	-	<0.1	<0.1	<0.1	0.46	0.38	0.25	0.5	0.68	<0.1	1.44	<0.1	0.27	<0.1	<0.1	0.72	1.16	6.46	5.7	3.1	32	97	-	56	-	-	1.3	428	1200	1120
C-5	C-5 West	9/19/2018	HQs					1.4	2.2	1.0	1.4	2.0		1.9		1.4			1.3	2.4	1.6	0.6	3.1	0.7	3.1		1.6				3.5	2.2	1.9
C-5	C-5 Centre	9/19/2018	Concentrations	-	<0.1	<0.1	<0.1	0.42	0.31	<0.2	0.39	0.47	<0.1	1.15	<0.1	0.25	<0.1	<0.1	0.58	0.92	5.29	3.7	0.86	20	66	-	49	-	-	0.53	244	500	781
C-5	C-5 Centre	9/19/2018	HQs					1.3	1.8		1.1	1.4		1.5		1.3			1.0	1.9	1.3	0.4	0.9	0.5	2.1		1.4				2.0	0.9	1.3
C-5	C-5 East	9/19/2018	Concentrations	-	0.18	<0.1	0.28	1.99	0.98	0.72	1.69	1.76	0.26	2.99	0.1	0.88	<0.1	0.15	0.93	2.94	15.95	12	8.5	37	136	-	145	-	-	3	414	900	978
C-5	C-5 East	9/19/2018	HQs		18.0		1.3	6.2	5.8	3.0	4.6	5.2	4.3	4.0	0.5	4.4			1.7	6.0	4.0	1.2	8.6	0.9	4.3		4.1				3.4	1.6	1.6
G-6	G-6 Comp	10/1/2019	Concentrations	39,000	0.02	0.084	0.12	0.61	0.63	0.34	0.75	1.1	0.13	2	0.087	0.54	0.027	0.029	0.89	1.5	7.3	4.29	0.609	22.6	64.1	18,800	46.1	390	0.104	0.342	339	180	904
G-6	G-6 Comp	10/1/2019	HQs		2.0	14.0	0.5	0.18	3.7	1.4	2.0	3.2	2.2	2.7	0.5	2.7	1.4	0.2	1.6	3.1	1.8	0.4	0.6	0.5	2.0	0.6	1.3	0.8	0.6		2.8	0.3	1.5
		95% UCLM	Concentrations		0.0423	0.341	0.867	1.83	1.236	0.71	1.712	2.155	0.242	6.834	0.395	0.997	0.0877	0.191	4.336	4.973	26.41	5.52	2.4	27.5	91	23967	57.9	589	0.187	1.126	349.3	841.8	1020
	Study Area Wide		HQs		4.2	56.8	3.9	5.7	7.3	3.0	4.6	6.3	4.0	9.1	2.1	5.0	4.4	1.1	7.7	10.1	6.6	0.6	2.5	0.6	2.9	0.8	1.6	1.3	1.0	-	2.9	1.5	1.7

EPC - Exposure point concentration
HQs - Hazard quotients
TRV - Toxicity reference value
HQs are obtained by dividing the EPC by the TRV
HQs >1.0 indicate potential risk
The mean HQ-Q for PAHs was calculated by summing the individual PAH HQs obtained with reliable TRV (PEC or PEL) and dividing this number by the number of individual PAHs included in the sum.

TABLE 6: SURFACE WATER HQs

Monitoring_Zone	Alternative_Name	Location_Code	Well_Screen_Interval	Sampled_Date_Time	Sample_Type	Field_ID	SampleCode	Lab_Report_Number
C-1		C-1 West	-	9/30/2019	Normal	C-1 West	C-1 West_-_30 Sep 19	330748
C-1		C-1 West	-	9/30/2019	Field_D	C-1 West Duplicate	C-1 West Duplicate_-_30 Sep 19	330748
C-3	A002	C-3 Centre	-	9/30/2019	Normal	C-3 Centre - G5	C-3 Centre - G5 _-_30 Sep 19	330748
C-3	A003	C-3 West	-	9/30/2019	Normal	C-3 West	C-3 West_-_30 Sep 19	330748
C-4	B003	C-4 West	-	9/30/2019	Normal	C-4 West	C-4 West_-_30 Sep 19	330748
C-5	C001	C-5 East	-	9/30/2019	Normal	C-5 East - G6	C-5 East - G6_-_30 Sep 19	330748
G-1		G-1 Comp	-	9/30/2019	Normal	G-1 Comp	G-1 Comp_-_30 Sep 19	330748
G-4		G-4 Comp	-	9/30/2019	Normal	G-4 Comp	G-4 Comp_-_30 Sep 19	330748
Reference		R-1	-	9/30/2019	Normal	R-1	R-1_-_30 Sep 19	330748
Reference		R-2	-	9/30/2019	Normal	R-2	R-2_-_30 Sep 19	330748

HAZARD QUOTIENTS

Field_ID	aluminum	Benthic (SAR)	Benthic (Community)	Aquatic Plants	Fish	Amphibians	aluminum (Filtered)	Benthic (SAR)	Benthic (Community)	Aquatic Plants	Fish	Amphibians	iron	Benthic (SAR)	Benthic (Community)	Aquatic Plants	Fish	Amphibians	nitrite (as N)	Benthic (SAR)	Benthic (Community)	Aquatic Plants	Fish	Amphibians
	µg/L						µg/L						µg/L						µg/L					
ON PWQO	15[#2]|75[#2]	HQ					15[#2]|75[#2]	HQ					300	HQ						HQ				
CCME WQG Freshwater Aquatic Life (long term)	5|100						5|100						300						60					
C-1 West	**145**	1.45	0.45	0.3	0.73	0.45	13	0.1	0.04	0.03	0.07	0.0	202	0.67	0.12	0.1	0.67	0.12	**220**	3.7	3.7	3.7	0.04	3.7
C-1 West Duplicate	**299**	2.99	0.93	0.7	1.5	0.93	14	0.1	0.04	0.03	0.07	0.0	**426**	1.42	0.24	0.2	1.42	0.24	**220**	3.7	3.7	3.7	0.04	3.7
C-3 Centre - G5	**467**	4.67	1.46	1.0	2.34	1.5	3	0.03	0.01	0.01	0.02	0.01	**883**	2.94	0.51	0.5	2.94	0.51	**110**	1.8	1.8	1.8	0.02	1.8
C-3 West	**468**	4.68	1.46	1.0	2.34	1.5	4	0.04	0.01	0.01	0.02	0.01	**890**	2.97	0.51	0.5	2.97	0.51	**130**	2.2	2.2	2.2	0.03	2.2
C-4 West	**489**	4.89	1.53	1.1	2.45	1.5	2	0.02	0.01	0.00	0.01	0.01	**990**	3.3	0.57	0.6	3.3	0.57	**90**	1.5	1.5	1.5	0.02	1.5
C-5 East - G6	**598**	5.98	1.87	1.3	2.99	1.9	<2	NC	NC	NC	NC	NC	**1180**	3.93	0.68	0.7	3.93	0.68	**70**	1.2	1.2	1.2	0.01	1.2
G-1 Comp	**160**	1.6	0.5	0.3	0.8	0.5	13	0.13	0.04	0.03	0.07	0.04	227	0.76	0.13	0.1	0.76	0.13	**200**	3.3	3.3	3.3	0.04	3.3
G-4 Comp	**307**	3.07	0.96	0.7	1.54	1.0	4	0.04	0.01	0.01	0.02	0.01	**628**	2.09	0.36	0.4	2.09	0.36	**280**	4.7	4.7	4.7	0.06	4.7
R-1	24	0.24	0.24	0.052	0.12	0.08	<2	NC	NC	NC	NC	NC	140	0.47	0.08	0.1	0.47	0.08	<50	NC	NC	NC	NC	NC
R-2	12	0.12	0.12	0.03	0.06	0.04	<2	NC	NC	NC	NC	NC	119	0.4	0.07	0.1	0.4	0.07	<50	NC	NC	NC	NC	NC

NC - not calculated. Concentration below laboratory detection limits.

Env Stds Description

ON PWQO:Ontario Provincial Water Quality Objectives, July 1994

CCME WQG Freshwater Aquatic Life (long term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Long-term)

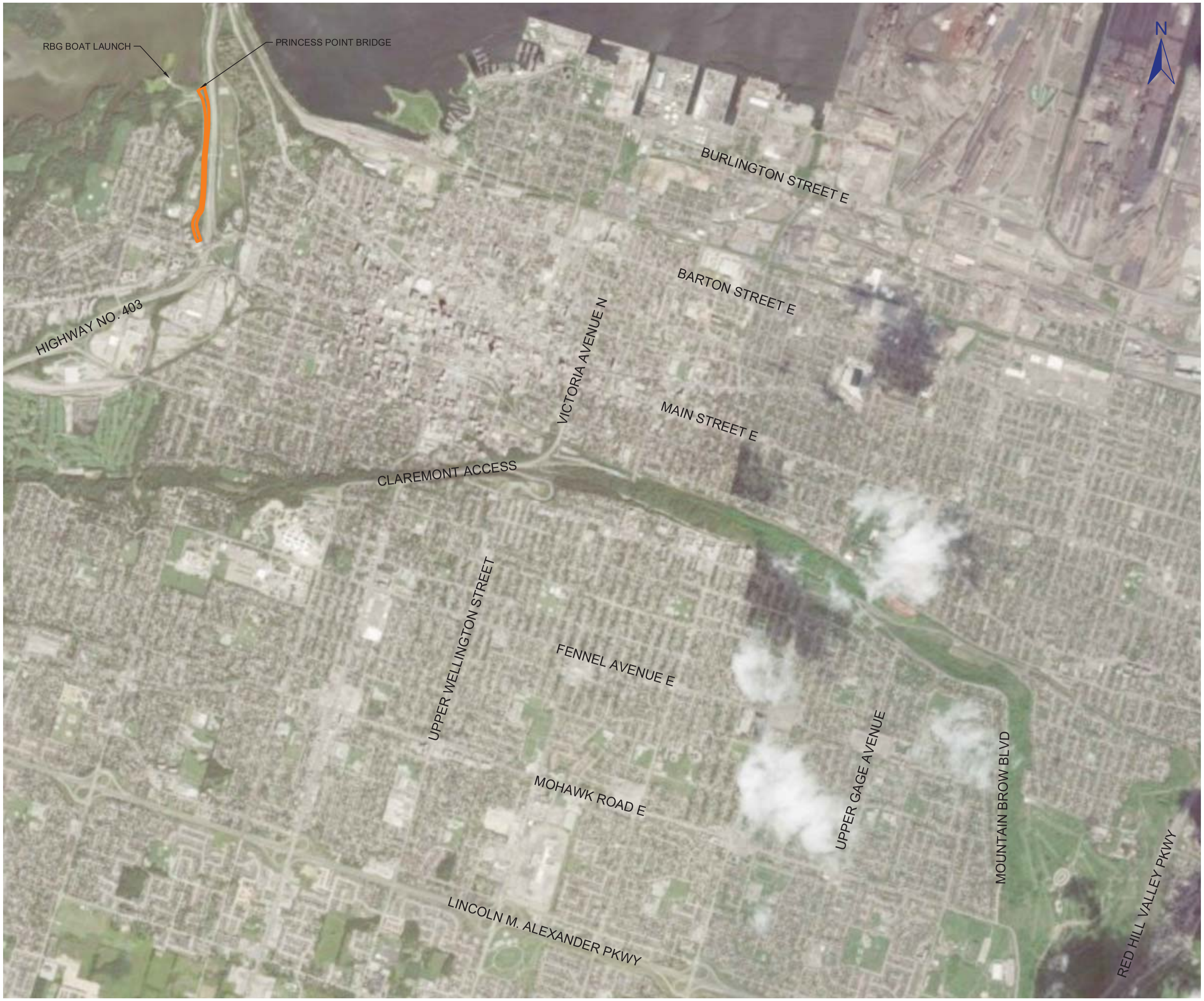
CCME WQG Freshwater Aquatic Life (short term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Short-term)

Env Stds Comments

#1:Dependent upon temperature, cold water biota, and warm water biota. Most conservative value listed.
#2:Interim PWQO
#3:Interim PWQO. The PWQO is 100 ug/L.
#4:Criteria varies with hardness.
#5:Criteria is for dissolved mercury.
#6:The percentage of un-ionized ammonia in aqueous ammonia solution varies with temperature and pH.
#7:Interim PWQO. Criteria changes with site, most conservative value given
#8:100 E. coli per 100 mL. (based on a geometric mean of at least 5 samples)
#9:Maximum increase of 25 mg/L from background levels. Further Narrative applies.
#10:Guideline is dependent on waterbody hardness.
#11:Guideline is dependent on waterbody hardness. Most conservative value listed.
#12:Guideline applies to dissolved concentration

DRAWINGS

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000



NOTES:
REFERENCED FROM CITY OF HAMILTON WEB MAPPING SERVICE

LEGEND:
STUDY AREA

0 0.25 0.5 1.0 1.5 km
SCALE 1:30,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM Zone 17 T

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

ECOLOGICAL RISK ASSESSMENT
FOR CHEDOKE CREEK

SITE LOCATION PLAN

Date:	January 16, 2020	Drawing No. 1
Project No.	209.40666.00000	

SLR
global environmental solutions

Cadfile name: S_209-40666-00000-A3.dwg

Cadfile name: S_209-40666-00000-A3.dwg

LEGEND:

- STUDY AREA
- STORM SEWER
- CSO OUTLET
- SAMPLE LOCATION

NOTES:
REFERENCED FROM CITY OF HAMILTON WEB MAPPING SERVICE

ON PSQG LEL = ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINE LOWEST EFFECT LEVEL

ON PSQG SEL = ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINE SEVERE EFFECT LEVEL

ON PSQG BACKGROUND = ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINE BACKGROUND

0 50 100 200 300 m

SCALE 1:5,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM Zone 17 T

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

ECOLOGICAL RISK ASSESSMENT FOR CHEDOKE CREEK

SAMPLE LOCATIONS

Date: January 16, 2020	Drawing No. 2
Project No. 209.40666.00000	

SLR global environmental solutions

NOTES:
REFERENCED FROM CITY OF HAMILTON WEB MAPPING SERVICE

LEGEND:
- STUDY AREA
- STORM SEWER
- CSO OUTLET
- SAMPLE LOCATION
- CHEDOKE BAY SAMPLE LOCATION (OUTSIDE STUDY AREA)

SEDIMENT SAMPLING
SURFACE WATER SAMPLING
BENTHIC INVERTEBRATES SAMPLING

0 0.25 0.5 1.0 1.5 km

SCALE 1:30,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM Zone 17 T

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

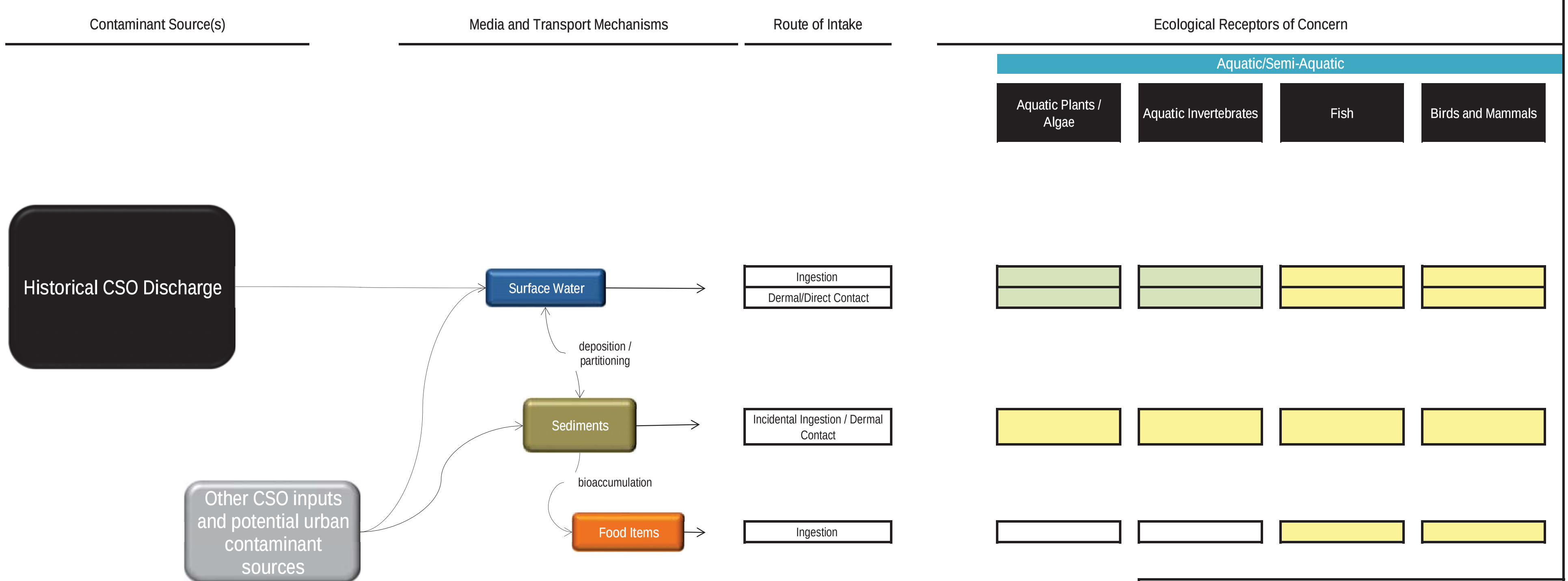
ECOLOGICAL RISK ASSESSMENT
FOR CHEDOKE CREEK

SAMPLE DETAILS AND REFERENCE LOCATIONS

Date: January 16, 2020	Drawing No. 3
Project No. 209.40666.00000	

SLR
global environmental solutions

Cadfile name: S_209-40666-00000-A3.dwg



Notes:

- Exposure pathway is potentially complete, quantitative assessment is recommended.
- Exposure pathway is potentially complete but insignificant (no final COPCs or infrequent exposure/low dose), quantitative assessment is not necessary.
- Exposure pathway is incomplete, quantitative assessment is not necessary.
- Exposure pathway is potentially complete but insufficient information to quantify risk. Additional assessment is recommended.

Chedoke Creek
Hamilton, Ontario

ECOLOGICAL RISK ASSESSMENT

CONCEPTUAL SITE MODEL

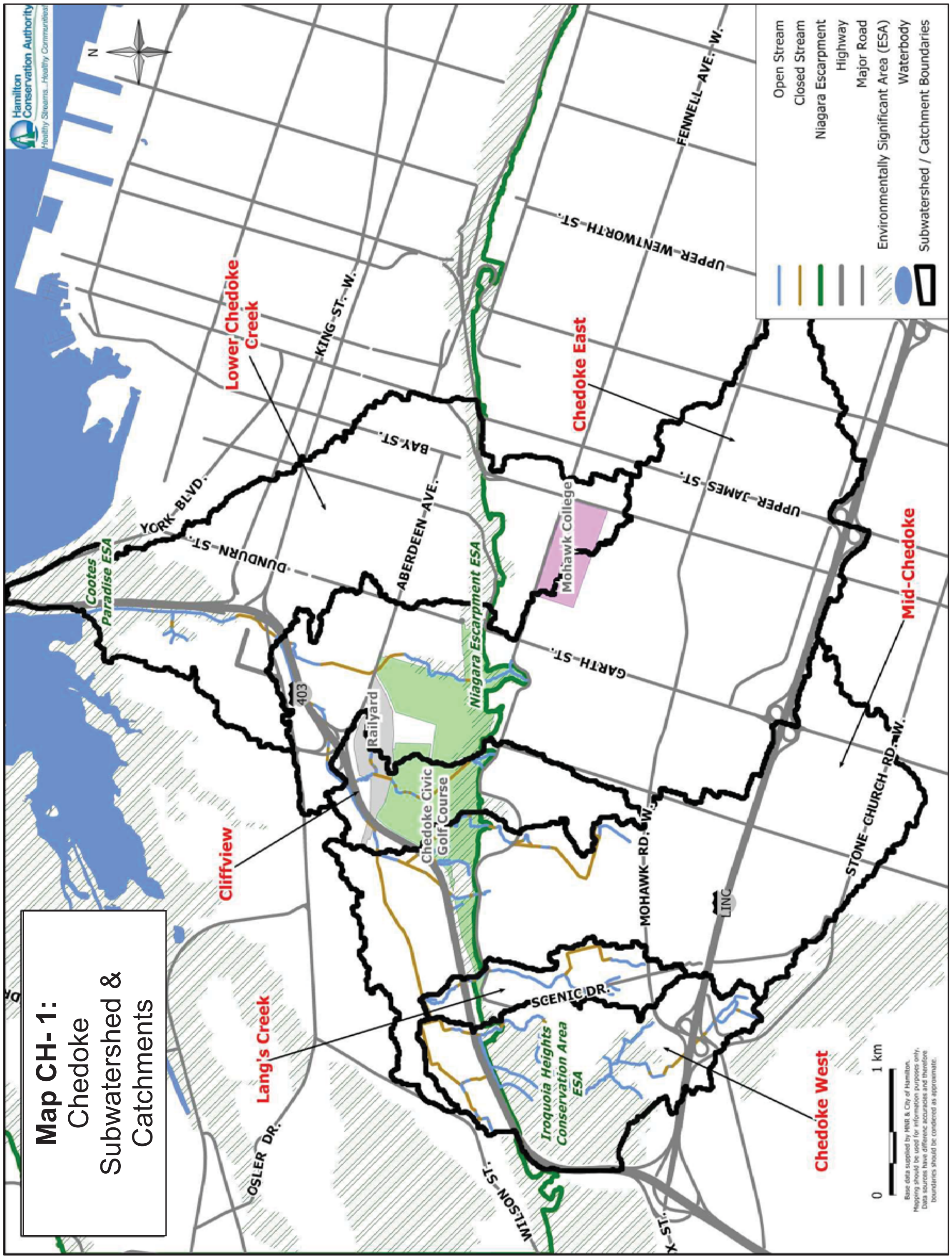
Date: January 2020

SLR Project No.: 209.40666.010000

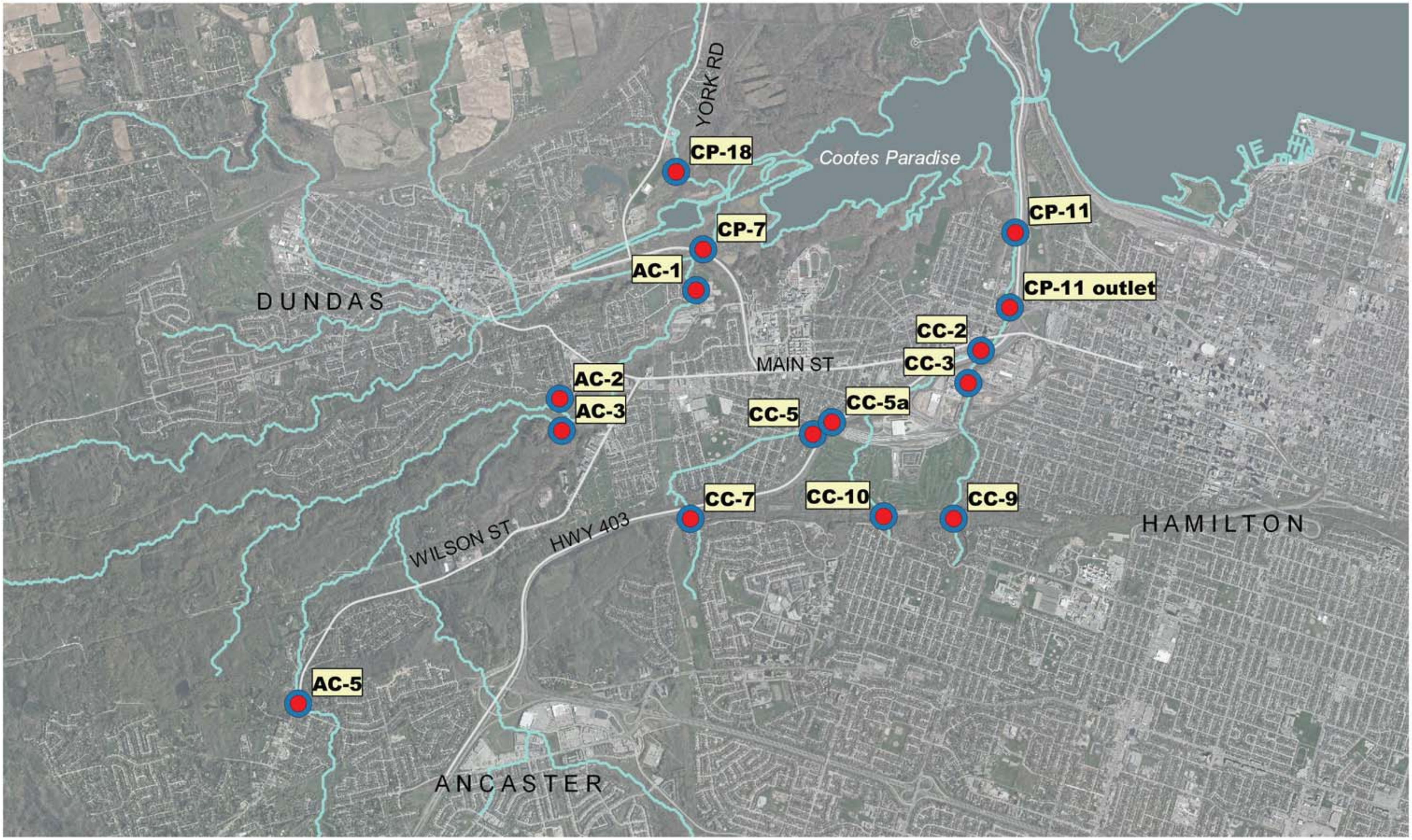
Drawing: 4

APPENDIX A
Previous Environmental Investigations Sampling Locations

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000


Map CH- 1:
Chedoke
Subwatershed &
Catchments
Hamilton Conservation Authority
Healthy Streams...Healthy Communities
N
Open Stream
Closed Stream
Niagara Escarpment
Highway
Major Road
Environmentally Significant Area (ESA)
Waterbody
Subwatershed / Catchment Boundaries
Lower Chedoke Creek
Chedoke East
Mid-Chedoke
Cliffview
Lang's Creek
Chedoke West
Cootes Paradise ESA
Niagara Escarpment ESA
Iroquoia Heights Conservation Area ESA
Mohawk College
Railyard
Chedoke Civic Golf Course
YORK BLVD.
KING ST. W.
BAY ST.
DUNDURN ST.
ABERDEEN AVE.
GARTH ST.
UPPER JAMES ST.
UPPER WENTWORTH ST.
FENNELL AVE. W.
MOHAWK RD. W.
STONE CHURCH RD. W.
SCENIC DR.
OSLER DR.
WILSON ST.
403
LINC
0
1 km

Cootes Paradise Water Quality Monitoring for HHRAP

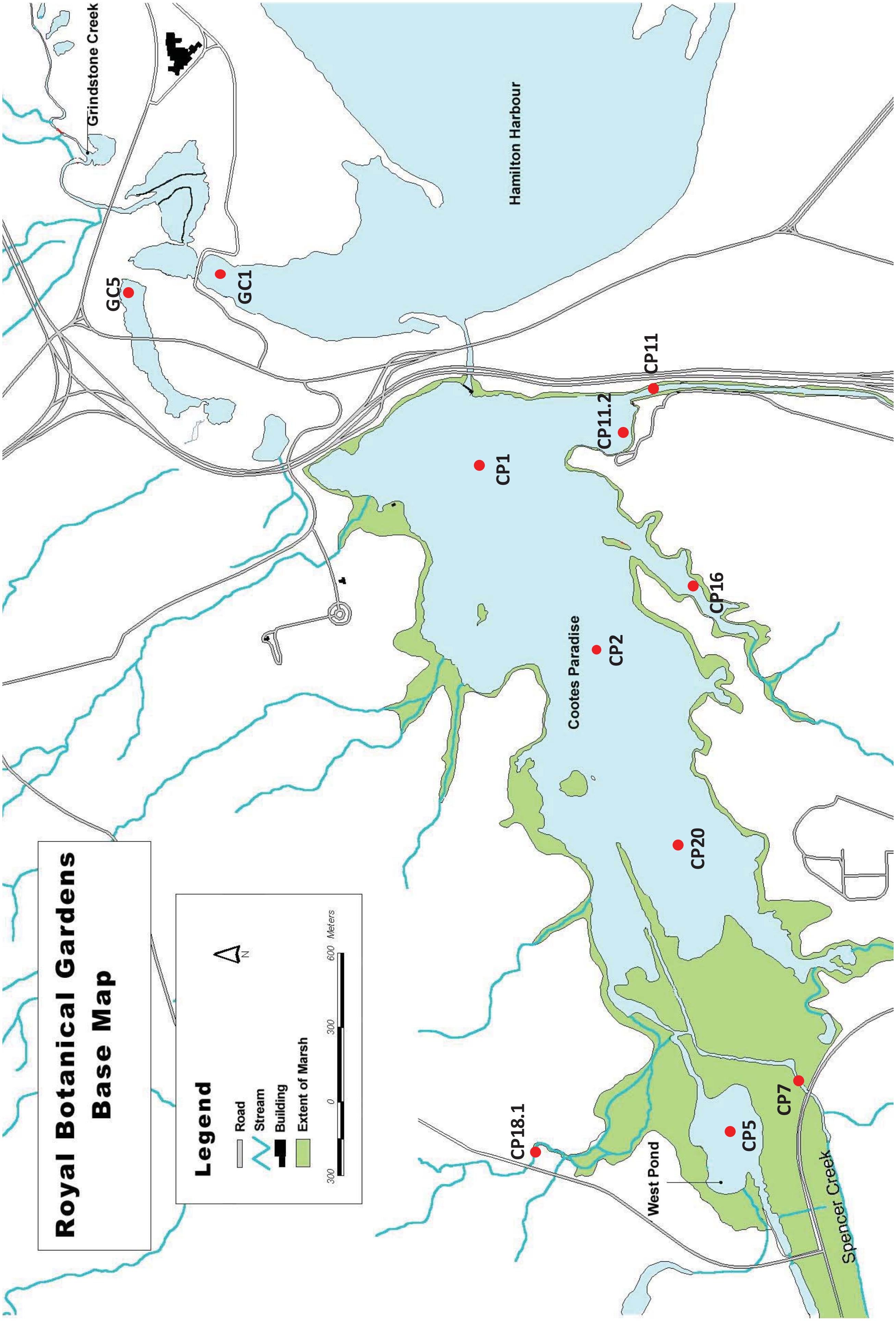


Legend
MONITORING STATION

0 1 2 km

N

Hamilton Conservation Authority
Healthy Streams...Healthy Communities
Hamilton


Royal Botanical Gardens
Base Map
Legend
Road
Stream
Building
Extent of Marsh
300
0
300
600
Meters
N
Grindstone Creek
Hamilton Harbour
GC5
GC1
CP11
CP11.2
CP1
CP16
Cootes Paradise
CP2
CP20
CP7
CP5
CP18.1
West Pond
Spencer Creek

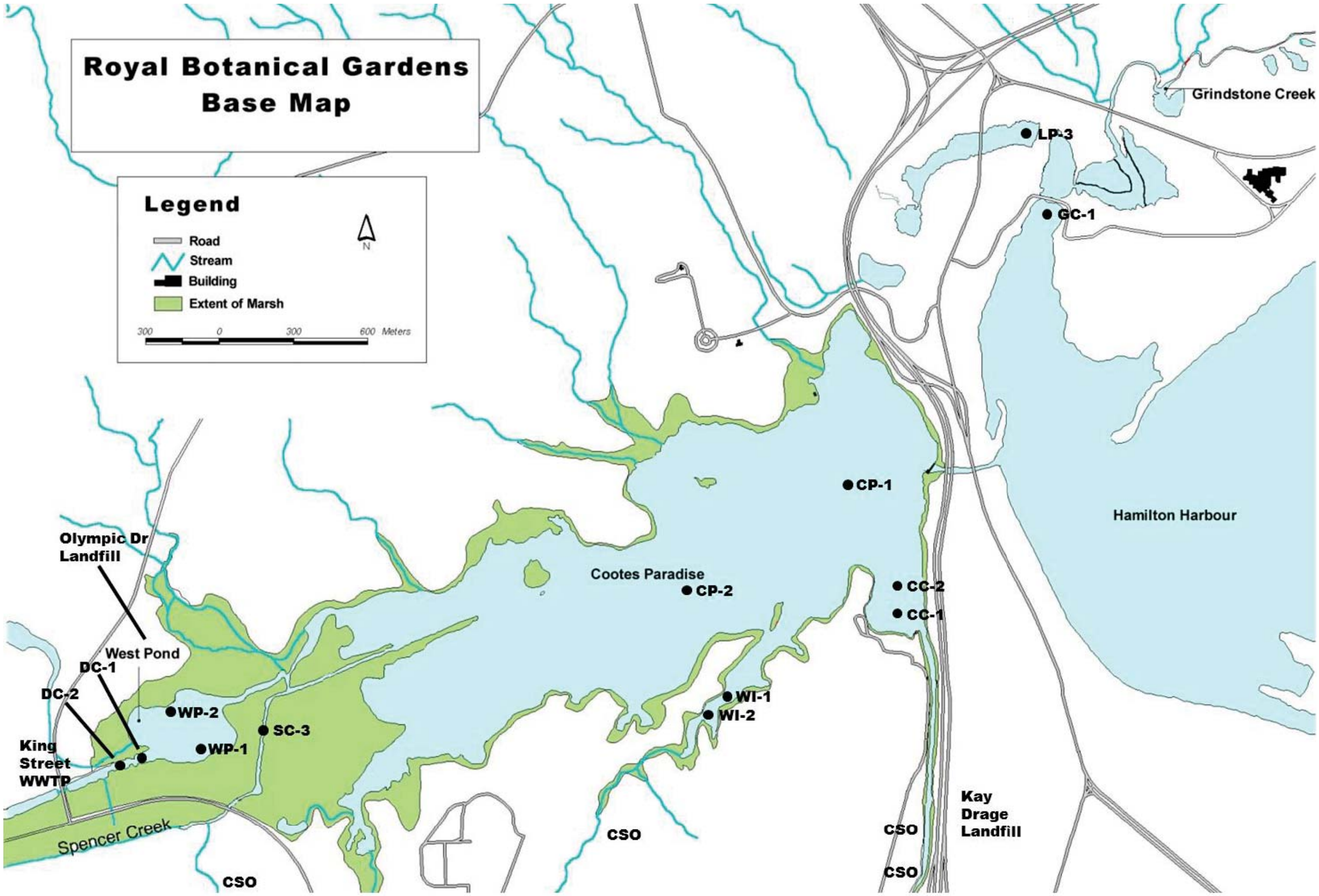


Figure 1. Map of RBG properties showing sediment sampling stations in 2013 in Cootes Paradise and Grindstone Creek marsh areas. Also highlighted are the locations of the CSOs, King Street WWTP, and landfill sites.

APPENDIX B
Laboratory Analytical Report

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

Your P.O. #: PENDING
Your Project #: 209.40666.00000
Your C.O.C. #: g141143

Attention: Celine Totman

SLR CONSULTING (CANADA) LTD
#200 - 1620 WEST 8TH AVENUE
VANCOUVER, BC
Canada V6J 1V4

Report Date: 2019/11/15
Report #: R2811669
Version: 2 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B985653
Received: 2019/10/03, 16:09

Sample Matrix: Sediment
Samples Received: 9

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Total Coliforms (MTF) in Soil (4)	9	N/A	2019/10/17	COR1 SOP-00019	Health Can MFHPB-19
Ecotox Report Attachment	7	2019/11/15	2019/11/15		
Escherichia Coli (MTF) in Soil (4)	9	N/A	2019/10/17	COR1 SOP-00019	Health Can MFHPB-19
Fecal Coliforms (MTF) in Solid (4)	9	N/A	2019/10/17	COR1 SOP-00019	Health Can MFHPB-19
Elements by ICPMS (total)	6	2019/10/09	2019/10/09	BBY7SOP-00004 / BBY7SOP-00001	EPA 6020b R2 m
Elements by ICPMS (total)	2	2019/10/09	2019/10/10	BBY7SOP-00004 / BBY7SOP-00001	EPA 6020b R2 m
Elements by ICPMS (total)	1	2019/10/10	2019/10/10	BBY7SOP-00004 / BBY7SOP-00001	EPA 6020b R2 m
Moisture	9	2019/10/08	2019/10/09	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Ammonia-N (Available) (1)	9	2019/10/11	2019/10/11	AB SOP-00027 / AB SOP-00007	SM 23 4500 NH3 A G m
PAH in Soil by GC/MS Lowlevel	9	2019/10/08	2019/10/10	BBY8SOP-00022	BCMOE BCLM Jul2017m
Total PAH and B(a)P Calculation (5)	9	N/A	2019/10/11	BBY WI-00033	Auto Calc
Phosphorus (Available by ICP) (1)	9	2019/10/12	2019/10/12	CAL SOP-00152 / AB SOP-00042	EPA 6010d R5 m
pH (2:1 DI Water Extract)	9	2019/10/09	2019/10/09	BBY6SOP-00028	BCMOE BCLM Mar2005 m
Total Carbon, Nitrogen & Sulphur in Soil (1)	9	N/A	2019/10/17	CAL SOP-00243	LECO 203-821-498 m
Texture by Hydrometer, incl Gravel (Wet)	9	N/A	2019/10/10	BBY6SOP-00051	Carter 2nd ed 55.3
Total Kjeldahl Nitrogen (Available) (2)	9	2019/10/11	2019/10/17	AB SOP-00027 / AB SOP-00008	EPA 351.1 R 1978 m
Total Organic Carbon Soil Subcontract (3)	9	2019/10/15	2019/10/15		

Sample Matrix: Water
Samples Received: 9

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Biochemical Oxygen Demand	9	2019/10/10	2019/10/15	BBY6SOP-00045	SM 23 5210 B m
Sulphide (as H2S)	9	N/A	2019/10/16	BBY WI-00033	Auto Calc
Total Sulphide (1)	9	N/A	2019/10/15	AB SOP-00080	SM 23 4500 S2-A D Fm

Remarks:

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

Your P.O. #: PENDING
Your Project #: 209.40666.00000
Your C.O.C. #: g141143

Attention: Celine Totman

SLR CONSULTING (CANADA) LTD
#200 - 1620 WEST 8TH AVENUE
VANCOUVER, BC
Canada V6J 1V4

Report Date: 2019/11/15
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CERTIFICATE OF ANALYSIS

BV LABS JOB #: B985653
Received: 2019/10/03, 16:09

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.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
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 BV Labs Calgary Environmental
(2) This test was performed by BV Labs Edmonton Environmental
(3) This test was performed by BV Labs Ontario (from Winnipeg)
(4) The matrix is non-food and is outside of the scope of the method. Sample(s) analyzed have not been subjected to Bureau Veritas Laboratories' standard validation process for the submitted matrix and is not an accredited method.
(5) Total PAHs in Soil include: Quinoline, Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Acridine, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b&j)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, and Benzo(g,h,i)perylene.

Total PAHs in Sediment include (B.C. Reg. 116/2018, Schedule 3.4): Naphthalene, 2-Methylnaphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(a)pyrene, and Dibenz(a,h)anthracene.

Encryption Key

AUTHORIZED REPORT
RAPPORT AUTORISÉ

Bureau Veritas Laboratories
15 Nov 2019 17:49:29

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Safiann Maiter, Key Account Specialist
Email: Safiann.Maiter@bvlabs.com
Phone# (604)639-2616

==

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 #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

BV Labs ID		WQ6244			WQ6245		WQ6246		
Sampling Date		2019/10/01 09:20			2019/10/01 10:55		2019/10/01 13:35		
COC Number		g141143			g141143		g141143		
	UNITS	**BOAT LAUNCH**	**RDL**	**QC Batch**	**C6 EAST / G7**	**RDL**	**C5 EAST / G6**	**RDL**	**QC Batch**
Misc. Inorganics									
Available (KCl) Total Kjeldahl Nitrogen	mg/kg	55 (1)	12	9630371	120	5.0	180 (1)	10	9630371
Ecotox									
No Parameter	N/A				ATTACHED	N/A	ATTACHED	N/A	9673836
Nutrients									
Available (KCl) Ammonia (N)	mg/kg	23	2.0	9623846	100	2.0	130	2.0	9623846
Available (NH4F) Phosphorus (P)	mg/kg	1.6	1.0	9625759	1.8	1.0	1.7	1.0	9625759
Physical Properties									
% sand by hydrometer	%	22	2.0	9620237	36	2.0	28	2.0	9620237
% silt by hydrometer	%	66	2.0	9620237	57	2.0	56	2.0	9620237
Clay Content	%	12	2.0	9620237	7.3	2.0	16	2.0	9620237
Gravel	%	<2.0	2.0	9620237	<2.0	2.0	<2.0	2.0	9620237
Internal Sublet Analysis									
Subcontract Parameter	N/A	ATTACHED	N/A	9627061	ATTACHED	N/A	ATTACHED	N/A	9627061

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to high moisture content, samples contain => 50% moisture.

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

BV Labs ID		WQ6247			WQ6248			WQ6249		
Sampling Date		2019/10/01 11:45			2019/10/01 09:30			2019/10/02 11:45		
COC Number		g141143			g141143			g141143		
	UNITS	**C4 WEST**	**RDL**	**QC Batch**	**BLIND DUPLICATE**	**RDL**	**QC Batch**	**C3 WEST**	**RDL**	**QC Batch**
Misc. Inorganics										
Available (KCl) Total Kjeldahl Nitrogen	mg/kg	330 (1)	11	9630371	55 (1)	12	9630371	95	5.0	9630371
Ecotox										
No Parameter	N/A	ATTACHED	N/A	9673836				ATTACHED	N/A	9673836
Nutrients										
Available (KCl) Ammonia (N)	mg/kg	190	2.0	9623846	32	2.0	9623846	26	2.0	9623846
Available (NH4F) Phosphorus (P)	mg/kg	4.6	1.0	9625759	1.8	1.0	9625759	3.1	1.0	9625759
Physical Properties										
% sand by hydrometer	%	32	2.0	9620237	32	2.0	9620237	39	2.0	9620237
% silt by hydrometer	%	61	2.0	9620237	59	2.0	9620237	53	2.0	9620237
Clay Content	%	7.3	2.0	9620237	9.4	2.0	9620237	8.0	2.0	9620237
Gravel	%	<2.0	2.0	9620237	<2.0	2.0	9620237	<2.0	2.0	9620237
Internal Sublet Analysis										
Subcontract Parameter	N/A	ATTACHED	N/A	9627061	ATTACHED	N/A	9627061	ATTACHED	N/A	9627061

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to high moisture content, samples contain => 50% moisture.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

BV Labs ID		WQ6250	WQ6251	WQ6252		
Sampling Date		2019/10/02 10:18	2019/10/02 12:50	2019/10/02 16:20		
COC Number		g141143	g141143	g141143		
	UNITS	**C3 CENTRE / G5**	**G4**	**C1 WEST**	**RDL**	**QC Batch**
Misc. Inorganics						
Available (KCl) Total Kjeldahl Nitrogen	mg/kg	35	47	5.8	5.0	9630371
Ecotox						
No Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	N/A	9673836
Nutrients						
Available (KCl) Ammonia (N)	mg/kg	13	27	3.6	2.0	9623846
Available (NH4F) Phosphorus (P)	mg/kg	1.1	2.4	<1.0	1.0	9625759
Physical Properties						
% sand by hydrometer	%	83	49	69	2.0	9620237
% silt by hydrometer	%	11	45	27	2.0	9620237
Clay Content	%	4.3	5.9	4.0	2.0	9620237
Gravel	%	<2.0	<2.0	<2.0	2.0	9620237
Internal Sublet Analysis						
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	N/A	9627061

RDL = Reportable Detection Limit
N/A = Not Applicable

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

PHYSICAL TESTING (SEDIMENT)

BV Labs ID		WQ6244	WQ6245	WQ6246	WQ6247	WQ6248	WQ6249		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55	2019/10/01 13:35	2019/10/01 11:45	2019/10/01 09:30	2019/10/02 11:45		
COC Number		g141143	g141143	g141143	g141143	g141143	g141143		
	UNITS	**BOAT LAUNCH**	**C6 EAST / G7**	**C5 EAST / G6**	**C4 WEST**	**BLIND DUPLICATE**	**C3 WEST**	**RDL**	**QC Batch**
Physical Properties									
Moisture	%	58	50	52	53	58	47	0.30	9619855
RDL = Reportable Detection Limit									

BV Labs ID		WQ6250	WQ6251	WQ6252		
Sampling Date		2019/10/02 10:18	2019/10/02 12:50	2019/10/02 16:20		
COC Number		g141143	g141143	g141143		
	UNITS	**C3 CENTRE / G5**	**G4**	**C1 WEST**	**RDL**	**QC Batch**
Physical Properties						
Moisture	%	23	42	26	0.30	9619855
RDL = Reportable Detection Limit						

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BV Labs Job #: B985653
Report Date: 2019/11/15

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Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

MICROBIOLOGY (SEDIMENT)

BV Labs ID		WQ6244	WQ6245	WQ6246	WQ6247	WQ6248	WQ6249		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55	2019/10/01 13:35	2019/10/01 11:45	2019/10/01 09:30	2019/10/02 11:45		
COC Number		g141143	g141143	g141143	g141143	g141143	g141143		
	UNITS	**BOAT LAUNCH**	**C6 EAST / G7**	**C5 EAST / G6**	**C4 WEST**	**BLIND DUPLICATE**	**C3 WEST**	**RDL**	**QC Batch**
Microbiological Param.									
E. coli	MPN/100g	790	170	5400	2800	130	5400	20	9632009
Fecal Coliforms	MPN/100g	790	170	5400	2800	130	5400	20	9632015
Total Coliforms	MPN/100g	9500	7900	13000	92000	230	92000	20	9632007
RDL = Reportable Detection Limit									

BV Labs ID		WQ6250	WQ6251	WQ6252		
Sampling Date		2019/10/02 10:18	2019/10/02 12:50	2019/10/02 16:20		
COC Number		g141143	g141143	g141143		
	UNITS	**C3 CENTRE / G5**	**G4**	**C1 WEST**	**RDL**	**QC Batch**
Microbiological Param.						
E. coli	MPN/100g	5400	2400	3500	20	9632009
Fecal Coliforms	MPN/100g	5400	2400	3500	20	9632015
Total Coliforms	MPN/100g	92000	160000	160000	20	9632007
RDL = Reportable Detection Limit						

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BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

MISCELLANEOUS (SEDIMENT)

BV Labs ID		WQ6244	WQ6245	WQ6246	WQ6247	WQ6248	WQ6249		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55	2019/10/01 13:35	2019/10/01 11:45	2019/10/01 09:30	2019/10/02 11:45		
COC Number		g141143	g141143	g141143	g141143	g141143	g141143		
	UNITS	**BOAT LAUNCH**	**C6 EAST / G7**	**C5 EAST / G6**	**C4 WEST**	**BLIND DUPLICATE**	**C3 WEST**	**RDL**	**QC Batch**
Misc. Inorganics									
Total Nitrogen	%	0.3	0.3	0.3	0.4	0.4	0.3	0.2	9631184
RDL = Reportable Detection Limit									

BV Labs ID		WQ6250	WQ6251	WQ6252		
Sampling Date		2019/10/02 10:18	2019/10/02 12:50	2019/10/02 16:20		
COC Number		g141143	g141143	g141143		
	UNITS	**C3 CENTRE / G5**	**G4**	**C1 WEST**	**RDL**	**QC Batch**
Misc. Inorganics						
Total Nitrogen	%	<0.2	<0.2	<0.2	0.2	9631184
RDL = Reportable Detection Limit						

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WR1662	WR1663	WR1664	WR1665		
Sampling Date		2019/10/01 09:20	2019/10/01 09:20	2019/10/01 09:20	2019/10/01 09:20		
COC Number		g141143	g141143	g141143	g141143		
	UNITS	**BOAT LAUNCH-PW**	**C6 EAST / G7-PW**	**C5 EAST / G6-PW**	**C4 WEST-PW**	**RDL**	**QC Batch**
Calculated Parameters							
Sulphide (as H2S)	mg/L	0.043	0.11	0.10	0.22	0.0019	9621785
Demand Parameters							
Biochemical Oxygen Demand	mg/L	<2.0	6.4	17	31	2.0	9622914
Anions							
Total Sulphide	mg/L	0.040	0.10	0.094	0.21	0.0018	9626992
RDL = Reportable Detection Limit							

BV Labs ID		WR1666	WR1667	WR1668	WR1669	WR1670		
Sampling Date		2019/10/01 09:20	2019/10/01 09:20	2019/10/01 09:20	2019/10/01 09:20	2019/10/01 09:20		
COC Number		g141143	g141143	g141143	g141143	g141143		
	UNITS	**BLIND DUPLICATE-PW**	**C3 WEST-PW**	**C3 CENTRE / G5-PW**	**G4-PW**	**C1 WEST-PW**	**RDL**	**QC Batch**
Calculated Parameters								
Sulphide (as H2S)	mg/L	0.029	0.069	0.027	0.089	0.028	0.0019	9621785
Demand Parameters								
Biochemical Oxygen Demand	mg/L	<2.0	9.5	6.4	14	8.5	2.0	9622914
Anions								
Total Sulphide	mg/L	0.027	0.065	0.025	0.084	0.027	0.0018	9626992
RDL = Reportable Detection Limit								

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
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Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6244	WQ6245		WQ6246	WQ6247		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55		2019/10/01 13:35	2019/10/01 11:45		
COC Number		g141143	g141143		g141143	g141143		
	UNITS	**BOAT LAUNCH**	**C6 EAST / G7**	**QC Batch**	**C5 EAST / G6**	**C4 WEST**	**RDL**	**QC Batch**
Physical Properties								
Soluble (2:1) pH	pH	7.84	7.93	9620788	8.10	8.14	N/A	9620516
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	14400	12300	9622706	9030	13200	100	9620498
Total Antimony (Sb)	mg/kg	0.95	1.13	9622706	0.92	1.54	0.10	9620498
Total Arsenic (As)	mg/kg	5.25	4.72	9622706	4.29	5.76	0.20	9620498
Total Barium (Ba)	mg/kg	125	121	9622706	77.8	123	0.10	9620498
Total Beryllium (Be)	mg/kg	0.65	0.60	9622706	0.44	0.67	0.20	9620498
Total Bismuth (Bi)	mg/kg	1.10	1.29	9622706	0.75	2.16	0.10	9620498
Total Boron (B)	mg/kg	19.9	24.7	9622706	14.9	23.4	1.0	9620498
Total Cadmium (Cd)	mg/kg	3.69	0.959	9622706	0.609	0.914	0.050	9620498
Total Calcium (Ca)	mg/kg	84800	64500	9622706	41500	61800	100	9620498
Total Chromium (Cr)	mg/kg	42.2	34.0	9622706	22.6	35.9	0.50	9620498
Total Cobalt (Co)	mg/kg	11.7	9.60	9622706	6.91	10.1	0.10	9620498
Total Copper (Cu)	mg/kg	116	99.8	9622706	64.1	125	0.50	9620498
Total Iron (Fe)	mg/kg	27500	24600	9622706	18800	25600	100	9620498
Total Lead (Pb)	mg/kg	73.9	50.9	9622706	46.1	51.3	0.10	9620498
Total Lithium (Li)	mg/kg	27.7	23.5	9622706	19.4	28.1	0.50	9620498
Total Magnesium (Mg)	mg/kg	16500	20500	9622706	13500	24000	100	9620498
Total Manganese (Mn)	mg/kg	589	537	9622706	390	594	0.20	9620498
Total Mercury (Hg)	mg/kg	0.278	0.174	9622706	0.104	0.197	0.050	9620498
Total Molybdenum (Mo)	mg/kg	1.87	1.67	9622706	1.05	2.34	0.10	9620498
Total Nickel (Ni)	mg/kg	29.4	24.7	9622706	18.0	26.6	0.50	9620498
Total Phosphorus (P)	mg/kg	1030	1140	9622706	904	1560	10	9620498
Total Potassium (K)	mg/kg	2490	2610	9622706	1620	2430	100	9620498
Total Selenium (Se)	mg/kg	0.57	<0.50	9622706	<0.50	0.74	0.50	9620498
Total Silver (Ag)	mg/kg	1.21	0.715	9622706	0.342	1.18	0.050	9620498
Total Sodium (Na)	mg/kg	334	319	9622706	321	447	100	9620498
Total Strontium (Sr)	mg/kg	311	175	9622706	108	151	0.10	9620498
Total Thallium (Tl)	mg/kg	0.297	0.242	9622706	0.180	0.263	0.050	9620498
Total Tin (Sn)	mg/kg	7.11	4.25	9622706	2.96	5.05	0.10	9620498

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6244	WQ6245		WQ6246	WQ6247		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55		2019/10/01 13:35	2019/10/01 11:45		
COC Number		g141143	g141143		g141143	g141143		
	UNITS	**BOAT LAUNCH**	**C6 EAST / G7**	**QC Batch**	**C5 EAST / G6**	**C4 WEST**	**RDL**	**QC Batch**
Total Titanium (Ti)	mg/kg	148	143	9622706	101	150	1.0	9620498
Total Tungsten (W)	mg/kg	<0.50	<0.50	9622706	<0.50	<0.50	0.50	9620498
Total Uranium (U)	mg/kg	0.923	0.862	9622706	0.483	0.886	0.050	9620498
Total Vanadium (V)	mg/kg	27.8	26.8	9622706	20.1	28.7	1.0	9620498
Total Zinc (Zn)	mg/kg	571	451	9622706	339	532	1.0	9620498
Total Zirconium (Zr)	mg/kg	5.19	1.08	9622706	0.60	0.59	0.50	9620498

RDL = Reportable Detection Limit

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Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6248		WQ6249		WQ6250	WQ6251		
Sampling Date		2019/10/01 09:30		2019/10/02 11:45		2019/10/02 10:18	2019/10/02 12:50		
COC Number		g141143		g141143		g141143	g141143		
	UNITS	**BLIND DUPLICATE**	**QC Batch**	**C3 WEST**	**QC Batch**	**C3 CENTRE / G5**	**G4**	**RDL**	**QC Batch**
Physical Properties									
Soluble (2:1) pH	pH	8.17	9620788	8.22	9620516	8.18	8.31	N/A	9620528
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	13800	9622706	12200	9620498	9420	10700	100	9620518
Total Antimony (Sb)	mg/kg	0.98	9622706	1.11	9620498	0.66	0.92	0.10	9620518
Total Arsenic (As)	mg/kg	4.98	9622706	4.97	9620498	3.71	4.13	0.20	9620518
Total Barium (Ba)	mg/kg	120	9622706	106	9620498	75.5	102	0.10	9620518
Total Beryllium (Be)	mg/kg	0.67	9622706	0.60	9620498	0.53	0.55	0.20	9620518
Total Bismuth (Bi)	mg/kg	1.03	9622706	1.03	9620498	0.40	0.55	0.10	9620518
Total Boron (B)	mg/kg	21.1	9622706	21.7	9620498	20.1	22.6	1.0	9620518
Total Cadmium (Cd)	mg/kg	3.57	9622706	0.753	9620498	0.601	0.623	0.050	9620518
Total Calcium (Ca)	mg/kg	73900	9622706	69600	9620498	78400	67400	100	9620518
Total Chromium (Cr)	mg/kg	40.1	9622706	31.5	9620498	19.8	25.7	0.50	9620518
Total Cobalt (Co)	mg/kg	11.2	9622706	10.3	9620498	9.07	8.77	0.10	9620518
Total Copper (Cu)	mg/kg	109	9622706	85.7	9620498	38.1	64.9	0.50	9620518
Total Iron (Fe)	mg/kg	25900	9622706	24800	9620498	21100	22600	100	9620518
Total Lead (Pb)	mg/kg	67.6	9622706	44.9	9620498	29.6	39.6	0.10	9620518
Total Lithium (Li)	mg/kg	25.3	9622706	26.9	9620498	21.7	24.6	0.50	9620518
Total Magnesium (Mg)	mg/kg	15100	9622706	23600	9620498	23700	24400	100	9620518
Total Manganese (Mn)	mg/kg	563	9622706	588	9620498	623	550	0.20	9620518
Total Mercury (Hg)	mg/kg	0.257	9622706	0.255	9620498	0.100	0.104	0.050	9620518
Total Molybdenum (Mo)	mg/kg	1.67	9622706	1.49	9620498	0.87	1.15	0.10	9620518
Total Nickel (Ni)	mg/kg	28.1	9622706	25.6	9620498	20.6	22.3	0.50	9620518
Total Phosphorus (P)	mg/kg	908	9622706	1170	9620498	871	993	10	9620518
Total Potassium (K)	mg/kg	2570	9622706	2330	9620498	2030	2280	100	9620518
Total Selenium (Se)	mg/kg	<0.50	9622706	<0.50	9620498	<0.50	<0.50	0.50	9620518
Total Silver (Ag)	mg/kg	1.10	9622706	0.607	9620498	0.263	0.387	0.050	9620518
Total Sodium (Na)	mg/kg	320	9622706	215	9620498	209	245	100	9620518
Total Strontium (Sr)	mg/kg	293	9622706	142	9620498	137	129	0.10	9620518
Total Thallium (Tl)	mg/kg	0.287	9622706	0.255	9620498	0.214	0.204	0.050	9620518
Total Tin (Sn)	mg/kg	6.84	9622706	4.32	9620498	1.63	6.31	0.10	9620518

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SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6248		WQ6249		WQ6250	WQ6251		
Sampling Date		2019/10/01 09:30		2019/10/02 11:45		2019/10/02 10:18	2019/10/02 12:50		
COC Number		g141143		g141143		g141143	g141143		
	UNITS	**BLIND DUPLICATE**	**QC Batch**	**C3 WEST**	**QC Batch**	**C3 CENTRE / G5**	**G4**	**RDL**	**QC Batch**
Total Titanium (Ti)	mg/kg	158	9622706	139	9620498	124	126	1.0	9620518
Total Tungsten (W)	mg/kg	<0.50	9622706	<0.50	9620498	<0.50	<0.50	0.50	9620518
Total Uranium (U)	mg/kg	0.840	9622706	0.766	9620498	0.798	0.680	0.050	9620518
Total Vanadium (V)	mg/kg	26.7	9622706	24.9	9620498	20.4	22.8	1.0	9620518
Total Zinc (Zn)	mg/kg	545	9622706	427	9620498	272	332	1.0	9620518
Total Zirconium (Zr)	mg/kg	5.18	9622706	0.78	9620498	1.70	0.81	0.50	9620518

RDL = Reportable Detection Limit

BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6252		
Sampling Date		2019/10/02 16:20		
COC Number		g141143		
	UNITS	**C1 WEST**	**RDL**	**QC Batch**
Physical Properties				
Soluble (2:1) pH	pH	8.45	N/A	9620516
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	10500	100	9620498
Total Antimony (Sb)	mg/kg	0.53	0.10	9620498
Total Arsenic (As)	mg/kg	3.56	0.20	9620498
Total Barium (Ba)	mg/kg	100	0.10	9620498
Total Beryllium (Be)	mg/kg	0.55	0.20	9620498
Total Bismuth (Bi)	mg/kg	0.22	0.10	9620498
Total Boron (B)	mg/kg	23.5	1.0	9620498
Total Cadmium (Cd)	mg/kg	1.32	0.050	9620498
Total Calcium (Ca)	mg/kg	75600	100	9620498
Total Chromium (Cr)	mg/kg	21.8	0.50	9620498
Total Cobalt (Co)	mg/kg	8.41	0.10	9620498
Total Copper (Cu)	mg/kg	44.6	0.50	9620498
Total Iron (Fe)	mg/kg	23000	100	9620498
Total Lead (Pb)	mg/kg	24.5	0.10	9620498
Total Lithium (Li)	mg/kg	25.3	0.50	9620498
Total Magnesium (Mg)	mg/kg	30100	100	9620498
Total Manganese (Mn)	mg/kg	566	0.20	9620498
Total Mercury (Hg)	mg/kg	0.057	0.050	9620498
Total Molybdenum (Mo)	mg/kg	1.05	0.10	9620498
Total Nickel (Ni)	mg/kg	22.0	0.50	9620498
Total Phosphorus (P)	mg/kg	715	10	9620498
Total Potassium (K)	mg/kg	2390	100	9620498
Total Selenium (Se)	mg/kg	<0.50	0.50	9620498
Total Silver (Ag)	mg/kg	0.083	0.050	9620498
Total Sodium (Na)	mg/kg	363	100	9620498
Total Strontium (Sr)	mg/kg	109	0.10	9620498
Total Thallium (Tl)	mg/kg	0.120	0.050	9620498
Total Tin (Sn)	mg/kg	1.36	0.10	9620498

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Sampler Initials: KAT

CSR/CCME METALS IN SOIL WITH HG (SEDIMENT)

BV Labs ID		WQ6252		
Sampling Date		2019/10/02 16:20		
COC Number		g141143		
	UNITS	**C1 WEST**	**RDL**	**QC Batch**
Total Titanium (Ti)	mg/kg	121	1.0	9620498
Total Tungsten (W)	mg/kg	<0.50	0.50	9620498
Total Uranium (U)	mg/kg	0.659	0.050	9620498
Total Vanadium (V)	mg/kg	22.1	1.0	9620498
Total Zinc (Zn)	mg/kg	214	1.0	9620498
Total Zirconium (Zr)	mg/kg	2.82	0.50	9620498
RDL = Reportable Detection Limit				

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BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

CSR PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

BV Labs ID		WQ6244		WQ6245		WQ6246		WQ6247		
Sampling Date		2019/10/01 09:20		2019/10/01 10:55		2019/10/01 13:35		2019/10/01 11:45		
COC Number		g141143		g141143		g141143		g141143		
	UNITS	**BOAT LAUNCH**	**RDL**	**C6 EAST / G7**	**RDL**	**C5 EAST / G6**	**RDL**	**C4 WEST**	**RDL**	**QC Batch**
Calculated Parameters										
Low Molecular Weight PAH`s	mg/kg	0.54	0.0022	1.1	0.0010	1.3	0.0020	1.1	0.0018	9618184
High Molecular Weight PAH`s	mg/kg	4.2	0.0022	6.9	0.0010	6.1	0.0020	6.6	0.0018	9618184
Total PAH	mg/kg	4.7	0.0022	8.0	0.0010	7.3	0.0020	7.8	0.0018	9618184
Polycyclic Aromatics										
Naphthalene	mg/kg	0.017 (1)	0.0022	0.028	0.0010	0.029 (1)	0.0020	0.023 (1)	0.0018	9621452
2-Methylnaphthalene	mg/kg	0.022 (1)	0.0022	0.025	0.0010	0.027 (1)	0.0020	0.034 (1)	0.0018	9621452
Acenaphthylene	mg/kg	0.023 (1)	0.0011	0.022	0.00050	0.020 (1)	0.0010	0.021 (1)	0.00090	9621452
Acenaphthene	mg/kg	0.030 (1)	0.0011	0.048	0.00050	0.084 (1)	0.0010	0.045 (1)	0.00090	9621452
Fluorene	mg/kg	0.040 (1)	0.0022	0.069	0.0010	0.087 (1)	0.0020	0.074 (1)	0.0018	9621452
Phenanthrene	mg/kg	0.33 (1)	0.0022	0.79	0.0010	0.89 (1)	0.0020	0.83 (1)	0.0018	9621452
Anthracene	mg/kg	0.078 (1)	0.0022	0.12	0.0010	0.12 (1)	0.0020	0.10 (1)	0.0018	9621452
Fluoranthene	mg/kg	1.3 (1)	0.0022	2.3	0.0010	2.0 (1)	0.0020	2.2 (1)	0.0018	9621452
Pyrene	mg/kg	0.99 (1)	0.0022	1.7	0.0010	1.5 (1)	0.0020	1.6 (1)	0.0018	9621452
Benzo(a)anthracene	mg/kg	0.47 (1)	0.0022	0.74	0.0010	0.61 (1)	0.0020	0.71 (1)	0.0018	9621452
Chrysene	mg/kg	0.70 (1)	0.0022	1.3	0.0010	1.1 (1)	0.0020	1.3 (1)	0.0018	9621452
Benzo(b&j)fluoranthene	mg/kg	1.1 (1)	0.0022	1.5	0.0010	1.3 (1)	0.0020	1.3 (1)	0.0018	9621452
Benzo(b)fluoranthene	mg/kg	0.74 (1)	0.0022	1.1	0.0010	0.93 (1)	0.0020	1.0 (1)	0.0018	9621452
Benzo(k)fluoranthene	mg/kg	0.34 (1)	0.0022	0.39	0.0010	0.34 (1)	0.0020	0.47 (1)	0.0018	9621452
Benzo(a)pyrene	mg/kg	0.60 (1)	0.0022	0.88	0.0010	0.75 (1)	0.0020	0.69 (1)	0.0018	9621452
Indeno(1,2,3-cd)pyrene	mg/kg	0.41 (1)	0.0044	0.55	0.0020	0.54 (1)	0.0040	0.63 (1)	0.0036	9621452
Dibenz(a,h)anthracene	mg/kg	0.12 (1)	0.0011	0.17	0.00050	0.13 (1)	0.0010	0.17 (1)	0.00090	9621452
Benzo(g,h,i)perylene	mg/kg	0.52 (1)	0.0044	0.72	0.0020	0.63 (1)	0.0040	0.74 (1)	0.0036	9621452
Surrogate Recovery (%)										
D10-ANTHRACENE (sur.)	%	83		81		83		83		9621452
D8-ACENAPHTHYLENE (sur.)	%	80		78		80		80		9621452
D8-NAPHTHALENE (sur.)	%	80		70		70		69		9621452
TERPHENYL-D14 (sur.)	%	76		73		78		76		9621452

RDL = Reportable Detection Limit

(1) Detection limits raised due to high moisture content, sample contains => 50% moisture.

BV Labs Job #: B985653
Report Date: 2019/11/15

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CSR PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

BV Labs ID		WQ6248		WQ6249	WQ6250	WQ6251	WQ6252		
Sampling Date		2019/10/01 09:30		2019/10/02 11:45	2019/10/02 10:18	2019/10/02 12:50	2019/10/02 16:20		
COC Number		g141143		g141143	g141143	g141143	g141143		
	UNITS	**BLIND DUPLICATE**	**RDL**	**C3 WEST**	**C3 CENTRE / G5**	**G4**	**C1 WEST**	**RDL**	**QC Batch**
Calculated Parameters									
Low Molecular Weight PAH`s	mg/kg	0.46	0.0021	3.7	0.91	0.79	1.1	0.0010	9618184
High Molecular Weight PAH`s	mg/kg	3.8	0.0021	9.1	4.8	4.5	5.5	0.0010	9618184
Total PAH	mg/kg	4.3	0.0021	13	5.7	5.3	6.7	0.0010	9618184
Polycyclic Aromatics									
Naphthalene	mg/kg	0.015 (1)	0.0021	0.13	0.0089	0.014	0.014	0.0010	9621452
2-Methylnaphthalene	mg/kg	0.022 (1)	0.0021	0.067	0.0096	0.014	0.012	0.0010	9621452
Acenaphthylene	mg/kg	0.022 (1)	0.0011	0.016	0.012	0.013	0.011	0.00050	9621452
Acenaphthene	mg/kg	0.024 (1)	0.0011	0.27	0.038	0.030	0.049	0.00050	9621452
Fluorene	mg/kg	0.037 (1)	0.0021	0.31	0.048	0.047	0.063	0.0010	9621452
Phenanthrene	mg/kg	0.27 (1)	0.0021	2.5	0.68	0.60	0.86	0.0010	9621452
Anthracene	mg/kg	0.067 (1)	0.0021	0.43	0.12	0.080	0.13	0.0010	9621452
Fluoranthene	mg/kg	1.1 (1)	0.0021	3.2	1.6	1.5	1.9	0.0010	9621452
Pyrene	mg/kg	0.88 (1)	0.0021	2.3	1.2	1.1	1.4	0.0010	9621452
Benzo(a)anthracene	mg/kg	0.43 (1)	0.0021	1.1	0.54	0.45	0.60	0.0010	9621452
Chrysene	mg/kg	0.65 (1)	0.0021	1.5	0.75	0.79	0.86	0.0010	9621452
Benzo(b&j)fluoranthene	mg/kg	0.99 (1)	0.0021	1.4	0.90	0.98	1.1	0.0010	9621452
Benzo(b)fluoranthene	mg/kg	0.70 (1)	0.0021	1.0	0.63	0.69	0.74	0.0010	9621452
Benzo(k)fluoranthene	mg/kg	0.27 (1)	0.0021	0.41	0.23	0.25	0.31	0.0010	9621452
Benzo(a)pyrene	mg/kg	0.57 (1)	0.0021	0.94	0.58	0.57	0.69	0.0010	9621452
Indeno(1,2,3-cd)pyrene	mg/kg	0.38 (1)	0.0042	0.54	0.36	0.39	0.45	0.0020	9621452
Dibenz(a,h)anthracene	mg/kg	0.11 (1)	0.0011	0.16	0.10	0.11	0.12	0.00050	9621452
Benzo(g,h,i)perylene	mg/kg	0.48 (1)	0.0042	0.57	0.38	0.43	0.46	0.0020	9621452
Surrogate Recovery (%)									
D10-ANTHRACENE (sur.)	%	84		82	83	81	84		9621452
D8-ACENAPHTHYLENE (sur.)	%	80		79	80	78	81		9621452
D8-NAPHTHALENE (sur.)	%	69		66	68	67	71		9621452
TERPHENYL-D14 (sur.)	%	74		76	81	77	81		9621452

RDL = Reportable Detection Limit

(1) Detection limits raised due to high moisture content, sample contains => 50% moisture.

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GENERAL COMMENTS

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

Package 1	8.0°C
Package 2	6.0°C
Package 3	6.0°C
Package 4	7.3°C
Package 5	6.0°C
Package 6	5.7°C
Package 7	6.0°C
Package 8	4.3°C
Package 9	5.3°C

Version #2: Report reissued to include results for Fecal Coliforms, Total Coliforms, and E. Coli on samples the following samples:
BOAT LAUNCH
C6 EAST / G7
C5 EAST / G6
C4 WEST
BLIND DUPLICATE
C3 WEST
C3 CENTRE / G5
G4
C1 WEST
As per client request received 2019/10/17.

Sample WR1662 [BOAT LAUNCH-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1663 [C6 EAST / G7-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1664 [C5 EAST / G6-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1665 [C4 WEST-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1666 [BLIND DUPLICATE-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1667 [C3 WEST-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1668 [C3 CENTRE / G5-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

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Sample WR1669 [G4-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Sample WR1670 [C1 WEST-PW] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Total Sulphide. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.

Results relate only to the items tested.

BV Labs Job #: B985653
Report Date: 2019/11/15

QUALITY ASSURANCE REPORT

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
9621452	D10-ANTHRACENE (sur.)	2019/10/10	83	50 - 140	83	50 - 140	88	%				
9621452	D8-ACENAPHTHYLENE (sur.)	2019/10/10	79	50 - 140	82	50 - 140	87	%				
9621452	D8-NAPHTHALENE (sur.)	2019/10/10	67	50 - 140	80	50 - 140	85	%				
9621452	TERPHENYL-D14 (sur.)	2019/10/10	80	50 - 140	84	50 - 140	91	%				
9619855	Moisture	2019/10/09					<0.30	%	3.5	20		
9620237	% sand by hydrometer	2019/10/10							0.46	35	95	90 - 110
9620237	% silt by hydrometer	2019/10/10							0.15	35		
9620237	Clay Content	2019/10/10							0.82	35		
9620237	Gravel	2019/10/10							NC	35		
9620498	Total Aluminum (Al)	2019/10/09	NC	75 - 125	104	75 - 125	<100	mg/kg	2.5	40	101	70 - 130
9620498	Total Antimony (Sb)	2019/10/09	92	75 - 125	102	75 - 125	<0.10	mg/kg	5.4	30	99	70 - 130
9620498	Total Arsenic (As)	2019/10/09	95	75 - 125	104	75 - 125	<0.20	mg/kg	4.2	30	90	70 - 130
9620498	Total Barium (Ba)	2019/10/09	200 (1)	75 - 125	101	75 - 125	<0.10	mg/kg	7.4	40	99	70 - 130
9620498	Total Beryllium (Be)	2019/10/09	92	75 - 125	98	75 - 125	<0.20	mg/kg	9.4	30	111	70 - 130
9620498	Total Bismuth (Bi)	2019/10/09	92	75 - 125	101	75 - 125	<0.10	mg/kg	8.2	30		
9620498	Total Boron (B)	2019/10/09	91	75 - 125	95	75 - 125	<1.0	mg/kg	15	30		
9620498	Total Cadmium (Cd)	2019/10/09	92	75 - 125	100	75 - 125	<0.050	mg/kg	4.2	30	98	70 - 130
9620498	Total Calcium (Ca)	2019/10/09	NC	75 - 125	100	75 - 125	<100	mg/kg	0.54	30	98	70 - 130
9620498	Total Chromium (Cr)	2019/10/09	100	75 - 125	104	75 - 125	<0.50	mg/kg	3.9	30	102	70 - 130
9620498	Total Cobalt (Co)	2019/10/09	87	75 - 125	97	75 - 125	<0.10	mg/kg	6.5	30	96	70 - 130
9620498	Total Copper (Cu)	2019/10/09	85	75 - 125	100	75 - 125	<0.50	mg/kg	3.0	30	101	70 - 130
9620498	Total Iron (Fe)	2019/10/09	NC	75 - 125	101	75 - 125	<100	mg/kg	4.6	30	97	70 - 130
9620498	Total Lead (Pb)	2019/10/09	94	75 - 125	103	75 - 125	<0.10	mg/kg	8.3	40	109	70 - 130
9620498	Total Lithium (Li)	2019/10/09	91	75 - 125	99	75 - 125	<0.50	mg/kg	10	30	100	70 - 130
9620498	Total Magnesium (Mg)	2019/10/09	NC	75 - 125	101	75 - 125	<100	mg/kg	1.4	30	100	70 - 130
9620498	Total Manganese (Mn)	2019/10/09	NC	75 - 125	102	75 - 125	<0.20	mg/kg	13	30	102	70 - 130
9620498	Total Mercury (Hg)	2019/10/09	95	75 - 125	103	75 - 125	<0.050	mg/kg			96	70 - 130
9620498	Total Molybdenum (Mo)	2019/10/09	93	75 - 125	97	75 - 125	<0.10	mg/kg	4.8	40	101	70 - 130
9620498	Total Nickel (Ni)	2019/10/09	87	75 - 125	100	75 - 125	<0.50	mg/kg	5.3	30	105	70 - 130
9620498	Total Phosphorus (P)	2019/10/09	NC	75 - 125	101	75 - 125	<10	mg/kg	0.51	30	96	70 - 130
9620498	Total Potassium (K)	2019/10/09	190 (1)	75 - 125	103	75 - 125	<100	mg/kg	4.4	40	90	70 - 130

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BV Labs Job #: B985653
Report Date: 2019/11/15

QUALITY ASSURANCE REPORT(CONT'D)

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
9620498	Total Selenium (Se)	2019/10/09	93	75 - 125	100	75 - 125	<0.50	mg/kg	1.0	30		
9620498	Total Silver (Ag)	2019/10/09	90	75 - 125	100	75 - 125	<0.050	mg/kg	2.7	40	89	70 - 130
9620498	Total Sodium (Na)	2019/10/09	99	75 - 125	105	75 - 125	<100	mg/kg	NC	40	94	70 - 130
9620498	Total Strontium (Sr)	2019/10/09	103	75 - 125	104	75 - 125	<0.10	mg/kg	1.1	40	106	70 - 130
9620498	Total Thallium (Tl)	2019/10/09	96	75 - 125	105	75 - 125	<0.050	mg/kg	3.7	30	98	70 - 130
9620498	Total Tin (Sn)	2019/10/09	94	75 - 125	101	75 - 125	<0.10	mg/kg	8.1	40	96	70 - 130
9620498	Total Titanium (Ti)	2019/10/09	117	75 - 125	100	75 - 125	<1.0	mg/kg	0.67	40		
9620498	Total Tungsten (W)	2019/10/09	90	75 - 125	102	75 - 125	<0.50	mg/kg	NC	40		
9620498	Total Uranium (U)	2019/10/09	95	75 - 125	101	75 - 125	<0.050	mg/kg	0.98	30	102	70 - 130
9620498	Total Vanadium (V)	2019/10/09	110	75 - 125	105	75 - 125	<1.0	mg/kg	4.2	30	102	70 - 130
9620498	Total Zinc (Zn)	2019/10/09	NC	75 - 125	104	75 - 125	<1.0	mg/kg	3.5	30	102	70 - 130
9620498	Total Zirconium (Zr)	2019/10/09	121	75 - 125	103	75 - 125	<0.50	mg/kg	3.4	40		
9620516	Soluble (2:1) pH	2019/10/09			100	97 - 103			0	20		
9620518	Total Aluminum (Al)	2019/10/09	NC	75 - 125	102	75 - 125	<100	mg/kg			103	70 - 130
9620518	Total Antimony (Sb)	2019/10/09	95	75 - 125	103	75 - 125	<0.10	mg/kg			103	70 - 130
9620518	Total Arsenic (As)	2019/10/09	98	75 - 125	101	75 - 125	<0.20	mg/kg			88	70 - 130
9620518	Total Barium (Ba)	2019/10/09	97	75 - 125	99	75 - 125	<0.10	mg/kg			101	70 - 130
9620518	Total Beryllium (Be)	2019/10/09	94	75 - 125	99	75 - 125	<0.20	mg/kg			102	70 - 130
9620518	Total Bismuth (Bi)	2019/10/09	96	75 - 125	98	75 - 125	<0.10	mg/kg				
9620518	Total Boron (B)	2019/10/09	91	75 - 125	100	75 - 125	<1.0	mg/kg				
9620518	Total Cadmium (Cd)	2019/10/09	96	75 - 125	101	75 - 125	<0.050	mg/kg			89	70 - 130
9620518	Total Calcium (Ca)	2019/10/09	NC	75 - 125	100	75 - 125	<100	mg/kg			94	70 - 130
9620518	Total Chromium (Cr)	2019/10/09	98	75 - 125	101	75 - 125	<0.50	mg/kg			100	70 - 130
9620518	Total Cobalt (Co)	2019/10/09	93	75 - 125	95	75 - 125	<0.10	mg/kg			94	70 - 130
9620518	Total Copper (Cu)	2019/10/09	92	75 - 125	96	75 - 125	<0.50	mg/kg			103	70 - 130
9620518	Total Iron (Fe)	2019/10/09	NC	75 - 125	99	75 - 125	<100	mg/kg			98	70 - 130
9620518	Total Lead (Pb)	2019/10/09	99	75 - 125	99	75 - 125	<0.10	mg/kg	2.5	40	106	70 - 130
9620518	Total Lithium (Li)	2019/10/09	95	75 - 125	101	75 - 125	<0.50	mg/kg			103	70 - 130
9620518	Total Magnesium (Mg)	2019/10/09	NC	75 - 125	99	75 - 125	<100	mg/kg			101	70 - 130
9620518	Total Manganese (Mn)	2019/10/09	136 (1)	75 - 125	100	75 - 125	<0.20	mg/kg			102	70 - 130
9620518	Total Mercury (Hg)	2019/10/09	98	75 - 125	99	75 - 125	<0.050	mg/kg			92	70 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
9620518	Total Molybdenum (Mo)	2019/10/09	94	75 - 125	95	75 - 125	<0.10	mg/kg			96	70 - 130
9620518	Total Nickel (Ni)	2019/10/09	95	75 - 125	99	75 - 125	<0.50	mg/kg			101	70 - 130
9620518	Total Phosphorus (P)	2019/10/09	93	75 - 125	97	75 - 125	<10	mg/kg			97	70 - 130
9620518	Total Potassium (K)	2019/10/09	107	75 - 125	100	75 - 125	<100	mg/kg			91	70 - 130
9620518	Total Selenium (Se)	2019/10/09	96	75 - 125	96	75 - 125	<0.50	mg/kg				
9620518	Total Silver (Ag)	2019/10/09	95	75 - 125	100	75 - 125	<0.050	mg/kg			102	70 - 130
9620518	Total Sodium (Na)	2019/10/09	128 (1)	75 - 125	101	75 - 125	<100	mg/kg			93	70 - 130
9620518	Total Strontium (Sr)	2019/10/09	105	75 - 125	100	75 - 125	<0.10	mg/kg			104	70 - 130
9620518	Total Thallium (Tl)	2019/10/09	100	75 - 125	99	75 - 125	<0.050	mg/kg			93	70 - 130
9620518	Total Tin (Sn)	2019/10/09	96	75 - 125	102	75 - 125	<0.10	mg/kg			99	70 - 130
9620518	Total Titanium (Ti)	2019/10/09	NC	75 - 125	96	75 - 125	<1.0	mg/kg				
9620518	Total Tungsten (W)	2019/10/09	91	75 - 125	100	75 - 125	<0.50	mg/kg				
9620518	Total Uranium (U)	2019/10/09	94	75 - 125	95	75 - 125	<0.050	mg/kg			95	70 - 130
9620518	Total Vanadium (V)	2019/10/09	103	75 - 125	100	75 - 125	<1.0	mg/kg			103	70 - 130
9620518	Total Zinc (Zn)	2019/10/09	95	75 - 125	100	75 - 125	<1.0	mg/kg			101	70 - 130
9620518	Total Zirconium (Zr)	2019/10/09	102	75 - 125	102	75 - 125	<0.50	mg/kg				
9620528	Soluble (2:1) pH	2019/10/09			101	97 - 103			0.34	20		
9620788	Soluble (2:1) pH	2019/10/09			100	97 - 103			0.26	20		
9621452	2-Methylnaphthalene	2019/10/10	74	50 - 140	81	50 - 140	<0.0010	mg/kg	33	50		
9621452	Acenaphthene	2019/10/10	84	50 - 140	88	50 - 140	<0.00050	mg/kg	33	50		
9621452	Acenaphthylene	2019/10/10	85	50 - 140	90	50 - 140	<0.00050	mg/kg	36	50		
9621452	Anthracene	2019/10/10	83	50 - 140	87	50 - 140	<0.0010	mg/kg	10	50		
9621452	Benzo(a)anthracene	2019/10/10	96	50 - 140	89	50 - 140	<0.0010	mg/kg	5.8	50		
9621452	Benzo(a)pyrene	2019/10/10	91	50 - 140	91	50 - 140	<0.0010	mg/kg	2.4	50		
9621452	Benzo(b&j)fluoranthene	2019/10/10	86	50 - 140	87	50 - 140	<0.0010	mg/kg	0.25	50		
9621452	Benzo(b)fluoranthene	2019/10/10	90	50 - 140	87	50 - 140	<0.0010	mg/kg	0.55	50		
9621452	Benzo(g,h,i)perylene	2019/10/10	67	50 - 140	89	50 - 140	<0.0020	mg/kg	8.3	50		
9621452	Benzo(k)fluoranthene	2019/10/10	83	50 - 140	86	50 - 140	<0.0010	mg/kg	0.43	50		
9621452	Chrysene	2019/10/10	92	50 - 140	87	50 - 140	<0.0010	mg/kg	0.31	50		
9621452	Dibenz(a,h)anthracene	2019/10/10	80	50 - 140	96	50 - 140	<0.00050	mg/kg	7.0	50		
9621452	Fluoranthene	2019/10/10	NC	50 - 140	90	50 - 140	<0.0010	mg/kg	5.2	50		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
9621452	Fluorene	2019/10/10	86	50 - 140	86	50 - 140	<0.0010	mg/kg	17	50		
9621452	Indeno(1,2,3-cd)pyrene	2019/10/10	72	50 - 140	94	50 - 140	<0.0020	mg/kg	4.3	50		
9621452	Naphthalene	2019/10/10	70	50 - 140	84	50 - 140	<0.0010	mg/kg	37	50		
9621452	Phenanthrene	2019/10/10	75	50 - 140	81	50 - 140	<0.0010	mg/kg	10	50		
9621452	Pyrene	2019/10/10	NC	50 - 140	90	50 - 140	<0.0010	mg/kg	4.4	50		
9622706	Total Aluminum (Al)	2019/10/10	NC	75 - 125	106	75 - 125	<100	mg/kg	1.0	40	109	70 - 130
9622706	Total Antimony (Sb)	2019/10/10	91	75 - 125	98	75 - 125	<0.10	mg/kg	NC	30	88	70 - 130
9622706	Total Arsenic (As)	2019/10/10	93	75 - 125	96	75 - 125	<0.20	mg/kg	3.5	30	84	70 - 130
9622706	Total Barium (Ba)	2019/10/10	97	75 - 125	96	75 - 125	<0.10	mg/kg	0.53	40	102	70 - 130
9622706	Total Beryllium (Be)	2019/10/10	91	75 - 125	99	75 - 125	<0.20	mg/kg	NC	30	102	70 - 130
9622706	Total Bismuth (Bi)	2019/10/10	95	75 - 125	97	75 - 125	<0.10	mg/kg	NC	30		
9622706	Total Boron (B)	2019/10/10	91	75 - 125	98	75 - 125	<1.0	mg/kg				
9622706	Total Cadmium (Cd)	2019/10/10	97	75 - 125	100	75 - 125	<0.050	mg/kg	NC	30	95	70 - 130
9622706	Total Calcium (Ca)	2019/10/10	NC	75 - 125	100	75 - 125	<100	mg/kg	5.5	30	100	70 - 130
9622706	Total Chromium (Cr)	2019/10/10	98	75 - 125	105	75 - 125	<0.50	mg/kg	3.9	30	103	70 - 130
9622706	Total Cobalt (Co)	2019/10/10	96	75 - 125	100	75 - 125	<0.10	mg/kg	6.5	30	104	70 - 130
9622706	Total Copper (Cu)	2019/10/10	NC	75 - 125	103	75 - 125	<0.50	mg/kg	186 (1)	30	109	70 - 130
9622706	Total Iron (Fe)	2019/10/10	NC	75 - 125	104	75 - 125	<100	mg/kg	5.8	30	107	70 - 130
9622706	Total Lead (Pb)	2019/10/10	93	75 - 125	100	75 - 125	<0.10	mg/kg	156 (1)	40	115	70 - 130
9622706	Total Lithium (Li)	2019/10/10	92	75 - 125	100	75 - 125	<0.50	mg/kg	4.1	30	93	70 - 130
9622706	Total Magnesium (Mg)	2019/10/10	122	75 - 125	101	75 - 125	<100	mg/kg	9.3	30	109	70 - 130
9622706	Total Manganese (Mn)	2019/10/10	116	75 - 125	101	75 - 125	<0.20	mg/kg	3.4	30	108	70 - 130
9622706	Total Mercury (Hg)	2019/10/10	102	75 - 125	104	75 - 125	<0.050	mg/kg	NC	40	117	70 - 130
9622706	Total Molybdenum (Mo)	2019/10/10	93	75 - 125	95	75 - 125	<0.10	mg/kg	NC	40	100	70 - 130
9622706	Total Nickel (Ni)	2019/10/10	97	75 - 125	101	75 - 125	<0.50	mg/kg	12	30	111	70 - 130
9622706	Total Phosphorus (P)	2019/10/10	93	75 - 125	97	75 - 125	<10	mg/kg	3.7	30	100	70 - 130
9622706	Total Potassium (K)	2019/10/10	104	75 - 125	100	75 - 125	<100	mg/kg	12	40	98	70 - 130
9622706	Total Selenium (Se)	2019/10/10	93	75 - 125	96	75 - 125	<0.50	mg/kg	NC	30		
9622706	Total Silver (Ag)	2019/10/10	93	75 - 125	98	75 - 125	<0.050	mg/kg	4.2	40	127	70 - 130
9622706	Total Sodium (Na)	2019/10/10	132 (1)	75 - 125	103	75 - 125	<100	mg/kg	5.3	40	105	70 - 130
9622706	Total Strontium (Sr)	2019/10/10	101	75 - 125	95	75 - 125	<0.10	mg/kg	11	40	107	70 - 130

BV Labs Job #: B985653
Report Date: 2019/11/15

QUALITY ASSURANCE REPORT(CONT'D)

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
9622706	Total Thallium (Tl)	2019/10/10	93	75 - 125	93	75 - 125	<0.050	mg/kg	NC	30	94	70 - 130
9622706	Total Tin (Sn)	2019/10/10	35 (1)	75 - 125	100	75 - 125	<0.10	mg/kg	196 (1)	40	103	70 - 130
9622706	Total Titanium (Ti)	2019/10/10	NC	75 - 125	100	75 - 125	<1.0	mg/kg	1.4	40		
9622706	Total Tungsten (W)	2019/10/10	91	75 - 125	97	75 - 125	<0.50	mg/kg				
9622706	Total Uranium (U)	2019/10/10	103	75 - 125	102	75 - 125	<0.050	mg/kg	1.3	30	112	70 - 130
9622706	Total Vanadium (V)	2019/10/10	101	75 - 125	104	75 - 125	<1.0	mg/kg	8.6	30	108	70 - 130
9622706	Total Zinc (Zn)	2019/10/10	92	75 - 125	103	75 - 125	<1.0	mg/kg	45 (1)	30	109	70 - 130
9622706	Total Zirconium (Zr)	2019/10/10	98	75 - 125	99	75 - 125	<0.50	mg/kg	6.9	40		
9622914	Biochemical Oxygen Demand	2019/10/15			94	85 - 115	<2.0	mg/L	4.5	20		
9623846	Available (KCl) Ammonia (N)	2019/10/11	NC	75 - 125	93	80 - 120	<2.0	mg/kg	17	35		
9625759	Available (NH4F) Phosphorus (P)	2019/10/12	98	75 - 125	94	80 - 120	<1.0	mg/kg	6.1	35		
9626992	Total Sulphide	2019/10/15	105	80 - 120	94	80 - 120	<0.0018	mg/L	NC	20		
9630371	Available (KCl) Total Kjeldahl Nitrogen	2019/10/17	NC	75 - 125	84	75 - 125	<5.0	mg/kg	16	30	100	75 - 125
9631184	Total Nitrogen	2019/10/17			104	80 - 120	<0.2	%	6.1	30	105	75 - 125

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.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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 or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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BV Labs Job #: B985653
Report Date: 2019/11/15

SLR CONSULTING (CANADA) LTD
Client Project #: 209.40666.00000
Your P.O. #: PENDING
Sampler Initials: KAT

VALIDATION SIGNATURE PAGE

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

Andy Lu, Ph.D., P.Chem., Scientific Specialist

Donald Lai, Lab Coordinator

Kenneth Goldie, Sample Reception

Harry (Peng) Liang, Senior Analyst

Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

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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COR FCD-00265 / 4
Page ___ of ___

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ADDITIONAL COOLER

CHAIN-OF-CU

B985653_ACTR

CHAIN OF CUSTODY #	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	

COOLER OBSERVATIONS:

COOLER ID	CUSTODY SEAL PRESENT (YES / NO)	CUSTODY SEAL INTACT (YES / NO)	ICE PRESENT (YES / NO)	TEMP 1	TEMP 2	TEMP 3
1	X /	X /	X /	2	3	5
2	X /	/ X	X /	4	3	3
3	X /	/ X	X /	6	7	4
4	X /	X /	X /	2	1	1
5	X /	X /	X /	1	3	1
6	X /	X /	X /	2	1	0
7	X /	X /	X /	1	2	3

RECEIVED BY (SIGN & PRINT)		DATE (YYYY/MM/DD)	TIME (HH:MM)
[signature]	PEDRO TACK	2019/10/05	12:18

COR FCD-00265 / 4
Page ___ of ___

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B985653_ACTR

ADDITIONAL COOLER TEMPI

CHAIN-OF-CUSTODY F

03-Oct-19 16:09
Ronklin Gracian
B9R8283
WVL ENV-593

MAXXAM J(

Page	CHAIN OF CUSTODY #
Page 1 of 2	G14143
Page 2 of 2	G14143
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	
Page ___ of ___	

COOLER OBSERVATIONS:

Cooler	Custody seal present (YES / NO)	Custody seal intact (YES / NO)	Ice present (YES / NO)	Cooler ID	Temp 1	Temp 2	Temp 3
1	NO ✓	NO ✓	NO ✓		8	8	8
2	NO ✓	NO ✓	NO ✓		6	6	6
3	NO ✓	NO ✓	NO ✓		6	6	6
4	NO ✓	NO ✓	NO ✓		8	7	7
5	NO ✓	NO ✓	NO ✓		6	6	4
6	NO ✓	NO ✓	NO ✓		4	6	5
7	NO ✓	NO ✓	NO ✓		6	6	6
8					3	6	4
9					5	6	5
10							
11–20							

RECEIVED BY (SIGN & PRINT)		DATE (YYYY/MM/DD)	TIME (HH:MM)
[signature]	COLENE CUKIMO	2019/10/03	16:09

340

BOD

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Toll Free (833)
Victoria: 460 Tennyson Place, Unit 1, Victoria, BC V8Z 6S8 Toll Free
bvlabs.com

BUREAU VERITAS

RECORD

G141143

Page 1 of 2

B985653_COC

Invoice Information	
Company:	SLR Consulting
Contact Name:	Celine Totman
Address:	Suite 200 - 1620 West 8th Avenue PC: V6J 1V4
Phone/Fax:	604-318-5294
Email:	ctotman@slrconsulting.com
Copies:	Kimberley Tasker

Report Information (if differs from invoice)	
Company:	
Contact Name:	
Address:	PC:
Phone/Fax:	
Email:	
Copies:	

Project #:	209.70666.00000
Site Location:	Chedoke
Site #:	
Sampled By:	KAT

Turnaround Time (TAT) Required

- ☒ 5 - 7 Days Regular (Most analyses)

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

- ☐ Same Day
- ☐ 1 Day
- ☐ 2 Days
- ☐ 3-4 Days

Date Required:

Rush Confirmation #:

Regulatory Criteria

- ☐ BC CSR
- ☐ YK CSR
- ☒ CCME
- ☐ Drinking Water
- ☐ BC Water Quality
- ☒ Other Table Ontario Sediment standards

Laboratory Use Only

	YES	NO	Cooler ID	
Seal Present		✓	Temp	3
Seal Intact		✓		2019/10/03
Cooling Media	✓			

	YES	NO	Cooler ID			
Seal Present			Temp	5	6	5
Seal Intact		✓				
Cooling Media						

	YES	NO	Cooler ID	
Seal Present			Temp	Refer to ACTR
Seal Intact				
Cooling Media				

Depot Reception

BBY: SEE ACTR

Analysis Requested

☐ BTEXS / VPH ☐ VOC / BTEXS / VPH ☐ MTBE ☐ BTEX F1 ☐ VOC / BTEX / F1 ☒ PAH ☐ LEPH / HEPH / PAH ☐ EPH ☐ TEH ☐ F2 - F4 ☐ Dissolved Metals ☐ Filtered? ☐ Preserved? ☐ Dissolved Mercury ☐ Filtered? ☐ Preserved? ☒ Total Metals ☐ Field Preserved? ☒ Total Mercury ☐ Field Preserved? ☐ Chloride ☐ Fluoride ☐ Sulphate ☐ TSS ☐ TDS ☒ BOD ☐ COD ☒ pH ☐ Conductivity ☐ Alkalinity ☐ Nitrite ☐ Nitrate ☐ Ammonia; TOXICITY; Hydrogen sulphide (porewater); MOISTURE; TOC; NUTRIENTS.; HOLD - DO NOT ANALYZE

#	Sample Identification	Date Sampled (yyyy/mm/dd)	Time Sampled (hh:mm)	Matrix	# of Containers	PAH	Total Metals	Total Mercury	TSS	pH	TOXICITY	Hydrogen sulphide	MOISTURE	TOC	NUTRIENTS	Special Instructions
1	Boat Launch	2019/10/01	09:20	Sediment	8	X	X	X	X	Y		X	X	X	X	BOD is porewater
2	C6 EAST / G7	2019/10/01	10:55	Sediment		X	X	X	X	X	X	X	X	X	X	HOLD Toxicity until
3	C5 EAST / G6	2019/10/01	13:35			X	X	X	X	X	X	X	X	X	X	Sediment quality
4	C4 WEST	2019/10/01	11:45			X	X	X	X	X		X	X	X	X	is completed
5	Blind Duplicate	2019/10/01	09:30			X	X	X	X	X	X	X	X	X	X	SLR to confirm
6	C3 WEST	2019/10/02	11:45			X	X	X	X	X	X	X	X	X	X	
7	C3 Centre / G5	2019/10/02	10:18			X	X	X	Y	X	X	X	X	X	Y	
8	G4	2019/10/02	12:50			X	X	X								
9	~~G1~~	~~2019/10/02~~														
10	C1 WEST	2019/10/02	16:20			X	X	X	Y	X	X	X	X	X	X	

Unless otherwise agreed to in writing, work submitted on this Chain of Custody is subject to Bureau Veritas' standard Terms and Conditions. Signing of this Chain of Custody document is acknowledgement and acceptance of our terms which are

Relinquished by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):	Received by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):
Kimberley Tasker / KIMBERLEY TASKER	2019/10/03	16:10	COLENE CURITTO	2019/10/03	16:09
			PEDRO TACK	2019/10/05	12:18

03-Oct-19 16:09
Ronklin Gracian
B9R8283
WVL ENV-593

COC-1020 FRANCINE CHONG 2019/10/04 14:30

Bureau Veritas Shaping a World of Trust©

BUREAU VERITAS

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Toll Free (833) 282-5227
Victoria: 460 Tennyson Place, Unit 1, Victoria, BC V8Z 6S8 Toll Free (833) 28
bvlabs.com

B985653_COC

RD

G141144

Page 2 of 2

Invoice Information		Report Information (if differs from invoice)			
Company:	SLR Consulting	Company:		Quo	
Contact Name:	Celine Totman	Contact Name:		P.O.	
Address:	Suite 200 - 1620 West 8th Ave Vancouver BC PC: V6J 1V4	Address: PC:		Project #:	209.40ddd.00000
				Site Location:	
Phone/Fax:	604-318-5294	Phone/Fax:		Site #:	
Email:	ctotman@slrconsulting.com	Email:		Sampled By:	KAT
Copies:	ktasker@slrconsulting.com	Copies:			

Turnaround Time (TAT) Required

☒ 5 - 7 Days Regular (Most analyses)

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ Same Day ☐ 2 Days
☐ 1 Day ☐ 3-4 Days

Date Required:

Rush Confirmation #:

Laboratory Use Only

	YES	NO	Cooler ID	SEE ACTR
Seal Present				
Seal Intact			Temp	
Cooling Media				
	YES	NO	Cooler ID	
Seal Present				
Seal Intact			Temp	
Cooling Media				
	YES	NO	Cooler ID	
Seal Present				
Seal Intact			Temp	
Cooling Media				

Depot Reception

Analysis Requested: # of Containers; ☐ BTEXS / VPH, ☐ VOC / BTEXS / VPH, ☐ MTBE; ☐ BTEX F1, ☐ VOC / BTEX / F1; ☐ PAH, ☐ LEPH / HEPH / PAH; ☐ EPH, ☐ TEH, ☐ F2 - F4; ☐ Dissolved Metals, ☐ Filtered?, ☐ Preserved?; ☐ Dissolved Mercury, ☐ Filtered?, ☐ Preserved?; ☐ Total Metals, ☐ Field Preserved?; ☐ Total Mercury, ☐ Field Preserved?; ☐ Chloride, ☐ Fluoride, ☐ Sulphate; ☐ TSS, ☐ TDS, ☐ BOD, ☐ COD; ☐ pH, ☐ Conductivity, ☐ Alkalinity; ☐ Nitrite, ☐ Nitrate, ☐ Ammonia; Bacteriology; Particle size (Pebble, sand, silt, clay); HOLD - DO NOT ANALYZE

Regulatory Criteria

☐ BC CSR
☐ YK CSR
☒ CCME
☐ Drinking Water
☐ BC Water Quality
☒ Other Table 1 Ontario Sediment Standards

Special Instructions

	Sample Identification	Date Sampled (yyyy/mm/dd)	Time Sampled (hh:mm)	Matrix	Bacteriology	Particle size	HOLD - DO NOT ANALYZE	Special Instructions
1	Boat Launch	2019/10/01	09:20	Sediment	X	X		
2	C6 East / G7	↓	10:55	↓	X	X		
3	C5 EAST / G6	↓	13:35	↓	X	X		
4	C4 WEST	↓	11:45	↓	X	X		
5	Blind Duplicate.	↓	09:30	↓	X	X		
6	C3 WEST	2019/10/02	11:45	↓	X	X		
7	C3 CENTRE / G5	↓	10:18	↓	X	X		
8	G4	↓	12:50	↓	X	X		
9	~~G1~~							
10	C1 WEST	↓	16:20	↓	X	X		

Unless otherwise agreed to in writing, work submitted on this Chain of Custody is subject to Bureau Veritas' standard Terms and Conditions. Signing of this Chain of Custody document is acknowledgement and acceptance of our terms which are available for viewing at www.bvlab.ca/terms

Relinquished by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):	Received by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):	BV Job #
Kimberley Tasker	2019/10/03	16:10	see page 1			
KIMBERLEY TASKER.			JM PEDRO TACK	2019/10/05	12:18	

COC-1020 see page 1

Bureau Veritas Shaping a World of Trust©

BBY FCD-00077/13

Your Project #: 209.40666.00000 [B985653]
Your C.O.C. #: B985653-ONTV-01-01

Attention: Safiann Maiter

Bureau Veritas Laboratories
4606 Canada Way
Burnaby, BC
CANADA V5G 1K5

Report Date: 2019/10/10
Report #: R5916219
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9S3356
Received: 2019/10/09, 09:20

Sample Matrix: Soil
Samples Received: 9

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Total Organic Carbon in Soil	9	N/A	2019/10/10	CAM SOP-00468	BCMOE TOC Aug 2014

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.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
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.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Your Project #: 209.40666.00000 [B985653]
Your C.O.C. #: B985653-ONTV-01-01

Attention: Safiann Maiter

Bureau Veritas Laboratories
4606 Canada Way
Burnaby, BC
CANADA V5G 1K5

Report Date: 2019/10/10
Report #: R5916219
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9S3356
Received: 2019/10/09, 09:20

Encryption Key

AUTHORIZED REPORT
RAPPORT AUTORISÉ

Bureau Veritas Laboratories
10 Oct 2019 15:15:07

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ronklin Gracian, Project Manager
Email: Ronklin.Gracian@bvlabs.com
Phone# (905)817-5752
==
This report has been generated and distributed using a secure automated process.
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 #: B9S3356
Report Date: 2019/10/10

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

RESULTS OF ANALYSES OF SOIL

BV Labs ID		KZM471	KZM472	KZM473	KZM474		
Sampling Date		2019/10/01 09:20	2019/10/01 10:55	2019/10/01 13:35	2019/10/01 11:45		
COC Number		B985653-ONTV-01-01	B985653-ONTV-01-01	B985653-ONTV-01-01	B985653-ONTV-01-01		
	UNITS	**WQ6244-BOAT LAUNCH**	**WQ6245-C6 EAST/G7**	**WQ6246-C5 EAST/G6**	**WQ6247-C4 WEST**	**RDL**	**QC Batch**
Inorganics							
Total Organic Carbon	mg/kg	35000	41000	39000	47000	500	6379999

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

BV Labs ID		KZM474	KZM475	KZM476	KZM477		
Sampling Date		2019/10/01 11:45	2019/10/01 09:30	2019/10/02 11:45	2019/10/02 10:18		
COC Number		B985653-ONTV-01-01	B985653-ONTV-01-01	B985653-ONTV-01-01	B985653-ONTV-01-01		
	UNITS	**WQ6247-C4 WEST Lab-Dup**	**WQ6248-BLIND DUPLICATE**	**WQ6249-C3 WEST**	**WQ6250-C3 CENTRE/G5**	**RDL**	**QC Batch**
Inorganics							
Total Organic Carbon	mg/kg	49000	37000	39000	20000	500	6379999

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

BV Labs ID		KZM478	KZM479		
Sampling Date		2019/10/02 12:50	2019/10/02 16:20		
COC Number		B985653-ONTV-01-01	B985653-ONTV-01-01		
	UNITS	**WQ6251-G4**	**WQ6252-C1 WEST**	**RDL**	**QC Batch**
Inorganics					
Total Organic Carbon	mg/kg	31000	26000	500	6379999

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

BV Labs Job #: B9S3356
Report Date: 2019/10/10

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

TEST SUMMARY

BV Labs ID: KZM471 **Collected:** 2019/10/01
Sample ID: WQ6244-BOAT LAUNCH **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM472 **Collected:** 2019/10/01
Sample ID: WQ6245-C6 EAST/G7 **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM473 **Collected:** 2019/10/01
Sample ID: WQ6246-C5 EAST/G6 **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM474 **Collected:** 2019/10/01
Sample ID: WQ6247-C4 WEST **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM474 Dup **Collected:** 2019/10/01
Sample ID: WQ6247-C4 WEST **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM475 **Collected:** 2019/10/01
Sample ID: WQ6248-BLIND DUPLICATE **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM476 **Collected:** 2019/10/02
Sample ID: WQ6249-C3 WEST **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs Job #: B9S3356
Report Date: 2019/10/10

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

TEST SUMMARY

BV Labs ID: KZM477 **Collected:** 2019/10/02
Sample ID: WQ6250-C3 CENTRE/G5 **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM478 **Collected:** 2019/10/02
Sample ID: WQ6251-G4 **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs ID: KZM479 **Collected:** 2019/10/02
Sample ID: WQ6252-C1 WEST **Shipped:**
Matrix: Soil **Received:** 2019/10/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Total Organic Carbon in Soil	COMB	6379999	N/A	2019/10/10	Dhruvik Modh

BV Labs Job #: B9S3356
Report Date: 2019/10/10

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

GENERAL COMMENTS

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

Package 1	7.3°C

Results relate only to the items tested.

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

BV Labs Job #: B9S3356
Report Date: 2019/10/10

QUALITY ASSURANCE REPORT

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
6379999	Total Organic Carbon	2019/10/10	<500	mg/kg	5.3	35	103	75 - 125

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

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

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

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BV Labs Job #: B9S3356
Report Date: 2019/10/10

Bureau Veritas Laboratories
Client Project #: 209.40666.00000 [B985653]
Sampler Initials: KAT

VALIDATION SIGNATURE PAGE

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

CHARTERED
Eva Pranjic
CHEMIST

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Certificate of Analysis

City of Hamilton
Environmental Laboratory
700 Woodward Avenue, Hamilton, ON L8H 6P4
P. (905) 546-2424 F. (905)545-0234

CLIENT INFORMATION

Client Name: HAMILTON WATER
Attention: MANI SERADJ

Address: 77 JAMES STREET NORTH
HAMILTON
L8R 2K3

LABORATORY INFORMATION

Sample Date: 2019-09-30
Date Submitted: 2019-10-01

Laboratory Work Order Number: 330748

Samples in this work order were analyzed using the following methods:

cBOD/BOD/DO DO-Meter	TSS/VSS Gravimetric	Alk/pH/Cond/Temp PC Titrate	Bacteria Membrane Filtration mFC-BCIG agar
Mercury Cold Vapour AA	Anions IC	Ammonia Skalar	TKN Skalar
TOC/DOC Colourimetric	LIMS Calculation	Subcontract	Field Parameters - Client
Metals ICP/MS	o-Phosphate Colourimetric		

NOTES:
'<' = less than the Method Detection Limit (MDL), 'IS' = Insufficient Sample, '>' = greater than the reported result.

Methods used by the City of Hamilton's Environmental Laboratory (CHEL) are based upon or modified from those found in published reference methods. Specific information on the methods used and equations used for calculated analytes are available upon request.
All analytical work performed at the CHEL is done according to accepted quality assurance and quality control procedures. Quality and other related data as well as uncertainty values are available upon request.

The results on this Certificate of Analysis relate only to the sample as received and analyzed.
Field data provided by the customer is identified as such and can affect the validity of CHEL's results.
The Certificate of Analysis shall not be reproduced except in full without approval of CHEL.

Final Report Approval by:

Digitally signed by Shannon Overholster
Date: 2019.10.22 16:43:42 -04'00'

Shannon Overholster
Supervisor, Quality Assurance

Water and Waste Water Systems Planning

Chedoke Creek Surface Water Analysis

C-1 West 2019-09-30 16:50:00 Record 604014

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.05	mg/L	0.01
Conductivity - Field	0.733	mS/cm	
Dissolved Organic Carbon	2.5	mg/L	0.4
Dissolved Oxygen-Field	10.23	mg/L	
Escherichia coli	4100	CFU/100mL	0
Hardness (Calculation)	253	mg/L	0.7
Nitrate as N	1.95	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	2.17	mg/L	0.02
Nitrite as N	0.22	mg/L	0.01
o-Phosphate as P	0.44	mg/L	0.05
pH	8.32	pH	0.01
pH - Field	8.25	pH	
Phosphorus Dissolved Total	0.401	mg/L	0.010
Phosphorus Total	0.415	mg/L	0.010
Temperature - Field	15.7	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	0.6	mg/L	0.2
Total Organic Carbon	2.6	mg/L	0.4
Total Suspended Solids	4.5	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	3.0	ug/L	0.1
Aluminum	0.145	mg/L	0.002
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0013	mg/L	0.0001
Barium	0.0394	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.149	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	72.3	mg/L	0.05
Chromium	0.0002	mg/L	0.0001
Cobalt	0.0001	mg/L	0.0001
Copper	0.0029	mg/L	0.0001
Dissolved Aluminum	0.013	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0429	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.143	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	69.4	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	<0.0001	mg/L	0.0001
Dissolved Copper	0.0019	mg/L	0.0001
Dissolved Iron	0.009	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	17.4	mg/L	0.05
Dissolved Manganese	0.0152	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0021	mg/L	0.0001
Dissolved Nickel	0.0010	mg/L	0.0001
Dissolved Potassium	3.35	mg/L	0.05

Analyte	Result	Units	MDL
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.77	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	81.7	mg/L	0.05
Dissolved Strontium	1.07	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0003	mg/L	0.0001
Dissolved Uranium	0.748	ug/L	0.002
Dissolved Vanadium	0.0007	mg/L	0.0001
Dissolved Zinc	0.012	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.202	mg/L	0.003
Lead	0.0004	mg/L	0.0001
Magnesium	17.5	mg/L	0.05
Manganese	0.0203	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0011	mg/L	0.0001
Potassium	3.40	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.05	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	80.8	mg/L	0.05
Strontium	1.09	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0031	mg/L	0.0001
Uranium	0.734	ug/L	0.002
Vanadium	0.0010	mg/L	0.0001
Zinc	0.017	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

Analyte	Result	Units	MDL
C-1 West Duplicate 2019-09-30 16:52:00 Record 604015			
Ammonia + Ammonium as N	0.07	mg/L	0.01
Dissolved Organic Carbon	2.6	mg/L	0.4
Escherichia coli	3100	CFU/100mL	0
Hardness (Calculation)	252	mg/L	0.7
Nitrate as N	1.91	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	2.13	mg/L	0.02
Nitrite as N	0.22	mg/L	0.01
o-Phosphate as P	0.44	mg/L	0.05
pH	8.32	pH	0.01
pH - Field	8.25	pH	
Phosphorus Dissolved Total	0.410	mg/L	0.010
Phosphorus Total	0.450	mg/L	0.010
Temperature - Field	15.7	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	0.6	mg/L	0.2
Total Organic Carbon	3.0	mg/L	0.4
Total Suspended Solids	13.8	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	4.1	ug/L	0.1
Aluminum	0.299	mg/L	0.002
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0013	mg/L	0.0001
Barium	0.0404	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.143	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	70.6	mg/L	0.05
Chromium	0.0004	mg/L	0.0001
Cobalt	0.0003	mg/L	0.0001
Copper	0.0037	mg/L	0.0001
Dissolved Aluminum	0.014	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0013	mg/L	0.0001
Dissolved Barium	0.0416	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.150	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	70.9	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	<0.0001	mg/L	0.0001
Dissolved Copper	0.0021	mg/L	0.0001
Dissolved Iron	0.008	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	18.3	mg/L	0.05
Dissolved Manganese	0.0158	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0021	mg/L	0.0001
Dissolved Nickel	0.0010	mg/L	0.0001
Dissolved Potassium	3.55	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.75	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	82.3	mg/L	0.05
Dissolved Strontium	1.13	mg/L	0.0005

Analyte	Result	Units	MDL
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0003	mg/L	0.0001
Dissolved Uranium	0.777	ug/L	0.002
Dissolved Vanadium	0.0008	mg/L	0.0001
Dissolved Zinc	0.011	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.426	mg/L	0.003
Lead	0.0010	mg/L	0.0001
Magnesium	17.8	mg/L	0.05
Manganese	0.0300	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0014	mg/L	0.0001
Potassium	3.47	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.16	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	80.8	mg/L	0.05
Strontium	1.07	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0058	mg/L	0.0001
Uranium	0.730	ug/L	0.002
Vanadium	0.0012	mg/L	0.0001
Zinc	0.022	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

C-3 Centre - G5 2019-09-30 16:35:00 Record 604016

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.62	mg/L	0.01
Conductivity - Field	0.760	mS/cm	
Dissolved Organic Carbon	3.4	mg/L	0.4

Analyte	Result	Units	MDL
Dissolved Oxygen-Field	5.99	mg/L	
Escherichia coli	1700	CFU/100mL	0
Hardness (Calculation)	244	mg/L	0.7
Nitrate as N	1.77	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	1.88	mg/L	0.02
Nitrite as N	0.11	mg/L	0.01
o-Phosphate as P	0.37	mg/L	0.05
pH	7.99	pH	0.01
pH - Field	7.61	pH	
Phosphorus Dissolved Total	0.260	mg/L	0.010
Phosphorus Total	0.371	mg/L	0.010
Temperature - Field	16.1	C	
Total Biochem. Oxygen Demand	2	mg/L	1
Total Kjeldahl Nitrogen as N	1.1	mg/L	0.2
Total Organic Carbon	4.0	mg/L	0.4
Total Suspended Solids	19.8	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	9.0	ug/L	0.1
Aluminum	0.467	mg/L	0.002
Antimony	0.0003	mg/L	0.0001
Arsenic	0.0015	mg/L	0.0001
Barium	0.0484	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.197	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	67.0	mg/L	0.05
Chromium	0.0007	mg/L	0.0001
Cobalt	0.0004	mg/L	0.0001
Copper	0.0035	mg/L	0.0001
Dissolved Aluminum	0.003	mg/L	0.002
Dissolved Antimony	0.0003	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0459	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.211	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	68.9	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0002	mg/L	0.0001
Dissolved Copper	0.0011	mg/L	0.0001
Dissolved Iron	0.007	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	17.5	mg/L	0.05
Dissolved Manganese	0.0563	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0022	mg/L	0.0001
Dissolved Nickel	0.0012	mg/L	0.0001
Dissolved Potassium	3.77	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.78	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	88.3	mg/L	0.05
Dissolved Strontium	0.940	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0002	mg/L	0.0001

Analyte	Result	Units	MDL
Dissolved Uranium	0.675	ug/L	0.002
Dissolved Vanadium	0.0011	mg/L	0.0001
Dissolved Zinc	0.006	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.883	mg/L	0.003
Lead	0.0019	mg/L	0.0001
Magnesium	17.5	mg/L	0.05
Manganese	0.0730	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0021	mg/L	0.0001
Nickel	0.0019	mg/L	0.0001
Potassium	3.88	mg/L	0.05
Selenium	0.0003	mg/L	0.0001
Silicon	3.52	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	82.1	mg/L	0.05
Strontium	0.947	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0086	mg/L	0.0001
Uranium	0.666	ug/L	0.002
Vanadium	0.0019	mg/L	0.0001
Zinc	0.020	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

C-3 West 2019-09-30 16:25:00 Record 604017

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.59	mg/L	0.01
Conductivity - Field	0.771	mS/cm	
Dissolved Organic Carbon	2.9	mg/L	0.4
Dissolved Oxygen-Field	6.38	mg/L	
Escherichia coli	1200	CFU/100mL	0
Hardness (Calculation)	248	mg/L	0.7

Analyte	Result	Units	MDL
Nitrate as N	1.80	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	1.93	mg/L	0.02
Nitrite as N	0.13	mg/L	0.01
o-Phosphate as P	0.38	mg/L	0.05
pH	8.03	pH	0.01
pH - Field	7.65	pH	
Phosphorus Dissolved Total	0.271	mg/L	0.010
Phosphorus Total	0.388	mg/L	0.010
Temperature - Field	15.9	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	1.1	mg/L	0.2
Total Organic Carbon	3.7	mg/L	0.4
Total Suspended Solids	20.8	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	9.2	ug/L	0.1
Aluminum	0.468	mg/L	0.002
Antimony	0.0003	mg/L	0.0001
Arsenic	0.0015	mg/L	0.0001
Barium	0.0480	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.193	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	68.9	mg/L	0.05
Chromium	0.0007	mg/L	0.0001
Cobalt	0.0004	mg/L	0.0001
Copper	0.0036	mg/L	0.0001
Dissolved Aluminum	0.004	mg/L	0.002
Dissolved Antimony	0.0003	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0466	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.204	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	69.8	mg/L	0.05
Dissolved Chromium	0.0001	mg/L	0.0001
Dissolved Cobalt	0.0002	mg/L	0.0001
Dissolved Copper	0.0010	mg/L	0.0001
Dissolved Iron	0.015	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	17.6	mg/L	0.05
Dissolved Manganese	0.0542	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0021	mg/L	0.0001
Dissolved Nickel	0.0013	mg/L	0.0001
Dissolved Potassium	3.74	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.80	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	89.8	mg/L	0.05
Dissolved Strontium	0.952	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0002	mg/L	0.0001
Dissolved Uranium	0.702	ug/L	0.002
Dissolved Vanadium	0.0011	mg/L	0.0001
Dissolved Zinc	0.005	mg/L	0.001

Analyte	Result	Units	MDL
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.890	mg/L	0.003
Lead	0.0021	mg/L	0.0001
Magnesium	17.9	mg/L	0.05
Manganese	0.0713	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0021	mg/L	0.0001
Nickel	0.0018	mg/L	0.0001
Potassium	3.87	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.62	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	84.2	mg/L	0.05
Strontium	0.976	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0089	mg/L	0.0001
Uranium	0.690	ug/L	0.002
Vanadium	0.0019	mg/L	0.0001
Zinc	0.021	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

C-4 West 2019-09-30 16:15:00 Record 604018

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.84	mg/L	0.01
Conductivity - Field	0.739	mS/cm	
Dissolved Organic Carbon	3.9	mg/L	0.4
Dissolved Oxygen-Field	4.85	mg/L	
Escherichia coli	800	CFU/100mL	0
Hardness (Calculation)	233	mg/L	0.7
Nitrate as N	1.64	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	1.73	mg/L	0.02
Nitrite as N	0.09	mg/L	0.01

Analyte	Result	Units	MDL
o-Phosphate as P	0.33	mg/L	0.05
pH	7.94	pH	0.01
pH - Field	7.52	pH	
Phosphorus Dissolved Total	0.217	mg/L	0.010
Phosphorus Total	0.363	mg/L	0.010
Temperature - Field	16.3	C	
Total Biochem. Oxygen Demand	2	mg/L	1
Total Kjeldahl Nitrogen as N	1.4	mg/L	0.2
Total Organic Carbon	4.4	mg/L	0.4
Total Suspended Solids	21.2	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	10.1	ug/L	0.1
Aluminum	0.489	mg/L	0.002
Antimony	0.0003	mg/L	0.0001
Arsenic	0.0016	mg/L	0.0001
Barium	0.0492	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.206	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	63.4	mg/L	0.05
Chromium	0.0008	mg/L	0.0001
Cobalt	0.0004	mg/L	0.0001
Copper	0.0036	mg/L	0.0001
Dissolved Aluminum	0.002	mg/L	0.002
Dissolved Antimony	0.0003	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0486	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.209	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	65.4	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0002	mg/L	0.0001
Dissolved Copper	0.0011	mg/L	0.0001
Dissolved Iron	0.006	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	16.7	mg/L	0.05
Dissolved Manganese	0.0630	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0020	mg/L	0.0001
Dissolved Nickel	0.0018	mg/L	0.0001
Dissolved Potassium	3.75	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.75	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	82.1	mg/L	0.05
Dissolved Strontium	0.869	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0001	mg/L	0.0001
Dissolved Uranium	0.601	ug/L	0.002
Dissolved Vanadium	0.0012	mg/L	0.0001
Dissolved Zinc	0.004	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.990	mg/L	0.003
Lead	0.0021	mg/L	0.0001

Analyte	Result	Units	MDL
Magnesium	17.0	mg/L	0.05
Manganese	0.0882	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0019	mg/L	0.0001
Potassium	3.89	mg/L	0.05
Selenium	0.0003	mg/L	0.0001
Silicon	3.55	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	79.8	mg/L	0.05
Strontium	0.881	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0092	mg/L	0.0001
Uranium	0.602	ug/L	0.002
Vanadium	0.0021	mg/L	0.0001
Zinc	0.020	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

C-5 East - G6 2019-09-30 16:05:00 Record 604019

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	1.05	mg/L	0.01
Conductivity - Field	0.700	mS/cm	
Dissolved Organic Carbon	4.1	mg/L	0.4
Dissolved Oxygen-Field	2.96	mg/L	
Escherichia coli	390	CFU/100mL	0
Hardness (Calculation)	223	mg/L	0.7
Nitrate as N	1.44	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	1.51	mg/L	0.02
Nitrite as N	0.07	mg/L	0.01
o-Phosphate as P	0.30	mg/L	0.05
pH	7.87	pH	0.01
pH - Field	7.43	pH	

Analyte	Result	Units	MDL
Phosphorus Dissolved Total	0.166	mg/L	0.010
Phosphorus Total	0.314	mg/L	0.010
Temperature - Field	16.3	C	
Total Biochem. Oxygen Demand	3	mg/L	1
Total Kjeldahl Nitrogen as N	1.5	mg/L	0.2
Total Organic Carbon	4.5	mg/L	0.4
Total Suspended Solids	26.8	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	10.3	ug/L	0.1
Aluminum	0.598	mg/L	0.002
Antimony	0.0004	mg/L	0.0001
Arsenic	0.0015	mg/L	0.0001
Barium	0.0495	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.177	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	61.4	mg/L	0.05
Chromium	0.0010	mg/L	0.0001
Cobalt	0.0005	mg/L	0.0001
Copper	0.0041	mg/L	0.0001
Dissolved Aluminum	<0.002	mg/L	0.002
Dissolved Antimony	0.0004	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0472	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.183	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	61.7	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0002	mg/L	0.0001
Dissolved Copper	0.0007	mg/L	0.0001
Dissolved Iron	0.011	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	16.7	mg/L	0.05
Dissolved Manganese	0.0762	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0020	mg/L	0.0001
Dissolved Nickel	0.0012	mg/L	0.0001
Dissolved Potassium	3.95	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.69	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	77.6	mg/L	0.05
Dissolved Strontium	0.869	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	<0.0001	mg/L	0.0001
Dissolved Uranium	0.577	ug/L	0.002
Dissolved Vanadium	0.0012	mg/L	0.0001
Dissolved Zinc	0.004	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	1.18	mg/L	0.003
Lead	0.0023	mg/L	0.0001
Magnesium	16.5	mg/L	0.05
Manganese	0.0989	mg/L	0.0001
Mercury	<0.05	ug/L	0.05

Analyte	Result	Units	MDL
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0020	mg/L	0.0001
Potassium	3.92	mg/L	0.05
Selenium	0.0003	mg/L	0.0001
Silicon	3.71	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	72.8	mg/L	0.05
Strontium	0.850	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0112	mg/L	0.0001
Uranium	0.556	ug/L	0.002
Vanadium	0.0023	mg/L	0.0001
Zinc	0.021	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

C-6 East - G7 2019-09-30 13:40:00 Record 604020

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.28	mg/L	0.01
Conductivity - Field	0.711	mS/cm	
Dissolved Organic Carbon	4.6	mg/L	0.4
Dissolved Oxygen-Field	9.06	mg/L	
Escherichia coli	60	CFU/100mL	0
Hardness (Calculation)	257	mg/L	0.7
Nitrate as N	0.35	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	0.35	mg/L	0.02
Nitrite as N	<0.05	mg/L	0.05
o-Phosphate as P	<0.05	mg/L	0.05
pH	8.27	pH	0.01
pH - Field	8.20	pH	
Phosphorus Dissolved Total	<0.010	mg/L	0.010
Phosphorus Total	0.169	mg/L	0.010
Temperature - Field	17.1	C	

Analyte	Result	Units	MDL
Total Biochem. Oxygen Demand	7	mg/L	1
Total Kjeldahl Nitrogen as N	1.3	mg/L	0.2
Total Organic Carbon	5.2	mg/L	0.4
Total Suspended Solids	37.6	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	16.4	ug/L	0.1
Aluminum	0.585	mg/L	0.002
Antimony	0.0003	mg/L	0.0001
Arsenic	0.0016	mg/L	0.0001
Barium	0.0640	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.104	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	67.0	mg/L	0.05
Chromium	0.0010	mg/L	0.0001
Cobalt	0.0005	mg/L	0.0001
Copper	0.0043	mg/L	0.0001
Dissolved Aluminum	<0.002	mg/L	0.002
Dissolved Antimony	0.0003	mg/L	0.0001
Dissolved Arsenic	0.0009	mg/L	0.0001
Dissolved Barium	0.0521	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.109	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	67.2	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0001	mg/L	0.0001
Dissolved Copper	0.0004	mg/L	0.0001
Dissolved Iron	0.007	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	20.5	mg/L	0.05
Dissolved Manganese	0.0228	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0068	mg/L	0.0001
Dissolved Nickel	0.0012	mg/L	0.0001
Dissolved Potassium	5.00	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.43	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	70.2	mg/L	0.05
Dissolved Strontium	0.954	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	<0.0001	mg/L	0.0001
Dissolved Uranium	0.966	ug/L	0.002
Dissolved Vanadium	0.0003	mg/L	0.0001
Dissolved Zinc	0.002	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	1.34	mg/L	0.003
Lead	0.0030	mg/L	0.0001
Magnesium	21.7	mg/L	0.05
Manganese	0.160	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0067	mg/L	0.0001
Nickel	0.0023	mg/L	0.0001
Potassium	5.54	mg/L	0.05

Analyte	Result	Units	MDL
Selenium	0.0002	mg/L	0.0001
Silicon	3.62	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	65.3	mg/L	0.05
Strontium	1.05	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0121	mg/L	0.0001
Uranium	1.02	ug/L	0.002
Vanadium	0.0020	mg/L	0.0001
Zinc	0.020	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

G-1 2019-09-30 17:00:00 Record 604021

Ammonia + Ammonium as N	0.07	mg/L	0.01
Conductivity - Field	0.729	mS/cm	
Dissolved Organic Carbon	2.5	mg/L	0.4
Dissolved Oxygen-Field	10.4	mg/L	
Escherichia coli	2800	CFU/100mL	0
Hardness (Calculation)	249	mg/L	0.7
Nitrate as N	1.94	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	2.14	mg/L	0.02
Nitrite as N	0.20	mg/L	0.01
o-Phosphate as P	0.44	mg/L	0.05
pH	8.42	pH	0.01
pH - Field	8.36	pH	
Phosphorus Dissolved Total	0.420	mg/L	0.010
Phosphorus Total	0.428	mg/L	0.010
Temperature - Field	15.7	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	0.5	mg/L	0.2
Total Organic Carbon	2.4	mg/L	0.4

Analyte	Result	Units	MDL
Total Suspended Solids	5.3	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	5.3	ug/L	0.1
Aluminum	0.160	mg/L	0.002
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0013	mg/L	0.0001
Barium	0.0386	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.143	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	69.9	mg/L	0.05
Chromium	0.0002	mg/L	0.0001
Cobalt	0.0002	mg/L	0.0001
Copper	0.0030	mg/L	0.0001
Dissolved Aluminum	0.013	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0012	mg/L	0.0001
Dissolved Barium	0.0385	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.147	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	71.0	mg/L	0.05
Dissolved Chromium	0.0001	mg/L	0.0001
Dissolved Cobalt	<0.0001	mg/L	0.0001
Dissolved Copper	0.0019	mg/L	0.0001
Dissolved Iron	0.019	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	17.5	mg/L	0.05
Dissolved Manganese	0.0118	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0021	mg/L	0.0001
Dissolved Nickel	0.0010	mg/L	0.0001
Dissolved Potassium	3.32	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.68	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	81.9	mg/L	0.05
Dissolved Strontium	1.09	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0002	mg/L	0.0001
Dissolved Uranium	0.750	ug/L	0.002
Dissolved Vanadium	0.0007	mg/L	0.0001
Dissolved Zinc	0.009	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.227	mg/L	0.003
Lead	0.0005	mg/L	0.0001
Magnesium	17.5	mg/L	0.05
Manganese	0.0181	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0012	mg/L	0.0001
Potassium	3.35	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.04	mg/L	0.01
Silver	<0.0001	mg/L	0.0001

Analyte	Result	Units	MDL
Sodium	78.0	mg/L	0.05
Strontium	1.10	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0037	mg/L	0.0001
Uranium	0.741	ug/L	0.002
Vanadium	0.0010	mg/L	0.0001
Zinc	0.017	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

G-4 2019-09-30 16:40:00 Record 604022

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.40	mg/L	0.01
Conductivity - Field	0.780	mS/cm	
Dissolved Organic Carbon	2.6	mg/L	0.4
Dissolved Oxygen-Field	7.01	mg/L	
Escherichia coli	1900	CFU/100mL	0
Hardness (Calculation)	257	mg/L	0.7
Nitrate as N	2.07	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	2.35	mg/L	0.02
Nitrite as N	0.28	mg/L	0.01
o-Phosphate as P	0.43	mg/L	0.05
pH	8.06	pH	0.01
pH - Field	7.67	pH	
Phosphorus Dissolved Total	0.343	mg/L	0.010
Phosphorus Total	0.425	mg/L	0.010
Temperature - Field	15.7	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	1.2	mg/L	0.2
Total Organic Carbon	2.8	mg/L	0.4
Total Suspended Solids	10.3	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	6.5	ug/L	0.1
Aluminum	0.307	mg/L	0.002

Analyte	Result	Units	MDL
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0014	mg/L	0.0001
Barium	0.0460	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.169	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	71.6	mg/L	0.05
Chromium	0.0004	mg/L	0.0001
Cobalt	0.0003	mg/L	0.0001
Copper	0.0035	mg/L	0.0001
Dissolved Aluminum	0.004	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0013	mg/L	0.0001
Dissolved Barium	0.0434	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.175	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	72.4	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0001	mg/L	0.0001
Dissolved Copper	0.0012	mg/L	0.0001
Dissolved Iron	0.009	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	18.1	mg/L	0.05
Dissolved Manganese	0.0398	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0022	mg/L	0.0001
Dissolved Nickel	0.0012	mg/L	0.0001
Dissolved Potassium	3.75	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.79	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	93.4	mg/L	0.05
Dissolved Strontium	1.02	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0002	mg/L	0.0001
Dissolved Uranium	0.741	ug/L	0.002
Dissolved Vanadium	0.0009	mg/L	0.0001
Dissolved Zinc	0.009	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.628	mg/L	0.003
Lead	0.0012	mg/L	0.0001
Magnesium	18.4	mg/L	0.05
Manganese	0.0504	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0021	mg/L	0.0001
Nickel	0.0017	mg/L	0.0001
Potassium	3.84	mg/L	0.05
Selenium	0.0003	mg/L	0.0001
Silicon	3.26	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	87.9	mg/L	0.05
Strontium	1.02	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003

Analyte	Result	Units	MDL
Tin	<0.0001	mg/L	0.0001
Titanium	0.0060	mg/L	0.0001
Uranium	0.730	ug/L	0.002
Vanadium	0.0014	mg/L	0.0001
Zinc	0.021	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

R-1 2019-09-30 13:20:00 Record 604023

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.03	mg/L	0.01
Conductivity - Field	1.200	mS/cm	
Dissolved Organic Carbon	2.4	mg/L	0.4
Dissolved Oxygen-Field	8.67	mg/L	
Escherichia coli	10	CFU/100mL	0
Hardness (Calculation)	414	mg/L	0.7
Nitrate as N	0.33	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	0.33	mg/L	0.02
Nitrite as N	<0.05	mg/L	0.05
o-Phosphate as P	<0.05	mg/L	0.05
pH	8.11	pH	0.01
pH - Field	7.76	pH	
Phosphorus Dissolved Total	<0.010	mg/L	0.010
Phosphorus Total	<0.010	mg/L	0.010
Temperature - Field	18.1	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	0.3	mg/L	0.2
Total Organic Carbon	2.9	mg/L	0.4
Total Suspended Solids	3.4	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	0.7	ug/L	0.1
Aluminum	0.024	mg/L	0.002
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0006	mg/L	0.0001
Barium	0.0626	mg/L	0.0001

Analyte	Result	Units	MDL
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.131	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	117	mg/L	0.05
Chromium	<0.0001	mg/L	0.0001
Cobalt	<0.0001	mg/L	0.0001
Copper	0.0012	mg/L	0.0001
Dissolved Aluminum	<0.002	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0005	mg/L	0.0001
Dissolved Barium	0.0611	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.141	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	118	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	<0.0001	mg/L	0.0001
Dissolved Copper	0.0010	mg/L	0.0001
Dissolved Iron	0.004	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	28.9	mg/L	0.05
Dissolved Manganese	0.101	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0021	mg/L	0.0001
Dissolved Nickel	0.0007	mg/L	0.0001
Dissolved Potassium	4.87	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	3.80	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	124	mg/L	0.05
Dissolved Strontium	2.58	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	0.0001	mg/L	0.0001
Dissolved Uranium	1.47	ug/L	0.002
Dissolved Vanadium	0.0001	mg/L	0.0001
Dissolved Zinc	0.004	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.140	mg/L	0.003
Lead	0.0001	mg/L	0.0001
Magnesium	28.9	mg/L	0.05
Manganese	0.136	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0007	mg/L	0.0001
Potassium	5.01	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.97	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	121	mg/L	0.05
Strontium	2.61	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0006	mg/L	0.0001
Uranium	1.46	ug/L	0.002

Analyte	Result	Units	MDL
Vanadium	0.0002	mg/L	0.0001
Zinc	0.005	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5
R-2 2019-09-30 13:00:00 Record 604024			
Ammonia + Ammonium as N	<0.01	mg/L	0.01
Conductivity - Field	1.205	mS/cm	
Dissolved Organic Carbon	2.4	mg/L	0.4
Dissolved Oxygen-Field	9.75	mg/L	
Escherichia coli	30	CFU/100mL	0
Hardness (Calculation)	457	mg/L	0.7
Nitrate as N	0.31	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	0.31	mg/L	0.02
Nitrite as N	<0.05	mg/L	0.05
o-Phosphate as P	<0.05	mg/L	0.05
pH	8.14	pH	0.01
pH - Field	8.02	pH	
Phosphorus Dissolved Total	<0.010	mg/L	0.010
Phosphorus Total	<0.010	mg/L	0.010
Temperature - Field	18.4	C	
Total Biochem. Oxygen Demand	<2	mg/L	1
Total Kjeldahl Nitrogen as N	<0.2	mg/L	0.2
Total Organic Carbon	3.4	mg/L	0.4
Total Suspended Solids	<2	mg/L	2
Unionized Ammonia as NH3 at Field Temperature (Calculation)	<0.4	ug/L	0.4
Aluminum	0.012	mg/L	0.002
Antimony	0.0002	mg/L	0.0001
Arsenic	0.0005	mg/L	0.0001
Barium	0.0592	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.129	mg/L	0.010

Analyte	Result	Units	MDL
Cadmium	<0.0001	mg/L	0.0001
Calcium	115	mg/L	0.05
Chromium	<0.0001	mg/L	0.0001
Cobalt	<0.0001	mg/L	0.0001
Copper	0.0011	mg/L	0.0001
Dissolved Aluminum	<0.002	mg/L	0.002
Dissolved Antimony	0.0002	mg/L	0.0001
Dissolved Arsenic	0.0005	mg/L	0.0001
Dissolved Barium	0.0624	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.137	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	136	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	<0.0001	mg/L	0.0001
Dissolved Copper	0.0010	mg/L	0.0001
Dissolved Iron	0.004	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	28.6	mg/L	0.05
Dissolved Manganese	0.106	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0020	mg/L	0.0001
Dissolved Nickel	0.0007	mg/L	0.0001
Dissolved Potassium	4.96	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	4.41	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	123	mg/L	0.05
Dissolved Strontium	2.57	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	<0.0001	mg/L	0.0001
Dissolved Uranium	1.45	ug/L	0.002
Dissolved Vanadium	0.0001	mg/L	0.0001
Dissolved Zinc	0.003	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	0.119	mg/L	0.003
Lead	<0.0001	mg/L	0.0001
Magnesium	27.9	mg/L	0.05
Manganese	0.125	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0020	mg/L	0.0001
Nickel	0.0007	mg/L	0.0001
Potassium	4.78	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.79	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	118	mg/L	0.05
Strontium	2.52	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0003	mg/L	0.0001
Uranium	1.45	ug/L	0.002
Vanadium	0.0002	mg/L	0.0001
Zinc	0.004	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004

Analyte	Result	Units	MDL
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

Boat Launch 2019-09-30 13:50:00 Record 604025

Analyte	Result	Units	MDL
Ammonia + Ammonium as N	0.18	mg/L	0.01
Conductivity - Field	0.710	mS/cm	
Dissolved Organic Carbon	4.4	mg/L	0.4
Dissolved Oxygen-Field	10.46	mg/L	
Escherichia coli	30	CFU/100mL	0
Hardness (Calculation)	259	mg/L	0.7
Nitrate as N	0.34	mg/L	0.01
Nitrate+Nitrite as N (Calculation)	0.34	mg/L	0.02
Nitrite as N	<0.05	mg/L	0.05
o-Phosphate as P	<0.05	mg/L	0.05
pH	8.32	pH	0.01
pH - Field	8.41	pH	
Phosphorus Dissolved Total	<0.010	mg/L	0.010
Phosphorus Total	0.173	mg/L	0.010
Temperature - Field	17.1	C	
Total Biochem. Oxygen Demand	9	mg/L	1
Total Kjeldahl Nitrogen as N	1.3	mg/L	0.2
Total Organic Carbon	5.3	mg/L	0.4
Total Suspended Solids	35.4	mg/L	0.8
Unionized Ammonia as NH3 at Field Temperature (Calculation)	16.6	ug/L	0.1
Aluminum	0.496	mg/L	0.002
Antimony	0.0003	mg/L	0.0001
Arsenic	0.0015	mg/L	0.0001
Barium	0.0622	mg/L	0.0001
Beryllium	<0.0001	mg/L	0.0001
Bismuth	<0.0001	mg/L	0.0001
Boron	0.100	mg/L	0.010
Cadmium	<0.0001	mg/L	0.0001
Calcium	68.7	mg/L	0.05
Chromium	0.0011	mg/L	0.0001

Analyte	Result	Units	MDL
Cobalt	0.0004	mg/L	0.0001
Copper	0.0034	mg/L	0.0001
Dissolved Aluminum	<0.002	mg/L	0.002
Dissolved Antimony	0.0003	mg/L	0.0001
Dissolved Arsenic	0.0009	mg/L	0.0001
Dissolved Barium	0.0581	mg/L	0.0001
Dissolved Beryllium	<0.0001	mg/L	0.0001
Dissolved Bismuth	<0.0001	mg/L	0.0001
Dissolved Boron	0.103	mg/L	0.010
Dissolved Cadmium	<0.0001	mg/L	0.0001
Dissolved Calcium	66.7	mg/L	0.05
Dissolved Chromium	<0.0001	mg/L	0.0001
Dissolved Cobalt	0.0001	mg/L	0.0001
Dissolved Copper	0.0005	mg/L	0.0001
Dissolved Iron	0.008	mg/L	0.003
Dissolved Lead	<0.0001	mg/L	0.0001
Dissolved Magnesium	20.4	mg/L	0.05
Dissolved Manganese	0.0076	mg/L	0.0001
Dissolved Mercury	<0.05	ug/L	0.05
Dissolved Molybdenum	0.0068	mg/L	0.0001
Dissolved Nickel	0.0013	mg/L	0.0001
Dissolved Potassium	5.05	mg/L	0.05
Dissolved Selenium	0.0002	mg/L	0.0001
Dissolved Silicon	2.45	mg/L	0.01
Dissolved Silver	<0.0001	mg/L	0.0001
Dissolved Sodium	67.4	mg/L	0.05
Dissolved Strontium	0.983	mg/L	0.0005
Dissolved Thallium	<0.0003	mg/L	0.0003
Dissolved Tin	<0.0001	mg/L	0.0001
Dissolved Titanium	<0.0001	mg/L	0.0001
Dissolved Uranium	0.983	ug/L	0.002
Dissolved Vanadium	0.0004	mg/L	0.0001
Dissolved Zinc	0.001	mg/L	0.001
Dissolved Zirconium	<0.0004	mg/L	0.0004
Iron	1.12	mg/L	0.003
Lead	0.0026	mg/L	0.0001
Magnesium	21.2	mg/L	0.05
Manganese	0.148	mg/L	0.0001
Mercury	<0.05	ug/L	0.05
Molybdenum	0.0068	mg/L	0.0001
Nickel	0.0020	mg/L	0.0001
Potassium	5.27	mg/L	0.05
Selenium	0.0002	mg/L	0.0001
Silicon	3.51	mg/L	0.01
Silver	<0.0001	mg/L	0.0001
Sodium	64.4	mg/L	0.05
Strontium	1.04	mg/L	0.0005
Thallium	<0.0003	mg/L	0.0003
Tin	<0.0001	mg/L	0.0001
Titanium	0.0102	mg/L	0.0001
Uranium	0.987	ug/L	0.002
Vanadium	0.0018	mg/L	0.0001
Zinc	0.015	mg/L	0.001
Zirconium	<0.0004	mg/L	0.0004
1-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
2-methylnaphthalene (Subcontract)	<0.5	ug/L	0.5
7H-dibenzo(c,g)carbazole (Subcontract)	<0.1	ug/L	0.1

Analyte	Result	Units	MDL
Acenaphthene (Subcontract)	<0.1	ug/L	0.1
Acenaphthylene (Subcontract)	<0.1	ug/L	0.1
Anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]anthracene (Subcontract)	<0.1	ug/L	0.1
Benzo[a]pyrene (Subcontract)	<0.01	ug/L	0.01
Benzo[b/j]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Benzo[e]pyrene (Subcontract)	<0.1	ug/L	0.1
Benzo[g,h,i]perylene (Subcontract)	<0.2	ug/L	0.2
Benzo[k]fluoranthene (Subcontract)	<0.1	ug/L	0.1
Chrysene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,i)pyrene (Subcontract)	<0.1	ug/L	0.1
Dibenzo(a,j)acridine (Subcontract)	<0.1	ug/L	0.1
Dibenzo[a,h]anthracene (Subcontract)	<0.1	ug/L	0.1
Fluoranthene (Subcontract)	<0.1	ug/L	0.1
Fluorene (Subcontract)	<0.1	ug/L	0.1
indeno[1,2,3-cd]pyrene (Subcontract)	<0.2	ug/L	0.2
Perylene (Subcontract)	<0.5	ug/L	0.5
Phenanthrene (Subcontract)	<0.1	ug/L	0.1
Pyrene (Subcontract)	<0.1	ug/L	0.1
PAHs Total (Subcontract)	<2	ug/L	2
Naphthalene (Subcontract)	<0.5	ug/L	0.5

Report Comment: Total PAHs is the sum of the individual PAH compounds reported.

CHAIN OF CUSTODY

ENVIRONMENTAL LABORATORY
700 Woodward Avenue, Hamilton, Ontario L8H 6P4
Tel: 905-546-2424 Ext 5834 Fax: 905-545-0234

LABORATORY WORK ORDER NUMBER: 330748

ANALYSIS REQUESTED:

Client Name: HAMILTON WATER - Water & Wastewater System Planning
Contact Name: Mani Seradj (cc: Kimberley Tasker- SLR)
Address: 77 JAMES STREET NORTH SUITE 400
Phone: 905-546-2424 EXT 4480

Is the sample(s) taken from a source intended for Human Consumption?
YES ☐ NO ☒

Chedoke Creek Surface Water Analysis 2019

LAB USE ONLY	Sample Location	# of bottles	Field Temperature °C	Field Conductivity mS/cm	Field pH pH	Field Dissolved Oxygen mg/L	Sample Matrix	Sample Type	Sample Date	Sample Time (24 hour clock) 00:00	See Attached Quotation 10166
604014	C-1 WEST	5	15.7	0.733	8.25	10.23	Water	Surface Water	Sept30/19	16:50	x
604016	C-3 Centre G5	5	16.1	0.760	7.61	5.99	Water	Surface Water	Sept30/19	16:35	x
604017	C-3 West	5	15.9	0.771	7.65	6.38	Water	Surface Water	Sept30/19	16:25	x
604018	C-4 West	5	16.3	0.739	7.52	4.85	Water	Surface Water	Sept30/19	16:15	x
604019	C-5 East G6	5	16.8	0.700	7.43	2.96	Water	Surface Water	Sept30/19	16:05	x
604020	C-6 East G7	5	17.1	0.711	8.20	9.06	Water	Surface Water	Sept30/19	13:40	x
604021	G-1	5	15.7	0.729	8.36	10.4	Water	Surface Water	Sept30/19	17:00	x
604022	G-4	5	15.7	0.780	7.67	7.01	Water	Surface Water	Sept30/19	16:40	x
	~~G-5~~						~~Water~~	~~Surface Water~~			~~x~~
	~~G-6~~						~~Water~~	~~Surface Water~~			~~x~~
	~~G-7~~						~~Water~~	~~Surface Water~~			~~x~~
604023	R-1	5	18.1	1.200	7.76	8.67	Water	Surface Water	Sept30	13:20	x
604024	R-2	5	18.4	1.205	8.02	9.75	Water	Surface Water	Sept30/19	13:00	x
604025	Boat Launch	5	17.1	0.710	8.41	10.46	Water	Surface Water	Sept30/19	13:50	x
	~~Chedoke Upstream~~						~~Water~~	~~Surface Water~~			~~x~~
604015	C1 WEST	5	—	—	—	—	WATER	SW	Sept30/19	16:52	X
	DUPLICATE										

CLIENT REQUIRES CSV REPORT ☐
APPLY PWQO GUIDELINES AT REPORTING ☐

FOR LAB USE ONLY:
Received by: [signature]
Date & Time: Oct. 1/19 09:00
Comments: Chedoke Creek Surface Water Analysis 2020
TAT: 21 Days.
ONE WORK ORDER
Print preservation report. Deliver samples to the bench.

FOR LAB USE ONLY:
Temperature Descriptor as Received
☑ COLD
☐ COOL TO THE TOUCH
☐ AMBIENT TEMPERATURE (representative of the source)

Run #123838
KSOi

Sample(s) Collected by: (Sign & Print Name) KIMBERLEY TASKER [signature]
Date & Time: (See above for details) Sept 30/19
~~19:00~~
13:00 – 16:52.

Sample(s) Delivered by: (Sign & Print Name) KIMBERLEY TASKER [signature]
Date & Time: Sept 30/19 19:00

Sample(s) meet requirements as per PW-WW-CR-EL-P-021-P-012 ☑

APPENDIX C
Ecological Receptors Supporting Information

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

Photograph 1. Study area of Chedoke Creek within Cootes Paradise ESA.

Photograph 2. Riparian bank edged with armour stone along Chedoke Creek.

Photograph 3. Steep concrete banks near box culvert at Glen Road and Tope Crescent.

Photograph 4. Treed vegetation found along the Chedoke Creek.

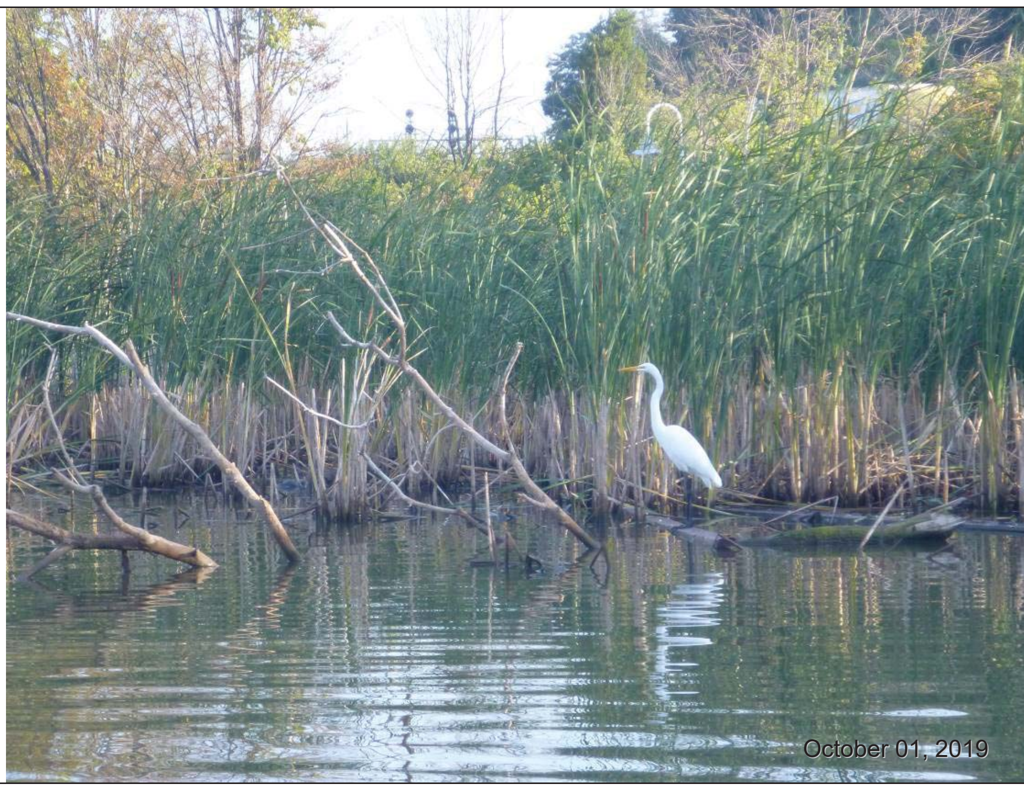
Photograph 5. Band of Cultural Meadow found along eastern banks of Chedoke Creek.

Photograph 6. Evidence of previous restoration efforts along shoreline.

Photograph 7. An example of Mixed Shallow Aquatic (SA) areas along the creek side.

Photograph 8. Another example of Mixed Shallow Aquatic (SA) areas along the creek.

Photograph 9. Example of shallow vegetation that provide opportunities for fish and wildlife.



Photograph 10. Great Egret sitting within the shallow vegetation at Chedoke Creek.

209.40666 **Hamilton Fish List**

Recorded fish community observed in seining and electrofishing fish surveys since 1970. Data from the watersheds were obtained from over 600 unpublished studies and were compiled into databases by the Hamilton Conservation Authority and Conservation Halton. Data from Cootes Paradise and Hamilton Harbour were from electrofishing, and entrapment surveys by DFO, RBG, and OMNR. Abundance Levels are based on quartiles with "1" as the lowest, and "4" as the highest relative abundance.

Bowlby et Al, 2009

Cootes Paradise / Chedoke Creek ***** Invaders and Cold Water Species are Excluded***

**** Strikeouts - Listed in SNC report but not listed in Bowlby 2009. Bowlby Considered more relevant to Study Area***

Scientific Name	***Species***	**Abundance**
Notropis atherinoides	Emerald shiner	4
N. hudsonius	Spottail shiner	4
Castostomus commersoni	Common white sucker	4
Ameiurus nebulosus	Brown bullhead	4
Ictalurus punctatus	Channel Catfish	4
Lepomis gibbosus	Pumpkinseed	4
Micropterus salmoides	Largemouth bass	4
Perca flavescens	Yellow perch	4
Aplodinotus grunniens	Fresh Water Drum	4
Amia calva	Bowfin	3
Esox lucius	Northern pike	3
Pimephales notatus	Bluntnose minnow	3
P. promelas	Fathead minnow	3
Ambloplites rupestris	Rock bass	3
Lepomis cyanellus	Green sunfish	3
Pomoxis nigromaculatus	Black crappie	3
Etheostoma nigrum	Johny Darter	3
Labidesthes sicculus	Brook Silverside	3
Lepisosteus osseus	Longnose gar	2
Luxilus cornutus	Common shiner	2
Notemigonus crysoleucas	Golden shiner	2
Ameiurus melas	Black Bullhead	2
Noturus gyrinus	Tadpole Madtom	2
Micropterus dolomieu	Smallmouth bass	2
Sander vitreus	Walleye	2
Ictiobus cyprinellus	Bigmouth Bufflo	2
Moxostoma macrolepidotum	Shorthead Redhorse	2
Lepisosteus osseus	Spotted gar	1
N. micropogon	River chub	1
N. ludibundus	Sand shiner	1
R. cataractae	Longnose dace	1
Semotilus atromaculatus	Creek chub	1
Morone chrysops	White bass	1
Pomoxis annularis	White crappie	1
Moxostoma anisurum	Silver Redhorse	1
Moxostoma valenciennesi	Greater Redhorse	1
Moxostoma erythrurum	Goldern Redhorse	1
~~Lampetra appendix~~	~~American brook lamprey~~	
~~Salvelinus fontinalis~~	~~Brook trout~~	

~~Umbra limi Central~~	~~mudminnow~~
~~Chrosomus eos~~	~~Northern redbelly dace~~
~~C. neogaeus~~	~~Finescale dace~~
~~Clinostomus elongates~~	~~Redside dace~~
~~Hybognathus hankinsoni~~	~~Brassy minnow~~
~~Nocomis biguttatus~~	~~Hornyhead chub~~
~~Notropis heterolepis~~	~~Blacknose shiner~~
~~N. rubellus~~	~~Rosyface shiner~~
~~Cyprinella spiloptera~~	~~Spotfin shiner~~
~~Notropis volucellus~~	~~Mimic shiner~~
~~Rhinichthys atratulus~~	~~Blacknose dace~~
~~Luxilus chrysocephalus~~	~~Striped shiner~~
~~Semotilus margarita~~	~~Pearl dace~~
~~Hypentelium nigricans~~	~~Northern hog sucker~~
~~Culaea inconstans~~	~~Brook stickleback~~
L. macrochirus	Bluegill
~~Etheostoma caeruleum~~	~~Rainbow darter~~
~~E. flabellare~~	~~Fantail darter~~

Cootes Paradise Heritage Lands Management Plan , Inventory, Issues and Opportunities, May 2018 (CPHLI, 2018), DFO SAR MAPS , 2019

Northern Brook Lamprey (SC)	Ichthyomyzon fossor	(CPHLI, 2018) - 1997 (historic), DFO
Eastern Pondmussel (SC)	Ligumia nasuta	(CPHLI, 2018), DFO
Mapleleaf Mussel (SC)	Quadrula quadrula	(CPHLI, 2018), DFO
Lilliput (THR)	Toxolasma parvum	(CPHLI, 2018), DFO

DO NOT INCLUDE - HABITATS NOT RELANT SOURCES (DATES) CANNOT NOT OBSERVED - Hendrie Valley Report (2018) or by LISTED BY DFO - EXCLUDE		**SOURCE**
~~Silver Lamprey (SC)~~	~~Ichthyomyzon unicuspis~~	~~CPHLI, 2018~~
~~Lake Sturgeon (THR)~~	~~Acipenser fulvescens~~	~~CPHLI, 2018 - Historic~~
~~Spotted Gar (THR)~~	~~Lepisosteus oculatus~~	~~CPHLI, 2018~~
~~American Eel (END)~~	~~Anguilla rostrata~~	~~CPHLI, 2018~~
~~Redside Dace (END)~~	~~Clinostomus elongatus~~	~~CPHLI, 2018 - 1950 (historic)~~
~~Black Redhorse (END)~~	~~Moxostoma duquesnei~~	~~CPHLI, 2018~~
~~Grass Pickerel (SC)~~	~~Esox americanus vermiculatus~~	~~CPHLI, 2018~~
~~Kiyi (SC)~~	~~Coregonus kiyi orientalis~~	~~CPHLI, 2018~~
~~Silver Shiner (THR)~~	~~Notropis photogenis~~	~~CPHLI, 2018~~
~~Shortnose Cisco~~	~~Coregonus reighardi~~	~~CPHLI, 2018 - Historic~~

209.40666.000 Flora
Chedoke Creek - Flora Screening

The following represents a selection of dominate vegetation known to occur and or observed within the Chedoke Creek Study Area

Source: SLR Consulting Canada, 2019 Field Inventories, Hamilton Conservation (Various Resources), Royal Botanical Garden (Various Resources).

RBG - Princes Point / Cootes Paradise Sanctuary 15 Coronation Park Cootes Paradise Sanctuary 1	TPO1 - Dry Tall Grass Prarie	FOD

Species	Botantial
Emergent Species	
American Bulrush	
Blueflag Iris	
Broad-leaved Cattail	
Broad-leaved Arrowhead	
Common Reed	
Narrow-leaved Cattail	
Narrow-leaved Arrowhead	
Pickerel Weed	
Reed Canary Grass	
Water Plantain	
Water Smartweed	
Submerent Species	
Brittle Naiad	
Canada Waterweed	
Coontail	
Curly-leaved Pondweed	
Eurasian Milfoil	
Floating-leaved Pondweed	
Sago Pondweed	
Floating Leaf	
Duckweed Sp.	
White Water lily	
Yellow Water Lily	

Source:
Cootes Paradise Heritage Lands Management Plan , Inventory, Issues and Opportunities, May 2018

Hamilton Conservation Authority (HCA) 2008. Chedoke Creek Subwatershed Stewardship Action Plan

Hamilton Fauna Species List - complied by KLF based on Secondary Sources, Report Resources and in field habitat assesments

** Hendrie Valley is a current and recent report with relevant species lists, local and habitat affinities and opertunities Radassao,et al. 2019. 2018 Environmental Review of Hendrie Valley. RBG Report No. 2019-6.
Cootes Paradise Heritage Lands Management Plan , Inventory, Issues and Opportunities, May 2018 (CPHLI, 2018) used as a second screeing. This report has all NHIC records and MNRF data compiled
Also eBIRD Canada, 2019. Online Dundas Marsh/Cootes Paradise (general location), Acessed at https://ebird.org/canada/hotspot
The two reports use the Nature Counts - Hamilton Conservation Area Inventory and Hamilton Conservation Authroity Species Listed Relevant for the Area.
All Non Aquatic SAR and Birds, Mamals, Amphibian, Reptiles (example Eastern Wood-pewee, Canada Warbler, Bats, Vernal Pool Frogs) have been excluded. Only those that would be relavent to the Aquatic Eniroment and Study Area are uncluded

Species	Scientific Name	Screening Source	Notes from CPHLI	COSSARO, SARO, ESA	Hendrie Valley / Last Seen / Heard	
Omnivorous						
Eastern Musk Turtle	Sternotherus odoratus	CPHLI, 2018		SC	2009/1965 Extirpated	aquatic invertebrates, fish, frogs, crayfish, carrion, berries, and aquatic debris. Capable of catching live fish
Blanding's Turtle	Emydoidea blandingii	CPHLI, 2018		THR	2018 Present	aquatic invertebrates, fish, frogs, crayfish, carrion, berries, and aquatic debris. Capable of catching live fish
Midland Painted Turtle	Chrysemys picta marginata	CPHLI, 2018		N/A - COSEWIC SC	2018 Present	aquatic invertebrates, fish, frogs, crayfish, carrion, berries, and aquatic debris. Capable of catching live fish
Northern Map Turtle	Graptemys geographica	CPHLI, 2018		SC	2018 Present	aquatic invertebrates, fish, frogs, crayfish, carrion, berries, and aquatic debris. Capable of catching live fish
Snapping Turtle	Chelydra serpentina	CPHLI, 2018		SC	2018 Present	aquatic invertebrates, fish, frogs, crayfish, carrion, berries, and aquatic debris. Capable of catching live fish
Eastern Ribbonsnake	Thamnophis sauritus	CPHLI, 2018		SC	Not identified / listed	
White Pelcan	Pelecanus erythrorhynchos	CPHLI, 2018	NON BREEDING	THR	2018 Present	
Bald Eagle	Haliaeetus leucocephalus	CPHLI, 2018		SC	2018 Present	
Golden Eagle	Aquila chrysaetos	CPHLI, 2018		END	2011 Present	
Horned Grebe	Podiceps auritus	CPHLI, 2018		SC	2018 Present	
Red Knot rufa subspecies	Calidris canutus rufa	CPHLI, 2018	NON BREEDING	END	1993 Absent	
Buff-breasted Sandpiper	Calidris subruficollis	CPHLI, 2018		N/A COSEWIC SC	Not identified / listed	
Red-necked Phalarope	Phalaropus lobatus	CPHLI, 2018		SC	Not identified / listed	
Black Tern	Chlidonias niger	CPHLI, 2018		SC	Not identified / listed	
Herbacious / Omnivore - seeds of aquatic plands, submergent and emergent (e. smartweeds, pondweeds, algae and duckweeds) as well as aquatic insects, mollusks an						
Gadwall	Anas strepera	CPHLI, 2018		Rare, Hamilton NAI		
American Wigeon	Anas americana	CPHLI, 2018		Rare, Hamilton NAI		
American Black Duck	Anas rubripes	CPHLI, 2018		Rare, Hamilton NAI		
Blue-winged Teal	Anas discors	CPHLI, 2018		Rare, Hamilton NAI		
Northern Shoveler	Anas clypeata	CPHLI, 2018		Rare, Hamilton NAI		
Northern Pintai	Anas acuta	CPHLI, 2018		Rare, Hamilton NAI		
Green-winged Teal	Anas crecca	CPHLI, 2018		Rare, Hamilton NAI		
Redhead	Aythya americana	CPHLI, 2018		Rare, Hamilton NAI		
Common Gallinule	Gallinula galeata	CPHLI, 2018		Rare, Hamilton NAI		
Carniverous / Inverterbrates						
Hooded Merganser	Lophodytes cucullatus	CPHLI, 2018		Rare, Hamilton NAI		** Feeds mainly on small fish, crayfish and other crustaceans, and aquatic insects; also some tadpoles, a few mollusks, small amounts of plant material. Young ducklings eat mostly insects at first.
Great Black-backed Gull	Larus marinus	CPHLI, 2018		Rare, Hamilton NAI		** eats carrion, fish, mollusks, crustaceans, aquatic worms, known to eat rodents, berries, eggs of birds
Pickerel Frog	Lithobates palustris	CPHLI, 2018		Rare, Hamilton NAI		** eastes terrestrial and aquatic invertebrates, including snails, small crayfish and a variety of insects
Osprey	Pandion haliaetus	CPHLI, 2018		Rare, Hamilton NAI		** exclusively live fish

** Below Species lists are not entire and provide a few reprensative speices only for Trophic Levels / Groups

Carnivorous Birds / Mamals/ Reptiles - NON RARE - NON SAR Represnative of Tropic Level Group Known or Observed for Chedoke Creek
Not exclusive to fish - small fish and also take crustaceans, mollusks, aquatic insects, leeches, and frogs
Herons - Example Great Blue Heron *Ardea herodias* , Green Heron *Butorides virescens* , Black-crowned Night-Heron *Nycticorax nycticorax*

Belted Kingfisher	Megaceryle alcyon	CPHLI, 2018
Great Egret	Ardea alba	CPHLI, 2018
Common Loon	Gavia immer	CPHLI, 2018
Common Golden Eye	Bucephala clangula	CPHLI, 2018
Terns - Example Caspian Tern	Hydroprogne caspia	CPHLI, 2018
Northern Watersnake	Nerodia sipedon sipedon	CPHLI, 2018
Eastern Gartersnake	Thamnophis sirtalis sirtalis	CPHLI, 2018

Shorebirds - NON RARE - NON SAR Represnative of Tropic Level Group Known or Observed for Chedoke Creek
Carniverous - Insects and insect larvae during the breeding season. During winter and migration, small fish, crustaceans, snails, and other aquatic animals

Greater Yellowlegs	Tringa melanoleuca	CPHLI, 2018
Upland Sandpiper	Bartramia longicauda	CPHLI, 2018
Spotted Sandpiper	Actitis macularius	CPHLI, 2018
Solitary Sandpiper	Tringa solitaria	CPHLI, 2018

Herbivorous Species - NON RARE - NON SAR Represnative of Tropic Level Group Known or Observed for Chedoke Creek
leaves, seeds, roots of many types of pond weeds, aquatic Vegetaion. Tubers and rhizomes

Canada Goose	Branta canadensis	CPHLI, 2018
Mallard	Anas platyrhynchos	CPHLI, 2018
Trumpeter Swan	Cygnus buccinator	CPHLI, 2018
Muskrat	Ondatra zibethicus	CPHLI, 2018

Amphibians - NON RARE - NON SAR Represnative of Tropic Level Group Known or Observed for Chedoke Creek

Green Frog	Lithobates clamitans	CPHLI, 2018		** use soft substrates for Hibernation / percutaneous absorption through their skin/ will lay eggs in vegetaion
Spring Peeper	Pseudacris crucifer	CPHLI, 2018		** use soft substrates for Hibernation / percutaneous absorption through their skin/ will lay eggs in vegetaion
Northern Leopard Frog	Lithobates pipiens	CPHLI, 2018		** use soft substrates for Hibernation / percutaneous absorption through their skin/ will lay eggs in vegetaion

Not a Huge Concern - Not including at this time
Secondary Species - when mammalian prey is scarce, eat birds, eggs, frogs, fish, and insects.
Or treeded vegeation / Leaves but do send time in Chedoke Creek and or substrates (beavers for example)

Ermine	Mustela erminea	CPHLI, 2018	Rare?, Hamilton NAI	
Beaver	Castor canadensis	CPHLI, 2018		tree bark and cambium, but can also eat roots and bugs and aquatic plants
American Mink	Neovison vison	CPHLI, 2018		

209.40666 **Hamilton Reference List - complied by KLF based on Secondary Sources and Report Resources in field and Internet Research**
**** Not all sources are listed yet see folder** *06 KLF BG_ Research [SAR FloraFauna]*

MASTER RESOURSE LIST - SAR / WILDLIFE

SNC Lavalin	2010	SNC Lavalin, 2010. City of Hamilton B-Line Light Rapid Transit - Draft Environmental Project Report, Appendix B.1Natural Heritage Features
Bowlby et Al	2009	Bowlby, J.N. , K. McCormack, and M.G. Heaton. 2009. Hamilton Harbour and Watershed Fisheries Management Plan. Ontario Ministry of Natural Resources and Royal Botanical Gardens.
Eakins, R. J	2019	Eakins, R. J. 2019. Ontario Freshwater Fishes Life History Database. Version 4.88. Online database. (http://www.ontariofishes.ca), accessed 03 January 2020
Hamilton Conservation Authority (HCA)	2018	Chedoke Creek Watershed Fact Sheet, 2018. http://conservationhamilton.ca/wp-content/uploads/sites/5/2018/04/Chedoke-Creek-Factsheet-2018.pdf
Hamilton Conservation Authority (HCA)	2008	Hamilton Conservation Authority (HCA) 2008. Chedoke Creek Subwatershed Stewardship Action Plan
Government of Ontario	2019	Government of Ontario, 2019. O. Reg. 230/08: Species at Risk in Ontario List - Under Endangered Species Act, 2007, S.O. 2007, c. 6 - Acessed On-line January 3 2020. Current to E-Laws currency date December 8, 2019
Department of Fisheries and Oceans	2019	Department of Fisheries and Oceans, 2019. Aquatic Species at Risk Mapping Date modified: 2019-08-23, Acessed On-line January 3, 2020. https://www.dfo-mpo.gc.ca
COSEWIC	2013	COSEWIC. 2013. COSEWIC assessment and status report on the Lilliput Toxolasma parvum in Canada. Committee on the Status of Endangered
		COSEWIC. 2016. COSEWIC assessment and status report on the Mapleleaf Quadrula quadrula, Great Lakes - Upper St. Lawrence population and Saskatchewan - Nelson Rivers population, in Canada.
COSEWIC	2016	Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 86 pp.
COSEWIC	2007a	COSEWIC 2007. COSEWIC assessment and status report on the Eastern Pondmussel Ligumia nasuta in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 34 pp.
		COSEWIC 2007. COSEWIC assessment and update status report on the northern brook lamprey Ichthyomyzon fossor (Great Lakes – Upper St. Lawrence populations and Saskatchewan – Nelson population) in Canada.
COSEWIC	2007b	Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 30 pp
Schwetz, N	2014	Schwetz, N. 2014. Hamilton Conservation Authority. Nature Counts. Hamilton Natural Areas Inventory Project, 3rd Edition. Site Summaries, Species Checklists. 753 pp + 287 pp.
Cootes to Escarpment EcoPark System (CEES)	2018	Cootes to Escarpment EcoPark System, 2018. Cootes Paradise Heritage Lands Management Plan , Inventory, Issues and Opportunities, May 2018 Acessed on-line
Vincent	2017	Vincent, K. 2017. 2017 Environmental Condition of Cootes Paradise South Shore. RBG Report No. 2018-12. Royal Botanical Gardens. Burlington, ON.
Radassao et al.	2019	Radassao, F., Barr, L., and Peirce, M. 2019. 2018 Environmental Review of Hendrie Valley. RBG Report No. 2019-6. Royal Botanical Gardens. Burlington, ON.
Oldham et al.	1995	Oldham, M., Bakowsky, W. and Sutherland, D. 1995. Floristic quality assessment for southern Ontario.Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario.
eBIRD Canada	2019	eBIRD Canada, 2019. Online Dundas Marsh/Cootes Paradise (general location), Acessed at https://ebird.org/canada/hotspot

APPENDIX D
ERA Analytical Chemistry Dataset

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

TABLE D-1: SOIL -PHYSICAL PARAMETERS

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	Carbon	Particle Size			
						Total Organic Carbon	% gravel (>2mm)	% sand by hydrometer	% silt by hydrometer	% clay (<4um)
						µg/g	%	%	%	%
ON PSQG LEL						**10000**				
ON PSQG SEL						100000				
C-1	C-1 West	0-0.15	2019-Oct-2	C1 WEST	Grab	**26,000**	<2	69	27	4
C-3	C-3 West	0-0.15	2019-Oct-2	C3 WEST	Grab	**39,000**	<2	39	53	8
C-4	C-4 West	0-0.15	2019-Oct-1	C4 WEST	Grab	**47,000**	<2	32	61	7.3
G-4	G-4 Comp	0-0.15	2019-Oct-2	G4	Grab	**31,000**	<2	49	45	5.9
G-5	G-5 Comp	0-0.15	2019-Oct-2	C3 CENTRE / G5	Grab	**20,000**	<2	83	11	4.3
G-6	G-6 Comp	0-0.15	2019-Oct-1	C5 EAST / G6	Grab	**39,000**	<2	28	56	16

Standards / Guidelines Descriptions:

- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level

Notes:

m - metres
µg/g - micrograms per gram
'-' - sample not analyzed for parameter indicated
• formatting of cells indicates exceedances of like-formatted standards
• where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded
µm - micrometres
• laboratory reports detail detection limits, testing protocols and QA/QC procedures.
% - percent
'-' - sample not analyzed for parameter indicated
> - denotes particle size greater than 75 micrometres

TABLE D-2: SEDIMENT - POLYCYCLIC AROMATIC HYDROCARBONS

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	moisture	PAHs: acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(b)fluoranthene	benzo(b+j)fluoranthenes	benzo(g,h,i)perylene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	methylnaphthalene, 1-	methylnaphthalene, 2-	naphthalene	phenanthrene	pyrene	light molecular weight PAHs	heavy molecular weight PAHs	PAHs (sum of total)
						%	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Reported Detection Limit						0.3	0.0005	0.0005	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.0005	0.001	0.001	0.002		0.001	0.001	0.001	0.001	0.001	0.001	0.001
ON PSQG LEL									0.22	0.32			0.17	0.24	0.37	0.34	0.06	0.75	0.19	0.2				0.56	0.49			4
ON PSQG SEL									7.77	29.6			6.4	26.8	28.8	9.2	2.6	20.4	3.2	6.4				19	17			200
ON Sediment Table 1 Background									0.22	0.32			0.17	0.24	0.37	0.34	0.06	0.75	0.19	0.2				0.56	0.49			
CCME SedQG Freshwater (ISQG)							0.00587	0.00671														0.0202	0.0346					
C-1	C-1 West	0-0.15	2018-Sep-18	C-1<15 (10:40)	Core	27.1	<0.1	1.49	4.69	6.6	8.37	-	4.36	2.29	6.01	7.15	0.79	24.5	1.76	3.45	<0.1	<0.1	<0.1	16.5	18.9	-	-	98.7
			2019-Oct-2	C1 WEST	Grab	26	0.011	0.049	0.13	0.6	0.74	1.1	0.46	0.31	0.69	0.86	0.12	1.9	0.063	0.45	-	0.012	0.014	0.86	1.4	1.1	5.5	6.7
C-2	C-2 West	0-0.15	2018-Sep-18	C-2<15 (11:10)	Core	31.1	<0.1	0.26	0.43	1.79	2.52	-	0.99	0.99	1.71	2.13	0.22	5.25	0.29	0.9	<0.1	<0.1	0.22	3.63	4.06	-	-	23
C-3	C-3 East	0-0.15	2018-Sep-18	C-3A<15 (16:50)	Core	34.4	<0.1	<0.1	<0.1	0.38	0.71	-	0.23	<0.2	0.39	0.5	<0.1	1.1	<0.1	0.2	<0.1	<0.1	<0.1	0.39	0.86	-	-	4.85
	C-3 Centre	0-0.15	2018-Sep-18	C-3B<15 (16:35)	Core	23.6	<0.1	0.27	0.28	1.1	1.64	-	0.44	0.63	1.05	1.34	0.12	3.7	0.26	0.46	<0.1	0.1	0.24	3.23	2.75	-	-	16
	C-3 West	0-0.15	2018-Sep-18	C-3C<15 (16:20)	Core	62.9	<0.1	<0.1	0.12	0.79	1.76	-	0.54	0.52	0.91	1.23	0.13	2.56	<0.1	0.54	<0.1	<0.1	<0.1	1.13	2.09	-	-	11
			2019-Oct-2	C3 WEST	Grab	47	0.016	0.27	0.43	1.1	1	1.4	0.57	0.41	0.94	1.5	0.16	3.2	0.31	0.54	-	0.067	0.13	2.5	2.3	3.7	9.1	13
C-4	C-4 East	0-0.15	2018-Sep-19	C-4A<15 14:35	Core	45.6	<0.1	<0.1	<0.1	0.44	1	-	0.37	0.23	0.48	0.66	<0.1	1.41	<0.1	0.27	<0.1	<0.1	<0.1	0.6	1.13	-	-	6.19
	C-4 Centre	0-0.15	2018-Sep-19	C-4B<15 15:15	Core	32.5	<0.1	<0.1	0.15	0.71	1.26	-	0.41	0.3	0.69	0.89	<0.1	2.12	0.11	0.35	<0.1	<0.1	<0.1	1.16	1.62	-	-	8.9
	C-4 West	0-0.15	2018-Sep-19	C-4C<15 15:35	Core	53.2	0.11	0.25	0.69	1.69	2.79	-	0.77	0.7	1.5	2.01	0.2	4.5	0.47	0.65	0.15	0.3	0.14	3.32	3.48	-	-	20.5
			2019-Oct-1	C4 WEST	Grab	53	0.021	0.045	0.1	0.71	1	1.3	0.74	0.47	0.69	1.3	0.17	2.2	0.074	0.63	-	0.034	0.023	0.83	1.6	1.1	6.6	7.8
C-5	C-5 East	0-0.15	2018-Sep-19	C-5A<15 14:10	Core	28.7	0.18	<0.1	0.28	1.99	2.16	-	0.98	0.72	1.69	1.76	0.26	2.99	0.1	0.88	<0.1	<0.1	0.15	0.93	2.94	-	-	16
	C-5 Centre	0-0.15	2018-Sep-19	C-5B<15 13:15	Core	25.5	<0.1	<0.1	<0.1	0.42	0.63	-	0.31	<0.2	0.39	0.47	<0.1	1.15	<0.1	0.25	<0.1	<0.1	<0.1	0.58	0.92	-	-	5.3
	C-5 West	0-0.15	2018-Sep-19	C-5C<15 14:20	Core	16.4	<0.1	<0.1	<0.1	0.46	0.96	-	0.38	0.25	0.5	0.68	<0.1	1.44	<0.1	0.27	<0.1	<0.1	<0.1	0.72	1.16	-	-	6.5
G-1	G-1 Comp	0-0.1	2018-Sep-18	G-1 Comp (10:30)	Grab	21.8	<0.1	0.83	0.99	2.96	3.59	-	1.45	1.37	2.4	3.24	0.37	9.08	0.84	1.34	0.2	0.3	0.98	9.53	6.75	-	-	42.2
G-2	G-2 Comp	0-0.1	2018-Sep-18	G2-Comp (12:00)	Grab	22.2	<0.1	<0.1	0.12	0.38	0.53	-	0.22	<0.2	0.36	0.45	<0.1	1.11	<0.1	0.19	<0.1	<0.1	<0.1	0.73	0.85	-	-	5.1
G-3	G-3 Comp	0-0.1	2018-Sep-18	G3-Comp (13:40)	Grab	25.1	<0.1	<0.1	<0.1	0.18	0.32	-	0.13	<0.2	0.18	0.26	<0.1	0.59	<0.1	0.11	<0.1	<0.1	<0.1	0.25	0.47	-	-	2.97
G-4	G-4 Comp	0-0.1	2018-Sep-18	G4-Comp (15:20)	Grab	30	<0.1	<0.1	<0.1	0.34	0.53	-	0.2	<0.2	0.33	0.42	<0.1	0.96	<0.1	0.18	<0.1	<0.1	<0.1	0.45	0.76	-	-	4.4
		0-0.15	2019-Oct-2	G4		42	0.013	0.03	0.08	0.45	0.69	0.98	0.43	0.25	0.57	0.79	0.11	1.5	0.047	0.39	-	0.014	0.014	0.6	1.1	0.79	4.5	5.3
G-5	G-5 Comp	0-0.1	2018-Sep-19	G-5 Comp 15:55	Grab	40.6	<0.1	<0.1	0.16	0.68	1.28	-	0.38	0.29	0.68	0.84	<0.1	1.91	<0.1	0.32	<0.1	<0.1	<0.1	0.94	1.48	-	-	8.2
		0-0.15	2019-Oct-2	C3 CENTRE / G5		23	0.012	0.038	0.12	0.54	0.63	0.9	0.38	0.23	0.58	0.75	0.1	1.6	0.048	0.36	-	0.0096	0.0089	0.68	1.2	0.91	4.8	5.7
G-6	G-6 Comp	0-0.15	2019-Oct-1	C5 EAST / G6	Grab	52	0.02	0.084	0.12	0.61	0.93	1.3	0.63	0.34	0.75	1.1	0.13	2	0.087	0.54	-	0.027	0.029	0.89	1.5	1.3	6.1	7.3

Standards / Guidelines Descriptions:
- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level
- ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards
- CCME SedQG Freshwater (ISQG):CCME Sediment Quality Guidelines for the Protection of Aquatic Life, Freshwater (Interim sediment quality guidelines)

Notes:
m - metres
µg/g - micrograms per gram
% - percent
< - less than reported detection limit
'-' - sample not analyzed for parameter indicated
- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

PAH - polycyclic aromatic hydrocarbons
- Total PAHs include acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene

TABLE D-3: SEDIMENT - METALS

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	pH (lab)	aluminum	antimony	arsenic	barium	beryllium	bismuth	boron	cadmium	calcium	chromium (III+VI)	cobalt	copper	iron	lead	lithium	magnesium	manganese	mercury	molybdenum	nickel	potassium	selenium	silver	sodium	strontium	thallium	tin	titanium	tungsten	uranium	vanadium	zinc	zirconium
						Metals																																	
						pH_Units	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Reported Detection Limit							100	0.1	0.2	0.1	0.2	0.1	1	0.05	100	0.5	0.1	0.5	100	0.1	0.5	100	0.2	0.05	0.1	0.5	100	0.5	0.05	100	0.1	0.05	0.1	1	0.5	0.05	1	1	0.5
ON PSQG Background Concentrations									4					1		31		25	30000	23			400	0.1		31												65	
ON PSQG LEL									**6**					**0.6**		**26**		**16**	**20000**	**31**			**460**	**0.2**		**16**												**120**	
ON PSQG SEL									33					10		110		110	40000	250			1100	2		75												820	
ON Sediment Table 1 Background									6					0.6		26	50	16		31				0.2		16			0.5									120	
C-1	C-1 West	0-0.15	2018-Sep-18	C-1<15 (10:40)	Core	-	-	<0.8	3.6	110	0.43	-	17	0.41	-	22	9.4	**30**	-	20	-	-	-	-	0.9	**23**	-	<0.7	0.11	-	-	0.09	-	-	-	0.58	18	**215**	-
			2019-Oct-2	C1 WEST	Grab	8.45	10,500	0.53	3.56	100	0.55	0.22	23.5	**1.32**	75,600	21.8	8.41	**44.6**	**23,000**	24.5	25.3	30,100	**566**	0.057	1.05	**22**	2390	<0.5	0.083	363	109	0.12	1.36	121	<0.5	0.659	22.1	**214**	2.82
C-2	C-2 West	0-0.15	2018-Sep-18	C-2<15 (11:10)	Core	-	-	<0.8	4.6	91	0.4	-	15	0.58	-	19	8.5	**51**	-	**34**	-	-	-	-	0.9	**20**	-	<0.7	0.19	-	-	0.11	-	-	-	0.55	17	**244**	-
C-3	C-3 East	0-0.15	2018-Sep-18	C-3A<15 (16:50)	Core	-	-	<0.8	3.8	69	0.28	-	11	**0.76**	-	16	6.4	**60**	-	**59**	-	-	-	-	0.6	16	-	<0.7	0.3	-	-	0.12	-	-	-	0.46	13	**310**	-
	C-3 Centre	0-0.15	2018-Sep-18	C-3B<15 (16:35)	Core	-	-	<0.8	3.5	85	0.33	-	13	0.39	-	26	7	**71**	-	28	-	-	-	-	0.7	**17**	-	<0.7	0.37	-	-	0.11	-	-	-	0.58	13	**202**	-
	C-3 West	0-0.15	2018-Sep-18	C-3C<15 (16:20)	Core	-	-	<0.8	4.7	120	0.44	-	15	**0.81**	-	**31**	8.6	**170**	-	**87**	-	-	-	-	2.4	**24**	-	1	1.6	-	-	0.23	-	-	-	0.88	22	***505***	-
			2019-Oct-2	C3 WEST	Grab	8.22	12,200	1.11	4.97	106	0.6	1.03	21.7	**0.753**	69,600	**31.5**	10.3	**85.7**	**24,800**	**44.9**	26.9	23,600	**588**	**0.255**	1.49	**25.6**	2330	<0.5	0.607	215	142	0.255	4.32	139	<0.5	0.766	24.9	**427**	0.78
C-4	C-4 East	0-0.15	2018-Sep-19	C-4A<15 14:35	Core	-	-	<0.8	4.3	80	0.35	-	11	**0.74**	-	22	7	**72**	-	**32**	-	-	-	-	1.2	**18**	-	<0.7	0.58	-	-	0.16	-	-	-	0.64	18	**298**	-
	C-4 Centre	0-0.15	2018-Sep-19	C-4B<15 15:15	Core	-	-	<0.8	4.1	70	0.32	-	14	0.56	-	19	6.8	**42**	-	28	-	-	-	-	0.8	**17**	-	<0.7	0.27	-	-	0.12	-	-	-	0.48	15	**215**	-
	C-4 West	0-0.15	2018-Sep-19	C-4C<15 15:35	Core	-	-	<0.8	5.5	141	0.46	-	20	***6.1***	-	**41**	11	**145**	-	**72**	-	-	-	-	1.8	**32**	-	0.8	3.3	-	-	0.2	-	-	-	0.76	21	***472***	-
			2019-Oct-1	C4 WEST	Grab	8.14	13,200	1.54	5.76	123	0.67	2.16	23.4	**0.914**	61,800	**35.9**	10.1	**125**	**25,600**	**51.3**	28.1	24,000	**594**	0.197	2.34	**26.6**	2430	0.74	1.18	447	151	0.263	5.05	150	<0.5	0.886	28.7	**532**	0.59
C-5	C-5 East	0-0.15	2018-Sep-19	C-5A<15 14:10	Core	-	-	1.3	**12**	210	0.57	-	20	***8.5***	-	**37**	11	**136**	-	***145***	-	-	-	-	2	**36**	-	1	3	-	-	0.17	-	-	-	0.59	23	***414***	-
	C-5 Centre	0-0.15	2018-Sep-19	C-5B<15 13:15	Core	-	-	<0.8	3.7	85	0.36	-	15	**0.86**	-	20	7.9	**66**	-	**49**	-	-	-	-	0.9	**22**	-	<0.7	0.53	-	-	0.13	-	-	-	0.56	15	**244**	-
	C-5 West	0-0.15	2018-Sep-19	C-5C<15 14:20	Core	-	-	<0.8	5.7	134	0.45	-	21	**3.1**	-	**32**	10	**97**	-	**56**	-	-	-	-	1.5	**29**	-	0.7	1.3	-	-	0.2	-	-	-	0.69	22	***428***	-
G-1	G-1 Comp	0-0.1	2018-Sep-18	G-1 Comp (10:30)	Grab	-	-	<0.8	3.8	130	0.42	-	17	0.37	-	21	9.1	**63**	-	16	-	-	-	-	1.2	**22**	-	<0.7	0.13	-	-	0.11	-	-	-	0.67	18	**187**	-
G-2	G-2 Comp	0-0.1	2018-Sep-18	G2-Comp (12:00)	Grab	-	-	<0.8	3	80	0.41	-	17	0.27	-	21	8.2	**50**	-	13	-	-	-	-	0.8	**21**	-	<0.7	0.1	-	-	0.08	-	-	-	0.58	16	**167**	-
G-3	G-3 Comp	0-0.1	2018-Sep-18	G3-Comp (13:40)	Grab	-	-	<0.8	3.9	130	0.38	-	15	0.56	-	20	7.8	**81**	-	**50**	-	-	-	-	1.1	**21**	-	<0.7	0.48	-	-	0.13	-	-	-	0.66	18	**311**	-
G-4	G-4 Comp	0-0.1	2018-Sep-18	G4-Comp (15:20)	Grab	-	-	<0.8	3.6	88	0.38	-	14	0.39	-	22	7.7	**58**	-	22	-	-	-	-	0.9	**20**	-	<0.7	0.31	-	-	0.13	-	-	-	0.58	16	**215**	-
		0-0.15	2019-Oct-2	G4		8.31	10,700	0.92	4.13	102	0.55	0.55	22.6	**0.623**	67,400	25.7	8.77	**64.9**	**22,600**	**39.6**	24.6	24,400	**550**	0.104	1.15	**22.3**	2280	<0.5	0.387	245	129	0.204	6.31	126	<0.5	0.68	22.8	**332**	0.81
G-5	G-5 Comp	0-0.1	2018-Sep-19	G-5 Comp 15:55	Grab	-	-	<0.8	3.9	77	0.37	-	13	0.57	-	21	7.2	**64**	-	**42**	-	-	-	-	1.1	**21**	-	<0.7	0.42	-	-	0.14	-	-	-	0.65	17	**275**	-
		0-0.15	2019-Oct-2	C3 CENTRE / G5		8.18	9420	0.66	3.71	75.5	0.53	0.4	20.1	**0.601**	78,400	19.8	9.07	**38.1**	**21,100**	29.6	21.7	23,700	**623**	0.1	0.87	**20.6**	2030	<0.5	0.263	209	137	0.214	1.63	124	<0.5	0.798	20.4	**272**	1.7
G-6	G-6 Comp	0-0.15	2019-Oct-1	C5 EAST / G6	Grab	8.1	9030	0.92	4.29	77.8	0.44	0.75	14.9	**0.609**	41,500	22.6	6.91	**64.1**	18,800	**46.1**	19.4	13,500	390	0.104	1.05	**18**	1620	<0.5	0.342	321	108	0.18	2.96	101	<0.5	0.483	20.1	**339**	0.6

Standards / Guidelines Descriptions:

- ON PSQG Background Concentrations:Ontario Provincial Sediment Quality Guideline - Table 3 and Table 4 Background Sediment Concentrations
- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level
- ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards

Notes:

m - metres

µg/g - micrograms per gram

< - less than reported detection limit

'-' - sample not analyzed for parameter indicated

- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

TABLE D-4: SEDIMENT -NUTRIENTS & BACTERIA

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	Inorganics						Ecological		
						ammonia and ammonium (as N)	ammonia as N	kjeldahl nitrogen total	nitrogen (total)	organic phosphorus	total phosphorus	E. coli	Fecal Coliforms	Total Coliforms
						µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	MPN/100g	MPN/100g	MPN/100g
Reported Detection Limit							2	5	2000	1	10	20	20	20
ON PSQG LEL								**550**			**600**			
ON PSQG SEL								4800			2000			
C-1	C-1 West	0-0.15	2018-Sep-18	C-1<15 (10:40)	Core	<100	-	500	-	-	598	-	12,000	-
			2019-Oct-2	C1 WEST	Grab	-	3.6	5.8	<2000	<1	**715**	3500	3500	160000
C-2	C-2 West	0-0.15	2018-Sep-18	C-2<15 (11:10)	Core	200	-	**1000**	-	-	**837**	-	21,000	-
C-3	C-3 East	0-0.15	2018-Sep-18	C-3A<15 (16:50)	Core	<100	-	**800**	-	-	**642**	-	19,000	-
	C-3 Centre	0-0.15	2018-Sep-18	C-3B<15 (16:35)	Core	<100	-	**600**	-	-	**660**	-	43,000	-
	C-3 West	0-0.15	2018-Sep-18	C-3C<15 (16:20)	Core	400	-	**1900**	-	-	**1622**	-	45,000	-
			2019-Oct-2	C3 WEST	Grab	-	26	95	3000	3.1	**1170**	5400	5400	92000
C-4	C-4 East	0-0.15	2018-Sep-19	C-4A<15 14:35	Core	100	-	**1000**	-	-	**861**	-	10,000	-
	C-4 Centre	0-0.15	2018-Sep-19	C-4B<15 15:15	Core	<100	-	**600**	-	-	**718**	-	17,000	-
	C-4 West	0-0.15	2018-Sep-19	C-4C<15 15:35	Core	300	-	**1600**	-	-	**1260**	-	11,000	-
			2019-Oct-1	C4 WEST	Grab	-	190	330	4000	4.6	**1560**	2800	2800	92000
C-5	C-5 East	0-0.15	2018-Sep-19	C-5A<15 14:10	Core	200	-	**900**	-	-	**978**	-	3000	-
	C-5 Centre	0-0.15	2018-Sep-19	C-5B<15 13:15	Core	<100	-	500	-	-	**781**	-	10,000	-
	C-5 West	0-0.15	2018-Sep-19	C-5C<15 14:20	Core	200	-	**1200**	-	-	**1120**	-	<1000	-
G-1	G-1 Comp	0-0.1	2018-Sep-18	G-1 Comp (10:30)	Grab	<100	-	**900**	-	-	**690**	-	8000	-
G-2	G-2 Comp	0-0.1	2018-Sep-18	G2-Comp (12:00)	Grab	<100	-	400	-	-	**628**	-	16,000	-
G-3	G-3 Comp	0-0.1	2018-Sep-18	G3-Comp (13:40)	Grab	<100	-	**600**	-	-	**795**	-	37,000	-
G-4	G-4 Comp	0-0.1	2018-Sep-18	G4-Comp (15:20)	Grab	<100	-	400	-	-	**737**	-	38,000	-
		0-0.15	2019-Oct-2	G4		-	27	47	<2000	2.4	**993**	2400	2400	160000
G-5	G-5 Comp	0-0.1	2018-Sep-18	G-5 Comp (17:10)	Grab	-	-	-	-	-	-	-	24,000	-
			2018-Sep-19	G-5 Comp 15:55		<100	-	**800**	-	-	**756**	-	30,000	-
		0-0.15	2019-Oct-2	C3 CENTRE / G5	Grab	-	13	35	<2000	1.1	**871**	5400	5400	92000
G-6	G-6 Comp	0-0.15	2019-Oct-1	C5 EAST / G6	Grab	-	130	180	3000	1.7	**904**	5400	5400	13000

Standards / Guidelines Descriptions:

- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level

Notes:

m - metres
µg/g - micrograms per gram
MPN - most probable number
< - less than reported detection limit
'-' - sample not analyzed for parameter indicated
- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

TABLE D-5: DEEP SEDIMENT - POLYCYCLIC AROMATIC HYDROCARBONS

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(b)fluoranthene	benzo(g,h,i)perylene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	methylnaphthalene, 1-	methylnaphthalene, 2-	naphthalene	phenanthrene	pyrene	Total PAHs
						PAHs																		
						µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
ON PSQG LEL								**0.22**	**0.32**		**0.17**	**0.24**	**0.37**	**0.34**	**0.06**	**0.75**	**0.19**	**0.2**				**0.56**	**0.49**	**4**
ON PSQG SEL								7.77	29.6		6.4	26.8	28.8	9.2	2.6	20.4	3.2	6.4				19	17	200
ON Sediment Table 1 Background								0.22	0.32		0.17	0.24	0.37	0.34	0.06	0.75	0.19	0.2				0.56	0.49	
CCME SedQG Freshwater (ISQG)						0.00587	0.00671													0.0202	0.0346			
C-1	C-1 West	0.15-0.3	2018-Sep-18	C-1>15 (10:40)	Core	<0.1	<0.1	0.13	**0.85**	1.37	**0.56**	**0.47**	**0.87**	**1.08**	**0.12**	**2.6**	<0.1	**0.5**	<0.1	<0.1	<0.1	**1.2**	**2.09**	**10.87**
C-2	C-2 West	0.15-0.3	2018-Sep-18	C-2>15 (11:10)	Core	<0.1	0.28	0.21	**1.27**	2.35	**0.72**	**0.77**	**1.36**	**1.87**	**0.18**	**4.85**	**0.29**	**0.68**	0.11	0.17	0.45	**4.39**	**3.69**	**21.11**
C-3	C-3 East	>0.3	2018-Sep-18	C-3A>30 (16:50)	Core	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.06	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.86
		0.15-0.3		C-3A>15 (16:50)		<0.05	<0.05	<0.05	0.12	0.21	<0.1	0.06	0.12	0.11	<0.06	0.3	<0.05	<0.1	<0.05	<0.05	<0.05	0.06	0.25	1.53
	C-3 West	0.15-0.3	2018-Sep-18	C-3C>15 (16:20)	Core	<0.1	0.91	**1.08**	**3.54**	4.96	**1.23**	**1.48**	**3.11**	**4.04**	**0.35**	**10.3**	**1.04**	**1.25**	0.28	0.37	1.2	**10**	**7.83**	**47.46**
C-4	C-4 East	0.15-0.3	2018-Sep-19	C-4A>15 14:35	Core	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.06	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.86
	C-4 Centre	0.15-0.3	2018-Sep-19	C-4B>15 15:15	Core	<0.1	0.92	**0.34**	**0.95**	1.6	**0.51**	**0.5**	**0.9**	**1.23**	**0.13**	**2.95**	**0.6**	**0.41**	0.85	1.92	<0.1	**2.92**	**2.31**	**14.87**
		>0.3		C-4B>30 15:15		<0.05	0.17	0.21	**0.6**	0.96	**0.37**	**0.31**	**0.59**	**0.7**	**0.09**	**1.51**	**0.25**	**0.31**	0.29	0.73	0.06	**1.31**	**1.24**	**7.77**
	C-4 West	0.15-0.3	2018-Sep-19	C-4C>15 15:35	Core	<0.1	0.29	**0.34**	**1.01**	1.5	**0.44**	**0.47**	**0.86**	**1.02**	**0.11**	**2.76**	**0.54**	**0.36**	0.73	1.57	0.14	**2.9**	**2.24**	**13.58**
		>0.3		C-4C>30 15:35		<0.05	0.23	**0.26**	**0.75**	1.18	**0.41**	**0.32**	**0.7**	**0.88**	**0.1**	**1.98**	**0.36**	**0.34**	0.47	1.21	0.07	**1.95**	**1.64**	**10.04**
C-5	C-5 East	0.15-0.3	2018-Sep-19	C-5A>15 14:10	Core	<0.1	<0.1	0.14	**0.7**	1.04	**0.6**	**0.37**	**0.76**	**0.72**	**0.14**	**1.3**	0.1	**0.47**	<0.1	0.18	0.18	**0.62**	**1.24**	**7.54**
	C-5 Centre	0.15-0.3	2018-Sep-19	C-5B>15 13:15	Core	<0.1	0.23	**0.31**	**0.98**	1.28	**0.59**	**0.45**	**0.92**	**1.06**	**0.13**	**2.74**	**0.27**	**0.51**	<0.1	<0.12	0.13	**2.41**	**2.22**	**13.05**
		>0.3		C-5B>30 13:15		<0.1	<0.1	0.13	**0.4**	0.54	**0.24**	<0.2	0.34	**0.42**	<0.1	**0.97**	0.16	0.19	0.12	<0.2	<0.1	**0.9**	**0.75**	**5.1**
	C-5 West	0.15-0.3	2018-Sep-19	C-5C>15 14:20	Core	<0.1	0.18	**0.27**	**0.77**	1.35	**0.45**	**0.34**	**0.72**	**0.96**	<0.1	**2.39**	**0.44**	**0.35**	0.42	0.76	<0.1	**2.02**	**1.89**	**11.08**
		>0.3		C-5C>30 14:20		<0.1	0.33	**0.56**	**1.51**	2.37	**0.89**	**0.6**	**1.38**	**1.75**	**0.21**	**4.37**	**0.67**	**0.71**	0.89	1.94	0.17	**3.81**	**3.4**	**20.46**
C-6	C-6 East	0.15-0.3	2018-Sep-19	C-6A>15 10:15	Core	<0.1	<0.1	<0.1	**0.56**	0.93	**0.39**	**0.28**	**0.56**	**0.71**	<0.1	**1.44**	<0.1	**0.33**	<0.1	<0.1	<0.1	0.52	**1.25**	**6.64**
		>0.3		C-6A>30 10:15		<0.1	0.11	0.18	**0.71**	0.98	**0.37**	**0.32**	**0.62**	**0.77**	<0.1	**1.67**	0.17	**0.32**	0.11	0.24	<0.1	**1.16**	**1.51**	**8.21**
	C-6 Centre	0.15-0.3	2018-Sep-19	C-6B>15 10:35	Core	<0.1	<0.1	0.14	**0.68**	1	**0.36**	**0.3**	**0.62**	**0.76**	<0.1	**1.66**	0.11	**0.31**	<0.1	<0.1	<0.1	**0.85**	**1.4**	**7.59**
		0.3		C-6B>30 10:35		<0.1	0.97	**1.12**	**2.48**	2.92	**1.2**	**1.11**	**2.09**	**2.51**	**0.27**	**6.15**	**1.06**	**1.04**	0.65	1.16	0.44	**6.88**	**5.35**	**32.77**
	C-6 West	0.15-0.3	2018-Sep-19	C-6C>15 11:20	Core	<0.1	0.13	0.2	**0.71**	0.96	**0.52**	**0.34**	**0.64**	**0.8**	**0.1**	**1.83**	**0.23**	**0.4**	0.22	0.43	<0.1	**1.25**	**1.53**	**8.88**
		>0.3		C-6C>30 11:20		<0.1	0.16	**0.3**	**0.99**	1.3	**0.66**	**0.52**	**0.89**	**1.1**	**0.14**	**2.5**	**0.33**	**0.49**	0.27	0.55	0.1	**1.96**	**2.09**	**12.33**

Standards / Guidelines Descriptions:
- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards
- CCME SedQG Freshwater (ISQG):CCME Sediment Quality Guidelines for the Protection of Aquatic Life, Freshwater (Interim sediment quality guidelines)
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level

Notes:
m - metres
µg/g - micrograms per gram
< - less than reported detection limit
'-' - sample not analyzed for parameter indicated
- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

PAH - polycyclic aromatic hydrocarbons
- Total PAHs include Acenaphthene, Acenaphthylene, Anthracene, Benzo[k]fluoranthene, Benzo[b]fluorine, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[g,h,i]perylene, Chrysene, Dibenzo[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene, Phenanthrene, and Pyrene

TABLE D-6: DEEP SEDIMENT - METALS

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	Metals																	
						antimony	arsenic	barium	beryllium	boron	cadmium	chromium (III+VI)	cobalt	copper	lead	molybdenum	nickel	selenium	silver	thallium	uranium	vanadium	zinc
						µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
ON PSQG Background Concentrations							4				1	31		25	23		31						65
ON PSQG LEL							6				0.6	26		16	31		16						120
ON PSQG SEL							33				10	110		110	250		75						820
ON Sediment Table 1 Background							6				0.6	26	50	16	31		16		0.5				120
C-1	C-1 West	0.15-0.3	2018-Sep-18	C-1>15 (10:40)	Core	<0.8	4.7	120	0.44	16	0.4	24	9.3	71	29	1.1	23	<0.7	0.37	0.13	0.64	19	250
C-2	C-2 West	0.15-0.3	2018-Sep-18	C-2>15 (11:10)	Core	<0.8	6	88	0.38	13	1.1	23	8.5	73	59	2.4	21	<0.7	1.2	0.11	0.48	18	339
C-3	C-3 East	>0.3	2018-Sep-18	C-3A>30 (16:50)	Core	<0.8	2.7	34	0.21	4	0.07	7.3	5.1	20	6.1	0.2	10	<0.7	<0.05	0.06	0.32	11	30
		0.15-0.3		C-3A>15 (16:50)		<0.8	3.1	40	0.24	5	3.8	12	6.2	29	20	0.3	15	<0.7	0.46	0.08	0.43	13	86
	C-3 West	0.15-0.3	2018-Sep-18	C-3C>15 (16:20)	Core	<0.8	4.2	80	0.31	11	0.81	26	6.9	61	100	1	18	<0.7	0.47	0.13	0.53	15	305
C-4	C-4 East	0.15-0.3	2018-Sep-19	C-4A>15 14:35	Core	<0.8	1.7	16	0.16	4	0.09	6.3	3.5	18	6.2	0.1	7.5	<0.7	0.06	0.04	0.3	11	31
	C-4 Centre	0.15-0.3	2018-Sep-19	C-4B>15 15:15	Core	0.8	6.8	217	0.52	23	22	50	14	124	141	1.1	51	<0.7	4.4	0.15	0.67	22	437
		>0.3		C-4B>30 15:15		1	7.1	145	0.48	21	11	31	13	85	94	0.9	37	<0.7	4.3	0.14	0.6	22	300
	C-4 West	0.15-0.3	2018-Sep-19	C-4C>15 15:35	Core	1	5.9	201	0.39	19	29	45	13	129	116	1	52	<0.7	7.7	0.11	0.55	18	412
		>0.3		C-4C>30 15:35		<0.8	5.4	143	0.41	20	14	32	11	86	89	0.8	35	<0.7	4.5	0.11	0.58	19	275
C-5	C-5 East	0.15-0.3	2018-Sep-19	C-5A>15 14:10	Core	1.1	16	265	0.85	24	7.6	45	12	127	181	3.3	37	1.5	2.4	0.25	0.81	30	546
	C-5 Centre	0.15-0.3	2018-Sep-19	C-5B>15 13:15	Core	0.9	4.9	143	0.34	15	8.9	28	11	82	134	0.6	47	<0.7	2.4	0.1	0.46	14	258
		>0.3		C-5B>30 13:15		1.3	6.2	209	0.39	21	12	35	15	111	140	0.7	55	<0.7	3.3	0.11	0.51	16	364
	C-5 West	0.15-0.3	2018-Sep-19	C-5C>15 14:20	Core	1.9	9	398	0.51	39	49	87	22	265	241	1.3	93	0.7	17	0.17	0.73	25	818
		>0.3		C-5C>30 14:20		1.7	9.1	397	0.51	45	68	97	21	358	228	1.5	89	0.7	27	0.18	0.78	26	922
C-6	C-6 East	0.15-0.3	2018-Sep-19	C-6A>15 10:15	Core	<0.8	3.5	80	0.29	23	1.2	21	6.9	65	67	0.6	19	<0.7	1.5	0.1	0.42	14	245
		>0.3		C-6A>30 10:15		<0.8	4.4	127	0.34	32	7.6	32	9.8	69	115	0.6	34	<0.7	3.8	0.1	0.46	15	324
	C-6 Centre	0.15-0.3	2018-Sep-19	C-6B>15 10:35	Core	<0.8	3.7	70	0.3	17	1.6	18	6.7	76	80	0.6	18	<0.7	0.87	0.1	0.43	14	253
		0.3		C-6B>30 10:35		1.4	6.9	228	0.45	40	20	52	15	126	194	1.2	59	<0.7	8.3	0.15	0.58	20	540
	C-6 West	0.15-0.3	2018-Sep-19	C-6C>15 11:20	Core	0.8	5.3	136	0.4	32	4.9	33	11	81	138	0.8	32	<0.7	3.2	0.12	0.52	17	368
		>0.3		C-6C>30 11:20		1.5	6.6	237	0.43	40	19	49	16	175	173	0.9	65	<0.7	6.7	0.12	0.53	18	489

Standards / Guidelines Descriptions:
- ON PSQG Background Concentrations:Ontario Provincial Sediment Quality Guideline - Table 3 and Table 4 Background Sediment Concentrations
- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level
- ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards

Notes:
m - metres
µg/g - micrograms per gram
< - less than reported detection limit
'-' - sample not analyzed for parameter indicated
- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

TABLE D-7: DEEP SEDIMENT -NUTRIENTS & BACTERIA

Site Area	Sample Location	Sample Depth (mbg)	Sample Date	Sample ID	Matrix Description	Inorganics			Ecological	Physical Parameters
						ammonia and ammonium (as N)	kjeldahl nitrogen total	phosphorus	Fecal Coliforms	moisture
						µg/g	µg/g	µg/g	MPN/100g	%
ON PSQG LEL							**550**	**600**		
ON PSQG SEL							**4800**	**2000**		
C-1	C-1 West	0.15-0.3	2018-Sep-18	C-1>15 (10:40)	Core	200	**600**	**934**	<1000	37.8
C-2	C-2 West	0.15-0.3	2018-Sep-18	C-2>15 (11:10)	Core	200	**800**	**937**	<1000	28
C-3	C-3 East	>0.3	2018-Sep-18	C-3A>30 (16:50)	Core	<100	<100	563	<1000	55.5
		0.15-0.3		C-3A>15 (16:50)		<100	300	**637**	<1000	25.7
	C-3 West	0.15-0.3	2018-Sep-18	C-3C>15 (16:20)	Core	200	**600**	**929**	9000	35.4
C-4	C-4 East	0.15-0.3	2018-Sep-19	C-4A>15 14:35	Core	<100	200	**636**	<1000	20.8
	C-4 Centre	0.15-0.3	2018-Sep-19	C-4B>15 15:15	Core	100	**700**	**1140**	<1000	36
		>0.3		C-4B>30 15:15		100	**600**	**909**	<1000	35.8
	C-4 West	0.15-0.3	2018-Sep-19	C-4C>15 15:35	Core	200	**900**	**1090**	<1000	33
		>0.3		C-4C>30 15:35		100	**800**	**881**	<1000	32.4
C-5	C-5 East	0.15-0.3	2018-Sep-19	C-5A>15 14:10	Core	100	**1400**	**1021**	1000	51.1
	C-5 Centre	0.15-0.3	2018-Sep-19	C-5B>15 13:15	Core	<100	200	**882**	<1000	21.3
		>0.3		C-5B>30 13:15		100	**600**	**995**	<1000	26.6
	C-5 West	0.15-0.3	2018-Sep-19	C-5C>15 14:20	Core	200	**1200**	**1760**	<1000	35.3
		>0.3		C-5C>30 14:20		200	**1500**	**1820**	1000	44.7
C-6	C-6 East	0.15-0.3	2018-Sep-19	C-6A>15 10:15	Core	100	**700**	**827**	<1000	26.1
		>0.3		C-6A>30 10:15		200	**1000**	**1084**	<1000	28.4
	C-6 Centre	0.15-0.3	2018-Sep-19	C-6B>15 10:35	Core	<100	500	**768**	<1000	26
		0.3		C-6B>30 10:35		100	**1300**	**1444**	<1000	28.3
	C-6 West	0.15-0.3	2018-Sep-19	C-6C>15 11:20	Core	100	**800**	**1059**	<1000	24.4
		>0.3		C-6C>30 11:20		200	**1200**	**1370**	<1000	29.7

Standards / Guidelines Descriptions:
- ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
- ON PSQG SEL:Ontario Provincial Sediment Quality Guideline - Severe Effect Level

Notes:
m - metres
µg/g - micrograms per gram
MPN - most probable number
< - less than reported detection limit
'-' - sample not analyzed for parameter indicated
- formatting of cells indicates exceedances of like-formatted standards
- where many exceedance formats are used, highlighted results reflect the least stringent standard/guideline exceeded

TABLE D-8: SURFACE WATER - FIELD MEASUREMENTS

Site Area	Sample Location	Sample Date	Sample ID	temp (field)	pH (field)	EC (field)	DO (field)
				Field			
				oC	pH_Units	µS/cm	mg/L
ON PWQO							5[#1]
C-1	C-1 West	2019-Sep-30	C-1 West	15.7	8.25	733	10.23
			C-1 West Duplicate	15.7	8.25	733	10.23
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	16.1	7.61	760	5.99
	C-3 West	2019-Sep-30	C-3 West	15.9	7.65	771	6.38
C-4	C-4 West	2019-Sep-30	C-4 West	16.3	7.52	739	4.85
C-5	C-5 East	2019-Sep-30	C-5 East - G6	16.3	7.43	700	2.96
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	15.7	8.36	729	10.4
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	15.7	7.67	780	7.01
Reference	R-1	2019-Sep-30	R-1	18.1	7.76	1200	8.67
	R-2	2019-Sep-30	R-2	18.4	8.02	1205	9.75

mg/L - milligram per litre
µS/cm -microseimens per centimeter
oC - degrees centigrade

Standard/Guideline Descriptions

- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994 (and updates)

Standard/Guideline Comments

#1:Dependent upon temperature, cold water biota, and warm water biota. Objective represents minimum DO concentration for warm water biota at 15 degrees.

TABLE D-9: SURFACE WATER - PHYSICAL PARAMETERS

Site Area	Sample Location	Sample Date	Sample ID	Physical Parameters: Total Suspended Solids (mg/L)	Physical Parameters: Total Organic Carbon (mg/L)	Physical Parameters: Dissolved Organic Carbon (Filtered) (mg/L)	Miscellanous: Biochemical Oxygen Demand (5-day test) (mg/L)	Miscellanous: Dibenz(a.j)acridine (mg/L)
C-1	C-1 West	2019-Sep-30	C-1 West	4.5	2.6	2.5	<2	<0.0001
			C-1 West Duplicate	13.8	3	2.6	<2	<0.0001
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	19.8	4	3.4	2	<0.0001
	C-3 West	2019-Sep-30	C-3 West	20.8	3.7	2.9	<2	<0.0001
C-4	C-4 West	2019-Sep-30	C-4 West	21.2	4.4	3.9	2	<0.0001
C-5	C-5 East	2019-Sep-30	C-5 East - G6	26.8	4.5	4.1	3	<0.0001
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	5.3	2.4	2.5	<2	<0.0001
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	10.3	2.8	2.6	<2	<0.0001
Reference	R-1	2019-Sep-30	R-1	3.4	2.9	2.4	<2	<0.0001
	R-2	2019-Sep-30	R-2	<2	3.4	2.4	<2	<0.0001

mg/L - milligram per litre

TABLE D-10: SURFACE WATER - POLYCYCLIC AROMATIC HYDROCARBONS

Site Area	Sample Location	Sample Date	Sample ID	acenaphthylene	acenaphthene	anthracene	benz(a)anthracene	benzo(b+j)fluoranthene (SPLP)	benzo(e)pyrene	benzo(g,h,i)perylene	benzo(k)fluoranthene	benzo(a)pyrene	chrysene	dibenz(a,h)anthracene	7H-Dibenzo[c,g]carbazole	dibenzo(a,i)pyrene	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	methylnaphthalene, 1-	methylnaphthalene, 2-	naphthalene	perylene	phenanthrene	pyrene	PAHs (sum of total)
				PAHs																						
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ON PWQO						0.0008[#1]	0.0004[#1]			0.00002[#1]	0.0002[#1]		0.0001[#1]	0.002[#1]			0.0008[#1]	0.2[#1]		2[#1]	2[#1]	7[#1]	0.00007[#1]	0.03[#1]		
CCME WQG Freshwater Aquatic Life (long term)					**5.8**	**0.012**	**0.018**					**0.015**					**0.04**	**3**				**1.1**		**0.4**	**0.025**	
C-1	C-1 West	2019-Sep-30	C-1 West	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
			C-1 West Duplicate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
	C-3 West	2019-Sep-30	C-3 West	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
C-4	C-4 West	2019-Sep-30	C-4 West	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
C-5	C-5 East	2019-Sep-30	C-5 East - G6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
Reference	R-1	2019-Sep-30	R-1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2
	R-2	2019-Sep-30	R-2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.5	<0.5	<0.5	<0.5	<0.1	<0.1	<2

µg/L - microgram per litre

Standard/Guideline Descriptions
- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994 (and Updates)
- CCME WQG Freshwater Aquatic Life (long term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Long-term)

Standard/Guideline Comments
#1:Interim PWQO

Page 200 of 406

TABLE D-11: SURFACE WATER - METALS

Site Area	Sample Location	Sample Date	Sample ID	Metals: hardness as CaCO3	pH (lab)	aluminum	aluminum (Filtered)	antimony	antimony (Filtered)	arsenic	arsenic (Filtered)	barium	barium (Filtered)	beryllium	beryllium (Filtered)
				mg/L	pH_Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ON PWQO						75[#1] *	75[#1] *	20[#1]	20[#1]	5[#2]	5[#2]			1100[#3] **	1100[#3] **
C-1	C-1 West	2019-Sep-30	C-1 West	253	8.32	**145**	13	0.2	0.2	1.3	1.2	39.4	42.9	<0.1	<0.1
			C-1 West Duplicate	252	8.32	**299**	14	0.2	0.2	1.3	1.3	40.4	41.6	<0.1	<0.1
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	244	7.99	**467**	3	0.3	0.3	1.5	1.2	48.4	45.9	<0.1	<0.1
	C-3 West	2019-Sep-30	C-3 West	248	8.03	**468**	4	0.3	0.3	1.5	1.2	48	46.6	<0.1	<0.1
C-4	C-4 West	2019-Sep-30	C-4 West	233	7.94	**489**	2	0.3	0.3	1.6	1.2	49.2	48.6	<0.1	<0.1
C-5	C-5 East	2019-Sep-30	C-5 East - G6	223	7.87	**598**	<2	0.4	0.4	1.5	1.2	49.5	47.2	<0.1	<0.1
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	249	8.42	**160**	13	0.2	0.2	1.3	1.2	38.6	38.5	<0.1	<0.1
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	257	8.06	**307**	4	0.2	0.2	1.4	1.3	46	43.4	<0.1	<0.1
Reference	R-1	2019-Sep-30	R-1	414	8.11	24	<2	0.2	0.2	0.6	0.5	62.6	61.1	<0.1	<0.1
	R-2	2019-Sep-30	R-2	457	8.14	12	<2	0.2	0.2	0.5	0.5	59.2	62.4	<0.1	<0.1

Site Area	Sample Location	Sample Date	Sample ID	bismuth	bismuth (Filtered)	boron	boron (Filtered)	cadmium	cadmium (Filtered)	calcium	calcium (Filtered)	chromium (III+VI)	chromium (III+VI) (Filtered)	cobalt	cobalt (Filtered)	copper	copper (Filtered)	iron	iron (Filtered)
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ON PWQO						200[#1]	200[#1]	0.1[#1] - 0.5[#1] **	0.1[#1] - 0.5[#1] **					0.9	0.9	5[#1] **	5[#1] **	300	300
C-1	C-1 West	2019-Sep-30	C-1 West	<0.1	<0.1	149	143	<0.1	<0.1	72.3	69.4	0.2	<0.1	0.1	<0.1	2.9	1.9	202	9
			C-1 West Duplicate	<0.1	<0.1	143	150	<0.1	<0.1	70.6	70.9	0.4	<0.1	0.3	<0.1	3.7	2.1	**426**	8
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	<0.1	<0.1	197	**211**	<0.1	<0.1	67	68.9	0.7	<0.1	0.4	0.2	3.5	1.1	**883**	7
	C-3 West	2019-Sep-30	C-3 West	<0.1	<0.1	193	**204**	<0.1	<0.1	68.9	69.8	0.7	0.1	0.4	0.2	3.6	1	**890**	15
C-4	C-4 West	2019-Sep-30	C-4 West	<0.1	<0.1	**206**	**209**	<0.1	<0.1	63.4	65.4	0.8	<0.1	0.4	0.2	3.6	1.1	**990**	6
C-5	C-5 East	2019-Sep-30	C-5 East - G6	<0.1	<0.1	177	183	<0.1	<0.1	61.4	61.7	1	<0.1	0.5	0.2	4.1	0.7	**1180**	11
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	<0.1	<0.1	143	147	<0.1	<0.1	69.9	71	0.2	0.1	0.2	<0.1	3	1.9	227	19
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	<0.1	<0.1	169	175	<0.1	<0.1	71.6	72.4	0.4	<0.1	0.3	0.1	3.5	1.2	**628**	9
Reference	R-1	2019-Sep-30	R-1	<0.1	<0.1	131	141	<0.1	<0.1	117	118	<0.1	<0.1	<0.1	<0.1	1.2	1	140	4
	R-2	2019-Sep-30	R-2	<0.1	<0.1	129	137	<0.1	<0.1	115	136	<0.1	<0.1	<0.1	<0.1	1.1	1	119	4

mg/L - milligram per litre
µg/L - microgram per litre

Standard/Guideline Descriptions
- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994 (and updates)

Standard/Guideline Comments
#1:Interim PWQO
#2:Interim PWQO. The PWQO is 100 ug/L.
#3:Criteria varies with hardness.
#4:Criteria is for dissolved mercury.
#5:Guideline is dependent on waterbody hardness.
#6:Guideline is dependent on waterbody hardness. Most conservative value listed.
#7:Guideline applies to dissolved concentration
*pH dependent
**hardness dependent

TABLE D-11: SURFACE WATER - METALS

Site Area	Sample Location	Sample Date	Sample ID	Metals													
				lead	lead (Filtered)	magnesium	magnesium (Filtered)	manganese	manganese (Filtered)	mercury	mercury (Filtered)	molybdenum	molybdenum (Filtered)	nickel	nickel (Filtered)	potassium	potassium (Filtered)
				µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ON PWQO				$1^{\#1}$ - $5^{\#1}$ **	$1^{\#1}$ - $5^{\#1}$ **					$0.2^{\#4}$	$0.2^{\#4}$	$40^{\#1}$	$40^{\#1}$	25	25		
C-1	C-1 West	2019-Sep-30	C-1 West	0.4	<0.1	17.5	17.4	20.3	15.2	<0.05	<0.05	2	2.1	1.1	1	3400	3350
			C-1 West Duplicate	1	<0.1	17.8	18.3	30	15.8	<0.05	<0.05	2	2.1	1.4	1	3470	3550
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	1.9	<0.1	17.5	17.5	73	56.3	<0.05	<0.05	2.1	2.2	1.9	1.2	3880	3770
	C-3 West	2019-Sep-30	C-3 West	2.1	<0.1	17.9	17.6	71.3	54.2	<0.05	<0.05	2.1	2.1	1.8	1.3	3870	3740
C-4	C-4 West	2019-Sep-30	C-4 West	2.1	<0.1	17	16.7	88.2	63	<0.05	<0.05	2	2	1.9	1.8	3890	3750
C-5	C-5 East	2019-Sep-30	C-5 East - G6	2.3	<0.1	16.5	16.7	98.9	76.2	<0.05	<0.05	2	2	2	1.2	3920	3950
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	0.5	<0.1	17.5	17.5	18.1	11.8	<0.05	<0.05	2	2.1	1.2	1	3350	3320
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	1.2	<0.1	18.4	18.1	50.4	39.8	<0.05	<0.05	2.1	2.2	1.7	1.2	3840	3750
Reference	R-1	2019-Sep-30	R-1	0.1	<0.1	28.9	28.9	136	101	<0.05	<0.05	2	2.1	0.7	0.7	5010	4870
	R-2	2019-Sep-30	R-2	<0.1	<0.1	27.9	28.6	125	106	<0.05	<0.05	2	2	0.7	0.7	4780	4960

Sample ID	Metals																			
	selenium	selenium (Filtered)	silver	silver (Filtered)	sodium	sodium (Filtered)	strontium	strontium (Filtered)	thallium	thallium (Filtered)	tin	tin (Filtered)	titanium	titanium (Filtered)	uranium	uranium (Filtered)	vanadium	vanadium (Filtered)	zinc	zinc (Filtered)	zirconium	zirconium (Filtered)
	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ON PWQO	100	100	0.1	0.1					$0.3^{\#1}$	$0.3^{\#1}$					$5^{\#1}$	$5^{\#1}$	$6^{\#1}$	$6^{\#1}$	$20^{\#1}$	$20^{\#1}$	$4^{\#1}$	$4^{\#1}$
C-1 West	0.2	0.2	<0.1	<0.1	80.8	81.7	1090	1070	<0.3	<0.3	<0.1	<0.1	3.1	0.3	0.734	0.748	1	0.7	17	12	<0.4	<0.4
C-1 West Duplicate	0.2	0.2	<0.1	<0.1	80.8	82.3	1070	1130	<0.3	<0.3	<0.1	<0.1	5.8	0.3	0.73	0.777	1.2	0.8	**22**	11	<0.4	<0.4
C-3 Centre - G5	0.3	0.2	<0.1	<0.1	82.1	88.3	947	940	<0.3	<0.3	<0.1	<0.1	8.6	0.2	0.666	0.675	1.9	1.1	20	6	<0.4	<0.4
C-3 West	0.2	0.2	<0.1	<0.1	84.2	89.8	976	952	<0.3	<0.3	<0.1	<0.1	8.9	0.2	0.69	0.702	1.9	1.1	**21**	5	<0.4	<0.4
C-4 West	0.3	0.2	<0.1	<0.1	79.8	82.1	881	869	<0.3	<0.3	<0.1	<0.1	9.2	0.1	0.602	0.601	2.1	1.2	20	4	<0.4	<0.4
C-5 East - G6	0.3	0.2	<0.1	<0.1	72.8	77.6	850	869	<0.3	<0.3	<0.1	<0.1	11.2	<0.1	0.556	0.577	2.3	1.2	**21**	4	<0.4	<0.4
G-1 Comp	0.2	0.2	<0.1	<0.1	78	81.9	1100	1090	<0.3	<0.3	<0.1	<0.1	3.7	0.2	0.741	0.75	1	0.7	17	9	<0.4	<0.4
G-4 Comp	0.3	0.2	<0.1	<0.1	87.9	93.4	1020	1020	<0.3	<0.3	<0.1	<0.1	6	0.2	0.73	0.741	1.4	0.9	**21**	9	<0.4	<0.4
R-1	0.2	0.2	<0.1	<0.1	121	124	2610	2580	<0.3	<0.3	<0.1	<0.1	0.6	0.1	1.46	1.47	0.2	0.1	5	4	<0.4	<0.4
R-2	0.2	0.2	<0.1	<0.1	118	123	2520	2570	<0.3	<0.3	<0.1	<0.1	0.3	<0.1	1.45	1.45	0.2	0.1	4	3	<0.4	<0.4

mg/L - milligram per litre
µg/L - microgram per litre

Standard/Guideline Descriptions

- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994 (and updates)

Standard/Guideline Comments

#1:Interim PWQO
#2:Interim PWQO. The PWQO is 100 ug/L.
#3:Criteria varies with hardness.
#4:Criteria is for dissolved mercury.
#5:Guideline is dependent on waterbody hardness.
#6:Guideline is dependent on waterbody hardness. Most conservative value listed.
#7:Guideline applies to dissolved concentration

*pH dependent
**hardness dependent

TABLE D-12: SURFACE WATER -NUTRIENTS & BACTERIA

Site Area	Sample Location	Sample Date	Sample ID	ammonia	ammonia and ammonium (as N)	kjeldahl nitrogen total	nitrate (as N)	nitrite (as N)	nitrate and nitrite (as N)	orthophosphate (PO4-P)	phosphorus	phosphorus (Filtered)	silicon	silicon (Filtered)	E. coli
				Inorganics											Ecological
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL
ON PWQO				0.02#1							0.01#2	0.01#2			100#3
CCME WQG Freshwater Aquatic Life (long term)				**0.019**				**0.06**							
C-1	C-1 West	2019-Sep-30	C-1 West	0.003	0.05	0.6	1.95	**0.22**	2.17	0.44	0.415	0.401	3.05	2.77	4100
			C-1 West Duplicate	0.0041	0.07	0.6	1.91	**0.22**	2.13	0.44	0.45	0.41	3.16	2.75	3100
C-3	C-3 Centre	2019-Sep-30	C-3 Centre - G5	0.009	0.62	1.1	1.77	**0.11**	1.88	0.37	0.371	0.26	3.52	2.78	1700
	C-3 West	2019-Sep-30	C-3 West	0.0092	0.59	1.1	1.8	**0.13**	1.93	0.38	0.388	0.271	3.62	2.8	1200
C-4	C-4 West	2019-Sep-30	C-4 West	0.0101	0.84	1.4	1.64	**0.09**	1.73	0.33	0.363	0.217	3.55	2.75	800
C-5	C-5 East	2019-Sep-30	C-5 East - G6	0.0103	1.05	1.5	1.44	**0.07**	1.51	0.3	0.314	0.166	3.71	2.69	390
G-1	G-1 Comp	2019-Sep-30	G-1 Comp	0.0053	0.07	0.5	1.94	**0.2**	2.14	0.44	0.428	0.42	3.04	2.68	2800
G-4	G-4 Comp	2019-Sep-30	G-4 Comp	0.0065	0.4	1.2	2.07	**0.28**	2.35	0.43	0.425	0.343	3.26	2.79	1900
Reference	R-1	2019-Sep-30	R-1	0.0007	0.03	0.3	0.33	<0.05	0.33	<0.05	<0.01	<0.01	3.97	3.8	10
	R-2	2019-Sep-30	R-2	<0.0004	<0.01	<0.2	0.31	<0.05	0.31	<0.05	<0.01	<0.01	3.79	4.41	30

CFU - colony-forming unit
mg/L - milligram per litre

Standard/Guideline Descriptions
- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994 (and updates)
- CCME WQG Freshwater Aquatic Life (long term):CCME Water Quality Guidelines for the Protection of Aquatic Life, Freshwater (Long-term)

Standard/Guideline Comments
#1:The percentage of un-ionized ammonia in aqueous ammonia solution varies with temperature and pH.
#2:Interim PWQO. Criteria changes with site, most conservative value given
#3:100 E. coli per 100 mL. (based on a geometric mean of at least 5 samples)

TABLE D-13: POREWATER - INORGANICS

	Inorganics		
	BOD	hydrogen sulfide	sulphide
	mg/L	mg/L	mg/L
Reported Detection Limit	2	0.0019	0.0018
ON PWQO		**0.002**	

Site Area	Sample Location	Well Screen Depth (mbg)	Sample Date	Sample ID	BOD	hydrogen sulfide	sulphide
C-1	C-1 West	-	2019-Oct-1	C1 WEST-PW	8.5	**0.028**	0.027
C-3	C-3 West	-	2019-Oct-1	C3 WEST-PW	9.5	**0.069**	0.065
C-4	C-4 West	-	2019-Oct-1	C4 WEST-PW	31	**0.22**	0.21
G-4	G-4 Comp	-	2019-Oct-1	G4-PW	14	**0.089**	0.084
G-5	G-5 Comp	-	2019-Oct-1	C3 CENTRE / G5-PW	6.4	**0.027**	0.025

Statistical Summary

	BOD	hydrogen sulfide	sulphide
Number of Results	9	9	9
Number of Detects	7	9	9
Minimum Concentration	<2	0.027	0.025
Minimum Detect	6.4	0.027	0.025
Maximum Concentration	31	0.22	0.21
Maximum Detect	31	0.22	0.21
Average Concentration	11	0.079	0.075
Median Concentration	8.5	0.069	0.065
Standard Deviation	9.3	0.062	0.059
Number of Guideline Exceedances	0	9	0
Number of Guideline Exceedances(Detects Only)	0	9	0

Standard/Guideline Descriptions

- ON PWQO:Ontario Provincial Water Quality Objectives, July 1994

APPENDIX E
BV Toxicity Report

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

SLR Consulting (Canada) Ltd.

Statistical Analysis
Benthic ID Contract 2019

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Page 215 of 443

TABLE OF CONTENTS

INTRODUCTION

DEFINITIONS

Morisita Horn Similarity Index: A measure of how similar two communities are. The index ranges from 0 (no similarity) to 1 (perfect similarity). The index is calculated as follows:

$$C_D = \frac{2\sum_{i=1}^{S} x_i y_i}{(D_x + D_y)XY}$$

where, xi is the number of times a taxa is represented in the total X of sample 1, yi is the number of times a taxa is represented in the total Y of sample 2, Dx and Dy are the Simpson's Diversity index for samples 1 and 2 respectively, and S is the number of unique taxa.

Principal Components Analysis (PCA): A method to summarize the variance in a data set. PCA provides an overview of linear relationships between the sites, taxa, and explanatory variables (Buttigieg and Ramette 2014).

Rarefaction Curve: A plot of the number of taxa as a function of the number of individual samples.

Redundancy Analysis (RDA): A statistical method to extract and summarise variation in a data set of variables that can be explained by another set of explanatory variables (Gotelli and Colwell, Ch. 4). In this report, the explanatory variables are the data from the sediment analysis.

RDA first involves multiple linear regression on the response variables on multiple variables and the fitted values are then subjected to a principal components analysis (PCA) (Buttigieg and Ramette 2014).

OBJECTIVES

Entomogen Inc. was contracted by SLR Consulting (Canada) Ltd. to analyze benthic identification data. The objectives of this analysis are to (1) calculate the species richness, Shannon diversity, and Simpson diversity, (2) calculate the similarity between all possible pair-wise combinations of sites, and (3) identify whether data from the sediment sampling have a strong influence on the explained variance in the data set.

MATERIALS AND METHODS

SOFTWARE

Data were recorded and input into Microsoft Excel 2010 and imported into the statistical computing program R version 6.1 (R Core Team 2019). Various analyses were performed with the following packages all downloaded directly form R*: iNEXT*, *vegan*, *stats*, and *SpadeR*. Microsoft PowerPoint was utilized to prepare the figures.

DATA ANALYSIS

We calculated the Hilsenhoff biotic index (HBI), Simpons Diversity Index (1-D), Shannon-Weiner Diversity Index (H), Pielou's eveness (J'), % Chironomidae, and % Ephemeroptera, Plecoptera, Trichoptera (EPT). These equations are found in the Appendix.

We plotted the number of taxa as a function of the number of individuals for each site using the *iNEXT* package (Chao et al. 2016, Hsieh and Chao 2019). We calculated the abundance-based Hill numbers according to Chao et al. (2016) using the combined raw abundance data for all samples (A, B, C).

We calculated the Morisita-Horn indices using the *SpadeR* package using Hellinger-transformed abundance data (Chao et al. 2016). Hellinger transformation was computed with the *vegan* package (Oksanen et al. 2019). We further classified similarity indices as either very low (0.00 - 0.24), low (0.25 – 0.49), moderate (0.50 – 0.74), and high (0.75 – 1.00). These classifications determined the colour of the heat map.

Entomogen Inc. was provided sediment data from SLR Consulting (Canada) Ltd. A summary of these data are observed in Table 1.

Table 1. Summary of sediment grain size data.

Explanatory Variables	Units	Code
Misc. Inorganics		
Available (KCl) Total Kjeldahl Nitrogen	mg/kg	Nitrogen
Nutrients		
Available (KCl) Ammonia (N)	mg/kg	Ammonia
Available (NH4F) Phosphorus (P)	mg/kg	Phosphorus
Physical Properties		
% sand by hydrometer	%	Sand
% silt by hydrometer	%	Silt
Clay Content	%	Clay
Gravel	%	Gravel

We set out to test the hypothesis that the explanatory variables had a significant effect on the variance of the data set. We performed a redundancy analyses with the explanatory variables serving as the constrained variables. Raw abundance data were first Hellinger-transformed using the *vegan* package in R (Oksanen et al. 2019). Sites G1 and R1 were omitted from this analysis because sediment data was not recorded. Gravel was removed from the analysis since it was less than 2% for each site. Available (NH4F) Phosphorus (P) for site C1 West was reported as less than 1%. For the statistical analysis we set this value to zero.

RESULTS AND INTERPRETATIONS

We summarize the abundance-based hill numbers species richness (q = 0), Shannon diversity (q = 1) and Simpson diversity (q = 2) in Table 2. Site G4 was observed to have the highest species richness and site C5 the lowest (Table 2). Additional diversity measures and indices are presented in Table 3 (attached excel file).

Table 2. Summary of Abundance-Based Hill Numbers calculated using the *iNEXT* package.

Site	**Species Richness (q = 0)**	**Shannon Diversity (q = 1)**	**Simpson Diversity (q = 2)**
G1	8	4.832 ± 1.802	3.206 ± 1.237
C6 East/G7	14	5.058 ± 0.545	3.437 ± 0.372
C3 West	11	3.859 ± 0.612	2.668 ± 0.323
C4 West	13	3.410 ± 0.352	2.327 ± 0.186
G4	22	5.526 ± 0.821	3.093 ± 0.349
C5 East/G6	6	2.522 ± 0.193	1.990 ± 0.134
C1 West	12	2.600 ± 0.104	2.183 ± 0.043
R1	10	3.718 ± 0.393	2.601 ± 0.225
C3 Centre/G5	12	4.828 ± 0.594	3.294 ± 0.364

Table 3. Classical diversity measures, indices, % Chironomidae, and % EPT for each sample.

Page 221 of 443

The sample-based rarefaction curves are observed below in Figure 1. The *iNEXT* package interpolates the estimated species diversity given the number of sampled individuals. For example, if we sampled 250 taxa we would expect to identify ~ 20 taxa from site G4 but only 10 taxa from site C1 West. Site C1 West and C5 East/G6 are approaching their asymptote (Figure 1). Therefore, we would not expect to identify more than 6 taxa at site C5 East/G6 and 12 for C1 West. The other sites require more sampling to fully describe the diversity of the aquatic communities. This is noted by the upward trend in the extrapolation curves.

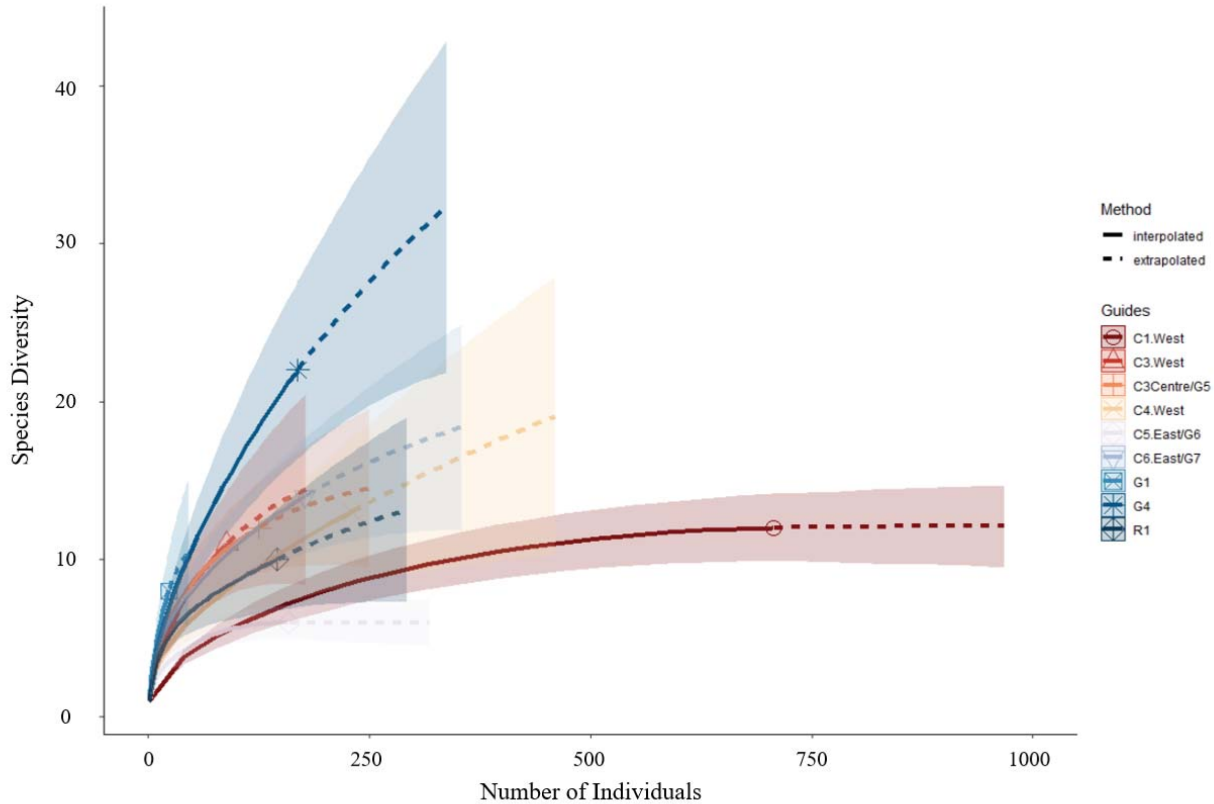

Figure 1. Sample based rarefaction curve. The shade regions represent the 95% CI.

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The Morisita Horn similarity indices and number of shared taxa for each pair of sites is presented in Figure 2. The top 3 similar site-pairs were (1) R1 & C6 East/G7, (2) R1 & C4 West, and (3) C4 West & C3 West. The top 3 dis-similar site-pairs were (1) C5 East/G6 & G1, (2) C4 West & G1, (3) and C6 East/G7 & G1 (Figure 2). G1 & C6 East/G7 and G1 and C5 East/G6 shared the least number of taxa (n=2) while C4 West & G4 shared the greatest (n=11) (Figure 2).

Morisita Horn Similarity Indices

Number of Shared Taxa

	G1	C6 East/G7	C3 West	C4 West	G4	C5 East/G6	C1 West	R1	C3 Centre/G5
G1	X	0.113	0.137	0.104	0.288	0.071	0.205	0.124	0.697
C6 East/G7	2	X	0.941	0.958	0.641	0.907	0.769	0.951	0.445
C3 West	3	6	X	0.964	0.788	0.835	0.926	0.999	0.601
C4 West	4	8	6	X	0.620	0.957	0.799	0.988	0.427
G4	4	9	8	11	X	0.422	0.942	0.714	0.895
C5 East/G6	2	4	5	3	5	X	0.611	0.891	0.235
C1 West	5	4	6	6	9	4	X	0.873	0.790
R1	3	6	5	7	8	3	5	X	0.530
C3 Centre/G5	5	5	5	8	8	3	6	7	X

Number of Shared Taxa	Morisita Horn Similarity Index	
10+	0.75 – 1.00	*High*
7 - 9	0.50 – 0.74	*Moderate*
3 - 6	0.25 – 0.49	*Low*
2	0.00 – 0.24	*Very Low*

Figure 2. Morisita Horn Similarity Indices and number of shared taxa among the sites.

We performed a redundancy analysis in R using the following model:

Model: rda(formula = Hellinger_abundance_data ~ Nitrogen + Ammonia + Phosphorus + Sand + Silt + Clay, data = data.slr)

We performed a permutation test with 999 permutations. We observed that a significant proportion of the variance was explained by the model ($F(6, 14) = 2.657$, $p < 0.001$). We performed additional permutation tests on the explanatory variables and axes. A summary of all permutational tests conducted is observed in Table 4. 53.2% of the variance was described by the explanatory variables and 46.8% of the variance was not explained.

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Table 4. Summary of permutational tests.

Variable	Variance	F statistic	P value
Model	0.136	2.657	< 0.001*
Nitrogen	0.041	4.850	0.004*
Ammonia	0.032	3.776	0.009*
Phosphorus	0.011	1.304	0.223
Sand	0.028	3.270	0.017
Silt	0.012	1.501	0.171
Clay	0.011	1.241	0.244
RDA1	0.081	9.6026	0.002*
RDA2	0.018	2.098	0.560
RDA3	0.014	1.623	0.694
RDA4	0.011	1.363	0.704

* Indicates significant results at the p = 0.05 level.

Trends in the variance of the data set are visualized in an ordination plot (Figure 3). The x-axis (RDA1) explained 60.2% of the total explained variance and the y-axis (RDA2) explained 13.2% of the total explained variance. The large cluster of taxa in the center of the plot means that these taxa are evenly dispersed among the sites. *Caecidotae* are strongly associated with sites G4, C4 West, and C3 Centre/G5. *Limnodrilus* are strongly associated with sites C5 East/G6 and C4 West. *Chironomus* are strongly associated with sites C3 West and C1 West. *Cryptochironomus* and Naididae: Tubificinae (immature without hairs) are associated with sites C6 East/G7 and C1 West.

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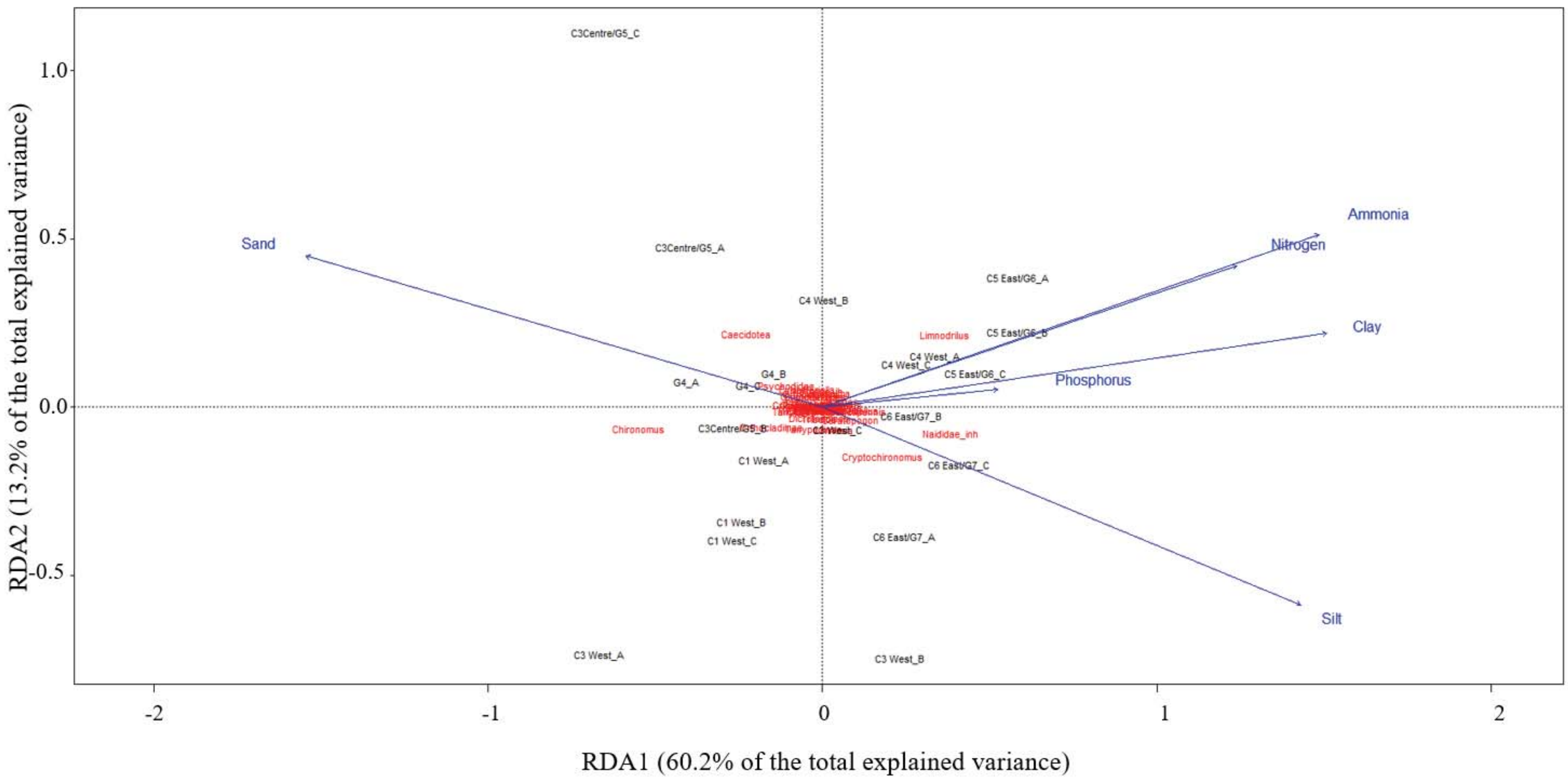

Figure 3. Ordination plot resulting from redundancy analysis (RDA).

Overall the model did not perform well. No single explanatory variable explained more than 5% of the variance (Table 4). Nitrogen, Ammonia, and the first axis were found to contribute to a significant proportion of the variance whereas all other variables were not significant (Table 4). We did not observe strong clustering among the sampling replicates (the A, B and C of each site). This indicates variation in the replicates (A, B, C) regarding both species diversity and abundance. We also observed a high proportion of variation not explained by the explanatory variables in our model (46.8%). These data together suggest that the sediment grain size data are not sufficient to describe variation in taxa at the sites and that other variables may be driving the system.

We performed an additional set of analyses where the A, B, C replicates were combined to yield the total abundance of each taxa. However, this data set did not yield a significant overall global permutation test result ($p > 0.05$).

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APPENDIX

Equations and Formulas

HBI= ∑(ni*ai)/N
n= number of specimens in taxa i
a= tolerance value of taxa i
N= total number of specimens in sample

Simpson's 1-D= 1- [∑n(n-1)/N(N-1)]
n= total number of individuals in each taxa
N= total number of individuals in all taxa

Shannon's H= -∑ [(pi)*ln(pi)]
pi= number of individuals of taxon i/ total # of organisms

J'= H'/H'max
H'= Shannon's index value
H'max= the maximum value for H' if species were perfectly distributed across the population = ln(S)
S= total richness

WOOD: Chedoke Creek, Aquatic Invertebrate Identifications 2018: Raw Data

Waterbody	G1			C6 East/G7			C3 West			C4 West			G4		
Station	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
DATE	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.
% Subsampled	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
TAXA LIST															
ACARIFORMES:															
HYDRYPHANTIDAE						1									
LIMNESIIDAE:															
Limnesia							2	1							1
ANNELIDA:HIRUDINIDA															
ERPOBDELLIDAE		1													
ANNELIDA:OLIGOCHAETA															
ENCHYTRAEIDAE:															
Lumbricillus			1												
NAIDIDAE:NAIDINAE						1									
Nais						1						2	1		
NAIDIDAE:TUBIFICINAE															
Immature with hairs					1					1					
Immature without hairs				10	27	48		34	13	47	9	86	11	16	8
Limnodrilus		2		6	8	9			2	10	8	11	2	9	2
CRUSTACEA:ISOPODA:															
ASELLIDAE:															
Caecidotea	6	2	4									1	1		2
INSECTA:															
DIPTERA:															
CERATOPOGONIDAE:															
Ceratopogon				2	1	2		1		1	1	2	1		
Culicoides															
CHIRONOMIDAE: CHIRONOMINAE:					3			1			1		2		
Chironomus			3	9	11	8	14	4	9	9	15	17	42	31	15
Cladopelma					1	1				1	2	2	2	2	2
Cladotanytarsus															1
Cryptochironomus				15	3	5	1	1							2
Dicrotendipes								1							
Glyptotendipes															
Microtendipes pedellus					1										
Phaenopsectra															1
Polypedilum													1		
Tanytarsus															
Tribelos								1							
CHIRONOMIDAE: ORTHOCLADIINAE:			2				2	1				1	1	2	2
Cricotopus bicinctus													1		
Eukiefferiella												1			1
Orthocladius															
CHIRONOMIDAE: TANYPODINAE:							1								
Procladius													1		
Tanypus neopunctipennis				1											
Tanypus						2								1	
CULICIDAE:															
Culex pipiens												1			
PSYCHODIDAE:													1		
Psychoda													1	1	
TIPULIDAE:															
Limonia															1
MOLLUSCA:BIVALVIA:															
PISIDIIDAE:		1													
MOLLUSCA:GASTROPODA:															
PHYSIDAE:															
Physella	1														
NEMATODA:										1			1		
Total Taxa	2	4	4	6	9	10	5	9	3	7	6	10	15	7	12
Total Specimens	7	6	10	43	56	78	20	45	24	70	36	124	69	62	38

WIlliam B. Morton
2018.10.05

WOOD: Chedoke Creek, Aquatic Invertebrate Identifications 2018: Raw Data

Waterbody	C5 East/G6			C1 West			R1			C3Centre/G5		
Station	A	B	C	A	B	C	A	B	C	A	B	C
DATE	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.	19.10.
% Subsampled	100	100	100	100	100	100	100	100	100	100	100	100
TAXA LIST												
ACARIFORMES:												
HYDRYPHANTIDAE												
LIMNESIIDAE:												
Limnesia		1	1									
ANNELIDA:HIRUDINIDA												
ERPOBDELLIDAE												1
ANNELIDA:OLIGOCHAETA												
ENCHYTRAEIDAE:												
Lumbricillus				2								
NAIDIDAE:NAIDINAE												
Nais								1				
NAIDIDAE:TUBIFICINAE												
Immature with hairs								5	2		1	
Immature without hairs	33	60	11	164	82	47	1	56	25	6	6	1
Limnodrilus	22	15	6	3	5	3		7	2	3	1	1
CRUSTACEA:ISOPODA:												
ASELLIDAE:												
Caecidotea				5			1			3		29
INSECTA:												
DIPTERA:												
CERATOPOGONIDAE:												
Ceratopogon												
Culicoides	2											
CHIRONOMIDAE: CHIRONOMINAE:								1	1		1	
Chironomus	2	1	2	156	134	88	14	11	11	24	15	20
Cladopelma												
Cladotanytarsus												
Cryptochironomus	2		1		1	1						
Dicrotendipes							1	2	3			
Glyptotendipes												1
Microtendipes pedellus												
Phaenopsectra												
Polypedilum								1				
Tanytarsus						1						
Tribelos												
CHIRONOMIDAE: ORTHOCLADIINAE:					4	2						4
Cricotopus bicinctus												
Eukiefferiella												2
Orthocladius												2
CHIRONOMIDAE: TANYPODINAE:						2						
Procladius												
Tanypus neopunctipennis												
Tanypus												
CULICIDAE:												
Culex pipiens												
PSYCHODIDAE:				1	1	1	1			1		3
Psychoda					1	1						
TIPULIDAE:												
Limonia												
MOLLUSCA:BIVALVIA:												
PISIDIIDAE:												
MOLLUSCA:GASTROPODA:												
PHYSIDAE:												
Physella												
NEMATODA:				1	1							
Total Taxa	5	4	5	7	8	9	5	8	6	5	5	10
Total Specimens	61	77	21	332	229	146	18	84	44	37	24	64

WIlliam B. Morton
2018.10.05

WOOD: Chedoke Creek, Aquatic Invertebrate Identifications 2018: Raw Data

	Tolerance Values (for HBI)
TAXA LIST	
ACARIFORMES:	
HYDRYPHANTIDAE	6
LIMNESIIDAE:	
Limnesia	6
ANNELIDA:HIRUDINIDA	
ERPOBDELLIDAE	8
ANNELIDA:OLIGOCHAETA	
ENCHYTRAEIDAE:	
Lumbricillus	10
NAIDIDAE:NAIDINAE	8
Nais	8
NAIDIDAE:TUBIFICINAE	
Immature with hairs	10
Immature without hairs	10
Limnodrilus	10
CRUSTACEA:ISOPODA:	
ASELLIDAE:	
Caecidotea	8
INSECTA:	
DIPTERA:	
CERATOPOGONIDAE:	
Ceratopogon	6
Culicoides	10
CHIRONOMIDAE: CHIRONOMINAE	6
Chironomus	10
Cladopelma	9
Cladotanytarsus	5
Cryptochironomus	8
Dicrotendipes	8
Glyptotendipes	10
Microtendipes pedellus	6
Phaenopsectra	7
Polypedilum	6
Tanytarsus	6
Tribelos	7
CHIRONOMIDAE: ORTHOCLADIIN/	5
Cricotopus bicinctus	7
Eukiefferiella	4
Orthocladius	6
CHIRONOMIDAE: TANYPODINAE:	7
Procladius	9
Tanypus neopunctipennis	10
Tanypus	10
CULICIDAE:	
Culex pipiens	8
PSYCHODIDAE:	10
Psychoda	10
TIPULIDAE:	
Limonia	6
MOLLUSCA:BIVALVIA:	
PISIDIIDAE:	6
MOLLUSCA:GASTROPODA:	
PHYSIDAE:	
Physella	8
NEMATODA:	8

WIlliam B. Morton
2018.10.05

Summary Statistics

Index	G1			C6 East/G7			C3 West		
	A	B	C	A	B	C	A	B	C
Hilsenhoff biotic index (HBI)	8.000	8.333	8.200	9.116	9.518	9.654	8.850	9.467	10.000
Species Richness (S)	2	4	4	6	9	10	5	9	3
Simpson's Diversity Index (1-D)	0.286	0.867	0.778	0.776	0.714	0.599	0.511	0.427	0.583
Shannon-Wiener Diversity index (H)	0.410	1.330	1.280	1.539	1.551	1.369	1.010	1.019	0.907
Pielou's evenness (J')	0.592	0.959	0.923	0.859	0.706	0.595	0.628	0.464	0.826
% Chironomidae	0.000	0.000	50.000	58.140	33.929	20.513	90.000	20.000	37.500
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

HBI= ∑(ni*ai)/N
n= number of specimens in taxa i
a= tolerance value of taxa i
N= total number of specimens in sample

Simpson's 1-D= 1- [∑n(n-1)/N(N-1)]
n= total number of individuals in each taxa
N= total number of individuals in all taxa

Shannon's H= -∑ [(pi)*ln(pi)]
pi= number of individuals of taxon i/ total # of organisms

J'= H'/H'max
H'= Shannon's index value

H'max= the maximum value for H' if species were perfectly distributed across the population = ln(S)
S= total richness

Summary Statistics

Index	C4 West A	C4 West B	C4 West C	G4 A	G4 B	G4 C	C5 East/G6 A	C5 East/G6 B	C5 East/G6 C
Hilsenhoff biotic index (HBI)	9.900	9.722	9.766	9.522	9.806	8.895	9.934	9.948	9.714
Species Richness (S)	7	6	10	15	7	12	5	4	5
Simpson's Diversity Index (1-D)	0.519	0.730	0.495	0.608	0.671	0.804	0.584	0.359	0.662
Shannon-Wiener Diversity index (H)	1.052	1.405	1.096	1.516	1.331	1.948	1.036	0.626	1.211
Pielou's evenness (J')	0.541	0.784	0.476	0.560	0.684	0.784	0.644	0.451	0.752
% Chironomidae	14.286	50.000	16.935	72.464	58.065	63.158	6.557	1.299	14.286
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

HBI= ∑(ni*ai)/N
n= number of specimens in taxa i
a= tolerance value of taxa i
N= total number of specimens in sample

Simpson's 1-D= 1- [∑n(n-1)/N(N-1)]
n= total number of individuals in each taxa
N= total number of individuals in all taxa

Shannon's H= -∑ [(pi)*ln(pi)]
pi= number of individuals of taxon i/ total # of organisms

J'= H'/H'max
H'= Shannon's index value

H'max= the maximum value for H' if species were perfectly distributed across the population = ln(S)
S= total richness

Summary Statistics

Index	C1 West A	C1 West B	C1 West C	R1 A	R1 B	R1 C	C3 Centre/G5 A	C3 Centre/G5 B	C3 Centre/G5 C
Hilsenhoff biotic index (HBI)	9.964	9.895	9.849	9.778	9.833	9.773	9.838	9.833	8.438
Species Richness (S)	7	8	9	5	8	6	5	5	10
Simpson's Diversity Index (1-D)	0.537	0.531	0.536	0.405	0.533	0.620	0.554	0.565	0.699
Shannon-Wiener Diversity index (H)	0.875	0.930	1.004	0.838	1.159	1.218	1.081	1.038	1.515
Pielou's evenness (J')	0.450	0.447	0.457	0.521	0.557	0.680	0.672	0.645	0.658
% Chironomidae	46.988	60.699	64.384	83.333	17.857	34.091	64.865	66.667	45.313
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

HBI= ∑(ni*ai)/N
n= number of specimens in taxa i
a= tolerance value of taxa i
N= total number of specimens in sample

Simpson's 1-D= 1- [∑n(n-1)/N(N-1)]
n= total number of individuals in each taxa
N= total number of individuals in all taxa

Shannon's H= -∑ [(pi)*ln(pi)]
pi= number of individuals of taxon i/ total # of organisms

J'= H'/H'max
H'= Shannon's index value

H'max= the maximum value for H' if species were perfectly distributed across the population = ln(S)
S= total richness

Site	G1			C6 East/G7			C3 West		
Index	A	B	C	A	B	C	A	B	C
Hilsenhoff biotic index (HBI)	8.000	8.333	8.200	9.116	9.518	9.654	8.850	9.467	10.000
Species Richness (S)	2	4	4	6	9	10	5	9	3
Simpson's Diversity Index (1-D)	0.286	0.867	0.778	0.776	0.714	0.599	0.511	0.427	0.583
Shannon-Wiener Diversity index (H)	0.410	1.330	1.280	1.539	1.551	1.369	1.010	1.019	0.907
Pielou's evenness (J')	0.592	0.959	0.923	0.859	0.706	0.595	0.628	0.464	0.826
% Chironomidae	0.000	0.000	50.000	58.140	33.929	20.513	90.000	20.000	37.500
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Site	C4 West			G4			C5 East/G6		
Index	A	B	C	A	B	C	A	B	C
Hilsenhoff biotic index (HBI)	9.900	9.722	9.766	9.522	9.806	8.895	9.934	9.948	9.714
Species Richness (S)	7	6	10	15	7	12	5	4	5
Simpson's Diversity Index (1-D)	0.519	0.730	0.495	0.608	0.671	0.804	0.584	0.359	0.662
Shannon-Wiener Diversity index (H)	1.052	1.405	1.096	1.516	1.331	1.948	1.036	0.626	1.211
Pielou's evenness (J')	0.541	0.784	0.476	0.560	0.684	0.784	0.644	0.451	0.752
% Chironomidae	14.286	50.000	16.935	72.464	58.065	63.158	6.557	1.299	14.286
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Site	C1 West			R1			C3 Centre/G5		
Index	A	B	C	A	B	C	A	B	C
Hilsenhoff biotic index (HBI)	9.964	9.895	9.849	9.778	9.833	9.773	9.838	9.833	8.438
Species Richness (S)	7	8	9	5	8	6	5	5	10
Simpson's Diversity Index (1-D)	0.537	0.531	0.536	0.405	0.533	0.620	0.554	0.565	0.699
Shannon-Wiener Diversity index (H)	0.875	0.930	1.004	0.838	1.159	1.218	1.081	1.038	1.515
Pielou's evenness (J')	0.450	0.447	0.457	0.521	0.557	0.680	0.672	0.645	0.658
% Chironomidae	46.988	60.699	64.384	83.333	17.857	34.091	64.865	66.667	45.313
% EPT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Page 239 of 443

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FRESHWATER SEDIMENT TOXICITY TESTING USING *CHIRONOMUS DILUTUS* AND *HYALELLA AZTECA*

Prepared for:

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Ecotoxicology Group
Bureau Veritas Laboratories

Job #: B985653
November 2019

EXECUTIVE SUMMARY

Freshwater sediment samples were collected between October 1st, 2019 and October 2nd, 2019 for testing. The samples arrived at Bureau Veritas Laboratories, in good condition, on October 3rd, 2019.

The following freshwater sediment toxicity tests were conducted on the samples; a 10 day survival and growth test with the freshwater midge, *Chironomus dilutus,* and a 14 day survival and growth test with the freshwater amphipod, *Hyalella azteca*.

All samples were initiated within their respective hold times with the *Chironomus* test ending on October 28, 2019 and the *Hyalella* test ending on October 31, 2019. The sample results were statistically assessed against the laboratory negative control for both the *Chironomus* test and the *Hyalella* test.

Details regarding the test results, methods, test conditions, organism acclimation, and quality control measures are summarised within the report. All tabulated data, raw data, and associated supporting documents are located within the report appendices.

Each test was considered valid as survival and growth in the negative control(s) met the validity criteria outlined in the associated reference methods.

TABLE OF CONTENTS

LIST OF TABLES

SECTION

1 SEDIMENT DESCRIPTION

1.1 Sample Information

Freshwater sediment samples were collected between October 1st, 2019 and October 2nd, 2019 for testing. The samples arrived at Bureau Veritas Laboratories, in good condition, on October 3rd, 2019.

Samples were collected separately for grain size, total organic carbon content, and moisture content. The data for these analyses were sent to the client directly and are not part of this report.

All tests were initiated within their respective hold times. Sample information, including sample descriptions, porewater ammonia analyses, and water quality data are located in Appendix A. Upon opening the sample containers, a description of each sample was recorded ("Sediment Sample Descriptions" in Appendix A).

Prior to testing, each sample was homogenized, using a stainless steel spoon. Any headspace in the sample container was purged with nitrogen gas prior to re-sealing it in order to prevent oxidation of the sediment during storage. When not in use, the sediments were stored in the dark at 4 ± 2°C.

1.2 Negative Control Sediment

The control sediment (negative control) for the toxicity tests was collected from Yaquina Bay, Newport, Oregon, by staff of Northwestern Aquatic Sciences. This beach sand has been used as a negative control in previous studies within our laboratory, and has been found to be non-toxic to a variety of organisms. It was wet sieved through 500 µm stainless steel mesh and thoroughly washed with the appropriate control water before use in the tests.

Table 1-1 Physiochemical Characterization of Yaquina Bay Beach Sand

Total Organic Carbon (mg/kg)	Moisture Content (%)	Sand (%)	Silt (%)	Clay (%)
<500	17	96	2.1	2.0

1.3 Porewater Characterization

On Day -1 of *Chironomus* testing, a seventh replicate of each sample was prepared, filled with reconstituted control water and aerated overnight, along with the test vessels. The following morning, the overlying water in the seventh replicate of each sample was decanted and aliquots of the sediment were distributed into 500 mL polycarbonate bottles. Nitrogen gas was placed over the sediments prior to centrifuging for 20 minutes at ~5,000 rpm. The resulting porewater was carefully decanted and analysed for ammonia, pH, and temperature.

Analysis of ammonia in porewater was performed at the Bureau Veritas Laboratories Inorganic Water Laboratory. The total ammonia concentrations as N (mg/L) in the samples, was measured under basic conditions using the Berthelot reaction in the presence of EDTA. A sample was treated sequentially until a blue indophenol complex formed, which could then be measured photometrically at 660 nm.

Results of the ammonia, temperature, and pH in porewater analyses for each of the test samples are available in Appendix A.

SECTION 2 10 DAY *CHIRONOMUS DILUTUS* SURVIVAL AND GROWTH TEST

2.1 Test Methods

The survival and growth of *Chironomus dilutus* larvae, when exposed to whole sediment samples for 10 days, was assessed according to the Bureau Veritas Laboratories Standard Operating Procedure: *Chironomus dilutus* 10-Day Survival and Growth Test (BBY2SOP-00010), which is based on the Environment Canada Biological Test Method: Test for Survival and Growth in Sediment Using the Larvae of Freshwater Midges (*Chironomus tentans* or *Chironomus riparius*) (EPS 1/RM/32).

One day prior to test initiation, the samples were homogenized, and a 100 mL aliquot was distributed into a 375 mL labelled test vessel including 2 additional replicates used for water quality and porewater measurements. Reconstituted moderately hard water was then slowly added to the vessel by pouring a stream of water onto a Plexiglas baffle to minimize disturbing the sediment layer. The test vessels were then randomized on the bench top, and airlines and lids were fitted to each test vessel.

The following day, aliquots of overlying water were removed from the test vessels for initial overlying water chemistry. The sixth replicate test vessel was used for water quality measurements for the duration of the test and the seventh replicate was decanted and centrifuged to extract porewater for ammonia, temperature, and pH measurements (see Section 1.3). To initiate the test, ten larval chironomids were randomly selected from their holding containers and directly seeded into the test vessels.

During the test, daily observations and aeration checks were performed. Temperature and dissolved oxygen measurements were taken three times per week in the test vessels designated for water quality measurements. Test vessels were also fed 3.75 mL Tetramin™ flakes, prepared as a 4 g dry solids/L slurry, on the days water quality measurements were taken.

At test termination, the contents of each test vessel were sieved through a 500 µm sieve in order to retrieve the live larval midges. The number of larvae found was recorded along with any other observations made. The organisms were then placed into pre-weighed aluminum weigh boats that were subsequently placed into a ~60°C drying oven for >24 hours. Missing chironomids were presumed to have died and decomposed during the test. Any larval midges that had reached the pupal or adult stage of development were excluded from the dry weight analysis, if applicable.

2.2 Organism Information

2.2.1 Organism Acclimation and Holding Information

One batch of laboratory-reared *Chironomus dilutus* larvae was received from Aquatic Biosystems on October 18, 2019. The midge larvae were shipped in 1L plastic containers filled with unbleached paper towels and overlying moderately hard water. Prior to shipping, the headspace in each container was filled with oxygen gas of a sufficient concentration to maintain adequate saturation levels in the shipping water. They were shipped directly for overnight delivery to Bureau Veritas Laboratories and arrived without incident.

Upon arrival at Bureau Veritas Laboratories, the water quality of the shipping water was measured and compared to the test conditions. Any moribund or deceased larvae were removed and recorded on the acclimation sheet, if applicable (Appendix B).

The chironomid larvae were not fed during the holding period as they were used the same day. Historically at Bureau Veritas Laboratories, it has been determined that little to no acclimation is required as long as the shipping, testing, and supplier laboratory conditions are similar.

2.2.2 Organism Health

The mortality rate during shipping did not exceed 10% overall. Bench sheets with the receiving water quality and observations of the number dead or inactive larvae are available in Appendix B.

2.2.3 Organism Age

At test initiation, 20 representative larvae were euthanized and their head capsule widths were measured to the nearest 0.01 mm, using an inverted microscope outfitted with an ocular micrometer. The average head capsule width of the organism batch was determined to be within the 0.33 – 0.45 mm range (see Table 2-1).

2.3 Test Conditions

See Table 2-1 for a detailed list of the test conditions. All bench sheets used to record raw data are available in Appendix B.

Table 2-1 Test Conditions for the 10-day *Chironomus dilutus* Test

Parameter	Conditions and Methods
Test Type and Duration	10 Day, Static (non-renewal)
Temperature	Average daily temperature 23 ± 1 °C; instantaneous temperature 23 ± 3 °C.
Photoperiod and Light Intensity	16 hours light: 8 hours dark. Wide spectrum cool white fluorescent lights used to provide 602-818 lux.
Aeration	< 100 bubbles/ minute. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing.
Test Chamber	375 mL glass jars with plastic lids containing small opening for airline tubing.
Sediment Volume	100 mL of each homogenized field replicate (3-4 cm depth).
Porewater Water Quality	Temperature, pH, and ammonia.
Overlying Water Source and Volume	175 mL (~5-6 cm depth); Reconstituted Moderately Hard Water; warmed to 23 ± 1°C and aerated >24 hours before use.
Overlying Water Quality	Temperature, pH, dissolved oxygen, conductance, hardness, alkalinity, and ammonia measurements on Day 0 and Day 10 of the test. Temperature and dissolved oxygen were also measured three times weekly during the test.
Replicates	5 replicates per sample, plus 2 additional replicates for water quality measurements and porewater analyses.
Control Sediment (Negative Control)	Yaquina Bay Beach Sand, rinsed with control water and sieved through a 500 µm stainless steel mesh.
Reference Sediment	None
Feeding	3.75 mL Tetramin™ flakes as slurry (4g dry solids/L) per vessel, three times weekly.
Organisms/ replicate	10
Organism Source	Aquatic Biosystems, Fort Collins, Colorado.
Mortality during acclimation	0.0%
Mean Head capsule width and organism age	0.44 ± 0.10 mm; 3rd instar larval midges
Endpoints	Mean Survival and Mean Dry Weight
Test Validity Criteria	≥70% mean survival in the negative controls. >0.6 mg mean dry weight in the negative controls.
Statistical Software	CETIS™ version 1.9.2.4. Tidepool Scientific Software (Copyright 2009-2016).

2.4 Quality Assurance/Quality Control

2.4.1 Reference Toxicant Results

A 96 hour reference toxicant test, or positive control test, was conducted alongside the sediment test. The water-only test, using copper sulphate ($CuSO_4$), was initiated to aid in the assessment of organism sensitivity and the precision of the results. The resulting LC50 was then compared in a control chart against the results of previous tests. Table 2-2 summarises the result of the reference toxicant test.

The calculated LC50 for the reference toxicant test was within two standard deviations (95%) range of the historic mean LC50. This supports the assumption that the sensitivity of the organism batch was comparable to batches previously test in this laboratory.

A reference toxicant test is only one of the tools used to assess the health of an organism. Natural variability accounts for the spread in reference toxicant LC50s. The method used in preparing the control charts was based on from “Ecotoxicology Control Charting” (COR2WI-00002).

Table 2-2 Reference Toxicant Test Result for *Chironomus dilutus*

Organism Batch	Test Date	LC50 with 95% Confidence Limits (mg/L Cu^{2+})	Previous Mean with 2SD (mg/L Cu^{2+})
AB191118	2019 Oct 18	0.71 (0.47, 0.98)	0.70 (0.38, 1.3)

2.4.2 Test Validity Criteria

The test is considered to be acceptable if the mean percent survival in the negative control is ≥70%, and the mean dry weight is ≥ 0.6 mg. The mean percent survival of the negative controls was 96%, and the mean dry weight was 1.67 mg.

2.5 Results

Total survival and dry weights in each replicate, and mean ± standard deviation (SD) in the control and test sediments are listed in the “*Chironomus dilutus* Survival and Growth Test - Survival of Larvae” and the “Chironomid Survival and Growth Test - Dry Weights of Larvae” data sheets, respectively. A summary of the test results is presented in Table 2-3.

Total ammonia concentrations, pH, temperature, dissolved oxygen, hardness, conductance, and alkalinity measurements of the overlying water at test initiation (Day 0) and completion (Day 10) are available in Appendix B.

2.5.1 Data Analysis

The survival and dry weight data for both the samples and the negative control were entered into the statistical program "Comprehensive Environmental Toxicity Information System" (CETIS™, 2009-2016). When determining the appropriate comparison tests to use, the Environment Canada "Guidance Document on Statistical Methods for Environmental Toxicity Tests" (EPS 1/RM/46, 2005) was followed.

See the CETIS™ Analytical Reports for information on the specific tests used for the mean survival and dry weight comparisons. Analyses between the negative control and samples were conducted as one-tailed comparisons. All analyses were done with the decision level for determining statistical significance set to 0.05 (p value <0.05). No significant difference between the samples versus the negative control was observed.

Table 2-3 Results for Mean *Chironomus dilutus* Survival and Growth

Sample ID	Mean Survival ± SD (%)	Mean Dry Weight ± SD (mg)
Negative Control	96 ± 5	1.67 ± 0.21
C6 East / G7	94 ± 13	2.45 ± 0.26
C5 East / G6	90 ± 10	2.34 ± 0.37
C4 West	78 ± 8	1.94 ± 0.36
C3 West	94 ± 9	2.47 ± 0.29
C3 Centre / G5	86 ± 11	2.53 ± 0.26
G4	84 ± 5	2.49 ± 0.34
C1 West	80 ± 23	2.47 ± 0.38

SD = Standard Deviation

2.6 Deviations and Observations

At test end, one pupated organism was found in replicate C of sample C6 East/G7, replicates A, B & D for sample C3 Centre/G5, and replicate E of sample G4. Pupated organisms were not included in mean dry weight analysis. A strong odour was noted in all replicates of the C4 West sample.

SECTION

3 14 DAY *HYALELLA AZTECA* SURVIVAL AND GROWTH TEST

3.1 Test Methods

The survival and growth of the freshwater amphipod, *Hyalella azteca*, when exposed to whole sediment samples for 14 days, were assessed according to the Bureau Veritas Laboratories SOP: *Hyalella azteca* 14-Day Survival and Growth Test (BBY2SOP-00011), which is based on the Environment Canada Biological Test Method: Test for Survival and Growth in Sediment and Water Using the Freshwater Amphipod *Hyalella azteca* (EPS 1/RM/33).

One day prior to test initiation, the samples were homogenised, and a 100 mL aliquot was distributed into a 375 mL labelled test vessel. A 100 mL portion of the sample was distributed into a sixth replicate test vessel used for water quality measurements. Reconstituted moderately hard water was then slowly added to the vessel by pouring a stream of water onto a Plexiglas baffle to minimize disturbing the sediment layer. The test vessels were then randomized on the bench top, and airlines and lids were fitted to each test vessel.

The following day, aliquots of overlying water were removed from the test vessels for initial overlying water chemistry. The sixth replicate test vessel was used for water quality measurements for the duration of the test. To initiate the test, the amphipods were removed from their holding containers and ten *Hyalella* were randomly selected and placed into plastic cups containing control water. Once enough organisms were collected to start the test, they were seeded into the test vessels.

During the test, daily observations and aeration checks were performed. Temperature and dissolved oxygen measurements were taken three times per week in the test vessel designated for water quality measurements. Test vessels were also fed 340 µL per replicate of a ground Tetramin™ flake slurry (4 g dry solids/L) and 0.75 mL YCT (yeast, alfalfa flakes, and digested trout chow) daily.

At test termination, the contents of each test vessel were examined, a small portion at a time, in a glass pan on a light table. The live amphipods were collected and counted. The amphipods were then placed into aluminum foil weigh boats that were subsequently placed into a ~60°C drying oven for >24 hours. Missing amphipods were presumed to have died and decomposed during the test.

3.2 Organism Information

3.2.1 Acclimation and Holding Information

One batch of *Hyalella azteca* was received from Aquatic Biosystems, Fort Collins, Colorado, USA, on October 15, 2019. Laboratory reared juvenile amphipods were packed into 1L plastic containers, filled with moderately hard water and a few plastic mesh squares. Prior to shipping, the headspace in each container was filled with oxygen gas of a sufficient concentration to maintain adequate saturation levels in the shipping water. They were shipped directly for overnight delivery to Bureau Veritas Laboratories and arrived without incident.

Upon arrival at Bureau Veritas Laboratories, the container contents were carefully poured into glass culture dishes. Gentle aeration was supplied to each culture pan. An aliquot of shipping water from each container was set aside for water quality. It was then ensured that temperature adjustments to the holding water of the amphipods did not exceed 3°C per day.

The organisms were held at Bureau Veritas Laboratories for four days before the test was initiated. The amphipods were fed YCT and Tetramin™ slurry at organism arrival and daily before test initiation. Datasheets containing the water quality measurements, with observations of number dead or inactive amphipods during the holding period, are available in Appendix C.

3.2.2 Organism Health

The average mortality rate in the culture did not exceed 10%.

3.2.3 Organism Age

At test initiation, the amphipods were 6-8 days old.

3.3 Test Conditions

See Table 3-1 for a detailed list of the test conditions. All bench sheets and raw data are available in Appendix C.

Table 3-1 Test Conditions for the 14-day *Hyalella azteca* Test

Parameter	Conditions and Methods
Test Type and Duration	14 Day; Static (non-renewal)
Temperature	Average daily temperature 23 ± 1 °C; instantaneous temperature 23 ± 3 °C.
Photoperiod and Light Intensity	16 hours light: 8 hours dark. Wide spectrum cool white fluorescent lights used to provide 602-818 lux.
Aeration	< 100 bubbles/ minute. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing.
Test Chamber	375 mL glass jars with plastic lids containing small opening for airline tubing.
Sediment Volume	100 mL of each homogenized field replicate (3-4 cm depth).
Overlying Water Volume and Source	175 mL (~5-6 cm depth); Reconstituted water; SAM5 recipe (Borgmann, 1996). Temperature adjusted and aerated >24h before use.
Overlying Water Quality	Temperature, pH, dissolved oxygen, conductance, hardness, alkalinity, and ammonia measurements on Day 0 and Day 14 of the test. Temperature and dissolved oxygen were also measured three times weekly during the test.
Feeding	340 µL of a ground Tetramin™ flake slurry (4g dry solids/mL) and 0.75 mL YCT per vessel, daily.
Replicates	5 replicates per sample, plus an additional replicate for water quality measurements.
Control Sediment	Yaquina Bay Beach Sand, rinsed with control water and sieved through a 500 µm stainless steel mesh.
Reference Sediment	None
Organisms/ Replicate	10
Organism Source and age	Aquatic Biosystems; amphipods aged 6-8 days at test start.
Mortality during acclimation	0.0%
Endpoints	Mean Survival and Mean Dry weight
Test Validity Criteria	≥ 80% mean survival in the controls. ≥0.1 mg/amphipod in the controls.
Statistical Software	CETIS™ version 1.9.2.4. Tidepool Scientific Software (Copyright 2009-2016).

3.4 Quality Assurance/Quality Control

3.4.1 Reference Toxicant Results

A 96 hour reference toxicant test, or positive control test, was conducted alongside the sediment test. The water-only test, using copper sulphate ($CuSO_4$) was initiated to aid in the assessment of organism sensitivity and the precision of the results. The reference toxicant test LC50 result was then compared in a control chart against the results of previous tests. Table 3-2 summarises the result of the reference toxicant test.

The calculated LC50 for the reference toxicant test was within two standard deviations (95%) range of the historic mean LC50. This supports the assumption that the sensitivity of the organism batch was comparable to batches previously test in this laboratory.

A reference toxicant test is only one of the tools used to assess the health of an organism. Natural variability accounts for the spread in reference toxicant LC50s. The method used in preparing the control charts was based on from “Ecotoxicology Control Charting” (COR2WI-00002).

Table 3-2 Reference Toxicant Test Results for *Hyalella azteca*

Organism Batch	Test Date	LC50 with 95% Confidence Limits (µg/L Cu^{2+})	Previous Mean with 2SD (µg/L Cu^{2+})
AB191015	2019 Oct 17	224 (185, 271)	228 (144, 361)

3.4.2 Test Validity Criteria

Survival data in the negative control is considered to be acceptable if the mean percent survival in the negative control is ≥80%, and the mean dry weight in the negative control is ≥0.1 mg/amphipod. The mean percent survival of the negative control was 98% and the mean dry weight was 0.1 mg/amphipod.

3.5 Results

Total survival and dry weights in each replicate, and mean ± standard deviation (SD) in the control and test sediments are listed in the “*Hyalella azteca* Survival and Growth Test-Survival” and “*Hyalella azteca* Survival and Growth Test- Dry Weights” data sheets, respectively. A summary of the results is located in Table 3-3.

Total ammonia concentrations, pH, temperature, dissolved oxygen, hardness, conductance, and alkalinity measurements in the overlying water at test initiation (Day 0) and completion (Day 14) are available in Appendix C.

3.5.1 Data Analysis

The survival and dry weight data for both the samples and the negative control were entered into the statistical program “Comprehensive Environmental Toxicity Information System” (CETIS™, 2009-2016). When determining the appropriate comparison tests to use, the Environment Canada “Guidance Document on Statistical Methods for Environmental Toxicity Tests” (EPS 1/RM/46, 2005) was followed.

See the CETIS™ Analytical Reports for information on the specific tests used for the mean survival and dry weight comparisons. Analyses between the control and samples were conducted as one-tailed comparisons. All analyses were done with the decision level for determining statistical significance set to 0.05 (p value <0.05).

Table 3-3 Results for Mean *Hyalella azteca* Survival and Growth

Sample ID	Mean Survival ± SD (%)	Mean Dry Weight ± SD (mg)
Negative Control	98 ± 4	0.14 ± 0.02
C6 East / G7	60 ± 19*	0.04 ± 0.02*
C5 East / G6	38 ± 23*	0.04 ± 0.02*
C4 West	2 ± 4*	0.06 ± N/A*
C3 West	48 ± 13*	0.03 ± 0.01*
C3 Centre / G5	86 ± 15	0.08 ± 0.01*
G4	64 ± 17*	0.05 ± 0.03*
C1 West	90 ± 17	0.10 ± 0.02*

SD = Standard Deviation N/A = Not Applicable

*Indicates a statistically significant decrease in the sample relative to negative control.

3.6 Deviations and Observations

Strong hydrocarbon order was noticed in all replicates of sample C4 West at test end.

SECTION 4 REFERENCES

Borgmann, U. 1996. Systematic Analysis of Aqueous Ion Requirements of *Hyalella azteca*: A Standard Artificial Medium Including the Essential Bromide Ion. Archives of Environmental Contamination and Toxicology. 30: 356-363.

Bureau Veritas Laboratories SOP for the *Chironomus dilutus* 10-Day Survival and Growth Test. BBY2SOP-00010.

Bureau Veritas Laboratories SOP for the *Hyalella azteca* 14-Day Survival and Growth Test. BBY2SOP-00011.

Bureau Veritas Laboratories WI for Ecotoxicology Control Charting. COR2 WI-00002.

Comprehensive Environmental Toxicity Information System (CETIS™). 2009-2016. Tidepool Scientific. LLC. Version 1.9.2.4

Environment Canada. 1997. Biological Test method: Test for Survival and Growth in Sediment of Freshwater Midges (*Chironomus tentans or Chironomus riparius*). Environmental Protection Publications, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/32.

Environment Canada. 2005. Guidance Document on Statistical Methods for Environmental Toxicity Tests. Environmental Protection Publications. Conservation and Protection. Ottawa, Ontario. EPS 1/RM/46.

Environment Canada. 2013. Biological Test method: Test for Survival and Growth in Sediment and Water Using the Freshwater Amphipod *Hyalella azteca*. Environmental Protection Publications, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/33.

APPENDICES

APPENDIX

A SAMPLE INFORMATION

Maxxam

ECOTOXICOLOGY
SEDIMENT SAMPLE DESCRIPTIONS

BBY2FCD-00136/3
Page 1 of 1

Client # / Name: 1776 SLR   Job #: B985653

Maxxam Sample Name	Sample #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed (e.g. rock, wood, plant, etc...)	Endemic Animals Removed	Odour	Additional Comments/Observations	Analyst
C6 EAST/G7	WQ6245	C6 EAST/G7	2019 OCT 16 2019 oct 17	muddy brown	NA	NA	Hydrocarbon like	NA	YS NS
C5 EAST/G6	WQ6246	C5 EAST/G6	2019 oct 16 2019 oct 17	Muddy Brown	n/a	n/a	were, DC 2019 oct 16 n/a	n/a	MIM NS
C4 WEST	WQ6247	C4 WEST	2019 OCT 16 2019 oct 17	muddy brown	NA	NA	Hydro-carbon like	NA	YS NS
C3 WEST	WQ6249	C3 WEST	2019 oct 16 2019 oct 17	Muddy Brown Bark	n/a	n/a	none	n/a	NS NS
C3 CENTRE/G5	WQ6250	C3 CENTRE/G5	2019 oct 16 2019 oct 17	muddy Brown Bark	n/a	n/a	Hydrocarbon-like		NS NS
G4	WQ6251	G4	2019 oct 16 2019 oct 17	muddy Brown	n/a	n/a	Hydrocarbon-like	n/a	NS NS
C1 WEST	WQ6252	C1 WEST	2019 oct 16 2019 oct 17	Muddy Brown	n/a	n/a	n/a	n/a	NS NS

DML 2019 Nov 06

Client Name: 1776 SLR CONSULTING   Date Measured: 2019 OCT 18

Method for Porewater Collection:
Collected sediments from vessels, spin in centrifudge bottle for 20 min at 5000 rpm. 4 °C
collected porewater for analysis afterwards

Sample ID	Temperature (°C)	pH	Ammonia (mg/L)
1776 Control	11.2	Ⓐ ~~7.7~~ 7.8	0.32
C4 West ✓	11.2	7.2	55
C5 EAST/G6 ✓	11.5	7.2	29
C3 West ✓	12.3	7.3	14
C3 Centre G5	11.2	7.4	1.3
C1 West ✓	12.1	7.7	0.64
G4 ✓	11.5	7.3	11
C6 EAST/G7 ✓	11.8	7.2	21
	DMC 2019 NOV 06		
Analyst	YS	YS	DMC
Date	2019 OCT 18	2019 OCT 18	2019 NOV 05

Comments:
Ⓐ WE, YS 2019 OCT 18

DMC 2019 NOV 06

BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9519		WS9520	WS9521	
Sampling Date		2019/10/18		2019/10/18	2019/10/18	
COC Number		18218		18218	18218	
	UNITS	1776 Control PW Chiron	RDL	1776 C6 East PW Chiron	1776 C5 East PW Chiron	RDL
Nutrients						
Total Ammonia (N)	mg/L	0.32	0.015	21 (1)	29 (1)	0.38

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WS9522		WS9523		WS9524	
Sampling Date		2019/10/18		2019/10/18		2019/10/18	
COC Number		18218		18218		18218	
	UNITS	1776 C4 West PW Chiron	RDL	1776 C3 West PW Chiron	RDL	1776 C3 Center PW Chiron	RDL
Nutrients							
Total Ammonia (N)	mg/L	55 (1)	0.75	14 (1)	0.15	1.3	0.015

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BUREAU VERITAS

BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9525		WS9526		WS9527	WS9528	
Sampling Date		2019/10/18		2019/10/18		2019/10/18	2019/10/18	
COC Number		18218		18218		18218	18218	
	UNITS	1776 G4 PW Chiron	RDL	1776 C1 West PW Chiron	RDL	1776 Control Overy Day 0 Chiron	1776 C6 East Overy Day 0 Chiron	RDL
Misc. Inorganics								
pH	pH					7.64	7.88	N/A
Anions								
Alkalinity (PP as CaCO3)	mg/L					<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L					60	97	1.0
Bicarbonate (HCO3)	mg/L					73	120	1.0
Carbonate (CO3)	mg/L					<1.0	<1.0	1.0
Hydroxide (OH)	mg/L					<1.0	<1.0	1.0
Nutrients								
Total Ammonia (N)	mg/L	11 (1)	0.15	0.64	0.015	0.074	0.13	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WS9529	WS9530	WS9531	WS9532	
Sampling Date		2019/10/18	2019/10/18	2019/10/18	2019/10/18	
COC Number		18218	18218	18218	18218	
	UNITS	1776 C5 East Overy Day 0 Chiron	1776 C4 West Overy Day 0 Chiron	1776 C3 West Overy Day 0 Chiron	1776 C3 Center Overy Day 0 Chiron	RDL
Misc. Inorganics						
pH	pH	7.99	7.99	8.01	7.93	N/A
Anions						
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	120	130	100	93	1.0
Bicarbonate (HCO3)	mg/L	150	160	120	110	1.0
Carbonate (CO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Nutrients						
Total Ammonia (N)	mg/L	0.32	1.3	0.48	0.17	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

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BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9533	WS9534	
Sampling Date		2019/10/18	2019/10/18	
COC Number		18218	18218	
	UNITS	1776 G4 Overy Day 0 Chiron	1776 C1 West Overy Day 0Chiron	RDL
Misc. Inorganics				
pH	pH	7.90	7.77	N/A
Anions				
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	100	93	1.0
Bicarbonate (HCO3)	mg/L	130	110	1.0
Carbonate (CO3)	mg/L	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	1.0
Nutrients				
Total Ammonia (N)	mg/L	0.14	0.11	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BUREAU VERITAS

BOD

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Toll Free (833)
Victoria: 460 Tennyson Place, Unit 1, Victoria, BC V8Z 6S8 Toll Free
bvlabs.com

B985653_COC

RECORD

G1-41143

Page 1 of 2

Invoice Information

Company: SLR Consulting
Contact Name: Celine Totman
Address: Suite 200 - 1620 West 8th Avenue PC: V6J 1V4
Phone/Fax: 604-318-5294
Email: ctotman@slrconsulting.com
Copies: Kimberley Tasker

Report Information (if differs from invoice)

Company:
Contact Name:
Address: PC:
Phone/Fax:
Email:
Copies:

Project #: 209.40606.00000
Site Location: Chedoke
Site #:
Sampled By: KAT

Turnaround Time (TAT) Required

☒ 5 - 7 Days Regular (Most analyses)

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ Same Day ☐ 2 Days
☐ 1 Day ☐ 3-4 Days

Date Required:
Rush Confirmation #:

Laboratory Use Only

	YES	NO	Cooler ID			
Seal Present		✓	Temp	3	4	3
Seal Intact		✓				
Cooling Media	✓					

2019/10/03

	YES	NO	Cooler ID			
Seal Present			Temp	5	6	5
Seal Intact						
Cooling Media						

	YES	NO	Cooler ID	Refer to ACTR		
Seal Present			Temp			
Seal Intact						
Cooling Media						

Depot Reception

BBY: SEE ACTR

Analysis Requested

☐ MTBE; ☐ BTEXS / VPH; ☐ VOC / BTEXS / VPH; ☐ BTEX F1; ☐ VOC / BTEX / F1; ☒ PAH; ☐ LEPH / HEPH / PAH; ☐ EPH; ☐ TEH; ☐ F2 - F4; ☐ Dissolved Metals; ☐ Filtered?; ☐ Preserved?; ☐ Dissolved Mercury; ☐ Filtered?; ☐ Preserved?; ☒ Total Metals; ☐ Field Preserved?; ☒ Total Mercury; ☐ Field Preserved?; ☐ Chloride; ☐ Fluoride; ☐ Sulphate; ☐ TSS; ☐ TDS; ☒ BOD; ☐ COD; ☒ pH; ☐ Conductivity; ☐ Alkalinity; ☐ Nitrite; ☐ Nitrate; ☐ Ammonia; TOXICITY; Hydrogen sulphide (porewater); MOISTURE; TOC; NUTRIENTS; HOLD - DO NOT ANALYZE

#	Sample Identification	Date Sampled (yyyy/mm/dd)	Time Sampled (hh:mm)	Matrix	# of Containers	PAH	Total Metals	Total Mercury	BOD	pH	TOXICITY	Hydrogen sulphide (porewater)	MOISTURE	TOC	NUTRIENTS	HOLD - DO NOT ANALYZE
1	Boat Launch	2019/10/01	09:20	Sediment	8	X	X	X	X	X		X	X	X	X	
2	C6 EAST / G7	2019/10/01	10:55	Sediment		X	X	X	X	X	X	X	X	X	X	
3	C5 EAST / G6	2019/10/01	13:35			X	X	X	X	X	X	X	X	X	X	
4	C4 WEST	2019/10/01	11:45			X	X	X	X	X	X	X	X	X	X	
5	Blind Duplicate	2019/10/01	09:30			X	X	X	X	X		X	X	X	X	
6	C3 WEST	2019/10/02	11:45			X	X	X	X	X	X	X	X	X	X	
7	C3 Centre / G5	2019/10/02	10:18			X	X	X	X	X	X	X	X	X	X	
8	G4	2019/10/02	12:50			X	X	X	X	X	X	X	X	X	X	
9	~~G1~~	2019/10/02														
10	C1 WEST	2019/10/02	16:20			X	X	X	X	X	X	X	X	X	X	

Regulatory Criteria

☐ BC CSR
☐ YK CSR
☒ CCME
☐ Drinking Water
☐ BC Water Quality
☒ Other Table Ontario Sediment standards

Special Instructions

BOD is porewater

~~HOLD Toxicity until Sediment quality is completed. SVA to confirm~~

03-Oct-19 16:09
Ronklin Gracian
B9R8283
WVL ENV-593

Unless otherwise agreed to in writing, work submitted on this Chain of Custody is subject to Bureau Veritas' standard Terms and Conditions. Signing of this Chain of Custody document is acknowledgement and acceptance of our terms which are :

Relinquished by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):	Received by: (Signature/ Print)	Date (yyyy/mm/dd):	Time (hh:mm):
Kimberley Tasker / KIMBERLEY TASKER	2019/10/03	16:10	COLENE CURITO	2019/10/03	16:09
			PEDRO TACK	2019/10/05	12:18

Bureau Veritas Shaping a World of Trust©

APPENDIX

B 10-DAY CHIRONOMUS DILUTUS SURVIVAL AND GROWTH TEST

CETIS Analytical Report

Report Date: 14 Nov-19 14:24 (p 1 of 2)
Test Code: CT-1776-0119 | 16-1846-9023

Chironomus 10-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	20-4584-5912	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:45	**Analysis:**	STP 2xK Contingency Tables	**Official Results:**	Yes
Batch ID:	02-9389-9538	**Test Type:**	Survival-AF Growth	**Analyst:**	
Start Date:	18 Oct-19 17:00	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	28 Oct-19 12:00	**Species:**	Chironomus dilutus	**Brine:**	Not Applicable
Duration:	9d 19h	**Source:**	Aquatic Biosystems, CO	**Age:**	

Fisher Exact/Bonferroni-Holm Test

Sample I	vs	Sample II	Test Stat	P-Type	P-Value	Decision(α:5%)
Control		C6 East / G7	0.5000	Exact	1.0000	Non-Significant Effect
		C5 East / G6	0.2180	Exact	0.6540	Non-Significant Effect
		C4 West	0.0073	Exact	0.0514	Non-Significant Effect
		C3 West	0.5000	Exact	1.0000	Non-Significant Effect
		C3 Centre / G5	0.0798	Exact	0.3190	Non-Significant Effect
		G4	0.0458	Exact	0.2291	Non-Significant Effect
		C1 West	0.0139	Exact	0.0832	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.142	3.036	0.0313	Outlier Detected

Data Summary

Sample	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
Control		48	2	50	0.96	0.04	0.0%
C6 East / G7		47	3	50	0.94	0.06	2.08%
C5 East / G6		45	5	50	0.9	0.1	6.25%
C4 West		39	11	50	0.78	0.22	18.75%
C3 West		47	3	50	0.94	0.06	2.08%
C3 Centre / G5		43	7	50	0.86	0.14	10.42%
G4		42	8	50	0.84	0.16	12.5%
C1 West		40	10	50	0.8	0.2	16.67%

Survival Rate Detail

Sample	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control		1.0000	1.0000	0.9000	0.9000	1.0000
C6 East / G7		1.0000	1.0000	1.0000	0.7000	1.0000
C5 East / G6		1.0000	0.8000	1.0000	0.9000	0.8000
C4 West		0.7000	0.8000	0.8000	0.7000	0.9000
C3 West		0.8000	0.9000	1.0000	1.0000	1.0000
C3 Centre / G5		0.9000	0.8000	1.0000	0.9000	0.7000
G4		0.8000	0.8000	0.8000	0.9000	0.9000
C1 West		0.8000	0.9000	0.4000	0.9000	1.0000

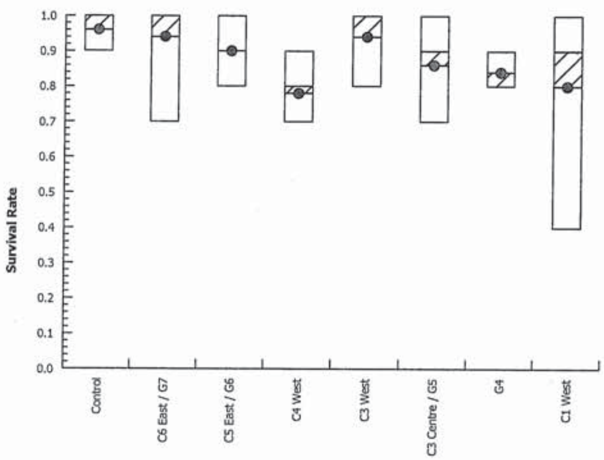
CETIS Analytical Report

Report Date: 14 Nov-19 14:24 (p 2 of 2)
Test Code: CT-1776-0119 | 16-1846-9023

Chironomus 10-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	20-4584-5912	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:45	**Analysis:**	STP 2xK Contingency Tables	**Official Results:**	Yes

Graphics



Analyst: DMC 2019 Nov14 QA: PH 2019Nov15

CETIS Analytical Report

Report Date: 14 Nov-19 14:24 (p 1 of 2)
Test Code: CT-1776-0119 | 16-1846-9023

Chironomus 10-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	01-3230-7964	**Endpoint:**	Mean Dry Weight	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:45	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	02-9389-9538	**Test Type:**	Survival-AF Growth	**Analyst:**	
Start Date:	18 Oct-19 17:00	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	28 Oct-19 12:00	**Species:**	Chironomus dilutus	**Brine:**	Not Applicable
Duration:	9d 19h	**Source:**	Aquatic Biosystems, CO	**Age:**	

Data Transform	Alt Hyp	Comparison Result	PMSD
Untransformed	C > T	C6 East / G7 passed mean dry weight	21.35%
		C5 East / G6 passed mean dry weight	21.35%
		C4 West passed mean dry weight	21.35%
		C3 West passed mean dry weight	21.35%
		C3 Centre / G5 passed mean dry weight	21.35%
		G4 passed mean dry weight	21.35%
		C1 West passed mean dry weight	21.35%

Equal Variance t Two-Sample Test

Sample I	vs	Sample II	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Control		C6 East / G7	-5.221	1.86	0.279	8	CDF	0.9996	Non-Significant Effect
		C5 East / G6	-3.559	1.86	0.349	8	CDF	0.9963	Non-Significant Effect
		C4 West	-1.476	1.86	0.344	8	CDF	0.9108	Non-Significant Effect
		C3 West	-5.066	1.86	0.295	8	CDF	0.9995	Non-Significant Effect
		C3 Centre / G5	-5.752	1.86	0.277	8	CDF	0.9998	Non-Significant Effect
		G4	-4.623	1.86	0.328	8	CDF	0.9991	Non-Significant Effect
		C1 West	-4.186	1.86	0.357	8	CDF	0.9985	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	1.708	3.036	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	3.46596	0.495138	7	5.064	6.0E-04	Significant Effect
Error	3.12858	0.0977682	32			
Total	6.59455		39			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	2.118	18.48	0.9530	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9594	0.9236	0.1599	Normal Distribution

Mean Dry Weight Summary

Sample	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control		5	1.672	1.417	1.927	1.633	1.399	1.957	0.09186	12.29%	0.00%
C6 East / G7		5	2.454	2.125	2.782	2.356	2.157	2.823	0.1184	10.79%	-46.80%
C5 East / G6		5	2.34	1.885	2.794	2.511	1.903	2.67	0.1637	15.64%	-39.96%
C4 West		5	1.945	1.498	2.391	2.031	1.544	2.423	0.1608	18.49%	-16.35%
C3 West		5	2.474	2.116	2.833	2.603	2.007	2.735	0.1291	11.67%	-48.02%
C3 Centre / G5		5	2.527	2.202	2.852	2.421	2.233	2.91	0.117	10.35%	-51.18%
G4		5	2.486	2.069	2.903	2.449	2.1	2.946	0.1503	13.52%	-48.71%
C1 West		5	2.475	2.007	2.943	2.47	1.999	2.959	0.1685	15.22%	-48.06%

Analyst: DWL 2019 Nov14 QA: PH 2019 NOV 15

CETIS Analytical Report

Report Date: 14 Nov-19 14:24 (p 2 of 2)
Test Code: CT-1776-0119 | 16-1846-9023

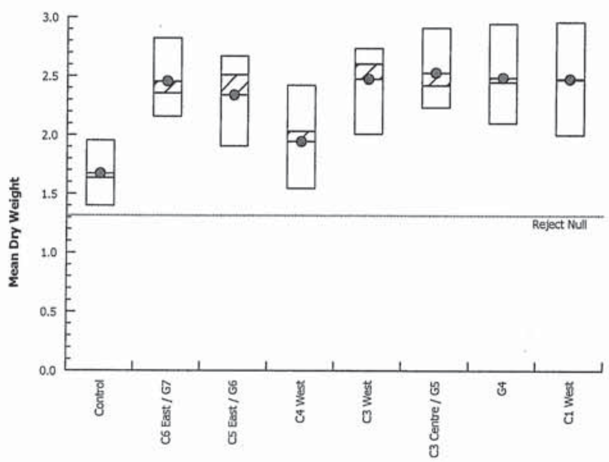
Chironomus 10-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

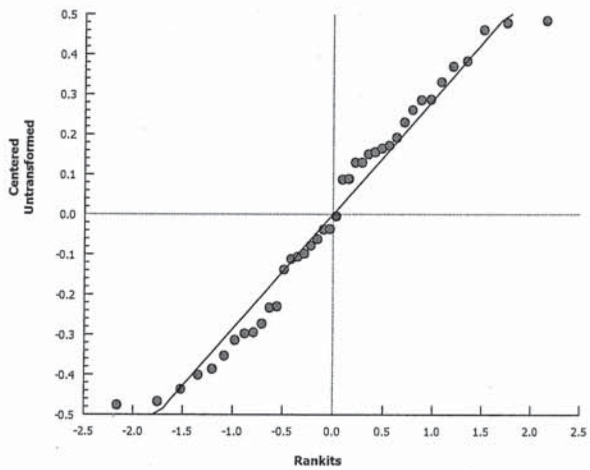
Analysis ID:	01-3230-7964	**Endpoint:**	Mean Dry Weight	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:45	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Mean Dry Weight Detail

Sample	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control		1.399	1.609	1.633	1.957	1.76
C6 East / G7		2.823	2.316	2.157	2.356	2.618
C5 East / G6		1.987	2.511	1.903	2.67	2.626
C4 West		2.423	2.095	2.031	1.544	1.631
C3 West		2.396	2.603	2.63	2.735	2.007
C3 Centre / G5		2.233	2.416	2.656	2.421	2.91
G4		2.1	2.946	2.678	2.449	2.256
C1 West		2.959	1.999	2.705	2.47	2.242

Graphics





ECOTOXICOLOGY

Chironomus dilutus Survival and Growth Test
Survival of Larvae

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BBY2FCD-00271/3
Page 1 of 1

Client # & Name: SLR
Job # B985653
Organism Lot #: AB191018
Start Date and Time: 2019 Oct 18
End Date: 2019 Oct 28

Analysts: P. Howes, S. Gupta, K. Tamaki, Y. Su

Sample	Rep	Initial # Larvae	Final # Larvae	% Survived	Survival Mean %	Survival SD %
Control	A	10	10	100	96	5
	B	10	10	100		
	C	10	9	90		
	D	10	9	90		
	E	10	10	100		
C6 East / G7	A	10	10	100	94	13
	B	10	10	100		
	C	10	10	100		
	D	10	7	70		
	E	10	10	100		
C5 East / G6	A	10	10	100	90	10
	B	10	8	80		
	C	10	10	100		
	D	10	9	90		
	E	10	8	80		
C4 West	A	10	7	70	78	8
	B	10	8	80		
	C	10	8	80		
	D	10	7	70		
	E	10	9	90		
C3 West	A	10	8	80	94	9
	B	10	9	90		
	C	10	10	100		
	D	10	10	100		
	E	10	10	100		
C3 Centre / G5	A	10	9	90	86	11
	B	10	8	80		
	C	10	10	100		
	D	10	9	90		
	E	10	7	70		
G4	A	10	8	80	84	5
	B	10	8	80		
	C	10	8	80		
	D	10	9	90		
	E	10	9	90		

ECOTOXICOLOGY

Chironomus dilutus Survival and Growth Test
Survival of Larvae

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BBY2FCD-00271/3
Page 1 of 1

Client # & Name: SLR
Job # B985653
Organism Lot #: AB191018
Start Date and Time: 2019 Oct 18
End Date: 2019 Oct 28

Analysts: P. Howes, S. Gupta, K. Tamaki, Y. Su

Sample	Rep	Initial # Larvae	Final # Larvae	% Survived	Survival Mean %	Survival SD %
C1 West	A	10	8	80	80	23
	B	10	9	90		
	C	10	4	40		
	D	10	9	90		
	E	10	10	100		

Proofed By: PHowes
2019Nov15

ECOTOXICOLOGY

Chironomid Survival and Growth Test
Dry Weights of Larvae

BBY2FCD-00231/3
Page 1 of 2

Client # & Name: 1776 SLR
Start Date and Time: 2019 OCT 18
Balance ID: BBY2-0260
End Date: 2019 OCT 28
Job # B985653
Weighing Dates: 2019 Oct 31
Drying Temperature (°C): 60
Drying Time (h) >24 h
Analyst(s): L. Nicholls D. Lai

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Worm Wt. (mg)	Mean Wt. /Worm (mg)	Mean Wt. /Sample (mg)	SD
556	CONTROL	A	10	1.10871	1.12270	13.99	1.40	1.67	0.21
557		B	10	1.09457	1.11066	16.09	1.61		
558		C	9	1.09082	1.10552	14.70	1.63		
559		D	9	1.09488	1.11249	17.61	1.96		
560		E	10	1.12393	1.14153	17.60	1.76		
561	C6 EAST/G7	A	10	1.10362	1.13185	28.23	2.82	2.45	0.26
562		B	10	1.12019	1.14335	23.16	2.32		
563		C*	9	1.11899	1.13840	19.41	2.16		
564		D	7	1.10809	1.12458	16.49	2.36		
565		E	10	1.10258	1.12876	26.18	2.62		
566	C5 EAST/G6	A	10	1.10960	1.12947	19.87	1.99	2.34	0.37
567		B	8	1.11065	1.13074	20.09	2.51		
568		C	10	1.11012	1.12915	19.03	1.90		
569		D	9	1.10493	1.12896	24.03	2.67		
570		E	8	1.09153	1.11254	21.01	2.63		
571	C4 WEST	A	7	1.10617	1.12313	16.96	2.42	1.94	0.36
572		B	8	1.10863	1.12539	16.76	2.09		
573		C	8	1.10503	1.12128	16.25	2.03		
574		D	7	1.11196	1.12277	10.81	1.54		
575		E	9	1.14219	1.15687	14.68	1.63		
576	C3 WEST	A	8	1.10191	1.12108	19.17	2.40	2.47	0.29
577		B	9	1.09426	1.11769	23.43	2.60		
578		C	10	1.10439	1.13069	26.30	2.63		
579		D	10	1.11424	1.14159	27.35	2.74		
580		E	10	1.11557	1.13564	20.07	2.01		
581	C3 CENTRE/G5	A*	8	1.10918	1.12704	17.86	2.23	2.53	0.26
582		B*	7	1.11818	1.13509	16.91	2.42		
583		C	10	1.11244	1.13900	26.56	2.66		
584		D*	8	1.10760	1.12697	19.37	2.42		
585		E	7	1.10960	1.12997	20.37	2.91		
		Analyst:		LN	DL				

The average dry weight for the replicate controls must be >0.6 mg, for the test to be valid.

Notes:*Pupated organism discovered at test end. Pupated organism removed from mean dry weight analysis.

ECOTOXICOLOGY

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Chironomid Survival and Growth Test
Dry Weights of Larvae

BBY2FCD-00231/3
Page 2 of 2

Client # & Name: 1776 SLR
Balance ID: BBY2-0260
Job # B985653
Drying Temperature (°C): 60
Analyst(s): L. Nicholls

Start Date and Time: 2019 OCT 18
End Date: 2019 OCT 28
Weighing Dates: 2019 Oct 31
Drying Time (h) >24 h

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Worm Wt. (mg)	Mean Wt. /Worm (mg)	Mean Wt. /Sample (mg)	SD
586	G4	A	8	1.09798	1.11478	16.80	2.10	2.49	0.34
587		B	8	1.09878	1.12235	23.57	2.95		
588		C	8	1.10970	1.13112	21.42	2.68		
589		D	9	1.11976	1.14180	22.04	2.45		
590		E*	8	1.13771	1.15576	18.05	2.26		
591	C1 WEST	A	8	1.10993	1.13360	23.67	2.96	2.47	0.38
592		B	9	1.13653	1.15452	17.99	2.00		
593		C	4	1.10844	1.11926	10.82	2.70		
594		D	9	1.11702	1.13925	22.23	2.47		
595		E	10	1.11038	1.13280	22.42	2.24		
596		QA/QC		1.10077	1.10079	-	-	-	-
597		QA/QC		1.11999	1.11993	-	-	-	-
586		0-A	8	1.09790	1.11458	16.68	-	-	-
		Analyst:		LN	DML				

The average dry weight for the replicate controls must be >0.6 mg, for the test to be valid.

Notes:*Pupated organism discovered at test end. Pupated organism removed from mean dry weight analysis.

Proofed By: RHawes
2019 Nov 15

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ECOTOXICOLOGY

BBY2FCD-00138/3

CHIRONOMUS DILUTUS SURVIVAL AND GROWTH TEST - TEST INFORMATION

Page 1 of 1

Client # & Name: 1776 SLR CONSULTING

Job #: B985653

Test Initiation Date & Time: October 18, 2019 @ 17:00 **Analyst:** YuSu

Test Completion Date: October 28, 2019

Analyst(s) - maintenance and test completion: Y. Su [illegible], [illegible], P. Howes, S. Gupta

Control Water Batch: 20191016

Control Sediment: yaquina sediment, 2019 OCT04

DMC 2019 Nov06

Organism Lot: AB191018 WE DMC 2019 Nov06

Age at Start of Test: ~~second star~~ 3rd instar

Feeding Regime: 3.75 mL Tetrafin slurry (4 g/L) per replicate 3x weekly

Food Preparation Date: 2019Oct18

Balance ID: BBY2-0260

Drying Oven ID: BBY2-0278

WQ Instrument ID: BBY2-0352, BBY2-0366

Additional Comments: NA

DMC 2019 Nov06

M Xam

ECOTOXICOLOGY
CHIRONOMID SURVIVAL AND GROWTH TEST – AERATION CHECKS

BBY2FCD-00137/2
Page 1 of 1

Client # & Name: 1776 SLR CONSULTING Start Date & Time: 2019 OCT 18

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day -1	Day 0	1	2	3	4	5	6	7	8	9	10
Date	2019 OCT 17	2019 OCT 18	2019 OCT 19	2019 Oct 20	2019 OCT 21	2019 OCT 22	2019 OCT 23	2019 OCT 24	2019 OCT 25	2019 OCT 26	2019 Oct 27	2019 OCT 28
Early AM	NA	YS	J	SG	J	YS	YS	YS	YS	YS	SG	YS
Mid-day	NA	YS	J	SG	J	YS	YS	YS	YS	YS	SG	NA
Late PM	YS	YS	J	SG	J	YS	YS	YS	YS	YS	SG	NA

Comments:

DMC 2019 Nov 06

ECOTOXICOLOGY

CHIRONOMUS DILUTUS TEST DATA SHEET

Sample ID: CONTROL

Sample Date: NA

Sample Received: NA

Start Date: 2019 OCT 18

End Date: 2019 OCT 28

Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.1	8.3	97	132	371	550	60	140	0.074	6.6

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	23.1	23.6	22.9	22.6	22.9
D.O. (mg/L)	8.2	8.6	8.8	8.3	8.6
Feeding	✓ KT	✓ J	✓	✓	
Analyst	YS	J	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	10	10	9	9	10
Analyst	PH	PH	PH	SG	SG

Date	Replicate	Comments	Analyst
		DML 2019 Nov 14	

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ECOTOXICOLOGY

***CHIRONOMUS DILUTUS* TEST DATA SHEET**

BBY2FCD-00140/3

Page 1 of 1

Sample ID: C6 EAST/G7

Sample Date: 2019 OCT 01 @ 10:55

Sample Received: 2019 OCT 23 @ 18:00

Start Date: 2019 OCT 18

End Date: 2019 OCT 28

Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.1	8.3	176	352	598	977	97	130	0.13	0.11

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	22.9	23.7	23.0	22.4	23.1
D.O. (mg/L)	8.3	8.6	8.7	8.6	8.5
Feeding	✓ KT	✓ Y	✓	✓	
Analyst	YS	Y	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	10	10	~~9~~ (A) 10	7	10
Analyst	KT	KT	KT	PH	KT

(A) WE KT 2019 Oct 28

Date	Replicate	Comments	Analyst
2019 Oct 28	C	1 pupated. Not included in weighboat	KT

DMC 2019 Nov 14

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ECOTOXICOLOGY
***CHIRONOMUS DILUTUS* TEST DATA SHEET**

BBY2FCD-00140/3
Page 1 of 1

Sample ID: C5 EAST/G6
Sample Date: 2019 OCT 01 @ 13:35
Sample Received: 2019 OCT 23 @ 18:00
Start Date: 2019 OCT 18
End Date: 2019 OCT 28
Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
7.9	8.1	199	256	677	913	120	97	0.32	0.10

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	23.0	23.6	22.8	22.6	23.0
D.O. (mg/L)	8.1	8.5	8.4	8.5	8.4
Feeding	✓ Kt	✓ Y	✓	✓	
Analyst	YS	Y	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	10	8	10	9	8
Analyst	Kt	SG	Kt	PH	SG.

Date	Replicate	Comments	Analyst
		DMC 2019 NOV 14	

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ECOTOXICOLOGY

***CHIRONOMUS DILUTUS* TEST DATA SHEET**

BBY2FCD-00140/3

Page 1 of 1

Sample ID: C4 WEST

Sample Date: 2019 OCT 01 @ 11:45

Sample Received: 2019 OCT 23 @ 18:00

Start Date: 2019 OCT 18

End Date: 2019 OCT 28

Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.2	8.2	197	264	662	854	80	110	1.3	0.12

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	22.9	23.6	23.2	22.7	22.9
D.O. (mg/L)	8.2	8.6	8.6	8.6	8.4
Feeding	✓ KT	✓ Y	✓	✓	
Analyst	YS	Y	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	7	8	8	7	9
Analyst	KT	PH	KT	PH	KT

Date	Replicate	Comments	Analyst
2019oct28	All	strong odour	PH

DML 2019 Nov 14

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ECOTOXICOLOGY
***CHIRONOMUS DILUTUS* TEST DATA SHEET**

Sample ID: C3 WEST
Sample Date: 2019 OCT 02 @ 11:45
Sample Received: 2019 OCT 23 @ 18:00
Start Date: 2019 OCT 18
End Date: 2019 OCT 28
Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.2	8.3	164	320	513	792	100	150	0.48	0.090

Initial overlying WQ measurements:	
Analyst YS	Date 2019OCT18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	22.9	23.6	23.3	22.9	22.9
D.O. (mg/L)	8.3	8.6	8.6	8.4	8.4
Feeding	✓ KT	✓ J	✓	✓	
Analyst	YS	J	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	8	9	10	10	10
Analyst	QG	YS	YS	KT	PH

Date	Replicate	Comments	Analyst
		DMU 2019 NOV14	

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ECOTOXICOLOGY

BBY2FCD-00140/3

CHIRONOMUS DILUTUS TEST DATA SHEET

Page 1 of 1

Sample ID:	C3 CENTRE/G5	**Start Date:**	2019 OCT 18
Sample Date:	2019 OCT 02 @ 10:18	**End Date:**	2019 OCT 28
Sample Received:	2019 OCT 23 @ 18:00	**Job/Sample #:**	B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.2	8.4	154	276	489	761	93	150	0.17	0.078

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	22.9	23.6	23.2	22.8	22.9
D.O. (mg/L)	8.3	8.6	8.7	8.5	8.4
Feeding	✓ KH	✓ J	✓	✓	
Analyst	YS	J	YS	YS	YS

Replicate	A	B *	C	D	E
# Surviving	9 *	8	10	9 *	7
Analyst	PH	YS	YS	KH	PH

Date	Replicate	Comments	Analyst
2019OCT28	D	1 pupated chironomid - not included in weighboat	KH
2019OCT28	B	1 pupated chironomid - not included in the weighboat	YS
2019Oct28	A	1 pupated chironomid, not included in weighboat	PH

DML 2019 Nov 14

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ECOTOXICOLOGY
CHIRONOMUS DILUTUS TEST DATA SHEET

BBY2FCD-00140/3
Page 1 of 1

Sample ID: G4
Sample Date: 2019 OCT 02 @ 12:50
Sample Received: 2019 OCT 23 @ 18:00
Start Date: 2019 OCT 18
End Date: 2019 OCT 28
Job/Sample #: B985653

Measurements						Samples Taken			
pH		Hardness ($mg/L\ CaCO_3$)		Conductance (µS/cm)		Alkalinity ($mg/L\ CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.1	8.3	161	797	507	8104	100	160	6.14	0.10

Initial overlying WQ measurements:	
Analyst YS	Date 2019 OCT 18

Final overlying WQ measurements:	
Analyst YS	Date 2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	23.1	23.6	23.4	22.9	22.9
D.O. (mg/L)	8.1	8.5	8.5	8.6	8.4
Feeding	✓ Kt	✓ J	✓	✓	
Analyst	YS	J	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	8	8	8	9	9
Analyst	Kt	YS	Kt	PH	Kt

Date	Replicate	Comments	Analyst
2019OCT28	E	1 pupated organism - Not included in weighboat	Kt

① ML 2019 Nov14

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ECOTOXICOLOGY

BBY2FCD-00140/3

CHIRONOMUS DILUTUS TEST DATA SHEET

Sample ID:	C1 WEST	**Start Date:**	2019 OCT 18
Sample Date:	2019 OCT 02 @ 16:20	**End Date:**	2019 OCT 28
Sample Received:	2019 OCT 23 @ 18:00	**Job/Sample #:**	B985653

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.0	8.4	181	312	627	1175	93	170	0.11	0.11

Initial overlying WQ measurements:			
Analyst	YS	Date	2019 OCT 18

Final overlying WQ measurements:			
Analyst	YS	Date	2019 OCT 28

Day	Friday Day 0	Monday Day 3	Wednesday Day 5	Friday Day 7	Monday Day 10
Temp. (ºC)	23.1	23.7	23.3	23.2	22.9
D.O. (mg/L)	7.8	8.5	8.6	8.5	8.4
Feeding	✓ Kt	✓ J	✓	✓	
Analyst	YS	J	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	8	9	4	9	10
Analyst	SG	Kt	SG	SG	YS

Date	Replicate	Comments	Analyst
2019 Oct 18	Measure	No of chironomids = 10 WB initial = 1.10328g	SG

JML
2019 Nov 14

ECOTOXICOLOGY

Reconstitued Water Recipe for Chironomus

Maxxam

BBY2FCD-00141/2
Page 1 of 1

BATCH ID : 2019 Oct 16
(Date Hardened)

Chironomus dilutus **H_2O Hardness Adjustment (Environment Canada 1997)**
(For water hardness 90 - 100 mg/L)

Chemical Weights	$CaCl_2X2H_2O$	$MgSO_4$ (g)	$CaSO_4$ (g)	$NaHCO_3$ (g)	KCl (g)
Brand	Fisher	Fisher	Alfa Aesar	Fisher	Fisher
Lot #	184678	183674	Q09E068	187508	172053
Calculated	3.97	1.80	3.00	5.76	0.24
Actual	3.9703	1.8000	3.0004	5.7602	0.2402

Balance ID: BBY2-0260
Analyst: G Mathesy
Add to Type 3 DI (L): 60
Water Use: 60L
DI Machine ID: BBY2-0160
Date: 2019 Oct 16

Water Quality:

Temp: 22.9
pH: 8.3
Hardness 100
Cond.: 361
DO: 8.4
Alkalinity:
Analyst: Y.Su
Date: 2019 OCT 17
Comments:

CaCl2 x 2H2O (Calcium Chloride - dihydrous)

MgSO4 (Magnesium Sulphate - anhydrous)

$CaSO_4$ (g) (Calcium Sulphate- anhydrous)

NaHCO3 (Sodium Bicarbonate)

KCl (Potassium Chloride)

Recipe: 0.45mM CaCl2: 0.37mM CaSO4: 0.25mM MgSO4: 1.14mM NaHCO3: 0.05mM KCl

ECOTOXICOLOGY

Chironomus dilutus (Formerly C. tentans)
Measurements of Head Capsule Widths

Maxxam
BBY2FCD-00247/1
Page 1 of 1

Client # & Name: SLR

Start Date and Time: 2019 Oct 18

End Date: 2019 Oct 28

Organism Lot #: AB191018

Head Widths at Beginning of Test

Chironomid #	Head Width (mm)
1	0.35
2	0.65
3	0.34
4	0.38
5	0.41
6	0.40
7	0.40
8	0.66
9	0.37
10	0.45
11	0.46
12	0.37
13	0.34
14	0.45
15	0.62
16	0.36
17	0.39
18	0.40
19	0.50
20	0.55
Average	0.44
SD	0.10
Analyst	DML

Average must be 0.33-0.45 mm (Environment Canada 1998)
1 mm=40 units on micrometer

ECOTOXICOLOGY

Chironomus dilutus (Formerly C. tentans) Measurements of Head Capsule Widths

Maxxam
BBY2FCD-00247/1
Page 1 of 1

Client # & Name: 1776, 254, 4737

Start Date and Time: 2019 Oct18

End Date: 2019 Oct28

Organism Lot #: AB191018

Head Widths at Beginning of Test

Chironomid #	Head Width (mm)
1	0.35
2	0.65
3	0.34
4	0.38
5	0.41
6	0.40
7	0.40
8	0.66
9	0.37
10	0.45
11	0.46
12	0.37
13	0.34
14	0.45
15	0.62
16	0.36
17	0.39
18	0.40
19	0.50
20	0.55
Average	#DIV/0!
SD	#DIV/0!
Analyst	DML

Average must be 0.33-0.45 mm (Environment Canada 1998)
1 mm=40 units on micrometer

1300 Blue Spruce Drive, Suite C
Fort Collins, Colorado 80524

AQUATIC BIO SYSTEMS ABS INC.

Toll Free: 800/331-5916
Tel:970/484-5091 Fax:970/484-2514

AB191018

ORGANISM HISTORY

1490 + 145 + 300

DATE: 10/17/2019

SPECIES: *Chironomus dilutus (formerly C. tentans)*

AGE: Deposited 10/7/2019

LIFE STAGE: Second Instar 10/16/2019

HATCH DATE: Emergent date 10/28/2019

BEGAN FEEDING: Immediately

FOOD: *Raphidocelis subcapitata*.*, Flake slurry

Water Chemistry Record:	**Current**	**Range**
TEMPERATURE:	24°C	24-26°C
SALINITY/CONDUCTIVITY:	--	--
TOTAL HARDNESS (as $CaCO_3$):	146 mg/l	100-180 mg/l
TOTAL ALKALINITY (as $CaCO_3$):	80 mg/l	50-90 mg/l
pH:	7.61	7.58-8.30

Comments: * Formerly known as *Psuedokirschneriella subcapitata* and *Selenastrum capricornutum*

Facility Supervisor

ECOTOXICOLOGY

ORGANISMS - ACCLIMATION AND HOLDING CONDITIONS

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BBY2FCD-00070/5

Page 1 of 1

Client #'s : 254/14737/1776

Date & Time of Arrival: 2019OCT18 @ 12:00

Organism Lot #: AB191018

Age upon Arrival: 3rd instar

Water (L) per Shipping Bag: 500 MP

Organism: Chironomus dilutus

Number of Shipping Bags: 11

#of Organisms Ordered: 1490+145+300

Light Intensity (lux): 602-818

Arrival Conditions

Bag ID	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
1	0	0	474	21.5	14.1	7.0		YS
2	0	0	471	21.7	19.1	7.0		YS
3	0	0	469	21.6	20.5	7.0		YS
4	0	0	475	~~475~~ 21.5	18.9	7.0		YS
5	0	0	470	21.5	14.2	7.0	N/A DMC 2019 Nov 04	YS
6	0	0	475	21.7	16.5	7.0		YS
7	0	0	475	21.8	13.8	7.0		YS
8	0	0	478	21.4	17.4	6.9		YS
9	0	0	470	21.9	19.4	7.0		YS
10	0	0	481	21.9	19.8	7.0		YS
11	0	0	519	21.8	19.0	7.0	NA	YS

Daily Conditions During Holding/Acclimation

Date	Mortalities		Water Quality					Analyst
	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	
Total Mortalities								

PH 2019 Oct 24

Equipment ID: BBY2-0408

Comments (e.g. feeding times and quantities; fish behaviour, acclimation conditions): Analyst

did water quality upon arrival. used shortly after DMC

DMC 2019 Nov 06

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ECOTOXICOLOGY

Randomization Chart

Tab: Sediment Tests

BBY2FCD-00438/2
Pg: 1 of 1

Test: CHIRONOMUS

Start Date: 2019 OCT 18

Client # & Name: 1776 SLR CONSULTING LTD

Back Wall		Position Map	
6	12	18	
5	11	17	
4	10	16	
3	9	15	
2	8	14	
1	7	13	etc.

Front of Counter

Position #	Sample ID	Replicate	Colour
35	CONTROL	A	Red
6		B	
40		C	
19		D	
14		E	
42		Measure	
33	C6 EAST/G7	A	Orange
37		B	
23		C	
7		D	
22		E	
24		Measure	
48	C5 EAST/G6	A	Yellow
10		B	
41		C	
21		D	
43		E	
9		Measure	
28	C4 WEST	A	Green
45		B	
8		C	
29		D	
3		E	
26		Measure	
11	C3 WEST	A	Dark Green
31		B	
38		C	
12		D	
30		E	
44		Measure	
20	C3CENTRE/G5	A	Blue
18		B	
27		C	
15		D	
46		E	
32		Measure	

Position #	Sample ID	Replicate	Colour
5	G4	A	Purple
13		B	
34		C	
16		D	
39		E	
1		Measure	
47	C1 WEST	A	Pink
4		B	
25		C	
36		D	
17		E	
2		Measure	
49		A	Light Blue
50		B	
51		C	
52		D	
53		E	
54		Measure	
55		A	Light Green
56		B	
57		C	
58		D	
59		E	
60		Measure	
61		A	Pink/Yellow
62		B	
63		C	
64		D	
65		E	
66		Measure	
67		A	Red/Green
68		B	
69		C	
70		D	
71		E	
72		Measure	

BUREAU VERITAS

BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9519		WS9520	WS9521	
Sampling Date		2019/10/18		2019/10/18	2019/10/18	
COC Number		18218		18218	18218	
	UNITS	**1776 Control PW Chiron**	**RDL**	**1776 C6 East PW Chiron**	**1776 C5 East PW Chiron**	**RDL**
Nutrients						
Total Ammonia (N)	mg/L	0.32	0.015	21 (1)	29 (1)	0.38

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WS9522		WS9523		WS9524	
Sampling Date		2019/10/18		2019/10/18		2019/10/18	
COC Number		18218		18218		18218	
	UNITS	**1776 C4 West PW Chiron**	**RDL**	**1776 C3 West PW Chiron**	**RDL**	**1776 C3 Center PW Chiron**	**RDL**
Nutrients							
Total Ammonia (N)	mg/L	55 (1)	0.75	14 (1)	0.15	1.3	0.015

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9525		WS9526		WS9527	WS9528	
Sampling Date		2019/10/18		2019/10/18		2019/10/18	2019/10/18	
COC Number		18218		18218		18218	18218	
	UNITS	1776 G4 PW Chiron	RDL	1776 C1 West PW Chiron	RDL	1776 Control Overy Day 0 Chiron	1776 C6 East Overy Day 0 Chiron	RDL
Misc. Inorganics								
pH	pH					7.64	7.88	N/A
Anions								
Alkalinity (PP as CaCO3)	mg/L					<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L					60	97	1.0
Bicarbonate (HCO3)	mg/L					73	120	1.0
Carbonate (CO3)	mg/L					<1.0	<1.0	1.0
Hydroxide (OH)	mg/L					<1.0	<1.0	1.0
Nutrients								
Total Ammonia (N)	mg/L	11 (1)	0.15	0.64	0.015	0.074	0.13	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WS9529	WS9530	WS9531	WS9532	
Sampling Date		2019/10/18	2019/10/18	2019/10/18	2019/10/18	
COC Number		18218	18218	18218	18218	
	UNITS	1776 C5 East Overy Day 0 Chiron	1776 C4 West Overy Day 0 Chiron	1776 C3 West Overy Day 0 Chiron	1776 C3 Center Overy Day 0 Chiron	RDL
Misc. Inorganics						
pH	pH	7.99	7.99	8.01	7.93	N/A
Anions						
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	120	130	100	93	1.0
Bicarbonate (HCO3)	mg/L	150	160	120	110	1.0
Carbonate (CO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Nutrients						
Total Ammonia (N)	mg/L	0.32	1.3	0.48	0.17	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BUREAU VERITAS

BV Labs Job #: B989884
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS9533	WS9534	
Sampling Date		2019/10/18	2019/10/18	
COC Number		18218	18218	
	UNITS	1776 G4 Overy Day 0 Chiron	1776 C1 West Overy Day 0Chiron	RDL
Misc. Inorganics				
pH	pH	7.90	7.77	N/A
Anions				
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	100	93	1.0
Bicarbonate (HCO3)	mg/L	130	110	1.0
Carbonate (CO3)	mg/L	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	1.0
Nutrients				
Total Ammonia (N)	mg/L	0.14	0.11	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

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BUREAU VERITAS

BV Labs Job #: B992765
Report Date: 2019/11/04

Bureau Veritas Laboratories (TOX Internal)
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WU6782		WU6783	WU6784	WU6785	
Sampling Date		2019/10/28		2019/10/28	2019/10/28	2019/10/28	
COC Number		18571		18571	18571	18571	
	UNITS	1776 Ch Day 10 Control	RDL	1776 Ch Day 10 C4 West	1776 Ch Day 10 C5 East/G6	1776 Ch Day 10 C3 West	RDL
Misc. Inorganics							
pH	pH	8.14	N/A	7.93	7.89	8.13	N/A
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	140	1.0	110	97	150	1.0
Bicarbonate (HCO3)	mg/L	180	1.0	130	120	190	1.0
Carbonate (CO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Nutrients							
Total Ammonia (N)	mg/L	6.6 (1)	0.075	0.12	0.10	0.090	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WU6786	WU6787	WU6788	WU6789	
Sampling Date		2019/10/28	2019/10/28	2019/10/28	2019/10/28	
COC Number		18571	18571	18571	18571	
	UNITS	1776 Ch Day 10 C3 Centre G5	1776 Ch Day 10 C1 West	1776 Ch Day 10 G4	1776 Ch Day 10 C6EAST/G7	RDL
Misc. Inorganics						
pH	pH	8.19	8.19	8.16	8.09	N/A
Anions						
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	150	170	160	130	1.0
Bicarbonate (HCO3)	mg/L	190	200	190	160	1.0
Carbonate (CO3)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Nutrients						
Total Ammonia (N)	mg/L	0.078	0.11	0.10	0.11	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

APPENDIX

C 14-DAY *HYALELLA AZTECA* SURVIVAL AND GROWTH TEST

CETIS Analytical Report

Report Date: 14 Nov-19 11:43 (p 1 of 2)
Test Code: HA-1776-0119 | 03-5566-2885

Hyalella 14-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	08-9493-9909	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:43	**Analysis:**	STP 2xK Contingency Tables	**Official Results:**	Yes
Batch ID:	16-9287-0172	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	17 Oct-19 16:34	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	31 Oct-19 12:00	**Species:**	Hyalella azteca	**Brine:**	Not Applicable
Duration:	13d 19h	**Source:**	Aquatic Biosystems, CO	**Age:**	

Fisher Exact/Bonferroni-Holm Test

Sample I	vs	Sample II	Test Stat	P-Type	P-Value	Decision(α:5%)
Control		C6 East / G7*	0.0000	Exact	4.7E-06	Significant Effect
		C5 East / G6*	0.0000	Exact	6.5E-11	Significant Effect
		C4 West*	0.0000	Exact	1.7E-25	Significant Effect
		C3 West*	0.0000	Exact	1.6E-08	Significant Effect
		C3 Centre / G5	0.0297	Exact	0.0594	Non-Significant Effect
		G4*	0.0000	Exact	2.1E-05	Significant Effect
		C1 West	0.1022	Exact	0.1022	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.899	3.036	0.0882	No Outliers Detected

Data Summary

Sample	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
Control		49	1	50	0.98	0.02	0.0%
C6 East / G7		30	20	50	0.6	0.4	38.78%
C5 East / G6		19	31	50	0.38	0.62	61.22%
C4 West		1	49	50	0.02	0.98	97.96%
C3 West		24	26	50	0.48	0.52	51.02%
C3 Centre / G5		43	7	50	0.86	0.14	12.24%
G4		32	18	50	0.64	0.36	34.69%
C1 West		45	5	50	0.9	0.1	8.16%

Survival Rate Detail

Sample	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control		1.0000	1.0000	1.0000	1.0000	0.9000
C6 East / G7		0.5000	0.5000	0.8000	0.4000	0.8000
C5 East / G6		0.5000	0.4000	0.4000	0.6000	0.0000
C4 West		0.0000	0.0000	0.0000	0.0000	0.1000
C3 West		0.5000	0.7000	0.4000	0.4000	0.4000
C3 Centre / G5		0.9000	1.0000	0.9000	0.6000	0.9000
G4		0.6000	0.8000	0.6000	0.8000	0.4000
C1 West		0.9000	1.0000	1.0000	1.0000	0.6000

DML 2019 Nov14 — 2019 Nov15 PH

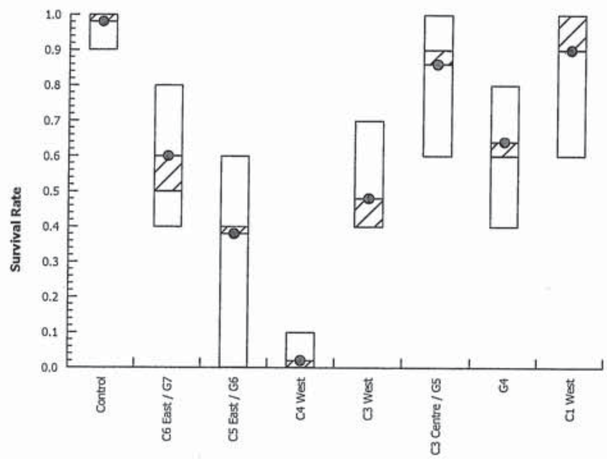
CETIS Analytical Report

Report Date: 14 Nov-19 11:43 (p 2 of 2)
Test Code: HA-1776-0119 | 03-5566-2885

Hyalella 14-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	08-9493-9909	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:43	**Analysis:**	STP 2xK Contingency Tables	**Official Results:**	Yes

Graphics



Analyst: DMC 2019 Nov14 QA: PH 2019 Nov15

CETIS Analytical Report

Report Date: 14 Nov-19 11:43 (p 1 of 2)
Test Code: HA-1776-0119 | 03-5566-2885

Hyalella 14-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

Analysis ID:	14-4476-8468	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:43	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Batch ID:	16-9287-0172	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	17 Oct-19 16:34	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	31 Oct-19 12:00	**Species:**	Hyalella azteca	**Brine:**	Not Applicable
Duration:	13d 19h	**Source:**	Aquatic Biosystems, CO	**Age:**	

Data Transform	Alt Hyp	Comparison Result	PMSD
Untransformed	C > T	C6 East / G7 failed mean dry weight-mg	14.18%
		C5 East / G6 failed mean dry weight-mg	14.18%
		C4 West failed mean dry weight-mg	14.18%
		C3 West failed mean dry weight-mg	14.18%
		C3 Centre / G5 failed mean dry weight-mg	14.18%
		G4 failed mean dry weight-mg	14.18%
		C1 West failed mean dry weight-mg	14.18%

Equal Variance t Two-Sample Test

Sample I	vs	Sample II	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Control		C6 East / G7*	9.529	1.86	0.019	8	CDF	6.1E-06	Significant Effect
		C5 East / G6*	8.422	1.895	0.022	7	CDF	3.3E-05	Significant Effect
		C4 West*	4.297	2.132	0.040	4	CDF	0.0063	Significant Effect
		C3 West*	13.48	1.86	0.015	8	CDF	4.4E-07	Significant Effect
		C3 Centre / G5*	7.181	1.86	0.017	8	CDF	4.7E-05	Significant Effect
		G4*	6.139	1.86	0.027	8	CDF	1.4E-04	Significant Effect
		C1 West*	3.64	1.86	0.020	8	CDF	0.0033	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.971	2.978	0.0516	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0472032	0.0067433	7	23.34	<1.0E-37	Significant Effect
Error	0.0078016	0.0002889	27			
Total	0.0550048		34			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Levene Equality of Variance Test	1.253	3.388	0.3101	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9727	0.9146	0.5210	Normal Distribution

Mean Dry Weight-mg Summary

Sample	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control		5	0.1415	0.12	0.163	0.134	0.1256	0.166	0.007743	12.24%	0.00%
C6 East / G7		5	0.04305	0.02406	0.06204	0.045	0.024	0.06	0.006841	35.53%	69.58%
C5 East / G6		4	0.04383	0.01638	0.07129	0.04667	0.022	0.06	0.008627	39.36%	69.02%
C4 West		1	0.06			0.06	0.06	0.06	0	0.00%	57.60%
C3 West		5	0.02939	0.02093	0.03784	0.028	0.0225	0.04	0.003045	23.17%	79.23%
C3 Centre / G5		5	0.07627	0.06307	0.08947	0.08167	0.05889	0.08444	0.004754	13.94%	46.11%
G4		5	0.0525	0.01846	0.08654	0.05	0.02333	0.0975	0.01226	52.21%	62.90%
C1 West		5	0.1022	0.08135	0.1231	0.09667	0.08444	0.121	0.007518	16.45%	27.76%

CETIS Analytical Report

Report Date: 14 Nov-19 11:43 (p 2 of 2)
Test Code: HA-1776-0119 | 03-5566-2885

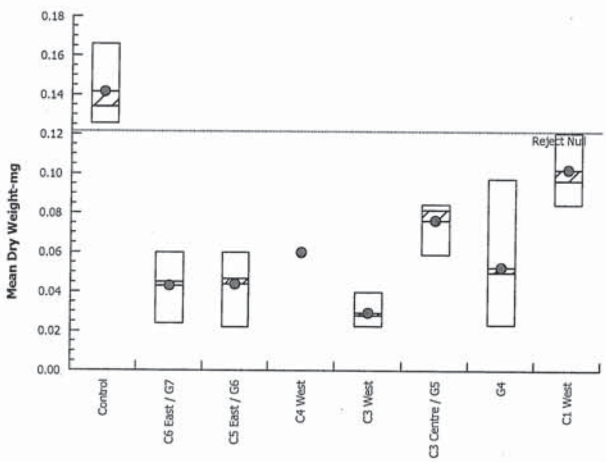
Hyalella 14-d Survival and Growth Sediment Test — **Bureau Veritas Laboratories**

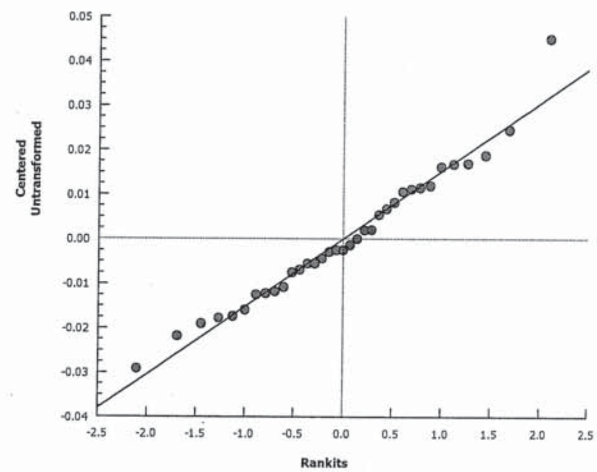
Analysis ID:	14-4476-8468	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.9.2
Analyzed:	14 Nov-19 11:43	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Mean Dry Weight-mg Detail

Sample	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control		0.129	0.153	0.166	0.134	0.1256
C6 East / G7		0.024	0.06	0.03125	0.055	0.045
C5 East / G6		0.022	0.055	0.06	0.03833	
C4 West		0.06				
C3 West		0.028	0.03143	0.04	0.025	0.0225
C3 Centre / G5		0.07333	0.083	0.05889	0.08167	0.08444
G4		0.04167	0.05	0.02333	0.05	0.0975
C1 West		0.08444	0.119	0.121	0.09	0.09667

Graphics





Analyst: DMC 2019 Nov14 QA: PH 2019Nov15

ECOTOXICOLOGY

Hyalella azteca Survival and Growth Test - Survival

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BBY2FCD-00275/4
Page 1 of 2

Client # & Name: SLR

Job # B985653

Organism Lot #: AB191015

Start Date and Time: 2019 Oct 17 @ 16:34

End Date: 2019 Oct 31

Analysts: M. Hamad, Y. Su, N. Shergill, S. Gupta, L. Nicholls, G. Matharu

Sample	Rep	Initial # Hyalella	Final # Hyalella	% Survived	Survival Mean %	Survival SD %
Control	A	10	10	100	98	4
	B	10	10	100		
	C	10	10	100		
	D	10	10	100		
	E	10	9	90		
C6 East / G7	A	10	5	50	60	19
	B	10	5	50		
	C	10	8	80		
	D	10	4	40		
	E	10	8	80		
C5 East / G6	A	10	5	50	38	23
	B	10	4	40		
	C	10	4	40		
	D	10	6	60		
	E	10	0	0		
C4 West	A	10	0	0	2	4
	B	10	0	0		
	C	10	0	0		
	D	10	0	0		
	E	10	1	10		
C3 West	A	10	5	50	48	13
	B	10	7	70		
	C	10	4	40		
	D	10	4	40		
	E	10	4	40		
C3 Centre / G5	A	10	9	90	86	15
	B	10	10	100		
	C	10	9	90		
	D	10	6	60		
	E	10	9	90		
G4	A	10	6	60	64	17
	B	10	8	80		
	C	10	6	60		
	D	10	8	80		
	E	10	4	40		

ECOTOXICOLOGY

Hyalella azteca Survival and Growth Test - Survival

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BBY2FCD-00275/4
Page 2 of 2

Client # & Name: SLR

Start Date and Time: 2019 Oct 17 @ 16:34

Job # B985653

End Date: 2019 Oct 31

Organism Lot #: AB191015

Analysts: M. Hamad, Y. Su, N. Shergill, S. Gupta, L. Nicholls, G. Matharu

Sample	Rep	Initial # Hyalella	Final # Hyalella	% Survived	Survival Mean %	Survival SD %
C1 West	A	10	9	90	90	17
	B	10	10	100		
	C	10	10	100		
	D	10	10	100		
	E	10	6	60		

Proofed By: DHawes
2019Nov15

ECOTOXICOLOGY

Hyalella azteca Survival and Growth Test - Dry Weights

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BBY2FCD-00129/5
Page 1 of 1

Client # & Name: 1776 SLR CONSULTING LTD
Job/Sample #: B985653
Organism Lot #: AB191015
Weighing Dates: 2019 Nov 12
Analysts: Y. Su

Start Date and Time: 2019 OCT 17 @ 16:34
End Date: 2019 Oct 31
Drying Temperature (°C): 60
Drying Time (h): >24

Boat #	Sample	Rep	# *Hyalella*	*Hyalella* Wt.(g)	*Hyalella* Wt. (mg)	Mean Wt./*Hyalella* (mg)	Mean Wt./Sample (mg)	SD
41	CONTROL	A	10	0.00129	1.29	0.13	0.14	0.02
42		B	10	0.00153	1.53	0.15		
43		C	10	0.00166	1.66	0.17		
44		D	10	0.00134	1.34	0.13		
45		E	9	0.00113	1.13	0.13		
46	C6 EAST / G7	A	5	0.00012	0.12	0.02	0.04	0.02
47		B	5	0.00030	0.30	0.06		
48		C	8	0.00025	0.25	0.03		
49		D	4	0.00022	0.22	0.06		
50		E	8	0.00036	0.36	0.05		
51	C5 EAST / G6	A	5	0.00011	0.11	0.02	0.04	0.02
52		B	4	0.00022	0.22	0.06		
53		C*	1	0.00006	0.06	0.06		
54		D	6	0.00023	0.23	0.04		
55		E	0		-	-		
56	C4 WEST	A	0		-	-	0.06	#DIV/0!
57		B	0		-	-		
58		C	0		-	-		
59		D	0		-	-		
60		E	1	0.00006	0.06	0.06		
61	C3 WEST	A	5	0.00014	0.14	0.03	0.03	0.01
62		B	7	0.00022	0.22	0.03		
63		C	4	0.00016	0.16	0.04		
64		D	4	0.00010	0.10	0.03		
65		E	4	0.00009	0.09	0.02		
66	C3 CENTRE/ G5	A	9	0.00066	0.66	0.07	0.08	0.01
67		B	10	0.00083	0.83	0.08		
68		C	9	0.00053	0.53	0.06		
69		D	6	0.00049	0.49	0.08		
70		E	9	0.00076	0.76	0.08		
71	G4	A	6	0.00025	0.25	0.04	0.05	0.03
72		B	8	0.00040	0.40	0.05		
73		C	6	0.00014	0.14	0.02		
74		D	8	0.00040	0.40	0.05		
75		E	4	0.00039	0.39	0.10		
46		QA/QC	5	0.00012	0.12	0.02		
41		0 - A	10	0.00128	1.28	0.13		
		Analyst:		YS				

The average dry weight for the replicate controls must be ≥0.1 mg, for the test to be valid.

Notes: * 3 missing organism discovered during dry weigh process. Mean dry weight adjsuted for missing organisms

ECOTOXICOLOGY

Hyalella azteca Survival and Growth Test - Dry Weights

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BBY2FCD-00129/5

Page 1 of 1

Client # & Name: 1776 SLR CONSULTING LTD

Start Date and Time: 2019 OCT 17 @ 16:34

Job/Sample #: B985653

End Date: 2019 Oct 31

Organism Lot #: AB191015

Drying Temperature (°C): 60

Weighing Dates: 2019 Nov 12

Drying Time (h): >24

Analysts: Y. Su

Boat #	Sample	Rep	# *Hyalella*	*Hyalella* Wt.(g)	*Hyalella* Wt. (mg)	Mean Wt./*Hyalella* (mg)	Mean Wt./Sample (mg)	SD
76	C1 WEST	A	9	0.00076	0.76	0.08	0.10	0.02
77		B	10	0.00119	1.19	0.12		
78		C	10	0.00121	1.21	0.12		
79		D	10	0.00090	0.90	0.09		
80		E	6	0.00058	0.58	0.10		
76		0 - A	9	0.00073	0.73	0.08		
		Analyst:		YS				

The average dry weight for the replicate controls must be ≥0.1 mg, for the test to be valid.

Notes:

Proofed By: DHaws
2019 Nov 15

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ECOTOXICOLOGY

BBY2FCD-00144/5

***HYALELLA AZTECA* SURVIVAL AND GROWTH TEST - TEST INFORMATION**

Client # & Name:	1776 SLR CONSULTING LTD
Job #:	B985653
Test Initiation Date & Time:	2019 OCT 17 @ 16:34
Test Completion Date:	2019 OCT 31 @ 18:35
Room #:	103
Analyst(s):	M. O'Toole, [illegible], Y. Su N Shergill, S. Gupta
Control Water Batch:	20191015
Control Sediment:	yaquina control sediments 2019 OCT 04
	DM 2019 NOV 06
Organism Lot:	AB191015
Age at Start of Test:	6-8 days
Feeding Regime:	1.75mL YCT & 800 µL tetramin slurry (4g/L) per replicate 3x weekly 0.75 mL YCT & 340 µL tetramin slurry (4g/L) per replicate daily feeding
YCT Batch Number:	20191002
Tetramin Preparation Date:	2019 OCT 18
Balance ID:	BBY2-0260
Drying Oven ID:	BBY2-0278
WQ Instrument ID:	BBY2-0352, BBY2-0366
Additional Comments:	DM 2019 NOV 14

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ECOTOXICOLOGY BBY2FCD-00142/2

***HYALELLA AZTECA* SURVIVAL AND GROWTH TEST – AERATION CHECKS** Page 1 of 1

Client # & Name: 1776 SLR CONSULTING Start Date: 2019 OCT 17

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day -1	Day 0	1	2	3	4	5	6
Date	2019 OCT 16	2019 OCT 17	2019 OCT 18	2019 OCT 19	2019 OCT 20	2019 OCT 21	2019 OCT 22	2019 OCT 23
Early AM	NA	YS	YS		WB		YS	YS
Mid-day	NA	YS	YS		SG		YS	YS
Late PM	YS	YS	YS		SG		YS	YS

	Day 7	8	9	10	11	12	13	14
Date	2019 OCT 24	2019 OCT 25	2019 OCT 26	2019 OCT 27	2019 OCT 28	2019 OCT 29	2019 OCT 30	2019 OCT 31
Early AM	Ⓐ ~~NA~~ YS	YS	YS	SG	YS	YS	YS	NS
Mid-day	Ⓐ ~~NA~~ YS	YS	YS	SG	YS	YS	YS	DMC 2019 NOV 26
Late PM	Ⓐ ~~YS~~ YS	YS	YS	SG	YS	YS	YS	

Comments:

DMC 2019 NOV 26

Ⓐ WE. YS 2019 OCT 25

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ECOTOXICOLOGY BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET Form: **Control**

Sample ID: CONTROL **Start Date:** October 17, 2019

Job #: B985653 **End Date:** October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
B ~~8.2~~ 8.1	8.5	112	152	A ~~458~~ 422	596	47	✓150	0.04	✓6.6

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst A ~~mo~~ NS	Date A ~~2019Oct17~~ 2019 Oct 31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	~~23.2~~ A B ~~22.8~~ 22.0	23.1	22.8	22.6	22.9	22.3	22.1
D.O. (mg/L)	B ~~8.4~~ 8.6	8.5	8.2	8.3	8.8	8.5	8.8
Subsampled for ammonia (√)	✓						✓
Analyst	mo / YS	SG	YS	YS	SG C	YS	NS

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	Y	SG	Y	YS	YS	YS	YS	YS	SG.	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	10	10	10	10	9
Analyst	MHM	YS	NS	MHM	SG

A WE mo 2019 Oct 17
WE mo 2019 Oct 17

B WE, YS 2019 OCT 17
C pH we and pH for SG 2019 Nov 15

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
		DMC 2019 Nov 14	

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ECOTOXICOLOGY
BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: **Sample**

Sample ID: C6 EAST / G7
Start Date: October 17, 2019
Job #/Sample #: B985653
End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.4	8.4	172	~~12~~ 416	~~1t~~ 617 WEmo2019Oct17	1219	100	✓ 200	7.5	✓ 0.098

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.6	23.4	23.0	22.8	22.8	22.7	22.2
D.O. (mg/L)	8.5	8.3	8.3	8.4	8.5	8.6	8.6
Subsampled for ammonia (√)	✓						✓
Analyst	mo	SY	YS	YS	SY	YS	NS

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	J	SY	J	YS	YS	YS	YS	YS	SY	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	5	5	8	4	8
Analyst	NS	YS	MHM	LW.	MHM

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
2019OCT31	B	a red worm was found in the sample	YS

DML 2019 Nov15

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ECOTOXICOLOGY
BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: Sample

Sample ID: C5 EAST / G6

Start Date: October 17, 2019

Job #/Sample #: B985653

End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.5	8.3	168	300	682	1106	120	✓ 110	11	✓ 0.16

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.6	23.2	22.9	22.9	22.9	22.8	22.5
D.O. (mg/L)	8.5	8.4	8.4	8.5	8.6	8.7	8.5
Subsampled for ammonia (√)	✓						✓
Analyst	mo	SG	YS	YS	SG	YS	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	Y	SG	Y	YS	YS	YS	VS	VS	SG.	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	5	4	4	6	0
Analyst	MHM	MHM	MHM	YS	MHM

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
		DMC 2019 Nov 15	

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ECOTOXICOLOGY

BBY2 FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: **Sample**

Sample ID: C4 WEST

Start Date: October 17, 2019

Job #/Sample #: B985653

End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.4	8.3	168	326	687	1009	140	✓ 180	20	✓ 0.10

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.7	23.2	22.9	22.9	22.8	22.7	22.5
D.O. (mg/L)	8.5	8.4	8.3	8.4	8.6	8.5	8.5
Subsampled for ammonia (√)	√						√
Analyst	mo	SG	YS	YS	SG	YS	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	Y	SG	Y	YS	YS	YS	YS	YS	SG	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	0	0	0	0	1
Analyst	LW.	LW.	YS	MHM	YS

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
2019 Oct 31	D	Sample is thick slurry with hydrocarbon odor	MHM
2019Oct31	E, C	strong hydrocarbon odor, several red worms were found	YS
2019Oct31	B, A	Strong hydrocarbon odor	LW
		DMC 2019 Nov 15	

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ECOTOXICOLOGY

BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: **Sample**

Sample ID: C3 WEST

Start Date: October 17, 2019

Job #/Sample #: B985653

End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.4	8.2	180	400	578	936	110	180	5.9	0.16

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.4	23.2	22.9	22.9	22.8	22.8	22.5
D.O. (mg/L)	8.6	8.5	8.2	8.4	8.4	8.5	8.4
Subsampled for ammonia (√)	√						√
Analyst	mo	SG	YS	YS	SG	YS	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	Y	SG	Y	YS	YS	YS	YS	YS	SG	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	5	7	4	4	4
Analyst	CS	CS	CS	YS	CS

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
2019OCT31	D	~~Two~~ ~~One~~ several Ⓐ red worms was found	YS
~~Ⓐ2019OCT31~~	~~E~~	~~several red worms were found.~~	~~YS~~

DMC 2019 Nov 14

Ⓐ WE YS 2019OCT31

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ECOTOXICOLOGY

BBY2 FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: Sample

Sample ID: C3 CENTRE / G5

Start Date: October 17, 2019

Job #/Sample #: B985653

End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final ✓	Initial	Final ✓
8.4	8.5	152	344	521	935	86	200	2.3	0.054

Initial overlying WQ measurements:	
Analyst MO	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.6	23.3	22.9	23.0	22.8	22.7	22.6
D.O. (mg/L)	8.6	8.4	8.4	8.5	8.3	8.4	8.4
Subsampled for ammonia (√)	✓						✓
Analyst	MO	SY	YS	YS	SY	YS	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	YS	YS	Y	SY	Y	YS	YS	YS	YS	YS	SY	YS	YS	YS

Replicate	A	B	C	D	E
# Surviving	9	16	9	6	~~8~~ 9 WESG 2019Oct31.
Analyst	YS	MHM	MHM	LW.	SY.

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
2019Oct31	D	Found 7 indigenous worms in sample.	
		DMC 2019 Nov14	

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ECOTOXICOLOGY

BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET

Form: **Sample**

Sample ID: G4

Start Date: October 17, 2019

Job #/Sample #: B985653

End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	✓ Final	Initial	✓ Final
8.3	8.2	160	360	553	1009	94	87	3.6	0.17

Initial overlying WQ measurements:	
Analyst mo	Date 2019Oct17

Final overlying WQ measurements:	
Analyst NS	Date 2019Oct31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.7	23.0	22.7	23.0	22.8	22.7	22.6
D.O. (mg/L)	8.5	8.5	8.5	8.4	8.5	8.6	8.5
Subsampled for ammonia (√)	√						✓
Analyst	mo	SY	ys	ys	SY	YS	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	ys	ys	y	SY	y	ys	ys	ys	YS	YS	SY	ys	ys	ys

Replicate	A	B	C	D	E
# Surviving	5	8	6	8	4
Analyst	Lw	GS	GS	GS	SY

Date	Replicate	Comments and/or additional WQ measurements:	Analyst
2019Oct31	E	Many Red worms found in the Sample	SY

DMC
2019 Nov14

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ECOTOXICOLOGY
BBY2FCD-00143/6

HYALELLA AZTECA SURVIVAL AND GROWTH TEST - DATA SHEET
Form: Sample

Sample ID: C1 WEST
Start Date: October 17, 2019

Job #/Sample #: B985653
End Date: October 31, 2019

Measurements						Samples Taken			
pH		Hardness (mg/L $CaCO_3$)		Conductance (µS/cm)		Alkalinity (mg/L $CaCO_3$)		Ammonia (mg/L)	
Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
8.4	8.2	176	420	717	1349	84	110 ✓	0.72	0.12 ✓

Initial overlying WQ measurements:	
Analyst mo	Date 20190Ct17

Final overlying WQ measurements:	
Analyst NS	Date 2019 Oct 31

Day	Thursday Day 0	Sunday Day 3	Tuesday Day 5	Thursday Day 7	Sunday Day 10	Tuesday Day 12	Thursday Day 14
Temp. (ºC)	22.5	23.1	22.7	23.0	22.9	22.7	22.5
D.O. (mg/L)	8.5	8.3	8.5	8.5	8.6	8.5	8.5
Subsampled for ammonia (√)	√						√
Analyst	mo	sq	ys	ys	sq	ys	

Feeding–Day:	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Analyst	ys	ys		SQ		ys	ys	ys	YS	YS	SQ	ys	ys	ys

Replicate	A	B	C	D	E
# Surviving	9	10	10	10	6
Analyst	sq	MHM	ys	ys	LW.

Date	Replicate	Comments and/or additional WQ measurements:	Analyst

DML 2019 Nov14

SAM-5S Water Recipe for Hyalella

BATCH ID : 2019 OCT 15
(Date Hardened)

SAM-5S Reconstituted Water Recipe for *Hyalella azteca* as per Borgmann 1996 (For water hardness ~125 mg/L)

Chemical Weights	$CaCl_2X2H_2O$	$MgSO_4$ (g)	NaBr (g)	$NaHCO_3$ (g)	KCl (g)
Brand	Fisher	Fisher	(A) ~~Fisher~~ ACROS	Fisher	Fisher
Lot #	184678	183674	(A) ~~187782~~ A0378421	187782	195613
Calculated	8.82	1.81	0.06	5.04	0.22
Actual	8.8249	1.8135	0.0612	5.0430	0.2219

Balance ID: BBY2-0260

Analyst: YuSu

Add to Type 3 DI (L): 60

Water Use: 60 L

DI Machine ID: BBY2-0160

Date: 2019 OCT 15

Water Quality:

Temp (°C): 23.0
pH: 8.0
Hardness (mg/L) 136

Cond (μs/cm): 383
DO (mg/L): 8.3
Alkalinity (mg/L): N/A

Analyst: YuSu
Date: 2019 OCT 16

Comments:

NaHCO3 (Sodium Bicarbonate)
NaBr (Sodium Bromide)
CaCl2 x 2H2O (Calcium Chloride - dihydrous)
MgSO4 (Magnesium Sulfate - anhydrous)
KCl (Potassium Chloride)
SAM-5S Recipe = 1 mM CaCl2, 1 mM NaHCO3, 0.01 mM NaBr, 0.05 mM KCl, and 0.25 mM MgSO4

Borgmann, U. 1996. Systematic analysis of aqueous ion requirements of *Hyalella azteca* : A standard artificial medium including the essential bromide ion. *Archives of Environmental Contamination and Toxicology* . 30: 356-363.

(A) WE, YS 2019 OCT 15

1300 Blue Spruce Drive, Suite C
Fort Collins, Colorado 80524

AQUATIC BIO SYSTEMS INC. ABS

Toll Free: 800/331-5916
Tel: 970/484-5091 Fax:970/484-2514

AB191015

#1370+135

ORGANISM HISTORY

DATE:	10/14/2019
SPECIES:	*Hyalella azteca*
AGE:	3-5 day
LIFE STAGE:	Juvenile
HATCH DATE:	Variable
BEGAN FEEDING:	Immediately
FOOD:	Flake slurry

Water Chemistry Record:	**Current**	**Range**
TEMPERATURE:	25°C	23-26°C
SALINITY/CONDUCTIVITY:	--	--
TOTAL HARDNESS (as $CaCO_3$):	178 mg/l	118-200 mg/l
TOTAL ALKALINITY (as $CaCO_3$):	85 mg/l	50-90 mg/l
pH:	8.03	7.56-8.20

Comments:

Facility Supervisor

ECOTOXICOLOGY

ORGANISMS - ACCLIMATION AND HOLDING CONDITIONS

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BBY2FCD-00070/5

Page 1 of 1

Client #'s : 254, 1176, 4737

Date & Time of Arrival: 2019 OCT 15 @ 13:00

Organism Lot #: AB191015

Age upon Arrival: 4-6 Days

Water (L) per Shipping Bag: 1 L

Organism: Hyalella azteca

Number of Shipping Bags: 3

#of Organisms Ordered: 1370 + 135

Light Intensity (lux): 602 ~ 818

Arrival Conditions

Bag ID	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
1	0	0	1421	20.5	8.1	7.6	5ml + 5ml	YS
2	0	0	1409	20.2	8.1	7.5	5ml + 5ml	YS
3	0	0	1405	20.1	8.2	7.5	5ml + 5ml	YS

DMC 2019 Nov06

Daily Conditions During Holding/Acclimation

Date	Mortalities		Water Quality					Analyst
	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	
2019OCT16	0	0	Ⓐ ~~1644~~ 1409	23.6	8.2	8.2	5ml + 5ml	YS
2019OCT16	0	0	1402	23.5	8.1	8.1	10ml + 10ml	YS
Total Mortalities								

DMC 2019 Nov06

Equipment ID: BBY2-0368 , BBY2-0468

Comments (e.g. feeding times and quantities; fish behaviour, acclimation conditions): Analyst

→ recieved organisms, did WTR quality, stored into 2 diff sizes of pyres dishes YS

→ 2019 OCT 16: did WTR Xchanges, WTR qualities, feeding. YS

Ⓐ WE, YS 2019 OCT 16

BUREAU VERITAS

BV Labs Job #: B989145
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS4947		WS4948		WS4949	
Sampling Date		2019/10/17		2019/10/17		2019/10/17	
COC Number		18213		18213		18213	
	UNITS	1776 Control Day 0 Hy Overly	RDL	1776 C6 East Day 0 Hy Overly	RDL	1776 C5 East Day 0 Hy Overly	RDL
Misc. Inorganics							
pH	pH	7.11	N/A	7.99	N/A	8.06	N/A
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	47	1.0	100	1.0	120	1.0
Bicarbonate (HCO3)	mg/L	57	1.0	130	1.0	140	1.0
Carbonate (CO3)	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0
Nutrients							
Total Ammonia (N)	mg/L	0.040	0.015	7.5 (1)	0.075	11 (1)	0.15

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WS4950		WS4951	WS4952	WS4953	
Sampling Date		2019/10/17		2019/10/17	2019/10/17	2019/10/17	
COC Number		18213		18213	18213	18213	
	UNITS	1776 C4 West Day 0 Hy Overly	RDL	1776 C3 West Day 0 Hy Overly	1776 C3 Center Day 0 Hy Overly	1776 G4 Day 0 Hy Overly	RDL
Misc. Inorganics							
pH	pH	8.12	N/A	7.97	7.77	7.86	N/A
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	140	1.0	110	86	94	1.0
Bicarbonate (HCO3)	mg/L	170	1.0	130	110	110	1.0
Carbonate (CO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Nutrients							
Total Ammonia (N)	mg/L	20 (1)	0.30	5.9 (1)	2.3 (1)	3.6 (1)	0.075

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: B989145
Report Date: 2019/10/25

Bureau Veritas Laboratories (TOX Internal)
Client Project #: B985653
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WS4954	
Sampling Date		2019/10/17	
COC Number		18213	
	UNITS	1776 C1 West Day 0 Hy Overly	RDL
Misc. Inorganics			
pH	pH	7.70	N/A
Anions			
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	84	1.0
Bicarbonate (HCO3)	mg/L	100	1.0
Carbonate (CO3)	mg/L	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	1.0
Nutrients			
Total Ammonia (N)	mg/L	0.72	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

BV Labs Job #: B993764
Report Date: 2019/11/06

Bureau Veritas Laboratories (TOX Internal)
Sampler Initials: YS

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WV1542		WV1543	WV1544	WV1545	
Sampling Date		2019/10/31 19:19		2019/10/31 19:19	2019/10/31 19:19	2019/10/31 19:19	
COC Number		18574		18574	18574	18574	
	UNITS	1776 Hy Day 14 Control	RDL	1776 Hy Day 14 C4 West	1776 Hy Day 14 C5 East/G6	1776 Hy Day 14 C3 West	RDL
Misc. Inorganics							
pH	pH	8.12	N/A	8.26	7.97	8.23	N/A
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Alkalinity (Total as CaCO3)	mg/L	150	1.0	180	110	180	1.0
Bicarbonate (HCO3)	mg/L	180	1.0	220	130	220	1.0
Carbonate (CO3)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Hydroxide (OH)	mg/L	<1.0	1.0	<1.0	<1.0	<1.0	1.0
Nutrients							
Total Ammonia (N)	mg/L	6.6 (1)	0.075	0.10	0.16	0.16	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

BV Labs ID		WV1546	WV1547	WV1548	WV1549	
Sampling Date		2019/10/31 19:19	2019/10/31 19:19	2019/10/31 19:19	2019/10/31 19:19	
COC Number		18574	18574	18574	18574	
	UNITS	1776 Hy Day 14 C3 Centre G5	1776 Hy Day 14 C1 West	1776 Hy Day 14 G4	1776 Hy Day 14 C6West/G7	RDL
Misc. Inorganics						
pH	pH	8.34	7.92	7.88	8.33	N/A
Anions						
Alkalinity (PP as CaCO3)	mg/L	1.7	<1.0	<1.0	1.4	1.0
Alkalinity (Total as CaCO3)	mg/L	200	110	87	200	1.0
Bicarbonate (HCO3)	mg/L	240	130	110	250	1.0
Carbonate (CO3)	mg/L	2.1	<1.0	<1.0	1.6	1.0
Hydroxide (OH)	mg/L	<1.0	<1.0	<1.0	<1.0	1.0
Nutrients						
Total Ammonia (N)	mg/L	0.054	0.12	0.17	0.098	0.015

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Laboratories Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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ECOTOXICOLOGY

Randomization Chart

Tab: Sediment Tests

BBY2FCD-00438/2

Test: HYALELLA   Start Date: 2019 OCT 17

Client # & Name: 1776 SLR CONSULTING LTD

Back Wall		**Position Map**	
6	12	18	
5	11	17	
4	10	16	
3	9	15	
2	8	14	
1	7	13	etc.

Front of Counter

Position #	Sample ID	Replicate	Colour
2	CONTROL	A	Red
17		B	
36		C	
25		D	
4		E	
47		Measure	
1	C6 EAST/G7	A	Orange
39		B	
16		C	
34		D	
13		E	
5		Measure	
32	C5 EAST/G6	A	Yellow
46		B	
15		C	
27		D	
18		E	
20		Measure	
44	C4 WEST	A	Green
30		B	
12		C	
38		D	
31		E	
11		Measure	
26	C3 WEST	A	Dark Green
3		B	
29		C	
8		D	
45		E	
28		Measure	
9	C3CENTRE/G5	A	Blue
43		B	
21		C	
41		D	
10		E	
48		Measure	

Position #	Sample ID	Replicate	Colour
24	G4	A	Purple
22		B	
7		C	
23		D	
37		E	
33		Measure	
42	C1 WEST	A	Pink
14		B	
19		C	
40		D	
6		E	
35		Measure	
49		A	Light Blue
50		B	
51		C	
52		D	
53		E	
54		Measure	
55		A	Light Green
56		B	
57		C	
58		D	
59		E	
60		Measure	
61		A	Pink/Yellow
62		B	
63		C	
64		D	
65		E	
66		Measure	
67		A	Red/Green
68		B	
69		C	
70		D	
71		E	
72		Measure	

APPENDIX F
ProUCL Outputs

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

Nonparametric UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM
From File	SED 0-0.15mbg Chemistry_input_v5.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

aluminum

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	17
Minimum	9030	Mean	10842
Maximum	13200	Median	10600
SD	1603	Std. Error of Mean	654.4
Coefficient of Variation	0.148	Skewness	0.492
Mean of logged Data	9.282	SD of logged Data	0.146

Note: Sample size is small (e.g., <10), if data are collected using ISM approach
you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options.

Nonparametric Distribution Free UCL Statistics
Data appear Normal Distributed at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	12160	95% Adjusted-CLT UCL (Chen-1995)	12059
		95% Modified-t UCL (Johnson-1978)	12182

Nonparametric Distribution Free UCLs

95% CLT UCL	11918	95% Jackknife UCL	12160
95% Standard Bootstrap UCL	11830	95% Bootstrap-t UCL	12715
95% Hall's Bootstrap UCL	13362	95% Percentile Bootstrap UCL	11820
95% BCA Bootstrap UCL	11987		
90% Chebyshev(Mean, Sd) UCL	12805	95% Chebyshev(Mean, Sd) UCL	13694
97.5% Chebyshev(Mean, Sd) UCL	14928	99% Chebyshev(Mean, Sd) UCL	17353

Suggested UCL to Use
Data appear Normal, May want to try Normal Distribution

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

antimony

General Statistics

Total Number of Observations	22	Number of Distinct Observations	7
		Number of Missing Observations	1
Number of Detects	7	Number of Non-Detects	15
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.53	Minimum Non-Detect	0.8
Maximum Detect	1.54	Maximum Non-Detect	0.8
Variance Detects	0.124	Percent Non-Detects	68.18%

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
60	Mean Detects	0.997	SD Detects	0.352
61	Median Detects	0.92	CV Detects	0.353
62	Skewness Detects	0.257	Kurtosis Detects	-0.651
63	Mean of Logged Detects	-0.0598	SD of Logged Detects	0.372
64				
65	**Nonparametric Distribution Free UCL Statistics**			
66	**Detected Data appear Normal Distributed at 5% Significance Level**			
67				
68	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
69	Mean	0.723	Standard Error of Mean	0.0714
70	SD	0.268	95% KM (BCA) UCL	0.932
71	95% KM (t) UCL	0.846	95% KM (Percentile Bootstrap) UCL	0.892
72	95% KM (z) UCL	0.84	95% KM Bootstrap t UCL	0.87
73	90% KM Chebyshev UCL	0.937	95% KM Chebyshev UCL	1.034
74	97.5% KM Chebyshev UCL	1.169	99% KM Chebyshev UCL	1.434
75				
76	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
77	KM SD (logged)	0.305	95% Critical H Value (KM-Log)	1.842
78	KM Mean (logged)	-0.377	KM Geo Mean	0.686
79	KM Standard Error of Mean (logged)	0.0929	95% H-UCL (KM -Log)	0.812
80				
81	**Suggested UCL to Use**			
82	**Data appear Normal, May want to try Normal Distribution.**			
83	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
84	Recommendations are based upon data size, data distribution, and skewness.			
85	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
86	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
87				
88				
89	**arsenic**			
90				
91	**General Statistics**			
92	Total Number of Observations	22	Number of Distinct Observations	19
93			Number of Missing Observations	1
94	Minimum	3	Mean	4.551
95	Maximum	12	Median	4
96	SD	1.82	Std. Error of Mean	0.388
97	Coefficient of Variation	0.4	Skewness	3.536
98	Mean of logged Data	1.468	SD of logged Data	0.283
99				
100	**Nonparametric Distribution Free UCL Statistics**			
101	**Data do not follow a Discernible Distribution (0.05)**			
102				
103	**Assuming Normal Distribution**			
104	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
105	95% Student's-t UCL	5.219	95% Adjusted-CLT UCL (Chen-1995)	5.502
106			95% Modified-t UCL (Johnson-1978)	5.268
107				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
108	**Nonparametric Distribution Free UCLs**			
109	95% CLT UCL	5.189	95% Jackknife UCL	5.219
110	95% Standard Bootstrap UCL	5.171	95% Bootstrap-t UCL	6.013
111	95% Hall's Bootstrap UCL	7.679	95% Percentile Bootstrap UCL	5.244
112	95% BCA Bootstrap UCL	5.517		
113	90% Chebyshev(Mean, Sd) UCL	5.715	95% Chebyshev(Mean, Sd) UCL	6.243
114	97.5% Chebyshev(Mean, Sd) UCL	6.975	99% Chebyshev(Mean, Sd) UCL	8.413
115				
116	**Suggested UCL to Use**			
117	95% Student's-t UCL	5.219	or 95% Modified-t UCL	5.268
118				
119	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
120	Recommendations are based upon data size, data distribution, and skewness.			
121	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
122	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
123				
124				
125	**barium**			
126				
127	**General Statistics**			
128	Total Number of Observations	22	Number of Distinct Observations	19
129			Number of Missing Observations	1
130	Minimum	69	Mean	103.8
131	Maximum	210	Median	95.5
132	SD	32.69	Std. Error of Mean	6.969
133	Coefficient of Variation	0.315	Skewness	1.703
134	Mean of logged Data	4.603	SD of logged Data	0.279
135				
136	**Nonparametric Distribution Free UCL Statistics**			
137	**Data appear Approximate Normal Distributed at 5% Significance Level**			
138				
139	**Assuming Normal Distribution**			
140	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
141	95% Student's-t UCL	115.8	95% Adjusted-CLT UCL (Chen-1995)	118
142			95% Modified-t UCL (Johnson-1978)	116.2
143				
144	**Nonparametric Distribution Free UCLs**			
145	95% CLT UCL	115.3	95% Jackknife UCL	115.8
146	95% Standard Bootstrap UCL	115	95% Bootstrap-t UCL	118.6
147	95% Hall's Bootstrap UCL	125.6	95% Percentile Bootstrap UCL	115
148	95% BCA Bootstrap UCL	117.9		
149	90% Chebyshev(Mean, Sd) UCL	124.7	95% Chebyshev(Mean, Sd) UCL	134.2
150	97.5% Chebyshev(Mean, Sd) UCL	147.4	99% Chebyshev(Mean, Sd) UCL	173.2
151				
152	**Suggested UCL to Use**			
153	**Data appear Normal, May want to try Normal Distribution**			
154				

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM								
5			From File	SED 0-0.15mbg Chemistry_input_v5.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
155	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
156	Recommendations are based upon data size, data distribution, and skewness.											
157	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
158	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
159												
160												
161	beryllium											
162												
163	General Statistics											
164					Total Number of Observations	22					Number of Distinct Observations	19
165											Number of Missing Observations	1
166					Minimum	0.28					Mean	0.44
167					Maximum	0.67					Median	0.425
168					SD	0.1					Std. Error of Mean	0.0213
169					Coefficient of Variation	0.227					Skewness	0.645
170					Mean of logged Data	-0.844					SD of logged Data	0.222
171												
172	Nonparametric Distribution Free UCL Statistics											
173	Data appear Normal Distributed at 5% Significance Level											
174												
175	Assuming Normal Distribution											
176	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
177					95% Student's-t UCL	0.477					95% Adjusted-CLT UCL (Chen-1995)	0.479
178											95% Modified-t UCL (Johnson-1978)	0.478
179												
180	Nonparametric Distribution Free UCLs											
181					95% CLT UCL	0.476					95% Jackknife UCL	0.477
182					95% Standard Bootstrap UCL	0.475					95% Bootstrap-t UCL	0.483
183					95% Hall's Bootstrap UCL	0.481					95% Percentile Bootstrap UCL	0.475
184					95% BCA Bootstrap UCL	0.477						
185					90% Chebyshev(Mean, Sd) UCL	0.504					95% Chebyshev(Mean, Sd) UCL	0.533
186					97.5% Chebyshev(Mean, Sd) UCL	0.574					99% Chebyshev(Mean, Sd) UCL	0.653
187												
188	Suggested UCL to Use											
189	Data appear Normal, May want to try Normal Distribution											
190												
191	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
192	Recommendations are based upon data size, data distribution, and skewness.											
193	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
194	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
195												
196												
197	boron											
198												
199	General Statistics											
200					Total Number of Observations	15					Number of Distinct Observations	11
201											Number of Missing Observations	8
202					Minimum	11					Mean	17.35
203					Maximum	23.5					Median	17

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
204	SD	3.981	Std. Error of Mean	1.028
205	Coefficient of Variation	0.229	Skewness	0.358
206	Mean of logged Data	2.829	SD of logged Data	0.23
207				
208	Nonparametric Distribution Free UCL Statistics			
209	Data appear Normal Distributed at 5% Significance Level			
210				
211	Assuming Normal Distribution			
212	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
213	95% Student's-t UCL	19.16	95% Adjusted-CLT UCL (Chen-1995)	19.14
214			95% Modified-t UCL (Johnson-1978)	19.17
215				
216	Nonparametric Distribution Free UCLs			
217	95% CLT UCL	19.04	95% Jackknife UCL	19.16
218	95% Standard Bootstrap UCL	19.01	95% Bootstrap-t UCL	19.34
219	95% Hall's Bootstrap UCL	19.02	95% Percentile Bootstrap UCL	18.96
220	95% BCA Bootstrap UCL	19		
221	90% Chebyshev(Mean, Sd) UCL	20.43	95% Chebyshev(Mean, Sd) UCL	21.83
222	97.5% Chebyshev(Mean, Sd) UCL	23.77	99% Chebyshev(Mean, Sd) UCL	27.57
223				
224	Suggested UCL to Use			
225	Data appear Normal, May want to try Normal Distribution			
226				
227	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
228	Recommendations are based upon data size, data distribution, and skewness.			
229	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
230	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
231				
232				
233	cadmium			
234				
235	General Statistics			
236	Total Number of Observations	22	Number of Distinct Observations	20
237			Number of Missing Observations	1
238	Minimum	0.27	Mean	1.354
239	Maximum	8.5	Median	0.616
240	SD	2.041	Std. Error of Mean	0.435
241	Coefficient of Variation	1.507	Skewness	2.883
242	Mean of logged Data	-0.217	SD of logged Data	0.867
243				
244	Nonparametric Distribution Free UCL Statistics			
245	Data do not follow a Discernible Distribution (0.05)			
246				
247	Assuming Normal Distribution			
248	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
249	95% Student's-t UCL	2.103	95% Adjusted-CLT UCL (Chen-1995)	2.356
250			95% Modified-t UCL (Johnson-1978)	2.147
251				

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM								
5			From File	SED 0-0.15mbg Chemistry_input_v5.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
252	**Nonparametric Distribution Free UCLs**											
253					95% CLT UCL	2.07					95% Jackknife UCL	2.103
254					95% Standard Bootstrap UCL	2.049					95% Bootstrap-t UCL	3.762
255					95% Hall's Bootstrap UCL	3.928					95% Percentile Bootstrap UCL	2.113
256					95% BCA Bootstrap UCL	2.427						
257					90% Chebyshev(Mean, Sd) UCL	2.66					95% Chebyshev(Mean, Sd) UCL	3.251
258					97.5% Chebyshev(Mean, Sd) UCL	4.072					99% Chebyshev(Mean, Sd) UCL	5.684
259												
260	**Suggested UCL to Use**											
261					95% Chebyshev (Mean, Sd) UCL	3.251						
262												
263	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
264	Recommendations are based upon data size, data distribution, and skewness.											
265	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
266	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
267												
268												
269	**chromium (III+VI)**											
270												
271	**General Statistics**											
272					Total Number of Observations	22					Number of Distinct Observations	16
273											Number of Missing Observations	1
274					Minimum	16					Mean	24.88
275					Maximum	41					Median	22
276					SD	6.79					Std. Error of Mean	1.448
277					Coefficient of Variation	0.273					Skewness	1.077
278					Mean of logged Data	3.182					SD of logged Data	0.252
279												
280	**Nonparametric Distribution Free UCL Statistics**											
281	**Data do not follow a Discernible Distribution (0.05)**											
282												
283	**Assuming Normal Distribution**											
284	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
285					95% Student's-t UCL	27.37					95% Adjusted-CLT UCL (Chen-1995)	27.61
286											95% Modified-t UCL (Johnson-1978)	27.42
287												
288	**Nonparametric Distribution Free UCLs**											
289					95% CLT UCL	27.26					95% Jackknife UCL	27.37
290					95% Standard Bootstrap UCL	27.18					95% Bootstrap-t UCL	27.89
291					95% Hall's Bootstrap UCL	27.45					95% Percentile Bootstrap UCL	27.23
292					95% BCA Bootstrap UCL	27.52						
293					90% Chebyshev(Mean, Sd) UCL	29.22					95% Chebyshev(Mean, Sd) UCL	31.19
294					97.5% Chebyshev(Mean, Sd) UCL	33.92					99% Chebyshev(Mean, Sd) UCL	39.28
295												
296	**Suggested UCL to Use**											
297					95% Student's-t UCL	27.37					or 95% Modified-t UCL	27.42
298												
299	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
300	Recommendations are based upon data size, data distribution, and skewness.											

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
301	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
302	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
303				
304				
305	copper			
306				
307	**General Statistics**			
308	Total Number of Observations	22	Number of Distinct Observations	22
309			Number of Missing Observations	0
310	Minimum	30	Mean	76.29
311	Maximum	170	Median	64.5
312	SD	36.81	Std. Error of Mean	7.847
313	Coefficient of Variation	0.482	Skewness	1.266
314	Mean of logged Data	4.237	SD of logged Data	0.443
315				
316	**Nonparametric Distribution Free UCL Statistics**			
317	**Data appear Gamma Distributed at 5% Significance Level**			
318				
319	**Assuming Normal Distribution**			
320	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
321	95% Student's-t UCL	89.79	95% Adjusted-CLT UCL (Chen-1995)	91.46
322			95% Modified-t UCL (Johnson-1978)	90.15
323				
324	**Nonparametric Distribution Free UCLs**			
325	95% CLT UCL	89.2	95% Jackknife UCL	89.79
326	95% Standard Bootstrap UCL	88.8	95% Bootstrap-t UCL	93.53
327	95% Hall's Bootstrap UCL	91.71	95% Percentile Bootstrap UCL	89.32
328	95% BCA Bootstrap UCL	91.01		
329	90% Chebyshev(Mean, Sd) UCL	99.83	95% Chebyshev(Mean, Sd) UCL	110.5
330	97.5% Chebyshev(Mean, Sd) UCL	125.3	99% Chebyshev(Mean, Sd) UCL	154.4
331				
332	**Suggested UCL to Use**			
333	**Data appear Gamma, May want to try Gamma Distribution**			
334				
335	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
336	Recommendations are based upon data size, data distribution, and skewness.			
337	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
338	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
339				
340				
341	iron			
342				
343	**General Statistics**			
344	Total Number of Observations	6	Number of Distinct Observations	6
345			Number of Missing Observations	17
346	Minimum	18800	Mean	22650
347	Maximum	25600	Median	22800
348	SD	2477	Std. Error of Mean	1011
349	Coefficient of Variation	0.109	Skewness	-0.496
350	Mean of logged Data	10.02	SD of logged Data	0.112

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
351				
352	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
353	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
354	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
355				
356	**Nonparametric Distribution Free UCL Statistics**			
357	**Data appear Normal Distributed at 5% Significance Level**			
358				
359	**Assuming Normal Distribution**			
360	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
361	95% Student's-t UCL	24688	95% Adjusted-CLT UCL (Chen-1995)	24094
362			95% Modified-t UCL (Johnson-1978)	24653
363				
364	**Nonparametric Distribution Free UCLs**			
365	95% CLT UCL	24313	95% Jackknife UCL	24688
366	95% Standard Bootstrap UCL	24180	95% Bootstrap-t UCL	24572
367	95% Hall's Bootstrap UCL	24307	95% Percentile Bootstrap UCL	24167
368	95% BCA Bootstrap UCL	23967		
369	90% Chebyshev(Mean, Sd) UCL	25684	95% Chebyshev(Mean, Sd) UCL	27058
370	97.5% Chebyshev(Mean, Sd) UCL	28965	99% Chebyshev(Mean, Sd) UCL	32711
371				
372	**Suggested UCL to Use**			
373	**Data appear Normal, May want to try Normal Distribution**			
374				
375	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
376	Recommendations are based upon data size, data distribution, and skewness.			
377	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
378	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
379				
380	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
381	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
382				
383				
384	lead			
385				
386	**General Statistics**			
387	Total Number of Observations	22	Number of Distinct Observations	21
388			Number of Missing Observations	0
389	Minimum	13	Mean	44.95
390	Maximum	145	Median	40.8
391	SD	28.85	Std. Error of Mean	6.15
392	Coefficient of Variation	0.642	Skewness	2.16
393	Mean of logged Data	3.649	SD of logged Data	0.562
394				
395	**Nonparametric Distribution Free UCL Statistics**			
396	**Data appear Gamma Distributed at 5% Significance Level**			
397				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
398	Assuming Normal Distribution			
399	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
400	95% Student's-t UCL	55.54	95% Adjusted-CLT UCL (Chen-1995)	58.1
401			95% Modified-t UCL (Johnson-1978)	56.01
402				
403	Nonparametric Distribution Free UCLs			
404	95% CLT UCL	55.07	95% Jackknife UCL	55.54
405	95% Standard Bootstrap UCL	54.62	95% Bootstrap-t UCL	61.18
406	95% Hall's Bootstrap UCL	102.2	95% Percentile Bootstrap UCL	55.5
407	95% BCA Bootstrap UCL	57.9		
408	90% Chebyshev(Mean, Sd) UCL	63.4	95% Chebyshev(Mean, Sd) UCL	71.76
409	97.5% Chebyshev(Mean, Sd) UCL	83.36	99% Chebyshev(Mean, Sd) UCL	106.1
410				
411	Suggested UCL to Use			
412	Data appear Gamma, May want to try Gamma Distribution			
413				
414	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
415	Recommendations are based upon data size, data distribution, and skewness.			
416	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
417	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
418				
419				
420	manganese			
421				
422	General Statistics			
423	Total Number of Observations	6	Number of Distinct Observations	6
424			Number of Missing Observations	17
425	Minimum	390	Mean	551.8
426	Maximum	623	Median	577
427	SD	83.12	Std. Error of Mean	33.93
428	Coefficient of Variation	0.151	Skewness	-1.96
429	Mean of logged Data	6.302	SD of logged Data	0.17
430				
431	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
432	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
433	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
434				
435	Nonparametric Distribution Free UCL Statistics			
436	Data do not follow a Discernible Distribution (0.05)			
437				
438	Assuming Normal Distribution			
439	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
440	95% Student's-t UCL	620.2	95% Adjusted-CLT UCL (Chen-1995)	578.6
441			95% Modified-t UCL (Johnson-1978)	615.7
442				
443	Nonparametric Distribution Free UCLs			
444	95% CLT UCL	607.6	95% Jackknife UCL	620.2
445	95% Standard Bootstrap UCL	603.4	95% Bootstrap-t UCL	603.2
446	95% Hall's Bootstrap UCL	584.9	95% Percentile Bootstrap UCL	595.3

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
447	95% BCA Bootstrap UCL	589		
448	90% Chebyshev(Mean, Sd) UCL	653.6	95% Chebyshev(Mean, Sd) UCL	699.7
449	97.5% Chebyshev(Mean, Sd) UCL	763.7	99% Chebyshev(Mean, Sd) UCL	889.5
450				
451	**Suggested UCL to Use**			
452	95% Student's-t UCL	620.2	or 95% Modified-t UCL	615.7
453				
454	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
455	Recommendations are based upon data size, data distribution, and skewness.			
456	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
457	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
458				
459	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
460	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
461				
462				
463	mercury			
464				
465	**General Statistics**			
466	Total Number of Observations	6	Number of Distinct Observations	5
467			Number of Missing Observations	17
468	Minimum	0.057	Mean	0.136
469	Maximum	0.255	Median	0.104
470	SD	0.0741	Std. Error of Mean	0.0303
471	Coefficient of Variation	0.544	Skewness	0.953
472	Mean of logged Data	-2.114	SD of logged Data	0.537
473				
474	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
475	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
476	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
477				
478	**Nonparametric Distribution Free UCL Statistics**			
479	**Data appear Approximate Normal Distributed at 5% Significance Level**			
480				
481	**Assuming Normal Distribution**			
482	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
483	95% Student's-t UCL	0.197	95% Adjusted-CLT UCL (Chen-1995)	0.199
484			95% Modified-t UCL (Johnson-1978)	0.199
485				
486	**Nonparametric Distribution Free UCLs**			
487	95% CLT UCL	0.186	95% Jackknife UCL	0.197
488	95% Standard Bootstrap UCL	0.181	95% Bootstrap-t UCL	0.295
489	95% Hall's Bootstrap UCL	0.694	95% Percentile Bootstrap UCL	0.185
490	95% BCA Bootstrap UCL	0.187		
491	90% Chebyshev(Mean, Sd) UCL	0.227	95% Chebyshev(Mean, Sd) UCL	0.268
492	97.5% Chebyshev(Mean, Sd) UCL	0.325	99% Chebyshev(Mean, Sd) UCL	0.437
493				
494	**Suggested UCL to Use**			
495	**Data appear Normal, May want to try Normal Distribution**			

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
496												
497	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
498	Recommendations are based upon data size, data distribution, and skewness.											
499	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
500	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
501												
502												
503	molybdenum											
504												
505	General Statistics											
506	Total Number of Observations					22	Number of Distinct Observations					15
507							Number of Missing Observations					1
508	Minimum					0.6	Mean					1.216
509	Maximum					2.4	Median					1.075
510	SD					0.506	Std. Error of Mean					0.108
511	Coefficient of Variation					0.416	Skewness					1.258
512	Mean of logged Data					0.124	SD of logged Data					0.375
513												
514	Nonparametric Distribution Free UCL Statistics											
515	Data appear Lognormal Distributed at 5% Significance Level											
516												
517	Assuming Normal Distribution											
518	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
519	95% Student's-t UCL					1.402	95% Adjusted-CLT UCL (Chen-1995)					1.424
520							95% Modified-t UCL (Johnson-1978)					1.406
521												
522	Nonparametric Distribution Free UCLs											
523	95% CLT UCL					1.393	95% Jackknife UCL					1.402
524	95% Standard Bootstrap UCL					1.39	95% Bootstrap-t UCL					1.443
525	95% Hall's Bootstrap UCL					1.422	95% Percentile Bootstrap UCL					1.4
526	95% BCA Bootstrap UCL					1.407						
527	90% Chebyshev(Mean, Sd) UCL					1.539	95% Chebyshev(Mean, Sd) UCL					1.686
528	97.5% Chebyshev(Mean, Sd) UCL					1.889	99% Chebyshev(Mean, Sd) UCL					2.289
529												
530	Suggested UCL to Use											
531	Data appear Lognormal, May want to try Lognormal Distribution											
532												
533	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
534	Recommendations are based upon data size, data distribution, and skewness.											
535	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
536	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
537												
538												
539	nickel											
540												
541	General Statistics											
542	Total Number of Observations					22	Number of Distinct Observations					15
543							Number of Missing Observations					0
544	Minimum					16	Mean					22.46

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
545	Maximum	36	Median	21.5
546	SD	4.931	Std. Error of Mean	1.051
547	Coefficient of Variation	0.22	Skewness	1.276
548	Mean of logged Data	3.091	SD of logged Data	0.204
549				
550	**Nonparametric Distribution Free UCL Statistics**			
551	**Data appear Gamma Distributed at 5% Significance Level**			
552				
553	**Assuming Normal Distribution**			
554	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
555	95% Student's-t UCL	24.27	95% Adjusted-CLT UCL (Chen-1995)	24.49
556			95% Modified-t UCL (Johnson-1978)	24.32
557				
558	**Nonparametric Distribution Free UCLs**			
559	95% CLT UCL	24.19	95% Jackknife UCL	24.27
560	95% Standard Bootstrap UCL	24.15	95% Bootstrap-t UCL	24.67
561	95% Hall's Bootstrap UCL	24.84	95% Percentile Bootstrap UCL	24.23
562	95% BCA Bootstrap UCL	24.34		
563	90% Chebyshev(Mean, Sd) UCL	25.61	95% Chebyshev(Mean, Sd) UCL	27.04
564	97.5% Chebyshev(Mean, Sd) UCL	29.02	99% Chebyshev(Mean, Sd) UCL	32.92
565				
566	**Suggested UCL to Use**			
567	**Data appear Gamma, May want to try Gamma Distribution**			
568				
569	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
570	Recommendations are based upon data size, data distribution, and skewness.			
571	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
572	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
573				
574	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
575	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
576				
577	selenium			
578				
579	**General Statistics**			
580	Total Number of Observations	22	Number of Distinct Observations	5
581			Number of Missing Observations	1
582	Number of Detects	5	Number of Non-Detects	17
583	Number of Distinct Detects	4	Number of Distinct Non-Detects	2
584	Minimum Detect	0.7	Minimum Non-Detect	0.5
585	Maximum Detect	1	Maximum Non-Detect	0.7
586	Variance Detects	0.0205	Percent Non-Detects	77.27%
587	Mean Detects	0.848	SD Detects	0.143
588	Median Detects	0.8	CV Detects	0.169
589	Skewness Detects	0.342	Kurtosis Detects	-2.987
590	Mean of Logged Detects	-0.176	SD of Logged Detects	0.168
591				
592	**Nonparametric Distribution Free UCL Statistics**			
593	**Detected Data appear Normal Distributed at 5% Significance Level**			

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
594				
595	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
596	Mean	0.579	Standard Error of Mean	0.0377
597	SD	0.158	95% KM (BCA) UCL	N/A
598	95% KM (t) UCL	0.644	95% KM (Percentile Bootstrap) UCL	N/A
599	95% KM (z) UCL	0.641	95% KM Bootstrap t UCL	N/A
600	90% KM Chebyshev UCL	0.692	95% KM Chebyshev UCL	0.743
601	97.5% KM Chebyshev UCL	0.814	99% KM Chebyshev UCL	0.954
602				
603	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
604	KM SD (logged)	0.228	95% Critical H Value (KM-Log)	1.792
605	KM Mean (logged)	-0.576	KM Geo Mean	0.562
606	KM Standard Error of Mean (logged)	0.0544	95% H-UCL (KM -Log)	0.631
607				
608	**Suggested UCL to Use**			
609	**Data appear Normal, May want to try Normal Distribution.**			
610	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
611	Recommendations are based upon data size, data distribution, and skewness.			
612	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
613	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
614				
615				
616	silver			
617				
618	**General Statistics**			
619	Total Number of Observations	22	Number of Distinct Observations	22
620			Number of Missing Observations	1
621	Minimum	0.083	Mean	0.721
622	Maximum	3.3	Median	0.379
623	SD	0.881	Std. Error of Mean	0.188
624	Coefficient of Variation	1.223	Skewness	2.171
625	Mean of logged Data	-0.856	SD of logged Data	1.017
626				
627	**Nonparametric Distribution Free UCL Statistics**			
628	**Data appear Lognormal Distributed at 5% Significance Level**			
629				
630	**Assuming Normal Distribution**			
631	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
632	95% Student's-t UCL	1.044	95% Adjusted-CLT UCL (Chen-1995)	1.123
633			95% Modified-t UCL (Johnson-1978)	1.058
634				
635	**Nonparametric Distribution Free UCLs**			
636	95% CLT UCL	1.03	95% Jackknife UCL	1.044
637	95% Standard Bootstrap UCL	1.024	95% Bootstrap-t UCL	1.368
638	95% Hall's Bootstrap UCL	1.516	95% Percentile Bootstrap UCL	1.033
639	95% BCA Bootstrap UCL	1.126		
640	90% Chebyshev(Mean, Sd) UCL	1.284	95% Chebyshev(Mean, Sd) UCL	1.54
641	97.5% Chebyshev(Mean, Sd) UCL	1.894	99% Chebyshev(Mean, Sd) UCL	2.59
642				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
643	**Suggested UCL to Use**			
644	**Data appear Lognormal, May want to try Lognormal Distribution**			
645				
646	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
647	Recommendations are based upon data size, data distribution, and skewness.			
648	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
649	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
650				
651				
652	sodium			
653				
654	**General Statistics**			
655	Total Number of Observations	6	Number of Distinct Observations	6
656			Number of Missing Observations	17
657	Minimum	209	Mean	300
658	Maximum	447	Median	283
659	SD	94.39	Std. Error of Mean	38.54
660	Coefficient of Variation	0.315	Skewness	0.678
661	Mean of logged Data	5.664	SD of logged Data	0.308
662				
663	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
664	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
665	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
666				
667	**Nonparametric Distribution Free UCL Statistics**			
668	**Data appear Normal Distributed at 5% Significance Level**			
669				
670	**Assuming Normal Distribution**			
671	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
672	95% Student's-t UCL	377.7	95% Adjusted-CLT UCL (Chen-1995)	374.8
673			95% Modified-t UCL (Johnson-1978)	379.4
674				
675	**Nonparametric Distribution Free UCLs**			
676	95% CLT UCL	363.4	95% Jackknife UCL	377.7
677	95% Standard Bootstrap UCL	357.3	95% Bootstrap-t UCL	390.2
678	95% Hall's Bootstrap UCL	364.5	95% Percentile Bootstrap UCL	358.7
679	95% BCA Bootstrap UCL	360.7		
680	90% Chebyshev(Mean, Sd) UCL	415.6	95% Chebyshev(Mean, Sd) UCL	468
681	97.5% Chebyshev(Mean, Sd) UCL	540.7	99% Chebyshev(Mean, Sd) UCL	683.4
682				
683	**Suggested UCL to Use**			
684	**Data appear Normal, May want to try Normal Distribution**			
685				
686	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
687	Recommendations are based upon data size, data distribution, and skewness.			
688	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
689	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
690				
691				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
692	**thallium**			
693				
694	**General Statistics**			
695	Total Number of Observations	22	Number of Distinct Observations	15
696			Number of Missing Observations	1
697	Minimum	0.08	Mean	0.158
698	Maximum	0.263	Median	0.135
699	SD	0.0533	Std. Error of Mean	0.0114
700	Coefficient of Variation	0.338	Skewness	0.554
701	Mean of logged Data	-1.902	SD of logged Data	0.337
702				
703	**Nonparametric Distribution Free UCL Statistics**			
704	**Data appear Approximate Normal Distributed at 5% Significance Level**			
705				
706	**Assuming Normal Distribution**			
707	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
708	95% Student's-t UCL	0.177	95% Adjusted-CLT UCL (Chen-1995)	0.178
709			95% Modified-t UCL (Johnson-1978)	0.177
710				
711	**Nonparametric Distribution Free UCLs**			
712	95% CLT UCL	0.176	95% Jackknife UCL	0.177
713	95% Standard Bootstrap UCL	0.176	95% Bootstrap-t UCL	0.179
714	95% Hall's Bootstrap UCL	0.178	95% Percentile Bootstrap UCL	0.176
715	95% BCA Bootstrap UCL	0.177		
716	90% Chebyshev(Mean, Sd) UCL	0.192	95% Chebyshev(Mean, Sd) UCL	0.207
717	97.5% Chebyshev(Mean, Sd) UCL	0.229	99% Chebyshev(Mean, Sd) UCL	0.271
718				
719	**Suggested UCL to Use**			
720	**Data appear Normal, May want to try Normal Distribution**			
721				
722	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
723	Recommendations are based upon data size, data distribution, and skewness.			
724	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
725	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
726				
727				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
728	tin			
729				
730	General Statistics			
731	Total Number of Observations	6	Number of Distinct Observations	6
732			Number of Missing Observations	17
733	Minimum	1.36	Mean	3.605
734	Maximum	6.31	Median	3.64
735	SD	1.963	Std. Error of Mean	0.802
736	Coefficient of Variation	0.545	Skewness	0.154
737	Mean of logged Data	1.134	SD of logged Data	0.624
738				
739	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
740	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
741	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
742				
743	Nonparametric Distribution Free UCL Statistics			
744	Data appear Normal Distributed at 5% Significance Level			
745				
746	Assuming Normal Distribution			
747	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
748	95% Student's-t UCL	5.22	95% Adjusted-CLT UCL (Chen-1995)	4.977
749			95% Modified-t UCL (Johnson-1978)	5.229
750				
751	Nonparametric Distribution Free UCLs			
752	95% CLT UCL	4.923	95% Jackknife UCL	5.22
753	95% Standard Bootstrap UCL	4.825	95% Bootstrap-t UCL	5.342
754	95% Hall's Bootstrap UCL	4.792	95% Percentile Bootstrap UCL	4.778
755	95% BCA Bootstrap UCL	4.822		
756	90% Chebyshev(Mean, Sd) UCL	6.01	95% Chebyshev(Mean, Sd) UCL	7.099
757	97.5% Chebyshev(Mean, Sd) UCL	8.61	99% Chebyshev(Mean, Sd) UCL	11.58
758				
759	Suggested UCL to Use			
760	Data appear Normal, May want to try Normal Distribution			
761				
762	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
763	Recommendations are based upon data size, data distribution, and skewness.			
764	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
765	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
766				
767				
768	titanium			
769				
770	General Statistics			
771	Total Number of Observations	6	Number of Distinct Observations	6
772			Number of Missing Observations	17
773	Minimum	101	Mean	126.8
774	Maximum	150	Median	125
775	SD	16.7	Std. Error of Mean	6.819
776	Coefficient of Variation	0.132	Skewness	-0.208

1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
777	Mean of logged Data	4.835	SD of logged Data	0.135
778				
779	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
780	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
781	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
782				
783	**Nonparametric Distribution Free UCL Statistics**			
784	**Data appear Normal Distributed at 5% Significance Level**			
785				
786	**Assuming Normal Distribution**			
787	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
788	95% Student's-t UCL	140.6	95% Adjusted-CLT UCL (Chen-1995)	137.4
789			95% Modified-t UCL (Johnson-1978)	140.5
790				
791	**Nonparametric Distribution Free UCLs**			
792	95% CLT UCL	138	95% Jackknife UCL	140.6
793	95% Standard Bootstrap UCL	136.9	95% Bootstrap-t UCL	141
794	95% Hall's Bootstrap UCL	144.5	95% Percentile Bootstrap UCL	136.2
795	95% BCA Bootstrap UCL	137.3		
796	90% Chebyshev(Mean, Sd) UCL	147.3	95% Chebyshev(Mean, Sd) UCL	156.6
797	97.5% Chebyshev(Mean, Sd) UCL	169.4	99% Chebyshev(Mean, Sd) UCL	194.7
798				
799	**Suggested UCL to Use**			
800	**Data appear Normal, May want to try Normal Distribution**			
801				
802	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
803	Recommendations are based upon data size, data distribution, and skewness.			
804	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
805	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
806				
807	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
808	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
809				
810				
811	**uranium**			
812				
813	**General Statistics**			
814	Total Number of Observations	22	Number of Distinct Observations	19
815			Number of Missing Observations	1
816	Minimum	0.46	Mean	0.645
817	Maximum	0.886	Median	0.645
818	SD	0.118	Std. Error of Mean	0.0252
819	Coefficient of Variation	0.183	Skewness	0.525
820	Mean of logged Data	-0.455	SD of logged Data	0.181
821				
822	**Nonparametric Distribution Free UCL Statistics**			
823	**Data appear Normal Distributed at 5% Significance Level**			
824				

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
825	**Assuming Normal Distribution**			
826	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
827	95% Student's-t UCL	0.688	95% Adjusted-CLT UCL (Chen-1995)	0.689
828			95% Modified-t UCL (Johnson-1978)	0.688
829				
830	**Nonparametric Distribution Free UCLs**			
831	95% CLT UCL	0.686	95% Jackknife UCL	0.688
832	95% Standard Bootstrap UCL	0.685	95% Bootstrap-t UCL	0.693
833	95% Hall's Bootstrap UCL	0.691	95% Percentile Bootstrap UCL	0.686
834	95% BCA Bootstrap UCL	0.687		
835	90% Chebyshev(Mean, Sd) UCL	0.72	95% Chebyshev(Mean, Sd) UCL	0.754
836	97.5% Chebyshev(Mean, Sd) UCL	0.802	99% Chebyshev(Mean, Sd) UCL	0.895
837				
838	**Suggested UCL to Use**			
839	**Data appear Normal, May want to try Normal Distribution**			
840				
841	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
842	Recommendations are based upon data size, data distribution, and skewness.			
843	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
844	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
847	vanadium			
848				
849	**General Statistics**			
850	Total Number of Observations	15	Number of Distinct Observations	11
851			Number of Missing Observations	8
852	Minimum	13	Mean	19.33
853	Maximum	28.7	Median	18
854	SD	4.313	Std. Error of Mean	1.114
855	Coefficient of Variation	0.223	Skewness	0.489
856	Mean of logged Data	2.939	SD of logged Data	0.223
857				
858	**Nonparametric Distribution Free UCL Statistics**			
859	**Data appear Normal Distributed at 5% Significance Level**			
860				
861	**Assuming Normal Distribution**			
862	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
863	95% Student's-t UCL	21.29	95% Adjusted-CLT UCL (Chen-1995)	21.32
864			95% Modified-t UCL (Johnson-1978)	21.32
865				
866	**Nonparametric Distribution Free UCLs**			
867	95% CLT UCL	21.17	95% Jackknife UCL	21.29
868	95% Standard Bootstrap UCL	21.11	95% Bootstrap-t UCL	21.38
869	95% Hall's Bootstrap UCL	21.65	95% Percentile Bootstrap UCL	21.15
870	95% BCA Bootstrap UCL	21.05		
871	90% Chebyshev(Mean, Sd) UCL	22.67	95% Chebyshev(Mean, Sd) UCL	24.19
872	97.5% Chebyshev(Mean, Sd) UCL	26.29	99% Chebyshev(Mean, Sd) UCL	30.41
873				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
874	Suggested UCL to Use			
875	Data appear Normal, May want to try Normal Distribution			
876				
877	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
878	Recommendations are based upon data size, data distribution, and skewness.			
879	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
880	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
881				
882				
883	zinc			
884				
885	General Statistics			
886	Total Number of Observations	22	Number of Distinct Observations	19
887			Number of Missing Observations	0
888	Minimum	167	Mean	309.9
889	Maximum	532	Median	286.5
890	SD	108.8	Std. Error of Mean	23.19
891	Coefficient of Variation	0.351	Skewness	0.688
892	Mean of logged Data	5.68	SD of logged Data	0.341
893				
894	Nonparametric Distribution Free UCL Statistics			
895	Data appear Normal Distributed at 5% Significance Level			
896				
897	Assuming Normal Distribution			
898	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
899	95% Student's-t UCL	349.8	95% Adjusted-CLT UCL (Chen-1995)	351.7
900			95% Modified-t UCL (Johnson-1978)	350.4
901				
902	Nonparametric Distribution Free UCLs			
903	95% CLT UCL	348	95% Jackknife UCL	349.8
904	95% Standard Bootstrap UCL	347.3	95% Bootstrap-t UCL	356.4
905	95% Hall's Bootstrap UCL	351.1	95% Percentile Bootstrap UCL	348
906	95% BCA Bootstrap UCL	349.3		
907	90% Chebyshev(Mean, Sd) UCL	379.5	95% Chebyshev(Mean, Sd) UCL	411
908	97.5% Chebyshev(Mean, Sd) UCL	454.7	99% Chebyshev(Mean, Sd) UCL	540.6
909				
910	Suggested UCL to Use			
911	Data appear Normal, May want to try Normal Distribution			
912				
913	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
914	Recommendations are based upon data size, data distribution, and skewness.			
915	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
916	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
917				

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
918	**acenaphthylene**			
919				
920	**General Statistics**			
921	Total Number of Observations	22	Number of Distinct Observations	9
922			Number of Missing Observations	1
923	Number of Detects	8	Number of Non-Detects	14
924	Number of Distinct Detects	8	Number of Distinct Non-Detects	1
925	Minimum Detect	0.011	Minimum Non-Detect	0.1
926	Maximum Detect	0.18	Maximum Non-Detect	0.1
927	Variance Detects	0.00396	Percent Non-Detects	63.64%
928	Mean Detects	0.0479	SD Detects	0.0629
929	Median Detects	0.018	CV Detects	1.314
930	Skewness Detects	1.787	Kurtosis Detects	2.258
931	Mean of Logged Detects	-3.639	SD of Logged Detects	1.068
932				
933	**Nonparametric Distribution Free UCL Statistics**			
934	**Data do not follow a Discernible Distribution at 5% Significance Level**			
935				
936	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
937	Mean	0.0273	Standard Error of Mean	0.00895
938	SD	0.0389	95% KM (BCA) UCL	0.0423
939	95% KM (t) UCL	0.0427	95% KM (Percentile Bootstrap) UCL	0.0429
940	95% KM (z) UCL	0.042	95% KM Bootstrap t UCL	0.101
941	90% KM Chebyshev UCL	0.0541	95% KM Chebyshev UCL	0.0663
942	97.5% KM Chebyshev UCL	0.0832	99% KM Chebyshev UCL	0.116
943				
944	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
945	KM SD (logged)	0.689	95% Critical H Value (KM-Log)	2.19
946	KM Mean (logged)	-3.994	KM Geo Mean	0.0184
947	KM Standard Error of Mean (logged)	0.177	95% H-UCL (KM -Log)	0.0325
948				
949	**Suggested UCL to Use**			
950	95% KM (Chebyshev) UCL	0.0663		
951	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
952	Recommendations are based upon data size, data distribution, and skewness.			
953	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
954	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
955				
956	**acenaphthene**			
957				
958	**General Statistics**			
959	Total Number of Observations	22	Number of Distinct Observations	11
960			Number of Missing Observations	1
961	Number of Detects	11	Number of Non-Detects	11
962	Number of Distinct Detects	10	Number of Distinct Non-Detects	1
963	Minimum Detect	0.03	Minimum Non-Detect	0.1
964	Maximum Detect	1.49	Maximum Non-Detect	0.1
965	Variance Detects	0.201	Percent Non-Detects	50%
966	Mean Detects	0.329	SD Detects	0.448

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
967	Median Detects	0.25	CV Detects	1.364
968	Skewness Detects	2.143	Kurtosis Detects	4.514
969	Mean of Logged Detects	-1.865	SD of Logged Detects	1.302
970				
971	**Nonparametric Distribution Free UCL Statistics**			
972	**Detected Data appear Gamma Distributed at 5% Significance Level**			
973				
974	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
975	Mean	0.189	Standard Error of Mean	0.0747
976	SD	0.333	95% KM (BCA) UCL	0.341
977	95% KM (t) UCL	0.318	95% KM (Percentile Bootstrap) UCL	0.327
978	95% KM (z) UCL	0.312	95% KM Bootstrap t UCL	0.583
979	90% KM Chebyshev UCL	0.413	95% KM Chebyshev UCL	0.515
980	97.5% KM Chebyshev UCL	0.656	99% KM Chebyshev UCL	0.932
981				
982	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
983	KM SD (logged)	1.093	95% Critical H Value (KM-Log)	2.714
984	KM Mean (logged)	-2.469	KM Geo Mean	0.0846
985	KM Standard Error of Mean (logged)	0.263	95% H-UCL (KM -Log)	0.294
986				
987	**Suggested UCL to Use**			
988	**Data appear Gamma, May want to try Gamma Distribution**			
989	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
990	Recommendations are based upon data size, data distribution, and skewness.			
991	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
992	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
993				
994	**anthracene**			
995				
996	**General Statistics**			
997	Total Number of Observations	22	Number of Distinct Observations	11
998			Number of Missing Observations	1
999	Number of Detects	16	Number of Non-Detects	6
1000	Number of Distinct Detects	11	Number of Distinct Non-Detects	1
1001	Minimum Detect	0.08	Minimum Non-Detect	0.1
1002	Maximum Detect	4.69	Maximum Non-Detect	0.1
1003	Variance Detects	1.279	Percent Non-Detects	27.27%
1004	Mean Detects	0.556	SD Detects	1.131
1005	Median Detects	0.155	CV Detects	2.035
1006	Skewness Detects	3.687	Kurtosis Detects	14.12
1007	Mean of Logged Detects	-1.384	SD of Logged Detects	1.074
1008				
1009	**Nonparametric Distribution Free UCL Statistics**			
1010	**Data do not follow a Discernible Distribution at 5% Significance Level**			
1011				
1012	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1013	Mean	0.426	Standard Error of Mean	0.211
1014	SD	0.957	95% KM (BCA) UCL	0.867
1015	95% KM (t) UCL	0.789	95% KM (Percentile Bootstrap) UCL	0.822

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1016	95% KM (z) UCL	0.773	95% KM Bootstrap t UCL	2.153
1017	90% KM Chebyshev UCL	1.058	95% KM Chebyshev UCL	1.345
1018	97.5% KM Chebyshev UCL	1.742	99% KM Chebyshev UCL	2.523
1019				
1020	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1021	KM SD (logged)	1.022	95% Critical H Value (KM-Log)	2.614
1022	KM Mean (logged)	-1.696	KM Geo Mean	0.183
1023	KM Standard Error of Mean (logged)	0.225	95% H-UCL (KM -Log)	0.555
1024				
1025	**Suggested UCL to Use**			
1026	95% KM (Chebyshev) UCL	1.345		
1027	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1028	Recommendations are based upon data size, data distribution, and skewness.			
1029	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1030	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1031				
1032				
1033	**benz(a)anthracene**			
1034				
1035	**General Statistics**			
1036	Total Number of Observations	22	Number of Distinct Observations	19
1037			Number of Missing Observations	1
1038	Minimum	0.18	Mean	1.133
1039	Maximum	6.6	Median	0.645
1040	SD	1.395	Std. Error of Mean	0.297
1041	Coefficient of Variation	1.232	Skewness	3.208
1042	Mean of logged Data	-0.271	SD of logged Data	0.822
1043				
1044	**Nonparametric Distribution Free UCL Statistics**			
1045	**Data appear Lognormal Distributed at 5% Significance Level**			
1046				
1047	**Assuming Normal Distribution**			
1048	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1049	95% Student's-t UCL	1.645	95% Adjusted-CLT UCL (Chen-1995)	1.839
1050			95% Modified-t UCL (Johnson-1978)	1.678
1051				
1052	**Nonparametric Distribution Free UCLs**			
1053	95% CLT UCL	1.622	95% Jackknife UCL	1.645
1054	95% Standard Bootstrap UCL	1.612	95% Bootstrap-t UCL	2.313
1055	95% Hall's Bootstrap UCL	3.555	95% Percentile Bootstrap UCL	1.653
1056	95% BCA Bootstrap UCL	1.83		
1057	90% Chebyshev(Mean, Sd) UCL	2.025	95% Chebyshev(Mean, Sd) UCL	2.429
1058	97.5% Chebyshev(Mean, Sd) UCL	2.99	99% Chebyshev(Mean, Sd) UCL	4.092
1059				
1060	**Suggested UCL to Use**			
1061	**Data appear Lognormal, May want to try Lognormal Distribution**			
1062				
1063	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1064	Recommendations are based upon data size, data distribution, and skewness.			

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1065	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1066	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1067				
1068				
1069	**benzo(b)fluoranthene**			
1070				
1071	**General Statistics**			
1072	Total Number of Observations	22	Number of Distinct Observations	18
1073			Number of Missing Observations	1
1074	Minimum	0.32	Mean	1.593
1075	Maximum	8.37	Median	1
1076	SD	1.728	Std. Error of Mean	0.368
1077	Coefficient of Variation	1.085	Skewness	3.171
1078	Mean of logged Data	0.145	SD of logged Data	0.748
1079				
1080	**Nonparametric Distribution Free UCL Statistics**			
1081	**Data appear Lognormal Distributed at 5% Significance Level**			
1082				
1083	**Assuming Normal Distribution**			
1084	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1085	95% Student's-t UCL	2.227	95% Adjusted-CLT UCL (Chen-1995)	2.465
1086			95% Modified-t UCL (Johnson-1978)	2.268
1087				
1088	**Nonparametric Distribution Free UCLs**			
1089	95% CLT UCL	2.199	95% Jackknife UCL	2.227
1090	95% Standard Bootstrap UCL	2.2	95% Bootstrap-t UCL	2.95
1091	95% Hall's Bootstrap UCL	4.64	95% Percentile Bootstrap UCL	2.262
1092	95% BCA Bootstrap UCL	2.517		
1093	90% Chebyshev(Mean, Sd) UCL	2.698	95% Chebyshev(Mean, Sd) UCL	3.199
1094	97.5% Chebyshev(Mean, Sd) UCL	3.894	99% Chebyshev(Mean, Sd) UCL	5.259
1095				
1096	**Suggested UCL to Use**			
1097	**Data appear Lognormal, May want to try Lognormal Distribution**			
1098				
1099	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1100	Recommendations are based upon data size, data distribution, and skewness.			
1101	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1102	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1103				
1104				
1105	**benzo(b+j)fluoranthenes**			
1106				
1107	**General Statistics**			
1108	Total Number of Observations	6	Number of Distinct Observations	5
1109			Number of Missing Observations	17
1110	Minimum	0.9	Mean	1.163
1111	Maximum	1.4	Median	1.2
1112	SD	0.2	Std. Error of Mean	0.0817
1113	Coefficient of Variation	0.172	Skewness	-0.236
1114	Mean of logged Data	0.138	SD of logged Data	0.177

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1115												
1116	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**											
1117	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**											
1118	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**											
1119												
1120	**Nonparametric Distribution Free UCL Statistics**											
1121	**Data appear Normal Distributed at 5% Significance Level**											
1122												
1123	**Assuming Normal Distribution**											
1124	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1125	95% Student's-t UCL					1.328	95% Adjusted-CLT UCL (Chen-1995)					1.289
1126							95% Modified-t UCL (Johnson-1978)					1.327
1127												
1128	**Nonparametric Distribution Free UCLs**											
1129	95% CLT UCL					1.298	95% Jackknife UCL					1.328
1130	95% Standard Bootstrap UCL					1.285	95% Bootstrap-t UCL					1.316
1131	95% Hall's Bootstrap UCL					1.265	95% Percentile Bootstrap UCL					1.283
1132	95% BCA Bootstrap UCL					1.267						
1133	90% Chebyshev(Mean, Sd) UCL					1.408	95% Chebyshev(Mean, Sd) UCL					1.52
1134	97.5% Chebyshev(Mean, Sd) UCL					1.674	99% Chebyshev(Mean, Sd) UCL					1.976
1135												
1136	**Suggested UCL to Use**											
1137	**Data appear Normal, May want to try Normal Distribution**											
1138												
1139	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1140	Recommendations are based upon data size, data distribution, and skewness.											
1141	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1142	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1143												
1144	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
1145	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
1146												
1147												
1148	**benzo(g,h,i)perylene**											
1149												
1150	**General Statistics**											
1151	Total Number of Observations					22	Number of Distinct Observations					20
1152							Number of Missing Observations					1
1153	Minimum					0.13	Mean					0.699
1154	Maximum					4.36	Median					0.435
1155	SD					0.874	Std. Error of Mean					0.186
1156	Coefficient of Variation					1.251	Skewness					3.822
1157	Mean of logged Data					-0.701	SD of logged Data					0.747
1158												
1159	**Nonparametric Distribution Free UCL Statistics**											
1160	**Data appear Approximate Gamma Distributed at 5% Significance Level**											
1161												

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1162	**Assuming Normal Distribution**			
1163	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1164	95% Student's-t UCL	1.019	95% Adjusted-CLT UCL (Chen-1995)	1.168
1165			95% Modified-t UCL (Johnson-1978)	1.045
1166				
1167	**Nonparametric Distribution Free UCLs**			
1168	95% CLT UCL	1.005	95% Jackknife UCL	1.019
1169	95% Standard Bootstrap UCL	1	95% Bootstrap-t UCL	1.542
1170	95% Hall's Bootstrap UCL	2.218	95% Percentile Bootstrap UCL	1.051
1171	95% BCA Bootstrap UCL	1.236		
1172	90% Chebyshev(Mean, Sd) UCL	1.258	95% Chebyshev(Mean, Sd) UCL	1.511
1173	97.5% Chebyshev(Mean, Sd) UCL	1.863	99% Chebyshev(Mean, Sd) UCL	2.553
1174				
1175	**Suggested UCL to Use**			
1176	**Data appear Approximate Gamma, May want to try Gamma Distribution**			
1177				
1178	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1179	Recommendations are based upon data size, data distribution, and skewness.			
1180	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1181	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1182				
1183	**benzo(k)fluoranthene**			
1184				
1185	**General Statistics**			
1186	Total Number of Observations	22	Number of Distinct Observations	16
1187			Number of Missing Observations	1
1188	Number of Detects	17	Number of Non-Detects	5
1189	Number of Distinct Detects	15	Number of Distinct Non-Detects	1
1190	Minimum Detect	0.23	Minimum Non-Detect	0.2
1191	Maximum Detect	2.29	Maximum Non-Detect	0.2
1192	Variance Detects	0.284	Percent Non-Detects	22.73%
1193	Mean Detects	0.606	SD Detects	0.533
1194	Median Detects	0.41	CV Detects	0.879
1195	Skewness Detects	2.328	Kurtosis Detects	5.964
1196	Mean of Logged Detects	-0.748	SD of Logged Detects	0.67
1197				
1198	**Nonparametric Distribution Free UCL Statistics**			
1199	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**			
1200				
1201	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1202	Mean	0.514	Standard Error of Mean	0.107
1203	SD	0.485	95% KM (BCA) UCL	0.71
1204	95% KM (t) UCL	0.697	95% KM (Percentile Bootstrap) UCL	0.688
1205	95% KM (z) UCL	0.689	95% KM Bootstrap t UCL	0.864
1206	90% KM Chebyshev UCL	0.833	95% KM Chebyshev UCL	0.978
1207	97.5% KM Chebyshev UCL	1.179	99% KM Chebyshev UCL	1.574
1208				
1209	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1210	KM SD (logged)	0.676	95% Critical H Value (KM-Log)	2.176

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1211	KM Mean (logged)	-0.944	KM Geo Mean	0.389
1212	KM Standard Error of Mean (logged)	0.149	95% H-UCL (KM -Log)	0.674
1213				
1214	**Suggested UCL to Use**			
1215	**Data appear Gamma, May want to try Gamma Distribution**			
1216	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1217	Recommendations are based upon data size, data distribution, and skewness.			
1218	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1219	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1220				
1221				
1222	**benzo(a)pyrene**			
1223				
1224	**General Statistics**			
1225	Total Number of Observations	22	Number of Distinct Observations	19
1226			Number of Missing Observations	1
1227	Minimum	0.18	Mean	1.068
1228	Maximum	6.01	Median	0.69
1229	SD	1.231	Std. Error of Mean	0.262
1230	Coefficient of Variation	1.153	Skewness	3.391
1231	Mean of logged Data	-0.274	SD of logged Data	0.767
1232				
1233	**Nonparametric Distribution Free UCL Statistics**			
1234	**Data appear Lognormal Distributed at 5% Significance Level**			
1235				
1236	**Assuming Normal Distribution**			
1237	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1238	95% Student's-t UCL	1.519	95% Adjusted-CLT UCL (Chen-1995)	1.702
1239			95% Modified-t UCL (Johnson-1978)	1.551
1240				
1241	**Nonparametric Distribution Free UCLs**			
1242	95% CLT UCL	1.499	95% Jackknife UCL	1.519
1243	95% Standard Bootstrap UCL	1.484	95% Bootstrap-t UCL	2.119
1244	95% Hall's Bootstrap UCL	3.209	95% Percentile Bootstrap UCL	1.56
1245	95% BCA Bootstrap UCL	1.712		
1246	90% Chebyshev(Mean, Sd) UCL	1.855	95% Chebyshev(Mean, Sd) UCL	2.212
1247	97.5% Chebyshev(Mean, Sd) UCL	2.706	99% Chebyshev(Mean, Sd) UCL	3.679
1248				
1249	**Suggested UCL to Use**			
1250	**Data appear Lognormal, May want to try Lognormal Distribution**			
1251				
1252	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1253	Recommendations are based upon data size, data distribution, and skewness.			
1254	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1255	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1256				
1257				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1258	chrysene			
1259				
1260	General Statistics			
1261	Total Number of Observations	22	Number of Distinct Observations	22
1262			Number of Missing Observations	1
1263	Minimum	0.26	Mean	1.379
1264	Maximum	7.15	Median	0.875
1265	SD	1.467	Std. Error of Mean	0.313
1266	Coefficient of Variation	1.064	Skewness	3.209
1267	Mean of logged Data	0.00898	SD of logged Data	0.749
1268				
1269	Nonparametric Distribution Free UCL Statistics			
1270	Data appear Gamma Distributed at 5% Significance Level			
1271				
1272	Assuming Normal Distribution			
1273	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1274	95% Student's-t UCL	1.917	95% Adjusted-CLT UCL (Chen-1995)	2.122
1275			95% Modified-t UCL (Johnson-1978)	1.952
1276				
1277	Nonparametric Distribution Free UCLs			
1278	95% CLT UCL	1.893	95% Jackknife UCL	1.917
1279	95% Standard Bootstrap UCL	1.896	95% Bootstrap-t UCL	2.574
1280	95% Hall's Bootstrap UCL	4.157	95% Percentile Bootstrap UCL	1.945
1281	95% BCA Bootstrap UCL	2.155		
1282	90% Chebyshev(Mean, Sd) UCL	2.317	95% Chebyshev(Mean, Sd) UCL	2.742
1283	97.5% Chebyshev(Mean, Sd) UCL	3.332	99% Chebyshev(Mean, Sd) UCL	4.49
1284				
1285	Suggested UCL to Use			
1286	Data appear Gamma, May want to try Gamma Distribution			
1287				
1288	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1289	Recommendations are based upon data size, data distribution, and skewness.			
1290	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1291	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1292				
1293	dibenz(a,h)anthracene			
1294				
1295	General Statistics			
1296	Total Number of Observations	22	Number of Distinct Observations	11
1297			Number of Missing Observations	1
1298	Number of Detects	13	Number of Non-Detects	9
1299	Number of Distinct Detects	11	Number of Distinct Non-Detects	1
1300	Minimum Detect	0.1	Minimum Non-Detect	0.1
1301	Maximum Detect	0.79	Maximum Non-Detect	0.1
1302	Variance Detects	0.0348	Percent Non-Detects	40.91%
1303	Mean Detects	0.222	SD Detects	0.187
1304	Median Detects	0.16	CV Detects	0.843
1305	Skewness Detects	2.723	Kurtosis Detects	8.07
1306	Mean of Logged Detects	-1.703	SD of Logged Detects	0.58

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1307				
1308	**Nonparametric Distribution Free UCL Statistics**			
1309	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**			
1310				
1311	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1312	Mean	0.172	Standard Error of Mean	0.0333
1313	SD	0.15	95% KM (BCA) UCL	0.242
1314	95% KM (t) UCL	0.229	95% KM (Percentile Bootstrap) UCL	0.225
1315	95% KM (z) UCL	0.227	95% KM Bootstrap t UCL	0.317
1316	90% KM Chebyshev UCL	0.272	95% KM Chebyshev UCL	0.317
1317	97.5% KM Chebyshev UCL	0.38	99% KM Chebyshev UCL	0.504
1318				
1319	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1320	KM SD (logged)	0.52	95% Critical H Value (KM-Log)	2.016
1321	KM Mean (logged)	-1.948	KM Geo Mean	0.143
1322	KM Standard Error of Mean (logged)	0.115	95% H-UCL (KM -Log)	0.205
1323				
1324	**Suggested UCL to Use**			
1325	**Data appear Gamma, May want to try Gamma Distribution**			
1326	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1327	Recommendations are based upon data size, data distribution, and skewness.			
1328	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1329	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1330				
1331				
1332	**fluoranthene**			
1333				
1334	**General Statistics**			
1335	Total Number of Observations	22	Number of Distinct Observations	22
1336			Number of Missing Observations	1
1337	Minimum	0.59	Mean	3.49
1338	Maximum	24.5	Median	1.955
1339	SD	5.055	Std. Error of Mean	1.078
1340	Coefficient of Variation	1.449	Skewness	3.783
1341	Mean of logged Data	0.816	SD of logged Data	0.818
1342				
1343	**Nonparametric Distribution Free UCL Statistics**			
1344	**Data appear Lognormal Distributed at 5% Significance Level**			
1345				
1346	**Assuming Normal Distribution**			
1347	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1348	95% Student's-t UCL	5.344	95% Adjusted-CLT UCL (Chen-1995)	6.191
1349			95% Modified-t UCL (Johnson-1978)	5.489
1350				
1351	**Nonparametric Distribution Free UCLs**			
1352	95% CLT UCL	5.262	95% Jackknife UCL	5.344
1353	95% Standard Bootstrap UCL	5.223	95% Bootstrap-t UCL	9.89
1354	95% Hall's Bootstrap UCL	12.29	95% Percentile Bootstrap UCL	5.368
1355	95% BCA Bootstrap UCL	6.834		

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1356	90% Chebyshev(Mean, Sd) UCL	6.723	95% Chebyshev(Mean, Sd) UCL	8.187
1357	97.5% Chebyshev(Mean, Sd) UCL	10.22	99% Chebyshev(Mean, Sd) UCL	14.21
1358				
1359	**Suggested UCL to Use**			
1360	**Data appear Lognormal, May want to try Lognormal Distribution**			
1361				
1362	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1363	Recommendations are based upon data size, data distribution, and skewness.			
1364	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1365	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1366				
1367	**fluorene**			
1368				
1369	**General Statistics**			
1370	Total Number of Observations	22	Number of Distinct Observations	13
1371			Number of Missing Observations	1
1372	Number of Detects	13	Number of Non-Detects	9
1373	Number of Distinct Detects	13	Number of Distinct Non-Detects	1
1374	Minimum Detect	0.047	Minimum Non-Detect	0.1
1375	Maximum Detect	1.76	Maximum Non-Detect	0.1
1376	Variance Detects	0.232	Percent Non-Detects	40.91%
1377	Mean Detects	0.343	SD Detects	0.482
1378	Median Detects	0.11	CV Detects	1.405
1379	Skewness Detects	2.493	Kurtosis Detects	6.637
1380	Mean of Logged Detects	-1.733	SD of Logged Detects	1.144
1381				
1382	**Nonparametric Distribution Free UCL Statistics**			
1383	**Detected Data appear Gamma Distributed at 5% Significance Level**			
1384				
1385	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1386	Mean	0.229	Standard Error of Mean	0.0847
1387	SD	0.382	95% KM (BCA) UCL	0.395
1388	95% KM (t) UCL	0.375	95% KM (Percentile Bootstrap) UCL	0.383
1389	95% KM (z) UCL	0.368	95% KM Bootstrap t UCL	0.67
1390	90% KM Chebyshev UCL	0.483	95% KM Chebyshev UCL	0.598
1391	97.5% KM Chebyshev UCL	0.758	99% KM Chebyshev UCL	1.072
1392				
1393	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1394	KM SD (logged)	1.001	95% Critical H Value (KM-Log)	2.585
1395	KM Mean (logged)	-2.162	KM Geo Mean	0.115
1396	KM Standard Error of Mean (logged)	0.229	95% H-UCL (KM -Log)	0.334
1397				
1398	**Suggested UCL to Use**			
1399	**Data appear Gamma, May want to try Gamma Distribution**			
1400	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1401	Recommendations are based upon data size, data distribution, and skewness.			
1402	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1403	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1404				
1405				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1406	**indeno(1,2,3-cd)pyrene**			
1407				
1408	**General Statistics**			
1409	Total Number of Observations	22	Number of Distinct Observations	19
1410			Number of Missing Observations	1
1411	Minimum	0.11	Mean	0.603
1412	Maximum	3.45	Median	0.42
1413	SD	0.698	Std. Error of Mean	0.149
1414	Coefficient of Variation	1.157	Skewness	3.547
1415	Mean of logged Data	-0.835	SD of logged Data	0.754
1416				
1417	**Nonparametric Distribution Free UCL Statistics**			
1418	**Data appear Approximate Gamma Distributed at 5% Significance Level**			
1419				
1420	**Assuming Normal Distribution**			
1421	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1422	95% Student's-t UCL	0.859	95% Adjusted-CLT UCL (Chen-1995)	0.968
1423			95% Modified-t UCL (Johnson-1978)	0.878
1424				
1425	**Nonparametric Distribution Free UCLs**			
1426	95% CLT UCL	0.848	95% Jackknife UCL	0.859
1427	95% Standard Bootstrap UCL	0.843	95% Bootstrap-t UCL	1.234
1428	95% Hall's Bootstrap UCL	1.859	95% Percentile Bootstrap UCL	0.857
1429	95% BCA Bootstrap UCL	0.997		
1430	90% Chebyshev(Mean, Sd) UCL	1.049	95% Chebyshev(Mean, Sd) UCL	1.252
1431	97.5% Chebyshev(Mean, Sd) UCL	1.532	99% Chebyshev(Mean, Sd) UCL	2.083
1432				
1433	**Suggested UCL to Use**			
1434	**Data appear Approximate Gamma, May want to try Gamma Distribution**			
1435				
1436	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1437	Recommendations are based upon data size, data distribution, and skewness.			
1438	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1439	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1440				
1441	**methylnaphthalene, 1-**			
1442				
1443	**General Statistics**			
1444	Total Number of Observations	16	Number of Distinct Observations	3
1445			Number of Missing Observations	7
1446	Number of Detects	2	Number of Non-Detects	14
1447	Number of Distinct Detects	2	Number of Distinct Non-Detects	1
1448	Minimum Detect	0.15	Minimum Non-Detect	0.1
1449	Maximum Detect	0.2	Maximum Non-Detect	0.1
1450	Variance Detects	0.00125	Percent Non-Detects	87.5%
1451	Mean Detects	0.175	SD Detects	0.0354
1452	Median Detects	0.175	CV Detects	0.202
1453	Skewness Detects	N/A	Kurtosis Detects	N/A
1454	Mean of Logged Detects	-1.753	SD of Logged Detects	0.203

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1455												
1456	Warning: Data set has only 2 Detected Values.											
1457	This is not enough to compute meaningful or reliable statistics and estimates.											
1458												
1459												
1460	Nonparametric Distribution Free UCL Statistics											
1461	Data do not follow a Discernible Distribution at 5% Significance Level											
1462												
1463	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
1464	Mean					0.109	Standard Error of Mean					0.00931
1465	SD					0.0263	95% KM (BCA) UCL					N/A
1466	95% KM (t) UCL					0.126	95% KM (Percentile Bootstrap) UCL					N/A
1467	95% KM (z) UCL					0.125	95% KM Bootstrap t UCL					N/A
1468	90% KM Chebyshev UCL					0.137	95% KM Chebyshev UCL					0.15
1469	97.5% KM Chebyshev UCL					0.168	99% KM Chebyshev UCL					0.202
1470												
1471	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
1472	KM SD (logged)					0.189	95% Critical H Value (KM-Log)					1.793
1473	KM Mean (logged)					-2.234	KM Geo Mean					0.107
1474	KM Standard Error of Mean (logged)					0.0667	95% H-UCL (KM -Log)					0.119
1475												
1476	Suggested UCL to Use											
1477	95% KM (t) UCL					0.126	KM H-UCL					0.119
1478	95% KM (BCA) UCL					N/A						
1479	Warning: One or more Recommended UCL(s) not available!											
1480	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1481	Recommendations are based upon data size, data distribution, and skewness.											
1482	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1483	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1484												
1485	methylnaphthalene, 2-											
1486												
1487	General Statistics											
1488	Total Number of Observations					22	Number of Distinct Observations					8
1489							Number of Missing Observations					1
1490	Number of Detects					9	Number of Non-Detects					13
1491	Number of Distinct Detects					8	Number of Distinct Non-Detects					1
1492	Minimum Detect					0.0096	Minimum Non-Detect					0.1
1493	Maximum Detect					0.3	Maximum Non-Detect					0.1
1494	Variance Detects					0.0142	Percent Non-Detects					59.09%
1495	Mean Detects					0.096	SD Detects					0.119
1496	Median Detects					0.034	CV Detects					1.244
1497	Skewness Detects					1.382	Kurtosis Detects					0.255
1498	Mean of Logged Detects					-3.083	SD of Logged Detects					1.315
1499												
1500	Nonparametric Distribution Free UCL Statistics											
1501	Detected Data appear Approximate Normal Distributed at 5% Significance Level											
1502												

	A–C	D–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**				
2					
3	User Selected Options				
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM			
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls			
6	Full Precision	OFF			
7	Confidence Coefficient	95%			
8	Number of Bootstrap Operations	2000			
9					
10					
1503	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**				
1504		Mean	0.0554	Standard Error of Mean	0.0193
1505		SD	0.0809	95% KM (BCA) UCL	0.0877
1506		95% KM (t) UCL	0.0886	95% KM (Percentile Bootstrap) UCL	0.0886
1507		95% KM (z) UCL	0.0871	95% KM Bootstrap t UCL	0.117
1508		90% KM Chebyshev UCL	0.113	95% KM Chebyshev UCL	0.139
1509		97.5% KM Chebyshev UCL	0.176	99% KM Chebyshev UCL	0.247
1510					
1511	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**				
1512		KM SD (logged)	1.018	95% Critical H Value (KM-Log)	2.607
1513		KM Mean (logged)	-3.53	KM Geo Mean	0.0293
1514		KM Standard Error of Mean (logged)	0.311	95% H-UCL (KM -Log)	0.0878
1515					
1516	**Suggested UCL to Use**				
1517	**Data appear Normal, May want to try Normal Distribution.**				
1518	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.				
1519	Recommendations are based upon data size, data distribution, and skewness.				
1520	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).				
1521	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.				
1522					
1523	**naphthalene**				
1524					
1525	**General Statistics**				
1526		Total Number of Observations	22	Number of Distinct Observations	11
1527				Number of Missing Observations	1
1528		Number of Detects	11	Number of Non-Detects	11
1529		Number of Distinct Detects	10	Number of Distinct Non-Detects	1
1530		Minimum Detect	0.0089	Minimum Non-Detect	0.1
1531		Maximum Detect	0.98	Maximum Non-Detect	0.1
1532		Variance Detects	0.0782	Percent Non-Detects	50%
1533		Mean Detects	0.177	SD Detects	0.28
1534		Median Detects	0.13	CV Detects	1.578
1535		Skewness Detects	2.779	Kurtosis Detects	8.388
1536		Mean of Logged Detects	-2.676	SD of Logged Detects	1.506
1537					
1538	**Nonparametric Distribution Free UCL Statistics**				
1539	**Detected Data appear Gamma Distributed at 5% Significance Level**				
1540					

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1541	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1542	Mean	0.0975	Standard Error of Mean	0.0458
1543	SD	0.205	95% KM (BCA) UCL	0.191
1544	95% KM (t) UCL	0.176	95% KM (Percentile Bootstrap) UCL	0.181
1545	95% KM (z) UCL	0.173	95% KM Bootstrap t UCL	0.305
1546	90% KM Chebyshev UCL	0.235	95% KM Chebyshev UCL	0.297
1547	97.5% KM Chebyshev UCL	0.384	99% KM Chebyshev UCL	0.553
1548				
1549	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1550	KM SD (logged)	1.279	95% Critical H Value (KM-Log)	2.992
1551	KM Mean (logged)	-3.395	KM Geo Mean	0.0335
1552	KM Standard Error of Mean (logged)	0.309	95% H-UCL (KM -Log)	0.175
1553				
1554	**Suggested UCL to Use**			
1555	**Data appear Gamma, May want to try Gamma Distribution**			
1556	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1557	Recommendations are based upon data size, data distribution, and skewness.			
1558	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1559	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1560				
1561				
1562	**phenanthrene**			
1563				
1564	**General Statistics**			
1565	Total Number of Observations	22	Number of Distinct Observations	21
1566			Number of Missing Observations	1
1567	Minimum	0.25	Mean	2.293
1568	Maximum	16.5	Median	0.875
1569	SD	3.766	Std. Error of Mean	0.803
1570	Coefficient of Variation	1.642	Skewness	3.124
1571	Mean of logged Data	0.163	SD of logged Data	1.033
1572				
1573	**Nonparametric Distribution Free UCL Statistics**			
1574	**Data do not follow a Discernible Distribution (0.05)**			
1575				
1576	**Assuming Normal Distribution**			
1577	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1578	95% Student's-t UCL	3.675	95% Adjusted-CLT UCL (Chen-1995)	4.185
1579			95% Modified-t UCL (Johnson-1978)	3.764
1580				
1581	**Nonparametric Distribution Free UCLs**			
1582	95% CLT UCL	3.614	95% Jackknife UCL	3.675
1583	95% Standard Bootstrap UCL	3.6	95% Bootstrap-t UCL	6.822
1584	95% Hall's Bootstrap UCL	9.29	95% Percentile Bootstrap UCL	3.672
1585	95% BCA Bootstrap UCL	4.336		
1586	90% Chebyshev(Mean, Sd) UCL	4.702	95% Chebyshev(Mean, Sd) UCL	5.793
1587	97.5% Chebyshev(Mean, Sd) UCL	7.307	99% Chebyshev(Mean, Sd) UCL	10.28
1588				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1589	**Suggested UCL to Use**			
1590	95% Chebyshev (Mean, Sd) UCL	5.793		
1591				
1592	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1593	Recommendations are based upon data size, data distribution, and skewness.			
1594	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1595	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1596				
1597				
1598	pyrene			
1599				
1600	**General Statistics**			
1601	Total Number of Observations	22	Number of Distinct Observations	22
1602			Number of Missing Observations	1
1603	Minimum	0.47	Mean	2.696
1604	Maximum	18.9	Median	1.49
1605	SD	3.887	Std. Error of Mean	0.829
1606	Coefficient of Variation	1.441	Skewness	3.804
1607	Mean of logged Data	0.562	SD of logged Data	0.815
1608				
1609	**Nonparametric Distribution Free UCL Statistics**			
1610	**Data appear Lognormal Distributed at 5% Significance Level**			
1611				
1612	**Assuming Normal Distribution**			
1613	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1614	95% Student's-t UCL	4.122	95% Adjusted-CLT UCL (Chen-1995)	4.778
1615			95% Modified-t UCL (Johnson-1978)	4.234
1616				
1617	**Nonparametric Distribution Free UCLs**			
1618	95% CLT UCL	4.059	95% Jackknife UCL	4.122
1619	95% Standard Bootstrap UCL	4.007	95% Bootstrap-t UCL	7.339
1620	95% Hall's Bootstrap UCL	9.386	95% Percentile Bootstrap UCL	4.095
1621	95% BCA Bootstrap UCL	4.973		
1622	90% Chebyshev(Mean, Sd) UCL	5.182	95% Chebyshev(Mean, Sd) UCL	6.308
1623	97.5% Chebyshev(Mean, Sd) UCL	7.871	99% Chebyshev(Mean, Sd) UCL	10.94
1624				
1625	**Suggested UCL to Use**			
1626	**Data appear Lognormal, May want to try Lognormal Distribution**			
1627				
1628	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1629	Recommendations are based upon data size, data distribution, and skewness.			
1630	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1631	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1632				
1633				

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1634	**ammonia and ammonium (as N)**			
1635				
1636	**General Statistics**			
1637	Total Number of Observations	16	Number of Distinct Observations	4
1638			Number of Missing Observations	7
1639	Number of Detects	6	Number of Non-Detects	10
1640	Number of Distinct Detects	4	Number of Distinct Non-Detects	1
1641	Minimum Detect	100	Minimum Non-Detect	100
1642	Maximum Detect	400	Maximum Non-Detect	100
1643	Variance Detects	10667	Percent Non-Detects	62.5%
1644	Mean Detects	233.3	SD Detects	103.3
1645	Median Detects	200	CV Detects	0.443
1646	Skewness Detects	0.666	Kurtosis Detects	0.586
1647	Mean of Logged Detects	5.366	SD of Logged Detects	0.469
1648				
1649	**Nonparametric Distribution Free UCL Statistics**			
1650	**Detected Data appear Normal Distributed at 5% Significance Level**			
1651				
1652	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1653	Mean	150	Standard Error of Mean	23.72
1654	SD	86.6	95% KM (BCA) UCL	N/A
1655	95% KM (t) UCL	191.6	95% KM (Percentile Bootstrap) UCL	N/A
1656	95% KM (z) UCL	189	95% KM Bootstrap t UCL	N/A
1657	90% KM Chebyshev UCL	221.2	95% KM Chebyshev UCL	253.4
1658	97.5% KM Chebyshev UCL	298.1	99% KM Chebyshev UCL	386
1659				
1660	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1661	KM SD (logged)	0.452	95% Critical H Value (KM-Log)	2.002
1662	KM Mean (logged)	4.89	KM Geo Mean	133
1663	KM Standard Error of Mean (logged)	0.124	95% H-UCL (KM -Log)	186.1
1664				
1665	**Suggested UCL to Use**			
1666	**Data appear Normal, May want to try Normal Distribution.**			
1667	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1668	Recommendations are based upon data size, data distribution, and skewness.			
1669	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1670	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1671				
1672				
1673	**ammonia as N**			
1674				
1675	**General Statistics**			
1676	Total Number of Observations	6	Number of Distinct Observations	6
1677			Number of Missing Observations	17
1678	Minimum	3.6	Mean	64.93
1679	Maximum	190	Median	26.5
1680	SD	76.54	Std. Error of Mean	31.25
1681	Coefficient of Variation	1.179	Skewness	1.169
1682	Mean of logged Data	3.419	SD of logged Data	1.468
1683				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1684	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
1685	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
1686	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
1687				
1688	Nonparametric Distribution Free UCL Statistics			
1689	Data appear Approximate Normal Distributed at 5% Significance Level			
1690				
1691	Assuming Normal Distribution			
1692	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1693	95% Student's-t UCL	127.9	95% Adjusted-CLT UCL (Chen-1995)	132.3
1694			95% Modified-t UCL (Johnson-1978)	130.4
1695				
1696	Nonparametric Distribution Free UCLs			
1697	95% CLT UCL	116.3	95% Jackknife UCL	127.9
1698	95% Standard Bootstrap UCL	112.8	95% Bootstrap-t UCL	420.4
1699	95% Hall's Bootstrap UCL	626.6	95% Percentile Bootstrap UCL	115.5
1700	95% BCA Bootstrap UCL	122.7		
1701	90% Chebyshev(Mean, Sd) UCL	158.7	95% Chebyshev(Mean, Sd) UCL	201.1
1702	97.5% Chebyshev(Mean, Sd) UCL	260.1	99% Chebyshev(Mean, Sd) UCL	375.8
1703				
1704	Suggested UCL to Use			
1705	Data appear Normal, May want to try Normal Distribution			
1706				
1707	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1708	Recommendations are based upon data size, data distribution, and skewness.			
1709	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1710	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1711				
1712				
1713	kjeldahl nitrogen total			
1714				
1715	General Statistics			
1716	Total Number of Observations	22	Number of Distinct Observations	15
1717			Number of Missing Observations	1
1718	Minimum	5.8	Mean	654.2
1719	Maximum	1900	Median	600
1720	SD	495.1	Std. Error of Mean	105.6
1721	Coefficient of Variation	0.757	Skewness	0.85
1722	Mean of logged Data	5.96	SD of logged Data	1.402
1723				
1724	Nonparametric Distribution Free UCL Statistics			
1725	Data appear Normal Distributed at 5% Significance Level			
1726				
1727	Assuming Normal Distribution			
1728	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1729	95% Student's-t UCL	835.9	95% Adjusted-CLT UCL (Chen-1995)	848.3
1730			95% Modified-t UCL (Johnson-1978)	839
1731				

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM								
5			From File	SED 0-0.15mbg Chemistry_input_v5.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
1732	**Nonparametric Distribution Free UCLs**											
1733					95% CLT UCL	827.8					95% Jackknife UCL	835.9
1734					95% Standard Bootstrap UCL	823.1					95% Bootstrap-t UCL	876.1
1735					95% Hall's Bootstrap UCL	878.8					95% Percentile Bootstrap UCL	828.4
1736					95% BCA Bootstrap UCL	841.8						
1737					90% Chebyshev(Mean, Sd) UCL	970.9					95% Chebyshev(Mean, Sd) UCL	1114
1738					97.5% Chebyshev(Mean, Sd) UCL	1313					99% Chebyshev(Mean, Sd) UCL	1704
1739												
1740	**Suggested UCL to Use**											
1741	**Data appear Normal, May want to try Normal Distribution**											
1742												
1743	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1744	Recommendations are based upon data size, data distribution, and skewness.											
1745	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1746	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1747												
1748	**nitrogen (total)**											
1749												
1750	**General Statistics**											
1751					Total Number of Observations	6					Number of Distinct Observations	3
1752											Number of Missing Observations	17
1753					Number of Detects	3					Number of Non-Detects	3
1754					Number of Distinct Detects	2					Number of Distinct Non-Detects	1
1755					Minimum Detect	3000					Minimum Non-Detect	2000
1756					Maximum Detect	4000					Maximum Non-Detect	2000
1757					Variance Detects	333333					Percent Non-Detects	50%
1758					Mean Detects	3333					SD Detects	577.4
1759					Median Detects	3000					CV Detects	0.173
1760					Skewness Detects	1.732					Kurtosis Detects	N/A
1761					Mean of Logged Detects	8.102					SD of Logged Detects	0.166
1762												
1763	**Warning: Data set has only 3 Detected Values.**											
1764	**This is not enough to compute meaningful or reliable statistics and estimates.**											
1765												
1766												
1767	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use**											
1768	**guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**											
1769	**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**											
1770	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1**											
1771												
1772	**Nonparametric Distribution Free UCL Statistics**											
1773	**Detected Data appear Approximate Normal Distributed at 5% Significance Level**											
1774												
1775	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**											
1776					Mean	2667					Standard Error of Mean	372.7
1777					SD	745.4					95% KM (BCA) UCL	N/A
1778					95% KM (t) UCL	3418					95% KM (Percentile Bootstrap) UCL	N/A
1779					95% KM (z) UCL	3280					95% KM Bootstrap t UCL	N/A
1780					90% KM Chebyshev UCL	3785					95% KM Chebyshev UCL	4291
1781					97.5% KM Chebyshev UCL	4994					99% KM Chebyshev UCL	6375

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1782				
1783	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
1784	KM SD (logged)	0.268	95% Critical H Value (KM-Log)	2.173
1785	KM Mean (logged)	7.852	KM Geo Mean	2570
1786	KM Standard Error of Mean (logged)	0.134	95% H-UCL (KM -Log)	3458
1787				
1788	Suggested UCL to Use			
1789	Data appear Normal, May want to try Normal Distribution.			
1790	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1791	Recommendations are based upon data size, data distribution, and skewness.			
1792	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1793	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1794				
1795	organic phosphorus			
1796				
1797	General Statistics			
1798	Total Number of Observations	6	Number of Distinct Observations	6
1799			Number of Missing Observations	17
1800	Number of Detects	5	Number of Non-Detects	1
1801	Number of Distinct Detects	5	Number of Distinct Non-Detects	1
1802	Minimum Detect	1.1	Minimum Non-Detect	1
1803	Maximum Detect	4.6	Maximum Non-Detect	1
1804	Variance Detects	1.837	Percent Non-Detects	16.67%
1805	Mean Detects	2.58	SD Detects	1.355
1806	Median Detects	2.4	CV Detects	0.525
1807	Skewness Detects	0.745	Kurtosis Detects	0.194
1808	Mean of Logged Detects	0.832	SD of Logged Detects	0.549
1809				
1810	Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use			
1811	guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.			
1812	For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
1813	Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1			
1814				
1815	Nonparametric Distribution Free UCL Statistics			
1816	Detected Data appear Normal Distributed at 5% Significance Level			
1817				
1818	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
1819	Mean	2.317	Standard Error of Mean	0.572
1820	SD	1.254	95% KM (BCA) UCL	3.25
1821	95% KM (t) UCL	3.47	95% KM (Percentile Bootstrap) UCL	3.267
1822	95% KM (z) UCL	3.258	95% KM Bootstrap t UCL	3.952
1823	90% KM Chebyshev UCL	4.033	95% KM Chebyshev UCL	4.811
1824	97.5% KM Chebyshev UCL	5.89	99% KM Chebyshev UCL	8.01
1825				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.112/31/2019 3:58:18 PM		
5	From File	SED 0-0.15mbg Chemistry_input_v5.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1826	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1827	KM SD (logged)	0.545	95% Critical H Value (KM-Log)	2.749
1828	KM Mean (logged)	0.693	KM Geo Mean	2
1829	KM Standard Error of Mean (logged)	0.249	95% H-UCL (KM -Log)	4.536
1830				
1831	**Suggested UCL to Use**			
1832	**Data appear Normal, May want to try Normal Distribution.**			
1833	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1834	Recommendations are based upon data size, data distribution, and skewness.			
1835	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1836	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1837				
1838				
1839	**phosphorus**			
1840				
1841	**General Statistics**			
1842	Total Number of Observations	22	Number of Distinct Observations	22
1843			Number of Missing Observations	1
1844	Minimum	598	Mean	904.4
1845	Maximum	1622	Median	816
1846	SD	284.7	Std. Error of Mean	60.69
1847	Coefficient of Variation	0.315	Skewness	1.383
1848	Mean of logged Data	6.767	SD of logged Data	0.281
1849				
1850	**Nonparametric Distribution Free UCL Statistics**			
1851	**Data appear Approximate Normal Distributed at 5% Significance Level**			
1852				
1853	**Assuming Normal Distribution**			
1854	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1855	95% Student's-t UCL	1009	95% Adjusted-CLT UCL (Chen-1995)	1023
1856			95% Modified-t UCL (Johnson-1978)	1012
1857				
1858	**Nonparametric Distribution Free UCLs**			
1859	95% CLT UCL	1004	95% Jackknife UCL	1009
1860	95% Standard Bootstrap UCL	1003	95% Bootstrap-t UCL	1044
1861	95% Hall's Bootstrap UCL	1041	95% Percentile Bootstrap UCL	1008
1862	95% BCA Bootstrap UCL	1020		
1863	90% Chebyshev(Mean, Sd) UCL	1086	95% Chebyshev(Mean, Sd) UCL	1169
1864	97.5% Chebyshev(Mean, Sd) UCL	1283	99% Chebyshev(Mean, Sd) UCL	1508
1865				
1866	**Suggested UCL to Use**			
1867	**Data appear Normal, May want to try Normal Distribution**			
1868				
1869	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1870	Recommendations are based upon data size, data distribution, and skewness.			
1871	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1872	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1873				

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1874	Fecal Coliforms											
1875												
1876	General Statistics											
1877	Total Number of Observations					17	Number of Distinct Observations					16
1878							Number of Missing Observations					6
1879	Number of Detects					16	Number of Non-Detects					1
1880	Number of Distinct Detects					15	Number of Distinct Non-Detects					1
1881	Minimum Detect					3000	Minimum Non-Detect					1000
1882	Maximum Detect					45000	Maximum Non-Detect					1000
1883	Variance Detects					1.768E+8	Percent Non-Detects					5.882%
1884	Mean Detects					21500	SD Detects					13297
1885	Median Detects					18000	CV Detects					0.618
1886	Skewness Detects					0.572	Kurtosis Detects					-0.959
1887	Mean of Logged Detects					9.761	SD of Logged Detects					0.731
1888												
1889	Nonparametric Distribution Free UCL Statistics											
1890	Detected Data appear Normal Distributed at 5% Significance Level											
1891												
1892	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
1893	Mean					20294	Standard Error of Mean					3354
1894	SD					13389	95% KM (BCA) UCL					25529
1895	95% KM (t) UCL					26149	95% KM (Percentile Bootstrap) UCL					25765
1896	95% KM (z) UCL					25811	95% KM Bootstrap t UCL					26981
1897	90% KM Chebyshev UCL					30356	95% KM Chebyshev UCL					34913
1898	97.5% KM Chebyshev UCL					41239	99% KM Chebyshev UCL					53664
1899												
1900	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution											
1901	KM SD (logged)					0.96	95% Critical H Value (KM-Log)					2.613
1902	KM Mean (logged)					9.593	KM Geo Mean					14668
1903	KM Standard Error of Mean (logged)					0.24	95% H-UCL (KM -Log)					43547
1904												
1905	Suggested UCL to Use											
1906	Data appear Normal, May want to try Normal Distribution.											
1907	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1908	Recommendations are based upon data size, data distribution, and skewness.											
1909	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1910	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1911												
1912	PAHs (sum of total)											
1913												
1914	General Statistics											
1915	Total Number of Observations					22	Number of Distinct Observations					22
1916							Number of Missing Observations					1
1917	Minimum					2.97	Mean					14.79
1918	Maximum					98.69	Median					7.55
1919	SD					20.71	Std. Error of Mean					4.415
1920	Coefficient of Variation					1.4	Skewness					3.549
1921	Mean of logged Data					2.262	SD of logged Data					0.817
1922												

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1923	Nonparametric Distribution Free UCL Statistics											
1924	Data appear Approximate Lognormal Distributed at 5% Significance Level											
1925												
1926	Assuming Normal Distribution											
1927	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
1928	95% Student's-t UCL					22.39	95% Adjusted-CLT UCL (Chen-1995)					25.63
1929							95% Modified-t UCL (Johnson-1978)					22.95
1930												
1931	Nonparametric Distribution Free UCLs											
1932	95% CLT UCL					22.06	95% Jackknife UCL					22.39
1933	95% Standard Bootstrap UCL					21.75	95% Bootstrap-t UCL					38.12
1934	95% Hall's Bootstrap UCL					51.19	95% Percentile Bootstrap UCL					23.26
1935	95% BCA Bootstrap UCL					26.41						
1936	90% Chebyshev(Mean, Sd) UCL					28.04	95% Chebyshev(Mean, Sd) UCL					34.04
1937	97.5% Chebyshev(Mean, Sd) UCL					42.37	99% Chebyshev(Mean, Sd) UCL					58.72
1938												
1939	Suggested UCL to Use											
1940	Data appear Approximate Lognormal, May want to try Lognormal Distribution											
1941												
1942	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1943	Recommendations are based upon data size, data distribution, and skewness.											
1944	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1945	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1946												
1947	PAHs (sum of total)											
1948												
1949	General Statistics											
1950	Total Number of Observations					21	Number of Distinct Observations					21
1951							Number of Missing Observations					1
1952	Minimum					2.97	Mean					10.8
1953	Maximum					42.23	Median					7.3
1954	SD					9.035	Std. Error of Mean					1.972
1955	Coefficient of Variation					0.837	Skewness					2.406
1956	Mean of logged Data					2.151	SD of logged Data					0.646
1957												
1958	Nonparametric Distribution Free UCL Statistics											
1959	Data appear Lognormal Distributed at 5% Significance Level											
1960												
1961	Assuming Normal Distribution											
1962	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
1963	95% Student's-t UCL					14.2	95% Adjusted-CLT UCL (Chen-1995)					15.15
1964							95% Modified-t UCL (Johnson-1978)					14.37
1965												

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.112/31/2019 3:58:18 PM								
5	From File			SED 0-0.15mbg Chemistry_input_v5.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1966	Nonparametric Distribution Free UCLs											
1967	95% CLT UCL					14.04	95% Jackknife UCL					14.2
1968	95% Standard Bootstrap UCL					13.95	95% Bootstrap-t UCL					16.77
1969	95% Hall's Bootstrap UCL					25.37	95% Percentile Bootstrap UCL					14.18
1970	95% BCA Bootstrap UCL					15.5						
1971	90% Chebyshev(Mean, Sd) UCL					16.71	95% Chebyshev(Mean, Sd) UCL					19.39
1972	97.5% Chebyshev(Mean, Sd) UCL					23.11	99% Chebyshev(Mean, Sd) UCL					30.41
1973												
1974	Suggested UCL to Use											
1975	Data appear Lognormal, May want to try Lognormal Distribution											
1976												
1977	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1978	Recommendations are based upon data size, data distribution, and skewness.											
1979	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1980	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**Acenaphthylene**			
12				
13	**General Statistics**			
14	Total Number of Observations	21	Number of Distinct Observations	2
15			Number of Missing Observations	0
16	Minimum	0.05	Mean	0.0881
17	Maximum	0.1	Median	0.1
18	SD	0.0218	Std. Error of Mean	0.00476
19	Coefficient of Variation	0.248	Skewness	-1.327
20	Mean of logged Data	-2.468	SD of logged Data	0.303
21				
22	**Nonparametric Distribution Free UCL Statistics**			
23	**Data do not follow a Discernible Distribution (0.05)**			
24				
25	**Assuming Normal Distribution**			
26	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
27	95% Student's-t UCL	0.0963	95% Adjusted-CLT UCL (Chen-1995)	0.0945
28			95% Modified-t UCL (Johnson-1978)	0.0961
29				
30	**Nonparametric Distribution Free UCLs**			
31	95% CLT UCL	0.0959	95% Jackknife UCL	N/A
32	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
33	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
34	95% BCA Bootstrap UCL	N/A		
35	90% Chebyshev(Mean, Sd) UCL	0.102	95% Chebyshev(Mean, Sd) UCL	0.109
36	97.5% Chebyshev(Mean, Sd) UCL	0.118	99% Chebyshev(Mean, Sd) UCL	0.135
37				
38	**Suggested UCL to Use**			
39	95% Student's-t UCL	0.0963	or 95% Modified-t UCL	0.0961
40				
41	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
42	Recommendations are based upon data size, data distribution, and skewness.			
43	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
44	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
45				
46	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
47	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
48				
50	**Acenaphthene**			
51				
52	**General Statistics**			
53	Total Number of Observations	21	Number of Distinct Observations	14
54			Number of Missing Observations	0
55	Minimum	0.05	Mean	0.265
56	Maximum	0.97	Median	0.16
57	SD	0.291	Std. Error of Mean	0.0635
58	Coefficient of Variation	1.099	Skewness	1.883
59	Mean of logged Data	-1.754	SD of logged Data	0.895

Row				
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
60				
61	Nonparametric Distribution Free UCL Statistics			
62	Data appear Approximate Gamma Distributed at 5% Significance Level			
63				
64	Assuming Normal Distribution			
65	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
66	95% Student's-t UCL	0.374	95% Adjusted-CLT UCL (Chen-1995)	0.397
67			95% Modified-t UCL (Johnson-1978)	0.379
68				
69	Nonparametric Distribution Free UCLs			
70	95% CLT UCL	0.369	95% Jackknife UCL	0.374
71	95% Standard Bootstrap UCL	0.366	95% Bootstrap-t UCL	0.415
72	95% Hall's Bootstrap UCL	0.356	95% Percentile Bootstrap UCL	0.375
73	95% BCA Bootstrap UCL	0.389		
74	90% Chebyshev(Mean, Sd) UCL	0.455	95% Chebyshev(Mean, Sd) UCL	0.542
75	97.5% Chebyshev(Mean, Sd) UCL	0.661	99% Chebyshev(Mean, Sd) UCL	0.897
76				
77	Suggested UCL to Use			
78	Data appear Approximate Gamma, May want to try Gamma Distribution			
79				
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
81	Recommendations are based upon data size, data distribution, and skewness.			
82	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
83	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
84				
85				
86	Anthracene			
87				
88	General Statistics			
89	Total Number of Observations	21	Number of Distinct Observations	15
90			Number of Missing Observations	0
91	Minimum	0.05	Mean	0.294
92	Maximum	1.12	Median	0.21
93	SD	0.294	Std. Error of Mean	0.0642
94	Coefficient of Variation	1.001	Skewness	2.168
95	Mean of logged Data	-1.587	SD of logged Data	0.861
96				
97	Nonparametric Distribution Free UCL Statistics			
98	Data appear Gamma Distributed at 5% Significance Level			
99				
100	Assuming Normal Distribution			
101	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
102	95% Student's-t UCL	0.405	95% Adjusted-CLT UCL (Chen-1995)	0.432
103			95% Modified-t UCL (Johnson-1978)	0.41
104				
105	Nonparametric Distribution Free UCLs			
106	95% CLT UCL	0.399	95% Jackknife UCL	0.405
107	95% Standard Bootstrap UCL	0.396	95% Bootstrap-t UCL	0.518

Nonparametric UCL Statistics for Data Sets with Non-Detects			
User Selected Options			
Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
From File	WorkSheet.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
95% Hall's Bootstrap UCL	0.968	95% Percentile Bootstrap UCL	0.404
95% BCA Bootstrap UCL	0.438		
90% Chebyshev(Mean, Sd) UCL	0.486	95% Chebyshev(Mean, Sd) UCL	0.574
97.5% Chebyshev(Mean, Sd) UCL	0.695	99% Chebyshev(Mean, Sd) UCL	0.932
Suggested UCL to Use			
Data appear Gamma, May want to try Gamma Distribution			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
Benzo[a]anthracene			
General Statistics			
Total Number of Observations	21	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	0.05	Mean	0.937
Maximum	3.54	Median	0.75
SD	0.796	Std. Error of Mean	0.174
Coefficient of Variation	0.85	Skewness	2.109
Mean of logged Data	-0.453	SD of logged Data	1.071
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.237	95% Adjusted-CLT UCL (Chen-1995)	1.308
		95% Modified-t UCL (Johnson-1978)	1.25
Nonparametric Distribution Free UCLs			
95% CLT UCL	1.223	95% Jackknife UCL	1.237
95% Standard Bootstrap UCL	1.21	95% Bootstrap-t UCL	1.484
95% Hall's Bootstrap UCL	2.95	95% Percentile Bootstrap UCL	1.235
95% BCA Bootstrap UCL	1.316		
90% Chebyshev(Mean, Sd) UCL	1.459	95% Chebyshev(Mean, Sd) UCL	1.695
97.5% Chebyshev(Mean, Sd) UCL	2.023	99% Chebyshev(Mean, Sd) UCL	2.666
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	1.695		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
156				
157				
158	**Benzo[b]fluoranthene**			
159				
160	**General Statistics**			
161	Total Number of Observations	21	Number of Distinct Observations	19
162			Number of Missing Observations	0
163	Minimum	0.05	Mean	1.376
164	Maximum	4.96	Median	1.18
165	SD	1.091	Std. Error of Mean	0.238
166	Coefficient of Variation	0.793	Skewness	1.888
167	Mean of logged Data	-0.0832	SD of logged Data	1.152
168				
169	**Nonparametric Distribution Free UCL Statistics**			
170	**Data do not follow a Discernible Distribution (0.05)**			
171				
172	**Assuming Normal Distribution**			
173	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
174	95% Student's-t UCL	1.787	95% Adjusted-CLT UCL (Chen-1995)	1.873
175			95% Modified-t UCL (Johnson-1978)	1.803
176				
177	**Nonparametric Distribution Free UCLs**			
178	95% CLT UCL	1.768	95% Jackknife UCL	1.787
179	95% Standard Bootstrap UCL	1.742	95% Bootstrap-t UCL	1.967
180	95% Hall's Bootstrap UCL	2.493	95% Percentile Bootstrap UCL	1.767
181	95% BCA Bootstrap UCL	1.88		
182	90% Chebyshev(Mean, Sd) UCL	2.091	95% Chebyshev(Mean, Sd) UCL	2.414
183	97.5% Chebyshev(Mean, Sd) UCL	2.863	99% Chebyshev(Mean, Sd) UCL	3.746
184				
185	**Suggested UCL to Use**			
186	95% Chebyshev (Mean, Sd) UCL	2.414		
187				
188	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
189	Recommendations are based upon data size, data distribution, and skewness.			
190	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
191	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
192				
193				
194	**Benzo[g,h,i]perylene**			
195				
196	**General Statistics**			
197	Total Number of Observations	21	Number of Distinct Observations	18
198			Number of Missing Observations	0
199	Minimum	0.1	Mean	0.515
200	Maximum	1.23	Median	0.45
201	SD	0.308	Std. Error of Mean	0.0672
202	Coefficient of Variation	0.598	Skewness	0.958
203	Mean of logged Data	-0.867	SD of logged Data	0.717

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
204				
205	Nonparametric Distribution Free UCL Statistics			
206	Data appear Approximate Normal Distributed at 5% Significance Level			
207				
208	Assuming Normal Distribution			
209	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
210	95% Student's-t UCL	0.631	95% Adjusted-CLT UCL (Chen-1995)	0.64
211			95% Modified-t UCL (Johnson-1978)	0.633
212				
213	Nonparametric Distribution Free UCLs			
214	95% CLT UCL	0.625	95% Jackknife UCL	0.631
215	95% Standard Bootstrap UCL	0.623	95% Bootstrap-t UCL	0.654
216	95% Hall's Bootstrap UCL	0.673	95% Percentile Bootstrap UCL	0.626
217	95% BCA Bootstrap UCL	0.644		
218	90% Chebyshev(Mean, Sd) UCL	0.716	95% Chebyshev(Mean, Sd) UCL	0.807
219	97.5% Chebyshev(Mean, Sd) UCL	0.934	99% Chebyshev(Mean, Sd) UCL	1.183
220				
221	Suggested UCL to Use			
222	Data appear Normal, May want to try Normal Distribution			
223				
224	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
225	Recommendations are based upon data size, data distribution, and skewness.			
226	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
227	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
228				
229				
230	Benzo[k]fluoranthene			
231				
232	General Statistics			
233	Total Number of Observations	21	Number of Distinct Observations	17
234			Number of Missing Observations	0
235	Minimum	0.05	Mean	0.443
236	Maximum	1.48	Median	0.34
237	SD	0.339	Std. Error of Mean	0.074
238	Coefficient of Variation	0.765	Skewness	1.761
239	Mean of logged Data	-1.115	SD of logged Data	0.89
240				
241	Nonparametric Distribution Free UCL Statistics			
242	Data appear Gamma Distributed at 5% Significance Level			
243				
244	Assuming Normal Distribution			
245	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
246	95% Student's-t UCL	0.571	95% Adjusted-CLT UCL (Chen-1995)	0.595
247			95% Modified-t UCL (Johnson-1978)	0.576
248				
249	Nonparametric Distribution Free UCLs			
250	95% CLT UCL	0.565	95% Jackknife UCL	0.571
251	95% Standard Bootstrap UCL	0.564	95% Bootstrap-t UCL	0.628

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM								
5			From File	WorkSheet.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
252					95% Hall's Bootstrap UCL	1.121					95% Percentile Bootstrap UCL	0.569
253					95% BCA Bootstrap UCL	0.602						
254					90% Chebyshev(Mean, Sd) UCL	0.665					95% Chebyshev(Mean, Sd) UCL	0.766
255					97.5% Chebyshev(Mean, Sd) UCL	0.905					99% Chebyshev(Mean, Sd) UCL	1.179
256												
257	Suggested UCL to Use											
258	Data appear Gamma, May want to try Gamma Distribution											
259												
260	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
261	Recommendations are based upon data size, data distribution, and skewness.											
262	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
263	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
264												
265												
266	Benzo[a]pyrene											
267												
268	General Statistics											
269					Total Number of Observations	21					Number of Distinct Observations	19
270											Number of Missing Observations	0
271					Minimum	0.05					Mean	0.864
272					Maximum	3.11					Median	0.72
273					SD	0.693					Std. Error of Mean	0.151
274					Coefficient of Variation	0.802					Skewness	1.939
275					Mean of logged Data	-0.512					SD of logged Data	1.044
276												
277	Nonparametric Distribution Free UCL Statistics											
278	Data do not follow a Discernible Distribution (0.05)											
279												
280	Assuming Normal Distribution											
281	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
282					95% Student's-t UCL	1.125					95% Adjusted-CLT UCL (Chen-1995)	1.182
283											95% Modified-t UCL (Johnson-1978)	1.136
284												
285	Nonparametric Distribution Free UCLs											
286					95% CLT UCL	1.113					95% Jackknife UCL	1.125
287					95% Standard Bootstrap UCL	1.11					95% Bootstrap-t UCL	1.264
288					95% Hall's Bootstrap UCL	2.578					95% Percentile Bootstrap UCL	1.121
289					95% BCA Bootstrap UCL	1.2						
290					90% Chebyshev(Mean, Sd) UCL	1.318					95% Chebyshev(Mean, Sd) UCL	1.524
291					97.5% Chebyshev(Mean, Sd) UCL	1.809					99% Chebyshev(Mean, Sd) UCL	2.37
292												
293	Suggested UCL to Use											
294					95% Chebyshev (Mean, Sd) UCL	1.524						
295												
296	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
297	Recommendations are based upon data size, data distribution, and skewness.											
298	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
299	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
300				
301				
302	**Chrysene**			
303				
304	**General Statistics**			
305	Total Number of Observations	21	Number of Distinct Observations	20
306			Number of Missing Observations	0
307	Minimum	0.05	Mean	1.076
308	Maximum	4.04	Median	0.88
309	SD	0.899	Std. Error of Mean	0.196
310	Coefficient of Variation	0.835	Skewness	1.998
311	Mean of logged Data	-0.336	SD of logged Data	1.125
312				
313	**Nonparametric Distribution Free UCL Statistics**			
314	**Data do not follow a Discernible Distribution (0.05)**			
315				
316	**Assuming Normal Distribution**			
317	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
318	95% Student's-t UCL	1.414	95% Adjusted-CLT UCL (Chen-1995)	1.49
319			95% Modified-t UCL (Johnson-1978)	1.428
320				
321	**Nonparametric Distribution Free UCLs**			
322	95% CLT UCL	1.398	95% Jackknife UCL	1.414
323	95% Standard Bootstrap UCL	1.397	95% Bootstrap-t UCL	1.605
324	95% Hall's Bootstrap UCL	2.903	95% Percentile Bootstrap UCL	1.417
325	95% BCA Bootstrap UCL	1.511		
326	90% Chebyshev(Mean, Sd) UCL	1.664	95% Chebyshev(Mean, Sd) UCL	1.93
327	97.5% Chebyshev(Mean, Sd) UCL	2.3	99% Chebyshev(Mean, Sd) UCL	3.027
328				
329	**Suggested UCL to Use**			
330	95% Chebyshev (Mean, Sd) UCL	1.93		
331				
332	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
333	Recommendations are based upon data size, data distribution, and skewness.			
334	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
335	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
336				
337				
338	**Dibenz[a,h]anthracene**			
339				
340	**General Statistics**			
341	Total Number of Observations	21	Number of Distinct Observations	11
342			Number of Missing Observations	0
343	Minimum	0.06	Mean	0.131
344	Maximum	0.35	Median	0.1
345	SD	0.0708	Std. Error of Mean	0.0154
346	Coefficient of Variation	0.54	Skewness	1.941
347	Mean of logged Data	-2.14	SD of logged Data	0.453

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
348				
349	**Nonparametric Distribution Free UCL Statistics**			
350	**Data appear Lognormal Distributed at 5% Significance Level**			
351				
352	**Assuming Normal Distribution**			
353	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
354	95% Student's-t UCL	0.158	95% Adjusted-CLT UCL (Chen-1995)	0.163
355			95% Modified-t UCL (Johnson-1978)	0.159
356				
357	**Nonparametric Distribution Free UCLs**			
358	95% CLT UCL	0.156	95% Jackknife UCL	0.158
359	95% Standard Bootstrap UCL	0.156	95% Bootstrap-t UCL	0.175
360	95% Hall's Bootstrap UCL	0.188	95% Percentile Bootstrap UCL	0.159
361	95% BCA Bootstrap UCL	0.164		
362	90% Chebyshev(Mean, Sd) UCL	0.177	95% Chebyshev(Mean, Sd) UCL	0.198
363	97.5% Chebyshev(Mean, Sd) UCL	0.227	99% Chebyshev(Mean, Sd) UCL	0.285
364				
365	**Suggested UCL to Use**			
366	**Data appear Lognormal, May want to try Lognormal Distribution**			
367				
368	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
369	Recommendations are based upon data size, data distribution, and skewness.			
370	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
371	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
372				
373				
374	**Fluoranthene**			
375				
376	**General Statistics**			
377	Total Number of Observations	21	Number of Distinct Observations	20
378			Number of Missing Observations	0
379	Minimum	0.05	Mean	2.589
380	Maximum	10.3	Median	1.98
381	SD	2.326	Std. Error of Mean	0.508
382	Coefficient of Variation	0.898	Skewness	2.041
383	Mean of logged Data	0.437	SD of logged Data	1.346
384				
385	**Nonparametric Distribution Free UCL Statistics**			
386	**Data appear Gamma Distributed at 5% Significance Level**			
387				
388	**Assuming Normal Distribution**			
389	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
390	95% Student's-t UCL	3.464	95% Adjusted-CLT UCL (Chen-1995)	3.665
391			95% Modified-t UCL (Johnson-1978)	3.502
392				
393	**Nonparametric Distribution Free UCLs**			
394	95% CLT UCL	3.424	95% Jackknife UCL	3.464
395	95% Standard Bootstrap UCL	3.4	95% Bootstrap-t UCL	3.926

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.11/13/2020 2:22:32 PM								
5	From File			WorkSheet.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
396	95% Hall's Bootstrap UCL					7.723	95% Percentile Bootstrap UCL					3.441
397	95% BCA Bootstrap UCL					3.594						
398	90% Chebyshev(Mean, Sd) UCL					4.112	95% Chebyshev(Mean, Sd) UCL					4.802
399	97.5% Chebyshev(Mean, Sd) UCL					5.759	99% Chebyshev(Mean, Sd) UCL					7.639
400												
401	Suggested UCL to Use											
402	Data appear Gamma, May want to try Gamma Distribution											
403												
404	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
405	Recommendations are based upon data size, data distribution, and skewness.											
406	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
407	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
408												
409												
410	Fluorene											
411												
412	General Statistics											
413	Total Number of Observations					21	Number of Distinct Observations					17
414							Number of Missing Observations					0
415	Minimum					0.05	Mean					0.332
416	Maximum					1.06	Median					0.25
417	SD					0.3	Std. Error of Mean					0.0655
418	Coefficient of Variation					0.904	Skewness					1.396
419	Mean of logged Data					-1.5	SD of logged Data					0.95
420												
421	Nonparametric Distribution Free UCL Statistics											
422	Data appear Approximate Normal Distributed at 5% Significance Level											
423												
424	Assuming Normal Distribution											
425	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
426	95% Student's-t UCL					0.445	95% Adjusted-CLT UCL (Chen-1995)					0.461
427							95% Modified-t UCL (Johnson-1978)					0.448
428												
429	Nonparametric Distribution Free UCLs											
430	95% CLT UCL					0.44	95% Jackknife UCL					0.445
431	95% Standard Bootstrap UCL					0.437	95% Bootstrap-t UCL					0.479
432	95% Hall's Bootstrap UCL					0.475	95% Percentile Bootstrap UCL					0.44
433	95% BCA Bootstrap UCL					0.459						
434	90% Chebyshev(Mean, Sd) UCL					0.528	95% Chebyshev(Mean, Sd) UCL					0.617
435	97.5% Chebyshev(Mean, Sd) UCL					0.741	99% Chebyshev(Mean, Sd) UCL					0.983
436												
437	Suggested UCL to Use											
438	Data appear Normal, May want to try Normal Distribution											
439												
440	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
441	Recommendations are based upon data size, data distribution, and skewness.											
442	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
443	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
444				
445				
446	**Indeno[1,2,3-cd]pyrene**			
447				
448	**General Statistics**			
449	Total Number of Observations	21	Number of Distinct Observations	18
450			Number of Missing Observations	0
451	Minimum	0.1	Mean	0.441
452	Maximum	1.25	Median	0.36
453	SD	0.288	Std. Error of Mean	0.0628
454	Coefficient of Variation	0.652	Skewness	1.465
455	Mean of logged Data	-1.02	SD of logged Data	0.684
456				
457	**Nonparametric Distribution Free UCL Statistics**			
458	**Data appear Gamma Distributed at 5% Significance Level**			
459				
460	**Assuming Normal Distribution**			
461	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
462	95% Student's-t UCL	0.55	95% Adjusted-CLT UCL (Chen-1995)	0.566
463			95% Modified-t UCL (Johnson-1978)	0.553
464				
465	**Nonparametric Distribution Free UCLs**			
466	95% CLT UCL	0.545	95% Jackknife UCL	0.55
467	95% Standard Bootstrap UCL	0.546	95% Bootstrap-t UCL	0.589
468	95% Hall's Bootstrap UCL	0.636	95% Percentile Bootstrap UCL	0.547
469	95% BCA Bootstrap UCL	0.569		
470	90% Chebyshev(Mean, Sd) UCL	0.63	95% Chebyshev(Mean, Sd) UCL	0.715
471	97.5% Chebyshev(Mean, Sd) UCL	0.833	99% Chebyshev(Mean, Sd) UCL	1.066
472				
473	**Suggested UCL to Use**			
474	**Data appear Gamma, May want to try Gamma Distribution**			
475				
476	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
477	Recommendations are based upon data size, data distribution, and skewness.			
478	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
479	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
480				
481				
482	**Methylnaphthalene, 1-**			
483				
484	**General Statistics**			
485	Total Number of Observations	21	Number of Distinct Observations	14
486			Number of Missing Observations	0
487	Minimum	0.05	Mean	0.289
488	Maximum	0.89	Median	0.12
489	SD	0.274	Std. Error of Mean	0.0597
490	Coefficient of Variation	0.949	Skewness	1.2
491	Mean of logged Data	-1.667	SD of logged Data	0.951

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
492				
493	**Nonparametric Distribution Free UCL Statistics**			
494	**Data appear Approximate Lognormal Distributed at 5% Significance Level**			
495				
496	**Assuming Normal Distribution**			
497	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
498	95% Student's-t UCL	0.392	95% Adjusted-CLT UCL (Chen-1995)	0.404
499			95% Modified-t UCL (Johnson-1978)	0.394
500				
501	**Nonparametric Distribution Free UCLs**			
502	95% CLT UCL	0.387	95% Jackknife UCL	0.392
503	95% Standard Bootstrap UCL	0.385	95% Bootstrap-t UCL	0.426
504	95% Hall's Bootstrap UCL	0.393	95% Percentile Bootstrap UCL	0.386
505	95% BCA Bootstrap UCL	0.4		
506	90% Chebyshev(Mean, Sd) UCL	0.468	95% Chebyshev(Mean, Sd) UCL	0.549
507	97.5% Chebyshev(Mean, Sd) UCL	0.662	99% Chebyshev(Mean, Sd) UCL	0.883
508				
509	**Suggested UCL to Use**			
510	**Data appear Approximate Lognormal, May want to try Lognormal Distribution**			
511				
512	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
513	Recommendations are based upon data size, data distribution, and skewness.			
514	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
515	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
516				
517				
518	**Methylnaphthalene, 2-**			
519				
520	**General Statistics**			
521	Total Number of Observations	21	Number of Distinct Observations	17
522			Number of Missing Observations	0
523	Minimum	0.05	Mean	0.571
524	Maximum	1.94	Median	0.24
525	SD	0.625	Std. Error of Mean	0.136
526	Coefficient of Variation	1.094	Skewness	1.229
527	Mean of logged Data	-1.212	SD of logged Data	1.235
528				
529	**Nonparametric Distribution Free UCL Statistics**			
530	**Data appear Gamma Distributed at 5% Significance Level**			
531				
532	**Assuming Normal Distribution**			
533	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
534	95% Student's-t UCL	0.807	95% Adjusted-CLT UCL (Chen-1995)	0.835
535			95% Modified-t UCL (Johnson-1978)	0.813
536				
537	**Nonparametric Distribution Free UCLs**			
538	95% CLT UCL	0.796	95% Jackknife UCL	0.807
539	95% Standard Bootstrap UCL	0.792	95% Bootstrap-t UCL	0.869

	A–L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**
2	
3	User Selected Options
4	Date/Time of Computation: ProUCL 5.11/13/2020 2:22:32 PM
5	From File: WorkSheet.xls
6	Full Precision: OFF
7	Confidence Coefficient: 95%
8	Number of Bootstrap Operations: 2000
9	
10	

	Statistic	Value	Statistic	Value
540	95% Hall's Bootstrap UCL	0.815	95% Percentile Bootstrap UCL	0.784
541	95% BCA Bootstrap UCL	0.834		
542	90% Chebyshev(Mean, Sd) UCL	0.981	95% Chebyshev(Mean, Sd) UCL	1.166
543	97.5% Chebyshev(Mean, Sd) UCL	1.423	99% Chebyshev(Mean, Sd) UCL	1.929
544				
545	**Suggested UCL to Use**			
546	**Data appear Gamma, May want to try Gamma Distribution**			
547				
548	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
549	Recommendations are based upon data size, data distribution, and skewness.			
550	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
551	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
552				
553				
554	**Naphthalene**			
555				
556	**General Statistics**			
557	Total Number of Observations	21	Number of Distinct Observations	11
558			Number of Missing Observations	0
559	Minimum	0.05	Mean	0.185
560	Maximum	1.2	Median	0.1
561	SD	0.257	Std. Error of Mean	0.056
562	Coefficient of Variation	1.387	Skewness	3.468
563	Mean of logged Data	-2.101	SD of logged Data	0.788
564				
565	**Nonparametric Distribution Free UCL Statistics**			
566	**Data do not follow a Discernible Distribution (0.05)**			
567				
568	**Assuming Normal Distribution**			
569	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
570	95% Student's-t UCL	0.282	95% Adjusted-CLT UCL (Chen-1995)	0.323
571			95% Modified-t UCL (Johnson-1978)	0.289
572				
573	**Nonparametric Distribution Free UCLs**			
574	95% CLT UCL	0.277	95% Jackknife UCL	0.282
575	95% Standard Bootstrap UCL	0.277	95% Bootstrap-t UCL	0.436
576	95% Hall's Bootstrap UCL	0.541	95% Percentile Bootstrap UCL	0.282
577	95% BCA Bootstrap UCL	0.33		
578	90% Chebyshev(Mean, Sd) UCL	0.353	95% Chebyshev(Mean, Sd) UCL	0.43
579	97.5% Chebyshev(Mean, Sd) UCL	0.535	99% Chebyshev(Mean, Sd) UCL	0.743
580				
581	**Suggested UCL to Use**			
582	95% Chebyshev (Mean, Sd) UCL	0.43		
583				
584	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
585	Recommendations are based upon data size, data distribution, and skewness.			
586	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
587	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
588				
589				
590	Phenanthrene			
591				
592	General Statistics			
593	Total Number of Observations	21	Number of Distinct Observations	20
594			Number of Missing Observations	0
595	Minimum	0.05	Mean	2.248
596	Maximum	10	Median	1.31
597	SD	2.426	Std. Error of Mean	0.529
598	Coefficient of Variation	1.079	Skewness	2.046
599	Mean of logged Data	0.13	SD of logged Data	1.48
600				
601	Nonparametric Distribution Free UCL Statistics			
602	Data appear Gamma Distributed at 5% Significance Level			
603				
604	Assuming Normal Distribution			
605	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
606	95% Student's-t UCL	3.161	95% Adjusted-CLT UCL (Chen-1995)	3.371
607			95% Modified-t UCL (Johnson-1978)	3.201
608				
609	Nonparametric Distribution Free UCLs			
610	95% CLT UCL	3.119	95% Jackknife UCL	3.161
611	95% Standard Bootstrap UCL	3.111	95% Bootstrap-t UCL	3.929
612	95% Hall's Bootstrap UCL	6.994	95% Percentile Bootstrap UCL	3.12
613	95% BCA Bootstrap UCL	3.394		
614	90% Chebyshev(Mean, Sd) UCL	3.836	95% Chebyshev(Mean, Sd) UCL	4.556
615	97.5% Chebyshev(Mean, Sd) UCL	5.554	99% Chebyshev(Mean, Sd) UCL	7.516
616				
617	Suggested UCL to Use			
618	Data appear Gamma, May want to try Gamma Distribution			
619				
620	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
621	Recommendations are based upon data size, data distribution, and skewness.			
622	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
623	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
624				
625				
626	Pyrene			
627				
628	General Statistics			
629	Total Number of Observations	21	Number of Distinct Observations	18
630			Number of Missing Observations	0
631	Minimum	0.05	Mean	2.096
632	Maximum	7.83	Median	1.64
633	SD	1.802	Std. Error of Mean	0.393
634	Coefficient of Variation	0.86	Skewness	1.895
635	Mean of logged Data	0.261	SD of logged Data	1.287

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
636				
637	Nonparametric Distribution Free UCL Statistics			
638	Data do not follow a Discernible Distribution (0.05)			
639				
640	Assuming Normal Distribution			
641	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
642	95% Student's-t UCL	2.774	95% Adjusted-CLT UCL (Chen-1995)	2.917
643			95% Modified-t UCL (Johnson-1978)	2.802
644				
645	Nonparametric Distribution Free UCLs			
646	95% CLT UCL	2.743	95% Jackknife UCL	2.774
647	95% Standard Bootstrap UCL	2.726	95% Bootstrap-t UCL	3.174
648	95% Hall's Bootstrap UCL	5.642	95% Percentile Bootstrap UCL	2.766
649	95% BCA Bootstrap UCL	2.878		
650	90% Chebyshev(Mean, Sd) UCL	3.276	95% Chebyshev(Mean, Sd) UCL	3.81
651	97.5% Chebyshev(Mean, Sd) UCL	4.552	99% Chebyshev(Mean, Sd) UCL	6.009
652				
653	Suggested UCL to Use			
654	95% Chebyshev (Mean, Sd) UCL	3.81		
655				
656	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
657	Recommendations are based upon data size, data distribution, and skewness.			
658	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
659	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
660				
662	PAHs (Total)			
663				
664	General Statistics			
665	Total Number of Observations	21	Number of Distinct Observations	20
666			Number of Missing Observations	0
667	Minimum	0.91	Mean	13.88
668	Maximum	52.42	Median	11.22
669	SD	11.97	Std. Error of Mean	2.612
670	Coefficient of Variation	0.862	Skewness	1.986
671	Mean of logged Data	2.245	SD of logged Data	1.036
672				
673	Nonparametric Distribution Free UCL Statistics			
674	Data appear Gamma Distributed at 5% Significance Level			
675				
676	Assuming Normal Distribution			
677	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
678	95% Student's-t UCL	18.39	95% Adjusted-CLT UCL (Chen-1995)	19.39
679			95% Modified-t UCL (Johnson-1978)	18.57
680				
681	Nonparametric Distribution Free UCLs			
682	95% CLT UCL	18.18	95% Jackknife UCL	18.39
683	95% Standard Bootstrap UCL	18.11	95% Bootstrap-t UCL	20.71
684	95% Hall's Bootstrap UCL	40.05	95% Percentile Bootstrap UCL	18.42

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
685	95% BCA Bootstrap UCL	19.31		
686	90% Chebyshev(Mean, Sd) UCL	21.72	95% Chebyshev(Mean, Sd) UCL	25.27
687	97.5% Chebyshev(Mean, Sd) UCL	30.19	99% Chebyshev(Mean, Sd) UCL	39.87
688				
689	**Suggested UCL to Use**			
690	**Data appear Gamma, May want to try Gamma Distribution**			
691				
692	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
693	Recommendations are based upon data size, data distribution, and skewness.			
694	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
695	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
696				
697	Antimony			
698				
699	**General Statistics**			
700	Total Number of Observations	21	Number of Distinct Observations	9
701	Number of Detects	11	Number of Non-Detects	10
702	Number of Distinct Detects	9	Number of Distinct Non-Detects	1
703	Minimum Detect	0.8	Minimum Non-Detect	0.8
704	Maximum Detect	1.9	Maximum Non-Detect	0.8
705	Variance Detects	0.138	Percent Non-Detects	47.62%
706	Mean Detects	1.218	SD Detects	0.371
707	Median Detects	1.1	CV Detects	0.305
708	Skewness Detects	0.615	Kurtosis Detects	-0.745
709	Mean of Logged Detects	0.156	SD of Logged Detects	0.298
710				
711	**Nonparametric Distribution Free UCL Statistics**			
712	**Detected Data appear Normal Distributed at 5% Significance Level**			
713				
714	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
715	Mean	1.019	Standard Error of Mean	0.0756
716	SD	0.33	95% KM (BCA) UCL	1.157
717	95% KM (t) UCL	1.149	95% KM (Percentile Bootstrap) UCL	1.143
718	95% KM (z) UCL	1.143	95% KM Bootstrap t UCL	1.189
719	90% KM Chebyshev UCL	1.246	95% KM Chebyshev UCL	1.349
720	97.5% KM Chebyshev UCL	1.491	99% KM Chebyshev UCL	1.771
721				
722	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
723	KM SD (logged)	0.28	95% Critical H Value (KM-Log)	1.819
724	KM Mean (logged)	-0.0243	KM Geo Mean	0.976
725	KM Standard Error of Mean (logged)	0.0641	95% H-UCL (KM -Log)	1.137
726				
727	**Suggested UCL to Use**			
728	**Data appear Normal, May want to try Normal Distribution.**			
729	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
730	Recommendations are based upon data size, data distribution, and skewness.			
731	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
732	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
733				
734				
735	Arsenic			
736				
737	**General Statistics**			
738	Total Number of Observations	21	Number of Distinct Observations	21
739			Number of Missing Observations	0
740	Minimum	1.7	Mean	5.867
741	Maximum	16	Median	5.4
742	SD	3.002	Std. Error of Mean	0.655
743	Coefficient of Variation	0.512	Skewness	1.942
744	Mean of logged Data	1.661	SD of logged Data	0.477
745				
746	**Nonparametric Distribution Free UCL Statistics**			
747	**Data appear Gamma Distributed at 5% Significance Level**			
748				
749	**Assuming Normal Distribution**			
750	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
751	95% Student's-t UCL	6.996	95% Adjusted-CLT UCL (Chen-1995)	7.241
752			95% Modified-t UCL (Johnson-1978)	7.043
753				
754	**Nonparametric Distribution Free UCLs**			
755	95% CLT UCL	6.944	95% Jackknife UCL	6.996
756	95% Standard Bootstrap UCL	6.931	95% Bootstrap-t UCL	7.554
757	95% Hall's Bootstrap UCL	12.33	95% Percentile Bootstrap UCL	6.971
758	95% BCA Bootstrap UCL	7.205		
759	90% Chebyshev(Mean, Sd) UCL	7.832	95% Chebyshev(Mean, Sd) UCL	8.722
760	97.5% Chebyshev(Mean, Sd) UCL	9.957	99% Chebyshev(Mean, Sd) UCL	12.38
761				
762	**Suggested UCL to Use**			
763	**Data appear Gamma, May want to try Gamma Distribution**			
764				
765	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
766	Recommendations are based upon data size, data distribution, and skewness.			
767	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
768	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
769				
770				
771	Barium			
772				
773	**General Statistics**			
774	Total Number of Observations	21	Number of Distinct Observations	19
775			Number of Missing Observations	0
776	Minimum	16	Mean	160.7
777	Maximum	398	Median	143
778	SD	105.6	Std. Error of Mean	23.04
779	Coefficient of Variation	0.657	Skewness	0.925
780	Mean of logged Data	4.828	SD of logged Data	0.805

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3			User Selected Options									
4			Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM								
5			From File	WorkSheet.xls								
6			Full Precision	OFF								
7			Confidence Coefficient	95%								
8			Number of Bootstrap Operations	2000								
9												
10												
781												
782	Nonparametric Distribution Free UCL Statistics											
783	Data appear Normal Distributed at 5% Significance Level											
784												
785	Assuming Normal Distribution											
786	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
787					95% Student's-t UCL	200.4					95% Adjusted-CLT UCL (Chen-1995)	203.5
788											95% Modified-t UCL (Johnson-1978)	201.2
789												
790	Nonparametric Distribution Free UCLs											
791					95% CLT UCL	198.6					95% Jackknife UCL	200.4
792					95% Standard Bootstrap UCL	198.5					95% Bootstrap-t UCL	207.9
793					95% Hall's Bootstrap UCL	209.6					95% Percentile Bootstrap UCL	198.9
794					95% BCA Bootstrap UCL	205						
795					90% Chebyshev(Mean, Sd) UCL	229.8					95% Chebyshev(Mean, Sd) UCL	261.1
796					97.5% Chebyshev(Mean, Sd) UCL	304.5					99% Chebyshev(Mean, Sd) UCL	389.9
797												
798	Suggested UCL to Use											
799	Data appear Normal, May want to try Normal Distribution											
800												
801	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
802	Recommendations are based upon data size, data distribution, and skewness.											
803	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
804	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
805												
806												
807	Beryllium											
808												
809	General Statistics											
810					Total Number of Observations	21					Number of Distinct Observations	18
811											Number of Missing Observations	0
812					Minimum	0.16					Mean	0.398
813					Maximum	0.85					Median	0.39
814					SD	0.143					Std. Error of Mean	0.0312
815					Coefficient of Variation	0.36					Skewness	1.336
816					Mean of logged Data	-0.981					SD of logged Data	0.357
817												
818	Nonparametric Distribution Free UCL Statistics											
819	Data appear Approximate Normal Distributed at 5% Significance Level											
820												
821	Assuming Normal Distribution											
822	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
823					95% Student's-t UCL	0.451					95% Adjusted-CLT UCL (Chen-1995)	0.459
824											95% Modified-t UCL (Johnson-1978)	0.453
825												
826	Nonparametric Distribution Free UCLs											
827					95% CLT UCL	0.449					95% Jackknife UCL	0.451
828					95% Standard Bootstrap UCL	0.448					95% Bootstrap-t UCL	0.465

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
829	95% Hall's Bootstrap UCL	0.497	95% Percentile Bootstrap UCL	0.45
830	95% BCA Bootstrap UCL	0.458		
831	90% Chebyshev(Mean, Sd) UCL	0.491	95% Chebyshev(Mean, Sd) UCL	0.534
832	97.5% Chebyshev(Mean, Sd) UCL	0.593	99% Chebyshev(Mean, Sd) UCL	0.708
833				
834	**Suggested UCL to Use**			
835	**Data appear Normal, May want to try Normal Distribution**			
836				
837	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
838	Recommendations are based upon data size, data distribution, and skewness.			
839	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
840	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
841				
842				
843	**Boron (Total)**			
844				
845	**General Statistics**			
846	Total Number of Observations	5	Number of Distinct Observations	5
847			Number of Missing Observations	0
848	Minimum	4	Mean	9.8
849	Maximum	16	Median	11
850	SD	5.167	Std. Error of Mean	2.311
851	Coefficient of Variation	0.527	Skewness	-0.0993
852	Mean of logged Data	2.146	SD of logged Data	0.612
853				
854	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
855	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
856	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
857				
858	**Nonparametric Distribution Free UCL Statistics**			
859	**Data appear Normal Distributed at 5% Significance Level**			
860				
861	**Assuming Normal Distribution**			
862	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
863	95% Student's-t UCL	14.73	95% Adjusted-CLT UCL (Chen-1995)	13.49
864			95% Modified-t UCL (Johnson-1978)	14.71
865				
866	**Nonparametric Distribution Free UCLs**			
867	95% CLT UCL	13.6	95% Jackknife UCL	14.73
868	95% Standard Bootstrap UCL	13.21	95% Bootstrap-t UCL	14.79
869	95% Hall's Bootstrap UCL	12.17	95% Percentile Bootstrap UCL	13.2
870	95% BCA Bootstrap UCL	12.8		
871	90% Chebyshev(Mean, Sd) UCL	16.73	95% Chebyshev(Mean, Sd) UCL	19.87
872	97.5% Chebyshev(Mean, Sd) UCL	24.23	99% Chebyshev(Mean, Sd) UCL	32.79
873				
874	**Suggested UCL to Use**			
875	**Data appear Normal, May want to try Normal Distribution**			
876				

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.11/13/2020 2:22:32 PM								
5	From File			WorkSheet.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
877	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
878	Recommendations are based upon data size, data distribution, and skewness.											
879	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
880	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
881												
882	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
883	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
884												
885												
886	Cadmium											
887												
888	**General Statistics**											
889	Total Number of Observations					21	Number of Distinct Observations					20
890							Number of Missing Observations					0
891	Minimum					0.07	Mean					13.43
892	Maximum					68	Median					7.6
893	SD					17.35	Std. Error of Mean					3.787
894	Coefficient of Variation					1.292	Skewness					2.073
895	Mean of logged Data					1.512	SD of logged Data					1.92
896												
897	**Nonparametric Distribution Free UCL Statistics**											
898	**Data appear Gamma Distributed at 5% Significance Level**											
899												
900	**Assuming Normal Distribution**											
901	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
902	95% Student's-t UCL					19.96	95% Adjusted-CLT UCL (Chen-1995)					21.49
903							95% Modified-t UCL (Johnson-1978)					20.25
904												
905	**Nonparametric Distribution Free UCLs**											
906	95% CLT UCL					19.66	95% Jackknife UCL					19.96
907	95% Standard Bootstrap UCL					19.39	95% Bootstrap-t UCL					24.26
908	95% Hall's Bootstrap UCL					48.13	95% Percentile Bootstrap UCL					20.01
909	95% BCA Bootstrap UCL					21.49						
910	90% Chebyshev(Mean, Sd) UCL					24.79	95% Chebyshev(Mean, Sd) UCL					29.94
911	97.5% Chebyshev(Mean, Sd) UCL					37.08	99% Chebyshev(Mean, Sd) UCL					51.11
912												
913	**Suggested UCL to Use**											
914	**Data appear Gamma, May want to try Gamma Distribution**											
915												
916	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
917	Recommendations are based upon data size, data distribution, and skewness.											
918	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
919	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
920												
921												

	A B C D E	F	G H I J K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
922	**Chromium Total**			
923				
924	**General Statistics**			
925	Total Number of Observations	21	Number of Distinct Observations	19
926			Number of Missing Observations	0
927	Minimum	6.3	Mean	35.89
928	Maximum	97	Median	32
929	SD	22.89	Std. Error of Mean	4.995
930	Coefficient of Variation	0.638	Skewness	1.36
931	Mean of logged Data	3.38	SD of logged Data	0.689
932				
933	**Nonparametric Distribution Free UCL Statistics**			
934	**Data appear Approximate Normal Distributed at 5% Significance Level**			
935				
936	**Assuming Normal Distribution**			
937	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
938	95% Student's-t UCL	44.5	95% Adjusted-CLT UCL (Chen-1995)	45.69
939			95% Modified-t UCL (Johnson-1978)	44.75
940				
941	**Nonparametric Distribution Free UCLs**			
942	95% CLT UCL	44.1	95% Jackknife UCL	44.5
943	95% Standard Bootstrap UCL	43.95	95% Bootstrap-t UCL	47.75
944	95% Hall's Bootstrap UCL	51.37	95% Percentile Bootstrap UCL	44.6
945	95% BCA Bootstrap UCL	46.36		
946	90% Chebyshev(Mean, Sd) UCL	50.87	95% Chebyshev(Mean, Sd) UCL	57.66
947	97.5% Chebyshev(Mean, Sd) UCL	67.08	99% Chebyshev(Mean, Sd) UCL	85.59
948				
949	**Suggested UCL to Use**			
950	**Data appear Normal, May want to try Normal Distribution**			
951				
952	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
953	Recommendations are based upon data size, data distribution, and skewness.			
954	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
955	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
956				
957				
958	**Cobalt**			
959				
960	**General Statistics**			
961	Total Number of Observations	5	Number of Distinct Observations	5
962			Number of Missing Observations	0
963	Minimum	5.1	Mean	7.2
964	Maximum	9.3	Median	6.9
965	SD	1.703	Std. Error of Mean	0.762
966	Coefficient of Variation	0.237	Skewness	0.0987
967	Mean of logged Data	1.951	SD of logged Data	0.242
968				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
969	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
970	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
971	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
972				
973	Nonparametric Distribution Free UCL Statistics			
974	Data appear Normal Distributed at 5% Significance Level			
975				
976	Assuming Normal Distribution			
977	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
978	95% Student's-t UCL	8.824	95% Adjusted-CLT UCL (Chen-1995)	8.489
979			95% Modified-t UCL (Johnson-1978)	8.829
980				
981	Nonparametric Distribution Free UCLs			
982	95% CLT UCL	8.453	95% Jackknife UCL	8.824
983	95% Standard Bootstrap UCL	8.328	95% Bootstrap-t UCL	9.384
984	95% Hall's Bootstrap UCL	9.733	95% Percentile Bootstrap UCL	8.3
985	95% BCA Bootstrap UCL	8.2		
986	90% Chebyshev(Mean, Sd) UCL	9.485	95% Chebyshev(Mean, Sd) UCL	10.52
987	97.5% Chebyshev(Mean, Sd) UCL	11.96	99% Chebyshev(Mean, Sd) UCL	14.78
988				
989	Suggested UCL to Use			
990	Data appear Normal, May want to try Normal Distribution			
991				
992	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
993	Recommendations are based upon data size, data distribution, and skewness.			
994	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
995	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
996				
997				
998	Copper			
999				
1000	General Statistics			
1001	Total Number of Observations	5	Number of Distinct Observations	5
1002			Number of Missing Observations	0
1003	Minimum	20	Mean	50.8
1004	Maximum	73	Median	61
1005	SD	24.64	Std. Error of Mean	11.02
1006	Coefficient of Variation	0.485	Skewness	-0.538
1007	Mean of logged Data	3.805	SD of logged Data	0.588
1008				
1009	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
1010	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
1011	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
1012				
1013	Nonparametric Distribution Free UCL Statistics			
1014	Data appear Normal Distributed at 5% Significance Level			
1015				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1016	**Assuming Normal Distribution**			
1017	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1018	95% Student's-t UCL	74.29	95% Adjusted-CLT UCL (Chen-1995)	66.09
1019			95% Modified-t UCL (Johnson-1978)	73.85
1020				
1021	**Nonparametric Distribution Free UCLs**			
1022	95% CLT UCL	68.93	95% Jackknife UCL	74.29
1023	95% Standard Bootstrap UCL	67.04	95% Bootstrap-t UCL	70.49
1024	95% Hall's Bootstrap UCL	60.79	95% Percentile Bootstrap UCL	67.4
1025	95% BCA Bootstrap UCL	63.8		
1026	90% Chebyshev(Mean, Sd) UCL	83.86	95% Chebyshev(Mean, Sd) UCL	98.83
1027	97.5% Chebyshev(Mean, Sd) UCL	119.6	99% Chebyshev(Mean, Sd) UCL	160.4
1028				
1029	**Suggested UCL to Use**			
1030	**Data appear Normal, May want to try Normal Distribution**			
1031				
1032	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1033	Recommendations are based upon data size, data distribution, and skewness.			
1034	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1035	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1036				
1037	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
1038	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
1039				
1040				
1041	Lead			
1042				
1043	**General Statistics**			
1044	Total Number of Observations	5	Number of Distinct Observations	5
1045			Number of Missing Observations	0
1046	Minimum	6.1	Mean	42.82
1047	Maximum	100	Median	29
1048	SD	37.39	Std. Error of Mean	16.72
1049	Coefficient of Variation	0.873	Skewness	1.014
1050	Mean of logged Data	3.371	SD of logged Data	1.073
1051				
1052	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
1053	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
1054	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
1055				
1056	**Nonparametric Distribution Free UCL Statistics**			
1057	**Data appear Normal Distributed at 5% Significance Level**			
1058				
1059	**Assuming Normal Distribution**			
1060	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1061	95% Student's-t UCL	78.47	95% Adjusted-CLT UCL (Chen-1995)	78.42
1062			95% Modified-t UCL (Johnson-1978)	79.73
1063				

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1064	**Nonparametric Distribution Free UCLs**			
1065	95% CLT UCL	70.32	95% Jackknife UCL	78.47
1066	95% Standard Bootstrap UCL	66.74	95% Bootstrap-t UCL	130.5
1067	95% Hall's Bootstrap UCL	282.1	95% Percentile Bootstrap UCL	69.4
1068	95% BCA Bootstrap UCL	71.6		
1069	90% Chebyshev(Mean, Sd) UCL	92.98	95% Chebyshev(Mean, Sd) UCL	115.7
1070	97.5% Chebyshev(Mean, Sd) UCL	147.2	99% Chebyshev(Mean, Sd) UCL	209.2
1071				
1072	**Suggested UCL to Use**			
1073	**Data appear Normal, May want to try Normal Distribution**			
1074				
1075	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1076	Recommendations are based upon data size, data distribution, and skewness.			
1077	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1078	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1079				
1080				
1081	**Molybdenum**			
1082				
1083	**General Statistics**			
1084	Total Number of Observations	21	Number of Distinct Observations	14
1085			Number of Missing Observations	0
1086	Minimum	0.1	Mean	1
1087	Maximum	3.3	Median	0.9
1088	SD	0.722	Std. Error of Mean	0.158
1089	Coefficient of Variation	0.722	Skewness	1.938
1090	Mean of logged Data	-0.241	SD of logged Data	0.771
1091				
1092	**Nonparametric Distribution Free UCL Statistics**			
1093	**Data appear Gamma Distributed at 5% Significance Level**			
1094				
1095	**Assuming Normal Distribution**			
1096	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1097	95% Student's-t UCL	1.272	95% Adjusted-CLT UCL (Chen-1995)	1.33
1098			95% Modified-t UCL (Johnson-1978)	1.283
1099				
1100	**Nonparametric Distribution Free UCLs**			
1101	95% CLT UCL	1.259	95% Jackknife UCL	1.272
1102	95% Standard Bootstrap UCL	1.25	95% Bootstrap-t UCL	1.435
1103	95% Hall's Bootstrap UCL	2.724	95% Percentile Bootstrap UCL	1.267
1104	95% BCA Bootstrap UCL	1.329		
1105	90% Chebyshev(Mean, Sd) UCL	1.473	95% Chebyshev(Mean, Sd) UCL	1.687
1106	97.5% Chebyshev(Mean, Sd) UCL	1.984	99% Chebyshev(Mean, Sd) UCL	2.567
1107				
1108	**Suggested UCL to Use**			
1109	**Data appear Gamma, May want to try Gamma Distribution**			
1110				

	A–E	F	G–K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1111	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1112	Recommendations are based upon data size, data distribution, and skewness.			
1113	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1114	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1115				
1116				
1117	Nickel			
1118				
1119	General Statistics			
1120	Total Number of Observations	5	Number of Distinct Observations	5
1121			Number of Missing Observations	0
1122	Minimum	10	Mean	17.4
1123	Maximum	23	Median	18
1124	SD	5.128	Std. Error of Mean	2.293
1125	Coefficient of Variation	0.295	Skewness	-0.607
1126	Mean of logged Data	2.816	SD of logged Data	0.33
1127				
1128	Note: Sample size is small (e.g., <10), if data are collected using ISM approach			
1129	you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
1130	Chebyshev UCL can be computed using the Nonparametric and All UCL Options.			
1131				
1132	Nonparametric Distribution Free UCL Statistics			
1133	Data appear Normal Distributed at 5% Significance Level			
1134				
1135	Assuming Normal Distribution			
1136	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1137	95% Student's-t UCL	22.29	95% Adjusted-CLT UCL (Chen-1995)	20.51
1138			95% Modified-t UCL (Johnson-1978)	22.19
1139				
1140	Nonparametric Distribution Free UCLs			
1141	95% CLT UCL	21.17	95% Jackknife UCL	22.29
1142	95% Standard Bootstrap UCL	20.79	95% Bootstrap-t UCL	21.48
1143	95% Hall's Bootstrap UCL	20.89	95% Percentile Bootstrap UCL	20.6
1144	95% BCA Bootstrap UCL	20		
1145	90% Chebyshev(Mean, Sd) UCL	24.28	95% Chebyshev(Mean, Sd) UCL	27.4
1146	97.5% Chebyshev(Mean, Sd) UCL	31.72	99% Chebyshev(Mean, Sd) UCL	40.22
1147				
1148	Suggested UCL to Use			
1149	Data appear Normal, May want to try Normal Distribution			
1150				
1151	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1152	Recommendations are based upon data size, data distribution, and skewness.			
1153	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1154	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1155				
1156	Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be			
1157	reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.			
1158				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1159	**Selenium**			
1160				
1161	**General Statistics**			
1162	Total Number of Observations	21	Number of Distinct Observations	2
1163	Number of Detects	3	Number of Non-Detects	18
1164	Number of Distinct Detects	2	Number of Distinct Non-Detects	1
1165	Minimum Detect	0.7	Minimum Non-Detect	0.7
1166	Maximum Detect	1.5	Maximum Non-Detect	0.7
1167	Variance Detects	0.213	Percent Non-Detects	85.71%
1168	Mean Detects	0.967	SD Detects	0.462
1169	Median Detects	0.7	CV Detects	0.478
1170	Skewness Detects	1.732	Kurtosis Detects	N/A
1171	Mean of Logged Detects	-0.103	SD of Logged Detects	0.44
1172				
1173	**Warning: Data set has only 3 Detected Values.**			
1174	**This is not enough to compute meaningful or reliable statistics and estimates.**			
1175				
1176				
1177	**Nonparametric Distribution Free UCL Statistics**			
1178	**Detected Data appear Approximate Normal Distributed at 5% Significance Level**			
1179				
1180	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1181	Mean	0.738	Standard Error of Mean	0.0455
1182	SD	0.17	95% KM (BCA) UCL	N/A
1183	95% KM (t) UCL	0.817	95% KM (Percentile Bootstrap) UCL	N/A
1184	95% KM (z) UCL	0.813	95% KM Bootstrap t UCL	N/A
1185	90% KM Chebyshev UCL	0.875	95% KM Chebyshev UCL	0.937
1186	97.5% KM Chebyshev UCL	1.022	99% KM Chebyshev UCL	1.191
1187				
1188	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1189	KM SD (logged)	0.162	95% Critical H Value (KM-Log)	1.751
1190	KM Mean (logged)	-0.32	KM Geo Mean	0.726
1191	KM Standard Error of Mean (logged)	0.0434	95% H-UCL (KM -Log)	0.784
1192				
1193	**Suggested UCL to Use**			
1194	**Data appear Normal, May want to try Normal Distribution.**			
1195	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1196	Recommendations are based upon data size, data distribution, and skewness.			
1197	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1198	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1199				
1200	**Silver**			
1201				
1202	**General Statistics**			
1203	Total Number of Observations	21	Number of Distinct Observations	20
1204	Number of Detects	20	Number of Non-Detects	1
1205	Number of Distinct Detects	19	Number of Distinct Non-Detects	1
1206	Minimum Detect	0.06	Minimum Non-Detect	0.05

1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1207	Maximum Detect	27	Maximum Non-Detect	0.05
1208	Variance Detects	42.21	Percent Non-Detects	4.762%
1209	Mean Detects	4.997	SD Detects	6.497
1210	Median Detects	3.25	CV Detects	1.3
1211	Skewness Detects	2.521	Kurtosis Detects	6.922
1212	Mean of Logged Detects	0.859	SD of Logged Detects	1.439
1213				
1214	Nonparametric Distribution Free UCL Statistics			
1215	Detected Data appear Gamma Distributed at 5% Significance Level			
1216				
1217	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
1218	Mean	4.761	Standard Error of Mean	1.404
1219	SD	6.269	95% KM (BCA) UCL	7.471
1220	95% KM (t) UCL	7.182	95% KM (Percentile Bootstrap) UCL	7.155
1221	95% KM (z) UCL	7.07	95% KM Bootstrap t UCL	9.62
1222	90% KM Chebyshev UCL	8.972	95% KM Chebyshev UCL	10.88
1223	97.5% KM Chebyshev UCL	13.53	99% KM Chebyshev UCL	18.73
1224				
1225	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
1226	KM SD (logged)	1.596	95% Critical H Value (KM-Log)	3.466
1227	KM Mean (logged)	0.676	KM Geo Mean	1.965
1228	KM Standard Error of Mean (logged)	0.357	95% H-UCL (KM -Log)	24.21
1229				
1230	Suggested UCL to Use			
1231	Data appear Gamma, May want to try Gamma Distribution			
1232	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1233	Recommendations are based upon data size, data distribution, and skewness.			
1234	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1235	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1236				
1238	Thallium			
1239				
1240	General Statistics			
1241	Total Number of Observations	21	Number of Distinct Observations	12
1242			Number of Missing Observations	0
1243	Minimum	0.04	Mean	0.122
1244	Maximum	0.25	Median	0.11
1245	SD	0.0441	Std. Error of Mean	0.00963
1246	Coefficient of Variation	0.362	Skewness	0.999
1247	Mean of logged Data	-2.169	SD of logged Data	0.382
1248				
1249	Nonparametric Distribution Free UCL Statistics			
1250	Data appear Normal Distributed at 5% Significance Level			
1251				
1252	Assuming Normal Distribution			
1253	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1254	95% Student's-t UCL	0.139	95% Adjusted-CLT UCL (Chen-1995)	0.14
1255			95% Modified-t UCL (Johnson-1978)	0.139

1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1256				
1257	**Nonparametric Distribution Free UCLs**			
1258	95% CLT UCL	0.138	95% Jackknife UCL	0.139
1259	95% Standard Bootstrap UCL	0.137	95% Bootstrap-t UCL	0.141
1260	95% Hall's Bootstrap UCL	0.147	95% Percentile Bootstrap UCL	0.138
1261	95% BCA Bootstrap UCL	0.14		
1262	90% Chebyshev(Mean, Sd) UCL	0.151	95% Chebyshev(Mean, Sd) UCL	0.164
1263	97.5% Chebyshev(Mean, Sd) UCL	0.182	99% Chebyshev(Mean, Sd) UCL	0.218
1264				
1265	**Suggested UCL to Use**			
1266	**Data appear Normal, May want to try Normal Distribution**			
1267				
1268	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1269	Recommendations are based upon data size, data distribution, and skewness.			
1270	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1271	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1272				
1273				
1274	Uranium			
1275				
1276	**General Statistics**			
1277	Total Number of Observations	21	Number of Distinct Observations	17
1278			Number of Missing Observations	0
1279	Minimum	0.3	Mean	0.54
1280	Maximum	0.81	Median	0.53
1281	SD	0.135	Std. Error of Mean	0.0294
1282	Coefficient of Variation	0.25	Skewness	0.323
1283	Mean of logged Data	-0.648	SD of logged Data	0.257
1284				
1285	**Nonparametric Distribution Free UCL Statistics**			
1286	**Data appear Normal Distributed at 5% Significance Level**			
1287				
1288	**Assuming Normal Distribution**			
1289	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1290	95% Student's-t UCL	0.59	95% Adjusted-CLT UCL (Chen-1995)	0.59
1291			95% Modified-t UCL (Johnson-1978)	0.591
1292				
1293	**Nonparametric Distribution Free UCLs**			
1294	95% CLT UCL	0.588	95% Jackknife UCL	0.59
1295	95% Standard Bootstrap UCL	0.586	95% Bootstrap-t UCL	0.592
1296	95% Hall's Bootstrap UCL	0.591	95% Percentile Bootstrap UCL	0.585
1297	95% BCA Bootstrap UCL	0.591		
1298	90% Chebyshev(Mean, Sd) UCL	0.628	95% Chebyshev(Mean, Sd) UCL	0.668
1299	97.5% Chebyshev(Mean, Sd) UCL	0.723	99% Chebyshev(Mean, Sd) UCL	0.832
1300				
1301	**Suggested UCL to Use**			
1302	**Data appear Normal, May want to try Normal Distribution**			
1303				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1304	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1305	Recommendations are based upon data size, data distribution, and skewness.			
1306	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1307	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1308				
1309				
1310	Vanadium			
1311				
1312	**General Statistics**			
1313	Total Number of Observations	5	Number of Distinct Observations	5
1314			Number of Missing Observations	0
1315	Minimum	11	Mean	15.2
1316	Maximum	19	Median	15
1317	SD	3.347	Std. Error of Mean	1.497
1318	Coefficient of Variation	0.22	Skewness	-0.088
1319	Mean of logged Data	2.701	SD of logged Data	0.227
1320				
1321	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
1322	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
1323	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
1324				
1325	**Nonparametric Distribution Free UCL Statistics**			
1326	**Data appear Normal Distributed at 5% Significance Level**			
1327				
1328	**Assuming Normal Distribution**			
1329	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1330	95% Student's-t UCL	18.39	95% Adjusted-CLT UCL (Chen-1995)	17.6
1331			95% Modified-t UCL (Johnson-1978)	18.38
1332				
1333	**Nonparametric Distribution Free UCLs**			
1334	95% CLT UCL	17.66	95% Jackknife UCL	18.39
1335	95% Standard Bootstrap UCL	17.38	95% Bootstrap-t UCL	18.88
1336	95% Hall's Bootstrap UCL	18.4	95% Percentile Bootstrap UCL	17.4
1337	95% BCA Bootstrap UCL	17.2		
1338	90% Chebyshev(Mean, Sd) UCL	19.69	95% Chebyshev(Mean, Sd) UCL	21.72
1339	97.5% Chebyshev(Mean, Sd) UCL	24.55	99% Chebyshev(Mean, Sd) UCL	30.09
1340				
1341	**Suggested UCL to Use**			
1342	**Data appear Normal, May want to try Normal Distribution**			
1343				
1344	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1345	Recommendations are based upon data size, data distribution, and skewness.			
1346	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1347	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1348				
1349	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
1350	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
1351				

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1352				
1353	Zinc			
1354				
1355	**General Statistics**			
1356	Total Number of Observations	5	Number of Distinct Observations	5
1357			Number of Missing Observations	0
1358	Minimum	30	Mean	202
1359	Maximum	339	Median	250
1360	SD	136.7	Std. Error of Mean	61.12
1361	Coefficient of Variation	0.677	Skewness	-0.469
1362	Mean of logged Data	4.985	SD of logged Data	1.04
1363				
1364	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach**			
1365	**you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
1366	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options.**			
1367				
1368	**Nonparametric Distribution Free UCL Statistics**			
1369	**Data appear Normal Distributed at 5% Significance Level**			
1370				
1371	**Assuming Normal Distribution**			
1372	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1373	95% Student's-t UCL	332.3	95% Adjusted-CLT UCL (Chen-1995)	288.8
1374			95% Modified-t UCL (Johnson-1978)	330.2
1375				
1376	**Nonparametric Distribution Free UCLs**			
1377	95% CLT UCL	302.5	95% Jackknife UCL	332.3
1378	95% Standard Bootstrap UCL	291.1	95% Bootstrap-t UCL	308.5
1379	95% Hall's Bootstrap UCL	261.3	95% Percentile Bootstrap UCL	289.8
1380	95% BCA Bootstrap UCL	285.6		
1381	90% Chebyshev(Mean, Sd) UCL	385.4	95% Chebyshev(Mean, Sd) UCL	468.4
1382	97.5% Chebyshev(Mean, Sd) UCL	583.7	99% Chebyshev(Mean, Sd) UCL	810.2
1383				
1384	**Suggested UCL to Use**			
1385	**Data appear Normal, May want to try Normal Distribution**			
1386				
1387	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1388	Recommendations are based upon data size, data distribution, and skewness.			
1389	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1390	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1391				
1392	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**			
1393	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**			
1394				
1395	Ammonia and Ammonium (as N)			
1396				
1397	**General Statistics**			
1398	Total Number of Observations	21	Number of Distinct Observations	2
1399	Number of Detects	16	Number of Non-Detects	5

	A–E	F	G–K	L
1	**Nonparametric UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1400	Number of Distinct Detects	2	Number of Distinct Non-Detects	1
1401	Minimum Detect	100	Minimum Non-Detect	100
1402	Maximum Detect	200	Maximum Non-Detect	100
1403	Variance Detects	2667	Percent Non-Detects	23.81%
1404	Mean Detects	150	SD Detects	51.64
1405	Median Detects	150	CV Detects	0.344
1406	Skewness Detects	0	Kurtosis Detects	-2.308
1407	Mean of Logged Detects	4.952	SD of Logged Detects	0.358
1408				
1409	**Nonparametric Distribution Free UCL Statistics**			
1410	**Data do not follow a Discernible Distribution at 5% Significance Level**			
1411				
1412	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
1413	Mean	138.1	Standard Error of Mean	10.94
1414	SD	48.56	95% KM (BCA) UCL	N/A
1415	95% KM (t) UCL	157	95% KM (Percentile Bootstrap) UCL	N/A
1416	95% KM (z) UCL	156.1	95% KM Bootstrap t UCL	N/A
1417	90% KM Chebyshev UCL	170.9	95% KM Chebyshev UCL	185.8
1418	97.5% KM Chebyshev UCL	206.4	99% KM Chebyshev UCL	247
1419				
1420	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
1421	KM SD (logged)	0.337	95% Critical H Value (KM-Log)	1.858
1422	KM Mean (logged)	4.869	KM Geo Mean	130.2
1423	KM Standard Error of Mean (logged)	0.0759	95% H-UCL (KM -Log)	158.5
1424				
1425	**Suggested UCL to Use**			
1426	95% KM (t) UCL	157	KM H-UCL	158.5
1427	95% KM (BCA) UCL	N/A		
1428	**Warning: One or more Recommended UCL(s) not available!**			
1429	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1430	Recommendations are based upon data size, data distribution, and skewness.			
1431	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1432	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1433				
1434	**Kjeldahl Nitrogen Total**			
1435				
1436	**General Statistics**			
1437	Total Number of Observations	21	Number of Distinct Observations	13
1438	Number of Detects	20	Number of Non-Detects	1
1439	Number of Distinct Detects	12	Number of Distinct Non-Detects	1
1440	Minimum Detect	200	Minimum Non-Detect	100
1441	Maximum Detect	1500	Maximum Non-Detect	100
1442	Variance Detects	142605	Percent Non-Detects	4.762%
1443	Mean Detects	795	SD Detects	377.6
1444	Median Detects	750	CV Detects	0.475
1445	Skewness Detects	0.265	Kurtosis Detects	-0.605
1446	Mean of Logged Detects	6.544	SD of Logged Detects	0.577
1447				

1	Nonparametric UCL Statistics for Data Sets with Non-Detects			
2				
3	User Selected Options			
4	Date/Time of Computation	ProUCL 5.11/13/2020 2:22:32 PM		
5	From File	WorkSheet.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
1448	Nonparametric Distribution Free UCL Statistics			
1449	Detected Data appear Normal Distributed at 5% Significance Level			
1450				
1451	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
1452	Mean	761.9	Standard Error of Mean	86.98
1453	SD	388.5	95% KM (BCA) UCL	895.2
1454	95% KM (t) UCL	911.9	95% KM (Percentile Bootstrap) UCL	900
1455	95% KM (z) UCL	905	95% KM Bootstrap t UCL	914.4
1456	90% KM Chebyshev UCL	1023	95% KM Chebyshev UCL	1141
1457	97.5% KM Chebyshev UCL	1305	99% KM Chebyshev UCL	1627
1458				
1459	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
1460	KM SD (logged)	0.687	95% Critical H Value (KM-Log)	2.177
1461	KM Mean (logged)	6.452	KM Geo Mean	633.7
1462	KM Standard Error of Mean (logged)	0.154	95% H-UCL (KM -Log)	1121
1463				
1464	Suggested UCL to Use			
1465	Data appear Normal, May want to try Normal Distribution.			
1466	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1467	Recommendations are based upon data size, data distribution, and skewness.			
1468	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1469	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1470				
1471				
1472	Phosphorus			
1473				
1474	General Statistics			
1475	Total Number of Observations	21	Number of Distinct Observations	21
1476			Number of Missing Observations	0
1477	Minimum	563	Mean	1033
1478	Maximum	1820	Median	937
1479	SD	330.8	Std. Error of Mean	72.19
1480	Coefficient of Variation	0.32	Skewness	1.092
1481	Mean of logged Data	6.895	SD of logged Data	0.304
1482				
1483	Nonparametric Distribution Free UCL Statistics			
1484	Data appear Gamma Distributed at 5% Significance Level			
1485				
1486	Assuming Normal Distribution			
1487	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1488	95% Student's-t UCL	1157	95% Adjusted-CLT UCL (Chen-1995)	1170
1489			95% Modified-t UCL (Johnson-1978)	1160
1490				

	A	B	C	D	E	F	G	H	I	J	K	L
1	Nonparametric UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.11/13/2020 2:22:32 PM								
5	From File			WorkSheet.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
1491	Nonparametric Distribution Free UCLs											
1492	95% CLT UCL					1151	95% Jackknife UCL					1157
1493	95% Standard Bootstrap UCL					1149	95% Bootstrap-t UCL					1186
1494	95% Hall's Bootstrap UCL					1193	95% Percentile Bootstrap UCL					1160
1495	95% BCA Bootstrap UCL					1163						
1496	90% Chebyshev(Mean, Sd) UCL					1249	95% Chebyshev(Mean, Sd) UCL					1347
1497	97.5% Chebyshev(Mean, Sd) UCL					1484	99% Chebyshev(Mean, Sd) UCL					1751
1498												
1499	Suggested UCL to Use											
1500	Data appear Gamma, May want to try Gamma Distribution											
1501												
1502	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1503	Recommendations are based upon data size, data distribution, and skewness.											
1504	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1505	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1506												

1 General Statistics on Uncensored Data

2 Date/Time of Computation: ProUCL 5.11/28/2020 3:53:17 PM

3 User Selected Options

4 From File: SED 0-0.15mbg Chemistry_input_v7.xls

5 Full Precision: OFF

6

7 **From File: SED 0-0.15mbg Chemistry_input_v7.xls**

8

9 General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method

10

Row	Variable	NumObs	# Missing	Num Ds	NumNDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
12	aluminum	6	17	6	0	0.00%	N/A	N/A	10842	2569377	1603	0.148
13	antimony	22	1	7	15	68.18%	0.8	0.8	0.723	0.0717	0.268	0.37
14	arsenic	22	1	22	0	0.00%	N/A	N/A	4.551	3.314	1.82	0.4
15	barium	22	1	22	0	0.00%	N/A	N/A	103.8	1069	32.69	0.315
16	beryllium	22	1	22	0	0.00%	N/A	N/A	0.44	0.01	0.1	0.227
17	boron	15	8	15	0	0.00%	N/A	N/A	17.35	15.85	3.981	0.229
18	cadmium	22	1	22	0	0.00%	N/A	N/A	1.354	4.166	2.041	1.507
19	chromium (III+VI)	22	1	22	0	0.00%	N/A	N/A	24.88	46.11	6.79	0.273
20	copper	15	8	15	0	0.00%	N/A	N/A	70.43	1269	35.63	0.506
21	iron	6	17	6	0	0.00%	N/A	N/A	22650	6135000	2477	0.109
22	lead	15	8	15	0	0.00%	N/A	N/A	37.67	381.1	19.52	0.518
23	manganese	6	17	6	0	0.00%	N/A	N/A	551.8	6909	83.12	0.151
24	mercury	6	17	6	0	0.00%	N/A	N/A	0.136	0.00549	0.0741	0.544
25	molybdenum	22	1	22	0	0.00%	N/A	N/A	1.216	0.256	0.506	0.416
26	nickel	15	8	15	0	0.00%	N/A	N/A	21.27	8.589	2.931	0.138
27	selenium	22	1	5	17	77.27%	0.5	0.7	0.579	0.025	0.158	0.273
28	silver	22	1	22	0	0.00%	N/A	N/A	0.721	0.777	0.881	1.223
29	sodium	6	17	6	0	0.00%	N/A	N/A	300	8910	94.39	0.315
30	thallium	22	1	22	0	0.00%	N/A	N/A	0.158	0.00284	0.0533	0.338
31	tin	6	17	6	0	0.00%	N/A	N/A	3.605	3.855	1.963	0.545
32	titanium	6	17	6	0	0.00%	N/A	N/A	126.8	279	16.7	0.132
33	uranium	22	1	22	0	0.00%	N/A	N/A	0.645	0.0139	0.118	0.183
34	vanadium	15	8	15	0	0.00%	N/A	N/A	19.33	18.6	4.313	0.223
35	zinc	15	8	15	0	0.00%	N/A	N/A	298.1	12894	113.6	0.381
36	acenaphthylene	22	1	8	14	63.64%	0.1	0.1	0.0273	0.00151	0.0389	1.425
37	acenaphthene	22	1	11	11	50.00%	0.1	0.1	0.189	0.111	0.333	1.764
38	anthracene	22	1	16	6	27.27%	0.1	0.1	0.426	0.917	0.957	2.248
39	benz(a)anthracene	22	1	22	0	0.00%	N/A	N/A	1.133	1.946	1.395	1.232
40	benzo(b)fluoranthene	22	1	22	0	0.00%	N/A	N/A	1.593	2.987	1.728	1.085
41	benzo(b+j)fluoranthenes	6	17	6	0	0.00%	N/A	N/A	1.163	0.0401	0.2	0.172
42	benzo(g,h,i)perylene	22	1	22	0	0.00%	N/A	N/A	0.699	0.764	0.874	1.251
43	benzo(k)fluoranthene	22	1	17	5	22.73%	0.2	0.2	0.514	0.235	0.485	0.945
44	benzo(a)pyrene	22	1	22	0	0.00%	N/A	N/A	1.068	1.515	1.231	1.153
45	chrysene	22	1	22	0	0.00%	N/A	N/A	1.379	2.151	1.467	1.064
46	dibenz(a,h)anthracene	22	1	13	9	40.91%	0.1	0.1	0.172	0.0226	0.15	0.875
47	fluoranthene	22	1	22	0	0.00%	N/A	N/A	3.49	25.55	5.055	1.449
48	fluorene	22	1	13	9	40.91%	0.1	0.1	0.229	0.146	0.382	1.668
49	indeno(1,2,3-cd)pyrene	22	1	22	0	0.00%	N/A	N/A	0.603	0.487	0.698	1.157
50	methylnaphthalene, 1-	16	7	2	14	87.50%	0.1	0.1	0.109	6.9336E-4	0.0263	0.241
51	methylnaphthalene, 2-	22	1	9	13	59.09%	0.1	0.1	0.0554	0.00655	0.0809	1.462
52	naphthalene	22	1	11	11	50.00%	0.1	0.1	0.0975	0.0419	0.205	2.1

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2			Date/Time of Computation	ProUCL 5.11/28/2020 3:53:17 PM									
3			User Selected Options										
4			From File	SED 0-0.15mbg Chemistry_input_v7.xls									
5			Full Precision	OFF									
6													
53	phenanthrene		22	1	22	0	0.00%	N/A	N/A	2.293	14.18	3.766	1.642
54	pyrene		22	1	22	0	0.00%	N/A	N/A	2.696	15.11	3.887	1.441
55	PAHs (sum of total)		22	1	22	0	0.00%	N/A	N/A	14.8	428.8	20.71	1.399
56	a and ammonium (as N)		16	7	6	10	62.50%	100	100	150	7500	86.6	0.577
57	ammonia as N		6	17	6	0	0.00%	N/A	N/A	64.93	5858	76.54	1.179
58	kjeldahl nitrogen total		22	1	22	0	0.00%	N/A	N/A	654.2	245131	495.1	0.757
59	nitrogen (total)		6	17	3	3	50.00%	2000	2000	2667	555556	745.4	0.28
60	organic phosphorus		6	17	5	1	16.67%	1	1	2.317	1.571	1.254	0.541
61	phosphorus		22	1	22	0	0.00%	N/A	N/A	904.4	81035	284.7	0.315
62	Fecal Coliforms		17	6	16	1	5.88%	1000	1000	20294	1.793E+8	13389	0.66
63													
64				General Statistics for Raw Data Sets using Detected Data Only									
65													
66	Variable		NumObs	# Missing	Minimum	Maximum	Mean	Median	Var	SD	MAD/0.675	Skewness	CV
67	aluminum		6	17	9030	13200	10842	10600	2569377	1603	2039	0.492	0.148
68	antimony		7	1	0.53	1.54	0.997	0.92	0.124	0.352	0.385	0.257	0.353
69	arsenic		22	1	3	12	4.551	4	3.314	1.82	0.593	3.536	0.4
70	barium		22	1	69	210	103.8	95.5	1069	32.69	26.83	1.703	0.315
71	beryllium		22	1	0.28	0.67	0.44	0.425	0.01	0.1	0.089	0.645	0.227
72	boron		15	8	11	23.5	17.35	17	15.85	3.981	4.448	0.358	0.229
73	cadmium		22	1	0.27	8.5	1.354	0.616	4.166	2.041	0.297	2.883	1.507
74	chromium (III+VI)		22	1	16	41	24.88	22	46.11	6.79	3.855	1.077	0.273
75	copper		15	8	30	170	70.43	63	1269	35.63	19.27	1.855	0.506
76	iron		6	17	18800	25600	22650	22800	6135000	2477	2743	-0.496	0.109
77	lead		15	8	13	87	37.67	34	381.1	19.52	17.94	1.073	0.518
78	manganese		6	17	390	623	551.8	577	6909	83.12	32.62	-1.96	0.151
79	mercury		6	17	0.057	0.255	0.136	0.104	0.00549	0.0741	0.0378	0.953	0.544
80	molybdenum		22	1	0.6	2.4	1.216	1.075	0.256	0.506	0.282	1.258	0.416
81	nickel		15	8	16	26.6	21.27	21	8.589	2.931	1.927	-0.0158	0.138
82	selenium		5	1	0.7	1	0.848	0.8	0.0205	0.143	0.148	0.342	0.169
83	silver		22	1	0.083	3.3	0.721	0.379	0.777	0.881	0.289	2.171	1.223
84	sodium		6	17	209	447	300	283	8910	94.39	105.3	0.678	0.315
85	thallium		22	1	0.08	0.263	0.158	0.135	0.00284	0.0533	0.0445	0.554	0.338
86	tin		6	17	1.36	6.31	3.605	3.64	3.855	1.963	2.535	0.154	0.545
87	titanium		6	17	101	150	126.8	125	279	16.7	13.34	-0.208	0.132
88	uranium		22	1	0.46	0.886	0.645	0.645	0.0139	0.118	0.0964	0.525	0.183
89	vanadium		15	8	13	28.7	19.33	18	18.6	4.313	3.558	0.489	0.223
90	zinc		15	8	167	532	298.1	272	12894	113.6	88.95	0.983	0.381
91	acenaphthylene		8	1	0.011	0.18	0.0479	0.018	0.00396	0.0629	0.00815	1.787	1.314
92	acenaphthene		11	1	0.03	1.49	0.329	0.25	0.201	0.448	0.298	2.143	1.364
93	anthracene		16	1	0.08	4.69	0.556	0.155	1.279	1.131	0.0964	3.687	2.035
94	benz(a)anthracene		22	1	0.18	6.6	1.133	0.645	1.946	1.395	0.363	3.208	1.232
95	benzo(b)fluoranthene		22	1	0.32	8.37	1.593	1	2.987	1.728	0.549	3.171	1.085
96	benzo(b+j)fluoranthenes		6	17	0.9	1.4	1.163	1.2	0.0401	0.2	0.222	-0.236	0.172
97	benzo(g,h,i)perylene		22	1	0.13	4.36	0.699	0.435	0.764	0.874	0.245	3.822	1.251
98	benzo(k)fluoranthene		17	1	0.23	2.29	0.606	0.41	0.284	0.533	0.237	2.328	0.879

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2			Date/Time of Computation	ProUCL 5.11/28/2020 3:53:17 PM									
3			User Selected Options										
4			From File	SED 0-0.15mbg Chemistry_input_v7.xls									
5			Full Precision	OFF									
6													
99		benzo(a)pyrene	22	1	0.18	6.01	1.068	0.69	1.515	1.231	0.408	3.391	1.153
100		chrysene	22	1	0.26	7.15	1.379	0.875	2.151	1.467	0.615	3.209	1.064
101		dibenz(a,h)anthracene	13	1	0.1	0.79	0.222	0.16	0.0348	0.187	0.0593	2.723	0.843
102		fluoranthene	22	1	0.59	24.5	3.49	1.955	25.55	5.055	1.223	3.783	1.449
103		fluorene	13	1	0.047	1.76	0.343	0.11	0.232	0.482	0.0934	2.493	1.405
104		indeno(1,2,3-cd)pyrene	22	1	0.11	3.45	0.603	0.42	0.487	0.698	0.237	3.547	1.157
105		methylnaphthalene, 1-	2	7	0.15	0.2	0.175	0.175	0.00125	0.0354	0.0371	N/A	0.202
106		methylnaphthalene, 2-	9	1	0.0096	0.3	0.096	0.034	0.0142	0.119	0.0362	1.382	1.244
107		naphthalene	11	1	0.0089	0.98	0.177	0.13	0.0782	0.28	0.159	2.779	1.578
108		phenanthrene	22	1	0.25	16.5	2.293	0.875	14.18	3.766	0.415	3.124	1.642
109		pyrene	22	1	0.47	18.9	2.696	1.49	15.11	3.887	0.912	3.804	1.441
110		PAHs (sum of total)	22	1	2.97	98.7	14.8	7.55	428.8	20.71	3.773	3.549	1.399
111		a and ammonium (as N)	6	7	100	400	233.3	200	10667	103.3	74.13	0.666	0.443
112		ammonia as N	6	17	3.6	190	64.93	26.5	5858	76.54	26.98	1.169	1.179
113		kjeldahl nitrogen total	22	1	5.8	1900	654.2	600	245131	495.1	444.8	0.85	0.757
114		nitrogen (total)	3	17	3000	4000	3333	3000	333333	577.4	0	1.732	0.173
115		organic phosphorus	5	17	1.1	4.6	2.58	2.4	1.837	1.355	1.038	0.745	0.525
116		phosphorus	22	1	598	1622	904.4	816	81035	284.7	209	1.383	0.315
117		Fecal Coliforms	16	6	3000	45000	21500	18000	1.768E+8	13297	11861	0.572	0.618
118													
119							Percentiles using all Detects (Ds) and Non-Detects (NDs)						
120													
121	Variable		NumObs	# Missing	10%ile	20%ile	25%ile(Q1)	50%ile(Q2)	75%ile(Q3)	80%ile	90%ile	95%ile	99%ile
122		aluminum	6	17	9225	9420	9690	10600	11825	12200	12700	12950	13150
123		antimony	22	1	0.8	0.8	0.8	0.8	0.8	0.896	1.091	1.291	1.49
124		arsenic	22	1	3.564	3.62	3.703	4	4.675	4.916	5.68	5.757	10.69
125		barium	22	1	75.65	78.24	80	95.5	122.3	128.6	133.6	140.7	195.5
126		beryllium	22	1	0.332	0.362	0.373	0.425	0.513	0.546	0.568	0.599	0.655
127		boron	15	8	13.4	14.72	14.95	17	20.9	21.88	23.08	23.43	23.49
128		cadmium	22	1	0.39	0.44	0.56	0.616	0.848	0.903	2.922	5.95	7.996
129		chromium (III+VI)	22	1	19.08	20	20.25	22	29.75	31.4	35.51	36.95	40.16
130		copper	15	8	40.7	48.92	50.5	63	76	81.94	109.3	138.5	163.7
131		iron	6	17	19950	21100	21475	22800	24350	24800	25200	25400	25560
132		lead	15	8	17.6	21.6	23.25	34	48.05	50.26	55.92	67.4	83.08
133		manganese	6	17	470	550	554	577	592.5	594	608.5	615.8	621.6
134		mercury	6	17	0.0785	0.1	0.101	0.104	0.174	0.197	0.226	0.241	0.252
135		molybdenum	22	1	0.8	0.876	0.9	1.075	1.418	1.498	1.98	2.323	2.387
136		nickel	15	8	17.4	19.6	20	21	22.65	23.2	24.96	25.9	26.46
137		selenium	22	1	0.5	0.54	0.7	0.7	0.7	0.7	0.794	0.99	1
138		silver	22	1	0.112	0.205	0.265	0.379	0.6	1.065	1.57	2.93	3.237
139		sodium	6	17	212	215	222.5	283	352.5	363	405	426	442.8
140		thallium	22	1	0.11	0.112	0.12	0.135	0.2	0.203	0.228	0.254	0.261
141		tin	6	17	1.495	1.63	1.963	3.64	4.868	5.05	5.68	5.995	6.247
142		titanium	6	17	111	121	121.8	125	135.8	139	144.5	147.3	149.5
143		uranium	22	1	0.49	0.564	0.58	0.645	0.688	0.746	0.795	0.876	0.885
144		vanadium	15	8	14.2	16	16.5	18	22.05	22.24	24.06	26.04	28.17

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2	Date/Time of Computation			ProUCL 5.11/28/2020 3:53:17 PM									
3	**User Selected Options**												
4	From File			SED 0-0.15mbg Chemistry_input_v7.xls									
5	Full Precision			OFF									
6													
145	zinc		15	8	193	211.6	214.5	272	335.5	356.6	473.8	513.1	528.2
146	acenaphthylene		22	1	0.0133	0.0202	0.0408	0.1	0.1	0.1	0.1	0.11	0.165
147	acenaphthene		22	1	0.0454	0.0872	0.1	0.1	0.213	0.258	0.27	0.802	1.351
148	anthracene		22	1	0.1	0.1	0.1	0.12	0.28	0.4	0.664	0.975	3.913
149	benz(a)anthracene		22	1	0.38	0.424	0.443	0.645	1.1	1.572	1.97	2.912	5.836
150	benzo(b)fluoranthene		22	1	0.54	0.642	0.695	1	1.73	2.08	2.763	3.55	7.366
151	benzo(b+j)fluoranthenes		6	17	0.94	0.98	1.01	1.2	1.3	1.3	1.35	1.375	1.395
152	benzo(g,h,i)perylene		22	1	0.221	0.322	0.373	0.435	0.713	0.764	0.989	1.427	3.749
153	benzo(k)fluoranthene		22	1	0.2	0.206	0.23	0.305	0.603	0.686	0.963	1.351	2.097
154	benzo(a)pyrene		22	1	0.363	0.408	0.485	0.69	1.023	1.41	1.708	2.366	5.252
155	chrysene		22	1	0.452	0.532	0.665	0.875	1.46	1.708	2.118	3.185	6.329
156	dibenz(a,h)anthracene		22	1	0.1	0.1	0.1	0.115	0.168	0.194	0.256	0.365	0.702
157	fluoranthene		22	1	1.101	1.202	1.418	1.955	3.148	3.6	5.175	8.889	21.26
158	fluorene		22	1	0.0641	0.0896	0.1	0.1	0.223	0.284	0.454	0.822	1.567
159	indeno(1,2,3-cd)pyrene		22	1	0.191	0.254	0.27	0.42	0.608	0.646	0.898	1.318	3.007
160	methylnaphthalene, 1-		16	7	0.1	0.1	0.1	0.1	0.1	0.1	0.125	0.163	0.193
161	methylnaphthalene, 2-		22	1	0.0153	0.0406	0.0753	0.1	0.1	0.1	0.1	0.29	0.3
162	naphthalene		22	1	0.0149	0.0432	0.1	0.1	0.123	0.138	0.213	0.239	0.825
163	phenanthrene		22	1	0.463	0.6	0.62	0.875	2.165	3.084	3.599	9.235	15.04
164	pyrene		22	1	0.851	0.956	1.108	1.49	2.638	2.902	4.002	6.616	16.35
165	PAHs (sum of total)		22	1	4.921	5.3	5.4	7.55	15.25	16	22.75	41.24	86.84
166	a and ammonium (as N)		16	7	100	100	100	100	200	200	250	325	385
167	ammonia as N		6	17	8.3	13	16.25	26.5	104.3	130	160	175	187
168	kjeldahl nitrogen total		22	1	51.8	210	347.5	600	900	980	1180	1580	1837
169	nitrogen (total)		6	17	2000	2000	2000	2500	3000	3000	3500	3750	3950
170	organic phosphorus		6	17	1.05	1.1	1.25	2.05	2.925	3.1	3.85	4.225	4.525
171	phosphorus		22	1	643.8	695	715.8	816	989.3	1095	1251	1545	1609
172	Fecal Coliforms		17	6	6000	10000	10000	17000	30000	35600	40000	43400	44680

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2		Date/Time of Computation		ProUCL 5.11/28/2020 3:56:56 PM									
3			User Selected Options										
4			From File	SED 0.15+mbg Chemistry_input_v2.xls									
5			Full Precision	OFF									
6													
7	From File: SED 0.15+mbg Chemistry_input_v2.xls												
8													
9				General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method									
10													
11	Variable		NumObs	# Missing	Num Ds	NumNDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
12	antimony		21	0	11	10	47.62%	0.8	0.8	1.019	0.109	0.33	0.324
13	arsenic		21	0	21	0	0.00%	N/A	N/A	5.867	9.009	3.002	0.512
14	barium		21	0	21	0	0.00%	N/A	N/A	160.7	11144	105.6	0.657
15	beryllium		21	0	21	0	0.00%	N/A	N/A	0.398	0.0205	0.143	0.36
16	boron		21	0	21	0	0.00%	N/A	N/A	22.1	146.8	12.12	0.548
17	cadmium		21	0	21	0	0.00%	N/A	N/A	13.43	301.1	17.35	1.292
18	chromium (III+VI)		21	0	21	0	0.00%	N/A	N/A	35.89	524	22.89	0.638
19	copper		21	0	21	0	0.00%	N/A	N/A	106.2	6333	79.58	0.749
20	lead		21	0	21	0	0.00%	N/A	N/A	112	4636	68.09	0.608
21	molybdenum		21	0	21	0	0.00%	N/A	N/A	1	0.521	0.722	0.722
22	nickel		21	0	21	0	0.00%	N/A	N/A	38.93	574.7	23.97	0.616
23	selenium		21	0	3	18	85.71%	0.7	0.7	0.738	0.029	0.17	0.231
24	silver		21	0	20	1	4.76%	0.05	0.05	4.761	39.3	6.269	1.317
25	thallium		21	0	21	0	0.00%	N/A	N/A	0.122	0.00195	0.0441	0.362
26	uranium		21	0	21	0	0.00%	N/A	N/A	0.54	0.0181	0.135	0.25
27	vanadium		21	0	21	0	0.00%	N/A	N/A	17.95	24.45	4.944	0.275
28	zinc		21	0	21	0	0.00%	N/A	N/A	361.5	48645	220.6	0.61
29	a and ammonium (as N)		21	0	16	5	23.81%	100	100	138.1	2358	48.56	0.352
30	kjeldahl nitrogen total		21	0	20	1	4.76%	100	100	761.9	150930	388.5	0.51
31	phosphorus		21	0	21	0	0.00%	N/A	N/A	1033	109452	330.8	0.32
32	Fecal Coliforms		21	0	3	18	85.71%	1000	1000	1381	2902494	1704	1.234
33	acenaphthylene		21	0	0	21	100.00%	0.05	0.1	N/A	N/A	N/A	N/A
34	acenaphthene		21	0	13	8	38.10%	0.05	0.1	0.253	0.085	0.292	1.153
35	anthracene		21	0	17	4	19.05%	0.05	0.1	0.291	0.0834	0.289	0.991
36	benz(a)anthracene		21	0	19	2	9.52%	0.05	0.05	0.937	0.604	0.777	0.829
37	benzo(b)fluoranthene		21	0	19	2	9.52%	0.05	0.05	1.376	1.134	1.065	0.774
38	benzo(g,h,i)perylene		21	0	18	3	14.29%	0.1	0.1	0.515	0.0902	0.3	0.583
39	benzo(k)fluoranthene		21	0	18	3	14.29%	0.05	0.2	0.436	0.114	0.337	0.773
40	benzo(a)pyrene		21	0	19	2	9.52%	0.05	0.05	0.864	0.458	0.677	0.783
41	chrysene		21	0	19	2	9.52%	0.05	0.05	1.076	0.769	0.877	0.815
42	dibenz(a,h)anthracene		21	0	13	8	38.10%	0.06	0.1	0.123	0.00548	0.074	0.601
43	fluoranthene		21	0	19	2	9.52%	0.05	0.05	2.589	5.153	2.27	0.877
44	fluorene		21	0	16	5	23.81%	0.05	0.1	0.327	0.0882	0.297	0.908
45	indeno(1,2,3-cd)pyrene		21	0	18	3	14.29%	0.1	0.1	0.441	0.0788	0.281	0.636
46	methylnaphthalene, 1-		21	0	13	8	38.10%	0.05	0.1	0.277	0.0763	0.276	0.998
47	methylnaphthalene, 2-		21	0	13	8	38.10%	0.05	0.2	0.555	0.387	0.622	1.121
48	naphthalene		21	0	10	11	52.38%	0.05	0.1	0.168	0.0662	0.257	1.527
49	phenanthrene		21	0	19	2	9.52%	0.05	0.05	2.248	5.606	2.368	1.053
50	pyrene		21	0	19	2	9.52%	0.05	0.05	2.096	3.093	1.759	0.839
51	Total PAHs		21	0	21	0	0.00%	N/A	N/A	12.5	118.6	10.89	0.871
52													

Page 400 of 443

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2		Date/Time of Computation		ProUCL 5.11/28/2020 3:56:56 PM									
3		User Selected Options											
4			From File	SED 0.15+mbg Chemistry_input_v2.xls									
5			Full Precision	OFF									
6													
53					General Statistics for Raw Data Sets using Detected Data Only								
54													
55		Variable	NumObs	# Missing	Minimum	Maximum	Mean	Median	Var	SD	MAD/0.675	Skewness	CV
56		antimony	11	0	0.8	1.9	1.218	1.1	0.138	0.371	0.445	0.615	0.305
57		arsenic	21	0	1.7	16	5.867	5.4	9.009	3.002	2.076	1.942	0.512
58		barium	21	0	16	398	160.7	143	11144	105.6	97.85	0.925	0.657
59		beryllium	21	0	0.16	0.85	0.398	0.39	0.0205	0.143	0.119	1.336	0.36
60		boron	21	0	4	45	22.1	21	146.8	12.12	11.86	0.328	0.548
61		cadmium	21	0	0.07	68	13.43	7.6	301.1	17.35	9.637	2.073	1.292
62		chromium (III+VI)	21	0	6.3	97	35.89	32	524	22.89	19.27	1.36	0.638
63		copper	21	0	18	358	106.2	82	6333	79.58	42.99	1.991	0.749
64		lead	21	0	6.1	241	112	115	4636	68.09	71.16	0.155	0.608
65		molybdenum	21	0	0.1	3.3	1	0.9	0.521	0.722	0.445	1.938	0.722
66		nickel	21	0	7.5	93	38.93	35	574.7	23.97	25.2	0.853	0.616
67		selenium	3	0	0.7	1.5	0.967	0.7	0.213	0.462	0	1.732	0.478
68		silver	20	0	0.06	27	4.997	3.25	42.21	6.497	3.284	2.521	1.3
69		thallium	21	0	0.04	0.25	0.122	0.11	0.00195	0.0441	0.0297	0.999	0.362
70		uranium	21	0	0.3	0.81	0.54	0.53	0.0181	0.135	0.104	0.323	0.25
71		vanadium	21	0	11	30	17.95	18	24.45	4.944	5.93	0.789	0.275
72		zinc	21	0	30	922	361.5	324	48645	220.6	117.1	0.957	0.61
73		ia and ammonium (as N)	16	0	100	200	150	150	2667	51.64	74.13	0	0.344
74		kjeldahl nitrogen total	20	0	200	1500	795	750	142605	377.6	296.5	0.265	0.475
75		phosphorus	21	0	563	1820	1033	937	109452	330.8	217.9	1.092	0.32
76		Fecal Coliforms	3	0	1000	9000	3667	1000	21333333	4619	0	1.732	1.26
77		acenaphthylene	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
78		acenaphthene	13	0	0.11	0.97	0.378	0.23	0.105	0.323	0.104	1.308	0.856
79		anthracene	17	0	0.13	1.12	0.348	0.26	0.0915	0.303	0.119	2.066	0.869
80		benz(a)anthracene	19	0	0.12	3.54	1.031	0.77	0.608	0.78	0.311	2.303	0.757
81		benzo(b)fluoranthene	19	0	0.21	4.96	1.516	1.28	1.107	1.052	0.474	2.167	0.694
82		benzo(g,h,i)perylene	18	0	0.24	1.23	0.584	0.515	0.076	0.276	0.2	1.406	0.472
83		benzo(k)fluoranthene	18	0	0.06	1.48	0.501	0.41	0.11	0.332	0.141	1.908	0.663
84		benzo(a)pyrene	19	0	0.12	3.11	0.95	0.76	0.453	0.673	0.208	2.174	0.708
85		chrysene	19	0	0.11	4.04	1.184	0.96	0.768	0.876	0.356	2.205	0.74
86		dibenz(a,h)anthracene	13	0	0.09	0.35	0.159	0.13	0.00582	0.0763	0.0445	1.651	0.479
87		fluoranthene	19	0	0.3	10.3	2.856	2.39	5.22	2.285	1.082	2.196	0.8
88		fluorene	16	0	0.1	1.06	0.414	0.31	0.0899	0.3	0.215	1.23	0.724
89		indeno(1,2,3-cd)pyrene	18	0	0.19	1.25	0.498	0.405	0.0734	0.271	0.133	1.78	0.543
90		methylnaphthalene, 1-	13	0	0.11	0.89	0.416	0.29	0.0782	0.28	0.267	0.601	0.672
91		methylnaphthalene, 2-	13	0	0.17	1.94	0.864	0.73	0.406	0.638	0.712	0.65	0.738
92		naphthalene	10	0	0.06	1.2	0.294	0.155	0.121	0.348	0.104	2.339	1.183
93		phenanthrene	19	0	0.06	10	2.479	1.95	5.947	2.439	1.438	2.036	0.984
94		pyrene	19	0	0.25	7.83	2.312	1.89	3.095	1.759	0.726	2.071	0.761
95		Total PAHs	21	0	0.86	47.46	12.5	10.04	118.6	10.89	5.041	1.995	0.871
96													

	A	B	C	D	E	F	G	H	I	J	K	L	M
1				General Statistics on Uncensored Data									
2		Date/Time of Computation		ProUCL 5.11/28/2020 3:56:56 PM									
3		User Selected Options											
4		From File		SED 0.15+mbg Chemistry_input_v2.xls									
5		Full Precision		OFF									
6													
97					Percentiles using all Detects (Ds) and Non-Detects (NDs)								
98													
99		Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1)	50%ile(Q2)	75%ile(Q3)	80%ile	90%ile	95%ile	99%ile
100		antimony	21	0	0.8	0.8	0.8	0.8	1.1	1.3	1.5	1.7	1.86
101		arsenic	21	0	3.1	3.7	4.2	5.4	6.8	6.9	9	9.1	14.62
102		barium	21	0	40	80	80	143	217	228	265	397	397.8
103		beryllium	21	0	0.24	0.3	0.31	0.39	0.45	0.48	0.51	0.52	0.784
104		boron	21	0	5	13	15	21	32	32	40	40	44
105		cadmium	21	0	0.4	1.1	1.2	7.6	19	20	29	49	64.2
106		chromium (III+VI)	21	0	12	21	23	32	45	49	52	87	95
107		copper	21	0	29	65	69	82	126	127	175	265	339.4
108		lead	21	0	20	59	67	115	141	173	194	228	238.4
109		molybdenum	21	0	0.3	0.6	0.6	0.9	1.1	1.2	1.5	2.4	3.12
110		nickel	21	0	15	18	19	35	52	55	65	89	92.2
111		selenium	21	0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.34
112		silver	21	0	0.37	0.47	0.87	3.2	4.5	6.7	8.3	17	25
113		thallium	21	0	0.08	0.1	0.1	0.11	0.14	0.15	0.17	0.18	0.236
114		uranium	21	0	0.42	0.43	0.46	0.53	0.6	0.64	0.73	0.78	0.804
115		vanadium	21	0	13	14	14	18	20	22	25	26	29.2
116		zinc	21	0	86	250	253	324	437	489	546	818	901.2
117		ia and ammonium (as N)	21	0	100	100	100	100	200	200	200	200	200
118		kjeldahl nitrogen total	21	0	200	500	600	700	1000	1200	1300	1400	1480
119		phosphorus	21	0	637	827	881	937	1090	1140	1444	1760	1808
120		Fecal Coliforms	21	0	1000	1000	1000	1000	1000	1000	1000	1000	7400
121		acenaphthylene	21	0	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1
122		acenaphthene	21	0	0.05	0.1	0.1	0.16	0.28	0.29	0.91	0.92	0.96
123		anthracene	21	0	0.05	0.13	0.13	0.21	0.31	0.34	0.56	1.08	1.112
124		benz(a)anthracene	21	0	0.12	0.56	0.6	0.75	0.99	1.01	1.51	2.48	3.328
125		benzo(b)fluoranthene	21	0	0.21	0.93	0.96	1.18	1.5	1.6	2.37	2.92	4.552
126		benzo(g,h,i)perylene	21	0	0.1	0.36	0.37	0.45	0.6	0.66	0.89	1.2	1.224
127		benzo(k)fluoranthene	21	0	0.06	0.28	0.3	0.34	0.5	0.52	0.77	1.11	1.406
128		benzo(a)pyrene	21	0	0.12	0.56	0.59	0.72	0.9	0.92	1.38	2.09	2.906
129		chrysene	21	0	0.11	0.7	0.71	0.88	1.1	1.23	1.87	2.51	3.734
130		dibenz(a,h)anthracene	21	0	0.06	0.1	0.1	0.1	0.14	0.14	0.21	0.27	0.334
131		fluoranthene	21	0	0.3	1.3	1.44	1.98	2.76	2.95	4.85	6.15	9.47
132		fluorene	21	0	0.05	0.1	0.1	0.25	0.44	0.54	0.67	1.04	1.056
133		indeno(1,2,3-cd)pyrene	21	0	0.1	0.31	0.31	0.36	0.5	0.51	0.71	1.04	1.208
134		methylnaphthalene, 1-	21	0	0.05	0.1	0.1	0.12	0.42	0.47	0.73	0.85	0.882
135		methylnaphthalene, 2-	21	0	0.05	0.1	0.1	0.24	0.76	1.16	1.57	1.92	1.936
136		naphthalene	21	0	0.05	0.07	0.1	0.1	0.14	0.17	0.44	0.45	1.05
137		phenanthrene	21	0	0.06	0.62	0.85	1.31	2.9	2.92	4.39	6.88	9.376
138		pyrene	21	0	0.25	1.24	1.24	1.64	2.24	2.31	3.69	5.35	7.334
139		Total PAHs	21	0	1.53	6.64	7.54	10.04	13.58	14.87	21.11	32.77	44.52

SED 0-0.15 mbss

Parameter	95% UCLM	ProUCL Method applied
aluminum	11987	95% BCA Bootstrap
antimony	0.932	95% KM (BCA)
arsenic	5.517	95% BCA Bootstrap
barium	117.9	95% BCA Bootstrap
beryllium	0.477	95% BCA Bootstrap
boron	19	95% BCA Bootstrap
cadmium	2.427	95% BCA Bootstrap
chromium (III+VI)	27.52	95% BCA Bootstrap
copper	91.01	95% BCA Bootstrap
iron	23967	95% BCA Bootstrap
lead	57.9	95% BCA Bootstrap
manganese	589	95% BCA Bootstrap
mercury	0.187	95% BCA Bootstrap
molybdenum	1.407	95% BCA Bootstrap
nickel	24.34	95% BCA Bootstrap
selenium	N/A	-
silver	1.126	95% BCA Bootstrap
sodium	360.7	95% BCA Bootstrap
thallium	0.177	95% BCA Bootstrap
tin	4.822	95% BCA Bootstrap
titanium	137.3	95% BCA Bootstrap
uranium	0.687	95% BCA Bootstrap
vanadium	21.05	95% BCA Bootstrap
zinc	349.3	95% BCA Bootstrap
acenaphthylene	0.0423	95% KM (BCA)
acenaphthene	0.341	95% KM (BCA)
anthracene	0.867	95% KM (BCA)
benz(a)anthracene	1.83	95% BCA Bootstrap
benzo(b)fluoranthene	2.517	95% BCA Bootstrap
benzo(b+j)fluoranthenes	1.267	95% BCA Bootstrap
benzo(g,h,i)perylene	1.236	95% BCA Bootstrap
benzo(k)fluoranthene	0.71	95% KM (BCA)
benzo(a)pyrene	1.712	95% BCA Bootstrap
chrysene	2.155	95% BCA Bootstrap
dibenz(a,h)anthracene	0.242	95% KM (BCA)
fluoranthene	6.834	95% BCA Bootstrap
fluorene	0.395	95% KM (BCA)
indeno(1,2,3-cd)pyrene	0.997	95% BCA Bootstrap
methylnaphthalene, 1-	N/A	-
methylnaphthalene, 2-	0.0877	95% KM (BCA)
naphthalene	0.191	95% KM (BCA)
phenanthrene	4.336	95% BCA Bootstrap
pyrene	4.973	95% BCA Bootstrap
PAHs (sum of total)	26.41	95% BCA Bootstrap
ammonia and ammonium (as N)	N/A	-
ammonia as N	122.7	95% BCA Bootstrap
kjeldahl nitrogen total	841.8	95% BCA Bootstrap
nitrogen (total)	N/A	-
organic phosphorus	3.25	95% KM (BCA)
phosphorus	1020	95% BCA Bootstrap
Fecal Coliforms	25529	95% KM (BCA)

SED 0.15+ mbss

Parameter	95% UCLM	ProUCL Method applied	
aluminum			
antimony	1.157	95% KM (BCA)	
arsenic	7.205	95% BCA Bootstrap	
barium	205	95% BCA Bootstrap	
beryllium	0.458	95% BCA Bootstrap	
boron	12.8	95% BCA Bootstrap	
cadmium	21.49	95% BCA Bootstrap	
chromium (III+VI)	46.36	95% BCA Bootstrap	
copper	63.8	95% BCA Bootstrap	only 5 samples
iron			
lead	71.6	95% BCA Bootstrap	
manganese			
mercury			
molybdenum	1.329	95% BCA Bootstrap	
nickel	20	95% BCA Bootstrap	only 5 samples
selenium	NC	only 3 samples detected	
silver	7.471	95% KM (BCA)	
sodium			
thallium	0.14	95% BCA Bootstrap	
tin			
titanium			
uranium	0.591	95% BCA Bootstrap	
vanadium	17.2	95% BCA Bootstrap	only 5 samples
zinc	285.6	95% BCA Bootstrap	only 5 samples
acenaphthylene	NC	ND	
acenaphthene	0.389	95% BCA Bootstrap	
anthracene	0.438	95% BCA Bootstrap	
benz(a)anthracene	1.316	95% BCA Bootstrap	
benzo(b)fluoranthene	1.88	95% BCA Bootstrap	
benzo(b+j)fluoranthenes			
benzo(g,h,i)perylene	0.644	95% BCA Bootstrap	
benzo(k)fluoranthene	0.602	95% BCA Bootstrap	
benzo(a)pyrene	1.2	95% BCA Bootstrap	
chrysene	1.511	95% BCA Bootstrap	
dibenz(a,h)anthracene	0.164	95% BCA Bootstrap	
fluoranthene	3.594	95% BCA Bootstrap	
fluorene	0.459	95% BCA Bootstrap	
indeno(1,2,3-cd)pyrene	0.569	95% BCA Bootstrap	
methylnaphthalene, 1-	0.4	95% BCA Bootstrap	
methylnaphthalene, 2-	0.834	95% BCA Bootstrap	
naphthalene	0.33	95% BCA Bootstrap	
phenanthrene	3.394	95% BCA Bootstrap	
pyrene	2.878	95% BCA Bootstrap	
PAHs (sum of total)	19.31	95% BCA Bootstrap	
ammonia and ammonium (as N)	NC	-	
ammonia as N			
kjeldahl nitrogen total	895.2	95% BCA Bootstrap	
nitrogen (total)	N/A	-	
organic phosphorus		95% KM (BCA)	
phosphorus	1163	95% BCA Bootstrap	
Fecal Coliforms		95% KM (BCA)	

Parameter	SED 0-0.15 mbss 95% UCLM	SED 0.15+ mbss 95% UCLM	Difference (Shallow - Deep)	
aluminum	11987		NC, deep not sampled	
antimony	0.932	1.157	-0.225	
arsenic	5.517	7.205	-1.688	
barium	117.9	205	-87.1	95% UCLM < T1 bknd
beryllium	0.477	0.458	0.019	
boron	19	12.8	6.2	
cadmium	2.427	21.49	-19.063	
chromium (III+VI)	27.52	46.36	-18.84	
copper	90.45	63.8	26.65	
iron	23967		NC, deep not sampled	
lead	47.47	71.6	-24.13	
manganese	589		NC, deep not sampled	
mercury	0.187		NC, deep not sampled	
molybdenum	1.407	1.329	0.078	
nickel	22.47	20	2.47	
selenium	N/A	NC	NC 95% UCLM not calculated	
silver	1.126	7.471	-6.345	
sodium	360.7		NC, deep not sampled	
thallium	0.177	0.14	0.037	
tin	4.822		NC, deep not sampled	
titanium	137.3		NC, deep not sampled	
uranium	0.687	0.591	0.096	
vanadium	21.05	17.2	3.85	
zinc	352.1	285.6	66.5	
acenaphthylene	0.0423	NC	NC 95% UCLM not calculated	
acenaphthene	0.341	0.389	-0.048	
anthracene	0.867	0.438	0.429	
benz(a)anthracene	1.83	1.316	0.514	
benzo(b)fluoranthene	2.517	1.88	0.637	
benzo(b+j)fluoranthenes	1.267		NC, deep not sampled	
benzo(g,h,i)perylene	1.236	0.644	0.592	
benzo(k)fluoranthene	0.71	0.602	0.108	
benzo(a)pyrene	1.712	1.2	0.512	
chrysene	2.155	1.511	0.644	
dibenz(a,h)anthracene	0.242	0.164	0.078	
fluoranthene	6.834	3.594	3.24	
fluorene	0.395	0.459	-0.064	
indeno(1,2,3-cd)pyrene	0.997	0.569	0.428	
methylnaphthalene, 1-	N/A	0.4	NC 95% UCLM not calculated	
methylnaphthalene, 2-	0.0877	0.834	-0.7463	
naphthalene	0.191	0.33	-0.139	
phenanthrene	4.336	3.394	0.942	
pyrene	4.973	2.878	2.095	
PAHs (sum of total)	26.41	19.31	7.1	
ammonia and ammonium (as N)	N/A	NC	NC 95% UCLM not calculated	
ammonia as N	122.7		NC, deep not sampled	
kjeldahl nitrogen total	841.8	895.2	-53.4	
nitrogen (total)	N/A	N/A	NC 95% UCLM not calculated	
organic phosphorus	3.25		NC, deep not sampled	
phosphorus	1020	1163	-143	
Fecal Coliforms	25529		NC, deep not sampled	

1	Deep sample > shallow
1	Deep sample < shallow

APPENDIX G
TRVs

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

APPENDIX G
SURFACE WATER TOXICITY REFERENCE VALUES

This appendix presents the surface water toxicity reference values (TRVs) used as part of the effects assessment section for aquatic life.

The selection of TRVs for aquatic life included a review of direct contact ecotoxicity values from the following sources:

- Technical supporting documents published by BC MOE as part of the BC AWQG, and WWQG;
- Technical supporting documents published by CCME as part of the Canadian Environmental Quality Guidelines for the protection of aquatic life;
- Technical supporting documents published by the USEPA to support the Ambient Water Quality Guidelines;
- Technical supporting document published by the Ontario Ministry of Energy and Environment as part of the provincial sediment quality standards; and
- Publications of peer reviewed toxicology literature, accessed from Web of Science citation indexing service.

Preferences were given to chronic sublethal toxicity data for reproduction and growth for species representative of a warm water system, if available, when selecting TRVs. For non-listed species, preferences were given to the lowest observed effect level (LOEL) or EC20, where available. In the ERA the goal was not to protect each individual from any toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained. Therefore, EC20s were considered appropriate TRVs where available for non-listed species. To account for the potential presence of SAR (i.e. the Lilliput mussel) in the study area, a no observed adverse effect level (NOAEL) was also selected for invertebrates following MECP guidance (MECP 2019).

The proposed TRVs are outlined in Table A and discussed below the table.

Table A: Surface Toxicological Reference Values for the Protection of Aquatic Life (µg/L)

COPC	Invertebrates	Aquatic Plants	Fish	Amphibians
Aluminum	320 (community) 100 (individual)[c]	460	200	320
Iron (total)	1740 (community) 300 (individual)[c]	1740	300[a]	1740
nitrite (as N)	60[b]		5,000	60[a]
phosphorus	30 µg/L (benchmark to prevent algal growth)			

a- PWQO guideline retained as TRV due to limited toxicity information for amphibians
b- PWQO guideline retained as TRV due to limited ROC-specific toxicity information available.
c- A NOAEL was selected, where available, to account for the potential presence of SAR (i.e. the Lilliput mussel) in the study area.

Aluminum

The toxicity of aluminum in surface water varies with pH. The PWQO for aluminum (total) is based on two laboratory studies and one field study for both cold water and warm water fish. The studies used for the PWQO indicated toxicity at 0.150 (LC50 in a 7 day study for goldfish, pH of 7.4) to 0.170 mg/L (LC50 in a 8 day study for large mouth bass, pH of 7.2-7.8) of aluminum. No effect concentrations on fish were reported using 0.045-0.06 mg/L aluminum. Only one study by Freeman and Everhart (1971) was reviewed with a non-lethal endpoint.

One toxicity study for Daphnia Magna was reviewed in the development of the PWQO guideline. The study showed a 16 percent reduction in reproduction for Daphnia Magna following a 21-day exposure to 0.32 mg/L of aluminum (pH of 7.7). Two toxicity studies for algae were reviewed in the development of the PWQO guideline. The results of the studies are summarized below:

- Call et Al. 1984: A 4-day study with aluminum concentrations of 0.46 to< 0.2 mg/L (pH of 7.6 to 7.5) and 0.57 to <0.2 mg/L (pH of 8.2 to 7.5) resulted in EC50 in biomass for *Selenastrum carpicornutum.*
- Rao and Subramaniam, 1982: A 8-day study with an aluminum concentration of 0.81 mg/L (pH of 7.9) resulted in growth inhibition in diatom *Cyclotella Meneghiana.*

The BC Environment and Climate Change (BC ENV) completed a review of toxicological studies for aluminum in has selected a maximum concentration of 100 µg/L for dissolved aluminum as a concentration considered safe for sensitive aquatic life (at pH > 6.5) (Butcher, 1988). The BC ENV guideline is based on the same studies as the PWQO and CCME guideline for waters with pH greater than 6.5 but is expressed in terms of dissolved aluminum. Dissolved aluminum was selected since most of the bio-reactive aluminum is likely to be in the dissolved fraction (BC ENV 2001).

Chronic toxicity data for aluminum reviewed by BC ENV ranged from 10 µg/L (95% survival of brook trout after 14 days exposure at pH 4.4 to 6,700 µg/L for chronic effects to midge larvae at pH 6.6 (endpoint not described). The lowest chronic toxicity value reviewed by BC MOE for pH ≥ 6.5 was 320 µg/L for Daphnia Magna (16% reproductive impairment at pH 7.7). The lowest chronic value for pH ≥ 6.5 for fish was a LC50 of 500 µg/L for rainbow trout obtained after 44 days exposure at pH ranging from 6.5 to 7.4 (Butcher, 1988). A LC20 of 1000 µg/L was reported for brook trout for eyed eggs mortality after 8 days of exposure at pH 6.5 (Butcher, 1988). CCME (1997) indicates that aquatic plants appear to be less sensitive than some invertebrates and reported a 50% reduction in root growth observed at 2500 µg/L at circumneutral pH for the eurasian milfoil *(Myriophyllum spicatum* L). BC ENV reported a 96-hour EC50 of 570 µg/L for biomass reduction (growth endpoint) for *Selenastrum carpicornutum* at pH 7.6 and of 460 µg/L at pH 8.2. Chronic toxicity values for aquatic plants obtained at pH higher than 6.5 were higher than the reported acute values. BC ENV also reported that aquatic macrophytes may be relatively tolerant to aluminum and reported that frond production in *Lemna minor* was not significantly affected after 96-hour exposure in water with aluminum ranging from 300 to 46,000 µg/L aluminum. BC ENV reported non-effect level for embryos of wood frog at total aluminum concentration of 200 µg/L and pH 5.57.

Species-specific TRVs were selected for aluminum. Based on the pH of the receiving environment, the lowest chronic value of 500 µg/L (LC50) obtained at pH > 6.5 (Butcher, 1988). This value was converted to an LC20 of **200 µg/L** and selected as the fish TRV. Based on the pH of the study area (7.87 – 8.42), the lowest chronic value of **460 µg/**L obtained at pH 8.2

(Butcher, 1988) and 7.6 to 7.5 (Call et Al. 1984, as reviewed in MOEE 1988) was selected as the TRV for aquatic plants. The lowest chronic toxicity value of **320 µg/L** for Daphnia Magna obtained at pH 7.7 was selected as the TRV for invertebrates and amphibians. The BC WQG for dissolved aluminum of **100 µg/L** was retained as the TRV to benthic invertebrate SAR.

Iron

The PWQQO for iron is based on the prevention of the creation of iron “floc” in surface water and subsequent physical effects on aquatic life. No observations of iron precipitate were documented at the site, therefore species-specific TRVs were selected. Uncertainty related to the precipitation of iron is discussed in Section 8.0.

The MECP completed a review of toxicological data for iron during the development of the PWQO in 1979, however, additional studies have been completed since this work was completed. The BC ENV updated their water quality guideline for Iron in 2008. The BC new water quality guideline for the protection of aquatic life is 1000 µg/L for total iron and 350 µg/L for dissolved iron (Phibben et al., 2008).

The guideline for total iron is based on recent field-based research of Linton *et al.* (2007). Linton *et al.* (2007) derived two benchmarks on change in community structure to establish the guideline. The first benchmark of 210 µg/L corresponds to no or minimal changes in aquatic community structure and function. The second benchmark of 1740 µg/L allows for a slight to moderate changes in community population (i.e., loss of some rare species and/or replacement of sensitive ubiquitous taxa with more tolerant taxa). Phibben et al (2008) selected 1000 µg/L as the value for the BC guideline based on the precautionary principle and noted that this value may be overprotective in some instances. They indicated that other recent research has recommended 1700 µg/L as a guideline for total iron.

The BCWQ guideline for dissolved iron is based toxicity tests conducted by the Pacific Environmental Science Center (PESC) for the BC MOE. The test species included rainbow trout, the amphipod *Hyalella azteca*, the chironomid *Chironomus tentans*, *Daphnia magna*, and *Selanastrum capricornutum.* The lowest toxicity value obtained with the above species was the acute LC_{50} of 3500 µg/L reported for *Hyalella* in soft water. The EC_{50} for *Hyalella* was divided by a safety factor of 10 and rounded down to 350 µg/L to derive the BC dissolved iron guideline (Phibben *et al.*, 2008). The LC50 for rainbow trout in soft water was >6400 µg/L and the LC50 for *selenastrum capricornatum* was 3600 µg/L.

Based on the above information the benchmark of **1740 µg/L** for total iron proposed by Linton et al (2007) was adopted as the TRV for protection of the benthic community. Linton et al (2007) set a benchmark of 210 µg/L for no or minimal changes to aquatic community structure and function, however this value is below the PWQO for iron of 300 µg/L. Therefore the PWQO of **300 µg/L** was adopted as the TRV for protection of benthic invertebrates on an individual level (i.e. SAR).

Phosphorus

Phosphorus compounds are not toxic to aquatic life and thus does not need to be controlled to protect aquatic life from any direct negative effects (MOE 1979).

Although phosphorus is not toxic to aquatic life, concentrations must be controlled to prevent increased algal growth may result in undesirable changes in the aquatic ecosystem. The PWQO of 10 μg/L was set to provide a "*high level of protection against aesthetic deterioration for the ice-free period*" (MOEE 1979). The MECP Rationale for the Establishment of the Provincial Water Quality Objectives (MOE 1979) states that excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 μg/L.

Nitrite

Fish

Salmonids are more sensitive to nitrite than are other fish species and show very little difference among the species. There is considerably more variation among warm-water fish species (Lewis and Morris 1986). A study by Palachek and Tomasso (1984) reviewed as part of CCREM 1987 indicated that 96-h LC50 values of nitrite-nitrogen for channel catfish (*Ictalurus punctatus*), tilapia (*Tilapia aurea*) and largemouth bass (*Micropterus salmoides*) were 7, 16 and 140 mg/L, respectively.

Small fish (including the larval stage) are unlikely to be more sensitive to nitrite than larger fish of the same species (CCREM 1987). A concentration of 0.06 mg/L was noted to be protective of salmonid species in two studies review in CCREM 1987:

- Russo et al. 1974 indicated no rainbow trout died over 10 d at a nitrite concentration of 0.06 mg/L; and
- Wedemeyer and Yasutake 1978 indicated steelhead juveniles exposed for 6 months first showed tissue damage in the gills at a concentration of 0.06 mg/L. No reduction in growth was noted over the 6 months' exposure period to 0.06 mg/L at a chloride concentrations of 2.3 mg/L.

Based on CCREM 1987, concentrations of nitrite (as N) of 5,000 μg/L, would be protective of most warm-water fish and concentrations at or below 60 μg/L should protect salmonid fish. Since Chedoke creek is a warm water system, **5,000 μg/L** was selected as the TRV for fish. It's noted that Wedemeyer and Yasutake 1978 (as reviewed in CCREM 1987) indicated that addition of chloride ions increases the tolerance of salmonid fish to nitrite. Although chloride concentrations were not measured within Chedoke Creek, based on the urban nature of the creek and location between two roadways (Macklan Street North and Highway 403) chloride levels are likely to be elevated.

Limited information on nitrite-toxicity to aquatic plants and invertebrates was available for review. The CCME WQG of **60 μg/L** was selected for the protection of aquatic plants and invertebrates.

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APPENDIX H
Uncertainty Assessment

Ecological Risk Assessment
Chedoke Creek
Hamilton, Ontario
SLR Project No.: 209.40666.00000

TABLE H-1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING - DEEPER SEDIMENT (>0.15 mbss) (mg/kg)

SEDIMENT CHARACTERIZATION													ECOLOGICAL HEALTH SCREENING		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration				Second Highest Concentration				Background		Screening Benchmarks		COPC?
			mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	
Deep Sediment (>0.15 mbss)															
Metals															
Antimony	21 (+0)	11 (+0)	1.9	C-5 West	0.15-0.3	9/19/2018	1.7	C-5 West	0.3	9/19/2018	1.0	-	-	-	Uncertain
Arsenic	21 (+0)	21 (+0)	16	C-5 East	0.15-0.3	9/19/2018	9.1	C-5 West	0.3	9/19/2018	-	4.0	**6**	5.9	**Yes; maximum > LEL**
Barium	21 (+0)	21 (+0)	398	C-5 West	0.15-0.3	9/19/2018	397	C-5 West	0.3	9/19/2018	210.0	-	-	-	Uncertain
Beryllium	21 (+0)	21 (+0)	0.85	C-5 East	0.15-0.3	9/19/2018	0.52	C-4 Centre	0.15-0.3	9/19/2018	2.5	-	-	-	No; maximum < Table 1 background
Boron	5 (+0)	5 (+0)	16	C-1 West	0.15-0.3	9/18/2018	13	C-2 West	0.15-0.3	9/18/2018	36.0	-	-	-	
Cadmium	21 (+0)	21 (+0)	68	C-5 West	0.3	9/19/2018	49	C-5 West	0.15-0.3	9/19/2018	-	1.0	**0.6**	0.6	**Yes; maximum > LEL**
Chromium (III+VI)	21 (+0)	21 (+0)	97	C-5 West	0.3	9/19/2018	87	C-5 West	0.15-0.3	9/19/2018	-	31.0	**26**	37.3	**Yes; maximum > LEL**
Copper	5 (+0)	5 (+0)	73	C-2 West	0.15-0.3	9/18/2018	71	C-1 West	0.15-0.3	9/18/2018	-	25.0	**16**	35.7	**Yes; maximum > LEL**
Lead	5 (+0)	5 (+0)	100	C-3 West	0.15-0.3	9/18/2018	59	C-2 West	0.15-0.3	9/18/2018	-	23.0	**31**	35	**Yes; maximum > LEL**
Molybdenum	21 (+0)	21 (+0)	3.3	C-5 East	0.15-0.3	9/19/2018	2.4	C-2 West	0.15-0.3	9/18/2018	2.0	-	-	-	Uncertain
Nickel	5 (+0)	5 (+0)	23	C-1 West	0.15-0.3	9/18/2018	21	C-2 West	0.15-0.3	9/18/2018	-	31.0	**16**	-	No; maximum < background
Selenium	21 (+0)	3 (+0)	1.5	C-5 East	0.15-0.3	9/19/2018	0.7	C-5 West	0.15-0.3	9/19/2018	1.2	-	-	-	Uncertain
Silver	21 (+0)	20 (+0)	27	C-5 West	0.3	9/19/2018	17	C-5 West	0.15-0.3	9/19/2018	-	**0.5**	-	-	Uncertain, maximum < background
Thallium	21 (+0)	21 (+0)	0.25	C-5 East	0.15-0.3	9/19/2018	0.18	C-5 West	0.3	9/19/2018	1.0	-	-	-	No; maximum < Table 1 background
Uranium	21 (+0)	21 (+0)	0.81	C-5 East	0.15-0.3	9/19/2018	0.78	C-5 West	0.3	9/19/2018	1.9	-	-	-	
Vanadium	5 (+0)	5 (+0)	19	C-1 West	0.15-0.3	9/18/2018	18	C-2 West	0.15-0.3	9/18/2018	86.0	-	-	-	
Zinc	5 (+0)	5 (+0)	339	C-2 West	0.15-0.3	9/18/2018	305	C-3 West	0.15-0.3	9/18/2018	-	65.0	**120**	123	**Yes; maximum > LEL**

TABLE H-1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING - DEEPER SEDIMENT (>0.15 mbss) (mg/kg)

SEDIMENT CHARACTERIZATION														ECOLOGICAL HEALTH SCREENING		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration				Second Highest Concentration				Background		Screening Benchmarks		COPC?
			mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	
PAHs															
Acenaphthylene	21 (+0)	0 (+0)	<0.1	C-1 West	0.15-0.3	9/18/2018	<0.1	C-2 West	0.15-0.3	9/18/2018	-	-	-	**0.00587**	No; not detected.
Acenaphthene	21 (+0)	13 (+0)	0.92	C-4 Centre	0.15-0.3	9/19/2018	0.91	C-3 West	0.225	0.15-0.3	-	-	-	**0.00671**	Yes; maximum > ISQG
Anthracene	21 (+0)	17 (+0)	1.08	C-3 West	0.15-0.3	9/18/2018	0.56	C-5 West	0.3	9/19/2018	-	-	**0.22**	0.0469	Yes; maximum > LEL
Benz(a)anthracene	21 (+0)	19 (+0)	3.54	C-3 West	0.15-0.3	9/18/2018	1.51	C-5 West	0.3	9/19/2018	-	-	**0.32**	0.0317	Yes; maximum > LEL
Benzo[b]fluoranthene	21 (+0)	19 (+0)	4.96	C-3 West	0.15-0.3	9/18/2018	2.37	C-5 West	0.3	9/19/2018	0.3	-	-	-	No; assessed as total PAHs[b]
benzo(g,h,i)perylene	21 (+0)	18 (+0)	1.23	C-3 West	0.15-0.3	9/18/2018	0.89	C-5 West	0.3	9/19/2018	-	-	**0.17**	-	Yes; maximum > LEL
benzo(k)fluoranthene	21 (+0)	18 (+0)	1.48	C-3 West	0.15-0.3	9/18/2018	0.77	C-2 West	0.15-0.3	9/18/2018	-	-	**0.24**	-	Yes; maximum > LEL
Benzo(a)pyrene	21 (+0)	19 (+0)	3.11	C-3 West	0.15-0.3	9/18/2018	1.38	C-5 West	0.3	9/19/2018	-	-	**0.37**	0.0319	Yes; maximum > LEL
Chrysene	21 (+0)	19 (+0)	4.04	C-3 West	0.15-0.3	9/18/2018	1.87	C-2 West	0.15-0.3	9/18/2018	-	-	**0.34**	0.0571	Yes; maximum > LEL
Dibenz(a,h)anthracene	21 (+0)	13 (+0)	0.35	C-3 West	0.15-0.3	9/18/2018	0.21	C-5 West	0.3	9/19/2018	-	-	**0.06**	0.00622	Yes; maximum > LEL
Fluoranthene	21 (+0)	19 (+0)	10.3	C-3 West	0.15-0.3	9/18/2018	4.85	C-2 West	0.15-0.3	9/18/2018	-	-	**0.75**	0.111	Yes; maximum > LEL
Fluorene	21 (+0)	16 (+0)	1.04	C-3 West	0.15-0.3	9/18/2018	0.67	C-5 West	0.3	9/19/2018	-	-	**0.19**	0.0212	Yes; maximum > LEL
indeno(1,2,3-cd)pyrene	21 (+0)	18 (+0)	1.25	C-3 West	0.15-0.3	9/18/2018	0.71	C-5 West	0.3	9/19/2018	-	-	**0.2**	-	Yes; maximum > LEL
Methylnaphthalene, 1-	21 (+0)	18 (+0)	0.89	C-5 West	0.3	9/19/2018	0.85	C-4 Centre	0.15-0.3	9/19/2018	0.05	-	-	-	Uncertain
Methylnaphthalene, 2-	21 (+0)	13 (+0)	1.94	C-5 West	0.3	9/19/2018	1.92	C-4 Centre	0.15-0.3	9/19/2018	-	-	-	0.0202	Yes; maximum > ISQG
Naphthalene	21 (+0)	10 (+0)	1.2	C-3 West	0.15-0.3	9/19/2018	0.45	C-2 West	0.15-0.3	9/18/2018	-	-	-	0.0346	Yes; maximum > ISQG
Phenanthrene	21 (+0)	19 (+0)	10	C-3 West	0.15-0.3	9/18/2018	4.39	C-2 West	0.15-0.3	9/18/2018	-	-	**0.56**	0.0419	Yes; maximum > LEL
Pyrene	21 (+0)	19 (+0)	7.83	C-3 West	0.15-0.3	9/18/2018	3.69	C-2 West	0.15-0.3	9/18/2018	-	-	**0.49**	0.053	Yes; maximum > LEL
PAHs (sum of total)	NM	NM	47.46	C-3 West	0.15-0.3	9/18/2018	32.77	C-6 Centre	0.3	9/19/2018	-	-	**4**	-	Yes; maximum > LEL

TABLE H-1. CONTAMINANTS OF POTENTIAL CONCERN (COPC) SCREENING - DEEPER SEDIMENT (>0.15 mbss) (mg/kg)

SEDIMENT CHARACTERIZATION													ECOLOGICAL HEALTH SCREENING		
Contaminant	No. of Samples Analyzed (+Dup)	No. of Detectable Conc. (+Dup)	Maximum Concentration				Second Highest Concentration				Background		Screening Benchmarks		COPC?
			mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	mg/kg	Sample ID	Sample Depth (mbss)	Sample Date	Table 1 Background Standards for Soil	MOE 2008, 2011[a]	ON PSQG LEL	CCME SedQG Freshwater (ISQG)	
Nutrients															
ammonia and ammonium (as N)	21 (+0)	16 (+0)	200	C-1 West	0.15-0.3	9/18/2018	200	C-2 West	0.15-0.3	9/18/2018	-	-	-	-	Uncertain
kjeldahl nitrogen total	21 (+0)	20 (+0)	1500	C-5 West	0.3	9/19/2018	1400	C-5 East	0.15-0.3	9/19/2018	-	-	**550**	-	Yes; maximum > LEL
phosphorus	21 (+0)	21 (+0)	1820	C-5 West	0.3	9/19/2018	1760	C-5 West	0.15-0.3	9/19/2018	-	-	**600**	-	Yes; maximum > LEL
Fecal Coliforms	21 (+0)	3 (+0)	9000	C-3 West	0.15-0.3	9/18/2018	1000	C-5 East	0.15-0.3	9/19/2018	-	-	-	-	Uncertain

Notes:
mg/kg - milligram per kilogram
mbss - metres below sediment surface
PWQO - Provincial Water Quality Objective
BC CSR - British Columbia Contaminated Site Regulation
COPC - Contaminant of Potential Concern
conc. - concentration
Dup - Duplicate
max. - maximum
NM - not measured - calculated parameter.
"-" No guideline available, or not selected, as provincial guideline is available.
Value selected for screening.
BOLD formatting indicates selected screening benchmark
a - Background sediment values from MOE 2008 (the great lakes basin) were preferentially selected where available.
b- total PAHs include Acenaphthene, Acenaphthylene, Anthracene, Benzo[k]fluoranthene, Benzo[b]fluorine, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[g,h,i]perylene, Chrysene, Dibenzo[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene, Phenanthrene, and Pyrene
MOE 2008. ON PSQG Background Concentrations:Ontario Provincial Sediment Quality Guideline - Table 3 and Table 4 Background Sediment Concentrations
ON PSQG LEL:Ontario Provincial Sediment Quality Guideline - Lowest Effect Level
MOE 2011. ON Sediment Table 1 Background:Ontario Sediment Table 1: Full Depth Background Site Condition Standards
CCME SedQG Freshwater (ISQG):CCME Sediment Quality Guidelines for the Protection of Aquatic Life, Freshwater (Interim sediment quality guidelines)

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Hamilton

CHEDOKE CREEK UPDATE

Dan McKinnon, General Manager, Public Works
Gord Wichert, SLR Consulting (Canada)


Spill Location
Hwy 403
Closed Landfill (Kay Drage Park)
Royal Stroud CSO tank
Main/King CSO tank
Unmonitored Outfalls
Sewer Cross Connections
Dundurn Castle
McMaster
King St W
York Blvd
Aberdeen Ave
Dundurn St S
Locke St S
Queen St S
Chedoke Civic Golf Course
Chedoke Falls
Garth St
Mohawk College
Mohawk Rd W

Video: Combined Sewer System, CSO Tanks & Spill into Chedoke Creek


Spill Location
RBG Cootes
Paradise
Sanctuary
HMCS Haida
National Historic Site
Bayfront Park
Dundurn Castle
McMaster
University
Hamilton
Chedoke Civic
Golf Course
Chedoke Falls
Mohawk
College
EAST HAMILTON
York Blvd
Barton St W
Barton St E
King St W
Cannon St E
Main St W
Osler Dr
Aberdeen Ave
Charlton Ave E
Claremont Access
Queensdale Ave E
Fennell Ave E
Concession St
Mohawk Rd W

Hamilton

Ministry Orders

Provincial Officer Order (August 2018)

- Required the City to retain an expert to evaluate the impacts to Chedoke Creek

Second Provincial Officer Order (November 2019)

- Required a more comprehensive Environmental Risk Assessment and expanded the scope to include Cootes Paradise
- The City formally requested a review of the order

Director’s Order (November 2019)

- Required an Ecological Risk Assessment of Chedoke Creek to be completed by **February 14, 2020** and Cootes Paradise by **May 1, 2020**

Director's Order

1. By February 14, 2020 the City shall submit to the Director a written report setting out the results of an ecological risk assessment in regard to Chedoke Creek (creek). This report shall include but not necessarily be limited to: an evaluation of the environmental impact to the creek from the sewage discharged by the City between January 28, 2014 and July 18, 2018, an identification and evaluation of sewage remaining in the creek, identification of any anticipated on-going environmental impacts to the creek as a result of the sewage spill, and a review of options designed to remediate the creek and monitor the environmental condition of the creek.

2. By February 14, 2020 the City shall submit to the Director written proposed actions with justification in respect to the remediation and the monitoring of the creek including but not necessarily limited to: selected option(s) for environmental remediation and monitoring, including all supporting documentation for the selected option(s), justification for the selected option(s), and an implementation timeline for all work designed to remediate the creek including significant milestones and any approvals required.

ECOLOGICAL RISK ASSESSMENT SUMMARY

Gord Wichert, SLR Consulting (Canada)

CHEDOKE CREEK ECOLOGICAL RISK ASSESSMENT

Presentation to Hamilton City Council

February 13, 2020

global **environmental** and **advisory** solutions

SLR

Background

- MECP Director’s Order
- SLR Team
  - Celine Totman, Senior Risk Assessor
  - Kathryn Matheson, Risk Assessor
  - Sam Reimer, Technical Director – Risk Assessment
  - Kim Laframboise, Terrestrial Ecologist
  - Kimberley Tasker, Senior Ecologist
  - Gordon Wichert, Technical Director - Ecology

Why Ecological Risk Assessment

- Accepted standardized tool to support evaluation and management of contaminated sediments.
- Provincial Sediment Quality Guidelines (PSGQ) are not clean-up numbers by themselves, and need to be used in a risk assessment framework (MECP, 2008).
  - Exceedances of environmental guidelines do not mean that adverse effects are occuring.
- To translate scientific data into information about the potential risks and enable informed environmental decisions.

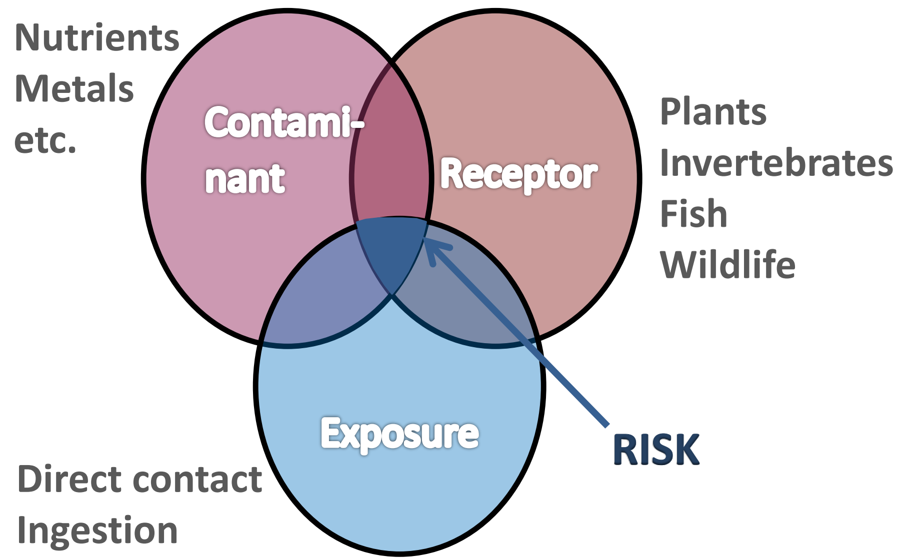
What is Ecological Risk Assessment?

An evaluation of the **potential for adverse effects** to ecological **receptors** resulting from **exposure** to chemical contamination or physical stressors.

A Standardized Tool with 4 Main Steps:

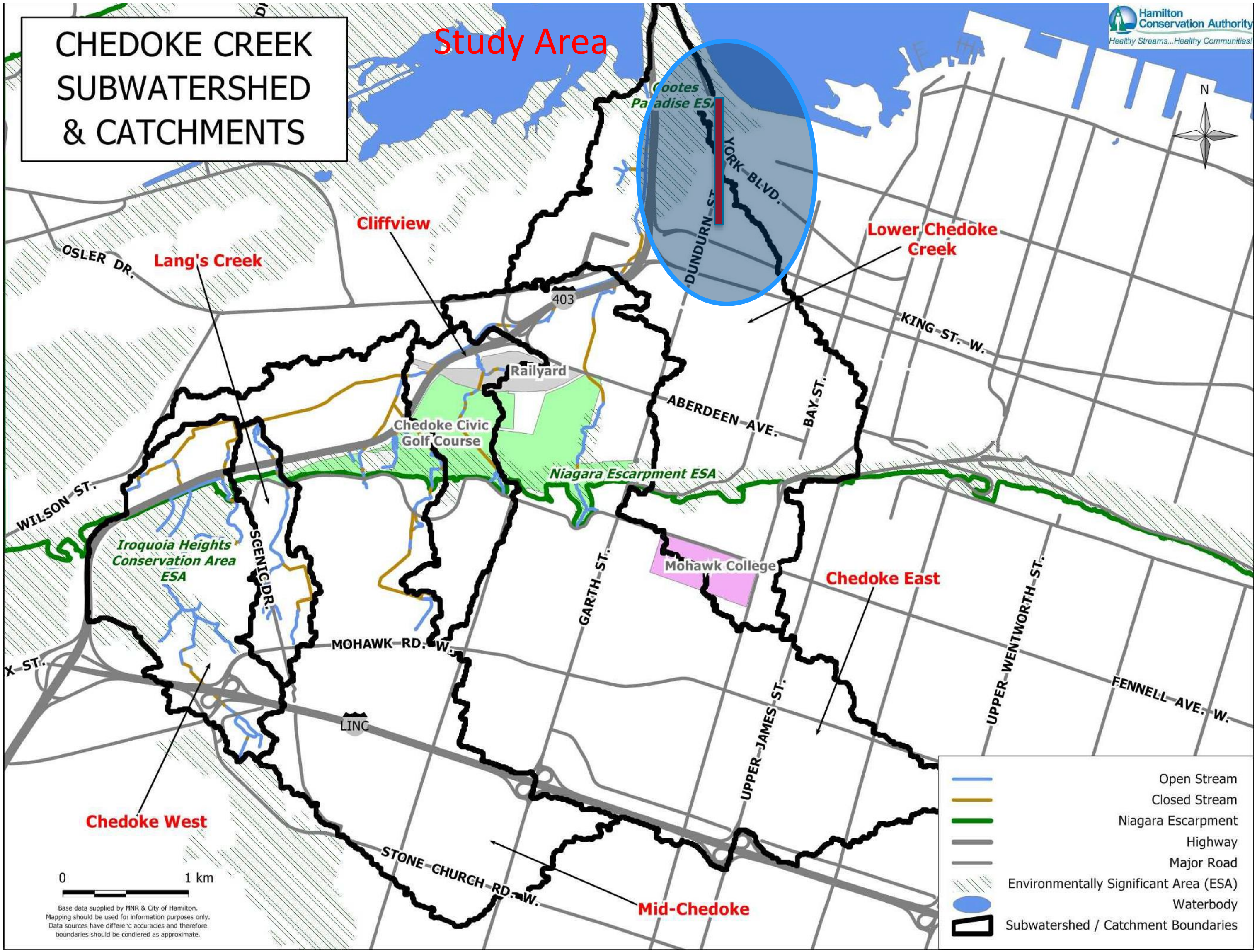
1. Problem Formulation - Setting the scene
2. Exposure Assessment - Quantifying how much of a contaminant a receptor may be exposed to
3. Effects Assessment – Evaluate the effects posed by each contaminant
4. Risk Characterization – Integration of results of exposure/effects assessments to evaluate risk

Risk Paradigm



EACH ELEMENT MUST BE PRESENT FOR RISK TO EXIST!

Study Area


CHEDOKE CREEK SUBWATERSHED & CATCHMENTS
Study Area
Hamilton Conservation Authority
Healthy Streams...Healthy Communities!
N
Cootes Paradise ESA
YORK BLVD.
DUNDURN ST.
Cliffview
Lang's Creek
OSLER DR.
Lower Chedoke Creek
403
KING ST. W.
Railyard
ABERDEEN AVE.
BAY ST.
Chedoke Civic Golf Course
Niagara Escarpment ESA
WILSON ST.
Iroquoia Heights Conservation Area ESA
SCENIC DR.
GARTH ST.
Mohawk College
Chedoke East
UPPER WENTWORTH ST.
MOHAWK RD. W.
LINC
UPPER JAMES ST.
FENNELL AVE. W.
Chedoke West
STONE CHURCH RD. W.
Mid-Chedoke
0
1 km
Base data supplied by MNR & City of Hamilton. Mapping should be used for information purposes only. Data sources have differenc accuracies and therefore boundaries should be condiered as approximate.
Open Stream
Closed Stream
Niagara Escarpment
Highway
Major Road
Environmentally Significant Area (ESA)
Waterbody
Subwatershed / Catchment Boundaries

ERA Approach

- Methods based on risk assessment procedures recommended by
  - Ministry of Environment, Conservation and Parks (MECP) and
  - Environment and Climate Chance Canada (ECC)
- Background Information – prior to discharge
  - Royal Botanical Gardens
    - water quality monitoring, nutrients and bacteria, 1994 – 2014
    - Sediment in the mouth of Chedoke Creek (upstream from Cootes), nutrients and metals, 2006 and 2013
  - Hamilton Conservation Authority water quality monitoring of nutrients, bacteria, 2014 to present
  - Environment Canada, 2002: sediment quality in Lake Ontario tributaries, metals and PAHs
- Post Discharge Datasets
  - Sediment and water quality chemistry, sediment toxicity and benthic invertebrate samples collected in 2018 and/or 2019
    - Wood in 2018
    - SLR in 2019

Ecological Receptors Selected for the ERA

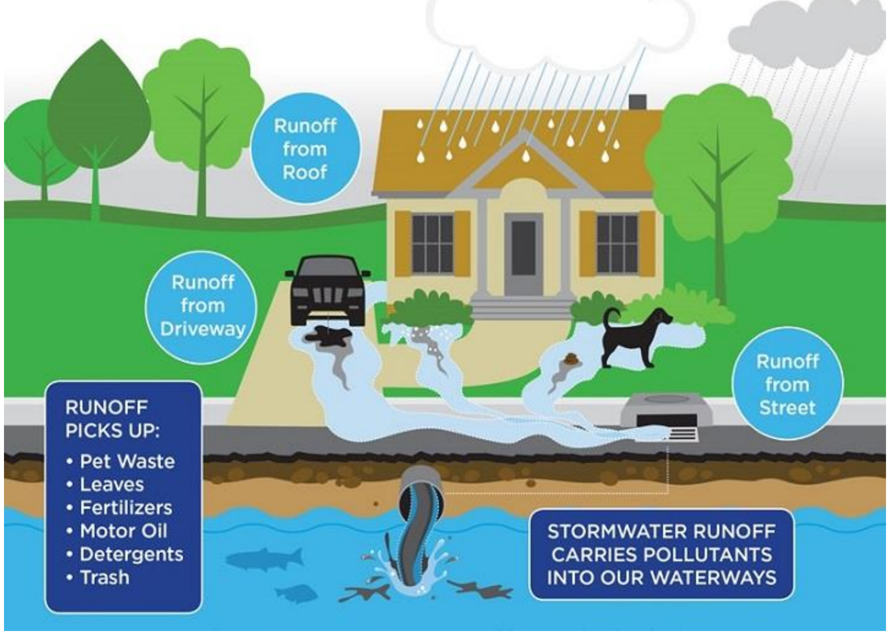
- Aquatic plants:
  - Emergent and submergent
- Aquatic invertebrates
  - Benthic invertebrates: directly exposed to sediment
  - Zooplankton: directly exposed to sediment
  - Food for fish
- Fish
  - White sucker
    - Bottom oriented, feeds on aquatic invertebrates in sediment
  - Northern pike
    - Feeds on fish, recreational fishing, exposed to water and some sediment
- Amphibians
  - Exposed to surface water and sediment, consumes aquatic invertebrates

Contaminants of Potential Concern (COPCs)

COPCs: substances are present at elevated concentrations (above guidelines/standards) in environmental media, typically associated with human activities

- Metals
  - Component of stormwater runoff
- Polycyclic aromatic hydrocarbons (PAHs)
  - Component of stormwater runoff
- Nutrients
  - Component of sewage and stormwater runoff
- Bacteria
  - Associated with sewage

Stormwater Runoff



Source: https://www.urbanaillinois.us/Stormwater_Pollution

ERA Findings

Risk Associated with Sediment Contact

	COPCs		
Receptors	**PAHs**	**Metals**	**Nutrients**
Benthic invertebrates	Low, moderate or high depending on location	Negligible to low	Negligible
Amphibians	Moderate	Negligible to low	Negligible
Fish	Moderate	Negligible to low	Negligible

- Toxicity Test: Sediment toxicity results showed effects to sensitive (amphipod) but not to tolerant (midge) species.
- The benthic invertebrate community makeup was limited to stress tolerant organisms because of contaminants in the study area, low oxygen in sediment and high degree of urbanization and disconnected habitat in the Chedoke Creek subwatershed.

Director's Order

- **Director's Order**
  - *an evaluation of the environmental impact to the creek from sewage discharged by the City between January 28, 2014 and July 18, 2018, an identification and evaluation of sewage remaining in the creek, identification of any anticipated on-going environmental impacts to the creek as a result of the sewage spill, and a review of options designed to remediate the creek and monitor the environmental condition of the creek.*

Findings Relevant to Director's Order

- The findings of this ERA and Wood (2019) indicated that some of the COPCs within the study area sediment are likely associated with the 2014-2018 Main/King CSO discharge; however:
  - COPCs, as well as sediment deposition within the study area, have many different point and nonpoint sources.
  - various CSO and stormwater outfalls in the Chedoke Creek subwatershed have discharged sewage and stormwater prior to, during and subsequent to the 2014-2018 Main/King CSO discharge.
  - elevated concentrations of COPCs have been a persistent and ongoing issue in Chedoke Creek sediment and/or surface water prior to and after the 2014-2018 discharge
  - Chedoke Creek is an urban watercourse and observed conditions are consistent with that observed in urbanized watersheds

Recommendations

- Assessed Alternatives
  - Physical capping
  - Chemical inactivation
  - Direct removal (dredging)
  - No-action
- Recommendations
  - Further remediation unnecessary
    - post-discharge levels of contaminants appear consistent with pre-discharge levels
    - cannot attribute environmental impacts to the sewage spill only as many prior and ongoing sources of COPCs exist
    - direct removal could disturb existing aquatic species and habitat
    - recontamination is likely
- Monitoring
  - environmental condition of the creek as it relates to ongoing operations for the Main/King CSO is occurring

HISTORICAL REMEDIATION & INVESTMENTS

Dan McKinnon, General Manager, Public Works

Historical Remediation & Investments

Infrastructure Projects

- CSO tank construction (9 tanks)
- Chemically enhanced primary treatment at Woodward
- Woodward Upgrades project
- Randle Reef sediment remediation
- Real-time control system
- Sewer-lateral cross connections
- Windemere basin project

$494 Million in capital investments

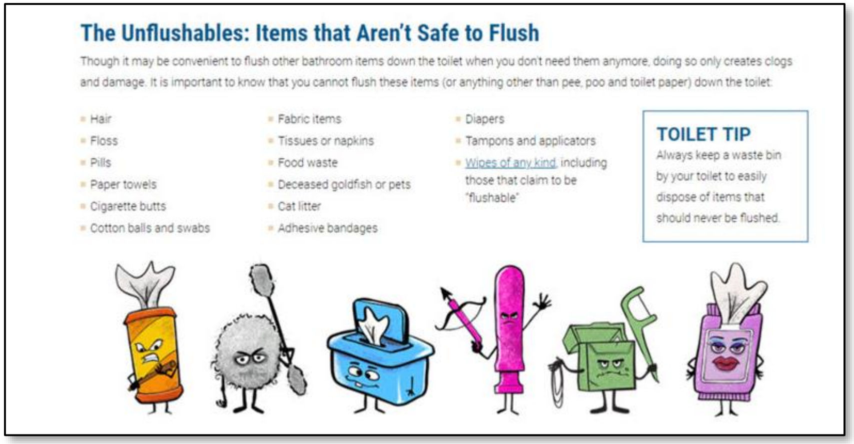
Historical Remediation & Investments

Ongoing Annual Investments

- Waterfoul management
- Windemere Basin monitoring
- Red Hill Creek monitoring
- Academic research in harbour
- Hamilton Conversation Authority sampling program and laboratory support services
- HHRAP office
- Royal Botanical Gardens laboratory support services

Outreach & Research Projects

- Clean Harbour Program
- Unflushables Program
- Floatables study

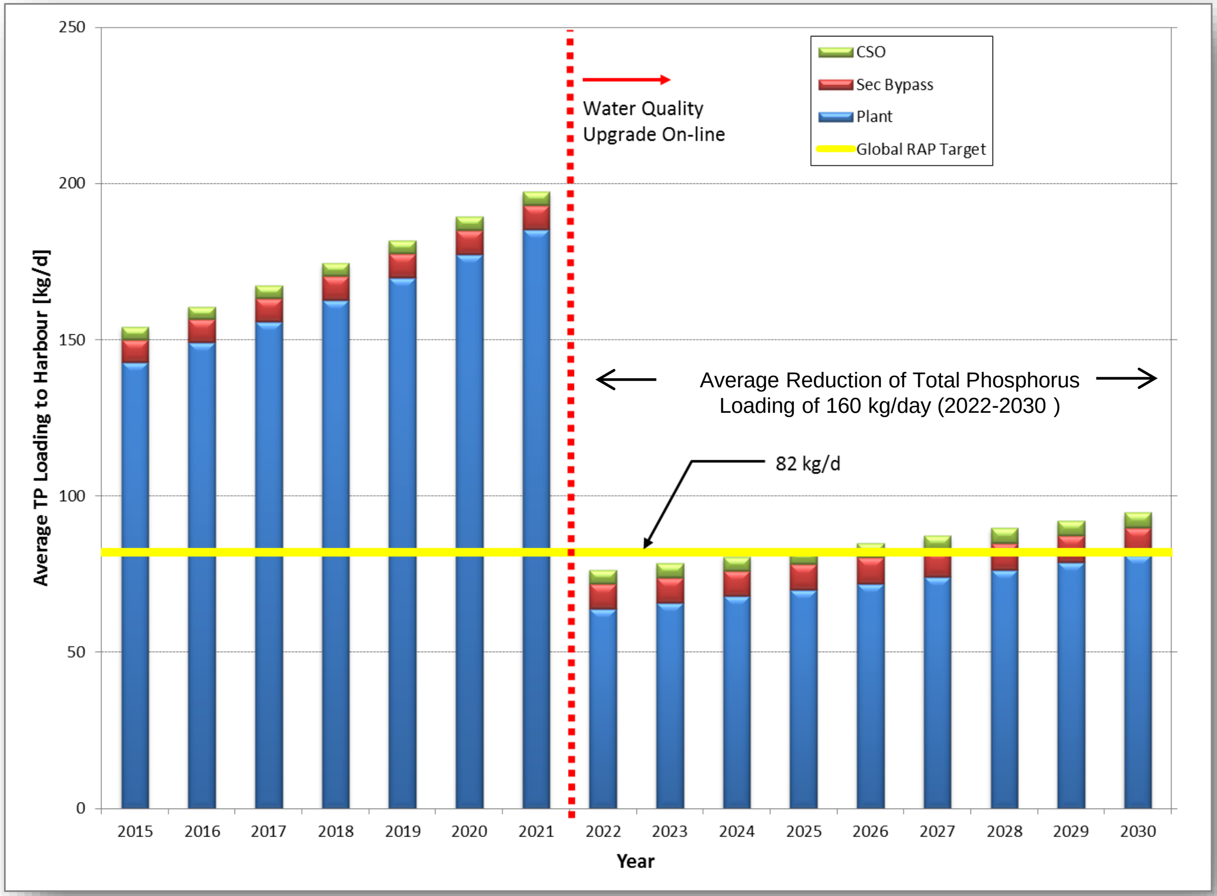


Investment Impacts: Phosphorous Reductions

Estimated reduction over 10 years

500 tonnes

of phosphorous

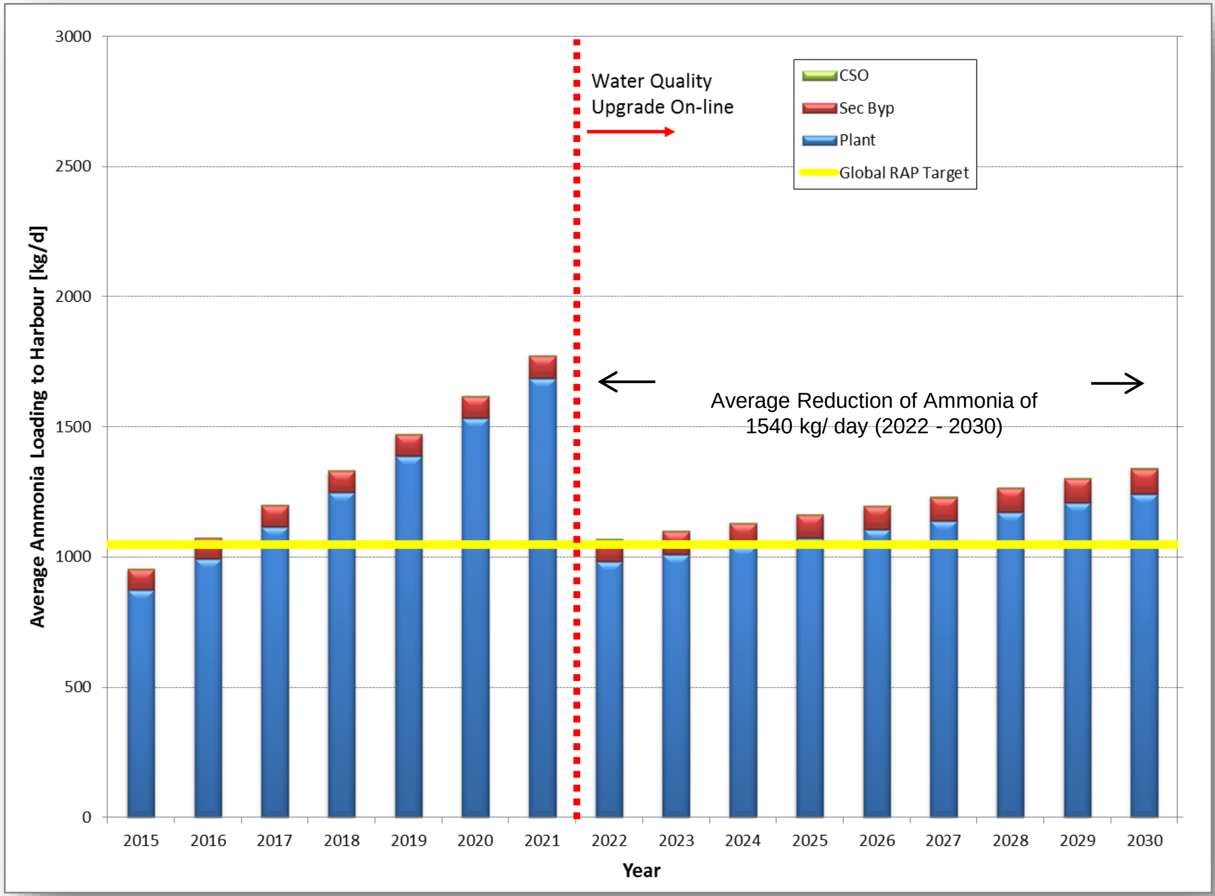


Investment Impacts: Ammonia Reductions

Estimated reduction over 10 years

6,100 tonnes

of ammonia

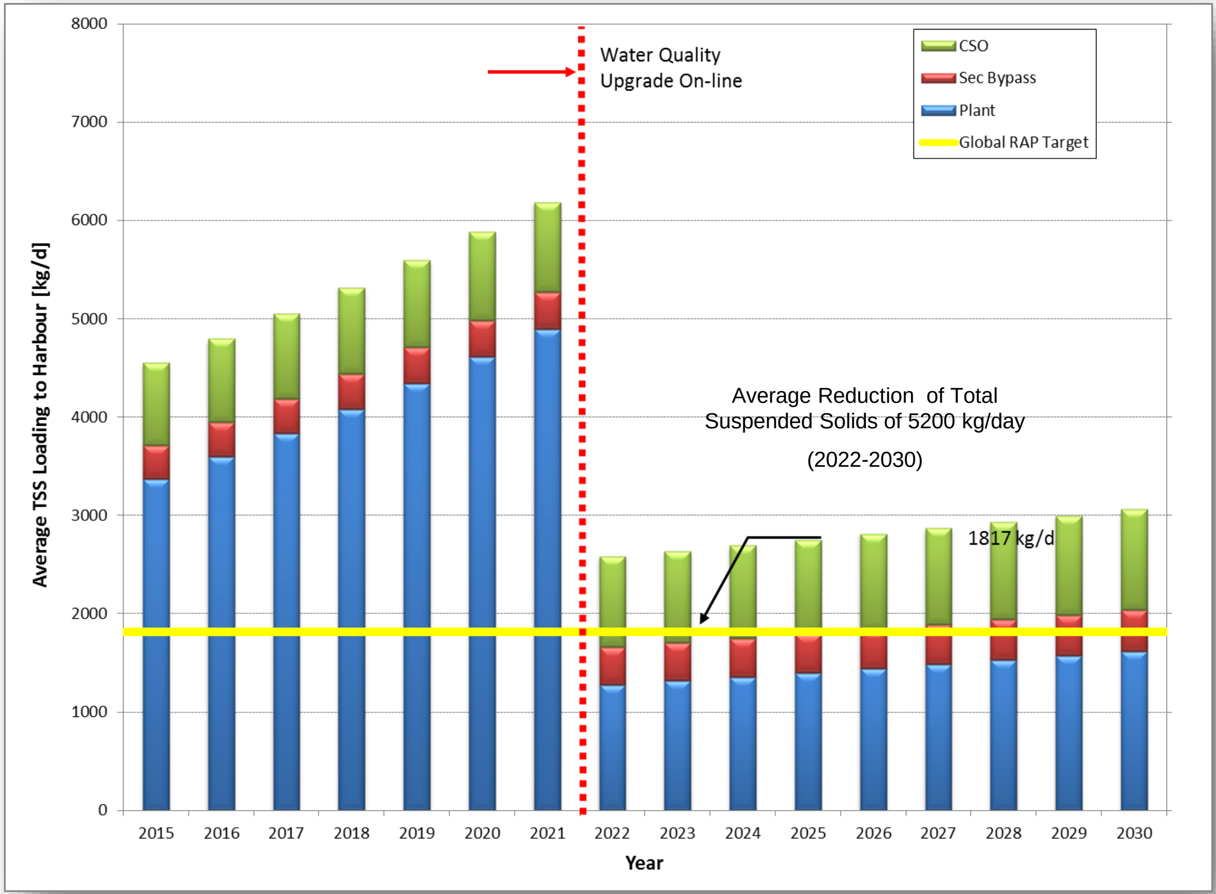


Investment Impacts: Suspended Solid Reductions

Estimated reduction over 10 years

14,900 tonnes

of suspended solids



Hamilton Harbour Remedial Action Plan: Next Steps

- Traditionally focused on Hamilton Harbor, connected shoreline and point source loading
- Watershed nutrient management and sediment management advisory group created to focus on broader watershed management
  - Urban Runoff Task Force – 26 recommendations
  - Sediment control on construction sites – 31 recommendations

- Initial discussions with external stakeholders around future of RAP
  - Bay Area Restoration Council (BARC)
  - Royal Botanical Gardens (RBG)
  - Hamilton Conservation Authority (HCA)
  - Hamilton Harbour Remedial Action Plan

HAMILTON HARBOUR REMEDIAL ACTION PLAN

Hamilton Harbour Watershed

Hamilton

THANK YOU