TOTAL SUSPENDED SOLIDS LIMIT FOR CONSTRUCTION SITE WATER

OLD SLYS LOCKSTATION, SMITHS FALL, ONTARIO

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18-2490
August 2018

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EXECUTIVE SUMMARY

EcoMetrix was retained by AEL Environment, on behalf of Parks Canada to develop a total suspended solids (TSS) concentration limit for releases of construction site water to surface water during planned construction work for the Old Slys Lockstation in Smiths Fall, Ontario. This TSS concentration limit will be used to trigger mitigation measures that may be needed during construction should the TSS concentration limit be exceeded in construction site water during a storm or unscheduled release.

A step-wise approach was followed to derive the TSS construction limit:

1) A mass balance equation was used to predict water concentrations of contaminants at different TSS levels in water, based on concentrations of contaminants in sediment and soil samples collected by AEL (2018) during a recent environmental site assessment.

2) Predicted water concentrations of contaminants were compared against the long-term WQGs protective of aquatic life to assess potential risks to aquatic life in the receiving environment.

3) The potential for mixture toxicity from the predicted water concentrations of contaminants was evaluated using an additive toxic unit approach and short-term WQGs or acute toxicity values.

4) A TSS limit value was selected that would be protective for both the physical effects of TSS and the effects of TSS associated contaminants.

5) An uncertainty evaluation was conducted to address potential uncertainties associated with the recommended TSS construction limit.

A TSS construction limit of 25 mg/L was recommended with an “equivalent” turbidity value of 8 NTU. It is recommended that the Contractor carrying out the planned construction work, collect site-specific data to refine the TSS turbidity-relationship, and either confirm the NTU value or set a revised site-specific NTU value corresponding to TSS of 25 mg/L.

Abbreviations

APV: Aquatic Protection Value

CCME: Canadian Council of Ministers of the Environment

CCREM: Canadian Council of Resource and Environment Ministers

CCC: Criterion Continuous Concentration

CMC: Criterion Maximum Concentration

COC: Contaminants of Concern

HWS: Hot Water-Soluble

ISQG: Interim sediment quality guideline

MECP: Ministry of Environment, Conservation and Parks

NTU: Nephelometric turbidity unit

PAH: Polycyclic Aromatic Hydrocarbon

PCB: Polychlorinated Biphenyl

PHCs: Petroleum Hydrocarbons

PWQO: Provincial Water Quality Objectives

SAR: Sodium Adsorption Ratio

SEV: Severity-of-ill-effects

TSS: Total Suspended Solids

TU: Toxicity Unit

VOCs: Volatile organic compounds

WQG: Water Quality Guideline

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1.0 INTRODUCTION

EcoMetrix was retained by AEL Environment (AEL), a division of Aeon Egmond Limited, on behalf of Parks Canada, to develop/recommend a total suspended solids (TSS) construction limit for releases of construction site water to surface water during planned construction work for the Old Slys Lockstation in Smiths Fall, Ontario. The purpose of the TSS construction limit is to prevent possible exposure to concentrations of TSS or associated contaminant concentrations above safe levels for aquatic life in the receiving environment (Rideau River), by triggering mitigation measures should the TSS concentration limit be exceeded in construction site water during a storm or unscheduled release.

The Canadian Council of Ministers of the Environment (CCME) water quality guideline (WQG) for TSS of 25 mg/L above background level for any short-term exposure (e.g. 24-h period) under clear flow conditions (CCME, 2002) was initially considered as a value that is protective for physical effects. This WQG is also appropriate because a storm event and unscheduled release of TSS into the receiving environment is considered to be a short-term event. This WQG is based on an adult salmonid severity-of-ill-effects (SEV) concentration-duration-response model from Caux et al. (1997). Based on this model, a TSS concentration above a 25 mg/L for 24 hours may cause behavioural and low sublethal effects on fish.

In order to have a fixed value of TSS as a limit, we have made a conservative assumption that the background level of TSS in river water may be as low as zero. Thus, a 25 mg/L concentration of TSS is considered as the objective to avoid physical effects on aquatic life. Concentrations of other contaminants that could be associated with 25 mg/L TSS, and with lower and higher values of TSS, were explored to see if these levels would be protective in terms of potential chemical effects on aquatic life.

2.0 BACKGROUND

2.1 Objective

The objective of this work was to determine an appropriate TSS construction limit for releases of construction site water to surface water, which would trigger mitigation measures should the TSS concentration limit be exceeded in construction site water during a storm or unscheduled release, at the Old Slys Lockstation.

The planned construction work, which is managed by Parks Canada, is expected to occur in the Fall of 2018. The proposed construction work may include:

- Construction of upstream and downstream cofferdams;
- De-watering of work areas;
- Removal of algae, debris and zebra mussels;
- Saw-cutting and raking mortar joints;
- Removal of deteriorated stones/materials;
- Potential for excavation behind lock/approach walls;
- Masonry/grouting; and
- Landscaping, site reinstatement to previous condition.

2.2 Environmental Site Assessment

In 2017, AEL (2018) completed an environmental site assessment (ESA) for Old Slys Island, located south of the lock station (Figure 1). In the 1960’s, the Island was used as a landfill by the Town of Smiths Falls. The landfill was not lined or capped and is of potential environmental concern due to the buried landfill materials.

AEL (2018) noted that the opening and closing of the locks causes vertical groundwater fluctuations on the Island between 1.5 m near the locks and 0.4 m away from the locks. This lock system effectively “flushes” water into the island when the locks are filled and enables groundwater to seep out when the locks are emptied.

As part of their investigation, AEL (2018) collected soil, groundwater, sediment, surface water, and/or seepage samples across the Island, and in areas along and in the lock system. These samples were submitted to an accredited laboratory for the analyses of petroleum hydrocarbons (PHCs), volatile organic compounds (VOCs), metals and inorganics, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). When compared to applicable federal (i.e. Canadian Council of Ministers of the Environment (CCME) and Federal Contaminated Sites Action Plan Guidance) and provincial (i.e. Ontario Regulation 153/04 and Provincial Water Quality Objectives (PWQO)) guidelines, the following contaminants were identified as contaminants of concern (COCs):

- Soil -PHCs, metals, VOCs and PAHs;
- Groundwater – PHCs, metals and inorganics, VOCs and PAHs;

- Sediment – Metals and PAHs;
- Surface Water– Inorganics; and
- Seepage – metals.

The soil, sediment, surface water and seepage results collected as part of the AEL (2018) environmental site assessment of the Island were evaluated and used for this assessment.

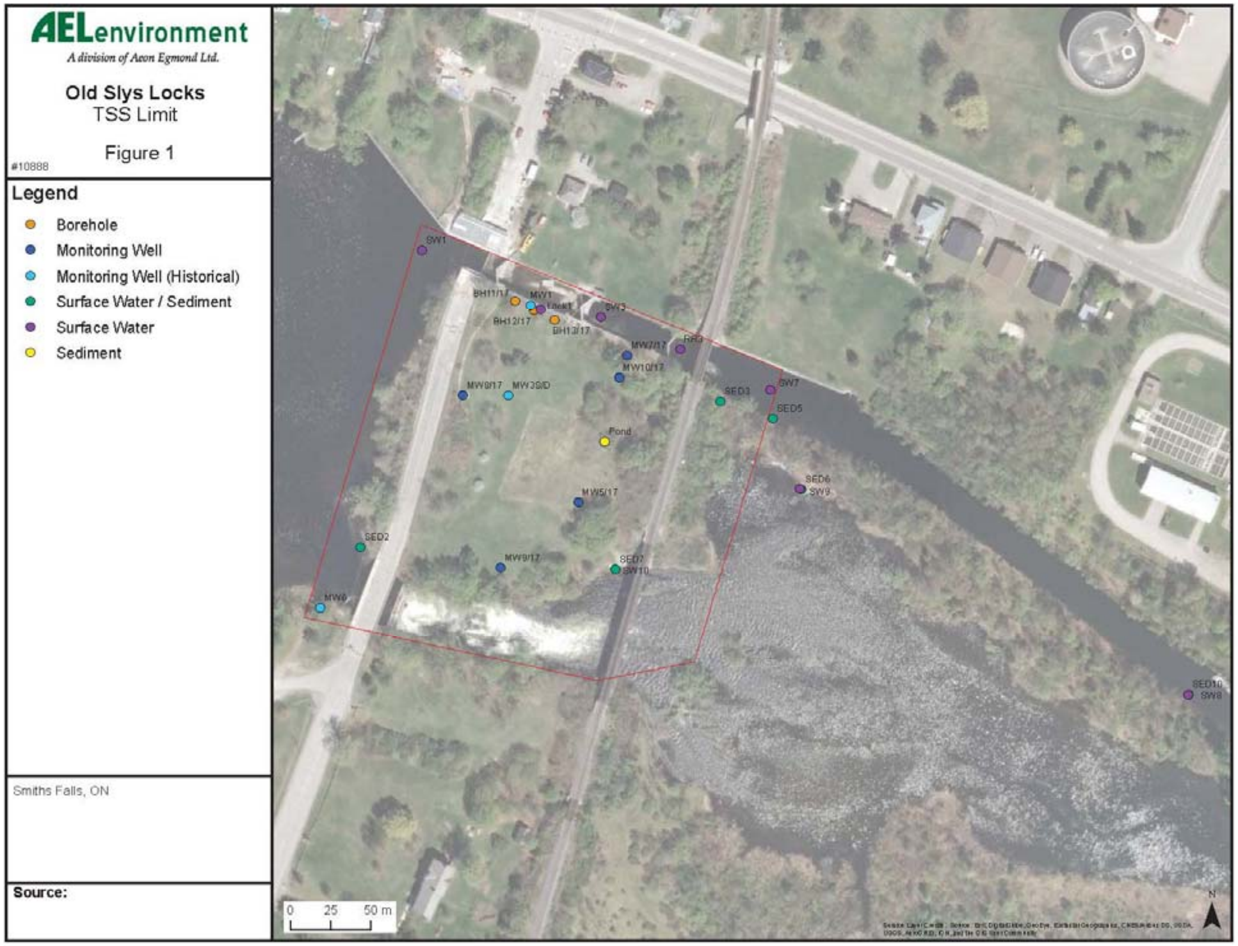

Figure 1: AEL (2018) monitoring locations, August 2017.

3.0 Regulatory Context

Although the Old Slys Lockstation is under federal jurisdiction, various federal and provincial regulatory statues were considered to determine an appropriate TSS limit for construction site water to trigger mitigation measures should the TSS concentration limit be exceeded during a storm or unscheduled release. These statues include:

- Canadian Environmental Protection Act, 1999 (federal);
- Fisheries Act (federal)
- Species at Risk Act (federal);
- (Ontario) Environmental Protection Act (provincial);
- Ontario Water Resources Act (provincial); and
- (Ontario) Endangered Species Act (provincial).

4.0 Assessment Approach

Sediment may be disturbed and suspended in the surface water during the construction of the cofferdams, dewatering of work areas, removal of aquatic biota (e.g. algae and zebra mussels) and debris, and excavation activities behind the lock/approach walls. Soil along the lock/approach walls may also be disturbed and transported into the surface water through the removal of deteriorated stones and materials, land run-off, especially after a storm, or landscaping activities. Aquatic biota may be exposed to suspended solids (i.e. sediment and soils) through direct contact or ingestion of the suspended solids. Aquatic biota may also be exposed to contaminants associated with the suspended solids, or partitioning from the solids to surface water, through direct contact, incidental ingestion, and uptake through the food chain. These potential exposure pathways to aquatic biota were considered in this assessment.

4.1 Approach

The following step-wise approach was used to assess the validity of using the TSS limit of 25 mg/L or the need for a lower TSS construction limit to trigger mitigation measures should the TSS concentration limit be exceeded during a storm or unscheduled release:

1) A mass balance equation was used to predict water concentrations of contaminants at different TSS levels in water, based on concentrations of contaminants in sediments and soils collected by AEL (2018). A series of TSS concentrations between 5 and 100 mg/L were incorporated into the model. The lower TSS value is the CCME (2002) long-term (24-hours to 30 days) guideline value for clear flow conditions. The upper TSS value is intended to represent a TSS water concentration that could arise during an unscheduled release.
2) Surface water and seepage water quality data collected by AEL (2018) were used in the mass balance equation as background surface water contaminant concentrations.
3) Predicted water concentrations of contaminants (TSS-associated plus background concentrations) were compared against the long-term WQGs protective of aquatic life. Exceedance of the long-term WQGs was considered to represent potential risks to the health of aquatic life. This is conservative because most storm events would not last long enough to result in long-term exposures at contaminant concentrations associated with a storm event release. The durations of toxicity tests used in developing long-term WQGs vary with organism type: greater than 7 days for fish and plants, 96-h for invertebrates, and 24-h for algae (CCME, 2007).
4) The potential for mixture toxicity for the predicted water quality concentrations was also evaluated using an additive toxic unit approach and short-term WQGs or acute toxicity values.
5) A TSS limit value was selected that would be protective for both the physical effects of TSS and the effects of TSS associated contaminants.

6) An uncertainty assessment was also completed to address potential uncertainties associated with the recommended TSS limit for release of construction site water.

4.2 Data Selection

Sediment, soil and water chemistry data from the recent sampling effort by AEL (2018) was initially screened for inclusion in the assessment based on the location where the sample was collected in relation to the proposed construction activities and potential exposure pathways to aquatic biota. A total of seven (7) sediment/soil sampling locations and five (5) surface water/seepage sampling locations were identified:

- Sediment chemistry collected near the lock system (i.e. SED3 and SED5) was selected and used to represent sediment contaminant concentrations that may be disturbed and suspended during construction activities within the lock system;
- Soil chemistry data collected located within 30 meters (i.e. BH11/17, BH12/17, BH13/17, MW7/17 and MW10/17) from the lock system was selected and used to represent potential soil transport into the receiving environment from natural run-off or after a storm event, landscaping activities, and/or the removal of deteriorated stones and materials along the shoreline/embankment;
- Surface water chemistry (i.e. SW1, RR3, and SW7) collected within and near the lock system was selected and used to represent background water quality; and
- Seepage chemistry (i.e. SW3 and Lock 1) collected at the locks was selected and also used to represent background water quality. These samples could contribute to background water quality during the opening and closing of the locks because the lock system effectively “flushes” water into Old Slys island when the locks are filled, which enables groundwater to seep out into the receiving environment when the locks are emptied.

Figure 2 shows the locations of the sediment, soil, surface water and seepage chemistry data used for this assessment.

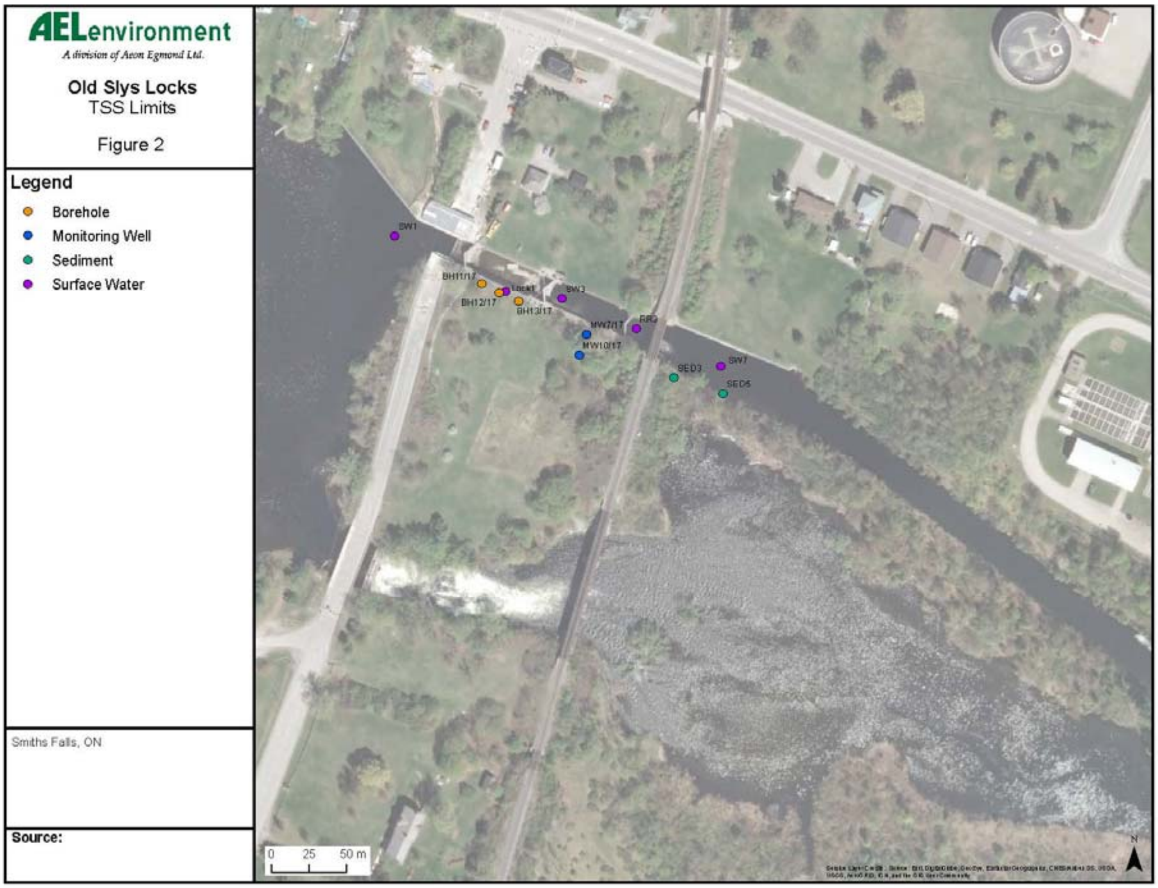

Figure 2: Sediment, Soil, Surface Water and Seepage Sample Locations Used for the Assessment.

The sediment and soil chemistry data were further screened by:

- selecting the maximum soil concentration for each contaminant for each borehole where soil samples were collected and analyzed for different soil strata;
- excluding sediment and soil chemistry parameters that were not detected in at least one (1) of the seven (7) sediment/soil samples. This approach was considered reasonable because most of the detection limits for the individual contaminants were below the applicable federal and provincial guidelines considered by AEL (2018), and it is unlikely that these non-detected contaminants will limit risks to aquatic biota exposed to suspended solids;
- excluding parameters/contaminants such as pH, conductivity, sodium adsorption ratio (SAR), and hot water-soluble boron (HWS boron) measured in sediments and soils because they are not considered to be aquatic life toxicants; potential adverse effects of conductivity, SAR, and HWS boron are limited to terrestrial plants;
- excluding PHC Fraction 3 and Fraction 4 because these fractions are sufficiently insoluble in water (CCME, 2008); and

- excluding PCBs because the environmental exposure to PCBs is predominantly via sediment, soil, and/or tissue, and the CCME (2001a) Canadian interim sediment quality guideline (ISQG) of 60 µg/g for PCBs for the protection of aquatic life is far above the maximum measured sediment/soil concentration of 0.19 µg/g.

Based on the above screen, the following sediment and soil contaminants were considered for this assessment:

PHCs

- F1 (C6-C10)
- F2 (C10-C16)

VOCs

- 1,4-Dichlorobenzene
- Ethylbenzene
- Toluene
- Trichloroethylene
- Xylene (Total)

Metals and Other Inorganics

- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Beryllium (Be)
- Cadmium (Cd)
- Chromium (Cr)
- Cobalt (Co)
- Copper (Cu)
- Cyanide (CN-)
- Lead (Pb)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Selenium (Se)
- Silver (Ag)
- Thallium (Tl)
- Tin (Sn)
- Uranium (U)
- Vanadium (V)
- Zinc (Zn)

PAHs

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b/j) fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenz(a,h)anthracene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd) pyrene
- 1-Methylnaphthalene
- 2-Methylnaphthalene
- Naphthalene
- Phenanthrene
- Pyrene

This list of sediment and soil contaminants was used to represent the contaminants potentially present in total suspended solids because measured values of contaminant concentrations in suspended solids of surface water and seepage are not available. The approach was considered to be conservative, as described in Section 6.0.

4.3 Selection of Water Quality Guidelines

4.3.1 Long-term (Chronic)

The predicted water quality concentrations were compared against the CCME long-term (chronic) water quality guidelines (WQG) for the protection of freshwater aquatic life to evaluate potential long-term risks to aquatic biota exposed to suspended solids in water. Where a CCME WQG was not available, chronic WQGs from other jurisdictions or acceptable literature, in order of preference, were selected:

- Ontario Provincial Water Quality Objectives (PWQOs; MOEE 1994);
- Ministry of Environment, Conservation and Parks (MECP) aquatic protection value (APV; MOE 2011);
- U.S. Environmental Protection Agency (U.S. EPA, 2018a) National Recommended Water Quality Criteria – Criterion Continuous Concentration (CCC); and
- Chronic benchmarks from Suter and Tsao (1996).

The PWQOs (MOEE, 1994) developed for emergency purposes were not considered for this assessment because they have not been peer reviewed.

For selenium, the U.S. EPA (2016) selenium CCC was selected over the CCME (2018; CCREM,1987) value because it is based on recent scientific knowledge.

Where a WQG was related to water hardness, a geometric mean water hardness of 113 mg/L as $CaCO_3$, estimated from the surface water and seepage samples considered in this assessment, was used.

The selected long-term WQGs and basis of the WQGs are provided in **Appendix A.**

4.3.2 Short-term (Acute)

The potential for mixture toxicity for the predicted water quality concentrations was evaluated using an additive toxic unit approach and short-term WQGs or acute toxicity values. This provides a conservative check to be sure that combined effects from multiple contaminants, all at their upper bound concentrations, are not toxic to aquatic life for a short-term event, such as a storm event or an unscheduled release. In order of preference, short-term WQGs or acute toxicity values were selected from:

- CCME short-term WQGs for the protection of freshwater aquatic life;
- The lowest acute toxicity values considered by the CCME in the derivation of their long-term WQGs for the protection of freshwater aquatic life;
- Acute endpoint considered by MECP in the derivation of their APVs (MOE, 2011);
- U.S. EPA (2018a) National Recommended Water Quality Criteria – Criterion Maximum Concentration (CMC);

- Suter and Tsao (1996) Tier II secondary acute value;
- U.S. EPA (2018b) ECOTOX database, and
- Narcosis approach from DiToro et al. (2000).

Where the selected acute value was obtained from the MECP (MOE, 2011) or Suter and Tsao (1996), the ECOTOX database (U.S. EPA, 2018b) was checked to see if more recent acute toxicity values were available. If a lower acute value was reported in the ECOTOX database (U.S. EPA, 2018b; e.g. cobalt and benzo(g,h,i)perylene), this acute value was selected for the assessment.

The endpoints considered in the ECOTOX database (U.S. EPA, 2018b) check included the lethal concentration (LC50), lethal time (LT50), effective concentration (EC50), and effective time (ET50) that produces a lethal or sublethal response to 50% of the test organisms. The test organisms considered in the ECOTOX database (U.S. EPA, 2018b) were mainly fish and invertebrates, while the effect measurements were immobility (intoxication) and survival (mortality).

For selenium, the U.S. EPA (2016) intermittent exposure formula was selected over other preferred sources because it is based on recent scientific knowledge.

Where a WQG was related to water hardness, a geometric mean water hardness of 113 mg/L as $CaCO_3$, estimated from the surface water and seepage samples considered in this assessment, was used.

The selected short-term WQGs or acute values and their basis are provided in **Appendix A**.

4.4 Water Quality Estimates

Predicted surface water quality concentrations for a series of TSS water concentrations (5, 25, 50, 75,100 mg/L) were estimated using a mass balance model (Equation 1):

$$C_W = \frac{C_{Sed/Soil} \times C_{TSS}}{1000} + C_{BKGw}$$

Equation (1)

Where:

C_w = Concentration of contaminant in water (µg/L)

$C_{Sed/Soil}$ = Concentration of contaminant in soil/sediment (µg/g)

C_{TSS} = Concentration of total suspended solid in water (mg/L)

C_{BKGw} = Concentration of background contaminant in water (µg/L)

1000 = Unit conversion factor (mg $_{\text{sediment/soil}}$ / g $_{\text{sediment/soil}}$)

The series of TSS concentrations include the CCME (2002) WQGs for suspended sediments under clear flow for a short-term (25 mg/L) and long term (5 mg/L) exposure duration, and the Department of Fisheries and Ocean's *Land Development Guidelines* (1992) value of 75 mg/L (above background) during design storm events for the protection of fish habitat (where spawning areas are not situated in the receiving environment). The upper TSS value of 100 mg/L is intended to represent a TSS water concentration during an unscheduled release.

The 75th percentile sediment/soil concentration was used for the water quality estimates. For non-detect samples, sample values were set equal to the reportable detection limit prior to calculating the 75th percentile.

The 75th percentile sediment/soil concentration was considered to be a reasonable upper bound concentration representative of suspended solids that may be present in the receiving environment during construction activities, a storm event or an unscheduled released.

The minimum, maximum, mean, median, 75th and 95th percentile sediment/soil concentrations are presented in **Appendix B.**

For consistency, the 75th percentile surface water/seepage concentrations, representative of background water, were added to the predicted surface water concentrations (Equation 1). In cases where a parameter was not detected in any of the surface water/seepage samples or where the contaminant was not analyzed by the laboratory, a background value was not added to the mass balance equation. For non-detect samples, sample values were set equal to the reportable detection limit to estimate the 75th percentile. The minimum, maximum, mean, median, 75th and 95th percentile surface water/seepage concentrations are provided in **Appendix B.**

The predicted surface water quality concentrations for the series of TSS concentrations, and the comparison to the long-term WQGs, are provided in **Appendix C**.

Seven (7) contaminants had predicted concentrations in surface water (**Appendix C**) above the long-term WQG, for at least some TSS concentrations:

- ≥ 10 mg/L TSS
    - Copper
    - Lead

- ≥ 50 mg/L TSS
    - Barium
    - Cadmium
    - Zinc

- 100 mg/L TSS
    - Cobalt

These exceedances suggest that there may be potential risks to aquatic life for contaminants associated with the suspended solids, for different release scenarios, and that potential mitigation options may be needed to address these risks.

For a TSS concentration of 25 mg/L, predicted copper and lead concentrations in water were found to exceed the long-term WQG. This comparison is conservative, since a long-term exceedance of the TSS limit would not be permitted. The implications of short-term exceedance of the TSS limit are considered in Section 4.5.

The long-term WQG for copper (CCREM, 1987) was derived using the U.S. EPA (1985a) copper toxicity-hardness equation multiplied by an application factor of 0.2 to account for uncertainty (**Appendix A**). If this application factor were removed, this would result in a long-term WQG for copper of 13 µg/L. Comparison of this value to the predicted concentrations in surface water (**Appendix C**) indicates that a copper exceedance would still exist for the 50, 75 and 100 mg/L TSS concentrations, but not for the TSS level of 25 mg/L.

Currently the U.S. EPA (2007) has endorsed the use of the biotic ligand model to derive their long-term (CCC) freshwater criteria. This approach uses metal speciation calculations to predict metal toxicity to aquatic organisms by accounting for the toxicity-modifying effects of major ions and dissolved organic carbon in water. This approach could not be used for this assessment because major ions and dissolved organic carbon in water were not measured as part of the AEL (2018) environmental site assessment. If this approach was used it is likely that a long-term WQG for copper of more than 13 µg/L could be derived.

The long-term WQG for lead (CCREM, 1987) was derived using the U.S. EPA (1985b) lead toxicity-hardness equation. The predicted lead water quality concentration of 3.9 µg/L for a TSS concentration of 25 mg/L exceeds the long-term WQG for lead of 3.7 µg/L by 5%. However, most of the predicted concentration will be adsorbed to the suspended solids, rather than dissolved in water. The WQG is based on toxicity tests with lead mostly in dissolved form, and it is therefore conservative. Therefore, the small exceedance is unlikely to produce toxicity, particularly for a short-term event.

Based on this evaluation, setting the TSS limit for construction site water to 25 mg/L is considered to be protective of aquatic life in the Rideau River.

4.5 Mixture Toxicity

The potential for the individual contaminants in sediment and soils to mix and cause acute (short-term) toxicity during a storm event or unscheduled release was evaluated using an additive toxic unit (TU) approach. A TU for each contaminant was calculated by dividing the predicted water concentration by a short-term WQG, or where a short-term WQG was not available, by a literature-based acute value causing a 50% response in a biological endpoint (e.g. mortality or immobility). The TUs for the individual contaminants were then added together (Equation 2):

$$\sum TU = \sum_{i=1}^{n} \frac{CW_i}{WQG_i}$$

Equation (2)

Where:

TU = Toxic Unit (unitless)

C_w = Concentration of contaminant in water (µg/L)

WQG = Is the short-term WQG or acute value causing a 50% biological response (µ/L)

The model assumes a similar mode of toxicity among the contaminants included in the sum. Where $\sum TU < 1$, acute toxicity is not expected for the mixture of contaminants. Where $\sum TU > 1$, acute toxicity is possible for the mixture of contaminants.

The calculations and the $\sum TU$ values are provided in **Appendix D**. The $\sum TU < 1$ for the 5, 10 and 25 mg/L TSS concentrations, whereas the $\sum TU > 1$ for the 50, 75 and 100 mg/L TSS concentrations. The latter suggests the potential for acute toxicity.

Based on this evaluation, setting the TSS limit for construction site water to 25 mg/L is considered to be protective of aquatic life in the Rideau River.

5.0 TSS Construction Site Water Limit

Based on the above evaluations, setting the TSS limit for construction site water to 25 mg/L for a short-term duration (e.g. 24-hours) is considered to be protective of aquatic life in the Rideau River. Based on an assumed TSS-turbidity relationship of 3:1 (CCME, 2002), the equivalent turbidity value is 8 NTU. The TSS and turbidity limits are intended to be compared directly to measured values in site water prior to discharge, and not increased by river background at the time.

The TSS turbidity-relationship outlined in CCME (2002) is a generic relationship. It is recommended that the Contractor carrying out the planned construction work, collect site-specific data to refine this TSS turbidity-relationship, and either confirm the NTU value or set a revised site-specific NTU value corresponding to TSS of 25 mg/L.

6.0 Uncertainty Assessment

Although there are a number of potential uncertainties inherent in this assessment, these uncertainties are addressed by making conservative assumptions and using site-specific data. These assumptions are discussed with respect to uncertainties associated with the quality and quantity of site data used in the assessment; the use of the mass balance model; the comparison of predicted water quality concentrations to long-term WQGs; the use of the additive TU model approach to evaluate mixture toxicity; and the selection of acute values used for the additive TU model.

Data Quality and Quantity

The inclusion of soil samples in the analysis, and the use of maximum measured soil concentrations for boreholes, where soil concentrations were measured at different depths, is conservative and likely to overestimate impact because:

- contaminant concentrations in soil were often measured higher in the soil samples compared to the sediment (**Appendix B**);
- maximum measured soil concentrations were often measured in subsurface soils (>1.5 m below ground surface) (AEL, 2018) which are not likely to be introduced to TSS in surface water runoff, due to mitigation measures during construction; and
- sediments are likely to be more disturbed and suspended in water, as compared to soils, because most of the construction activity is likely to take place in water (i.e. within the lock system).

For this assessment non-detect values in sediment/soil and surface water/seepage samples were set equal to the reportable detection limit. This approach is likely to overestimate actual contaminant concentrations.

Few sediment/soil and surface water/seepage samples were collected for inclusion in the assessment. However, the samples that were used may likely overestimate contaminant concentrations because the environmental site assessment (AEL,2018) was focused on sampling areas of known or suspected contamination. Moreover, the use of the 75th percentile in this assessment is conservative.

Long-term Water Quality Guidelines

The use of long-term WQGs in the screening of the predicted water quality concentrations is conservative because they assume longer exposure durations than those that are likely to occur with the release of suspended solids during a storm event or unscheduled release.

The WQGs are also conservative because they are based on toxicity tests in which contaminants are mostly dissolved, whereas the contaminants transported with suspended solids will be mostly adsorbed to the solids.

Mixture Toxicity

Adding TUs from different contaminant groups (e.g. VOCs, PAHs and metals) to assess mixture toxicity may over-predict and/or under-predict mixture toxicity because the synergistic and antagonistic interactions of these chemicals have not been thoroughly studied; however, the assumption of similar modes of action for all these contaminants is likely conservative.

There are also uncertainties associated with the use of the selected acute values used to evaluate mixture toxicity. These uncertainties may include: outdated studies or limited studies; extrapolating results from laboratory tests to the field; differences in sensitivity between the test organism and resident organisms; laboratory conditions that are not representative of field conditions; the form of the contaminant used in toxicity testing is either unknown or not representative of the form found at the site.

The use of acute values from laboratory studies tends to be conservative because these studies typically use highly bioavailable forms of the contaminant. In field situations, the chemical form of the contaminant may be less bioavailable, and toxicity-modifying factors may be present that were not acting in laboratory tests. For this assessment, the lowest acute value reviewed and used by different jurisdictions in the derivation of WQGs protective of aquatic life were selected. In addition, acute values were also cross-checked with the lowest acute values reported in the ECOTOX database (U.S. EPA, 2018b) to be sure that the lowest acute value was selected for this assessment.

To have confidence in the TSS limit for construction site water of 25 mg/L, there must be a high level of certainty or an acceptable and reasonable level of conservatism. Considering the above uncertainties and how these uncertainties were addressed for this assessment, there is confidence that the TSS limit of 25 mg/L for construction site water should be protective to the aquatic life in the Rideau River, and therefore appropriate as a trigger for mitigation measures should the TSS concentration limit be exceeded during a storm event or unscheduled release.

7.0 References

Abernethy, S., A.M. Bobra, W.Y. Shiu, RG. Wells, and D. Mackay. 1986. Acute lethal toxicity of hydrocarbons and chlorinated hydrocarbons to two planktonic crustaceans: The key role of organism–water partitioning. Aquat. Toxicol. 8:163–174 (as cited in the CCME, 1999d).

AEL (AEL Environment). 2018. Risk Assessment and Environmental Monitoring Old Slys Lockstation, Smiths Falls, Ontario, PIN:052740116 and 052740097, FSCI# 09412002. Prepared for Parks Canada Agency, Gatineau, Quebec. Prepared by AEL Environment, a division of Aeon Egmond Limited., Mississauga, Ontario, June 2018.

Ahmad, N., D. Benoit, L. Brooke, D. Call, A. Carlson, D. DeFoe, J. Huot, A. Moriatry, J. Richter, P. Subat, G. Veith, and C. Wallbridge. 1984. Aquatic toxicity tests to characterize the hazard of volatile organic chemicals in water: A toxicity summary - Parts I and II. EPA-600/3-84-009. U.S. Environmental Protection Agency, Duluth MN (as cited in CCME, 1999a).

Allred, P.M., Giesy, J.P. 1985. Solar radiation-induced toxicity of anthracene to Daphnia pulex. Environmental Toxicology and Chemistry, 4: 219–226.

ATRG (Aquatic Toxicity Research Group). 1988. Aquatic toxicity of multiple organic compounds. II. Chlorinated ethanes and chlorinated ethylenes. A summary report prepared for the Ontario Ministry of the Environment by the Aquatic Toxicity Research Group, Lakehead University, Thunder Bay, ON (as cited in the CCME, 1999d).

Birge,W.J. 1978. Aquatic toxicology of trace elements of coal and fly ask, pp. 219-240. In Energy and environmental stress in aquatic systems, J.H. Thorp and J. Whitfield Gibbons [eds]. Department of Energy Symposium Series, 48. NTIS CONF-771114. Springfield, VA (as cited in MOEE, 1996).

Birge,W.J., J.A. Black, and D.M. Bruser.1979. Toxicity of Organic Chemicals to Embryo-Larval Stages of Fish. U.S.EPA, Washington, D.C.: 60 p EPA-560/11-79-007 (as cited in U.S. EPA, 2018b).

Black, J.A., W.J. Birge, W.E. McDonnell, A.G. Westerman, B.A. Ramey, and D.M. Bruser. 1982. The aquatic toxicity of organic compounds to embryo–larval stages of fish and amphibians. Research Report No. 133, University of Kentucky Water Resources Research.

Black, J.A., Birge, W.J., Westerman,A.G., Francis, P.C.. 1983. Comparative aquatic toxicology of aromatic hydrocarbons. Fundam. Appl. Toxicol. 3(9/10):353–358 (as cited in CCME, 1999h).

Borgmann,U., Couillard, Y., Doyle, P., Dixon,D.G. 2005. Toxicity of Sixty-Three Metals and Metalloids to Hyalella azteca at Two Levels of Water Hardness. Environ. Toxicol. Chem., 24: 641-652.

Brown, B.T., and B.M. Rattigan. 1979. Toxicity of soluble copper and other metal ions to Elodea canadensis. Environ. Pollut. 20:303–314 (as cited in CCME, 1999g).

Call, D.J., L.T. Brooke, S.L. Harting, S.H. Poirier, and D.J. McCauley. 1986. Toxicity of phenanthrene to several freshwater species. University of Wisconsin—Superior, Center for Lake Superior Environmental Studies, Superior, WI (as cited in CCME, 1999h).

Caux, P.-Y., Moore, D.R.J., MacDonald, D. 1997. Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments, Technical Appendix. Prepared for: British Columbia Ministry of Environment, Lands and Park. Prepared by: Cadmus Group Inc. and MacDonald Environmental Sciences Ltd., April 1997.

CCME (Canadian Council of Ministers of the Environment). 1995. Protocol for the derivation of Canadian sediment quality guidelines for the protection of aquatic life. CCME EPC-98E. Prepared by Environment Canada, Guidelines Division, Technical Secretariat of the CCME Task Group on Water Quality Guidelines, Ottawa. [Reprinted in Canadian environmental quality guidelines, Chapter 6, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

CCME. 1999a. Canadian water quality guidelines for the protection of aquatic life: Chlorinated benzenes—1,4-Dichlorobenzene. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999b. Canadian water quality guidelines for the protection of aquatic life: Ethylbenzene. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999c. Canadian water quality guidelines for the protection of aquatic life: Toluene. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999d. Canadian water quality guidelines for the protection of aquatic life: Chlorinated ethenes—1,1,2-Trichloroethene (trichloroethylene). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999e. Canadian water quality guidelines for the protection of aquatic life: Chromium — Hexavalent chromium and trivalent chromium. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999f. Canadian water quality guidelines for the protection of aquatic life: Molybdenum. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999g. Canadian water quality guidelines for the protection of aquatic life: Thallium. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 1999h. Canadian water quality guidelines for the protection of aquatic life: Polycyclic aromatic hydrocarbons (PAHs). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2001a. Canadian sediment quality guidelines for the protection of aquatic life: Polychlorinated biphenyls (PCBs). Updated. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2001b. Canadian water quality guidelines for the protection of aquatic life: Arsenic. Updated. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2002. Canadian water quality guidelines for the protection of aquatic life: Total particulate matter. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2003. Canadian water quality guidelines for the protection of aquatic life: Inorganic mercury and methylmercury. In: Canadian environmental quality guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment. 2007. A protocol for the derivation of water quality guidelines for the protection of aquatic life 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, 1999, Winnipeg.

CCME. 2008. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, Support Technical Document, Canadian Council of Ministers of the Environment, Winnipeg, January 2008.

CCME. 2011. Canadian water quality guidelines for the protection of aquatic life: Uranium. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2014. Canadian water quality guidelines for the protection of aquatic life: Cadmium. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2015. Canadian water quality guidelines for the protection of aquatic life: Silver. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2018. Summary Table. Available at: http://st-ts.ccme.ca/en/index.html, retrieved July 2018.

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian Water Quality Guidelines. Task Force on Water Quality Guidelines of the Canadian Council of Ministers of the Environment.

DFO (Department of Fisheries and Oceans and Ministry of Environment Lands and Parks). 1992. Land development guidelines for the protection of aquatic habitat, May 1992 (first printing), September, 1993 (second printing). Available at: http://www.dfo-mpo.gc.ca/Library/165353.pdf.

Di Toro, D.M., McGrath, J.A., Hansen, D.J. 2000. Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue. Environmental Toxciology and Chemistry, 19:1951-1970.

EC (Environment Canada). 2003. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Inorganic Mercury and Methylmercury. Scientific Supporting Document, Ecosystem Health: Science-based Solutions Report No. 1-7. National Guidelines and Standards Office, Water Policy and Coordination Directorate, Environment Canada, Ottawa. pp.107.

EC. 2017. Canadian Environmental Protection Act, 1999, Federal Environmental Quality Guidelines, Cobalt. Environment Canada, May 2017.

ECCC (Environment and Climate Change Canada). 2016. Canadian Environmental Protection Act, 1999, Federal Environmental Quality Guidelines, Vanadium. Environment and Climate Change Canada, May 2016.

EPA. 1993a. Water quality guidance for the Great Lakes System and correction; Proposed rules. Federal Register. 58(72):20802-21047 (as cited in Suter and Tsao, 1996).

Finger, S.E., E.F. Little, M.G. Henry, J.F. Fairchild, and T.P. Boyle. 1985. Comparison of laboratory and field assessment of fluorene. Part I. Effects of fluorene on the survival, growth, reproduction, and behavior of aquatic organisms in laboratory tests. In: Validation and predictability of laboratory methods for assessing the fate and effects of contaminants in aquatic ecosystems, ASTM STP 865. T.P. Boyle, ed. Philadelphia (as cited in the CCME, 1999h).

Fletcher T, G.L. Stephenson, B. Muncaster, C.D. Wren, and D.J. Spry. 1997. Scientific criteria document for the development of an interim provincial water quality objective for molybdenum. Ontario Ministry of Environment and Energy, Standards Development Branch, Toronto (as cited in CCME, 1999f).

Galassi,S., Mingazzini,M., Viganò, L., Cesareo,D, Tosat, M.L. 1988. Approaches to Modeling Toxic Responses of Aquatic Organisms to Aromatic Hydrocarbons. Ecotoxicology and Environmental Safety, 16: 158-169.

Heit, M. and M. Fingermann. 1977. The influence of size, sex and temperature on the toxicity of mercury to two species of crayfishes. Bull. Environ. Contam. Toxicol. 18:572-580 (as cited in EC, 2003).

Holcombe, G.W.,Phipps, G.L.,Fiandt, J.T. 1983. Toxicity of selected priority pollutants to various aquatic organisms selected priority pollutants to various aquatic organisms. Ecotoxicol. Environ. Saf. 7:400–409 (as cited in the CCME, 1999h).

Lampi,M.A., J. Gurska, K.I.C. McDonald, F. Xie, X.D. Huang, D.G. Dixon, and B.M. Greenberg. 2006. Photoinduced Toxicity of Polycyclic Aromatic Hydrocarbons to Daphnia magna: Ultraviolet-Mediated Effects and the Toxicity of Polycyclic Aromatic Hydrocarbon Photoproducts. Environmental Toxicology and Chemistry, 25: 1079-1087.

Lilius,H., Isomaa, B., Holmstrom, T. 1994. A Comparison of the Toxicity of 50 Reference Chemicals to Freshly Isolated Rainbow Trout Hepatocytes and Daphnia magna. Aquat. Toxicol.30:47-60.

Kagan, J., and E.D. Kagan. 1986. The toxicity of benzo(a)pyrene and pyrene in the mosquito Aedes aegypti, in the dark and in the presence of ultraviolet light. Chemosphere 15:243–251 (as cited in CCME, 1999h).

Kagan, J., Kagan, E.D., Kagan, I.A., Kagan, P.A., Quigley, S. 1985. The phototoxicity of non-carcinogenic polycyclic aromatic hydrocarbons in aquatic organisms. Chemosphere 14:1829–1834 (as cited in CCME, 1999h).

Kennedy, C.J. 1990. Toxicokinetic Studies of Chlorinated Phenols and Polycyclic Aromatic Hydrocarbons in Rainbow Trout (Oncorhynchus mykiss) Ph.D. Thesis, Simon Fraser University, Canada:188p; Abstr. Int. B. Sci. Eng. 53(1):18 (1992) (as cited in MOE, 2011).

Khangarot, B.S. 1991. Toxicity of metals to a freshwater tubificid worm, *Tubifex tubifex* (Muller). Bull. Environ. Contam. Toxicol. 46:906–912 (as cited in the CCME, 1999f).

Kimball, G. (n.d.). The effects of lesser known metals and one organic to fathead minnows (*Pimephales promelas*) and Daphnia magna. University of Minnesota, Department of Entomology, Fisheries and Wildlife, Minneapolis, MN (as cited in CCME, 1999h).

MADEP (Massachusetts Department of Environmental Protection). 2008. Massachusetts Contingency Plan (MCP) Numerical Standards Development Spreadsheets. Massachusetts Department of Environmental Protection. Brureau of Waste Site Cleanup (as cited in the MOE, 2011).

Mayer,F.L.,Jr., and M.R. Ellersieck. 1986. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. USDI Fish and Wildlife Service, Publication No.160, Washington, DC:505 p.

MOE (Ontario Ministry of the Environment). 1979. Rationale for the Establishment of Ontario's Water Quality Objectives. Ontario Ministry of the Environment, September, 1979.

MOE. 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. Standards Development Branch, Ontario Ministry of the Environment, April 2011, PIBS 7386e01.

MOEE (Ministry of Environment and Energy). 1994. Water Management. Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy. Ministry of Environment and Energy, Queen’s Printer for Ontario, July 1994, Reprinted February 1999, PIBS 3303e.

MOEE. 1996. Scientific Criteria Document for the Development of an Interim Provincial Water Quality Objective for Antimony. Ministry of Environment and Energy, Queen’s Printer for Ontario, January 1996, PIBS 3348E02.

Moles, A. 1981. Reduced growth of coho salmon fry exposed to two petroleum components, toluene and naphthalene in freshwater. Trans. Am. Fish. Soc. 110:430–436 (as cited in the CCME, 1999c).

Nagpal, N.K. 2004. Technical report, water quality guidelines for cobalt, Water Protection Section, Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Victoria, BC, July 2004.

Newcombe, C.P. 1994. Suspended sediment pollution: Dose response characteristics of various fishes. British Columbia Ministry of Environment, Lands and Parks, Habitat Protection Branch, Victoria, BC (as cited in the CCME, 2002).

Newcombe, C.P, Jensen, J.O.T. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries management, 16:693-727 (as cited in CCME, 2002).

Newsted,J.L., Giesy, J.P. 1987. Predictive Models for Photoinduced Acute Toxicity of Polycyclic Aromatic Hydrocarbons to Daphnia magna, Strauss (Cladocera, Crustacea). Environmental Toxicology and Chemistry, 6: 445-461.

Passino, D.R.M., and A.J. Novak. 1984. Toxicity of arsenate and DDT to the cladoceran Bosmina longirostris. Bull. Environ. Contam. Toxicol. 33:325–329 (as cited in CCME, 2001).

Smith, A.D., A. Bharath, C. Mallard, D. Orr, K. Smith, J.A. Sutton, J. Vukmanich, L.S. McCarty, and G.W. Ozburn. 1991. The acute and chronic toxicity of 10 chlorinated organic compounds to the American flagfish *Jordanella floridae* (Goode and Bean). Arch. Environ. Contam. Toxicol. 20:94–102 (as cited in CCME, 1999a).

Snarski, V. M. and G. F. Olson 1982. Chronic toxicity and bioaccumulation of mercuric chloride in the fathead minnow (*Pimephales promelas*). Aquat. Toxicol. 2:143-156 (as cited in CCME, 2003).

Stevens, D.G., and G.A. Chapman. 1984. Toxicity of trivalent chromium to early life stages of steelhead trout. Environ. Toxicol. Chem. 3:125–133 (as cited in the CCME, 1999e).

Suter II, G.W., Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. Risk Assessment Program, Health Sciences Research Division, Oak Ridge, Tennessee, June 1996.

Trucco, R.G., F.R. Engelhardt, and B. Stacey. 1983. Toxicity, accumulation and clearance of aromatic hydrocarbons in *Daphnia pulex*. Environ. Pollut. Ser. A. Ecol. Biol. 31:191–202 (as cited in CCME, 1999h).

U.S. EPA (U.S. Environmental Protection Agency). 1980. Ambient Water Quality Criteria for Nickel. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Criteria and Standards Division, Washington, D.C.

U.S. EPA 1985a. Ambient Water Quality Criteria for Copper- 1984. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Criteria and Standards Division, Washington, D.C., January 1985.

U.S. EPA. 1985b. Ambient Water Quality Criteria for Cyanide - 1984. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Criteria and Standards Division, Washington, D.C., January 1985.

U.S. EPA. 1985c. Ambient Water Quality Criteria for Lead - 1984. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Criteria and Standards Division, Washington, D.C., January 1985.

U.S. EPA. 1986. Quality Criteria for Water -1986. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Washington, D.C., May 1986.

U.S. EPA. 1988. Draft Ambient Aquatic Life Water Quality Criteria for Antimony (III). U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratories, Duluth, Minnesota, and Narragansett, Rhode Island, August 1988.

U.S. EPA. 1996. 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water. United States Environmental Protection Agency, Office of Water, Washington, D.C.

U.S. EPA. 2007. Aquatic Life Ambient Freshwater Quality Criteria - Copper, 2007 Revision. U.S. Environmental Protection Agency, Office of Water, Washington, DC, February 2007.

U.S. EPA. 2016. Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater, 2016. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, D.C., June 2016.

U.S. EPA. 2018a. National Recommended Water Quality Criteria – Aquatic Life Criteria Table. Available: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria- /. Retrieved July 2018.

U.S. EPA. 2018b. ECOTOX User Guide: ECOTOXicology Knowledgebase System. Version 4.0. Available: http:/www.epa.gov/ecotox/. Retrieved July 2018.

Vigano, L. 1993. Reproductive strategy of Daphnia magna and toxicity of organic compounds. Water Res. 27:903–909 (as cited in CCME, 1999b).

Vocke, R.W., K.L. Sears, J.J. O'Toole, and R.B. Wildman. 1980. Growth responses of selected freshwater algae to trace elements and scrubber ash slurry generated by coal-fired power plants. Water Res. 14:141–150 (as cited in the CCME, 2001).

Wernersson, A.-S, Dave, G. 1997. Phototoxicity Identification by Soilid Phase Extraction and Photoinduced Toxicity to Daphnia magna. Archives of Environmental Contamination and Toxicology, 32:268-273.

Appendix A Selected Long-Term and Short-Term Water Quality Guidelines (or Acute Values)

Table A-1: Selected Long-term and Short-term Water Quality Guidelines (or Acute Values)

	Long-term			Short-term		
	Benchmark (µg/L)	Basis	Source	Benchmark (µg/L)	Basis	Source
Total Suspended Solids	5 000	Canadian water quality guidelines for suspended sediments for the protection of aquatic life for exposures lasting between 24-h and 30-days. Based on adult salmonids severity-of-ill-effects (SEV) concentration-duration-response model from Caux et al. (1997), which is based on the SEV concentration-duration response approach from Newcombe (1994) and Newcombe and Jensen, (1996). A TSS concentration above a 5000 µg/L change from background concentrations may cause minor physiological stress, and increased rates of coughing and respiration in fish (CCME, 2002).	CCME, 2002	25 000	Canadian water quality guidelines for suspended sediments for the protection of aquatic life for any short-term exposure (24-h period). 'Based on adult salmonids SEV concentration-duration-response model from Caux et al. (1997). A TSS concentration above a 25 000 µg/L change from background concentrations may cause behavioural and low sublethal effects on fish (CCME, 2002).	CCME, 2002
PHCs						
F1 (C6-C10) - BTEX	167	Surrogate approach from the CCME (2008). The geometric mean of 48-hr LC50 for Daphnia magna and 24-h LC50 for Artemia salina of 3700 µg/L divided by an uncertainty factor of 20 for n-hexane, and 48-h EC50 (immobility) for 601 µg/L Daphnia magna divided by an uncertainty factor of 5 for isopropylbenzene (cumene).	CCME, 2008	1822	a modified surrogate approach from the CCME (2008). The geometric mean of 48-hr LC50 for*Daphnia magna* and 24-h LC50 for *Artemia salin* a of 3700 µg/L for n-hexane, and 48-h EC50 (immobility) of 601 µg/L for *Daphnia magna* for isopropylbenzene (cumene).	CCME, 2008
F2 (C10-C16 Hydrocarbons)	42	Surrogate approach from the CCME (2008). The 48-h NOAEL for *Daphnia magna* of 1300 µg/L divided by an uncertainty factor of 10 for decane, and the geometric mean of rainbow trout hatchability in embryo-stage larvae of 11 µg/L for naphthalene.		53	a modified individual surrogate approach from the CCME (2008) without the inclusion of uncertainty factors. The 48-h NOAEL for *Daphnia magna* of 1300 µg/L for the surrogate parameter decane, and the geometric mean of rainbow trout hatchability in embryo-stage larvae of 11 µg/L for naphthalene.	
VOCs						
1,4-Dichlorobenzene	26	CCME (1999a) Interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the reduction in larval survival after a 10-day exposure of 263 µg/L for the American flagfish (*Jordanella floridae*)(Smith et al., 1991) by a safety factor of 0.1 (CCME, 1999a).	CCME, 1999a	1100	96-h LC50 of 1100 µg/L for Rainbow Trout (*Oncorhynchus mykiss*) (Ahmad et al., 1984). This is the lowest acute value considered by the CCME (1999a) in the derivation of the interim 1,4-dichlorobenzene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999a
Ethylbenzene	90	CCME (1999b) Interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 48-h EC50 (immobilization) of 1800 µg/L for *Daphnia magna* (Vigano, 1993), by a safety factor of 0.05 (CCME, 1999b).	CCME, 1999b	1800	48-h EC50 (immobilization) of 1800 µg/L for *Daphnia magna* (Vigano, 1993). This is the lowest acute value considered by the CCME (1999b) in the derivation of the interim ethylbenzene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999b
Toluene	2	CCME (1999c) Interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 27-day LC50 of 20 µg/L for Rainbow Trout (*Oncorhynchus mykiss*) (Black et al., 1982) by a safety factor of 0.1 (CCME, 1999c).	CCME, 1999c	5460	96-h LC50 of 5460 µg/L for coho salmon (*Oncorhynchus kisutch*) (Moles, 1981). This is the lowest acute value considered by the CCME (1999c) in the derivation of the interim toluene water quality guideline for the protection of freshwater aquatic life.	CCME, 1999c
Trichloroethylene	21	CCME (1999d) Interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the LOEC of 210 µg/L (decreased swim-up survival and 120-day fry weight and growth) for Brook Trout (Salvelinus fontinalis) (ATRG, 1988) by a safety factor of 0.1 (CCME, 1999d).	CCME, 1999d	7760	48-h EC50 of 7760 µg/L for *Daphnia magna* (Abernethy et al., 1986). This is the second lowest acute value considered by the CCME (1999c) in the derivation of the interim trichloroethylene water quality guideline for the protection of freshwater aquatic life. The lowest acute value considered by the CCME (1999d) was 5000 µg/L for the Rainbow Trout (*Oncorhynchus mykiss*). This value was based on the lowest concentration of at which a toxic condition (increased respiration rates) was developed within 24-h after exposure to trichloroethylene to the Rainbow Trout. The endpoint value was not considered appropriate for this assessment.	CCME, 1999d
Xylene Mixture (Total)	2	The interim Ontario Provincial water quality objective for xylene, m-. Although, the basis of the 2 µg/L is not known, the interim PWQO for this parameter is derived based on the lowest effect concentration reported and an uncertainty factor (MOEE, 1994).	MOEE, 1994	3300	96-h LC50 of 3300 µg/L for Rainbow Trout (Mayer and Ellersieck, 1986 from ECOTOX). This value was used by the MOE (2011) in the derivation of their aquatic protection value for the protection of aquatic biota exposed to xylene mixtures from the migration of contaminated groundwater to surface water.	MOE, 2011

Table A-1: Selected Long-term and Short-term Water Quality Guidelines (or Acute Values)

	Long-term			Short-term		
	Benchmark (µg/L)	**Basis**	**Source**	**Benchmark (µg/L)**	**Basis**	**Source**
Metals and other Inorganics						
Antimony (Sb)	20	An interim Ontario Provincial water quality objective derived by multiplying the 7-day LC50 of 300 µg/L for the Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*) (Birge, 1978) by an final uncertainty factor of 14.5 (MOEE, 1996).	MOEE, 1994	175	US EPA (1988) draft final acute value.	US EPA, 1988
Arsenic (As)	5.0	CCME (2001) Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 14-d EC50 of 50 µg/L for the alga (*Scenedesmus obliquus*) (Vocke et al., 1980), by a safety factor of 0.1 (CCME, 2001).	CCME, 2001b	850	96-h EC50 (immobility) for *Bosmina longirostris* (Passino and Novak 1984). This is the lowest acute value considered by the CCME (2001) in the derivation of the arsenic Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 2001b
Barium (Ba)	4	Secondary chronic value from Suter and Tsao (1996). Derived by dividing the lowest LC50 genus mean acute value of 977 µg/L for Potamopyrgus jenkinsi by a final acute value factor of 8.6 and an secondary acute chronic ratio of 28.3 (Suter and Tsao, 1996). Although, MOE (2011) reported an aquatic protection value (APV) of 2300 µg/L based on 91.3-d LOEL (reduced growth) for *Chlorella vulgaris*, this value was higher than the short-term benchmark selected for barium. The selected chronic benchmark should not cause lethal effects.	Suter and Tsao, 1996	71	24-h EC50 (immobility) of 71 µg/L for *Daphnia magna* (Lilius et al., 1994 from ECOTOX).	ECOTOX, 2018b
Beryllium (Be)	5.3	The final chronic criterion from the U.S. EPA (1986) and the lowest chronic value for daphnids (MATC) from Sutur and Tsao (1996). Although there is a PWQO for Beryllium of 1100 µg/L for water hardness greater than 75 mg/L as $CaCO_3$, this value is higher than the short-term benchmark selected for beryllium. The selected chronic benchmark should not cause lethal effects.	MOE, 2011	35	Suter and Tsao (1996) Tier II secondary acute value. Derived by dividing the lowest LC50 genus mean acute value of 140 µg/L for *Caenorhabditis elegans* by a final acute value factor of 4.0.	Suter and Tsao, 1996
Cadmium (Cd)	0.18	CCME (2014) Canadian water quality guideline for the protection of freshwater aquatic life. Derived using the long-term toxicity-hardness relationship (based on the 5th percentile of a species sensitivity distribution (SSD)) from CCME (2014) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. Hardness estimated from the surface water samples used for this assessment.	CCME, 2014	2.4	CCME (2014) Canadian water quality guideline for the protection of freshwater aquatic life. Derived using the short-term toxicity-hardness relationship (based on the 5th percentile of a SSD) from CCME (2014) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. Hardness estimated from the surface water samples used for this assessment.	CCME, 2014
Chromium (Cr (III))	8.9	CCME (1999e) Interim chromium (III) water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 102-d LOEC (mortality) of 89 µg/L for Rainbow Trout (*Oncorhynchus mykiss*) (Stevens and Chapman, 1984) by a safety factor of 0.1 (CCME, 1999e).	CCME, 1999e	1200	64-h EC50 of 1200 µg/L for *Daphnia magna*. This is the lowest acute value considered by the CCME (1999e) in the derivation of the interim chromium (III) water quality guideline for the protection of freshwater aquatic life.	CCME, 1999e
Cobalt (Co)	1.1	Federal Environmental Quality Guideline (EC, 2017) to support federal environmental quality monitoring. Derived using the long-term toxicity-hardness relationship (based on the 5th percentile of SSD) from EC (2017) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. Hardness estimated from the surface water samples used for this assessment.	EC, 2017	61	7-day LC50 of 61 µg/L (water hardwater of 124 mg/L as $CaCO_3$) for *Hyalella azteca* (Borgmann et al., 2005 from ECOTOX).	ECOTOX, 2018b
Copper (Cu)	2.6	CCREM (1987) Canadian water quality guideline. Derived using toxicity-hardness equation from U.S. EPA (1985a) multiplied by an application factor of 0.2. A geometric mean water hardness of 113 mg/L as CaCO3 was used in the toxicity-hardness equation. Water hardness was estimated from the surface water samples used for this assessment.	CCREM, 1987	16	Calculated using the updated toxicity- hardness equation from the U.S. EPA (1996) and a geometric mean water hardness of 113 mg/L as CaCO3 estimated from the surface water samples used for this assessment. Currently the U.S. EPA (2007) has adopted a biotic ligand model approach for derivation of their freshwater criteria. The biotic model approach could not be applied for this assessment because the measurement of surface water major ions required to run the biotic ligand model were not a measured in surface water.	U.S. EPA, 1996
Cyanide (free)	5	CCREM (1987) Canadian water quality guideline protective of freshwater aquatic life. Based on chronic effects on fish growth and reproduction (MOEE, 1994).	CCREM, 1987	22	The U.S. EPA (1985b) Criterion Maximum Concentration. Derived by dividing the final acute value of 44.73 µg/L for Rainbow Trout by 2.	U.S. EPA, 1985b
Lead (Pb)	3.7	CCREM (1987) Canadian water quality guideline. Calculated using toxicity-hardness equation from the U.S. EPA (1985b) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. The water hardness was estimated from the surface water samples used for this assessment.	CCREM, 1987	95	Calculated using the U.S. EPA (1985b) toxicity-hardness equation and a geometric mean water hardness of 113 mg/L as $CaCO_3$. The water hardness was estimated from the surface water samples used for this assessment.	US EPA, 1985c

Table A-1: Selected Long-term and Short-term Water Quality Guidelines (or Acute Values)

	Long-term			Short-term		
	Benchmark (µg/L)	Basis	Source	Benchmark (µg/L)	Basis	Source
Mercury (Hg)	0.026	CCME (2003) Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 60-day LOAEL (growth and weight loss) of 0.26 µg/L as mercuric chloride ($HgCl_2$) for Fathead Minnow (*Pimephales promelas*) (Snarski and Olson, 1982) by a safety factor of 0.1 (CCME, 2003; EC, 2003).	CCME, 2003; EC, 2003	20	96-h LC50 of 20 µg/L (as $HgCl_2$) for crayfish (*Faxonella clypeata*) (Heit and Fingerman, 1977; EC, 2003). This was the lowest acute value considered by the CCME (2003) in the derivation of the inorganic mercury Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 2003
Molybdenum (Mo)	73	CCME (1999f) interim molybdenum Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 28-day LC50 of 730 µg/ L for Rainbow Trout (*Oncorhynchus mykiss*) (Fletcher et al. 1997), by a safety factor of 0.1 (CCME, 1999f).	CCME, 1999f	29000	96-h EC50 of 29 000 µg/L for *Tubifex tubifex* (Khangarot 1991). This is the lowest acute value considered by the CCME (1999f) in the derivation of the interim molybdenum Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999f
Nickel (Ni)	105	CCREM (1987) Canadian water quality guideline. Derived using the toxicity-hardness equation from U.S. EPA (1980) and a geometric mean water hardness of 113 mg/L. Water hardness estimated from the surface water samples used for this assessment.	CCREM, 1987	520	Calculated using the updated toxicity- hardness equation from the U.S. EPA (1996) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. Water hardness estimated from the surface water samples used for this assessment.	U.S. EPA, 1996
Selenium (Se)	1.5	U.S. EPA (2016) final criterion (element) for lentic waters (e.g. lakes). Derived by translating the U.S. EPA (2016) egg-ovary criterion element to a distribution of water concentrations using enrichment factors (that represent the partitioning of selenium between the dissolve and particulate state), and selecting the 20th percentile of the distribution as the criterion.	U.S. EPA, 2016	45	U.S. EPA (2016) intermittent exposure calculated using the final criterion (element) of 1.5 µg/L for selenium for lentic waters divided by a 1 day fraction of any 30-day period (i.e. 0.033) during which elevated selenium concentrations occur.	U.S. EPA, 2016
Silver (Ag)	0.25	CCME (2015) Canadian water quality guideline for the protection of freshwater aquatic life. Derived using the a species sensitivity distribution (SSD) with the 5th percentile calculated from the SSD set as the long-term Canadian water quality guideline for silver protective of aquatic life (CCME, 2015).	CCME, 2015	0.25	CCME (2015) did not recommend a short-term water quality for silver because the long-term SSD 5th percentile and short-term SSD 5th percentile (0.22 µg/L) are essential equal. For the purpose of this assessment the long-term SSD 5th percentile was set as the acute value for this assessment.	CCME, 2015
Thallium (Tl)	0.80	CCME (1999g) Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 14-day EC50 of 8 µg/L for duckweed (*Lemna minor*) (Brown and Rattigan, 1979), by a safety factor of 0.1.	CCME, 1999g	680	96-h EC50 of 680 µg/L for *Daphnia magna* (Kimball n.d.). This is the lowest acute value considered by the CCME (1999g) in the derivation of the thallium Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999g
Tin (Sn)	73	Tier II secondary chronic value from Suter and Tsao (1996). Derived by dividing the secondary acute value of 2700 µg/L (rounded) by the secondary acute chronic ratio of 37 µg/L (rounded).	Suter and Tsao, 1996	2700	Suter and Tsao (1996) Tier II secondary acute value. Derived by diving the LC50 genus mean acute value of 55000 µg/L for *Daphnia magna* by a final acute value factor of 20.5.	Suter and Tsao, 1996
Uranium (U)	15	CCME (2011) Canadian water quality guideline for the protection of freshwater aquatic life. long-term SSD 5th percentile.	CCME, 2011	33	CCME (2011) Canadian water quality guideline for the protection of freshwater aquatic life. short-term SSD 5th percentile.	CCME, 2011
Vanadium (V)	120	Federal Environmental Quality Guideline (ECCC, 2016) to support federal environmental quality monitoring. Long-term 5th percentile for a SSD.	ECCC, 2016	280	Suter and Tsao (1996) Tier II secondary acute value. Derived by dividing the lowest LC50 genus mean acute value of 1850 µg/L for Fathead Minnow (*Pimephales promelas*) by a final acute value factor of 6.5.	Suter and Tsao, 1996
Zinc (Zn)	30	CCREM (1987) Canadian water quality guideline. Guideline tentatively recommended because it coincides with the measured "no effect" concentration for Rainbow Trout (36 µg/L) and Fathead Minnows (30 µg/L), and the beginning of growth inhibition in algae (CCREM, 1987).	CCREM, 1987	133	Calculated using the updated toxicity- hardness equation from the U.S. EPA (1996) and a geometric mean water hardness of 113 mg/L as $CaCO_3$. Water hardness estimated from the surface water samples used for this assessment.	U.S. EPA, 1996

Table A-1: Selected Long-term and Short-term Water Quality Guidelines (or Acute Values)

	Long-term			Short-term		
	Benchmark (µg/L)	**Basis**	**Source**	**Benchmark (µg/L)**	**Basis**	**Source**
PAHs						
Acenaphthene	5.8	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 96-h LC50 of 580 µg/L for Brown Trout (*Salmo trutta*) (Holcombe et al. 1983) by a safety factor of 0.01 (CCME, 1999h).	CCME, 1999h	580	96-h LC50 of 580 µg/L for Brown Trout (*Salmo trutta*) (Holcombe et al. 1983). This is the lowest acute value considered by the CCME (1999h) in the derivation of the interim acenaphthene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Acenaphthylene	0.14	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. The APV value is a median PAH phototoxicity from Massachusetts Department of Environmental Protection (MADEP, 2008)	MOE, 2011	605	Derived using the LC50 and Kow relationship for fish presented in DiToro et al. 2000 (e.g. equation 1). This relationship assumes that the most of the toxicity is associated with a narcosis/baseline-type endpoint.	Di Toro et al. 2000
Anthracene	0.012	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying a 0.25-h LT50 (phototoxicity) of 1.2 µg/L for *Daphnia pulex* (Allred and Giesy 1985) by a safety factor of 0.01 (CCME, 1999h).	CCME, 1999h	1.2	0.25-h LT50 (phototoxicity) of 1.2 µg/L for *Daphnia pulex* (Allred and Giesy 1985). This is the lowest acute value considered by the CCME (1999h) in the derivation of the interim anthracene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Benzo(a)anthracene	0.018	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 12.5-h LT50 (phototoxicity) of 1.8 µg/L for *Daphnia magna* (Newsted and Giesy, 1987) by a safety factor of 0.01 (CCME, 1999h).	CCME, 1999h	1.8	12.5-h LT50 (phototoxicity) of 1.8 µg/L for *Daphnia magna* (Newsted and Giesy, 1987). This is the lowest acute value considered by the CCME (1999h) in the derivation of the interim Benzo(a)anthracene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Benzo(a)pyrene	0.015	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 4.4-h LT50 (phototoxicity) of 1.5 µg/L for *Daphnia magna* (Newsted and Giesy, 1987) by a safety factor of 0.01 (CCME, 1999h).	CCME, 1999h	1.5	4.4-h LT50 (phototoxicity) of 1.5 µg/L for *Daphnia magna* (Newsted and Giesy, 1987). This is the lowest acute value considered by the CCME (1999h) in the derivation of the interim benzo(a)pyrene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Benzo(b/j)fluoranthene	0.42	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by dividing the a UV-24h- EC50 (following 2-h of UV irradiation) of 4.2µg/L for the *Daphnia magna* (Wernersson and Dave, 1997) by 10.	MOE, 2011	4.2	UV-EC50 (24-h EC50 values following 2-h of UV irradiation) of 4.2µg/L for the *Daphnia magna* (Wernersson and Dave, 1997).	MOE, 2011
Benzo(g,h,i)perylene	0.02	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by dividing the 13.8h-LT50 (UV induced) of 0.2 µg/L for *Daphnia magna* (Newsted and Giesy, 1987) by 10.	MOE, 2011	0.13	48-hr EC50 (visible plus simulated solar radiation: UVA and UVB) of 0.13 µg/L (0.48 nm) for *Daphnia magna* (Lampi et al. 2005 from ECOTOX)	ECOTOX,2018b
Benzo(k)fluoranthene	0.14	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by dividing the 13h-LT50 (UV induced) of 1.4 µg/L for *Daphnia magna* (Newsted and Giesy, 1987) by 10.	MOE, 2011	1.4	13 h-LT50 (Photoinduced) of 1.4 µg/L for *Daphnia magna* (Newsted and Giesy, 1987 from ECOTOX)	MOE, 2011
Chrysene	0.07	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by dividing the 24-h LT50 (UV induced) of 0.7 µg/L for *Daphnia magna* (Newsted and Giesy, 1987) by 10.	MOE, 2011	0.7	~24-h LT50 (UV induced) of 0.7 µg/L for *Daphnia magna* (Newsted and Giesy, 1987 from CCME, 1999h)	CCME, 1999h
Dibenz(a,h)anthracene	0.04	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by dividing 3h-LT50 (UV induced) of 0.4 µg/L for *Daphnia magna* (Newsted and Giesy 1987) by 10.	MOE, 2011	0.4	3h-LT50 (Photoinduced) of 0.4 µg/L in *Daphnia magna* (Newstead and Giesy, 1987 from ECOTOX).	MOE, 2011
Fluoranthene	0.04	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying a 1-h LC_{50} of 4 µg/L for *Daphnia magna* exposed to UV light (Kagan et al. 1985) by a safety factor of 0.01 (CCME,1999h).	CCME, 1999h	4	1-h LC50 of 4 µg/L for *Daphnia magna* after 1 h irradiation with UV light (Kagan et al., 1985) This is the lowest acute value reviewed by CCME (1999h).	CCME, 1999h

Table A-1: Selected Long-term and Short-term Water Quality Guidelines (or Acute Values)

	Long-term			Short-term		
	Benchmark (µg/L)	**Basis**	**Source**	**Benchmark (µg/L)**	**Basis**	**Source**
Fluorene	3.0	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the 14-day LOEC of 125 µg/L for *Daphnia magna* (Finger et al. 1985) by a safety factor of 0.1 and a correction factor of 0.24 because the actual (or measured) fluorene concentration during chronic tests was on average of 24% of the nominal LOEC of 125 µg/L (CCME, 1999h).	CCME, 1999h	820	96-h LC50 of 820 µg/L for Rainbow Trout (*Oncorhynchus mykiss)* (Finger et al. 1985). This is one of the lowest acute value considered by the CCME (1999h) in the derivation of the interim fluorene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Indeno(1,2,3-cd)pyrene	0.14	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. The APV value is a median PAH phototoxicity from Massachusetts Department of Environmental Protection (MADEP, 2008).	MOE, 2011	NV	No value identified	NA
1-Methylnaphthalene	2	The interim Ontario Provincial water quality objective. Although the basis of the water quality objective is no known it is derived based on the lowest effect concentration reported and an uncertainty factor (MOEE, 1994).	MOEE, 1994	37	Suter and Tsao (1996) Tier II secondary acute value. Derived by dividing the 24 to 96h-LC50 of 9000 µg/L for Fathead Minnow (*Pimephales promelas)* by a final acute factor of 242.	Suter and Tsao, 1996
2-Methylnaphthalene	146	The MOE (2011) APV to protect aquatic biota exposed to contaminants from the migration of contaminated groundwater to surface water. Derived by diving the 96-h LC50 of 1456 µg/L for Rainbow Trout (Kennedy, 1990) by 10.	MOE, 2011	982	Derived using the LC50 and Kow relationship for fish presented in Di Toro et al. (2000; e.g. equation 1). This relationship assumes that the most of the toxicity is associated with a narcosis/baseline-type endpoint	Di Toro et al.,2000
Naphthalene	1.1	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the chronic LOEL of 11 µg/L (geometric mean of the lowest two chronic values corresponding to the 97 (8 µg/L) and 91 (15 µg/L) survival success for Rainbow Trout embryo–larval stages (Black et al. 1983), by a safety factor of 0.1 (CCME, 1999h).	CCME, 1999h	1000	96-h LC50 of 1000 µg/L for *Daphnia pulex* (Trucco et al., 1983). This is one of the lowest acute value considered by the CCME (1999h) in the derivation of the interim naphthalene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Phenanthrene	0.4	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the chronic LOEL of 4 µg/L for Rainbow Trout (corresponding to the control-adjusted 93% survival of the trout) (Black et al. 1983) by a safety factor of 0.1 (CCME, 1999h).	CCME, 1999h	49	96-h EC50 (loss of equilibrium) of 49 µg/L for Bluegill Sunfish (*Lepomis macrochirus)* and 50 µg/L for the Rainbow Trout (*Oncorhynchus mykiss*) (Call et al., 1986). These values were two of the lowest acute value considered by the CCME (1999h) in the derivation of the interim naphthalene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h
Pyrene	0.025	CCME (1999h) interim Canadian water quality guideline for the protection of freshwater aquatic life. Derived by multiplying the LC50 of 2.5 µg/L for mosquito larvae (*Aedes aegypti*) (Kagan and Kagan 1986) by a safety factor of 0.01 (CCME, 1999h).	CCME, 1999h	2.5	LC50 of 2.5 µg/L for mosquito larvae (*Aedes aegypti*) (Kagan and Kagan 1986). This is one of the lowest acute value considered by the CCME (1999h) in the derivation of the interim Pyrene Canadian water quality guideline for the protection of freshwater aquatic life.	CCME, 1999h

Appendix B Summary of Chemistry Data

Table B-1: Summary Statistics for Sediment and Soil Samples Used in the Assessment

Location		SED3	SED5	MW7/17	MW10	BH11/17	BH12/17	BH13/17	Minimum	Mean	Standard Deviation	Median	75th percentile	95th percentile	Maximum
Sample ID		A0206	A0204	A0215 A0216 A0217	A219 A0221	A0228 A0229	A0223 A0224	A0230 A0232							
Sample Date		2017-08-29	2017-08-29	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30							
Depth (m)	From	0	0	0.76	0.76	1.52	0.76	0							
	To	0.1	0.1	3.81	3.81	4.57	3.05	4.51							
Contaminants	Units	Results	Results	Results	Results	Results	Results	Results							
PHCs															
F1 (C6-C10) - BTEX	µg/g	<10	<10	<10	1.50E+01	<10	<10	<10	1.00E+01	1.07E+01	1.89E+00	1.00E+01	1.00E+01	1.35E+01	1.50E+01
F2 (C10-C16 Hydrocarbons)	µg/g	<10	<10	<10	1.30E+02	3.20E+01	<10	1.10E+01	1.00E+01	3.04E+01	4.47E+01	1.00E+01	2.15E+01	1.01E+02	1.30E+02
VOCs															
1,4-Dichlorobenzene	µg/g	<0.05	<0.05	<0.05	<0.05	6.00E-02	<0.05	<0.05	5.00E-02	5.14E-02	3.78E-03	5.00E-02	5.00E-02	5.70E-02	6.00E-02
Ethylbenzene	µg/g	<0.02	<0.02	<0.01	4.40E-01	1.10E-02	<0.01	1.50E-02	1.00E-02	7.51E-02	1.61E-01	1.50E-02	2.00E-02	3.14E-01	4.40E-01
Toluene	µg/g	<0.02	<0.02	<0.02	2.40E-02	3.00E-02	<0.02	2.00E-02	2.00E-02	2.20E-02	3.83E-03	2.00E-02	2.20E-02	2.82E-02	3.00E-02
Trichloroethylene	µg/g	<0.05	<0.05	<0.01	<0.01	4.80E-01	<0.01	<0.01	1.00E-02	8.86E-02	1.74E-01	1.00E-02	5.00E-02	3.51E-01	4.80E-01
Xylene (Total)	µg/g	<0.02	<0.02	<0.02	5.00E+00	8.00E-02	1.10E-01	4.80E-02	2.00E-02	7.57E-01	1.87E+00	4.80E-02	9.50E-02	3.53E+00	5.00E+00
Metals and Inorganics															
Antimony (Sb)	µg/g	4.70E-01	7.70E-01	5.90E+00	9.80E+00	4.70E+00	1.40E+00	3.50E+00	4.70E-01	3.79E+00	3.35E+00	3.50E+00	5.30E+00	8.63E+00	9.80E+00
Arsenic (As)	µg/g	1.30E+00	2.50E+00	1.70E+01	1.20E+01	7.60E+00	4.00E+00	4.40E+00	1.30E+00	6.97E+00	5.68E+00	4.40E+00	9.80E+00	1.55E+01	1.70E+01
Barium (Ba)	µg/g	2.80E+01	7.90E+01	1.30E+02	2.80E+02	1.60E+02	1.40E+02	1.20E+02	2.80E+01	1.34E+02	7.80E+01	1.30E+02	1.50E+02	2.44E+02	2.80E+02
Beryllium (Be)	µg/g	<0.20	<0.20	5.30E-01	3.90E-01	4.70E-01	2.10E-01	3.90E-01	2.00E-01	3.41E-01	1.38E-01	3.90E-01	4.30E-01	5.12E-01	5.30E-01
Cadmium (Cd)	µg/g	<0.10	<0.10	3.40E+00	1.70E+00	1.30E+01	4.30E+00	8.60E-01	1.00E-01	3.35E+00	4.55E+00	1.70E+00	3.85E+00	1.04E+01	1.30E+01
Chromium (Cr)	µg/g	1.00E+01	5.80E+00	4.20E+01	5.10E+01	3.90E+01	2.00E+01	2.50E+01	5.80E+00	2.75E+01	1.70E+01	2.50E+01	4.05E+01	4.83E+01	5.10E+01
Cobalt (Co)	µg/g	2.60E+00	2.20E+00	8.60E+00	9.50E+00	7.00E+00	4.10E+00	5.80E+00	2.20E+00	5.69E+00	2.86E+00	5.80E+00	7.80E+00	9.23E+00	9.50E+00
Copper (Cu)	µg/g	1.40E+01	6.10E+00	3.20E+02	2.10E+02	6.20E+01	5.10E+01	7.10E+02	6.10E+00	1.96E+02	2.54E+02	6.20E+01	2.65E+02	5.93E+02	7.10E+02
Cyanide (Free)	µg/g	1.00E-02	2.00E-02	2.60E-01	2.00E-01	3.00E-02	1.00E-01	1.30E-01	1.00E-02	1.07E-01	9.62E-02	1.00E-01	1.65E-01	2.42E-01	2.60E-01
Lead (Pb)	µg/g	5.00E+01	1.10E+02	3.50E+02	5.30E+02	2.00E+02	3.30E+02	1.10E+02	5.00E+01	2.40E+02	1.71E+02	2.00E+02	3.40E+02	4.76E+02	5.30E+02
Mercury (Hg)	µg/g	<0.05	1.30E-01	6.40E-01	2.70E-01	2.10E-01	1.60E-01	1.50E-01	5.00E-02	2.30E-01	1.93E-01	1.60E-01	2.40E-01	5.29E-01	6.40E-01
Molybdenum (Mo)	µg/g	<0.50	6.10E-01	4.10E+00	6.70E+00	2.30E+00	3.20E+00	3.10E+00	5.00E-01	2.93E+00	2.14E+00	3.10E+00	3.65E+00	5.92E+00	6.70E+00
Nickel (Ni)	µg/g	5.20E+00	3.70E+00	5.50E+02	4.30E+01	2.00E+01	1.80E+01	1.40E+01	3.70E+00	9.34E+01	2.02E+02	1.80E+01	3.15E+01	3.98E+02	5.50E+02
Selenium (Se)	µg/g	<0.50	<0.50	<0.50	9.10E-01	<0.50	<0.50	<0.50	5.00E-01	5.59E-01	1.55E-01	5.00E-01	5.00E-01	7.87E-01	9.10E-01
Silver (Ag)	µg/g	<0.20	<0.20	3.60E-01	9.90E-01	3.00E-01	<0.20	8.40E-01	2.00E-01	4.41E-01	3.32E-01	3.00E-01	6.00E-01	9.45E-01	9.90E-01
Thallium (Tl)	µg/g	<0.05	8.60E-02	1.90E-01	2.10E-01	2.40E-01	1.60E-01	1.90E-01	5.00E-02	1.61E-01	6.86E-02	1.90E-01	2.00E-01	2.31E-01	2.40E-01
Tin (Sn)		-	-	2.30E+02	2.10E+02	1.30E+02	1.50E+02	5.70E+01	5.70E+01	1.55E+02	6.87E+01	1.50E+02	2.10E+02	2.26E+02	2.30E+02
Uranium (U)	µg/g	4.20E-01	1.70E-01	6.60E-01	6.60E-01	6.30E-01	6.40E-01	7.10E-01	1.70E-01	5.56E-01	1.94E-01	6.40E-01	6.60E-01	6.95E-01	7.10E-01
Vanadium (V)	µg/g	3.20E+01	5.50E+00	3.50E+01	2.90E+01	3.10E+01	1.90E+01	3.20E+01	5.50E+00	2.62E+01	1.05E+01	3.10E+01	3.20E+01	3.41E+01	3.50E+01
Zinc (Zn)	µg/g	2.70E+01	3.50E+01	5.90E+02	8.80E+02	1.50E+02	4.50E+03	3.40E+02	2.70E+01	9.32E+02	1.60E+03	3.40E+02	7.35E+02	3.41E+03	4.50E+03
PAHs															
Acenaphthene	µg/g	<0.005	9.80E-03	<0.005	9.90E-02	<0.005	<0.05	<0.005	5.00E-03	2.55E-02	3.64E-02	5.00E-03	2.99E-02	8.43E-02	9.90E-02
Acenaphthylene	µg/g	<0.005	8.60E-03	<0.005	1.80E-02	<0.005	<0.05	<0.005	5.00E-03	1.38E-02	1.67E-02	5.00E-03	1.33E-02	4.04E-02	5.00E-02
Anthracene	µg/g	<0.005	2.10E-02	<0.01	1.50E-02	1.10E-02	<0.05	1.00E-02	5.00E-03	1.74E-02	1.52E-02	1.10E-02	1.80E-02	4.13E-02	5.00E-02
Benzo(a)anthracene	µg/g	1.50E-02	7.30E-02	<0.005	3.20E-02	4.30E-02	<0.05	3.90E-02	5.00E-03	3.67E-02	2.25E-02	3.90E-02	4.65E-02	6.61E-02	7.30E-02
Benzo(a)pyrene	µg/g	1.20E-02	6.30E-02	2.90E-02	2.90E-02	4.30E-02	<0.05	3.90E-02	1.20E-02	3.79E-02	1.65E-02	3.90E-02	4.65E-02	5.91E-02	6.30E-02
Benzo(b/j)fluoranthene	µg/g	3.20E-02	9.70E-02	1.70E-02	4.40E-02	6.10E-02	<0.05	5.30E-02	1.70E-02	5.06E-02	2.51E-02	5.00E-02	5.70E-02	8.62E-02	9.70E-02
Benzo(g,h,i)perylene	µg/g	9.50E-03	4.20E-02	4.30E-02	2.00E-02	2.40E-02	<0.05	2.10E-02	9.50E-03	2.99E-02	1.50E-02	2.40E-02	4.25E-02	4.79E-02	5.00E-02
Benzo(k)fluoranthene	µg/g	7.80E-03	3.50E-02	<0.005	1.60E-02	1.90E-02	<0.05	1.70E-02	5.00E-03	2.14E-02	1.59E-02	1.70E-02	2.70E-02	4.55E-02	5.00E-02
Chrysene	µg/g	2.60E-02	7.00E-02	<0.01	3.60E-02	4.40E-02	<0.05	3.50E-02	1.00E-02	3.87E-02	1.89E-02	3.60E-02	4.70E-02	6.40E-02	7.00E-02
Dibenz(a,h)anthracene	µg/g	<0.005	1.10E-02	<0.005	<0.005	6.20E-03	<0.05	6.20E-03	5.00E-03	1.26E-02	1.66E-02	6.20E-03	8.60E-03	3.83E-02	5.00E-02
Fluoranthene	µg/g	5.60E-02	1.40E-01	5.40E-03	7.30E-02	7.60E-02	1.00E-01	6.90E-02	5.40E-03	7.42E-02	4.10E-02	7.30E-02	8.80E-02	1.28E-01	1.40E-01
Fluorene	µg/g	<0.005	9.40E-03	<0.005	2.10E-01	<0.005	<0.05	<0.005	5.00E-03	4.13E-02	7.62E-02	5.00E-03	2.97E-02	1.62E-01	2.10E-01
Indeno(1,2,3-cd)pyrene	µg/g	9.30E-03	4.60E-02	1.40E-02	2.00E-02	2.80E-02	<0.05	2.30E-02	9.30E-03	2.72E-02	1.55E-02	2.30E-02	3.70E-02	4.88E-02	5.00E-02
1-Methylnaphthalene	µg/g	<0.005	<0.005	<0.005	2.30E+00	<0.005	<0.05	5.10E-03	5.00E-03	3.39E-01	8.65E-01	5.00E-03	2.76E-02	1.63E+00	2.30E+00
2-Methylnaphthalene	µg/g	5.20E-03	<0.005	<0.005	2.90E+00	<0.005	<0.2	8.10E-03	5.00E-03	4.47E-01	1.08E+00	5.20E-03	1.04E-01	2.09E+00	2.90E+00
Naphthalene	µg/g	<0.005	<0.005	<0.005	3.70E+00	<0.005	<0.05	<0.005	5.00E-03	5.39E-01	1.39E+00	5.00E-03	2.75E-02	2.61E+00	3.70E+00
Phenanthrene	µg/g	1.90E-02	8.30E-02	8.50E-03	5.50E-02	4.20E-02	7.30E-02	4.10E-02	8.50E-03	4.59E-02	2.69E-02	4.20E-02	6.40E-02	8.00E-02	8.30E-02
Pyrene	µg/g	4.20E-02	1.10E-01	2.10E-02	7.60E-02	6.50E-02	1.00E-01	5.80E-02	2.10E-02	6.74E-02	3.12E-02	6.50E-02	8.80E-02	1.07E-01	1.10E-01

Note:

1. Data source: AEL (2018)
2. Non-detected values were set to the detection limit

Table B-2: Summary Statistics for Surface Water and Seepage Samples Used in the Assessment

Location			SW1	RR3	SW7	SW3	LOCK1	Minimum	Mean	Standard Deviation	Median	75^{th} percentile	95^{th} percentile	Maximum
Sample ID			A0211	A0207	A0205	A0237	A0239							
Sample Date			2017-08-29	2017-08-29	2017-08-29	2017-08-31	2017-08-31							
Chemicals	Units	RDL	Results	Results	Results	Results	Results							
PHCs														
F1 (C6-C10) - BTEX	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
F2 (C10-C16 Hydrocarbons)	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
VOCs														
1,4-Dichlorobenzene	µg/L	2.00E-01	<0.20	<0.20	<0.20	<0.20	<0.20	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	1.00E-01	<0.10	<0.10	<0.10	<0.10	<0.10	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	2.00E-01	<0.20	<0.20	<0.20	3.00E-01	<0.20	2.00E-01	2.20E-01	4.47E-02	2.00E-01	2.00E-01	2.80E-01	3.00E-01
Trichloroethylene	µg/L	1.00E-01	<0.10	<0.10	<0.10	<0.10	<0.10	ND	ND	ND	ND	ND	ND	ND
Xylene (Total)	µg/L	1.00E-01	<0.10	<0.10	<0.10	<0.10	<0.10	ND	ND	ND	ND	ND	ND	ND
Metals and Inorganics														
Antimony (Sb)	µg/L	5.00E-01	<0.50	<0.50	<0.50	<0.50	<0.50	ND	ND	ND	ND	ND	ND	ND
Arsenic (As)	µg/L	1.00E+00	<1.0	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	ND
Barium (Ba)	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Beryllium (Be)	µg/L	5.00E-01	<0.50	<0.50	<0.50	<0.50	<0.50	ND	ND	ND	ND	ND	ND	ND
Cadmium (Cd)	µg/L	1.00E-01	<0.10	<0.10	<0.10	<0.10	<0.10	ND	ND	ND	ND	ND	ND	ND
Chromium (Cr)	µg/L	5.00E+00	<5.0	<5.0	<5.0	<5.0	<5.0	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	µg/L	5.00E-01	<0.50	<0.50	<0.50	5.10E-01	<0.50	5.00E-01	5.02E-01	4.47E-03	5.00E-01	5.00E-01	5.08E-01	5.10E-01
Copper (Cu)	µg/L	1.00E+00	1.40E+00	<1.0	<1.0	<1.0	<1.0	1.00E+00	1.08E+00	1.79E-01	1.00E+00	1.00E+00	1.32E+00	1.40E+00
Cyanide (Free)	µg/L	1.00E+00	6.00E+00	<1	<1	<1	<1	1.00E+00	2.00E+00	2.24E+00	1.00E+00	1.00E+00	5.00E+00	6.00E+00
Lead (Pb)	µg/L	5.00E-01	<0.50	<0.50	1.50E+00	<0.50	<0.50	5.00E-01	7.00E-01	4.47E-01	5.00E-01	5.00E-01	1.30E+00	1.50E+00
Mercury (Hg)	µg/L	1.00E-01	<0.1	<0.1	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND	ND
Molybdenum (Mo)	µg/L	5.00E-01	<0.50	<0.50	<0.50	<0.50	<0.50	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	µg/L	1.00E+00	<1.0	<1.0	<1.0	1.60E+00	<1.0	1.00E+00	1.12E+00	2.68E-01	1.00E+00	1.00E+00	1.48E+00	1.60E+00
Selenium (Se)	µg/L	2.00E+00	<2.0	<2.0	<2.0	<2.0	<2.0	ND	ND	ND	ND	ND	ND	ND
Silver (Ag)	µg/L	1.00E-01	<0.10	<0.10	<0.10	<0.10	<0.10	ND	ND	ND	ND	ND	ND	ND
Thallium (Tl)	µg/L	5.00E-02	<0.05	<0.05	<0.05	<0.05	<0.05	ND	ND	ND	ND	ND	ND	ND
Tin (Sn)	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Uranium (U)	µg/L	1.00E-01	1.00E-01	1.10E-01	1.30E-01	<0.10	1.10E-01	1.00E-01	1.10E-01	1.22E-02	1.10E-01	1.10E-01	1.26E-01	1.30E-01
Vanadium (V)	µg/L	5.00E-01	<0.50	<0.50	<0.50	6.40E-01	8.80E-01	5.00E-01	6.04E-01	1.66E-01	5.00E-01	6.40E-01	8.32E-01	8.80E-01
Zinc (Zn)	µg/L	5.00E+00	<5.0	<5.0	<5.0	5.50E+00	<5.0	5.00E+00	5.10E+00	2.24E-01	5.00E+00	5.00E+00	5.40E+00	5.50E+00
PAHs														
Acenaphthene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Acenaphthylene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Anthracene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Benzo(a)anthracene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Benzo(a)pyrene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Benzo(b/j)fluoranthene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Benzo(k)fluoranthene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Chrysene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Fluoranthene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Fluorene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
1-Methylnaphthalene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
2-Methylnaphthalene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Naphthalene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Phenanthrene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-
Pyrene	µg/L	-	NA	NA	NA	NA	NA	-	-	-	-	-	-	-

Note:

1. Data source: AEL (2018)

RDL: Reportable Detection Limit

NA: Not Analyzed

ND: Non-detected

Appendix C Water Quality Predictions

Table C-1: Predicted Surface Water Quality for a Series of TSS concentrations

Chemicals	75th Percentile Sediment and Soil (µg/g)	75th Percentile Surface Water (µg/L)	Predicted Concentrations in Surface Water (µg/L)						Long-term Water Quality Guideline (µg/L)	Reference
TSS (mg/L)			**5**	**10**	**25**	**50**	**75**	**100**	**25**	CCME, 2002
PHCs										
F1 (C6-C10) - BTEX	1.00E+01	-	5.00E-02	1.00E-01	2.50E-01	5.00E-01	7.50E-01	1.00E+00	167	CCME, 2008
F2 (C10-C16 Hydrocarbons)	2.15E+01	-	1.08E-01	2.15E-01	5.38E-01	1.08E+00	1.61E+00	2.15E+00	42	
VOCs										
1,4-Dichlorobenzene	5.00E-02	ND	2.50E-04	5.00E-04	1.25E-03	2.50E-03	3.75E-03	5.00E-03	26	CCME, 1999a
Ethylbenzene	2.00E-02	ND	1.00E-04	2.00E-04	5.00E-04	1.00E-03	1.50E-03	2.00E-03	90	CCME, 1999b
Toluene	2.20E-02	2.00E-01	2.00E-01	2.00E-01	2.01E-01	2.01E-01	2.02E-01	2.02E-01	2	CCME, 1999c
Trichloroethylene	5.00E-02	ND	2.50E-04	5.00E-04	1.25E-03	2.50E-03	3.75E-03	5.00E-03	21	CCME, 1999d
Xylene (Total)	9.50E-02	ND	4.75E-04	9.50E-04	2.38E-03	4.75E-03	7.13E-03	9.50E-03	2	MOEE, 1994
Metals and Inorganics										
Antimony (Sb)	5.30E+00	ND	2.65E-02	5.30E-02	1.33E-01	2.65E-01	3.98E-01	5.30E-01	20	MOEE, 1994
Arsenic (As)	9.80E+00	ND	4.90E-02	9.80E-02	2.45E-01	4.90E-01	7.35E-01	9.80E-01	5.0	CCME, 2001
Barium (Ba)	1.50E+02	-	7.50E-01	1.50E+00	3.75E+00	**7.50E+00**	**1.13E+01**	**1.50E+01**	4	Suter and Tsao, 1996
Beryllium (Be)	4.30E-01	ND	2.15E-03	4.30E-03	1.08E-02	2.15E-02	3.23E-02	4.30E-02	5.3	MOE, 2011
Cadmium (Cd)	3.85E+00	ND	1.93E-02	3.85E-02	9.63E-02	**1.93E-01**	**2.89E-01**	**3.85E-01**	0.18	CCME, 2014
Chromium (Cr)	4.05E+01	ND	2.03E-01	4.05E-01	1.01E+00	2.03E+00	3.04E+00	4.05E+00	8.9	CCME, 1999e
Cobalt (Co)	7.80E+00	5.00E-01	5.39E-01	5.78E-01	6.95E-01	8.90E-01	1.09E+00	**1.28E+00**	1.1	EC, 2017
Copper (Cu)	2.65E+02	1.00E+00	2.33E+00	**3.65E+00**	**7.63E+00**	**1.43E+01**	**2.09E+01**	**2.75E+01**	2.6	CCREM, 1987
Cyanide	1.65E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.01E+00	1.01E+00	1.02E+00	5	CCREM, 1987
Lead (Pb)	3.40E+02	5.00E-01	2.20E+00	**3.90E+00**	**9.00E+00**	**1.75E+01**	**2.60E+01**	**3.45E+01**	3.7	CCREM, 1987
Mercury (Hg)	2.40E-01	ND	1.20E-03	2.40E-03	6.00E-03	1.20E-02	1.80E-02	2.40E-02	0.026	CCME, 2003; EC, 2003
Molybdenum (Mo)	3.65E+00	ND	1.83E-02	3.65E-02	9.13E-02	1.83E-01	2.74E-01	3.65E-01	73	CCME, 1999f
Nickel (Ni)	3.15E+01	1.00E+00	1.16E+00	1.32E+00	1.79E+00	2.58E+00	3.36E+00	4.15E+00	105	CCREM, 1987
Selenium (Se)	5.00E-01	ND	2.50E-03	5.00E-03	1.25E-02	2.50E-02	3.75E-02	5.00E-02	1.5	U.S. EPA, 2016
Silver (Ag)	6.00E-01	ND	3.00E-03	6.00E-03	1.50E-02	3.00E-02	4.50E-02	6.00E-02	0.25	CCME, 2015
Thallium (Tl)	2.00E-01	ND	1.00E-03	2.00E-03	5.00E-03	1.00E-02	1.50E-02	2.00E-02	0.80	CCME, 1999g
Tin (Sn)	2.10E+02	-	1.05E+00	2.10E+00	5.25E+00	1.05E+01	1.58E+01	2.10E+01	73	Suter and Tsao, 1996
Uranium (U)	6.60E-01	1.10E-01	1.13E-01	1.17E-01	1.27E-01	1.43E-01	1.60E-01	1.76E-01	15	CCME, 2011
Vanadium (V)	3.20E+01	6.40E-01	8.00E-01	9.60E-01	1.44E+00	2.24E+00	3.04E+00	3.84E+00	120	ECCC, 2016
Zinc (Zn)	7.35E+02	5.00E+00	8.68E+00	1.24E+01	2.34E+01	**4.18E+01**	**6.01E+01**	**7.85E+01**	30	CCREM, 1987

Table C-1: Predicted Surface Water Quality for a Series of TSS concentrations

Chemicals	75th Percentile Sediment and Soil (µg/g)	75th Percentile Surface Water (µg/L)	Predicted Concentrations in Surface Water (µg/L)						Long-term Water Quality Guideline (µg/L)	Reference
TSS (mg/L)			**5**	**10**	**25**	**50**	**75**	**100**	**25**	CCME, 2002
PAHs										
Acenaphthene	2.99E-02	-	1.50E-04	2.99E-04	7.48E-04	1.50E-03	2.24E-03	2.99E-03	5.8	CCME, 1999h
Acenaphthylene	1.33E-02	-	6.65E-05	1.33E-04	3.33E-04	6.65E-04	9.98E-04	1.33E-03	0.14	MOE, 2011
Anthracene	1.80E-02	-	9.00E-05	1.80E-04	4.50E-04	9.00E-04	1.35E-03	1.80E-03	0.012	CCME, 1999h
Benzo(a)anthracene	4.65E-02	-	2.33E-04	4.65E-04	1.16E-03	2.33E-03	3.49E-03	4.65E-03	0.018	CCME, 1999h
Benzo(a)pyrene	4.65E-02	-	2.33E-04	4.65E-04	1.16E-03	2.33E-03	3.49E-03	4.65E-03	0.015	CCME, 1999h
Benzo(b/j)fluoranthene	5.70E-02	-	2.85E-04	5.70E-04	1.43E-03	2.85E-03	4.28E-03	5.70E-03	0.42	MOE, 2011
Benzo(g,h,i)perylene	4.25E-02	-	2.13E-04	4.25E-04	1.06E-03	2.13E-03	3.19E-03	4.25E-03	0.02	MOE, 2011
Benzo(k)fluoranthene	2.80E-02	-	1.40E-04	2.80E-04	7.00E-04	1.40E-03	2.10E-03	2.80E-03	0.14	MOE, 2011
Chrysene	4.70E-02	-	2.35E-04	4.70E-04	1.18E-03	2.35E-03	3.53E-03	4.70E-03	0.07	MOE, 2011
Dibenz(a,h)anthracene	8.60E-03	-	4.30E-05	8.60E-05	2.15E-04	4.30E-04	6.45E-04	8.60E-04	0.04	MOE, 2011
Fluoranthene	8.80E-02	-	4.40E-04	8.80E-04	2.20E-03	4.40E-03	6.60E-03	8.80E-03	0.04	CCME, 1999h
Fluorene	2.97E-02	-	1.49E-04	2.97E-04	7.43E-04	1.49E-03	2.23E-03	2.97E-03	3.0	CCME, 1999h
Indeno(1,2,3-cd)pyrene	3.70E-02	-	1.85E-04	3.70E-04	9.25E-04	1.85E-03	2.78E-03	3.70E-03	0.14	MOE, 2011
1-Methylnaphthalene	2.76E-02	-	1.38E-04	2.76E-04	6.89E-04	1.38E-03	2.07E-03	2.76E-03	2	MOEE, 1994
2-Methylnaphthalene	1.04E-01	-	5.20E-04	1.04E-03	2.60E-03	5.20E-03	7.80E-03	1.04E-02	146	MOE, 2011
Naphthalene	2.75E-02	-	1.38E-04	2.75E-04	6.88E-04	1.38E-03	2.06E-03	2.75E-03	1.1	CCME, 1999h
Phenanthrene	6.40E-02	-	3.20E-04	6.40E-04	1.60E-03	3.20E-03	4.80E-03	6.40E-03	0.4	CCME, 1999h
Pyrene	8.80E-02	-	4.40E-04	8.80E-04	2.20E-03	4.40E-03	6.60E-03	8.80E-03	0.025	CCME, 1999h

Note:

1. Data source: AEL (2018)

Predicted contaminant concentration exceeds long-term water quality guideline

Appendix D Toxic Unit Predictions

Table D-1: Sum of Toxic Units for a Series of TSS Concentrations

Chemicals	Short-term Benchmark (µg/L)	Reference	Calculated TU in Surface Water					
TSS	25	CCME, 2002	**5**	**10**	**25**	**50**	**75**	**100**
PHCs								
F1 (C6-C10) - BTEX	1822	CCME, 2008	2.7E-05	5.5E-05	1.4E-04	2.7E-04	4.1E-04	5.5E-04
F2 (C10-C16 Hydrocarbons)	53		2.0E-03	4.0E-03	1.0E-02	2.0E-02	3.0E-02	4.0E-02
VOCs								
1,4-Dichlorobenzene	1100	CCME, 1999a	2.3E-07	4.5E-07	1.1E-06	2.3E-06	3.4E-06	4.5E-06
Ethylbenzene	1800	CCME, 1999b	5.6E-08	1.1E-07	2.8E-07	5.6E-07	8.3E-07	1.1E-06
Toluene	5460	CCME, 1999c	3.7E-05	3.7E-05	3.7E-05	3.7E-05	3.7E-05	3.7E-05
Trichloroethylene	7760	CCME, 1999d	3.2E-08	6.4E-08	1.6E-07	3.2E-07	4.8E-07	6.4E-07
Xylene (Total)	3300	MOE, 2011	1.4E-07	2.9E-07	7.2E-07	1.4E-06	2.2E-06	2.9E-06
Metals and Inorganics								
Antimony (Sb)	175	US EPA, 1988	1.5E-04	3.0E-04	7.6E-04	1.5E-03	2.3E-03	3.0E-03
Arsenic (As)	850	CCME, 2001	5.8E-05	1.2E-04	2.9E-04	5.8E-04	8.6E-04	1.2E-03
Barium (Ba)	71	ECOTOX, 2018b	1.1E-02	2.1E-02	5.3E-02	1.1E-01	1.6E-01	2.1E-01
Beryllium (Be)	35	Suter and Tsao, 1996	6.1E-05	1.2E-04	3.1E-04	6.1E-04	9.2E-04	1.2E-03
Cadmium (Cd)	2.4	CCME, 2014	8.0E-03	1.6E-02	4.0E-02	8.0E-02	1.2E-01	1.6E-01
Chromium (Cr)	1200	CCME, 1999e	1.7E-04	3.4E-04	8.4E-04	1.7E-03	2.5E-03	3.4E-03
Cobalt (Co)	61	ECOTOX, 2018b	8.8E-03	9.5E-03	1.1E-02	1.5E-02	1.8E-02	2.1E-02
Copper (Cu)	16	U.S. EPA, 1996	1.5E-01	2.3E-01	4.8E-01	8.9E-01	1.3E+00	1.7E+00
Cyanide	22	U.S. EPA, 1985b	4.5E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02	4.6E-02
Lead (Pb)	95	US EPA, 1985c	2.3E-02	4.1E-02	9.5E-02	1.8E-01	2.7E-01	3.6E-01
Mercury (Hg)	20	CCME, 2003	6.0E-05	1.2E-04	3.0E-04	6.0E-04	9.0E-04	1.2E-03
Molybdenum (Mo)	29000	CCME, 1999f	6.3E-07	1.3E-06	3.1E-06	6.3E-06	9.4E-06	1.3E-05
Nickel (Ni)	520	U.S. EPA, 1996	2.2E-03	2.5E-03	3.4E-03	5.0E-03	6.5E-03	8.0E-03
Selenium (Se)	45	U.S. EPA, 2016	5.6E-05	1.1E-04	2.8E-04	5.6E-04	8.3E-04	1.1E-03
Silver (Ag)	0.25	CCME, 2015	1.2E-02	2.4E-02	6.0E-02	1.2E-01	1.8E-01	2.4E-01
Thallium (Tl)	680	CCME, 1999g	1.5E-06	2.9E-06	7.4E-06	1.5E-05	2.2E-05	2.9E-05
Tin (Sn)	2700	Suter and Tsao, 1996	3.9E-04	7.8E-04	1.9E-03	3.9E-03	5.8E-03	7.8E-03
Uranium (U)	33	CCME, 2011	3.4E-03	3.5E-03	3.8E-03	4.3E-03	4.8E-03	5.3E-03
Vanadium (V)	280	Suter and Tsao, 1996	2.9E-03	3.4E-03	5.1E-03	8.0E-03	1.1E-02	1.4E-02
Zinc (Zn)	133	U.S. EPA, 1996	6.5E-02	9.3E-02	1.8E-01	3.1E-01	4.5E-01	5.9E-01
PAHs								
Acenaphthene	580	CCME, 1999h	2.6E-07	5.2E-07	1.3E-06	2.6E-06	3.9E-06	5.2E-06
Acenaphthylene	605	Di Toro et al. 2000	1.1E-07	2.2E-07	5.5E-07	1.1E-06	1.6E-06	2.2E-06
Anthracene	1.2	CCME, 1999h	7.5E-05	1.5E-04	3.8E-04	7.5E-04	1.1E-03	1.5E-03
Benzo(a)anthracene	1.8	CCME, 1999h	1.3E-04	2.6E-04	6.5E-04	1.3E-03	1.9E-03	2.6E-03
Benzo(a)pyrene	1.5	CCME, 1999h	1.6E-04	3.1E-04	7.8E-04	1.6E-03	2.3E-03	3.1E-03
Benzo(b/j)fluoranthene	4.2	MOE, 2011	6.8E-05	1.4E-04	3.4E-04	6.8E-04	1.0E-03	1.4E-03
Benzo(g,h,i)perylene	0.13	ECOTOX,2018b	1.6E-03	3.2E-03	8.0E-03	1.6E-02	2.4E-02	3.2E-02
Benzo(k)fluoranthene	1.4	MOE, 2011	1.0E-04	2.0E-04	5.0E-04	1.0E-03	1.5E-03	2.0E-03
Chrysene	0.7	CCME, 1999h	3.4E-04	6.7E-04	1.7E-03	3.4E-03	5.0E-03	6.7E-03
Dibenz(a,h)anthracene	0.4	MOE, 2011	1.1E-04	2.2E-04	5.4E-04	1.1E-03	1.6E-03	2.2E-03
Fluoranthene	4	CCME, 1999h	1.1E-04	2.2E-04	5.5E-04	1.1E-03	1.7E-03	2.2E-03
Fluorene	820	CCME, 1999h	1.8E-07	3.6E-07	9.1E-07	1.8E-06	2.7E-06	3.6E-06
Indeno(1,2,3-cd)pyrene	NV	NA	-	-	-	-	-	-
1-Methylnaphthalene	37	Suter and Tsao, 1996	3.7E-06	7.4E-06	1.9E-05	3.7E-05	5.6E-05	7.4E-05
2-Methylnaphthalene	982	Di Toro et al.,2000	5.3E-07	1.1E-06	2.6E-06	5.3E-06	7.9E-06	1.1E-05
Naphthalene	1000	CCME, 1999h	1.4E-07	2.8E-07	6.9E-07	1.4E-06	2.1E-06	2.8E-06
Phenanthrene	49	CCME, 1999h	6.5E-06	1.3E-05	3.3E-05	6.5E-05	9.8E-05	1.3E-04
Pyrene	2.5	CCME, 1999h	1.8E-04	3.5E-04	8.8E-04	1.8E-03	2.6E-03	3.5E-03
Total Toxicity Unit			**0.3**	**0.5**	**1.0**	**1.8**	**2.7**	**3.5**