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SUPPLIER DOCUMENT

SURFACE WATER QUALITY ASSESSMENT FOR THE NEAR SURFACE DISPOSAL FACILITY

232-03710-REPT-007

Revision 0

Accepted by: Martin Klukas 2019-Nov-15

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Date

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CANADIAN NUCLEAR LABORATORIES

Technical Supporting Document

Surface Water Quality Assessment for the Near Surface Disposal Facility Revision 0

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REPORT

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Revision History

Version	Date	Document	Prepared By	Reviewed By
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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AECL	Atomic Energy of Canada Ltd.
CCME	Canadian Council Ministers of the Environment
CNL	Canadian Nuclear Laboratories
COPC	Constituents of Potential Concern
CRL	Chalk River Laboratories
ECM	Engineered Containment Mound
EDT	Effluent Discharge Target
EIS	Environmental Impact Statement
ESW	East Swamp Weir
ETMF	Exposure and Toxicity Modifying Factor
MDL	Method Detection Limit
MSC	Main Stream Culvert
NCB	No Change from existing baseline concentrations
NEC	No Effects Concentration
NSDF	Near Surface Disposal Facility
OR	Ottawa River
PCO	Perch Lake Outlet
PCW	Perch Lake Weir
PL	Perch Lake
Project	Near Surface Disposal Facility Project
RB	Risk Benchmark
SSW	South Swamp Weir
TSD	Technical Support Document
US EPA	United States Environmental Protection Agency
WWTP	Wastewater Treatment Plant

LIST OF UNITS

Units	Definition
%	percent
µg/L	micrograms per litre
Bq/L	Becquerels per litre
m^2	square metre
m^3	cubic metre
m^3/hr	cubic metres per hour
m^3/yr	cubic metres per year
mg N/L	milligrams per litre as nitrogen
mg/L	milligrams per litre
mSv/yr	millisieverts per year
NH3-N	un-ionized ammonia as nitrogen

1.0 INTRODUCTION

Canadian Nuclear Laboratories (CNL) is proposing to construct the Near Surface Disposal Facility (NSDF) Project at its Chalk River Laboratory (CRL) site for the long-term management of large quantities of waste from legacy waste, current operations, and decommissioning projects at the CRL site and its other business locations. The NSDF Project will provide a safe, permanent solution for the disposal of solid, low-level radioactive waste and other acceptable waste streams at the CRL site and replace the current CNL practice of placing the waste in temporary storage.

This Surface Water Quality Assessment Technical Supporting Document (TSD) has been prepared to support the surface water quality assessment for the Environmental Impact Statement (EIS) for the NSDF Project. This TSD comprises four elements for the residual effects analysis of surface water quality in the NSDF Project watersheds and the Ottawa River, which are presented in Sections 2.0 through 5.0:

- Section 2.0: Methods;
- Section 3.0: Model Results;
- Section 4.0: Prediction Confidence and Uncertainty; and
- Section 5.0: Conclusions.

2.0 METHODS

Residual effects to surface water quality are limited to operational discharges of treated effluent from the wastewater treatment plant (WWTP) to the exfiltration gallery and to Perch Lake, and it's potential to change surface water chemistry in the receiving and downstream environment. This assessment includes an assessment focused on select non-radiological constituents and a small number of radiological constituents.

2.1 Model Overview

The effect of the NSDF Project to surface water quality on the receiving and downstream environment was modelled using the GoldSim modelling program. GoldSim is a graphical Windows-based simulation software package developed by the GoldSim Technology Group. The GoldSim model was employed as a "graphical spreadsheet" to estimate non-radiological and radiological contaminant concentrations at focal surface water assessment nodes within the Perch Lake and Perch Creek catchment basins based on an instantaneous mixing zone mass balance approach. The model was run using site specific information, and projected flow data and projected wastewater effluent quality and quantity data for select constituents of potential concerns (COPCs) provided by previous hydrologic studies, recent water quality reports, and the NSDF Project Description (Section 3 of the EIS).

The following list summarizes the water quantity and quality reference documents used to characterize the surface water quality GoldSim model:

- Water Quantity:
  - Average monthly flow rates and precipitation data from 1969 to 1980 for five Perch Lake inlets (PL1, PL2, PL3, PL4, and PL5) and one outlet flow (PL0; Robertson and Barry 1985);

- Monthly flow rates based on annual averages for Main Stream Culvert (MSC), South Swamp Weir (SSW), and East Swamp Weir (ESW) (CNL 2016);
- Projected leachate and contact wastewater generation rates as a result of normal operation and back-to-back 100-year storm events (AECOM 2019);
- Perch Creek catchment annual flow rates downstream of Perch Lake Outlet (PLO; CNL 2016); and
- Average annual Ottawa River flow rates (Table 5.4.1-4 of the EIS).

- Water Quality:
  - Average annual non-radiological water chemistry existing environmental concentrations at surface water model nodes of interest from 2010 to 2018 (CNL 2018a, CNL 2017, CNL 2019a);
  - Radiological WWTP projected treated effluent concentrations and effluent discharge targets (AECOM 2018a, CNL 2019b);
  - Non-radiological WWTP projected treated effluent concentrations and effluent discharge targets (AECOM 2018a, CNL 2019b); and
  - Non-radiological and radiological monitored water chemistry for Perch Lake from a 2018 lake survey (CNL 2018b).

2.2 Model Scenarios

The GoldSim model is designed to simulate operating conditions during years 45 to 50 of the NSDF Project when the greatest amount of contact water requires treatment and when the largest volume of treated effluent from the WWTP is expected to be generated. The construction phase from 2021 to 2023 was removed from consideration as a model scenario because of its time-period (as COPCs are not expected to be generated in reasonable quantities during construction to affect receiving and downstream water quality as described in Section 5.4.2.6.2 of the EIS). The Engineered Containment Mound (ECM) will have a final waste capacity of 1,000,000 m^3 and will be comprised of ten cells – each with an average surface area of approximately 12,000 square metres (m^2). The model implicitly considers the contact water that is generated over the surface area of the ECM by including the back-to-back 100-year freshet storm event flows with normal operating condition flows. Thus, the normal operating condition is represented as one single annual discharge of 13,320 cubic metres per year (m^3/yr), which is comprised of:

- two weeks of 22.5 m^3/hr discharge (at 8 hours per day) corresponding to the storm event (i.e. 2,520 m^3/yr); and
- 120 days of 11.25 m^3/hr discharge (at 8 hours per day) corresponding to normal operating conditions spread over mid-March to October (i.e. 10,800 m^3/yr).

The combination of these discharge conditions represents a single bound annual discharge scenario that results in a cumulative discharge volume of 13,320 m^3. This volume is an 18% increase above the annual estimated discharge wastewater volume of 11,230 m^3, which represents the maximum projected wastewater volume generated over the life of the NSDF Project (AECOM 2018). The volume generated for the back to back 100-year storm event (i.e., 2,520 m^3) represents 70% of the volume estimated for back to back 100-year storm, based on 1,800 m^3 generated for the NSDF Project from a 100-year storm event over a 24-hr period (AECOM 2018).

For the purposes of the assessment, it was assumed that the WWTP would only need to discharge at a higher rate for two weeks to reduce the volume of wastewater to a manageable volume to allow normal operating conditions to resume.

Using the single annual discharge condition as a baseline, the GoldSim model was run using two scenarios as detailed in the following sections.

Scenario 1

- Total annual WWTP discharge of 13,320 m^3/yr.
- 50% discharge to East Swamp Wetland via the exfiltration gallery and 50% discharge to Perch Lake.

This scenario divides the total annual discharge equally between the exfiltration gallery and Perch Lake (direct pumping to Perch Lake via transfer line). The exfiltration gallery is considered to be the downstream portion of East Swamp (upstream of ESW) and the outfall location is considered to be at the northeastern shoreline of Perch Lake.

Scenario 2

- Total annual WWTP discharge of 13,320 m^3/yr (same as Scenario 1).
- 100% discharge to Perch Lake.

This scenario discharges 100% of the total annual discharge directly into Perch Lake at the deepest location in the lake.

2.3 Model Inputs and Assumptions

GoldSim was run for the two scenarios using monthly time steps for a total of 178 months, or approximately 15 years, to illustrate concentration trends. The mass balance calculations assumed year-to-year continuous time series of seasonal effluent discharge from mid-March to October, instantaneous and complete mixing, and contaminants were modelled to be fully conservative (no decay and no sorption). A warm-up period of three years allowed initial Perch Lake mass inputs to reach equilibrium. Perch Lake was simulated as a reservoir storage unit with multiple inflow sources (P1, P2, P3, P4, and P5) and one outflow location (PLO), with an initial volume of approximately 900,000 m^3.

The model considered several nodes upstream of Perch Lake, namely, MSC, SSW, and ESW, which correspond to the surface water quality monitoring stations as shown on Figure 1. Similarly, downstream nodes relative to Perch Lake include Perch Creek weir (PCW) and Perch Creek Outlet (PCO) where PCO is assumed to be fully mixed at the confluence with the Ottawa River. Existing baseline concentrations at the PCO location were not available so existing baseline concentrations for PCW were assigned to the PCO node. This is considered a reasonable assumption since the PCO is located just downstream of PCW; additionally, the region of Perch Creek between PCW and PCO is not expected to receive any further supplemental flows from the surface water quality Site Study Area (SSA)[1].

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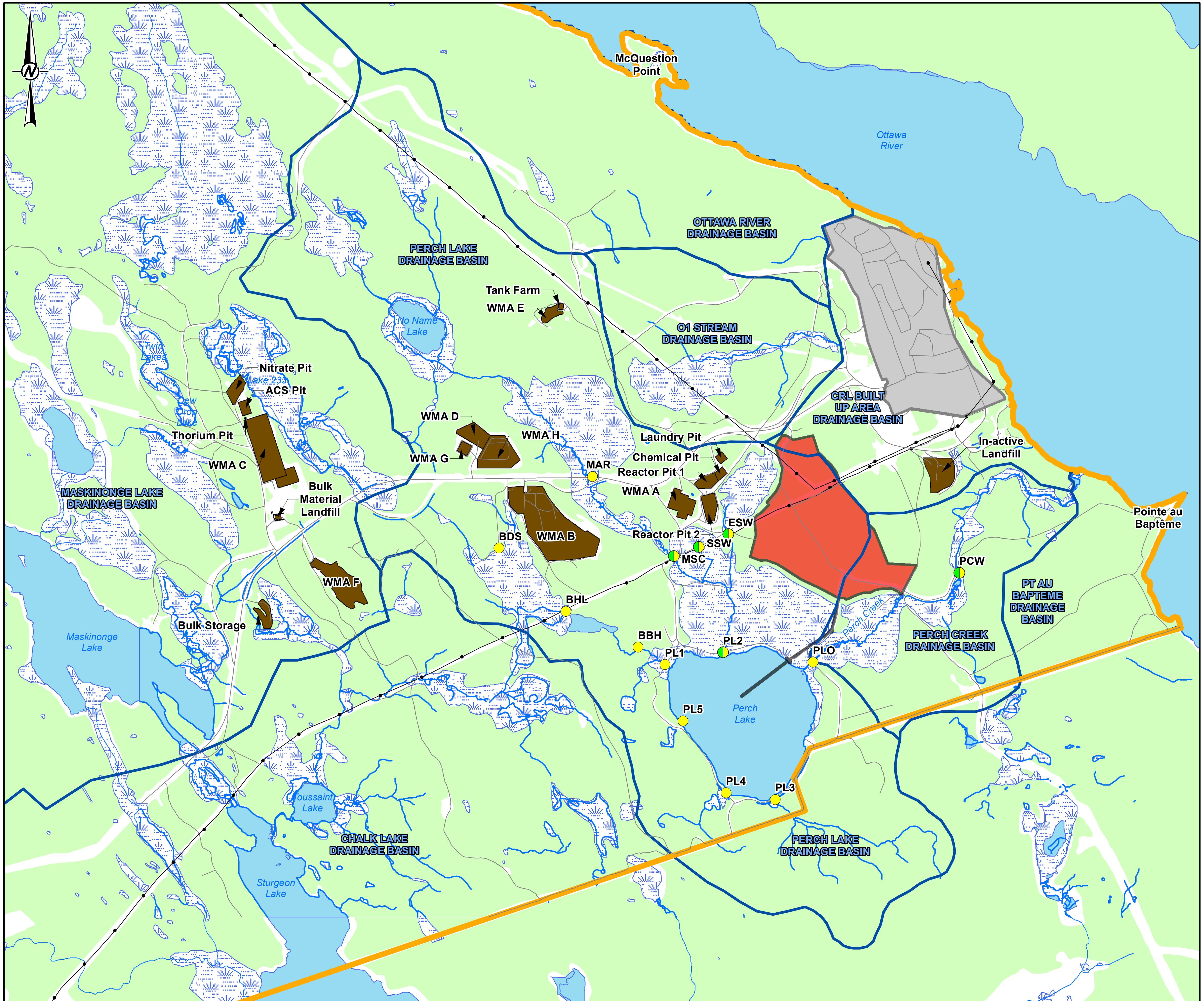
[1] The surface water quality Site Study Area (SSA) is the NSDF Project footprint (i.e., where project activities would be undertaken including proposed facilities, buildings, and infrastructure).

A total model run time of 15 years was initially selected as this corresponded to the available measured monthly flows from 2001 to 2015 at PCW. However, as measured monthly flows at other key assessments nodes were not available during the same time frame, it was not possible to close the water balance. As such, GoldSim was run over the 15 year modelling period using a looping series of average monthly flows, based on a previous water balance study (Robertson and Barry 1985), with the expectation that should measured flow data become available in the future at all other assessment nodes, the model can be readily updated.

The 1985 water balance study (Robertson and Barry 1985) provided monthly estimates of inflow and outflow at the Perch Lake inlets and outlets with an average annual surplus of approximately 52,000 m^3 – this discrepancy conflicts with the assumption that the lake volume will remain constant in the model as the surplus represents a non-trivial 6% of the lake's total volume. In order to maintain a constant volume within Perch Lake and to reduce model complexity, the annual surplus was nullified by considering an equal outflow amount as potential evapotranspiration. Monthly seasonal variation was achieved by examining Environment Canada water balance evapotranspiration trends from years 1970 to 2006 at the AECL 6101335 meteorological station. Due to the limited resolution of the input data and the lack of measured data, year-to-year wet year or dry year variation was not considered in the water quality model.

Model inflow rates for Perch Lake inflows were assumed to be representative of a typical predominately natural watershed with high snowmelt flows occurring in April. In the interest of using consistent input data, measured monthly flow data at PCW were not used in conjunction with the rest of the model, which relied upon calculated looping monthly and annual averages based on the 1985 water balance study (Robertson and Barry 1985).



LEGEND

- ROADS
- RAILWAY
- TRANSMISSION LINE
- RIVER/STREAM
- WATERBODY
- WETLAND
- WOODED AREA
- DRAINAGE BASIN
- SITE STUDY AREA (NSDF PROJECT SITE)
- CRL MAIN CAMPUS
- CRL SITE
- WASTE MANAGEMENT AREA (WMA) [1]
- SAMPLING LOCATION
- WEIR
- SAMPLING LOCATION AND WEIR

500 0 500

1:20,000 METRES

NOTE(S)

1. LIQUID DISPOSAL AREA ENCOMPASSES REACTOR PIT 1 AND 2, CHEMICAL PIT AND LAUNDRY PIT.

REFERENCE(S)

1. BASEDATA ONTARIO MNRF 2016, CANVEC 2016, AND CNL 2016
2. PROPERTY BOUNDARY AND NSDF LOCATION PROVIDED BY CNL (MAY 2016 AND MAY 2017)
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18N

CLIENT

CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT

NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL IMPACT STATEMENT
CHALK RIVER, ONTARIO

TITLE

LOCATIONS OF SURFACE WATER MONITORING STATIONS AND WEIRS

CONSULTANT

GOLDER

DATE	NOVEMBER 2019
DESIGNED	SO
PREPARED	SO
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APPROVED	AB

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The 1985 water balance study (Robertson and Barry 1985) estimated an annual average flow rate at the outlet of Perch Lake of approximately 1,788,000 m^3/yr – a reasonable estimate in comparison to the annual average flow rate at the same outlet of 1,700,000 m^3/yr provided by CNL (CNL 2016). CNL also provided an estimate of the average annual flow rate at the outlet of Perch Creek of 2,210,000 m^3/yr (CNL 2016).

The ECM has ten cells used for waste storage over the life of the NSDF Project. Each of the ten ECM cells is assumed to actively receive waste for a period of five years before being closed and covered, during which time leachate and contact water are generated from precipitation in the cell. Depending on the active cell in use over the life of the NSDF Project, and the stage of operations, the total annual volume of water expected to require treatment will range from 11,095 m^3 (years 1 to 5) to 11,230 m^3 (years 45 to 50) (AECOM 2018). The source of volumes assumes approximately 2,400 m^3 of leachate from the active cell, 3,400 m^3 of contact water from the active cell, 5,200 m^3 from the temporary storage pad, and 100 m^3 of decontamination water (AECOM 2018). For context, the assumed total annual WWTP discharge for the modelling of 13,320 m^3/yr represents less than 1% of Perch Creek annual outlet flows.

Existing environmental water quality conditions for Perch Lake were limited to a baseline survey completed in 2018. Therefore, constituent baseline water quality concentrations in Perch Lake were derived from the flow-weighted sum of average measured concentrations for each constituent from the available environmental monitoring data collected at the inflow monitoring stations to Perch Lake; that is, PL1, PL2, PL3, PL4, and PL5. Relative to the total inflow to Perch Lake of each of the inflowing streams to Perch Lake represented by these monitoring stations, PL1 received a weighting of 15%, PL2 received a weighting of 67%, and PL3 through PL5 combined received a weighting of 18%. The baseline Perch Lake concentration for each constituent was estimated from the resulting inflow loading of that constituent to Perch Lake. The 2018 data for Perch Lake provided a basis for comparison of the flow-weighted data.

2.4 Model Screening for Constituents of Potential Concern

The COPCs included for further analysis in the GoldSim model represent a collection of key parameters that have undergone an iterative screening process throughout the life of the NSDF Project using best available information from WWTP design and waste characterization documents at the time. The initial list of COPCs for modelling focused on those that were known to be important to human and aquatic life, and radiological parameters that have been conventionally monitored for decades by CNL. The final list of COPCs represented a total of 40 different non-radiological and radiological parameters.

Non-radiological COPCs were screened in or out based on the following screening factors:

1) Availability of Projected Wastewater Characteristics:

   - Various constituents were omitted as their leaching potential was assumed to be negligible for the projected wastewater characteristics (either untreated or treated effluent) based on the minimal sources in the waste inventory.

2) Treatment Requirement:

   - Various constituents characterized by high projected effluent concentrations relative to their respective effluent discharge target were carried forward for further analysis as treatment was required for discharge (i.e., aluminum, boron, calcium, cobalt, iron, and manganese).

3) High Existing Environmental Conditions:

- Various constituents characterized by high existing baseline concentrations that exceeded proposed effluent discharge targets were automatically carried forward for further analysis (i.e., barium, copper, lead, selenium, and silver).

4) Potential for Nutrient Enrichment Effects on Trophic States:

- Although not typically defined as a toxicant, phosphorus was carried forward for further analysis due to its roles in contributing to the trophic state (or productivity) of waterbodies.
- Nitrate, nitrite, and ammonia (as unionized ammonia - nitrogen) were carried forward for further analysis due to their close relation to the nitrogen/nutrient cycle (productivity role) and their potential toxicity to aquatic life.

5) Ionic Composition:

- Sodium, chloride, sulfate, and hardness were carried forward for further analysis due to their role in establishing the ionic composition of wastewater and water in the receiving environment and to support the evaluation of hardness-dependent parameters, such as copper.
- Other cations and anions that contribute to the major ionic composition were included for further analysis (i.e. fluoride, magnesium, and potassium).

6) Potential for Effects on Aquatic Life:

- Despite not requiring treatment, various metals were carried forward for further analysis due to their known toxicity to aquatic life (i.e., antimony, cadmium, chromium, mercury, molybdenum, nickel, strontium, thallium, tin, uranium, vanadium and zinc).

Based on the above approach, the following non-radiological parameters screened into the surface water quality assessment:

- Major ions – sodium, potassium, calcium, magnesium, fluoride, sulphate, and chloride (including hardness).
- Nutrients – nitrate, nitrite, and phosphorus.
- Metals – aluminum, antimony, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, uranium, vanadium, and zinc.

Organic compounds were not included in the modelling as these compounds are generally only present in trace amounts, with no obvious source in the waste inventory. The final list of non-radiological COPCs and their existing baseline concentration ranges and risk benchmarks are summarized in Table 5.4.2-5 of the EIS.

Radiological COPCs were screened in or out based on the following screening factors:

1) The predicted treated effluent concentration for a radionuclide was greater than 1% of the No Effect Concentration (NEC) for that radionuclide. A 1% threshold was selected as this value would ensure that the cumulative effect for those radionuclides excluded from the assessment would be negligible. The NEC represented benchmark concentrations for which no adverse effects on biota are expected. No effect concentrations for radionuclides were sourced from (CNL 2019b; Arcadis and Quintessa 2019; Arcadis 2019).

2) Where NEC were not available for a radionuclide, screening was based on human exposure for a person ingesting the treated WWTP effluent using a screening dose of 0.001 millisieverts per year (mSv/yr; which is consistent with the NSDF Project's *Postclosure Safety Assessment* [Arcadis and Quintessa 2019]). This represents less than1% of the allowable dose to the public from CRL operations.

3) Radionuclides where of public interest or site focus.

The following radiological parameters screened into the surface water quality assessment:

- Carbon-14 – the predicted treated effluent concentration exceeds 1% of the NEC for biota.
- Caesium-137 – although treated effluent concentration is well below 1% of the NEC, it is present in slightly elevated concentrations in surface water within the Perch Creek and Perch Lake Watershed.
- Cobalt-60 – the predicted treated effluent concentration exceeds 1% of the NEC for biota.
- Gross Beta (noting that strontium-90 is the main contributor to the gross beta concentrations) – although the treated effluent concentration for strontium-90 is well below 1% of the NEC, it is present in elevated concentrations in surface water within the Perch Creek and Perch Lake Watershed.
- Tritium – is of public interest. The predicted treated effluent concentration also approaches 1% of the NEC.

The final list of radiological COPCs and their existing baseline concentration ranges and NEC's are summarized in Table 5.4.2-6 of the EIS A more detailed description of radiological baseline concentrations is provided in Section 5.7 of the EIS.

2.5 Model Inputs for the Treated Effluent Discharge

For the majority of the COPCs in the assessment, the maximum projected wastewater concentration was lower than the effluent discharge target (e.g., antimony). Although in this situation targeted treatment of this COPC would not be required prior to discharge, mass loading inputs to the water quality model for the operational discharge scenarios used the effluent discharge target. This approach applied a high level of conservatism to the modelling assessment.

For a subset of the COPCs (i.e., aluminum, cobalt, iron, manganese, nitrate, nitrite, sulphate and cobalt-60), the maximum projected wastewater concentration was higher than the treated effluent discharge trigger (e.g., aluminum: wastewater concentration = 150 micrograms per litre [µg/L]; treated effluent discharge trigger = 50 µg/L). This means that treatment of the COPCs is required prior to discharge being acceptable. For these COPCs, the mass loading input to the water quality model for the operational discharge scenarios used the treated effluent discharge target concentration and assumes that the treated effluent discharge will consistently meet the effluent discharge target. This approach applied a lower level of conservatism to the modelling assessment for these COPCs.

In a few instances (e.g., ammonia, phosphorus, uranium), the maximum projected wastewater concentration was not available. In these cases, the treated effluent discharge target was assigned to the treatment specifications. For these COPCs, the mass loading input for each modelling scenario used the treated effluent discharge target.

For phosphorus, despite the maximum projected wastewater concentration not being available, there is confidence in the ability of the WWTP to meet the treated effluent discharge target. The WWTP treatment process for phosphorus is chemical precipitation by ferric chloride. If higher than normal phosphorus concentrations are measured in the wastewater feed to the WWTP treatment process, the ferric chloride precipitation process can be optimized for enhance phosphorus removal. If phosphorus concentrations in water in the final effluent tank prior to discharge exceeds the effluent discharge target, this water will be returned to the beginning of the treatment process for further treatment.

The effluent discharge input loadings for each of the screened non-radiological and radiological constituent in the model are presented in the results tables in Sections 3.1 and 3.2, respectively.

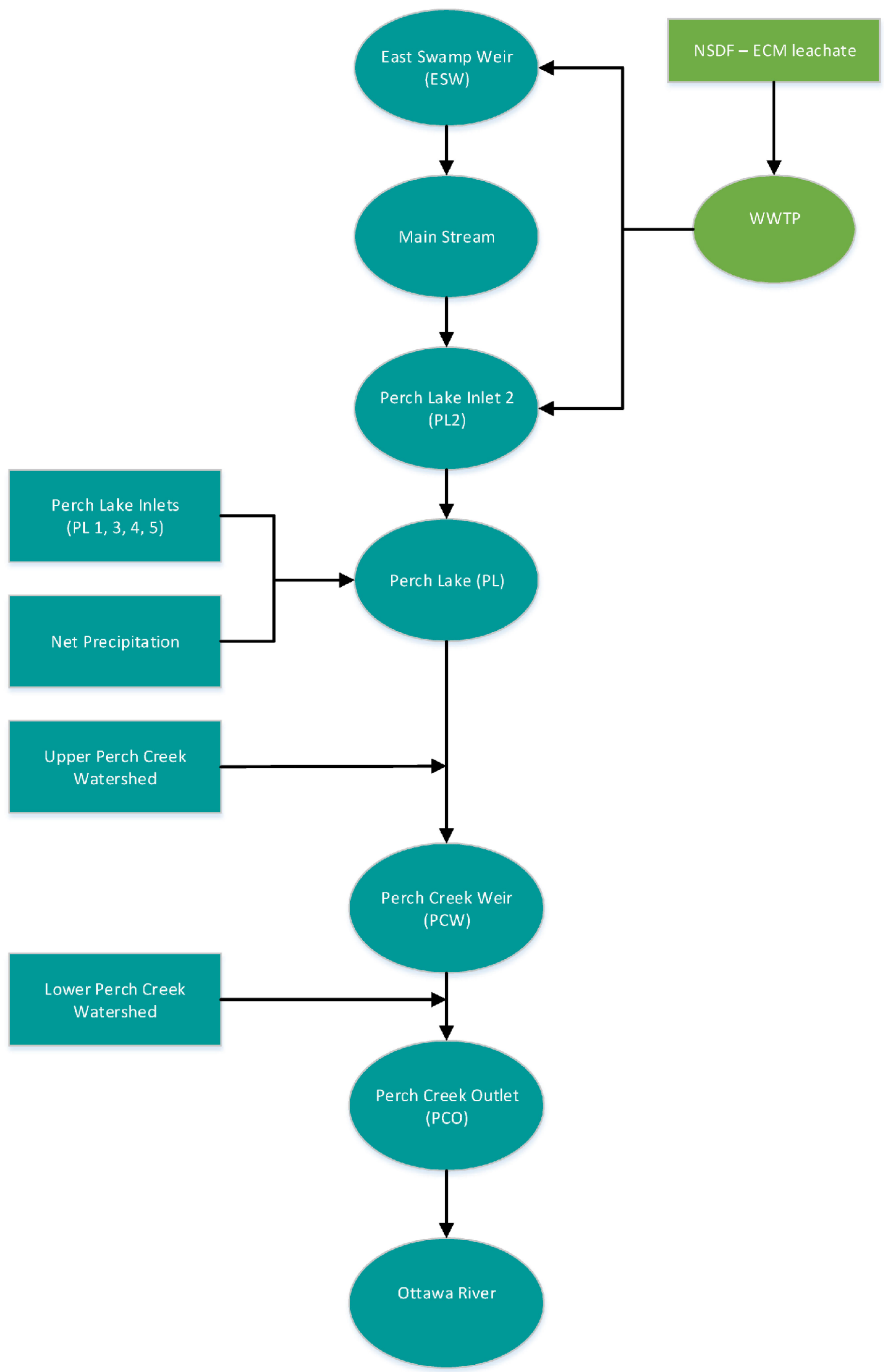
2.6 Model Output

The assessment nodes at which water quality concentrations were estimated are listed as follows, and are illustrated in the annual average water balance on Figure 2.

1) ESW: East Swamp Weir;
2) PL2: Perch Lake Inlet #2;
3) PL: Perch Lake;
4) PCW: Perch Creek Weir;
5) PCO: Perch Creek Outlet; and
6) OR: Ottawa River.

The Ottawa River assessment node is located 8 km downstream of the CRL Built-up Area, where it is assumed that any discharge from the Perch Creek and Perch Lake Watershed has been completely mixed.

Model results for the COPCs are presented by node and model scenario. All modelled concentrations are inclusive of the existing baseline concentrations (at nodes where existing baseline information was available). Where existing baseline data were not available, the modelled results were limited to providing only an indication of incremental increase to that parameter concentration at the assessment node. The modelled results for the screened COPCs at each assessment node in the Perch Creek and Perch Lake Watershed downstream of the NSDF Project are presented as the average, 95th percentile, and maximum concentrations as these statistical values are used to further classify the COPCs for monitoring requirements and to determine the likelihood of environmental (e.g., aquatic) effects. These summary statistics were generated from the modelled monthly concentrations over the 15-year run time during operating conditions associated with Years 45 to 50 of the NSDF Project. This specific operations focus in the modelling is associated with the highest amount of contact water that requires treatment and when the largest volume of treated effluent from the WWTP is expected to be generated for discharge. All resultant modelled concentrations for each COPC were evaluated against the respective effluent discharge target (if available) and their risk benchmark or no effects concentration.



REFERENCE(S)
1. REGIONAL TOPOGRAPHY SOURCE CNL 2019

CLIENT
CANADIAN NUCLEAR LABORATORIES LTD.

PROJECT
NEAR SURFACE DISPOSAL FACILITY, ENVIRONMENTAL IMPACT STATEMENT
CHALK RIVER, ONTARIO

TITLE
CONCEPTUAL FLOW DIAGRAM OF WWTP EFFLUENT DISCHARGE AND PERCH LAKE BASIN SURFACE WATER FLOWS

CONSULTANT
GOLDER

DATE	NOVEMBER 2019
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3.0 APPLICATION CASE MODEL RESULTS

Model results for the COPCs are presented by node and model scenario. All concentrations are inclusive of the background concentrations (at nodes where background information was available). Cells highlighted in grey indicate a projected COPC concentration higher than effluent discharge target and cells highlighted in grey with bold font indicate a value higher than the risk benchmark. Where background data were not available, the modelled results are limited to providing only an indication of incremental increase to that parameter concentration at the assessment node.

The definitions for COPC Effluent Discharge Target, Risk Benchmark, No Effects Concentration, and No Change from existing Baseline concentrations (NCB) are provided below.

- COPC Effluent Discharge Target (EDT): The effluent discharge targets are the maximum concentrations of each radiological and non-radiological COPC in the WWTP effluent that can be discharged to the environment without adverse effects to human health or the environment (CNL 2019b).
  - The treated effluent discharge targets for non-radioactive constituents are based on guidelines for the protection of aquatic life, using a variety of source documents including CCME water quality guidelines for the protection of aquatic life (CCME 1999) and the Ontario Provincial Water Quality Objectives (PWQO) developed to ensure that water quality is satisfactory for aquatic life and recreation (MOEE 1994). Other reference documents were used if COPCs were not listed in the CCME guidelines or guidelines by the Ontario Ministry of Environment, Conservation and Parks guidelines.
  - The treated effluent discharge targets for radionuclides are the maximum acceptable concentrations for drinking water and are derived using Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada 2009). The use of drinking water concentrations for radionuclides is considered conservative as there is no public access to the Perch Creek and Perch Lake watershed where WWTP effluent discharges will occur. The method for calculation of the maximum acceptable concentrations is provided in Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada 2009). Special consideration was made for the effluent discharge target for tritium due to the lack of treatment technologies specifically for tritium and its propensity to disperse rapidly once released into the environment. The effluent discharge target for tritium was set at 360,000 Becquerels per litre (Bq/L). The discharge target of 360,000 Bq/L ensures that tritium concentrations in Perch Creek remain below 7,000 Bq/L, the health Canada drinking water guideline (CNL 2019b). Perch Creek drains the Perch Lake basin and discharges to the Ottawa River.
- Risk Benchmarks (RB) and No Effects Concentrations (NEC): The risk benchmarks for non-radiological and No Effects Concentrations for radiological COPCs are based on ecological effects-based criteria to identify if there is potential for ecological risk (i.e., probable effects).
  - The Risk Benchmarks for non-radiological constituents are based on the Lowest Observable Effect Level (LOEL) with acute exposure at which population level effects may occur. They are based on:
    - Federal or provincial guidelines for acute exposure; and,
    - Lowest observable effect levels from the literature.

- The No Effect Concentrations are derived from radiation benchmarks established for the protection of biota (i.e., 100 microGray per hour [µGy/hr] for terrestrial biota and 400 µGy/hr for aquatic biota) (CNL 2019b).

Exceedance of an RB or NEC does not necessarily imply that ecological impacts would occur, but instead indicates that there is some potential for ecological impacts.

- No Change from existing Baseline concentrations (NCB): No change from baseline indicates that an incremental increase in modelled COPC concentration is expected not to be measurable; therefore, the modelled COPC projection is no change from existing baseline condition.

3.1 Non-Radiological Results

Aluminum

The maximum projected wastewater concentration for aluminum (150 µg/L) is higher than the treated effluent discharge target (50 µg/L) so treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target concentration.

Aluminum existing baseline concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed up to the Ottawa River confluence ranged between 129 and 631 µg/L; the background concentration assigned to the Ottawa River is more than four times higher than the treated effluent discharge target.

All modelled concentrations for both discharge scenarios were, in many cases, higher than the risk benchmark (100 µg/L); however, for each assessment node they remained consistent with the existing baseline concentrations and showed a slight attenuation through the Perch Creek and Perch Lake Watershed. Overall, no measurable change to aluminum concentrations in the Perch Creek and Perch Lake Watershed and Ottawa River is anticipated.

The incremental increase in aluminum as a result of the NSDF Project is negligible during operational discharge conditions, especially in the context of the higher aluminum existing baseline concentrations in the Ottawa River. The water quality modelling results for aluminum are presented in Table 3-1.

Table 3-1: Water Quality Modeling Results for Aluminum

Aluminum	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 50; RB: 100					
Existing Baseline Concentration	µg/L	**169**	**138**	**129**	**138**	**138[(b)]**	**631**
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	**155**	**153**	**104**	80	72	**631**
95th Percentile	µg/L	**169**	**154**	**112**	**102**	98	**631**
Maximum	µg/L	**169**	**154**	**112**	**102**	98	**631**
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	**169**	**154**	**104**	80	72	**631**
95th Percentile	µg/L	**169**	**154**	**112**	**102**	98	**631**
Maximum	µg/L	**169**	**154**	**112**	**102**	98	**631**

Notes: Shading = concentration higher than the treated effluent discharge target

Shading and bold = concentration higher than the effluent discharge limit and risk benchmark

(a) Perch Lake existing baseline concentration based on a flow-weighted calculation using all available upstream data sources. Existing baseline aluminum concentrations in Perch Lake only available from 2018 (average = 33 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Ammonia

All mention of ammonia herein refers specifically to un-ionized ammonia as nitrogen (NH_3-N).

The maximum projected wastewater concentration for ammonia was not available, so the mass loading input for each modelling scenario conservatively used the treated effluent discharge target (0.02 milligrams per litre as nitrogen [mg N/L] as un-ionized ammonia). Additionally, existing baseline concentration data for ammonia in the Perch Creek and Perch Lake Watershed and Ottawa River were not available and thus a background concentration of zero was assigned to each node, which assumes that no un-ionized ammonia was present in the watershed.

In all operations scenarios, ammonia concentrations at all assessment nodes in the Perch Creek and Perch Lake Watershed remained below the treated effluent discharge target of 0.02 mg/L. It is acknowledged that these modelled projections for ammonia may not represent the most conservative case due to a lack of background data; however, the results indicate that ammonia concentrations attenuate through the watershed. Overall, no measurable change to ammonia concentrations in the Perch Creek and Perch Lake Watershed and Ottawa River is predicted. The water quality modelling results for ammonia are presented in Table 3-2.

Table 3-2: Water Quality Modeling Results for Ammonia

Ammonia	Units	ESW[(a)]	PL2[(a)]	PL[(a)]	PCW[(a)]	PCO[(a)]	OR[(a)]
Criteria	mg N/L	EDT: 0.02; RB: No data					
Existing Baseline Concentration	mg N/L	No data	No data	No data	No data	No data	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg N/L	0.002	NCB	NCB	NCB	NCB	NCB
95th Percentile	mg N/L	0.007	0.001	NCB	NCB	NCB	NCB
Maximum	mg N/L	0.007	0.001	NCB	NCB	NCB	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg N/L	NCB	NCB	NCB	NCB	NCB	NCB
95th Percentile	mg N/L	NCB	NCB	NCB	NCB	NCB	NCB
Maximum	mg N/L	NCB	NCB	NCB	NCB	NCB	NCB

(a) All results are based on an assumed zero background concentration due to an absence of existing baseline concentration data.

A modelled result showing 'NCB' indicates that an incremental increase in ammonia is expected not to be measurable; therefore, the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; mg N/L = milligrams per litre as nitrogen; EDT = treated effluent discharge target; RB = risk benchmark.

Antimony

The maximum projected wastewater concentration for antimony (0.00033 µg/L) is lower than the treated effluent discharge target (20 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline antimony concentrations in the Perch for the assessment nodes ESW, PL2, and PCW ranged between 0.027 and 0.050 µg/L. Existing baseline data for Perch Lake were limited to 2018 monitoring data.

All modelled concentrations at all assessment nodes were below the treated effluent discharge target and were below the risk benchmark (180 µg/L), suggesting that antimony is a low-priority COPC where organism-level effects are unlikely. There were higher projected antimony concentrations in ESW and PL2 in the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake; however, concentrations at these locations remained well below the risk benchmark.

Any incremental increase in antimony through the Perch Creek and Perch Lake Watershed as a result of the NSDF Project is expected not to be measurable in the Ottawa River. The water quality modelling results for antimony are presented in Table 3-3.

Table 3-3: Water Quality Modeling Results for Antimony

Antimony	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 20; RB: 180					
Existing Baseline Concentration	µg/L	0.050	0.036	0.034	0.027	0.027[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	2.488	0.199	0.175	0.135	0.122	NCB
95th Percentile	µg/L	7.104	0.566	0.214	0.181	0.174	NCB
Maximum	µg/L	7.209	0.578	0.214	0.181	0.174	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.050	0.038	0.175	0.135	0.122	NCB
95th Percentile	µg/L	0.050	0.038	0.214	0.181	0.174	NCB
Maximum	µg/L	0.050	0.038	0.214	0.181	0.174	NCB

(a) The Perch Lake existing baseline antimony concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline antimony concentrations in Perch Lake were only available from 2018 (average = 0.034 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in antimony is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Barium

The maximum projected wastewater concentration for barium (0.71 µg/L) is lower than the treated effluent discharge target (4 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline barium concentrations were available for the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 17 to 18 µg/L, which are higher than the treated effluent discharge target. Baseline data for Perch Lake were only available for 2018, which were consistent with a flow-weighted average concentration derived from the inflowing streams to Perch Lake (13 µg/L).

All projected concentrations are above the treated effluent discharge target and below the risk benchmark (110 µg/L), but remained similar to existing baseline concentrations, indicating barium is a relatively low-priority COPC where organism-level effects are unlikely. Any incremental changes in concentration in the Perch Creek and Perch Lake Watershed as a result of the NSDF Project are expected not to be measurable in the Ottawa River. The water quality modelling results for barium are presented in Table 3-4.

Table 3-4: Water Quality Modeling Results for Barium

Barium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 4.0; RB: 110					
Existing Baseline Concentration	µg/L	17.0	18.0	17.2	17.0	17.0[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	15.4	18.7	13.2	10.2	9.2	NCB
95th Percentile	µg/L	17.0	18.8	14.2	12.9	12.4	NCB
Maximum	µg/L	17.0	18.8	14.2	12.9	12.4	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	17.0	18.8	13.2	10.2	9.2	NCB
95th Percentile	µg/L	17.0	18.8	14.2	12.9	12.4	NCB
Maximum	µg/L	17.0	18.8	14.2	12.9	12.4	NCB

Note: Shading = exceedance of treated effluent discharge target.

(a) the Perch Lake existing baseline barium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline barium concentrations in Perch Lake were only available from 2018 (average = 13 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing ‘NCB’ indicates that an incremental increase in barium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Boron

The maximum projected wastewater concentration for boron (120 µg/L) is lower than the treated effluent discharge target (200 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline concentrations of boron at the assessment nodes in the Perch Creek and Perch Lake Watershed up to the Ottawa River ranged between 6.5 and 37 µg/L.

All modelled concentrations remained below the treated effluent discharge target and were below the risk benchmark (29,000 µg/L), suggesting that boron is a low-priority COPC where organism-level effects are unlikely. Higher projected Boron concentrations are modelled in ESW and PL2 in the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake.

Attenuation of Boron through the Perch Creek and Perch Lake Watershed is discernible, with incremental changes in concentration as a result of the NSDF Project unlikely to be measurable in the Ottawa River. The water quality modelling results for boron are presented in Table 3-5.

Table 3-5: Water Quality Modeling Results for Boron

Boron	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 200; RB: 29,000					
Existing Baseline Concentration	µg/L	13.1	7.2	6.5	12.8	12.8[(b)]	37
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	36.0	9.7	7.0	5.4	4.9	37
95th Percentile	µg/L	79.2	13.2	7.5	6.9	6.7	37
Maximum	µg/L	80.2	13.3	7.5	7.0	6.7	37
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	13.1	8.1	7.0	5.4	4.9	37
95th Percentile	µg/L	13.1	8.1	7.5	6.9	6.7	37
Maximum	µg/L	13.1	8.1	7.5	7.0	6.7	37

(a) The Perch Lake existing baseline boron concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline boron concentrations in Perch Lake were only available from 2018 (average = 2.0 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Cadmium

The maximum projected wastewater concentration for cadmium (0.0029 µg/L) is lower than the treated effluent discharge target (0.09 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, model mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Cadmium existing baseline concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed up to the Ottawa River ranged between 0.013 and 0.058 µg/L.

Modelled projected concentrations at all assessment nodes remained similar to existing baseline concentrations and were below the treated effluent discharge target and the risk benchmark (1 µg/L). Any incremental changes in cadmium concentration through the Perch Creek and Perch Lake Watershed during operations are expected to not be measurable in the Ottawa River. The water quality modelling results for cadmium are presented in Table 3-6.

Table 3-6: Water Quality Modeling Results for Cadmium

Cadmium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 0.09; RB: 1.0					
Existing Baseline Concentration	µg/L	0.052	0.058	0.049	0.013	0.013[(b)]	0.026
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.056	0.062	0.040	0.031	0.028	0.026
95th Percentile	µg/L	0.065	0.062	0.043	0.039	0.038	0.026
Maximum	µg/L	0.065	0.062	0.043	0.039	0.038	0.026
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.052	0.062	0.040	0.031	0.028	0.026
95th Percentile	µg/L	0.052	0.062	0.043	0.039	0.038	0.026
Maximum	µg/L	0.052	0.062	0.043	0.039	0.038	0.026

(a) The Perch Lake existing baseline cadmium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline cadmium concentrations in Perch Lake were only available from 2018 (average = 0.004 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Calcium

The maximum projected wastewater concentration for calcium (100 mg/L) is lower than the treated effluent discharge target (116 mg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline calcium concentrations were only available for 2018 at the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 7.0 to 7.6 mg/L, which are lower than the treated effluent discharge target.

Higher projected calcium concentrations were shown in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Calcium, *per se*, does not have a protection of aquatic life guideline as there is no evidence of adverse effects due to calcium, but it is a major contributing ion to hardness. Hardness is an exposure and toxicity modifying factor (ETMF), which when present in sufficient concentrations can reduce the toxicity potential of some metals to aquatic life. With the exception of the modelled calcium concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations were similar to background concentrations.

Some attenuation of calcium through the Perch Creek and Perch Lake Watershed downstream of PL2 is discernible; however, incremental changes in calcium concentration as a result of the NSDF Project are expected not to be measurable in the Ottawa River. The water quality modelling results for calcium are presented in Table 3-7.

Table 3-7: Water Quality Modeling Results for Calcium

Calcium	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	mg/L	EDT: 116; RB: No data					
Existing Baseline Concentration	mg/L	7.5	7.1	7.0	7.6	7.6[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	20.7	8.3	6.2	4.8	4.3	NCB
95th Percentile	mg/L	45.8	10.3	6.6	6.1	5.9	NCB
Maximum	mg/L	46.4	10.4	6.6	6.1	5.9	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	7.5	7.4	6.2	4.8	4.3	NCB
95th Percentile	mg/L	7.5	7.4	6.6	6.1	5.9	NCB
Maximum	mg/L	7.5	7.4	6.6	6.1	5.9	NCB

(a) The Perch Lake existing baseline calcium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline calcium concentrations in Perch Lake were only available from 2018 (average = 6.5 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in calcium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Chloride

The maximum projected wastewater concentration for chloride (17 mg/L) is lower than the treated effluent discharge target (120 mg/L), so targeted treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline chloride concentrations were only available for 2018 at the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 15.7 to 54 mg/L, which are lower than the treated effluent discharge target.

All modelled concentrations were below the treated effluent discharge target and were below the risk benchmark (640 mg/L), suggesting that chloride is a low-priority COPC where organism-level effects are unlikely. For both scenarios, a higher incremental increase in chloride concentrations is projected at PL2; the source of this increase is attributed to an elevated background concentration at MSC measured in 2018 (one of the CRL monitoring stations upstream of Perch Lake), which was incorporated into the flow-weighted background concentration for PL2.

From the modelled results, any incremental changes in chloride concentration through the Perch Creek and Perch Lake Watershed during operations are expected to remain below the risk benchmark. No incremental change in chloride concentrations are projected in the Ottawa River. The water quality modelling results for chloride are presented in Table 3-8.

Table 3-8: Water Quality Modeling Results for Chloride

Chloride	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	mg/L	EDT: 120; RB: 640					
Existing Baseline Concentration	mg/L	15.7	54.0	40.7	19.9	19.9[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	28.5	107.5	62.9	48.6	43.7	NCB
95th Percentile	mg/L	52.6	107.7	67.9	61.3	58.9	NCB
Maximum	mg/L	53.1	107.7	67.9	61.4	59.0	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	15.7	107.4	62.9	48.6	43.7	NCB
95th Percentile	mg/L	15.7	107.4	67.9	61.3	58.9	NCB
Maximum	mg/L	15.7	107.4	67.9	61.4	59.0	NCB

(a) The Perch Lake existing baseline chloride concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline chloride concentrations in Perch Lake were only available from 2018 (average = 26.2 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in chloride is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Chromium

The maximum projected wastewater concentration for chromium (0.25 µg/L) is lower than the treated effluent discharge target (8.9 µg/L), so treatment of this constituent prior to discharge is not required for discharge. However, for conservatism mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline chromium concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed up to the Ottawa River ranged between 0.768 and 1.38 µg/L. The baseline concentration at ESW was slightly above the effluent discharge target.

Except for ESW, all modelled chromium concentrations were below the treated effluent discharge target and the risk benchmark (1,700 µg/L), suggesting that chromium is a low-priority COPC where organism-level effects are unlikely. Projected chromium concentrations at all assessment nodes were consistent with background concentrations.

Some attenuation of chromium through the Perch Creek and Perch Lake Watershed downstream to PL2 is discernible; however, incremental changes in chromium concentration as a result of the NSDF Project are unlikely to be measurable in the Ottawa River. The water quality modelling results for chromium are presented in Table 3-9.

Table 3-9: Water Quality Modeling Results for Chromium

Chromium	Units	ESW	PL2	PL[a]	PCW	PCO	OR
Criteria	µg/L	EDT: 1[b]; RB: 1,700					
Existing Baseline Concentration	µg/L	1.38	0.77	0.77	0.88	0.88[c]	0.87
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	1.33	0.85	0.60	0.46	0.42	0.87
95th Percentile	µg/L	1.38	0.86	0.64	0.59	0.56	0.87
Maximum	µg/L	1.38	0.86	0.64	0.59	0.56	0.87
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	1.38	0.85	0.60	0.46	0.42	0.87
95th Percentile	µg/L	1.38	0.85	0.64	0.59	0.56	0.87
Maximum	µg/L	1.38	0.85	0.64	0.59	0.56	0.87

Note: Shading = exceedance of treated effluent discharge target.

(a) The Perch Lake existing baseline chromium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline chromium concentrations in Perch Lake were only available from 2018 (average = 3.0 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) The EDT is based on the CCME water quality protection of aquatic life guideline for Cr(VI).

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Cobalt

The maximum projected wastewater concentration for cobalt (2.7 µg/L) is higher than the treated effluent discharge target (0.9 µg/L), so treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target concentration and assumed that treated discharge will consistently meet the effluent discharge target.

Cobalt existing baseline concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 0.24 to 0.45 µg/L. No baseline cobalt data were available for the Ottawa River.

Modelled concentrations of cobalt at all assessment nodes were below the treated effluent discharge target and the risk benchmark (1,500 µg/L), suggesting that cobalt is a low-priority COPC where organism-level effects are unlikely. In the combined discharge scenario, slightly higher projected cobalt concentrations are shown in ESW and PL2 compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake; however, the concentrations at these locations remained well below benchmarks.

Except for the modelled cobalt concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations were similar to existing baseline concentrations. Incremental changes in cobalt concentration as a result of the NSDF Project are therefore expected not to be measurable in the Ottawa River. The water quality modelling results for cobalt are presented in Table 3-10.

Table 3-10: Water Quality Modeling Results for Cobalt

Cobalt	Units	ESW	PL2	PL(a)	PCW	PCO	OR(b)
Criteria	µg/L	EDT: 0.9; RB: 1,500					
Existing Baseline Concentration	µg/L	0.450	0.330	0.351	0.240	0.240(c)	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.505	0.356	0.278	0.215	0.194	NCB
95th Percentile	µg/L	0.609	0.366	0.299	0.274	0.263	NCB
Maximum	µg/L	0.611	0.366	0.299	0.274	0.264	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.450	0.351	0.278	0.215	0.194	NCB
95th Percentile	µg/L	0.450	0.351	0.299	0.274	0.263	NCB
Maximum	µg/L	0.450	0.351	0.299	0.274	0.264	NCB

(a) The Perch Lake existing baseline cobalt concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline cobalt concentration data for Perch Lake were only available from 2018 (average = 0.1 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in cobalt is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Copper

The maximum projected wastewater concentration for copper (0.8 µg/L) is lower than the treated effluent discharge target (2.0 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Copper existing baseline concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed ranged from 3.48 to 8.94 µg/L; the existing baseline concentration for the Ottawa River was 4.7 µg/L. These concentrations are higher than the treated effluent discharge target, and possibly higher than the risk benchmark (when exposure and toxicity modifying factors are accounted for). Also, the existing baseline concentration for the Ottawa River is naturally elevated in comparison to the treated effluent discharge target and the CCME guideline for the protection of aquatic life (CCME 1999).

As observed for chloride, modelled copper concentrations showed an incremental increase at PL2 for both discharge scenarios. The source of this elevated concentration at this assessment node is attributed to an elevated background concentration measured at MSC in 2018 (one of the CRL monitoring stations upstream of Perch Lake), which was incorporated into the flow-weighted background concentration calculations for PL2.

All projected concentrations remained similar to existing baseline concentrations, and above the treated effluent discharge target. However, any incremental increases in copper as a result of the NSDF Project are expected not to be measurable at the assessment nodes and the Ottawa River, especially in the context of copper background concentrations in the Ottawa River. The water quality modelling results for copper are presented in Table 3-11.

Table 3-11: Water Quality Modeling Results for Copper

Copper	Units	ESW	PL2	PL[a]	PCW	PCO	OR
Criteria	µg/L	EDT: 2.0; RB: Narrative[b]					
Measured Background Concentration	µg/L	**3.48**	**7.88**	**6.90**	**8.94**	**8.94[c]**	**4.7**
Scenario 1 - Nine Closed Cells, One Active Cell, 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	**3.30**	**8.37**	**5.71**	**4.42**	**3.98**	**4.7**
95th Percentile	µg/L	**3.48**	**8.42**	**6.17**	**5.60**	**5.38**	**4.7**
Maximum	µg/L	**3.48**	**8.42**	**6.17**	**5.60**	**5.38**	**4.7**
Scenario 2 - Nine Closed Cells, One Active Cell, 100% Direct Discharge to Perch Lake							
Mean	µg/L	**3.48**	**8.42**	**5.71**	**4.42**	**3.98**	**4.7**
95th Percentile	µg/L	**3.48**	**8.42**	**6.17**	**5.60**	**5.38**	**4.7**
Maximum	µg/L	**3.48**	**8.42**	**6.17**	**5.60**	**5.38**	**4.7**

Notes: Shading = exceedance of treated effluent discharge target

Shading and bold = concentration higher than the effluent discharge limit and risk benchmark

(a) The Perch Lake existing baseline copper concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline copper concentrations in Perch Lake were only available from 2018 (average = 9.7 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) Risk benchmark is dependent on other water quality factors (exposure and toxicity modifying factors) that may modify potential toxicity (e.g., water hardness).

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Fluoride

The maximum projected wastewater concentration for fluoride (0.12 mg/L) is equivalent to the treated effluent discharge target (0.12 mg/L), so targeted treatment of this constituent prior to discharge is not required. Mass loading inputs to the water quality model for the operational discharge scenarios assumed that treated discharge will consistently meet the treated effluent discharge target.

There were no existing baseline fluoride concentrations for the assessment nodes in the Perch Creek and Perch Lake Watershed or the Ottawa River. For the modelling scenarios, a background concentration of zero was assigned to each node, with modelled projections providing an indication of the incremental increase at each of the assessment nodes.

All modelled concentrations were below the treated effluent discharge target (considering no available existing baseline data) and were below the risk benchmark (3 mg/L). Higher projected fluoride concentrations are evident in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled fluoride concentrations at ESW and PL2 during operations for the combined discharge, fluoride is assumed to remain similar to existing baseline concentrations through the downstream Perch Creek and Perch Lake Watershed.

As a result, any incremental changes to fluoride concentrations as a result of the NSDF Project are expected to not be measurable in the Ottawa River. The water quality modelling results for fluoride are presented in Table 3-12.

Table 3-12: Water Quality Modeling Results for Fluoride

Fluoride	Units	ESW	PL2	PL	PCW	PCO	OR[a]
Criteria	mg/L	EDT: 0.12; RB: 3					
Existing Baseline Concentration	mg/L	No data	No data	No data	No data	No data	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	0.015	0.001	0.001	0.001	0.001	NCB
95th Percentile	mg/L	0.042	0.003	0.001	0.001	0.001	NCB
Maximum	mg/L	0.043	0.003	0.001	0.001	0.001	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	NCB	NCB	0.001	0.001	0.001	NCB
95th Percentile	mg/L	NCB	NCB	0.001	0.001	0.001	NCB
Maximum	mg/L	NCB	NCB	0.001	0.001	0.001	NCB

(a) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

A modelled result showing 'NCB' indicates that an incremental increase in fluoride is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Hardness

The maximum projected wastewater value for hardness (354 mg/L) is higher than the treated effluent discharge target (80 to 100 mg/L), so treatment of this constituent prior to discharge is required. The treated effluent discharge target is based on drinking water quality guidelines (Health Canada 2017) as opposed to guidelines for the protection of aquatic life. Hardness levels between 80 and 100 mg/L (as calcium carbonate) mitigate the potential for damage to reticulation systems (i.e., through corrosion or scaling). In addition, hardness is an ETMF, which can influence the potential toxicity of some water quality parameters (e.g., cadmium, copper, nickel, silver, zinc) to aquatic organisms by affecting their environmental fate, behaviour, and bioavailability. Other ETMFs include dissolved organic carbon and pH. Mass loading inputs to the water quality model for the operational discharge scenarios conservatively used the maximum projected wastewater value of 354 mg/L.

Existing baseline hardness values in the Perch Creek and Perch Lake Watershed ranged between 28 to 61 mg/L. No hardness values were available for the Ottawa River.

All modelled hardness values were below the lower bound or within the drinking water treated effluent discharge target range, with the exception of the 95th Percentile and Maximum concentrations at ESW for Scenario 1. Higher projected hardness values are shown in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled hardness at ESW and PL2 during operations for the combined discharge, hardness is assumed to remain similar to background concentrations through the downstream Perch Creek and Perch Lake Watershed.

Any incremental increases in hardness downstream of Perch Lake as a result of the NSDF Project are expected not to be measurable in the Ottawa River. The water quality modelling results for hardness are presented in Table 3-13.

Table 3-13: Water Quality Modeling Results for Hardness

hardness	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	mg/L	EDT: 80 to 100[(c)]; RB: No data					
Existing Baseline Concentration	mg/L	61	31	28	30	30[(d)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	97	43	28	22	20	NCB
95th Percentile	mg/L	164	49	30	28	27	NCB
Maximum	mg/L	166	49	30	28	27	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	61	40	28	22	20	NCB
95th Percentile	mg/L	61	40	30	28	27	NCB
Maximum	mg/L	61	40	30	28	27	NCB

Note: Shading = exceedance of treated effluent discharge target

(a) The Perch Lake existing baseline hardness is based on a flow-weighted calculation using all available upstream data sources. Existing baseline hardness in Perch Lake is only available from 2018 (average = 25 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) Optimal range for drinking water (CNL 2017c; Health Canada 2009).

(d) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing ‘NCB’ indicates that an incremental increase in hardness is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Iron

The maximum projected wastewater concentration for iron (125 mg/L) is higher than the treated effluent discharge target (0.3 mg/L), so targeted treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet this discharge concentration.

Existing baseline iron concentrations at the assessment in the Perch Creek and Perch Lake Watershed and the Ottawa River ranged between 0.5 and 2.87 mg/L. These concentrations are all above the treated effluent discharge target.

The projected concentrations of iron at each of the assessment nodes remained above the treated effluent discharge target for each of the discharge scenarios but were below the risk benchmark (3.4 mg/L). The modelled concentrations remained similar to the existing background concentrations. Therefore, any incremental increase in iron through the Perch Creek and Perch Lake Watershed as a result of the NSDF Project is therefore expected not to be measurable in the Ottawa River. The water quality modelling results for iron are presented in Table 3-14.

Table 3-14: Water Quality Modeling Results for Iron

Iron	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	mg/L	EDT: 0.3; RB: 3.4					
Existing Baseline Concentration	mg/L	2.87	2.56	2.07	1.65	1.65[(b)]	0.5
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	2.55	2.74	1.68	1.30	1.17	0.5
95^{th} Percentile	mg/L	2.87	2.76	1.82	1.64	1.58	0.5
Maximum	mg/L	2.87	2.76	1.82	1.65	1.58	0.5
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	2.87	2.76	1.68	1.30	1.17	0.5
95^{th} Percentile	mg/L	2.87	2.76	1.82	1.64	1.58	0.5
Maximum	mg/L	2.87	2.76	1.82	1.65	1.58	0.5

Note: Shading = concentration higher than the treated effluent discharge target

(a) The Perch Lake existing baseline iron concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline iron concentrations in Perch Lake were only available from 2018 (average = 1.34 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Lead

The maximum projected wastewater concentration for lead (0.024 µg/L) is lower than the treated effluent discharge target (1.0 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline lead concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed and the Ottawa River ranged between 1.17 and 5.9 µg/L. These background concentrations are all above the effluent discharge limit.

Almost all of the projected concentrations of lead at the assessment nodes were above the treated effluent discharge target for each of the discharge scenarios; the exceptions being mean modelled concentrations at PCO for each scenario, which were projected to be at the treated effluent discharge target. Despite the modelled exceedances, they remained below the risk benchmark (7 mg/L) and similar to existing baseline concentrations. Like chloride and copper, modelled lead concentrations showed a further incremental increase at PL2 for both discharge scenarios. The source of this elevated concentration at this assessment node is attributed to an elevated background concentration at MSC measured in 2018, which was incorporated into the flow-weighted background concentration calculations for PL2.

Any incremental increase in lead through the Perch Creek and Perch Lake Watershed as a result of the NSDF Project is therefore expected not to be measurable in the Ottawa River. The water quality modelling results for lead are presented in Table 3-15.

Table 3-15: Water Quality Modeling Results for Lead

Lead	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 1.0; RB: 7					
Existing Baseline Concentration*	µg/L	1.17	1.94	1.94	2.10	2.10[(b)]	5.9
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	1.15	2.00	1.44	1.11	1.00	5.9
95th Percentile	µg/L	1.17	2.01	1.55	1.42	1.36	5.9
Maximum	µg/L	1.17	2.01	1.55	1.42	1.36	5.9
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	1.17	2.01	1.44	1.11	1.00	5.9
95th Percentile	µg/L	1.17	2.01	1.55	1.42	1.36	5.9
Maximum	µg/L	1.17	2.01	1.55	1.42	1.36	5.9

Note: Shading = concentration higher than the treated effluent discharge target

(a) The Perch Lake existing baseline lead concentration is based on a flow-weighted approach using all available upstream data sources. Existing baseline lead concentrations in Perch Lake were only available from 2018 (average = 8.0 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Magnesium

The maximum projected wastewater concentration for magnesium (68 mg/L) is lower than the treated effluent discharge target (82 mg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline magnesium concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed ranged between 2.328 and 2.53 µg/L. No baseline magnesium data were available for the Ottawa River.

Higher projected magnesium concentrations were modelled for ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Like calcium, magnesium does not have a protection of aquatic life guideline as there is no evidence of adverse effects from magnesium, but it is a major contributing ion to hardness. Except for the modelled magnesium concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations were similar to background concentrations.

Slight attenuation of magnesium through the Perch Creek and Perch Lake Watershed downstream of PL2 is discernible; however, incremental changes in calcium concentration as a result of the NSDF Project are expected not to be measurable in the Ottawa River. The water quality modelling results for magnesium are presented in Table 3-16.

Table 3-16: Water Quality Modeling Results for Magnesium

Magnesium	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	mg/L	EDT: 82; RB: No data					
Existing Baseline Concentration	mg/L	2.530	2.328	2.369	2.494	2.494[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	12.241	3.089	2.352	1.823	1.641	NCB
95th Percentile	mg/L	30.627	4.551	2.545	2.352	2.260	NCB
Maximum	mg/L	31.048	4.599	2.545	2.353	2.262	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	2.530	2.448	2.352	1.823	1.641	NCB
95th Percentile	mg/L	2.530	2.448	2.545	2.352	2.260	NCB
Maximum	mg/L	2.530	2.448	2.545	2.353	2.262	NCB

(a) The Perch Lake existing baseline magnesium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline magnesium concentrations in Perch Lake were only available from 2018 (average = 2.16 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in magnesium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Manganese

The maximum projected wastewater concentration for manganese (5,800 µg/L) is higher than the treated effluent discharge target (120 µg/L), so treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet this discharge concentration.

Existing baseline manganese concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 52 to 130 µg/L, with the PCW background concentration (and therefore PCO) just above the treated effluent discharge target. No baseline manganese data were available for the Ottawa River.

All modelled projected concentrations for the assessment nodes were below the treated effluent discharge target and the risk benchmark (2,300 µg/L), suggesting that manganese is a low-priority COPC where organism-level effects are unlikely. Slightly higher projected 95th Percentile and Maximum manganese concentrations are shown in ESW in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Despite this exception, all other modelled concentrations were similar to, or less than, existing baseline concentrations, with a discernible attenuation downstream of PL2. Incremental changes in manganese concentration as a result of the NSDF Project are therefore expected not to be measurable in the Ottawa River. The water quality modelling results for manganese are presented in Table 3-17.

Table 3-17: Water Quality Modeling Results for Manganese

Manganese	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 120; RB: 2,300					
Measured Background Concentration	µg/L	84	52	64	130	130[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	88	56	47	36	33	NCB
95th Percentile	µg/L	97	58	50	46	45	NCB
Maximum	µg/L	97	58	50	46	45	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	84	56	47	36	33	NCB
95th Percentile	µg/L	84	56	50	46	45	NCB
Maximum	µg/L	84	56	50	46	45	NCB

Note: Shading = concentration higher than the treated effluent discharge target.

(a) The Perch Lake existing baseline manganese concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline manganese concentrations in Perch Lake were only available from 2018 (average = 56 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in manganese is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Mercury

The maximum projected wastewater concentration for mercury (0.0023 µg/L) is lower than the treated effluent discharge target (0.026 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline mercury concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed and the Ottawa River ranged from 0.004 to 0.009 µg/L, which are below the treated effluent discharge target.

All modelled mercury concentrations were below the treated effluent discharge limit target and the risk benchmark (2.4 µg/L), suggesting that mercury is a low-priority COPC suggesting that manganese is a low-priority COPC where organism-level effects are unlikely. Slightly higher projected mercury concentrations are shown in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled mercury concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations were similar to background concentrations.

The incremental increase in mercury as a result of the NSDF Project at all assessment nodes is negligible. The water quality modelling results for mercury are presented in Table 3-18.

Table 3-18: Water Quality Modeling Results for Mercury

Mercury	Units	ESW	PL2	PL(a)	PCW	PCO	OR
Criteria	µg/L	EDT: 0.026; RB: 2.4					
Existing Baseline Concentration	µg/L	0.009	0.007	0.007	0.006	0.006(b)	0.004
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.011	0.008	0.006	0.005	0.004	0.004
95th Percentile	µg/L	0.015	0.009	0.006	0.006	0.006	0.004
Maximum	µg/L	0.015	0.009	0.006	0.006	0.006	0.004
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.008	0.008	0.006	0.005	0.004	0.004
95th Percentile	µg/L	0.008	0.008	0.006	0.006	0.006	0.004
Maximum	µg/L	0.008	0.008	0.006	0.006	0.006	0.004

(a) The Perch Lake existing baseline mercury concentration is based on a flow-weighted calculation using all available upstream data sources. Baseline mercury concentrations specifically for Perch Lake were not available.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Molybdenum

The maximum projected wastewater concentration for molybdenum (3.9 µg/L) is lower than the treated effluent discharge target (40 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, the mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline molybdenum concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The molybdenum concentrations were consistently measured at 0.300 µg/L. No baseline molybdenum data were available for the Ottawa River.

All modelled concentrations were below the treated effluent discharge target and the risk benchmark (16,000 µg/L), meaning that molybdenum is a low-priority COPC, where organism-level effects are unlikely. Higher projected molybdenum concentrations are shown in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake; however, the concentrations at this location remained well below the risk benchmark.

A discernible attenuation in molybdenum concentrations is projected downstream of PL2, with incremental changes in concentration in the Perch Creek assessment nodes above existing concentrations. However, increases in molybdenum as a result of the NSDF Project in the Ottawa River are expected not to be measurable. The water quality modelling results for molybdenum are presented in Table 3-19.

Table 3-19: Water Quality Modeling Results for Molybdenum

Molybdenum	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	µg/L	EDT: 40; RB: 16,000					
Existing Baseline Concentration	µg/L	0.300	0.300	0.300	0.300	0.300[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
mg/L	µg/L	5.151	0.634	0.519	0.402	0.362	NCB
mg/L	µg/L	14.336	1.364	0.596	0.529	0.508	NCB
mg/L	µg/L	14.546	1.387	0.597	0.529	0.508	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
mg/L	µg/L	0.300	0.314	0.519	0.402	0.362	NCB
mg/L	µg/L	0.300	0.314	0.596	0.529	0.508	NCB
mg/L	µg/L	0.300	0.314	0.597	0.529	0.508	NCB

(a) The Perch Lake existing baseline molybdenum concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline molybdenum concentrations in Perch Lake were only available from 2018 (average = 0.300 µg/L), which was consistent with the flow-weighted average calculation.

(b) All results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in molybdenum is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Nickel

The maximum projected wastewater concentration for nickel (0.055 µg/L) is lower than the treated effluent discharge target (25 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline nickel concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed ranged from 0.786 to 1.46 µg/L. The background nickel concentration for the Ottawa River was 14.5 µg/L, approximately ten times the range of background Perch Creek and Perch Lake Watershed concentrations.

All modelled concentrations were below the treated effluent discharge target and the risk benchmark (1,400 µg/L), suggesting that nickel is a low-priority COPC, where organism-level effects are unlikely. Higher projected nickel concentrations are shown in ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake; however, the concentrations at these locations prior to Perch Lake remained well below the risk benchmark. Except for the modelled nickel concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations were consistent with existing baseline concentrations.

Incremental changes in nickel concentration in the Ottawa River as a result of the NSDF Project are expected to be negligible (concentration changes in the Ottawa River are projected not to be measurable). The water quality modelling results for nickel are presented in Table 3-20.

Table 3-20: Water Quality Modeling Results for Nickel

Nickel	Units	ESW	PL2	PL(a)	PCW	PCO	OR
Criteria	µg/L	EDT: 25; RB: 1,400					
Existing Baseline Concentration	µg/L	0.960	0.786	0.938	1.460	1.460(b)	14.5
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
mg/L	µg/L	3.898	1.029	0.831	0.644	0.580	14.5
mg/L	µg/L	9.460	1.474	0.900	0.832	0.800	14.5
mg/L	µg/L	9.587	1.488	0.900	0.833	0.800	14.5
Scenario 2 - 100% Direct Discharge to Perch Lake							
mg/L	µg/L	0.960	0.835	0.831	0.644	0.580	14.5
mg/L	µg/L	0.960	0.835	0.900	0.832	0.800	14.5
mg/L	µg/L	0.960	0.835	0.900	0.833	0.800	14.5

(a) The Perch Lake existing baseline nickel concentration is based on a flow-weighted calculation using all upstream data sources. Existing baseline nickel concentrations in Perch Lake were only available from 2018 (average = 4.0 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Nitrate

All mention of nitrate herein refers specifically to nitrate as nitrogen (i.e., NO_3-N).

The maximum projected wastewater concentration for nitrate (6.6 mg N/L) is higher than the treated effluent discharge target (2.93 mg N/L), so treatment of this constituent prior to discharge is required. The mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet this discharge concentration.

Existing baseline concentrations for nitrate at the assessment nodes in the Perch Creek and Perch Lake Watershed ranged from 0.029 to 0.055 mg N/L. The background concentration determined for the Ottawa River was 0.18 mg N/L.

All modelled nitrate concentrations were below the treated effluent discharge target and the risk benchmark (124 mg N/L), suggesting that nitrate is a low-priority COPC where organism-level effects are unlikely. Higher nitrate concentrations are projected for ESW and PL2, particularly ESW, in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake.

Nitrate concentrations attenuate downstream of Perch Lake, with incremental changes in concentration in the Ottawa River as a result of the NSDF Project expected not to be measurable. The water quality modelling results for nitrate are presented in Table 3-21.

Table 3-21: Water Quality Modeling Results for Nitrate

Nitrate	Units	ESW	PL2	PL[a]	PCW	PCO	OR
Criteria	mg N/L	EDT: 2.93; RB: 124					
Existing Baseline Concentration	mg N/L	0.055	0.037	0.029	0.053	0.053[b]	0.18
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg N/L	0.854	0.128	0.093	0.072	0.065	0.18
95th Percentile	mg N/L	2.369	0.248	0.106	0.094	0.090	0.18
Maximum	mg N/L	2.403	0.252	0.106	0.094	0.090	0.18
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg N/L	0.055	0.076	0.093	0.072	0.065	0.18
95th Percentile	mg N/L	0.055	0.076	0.106	0.094	0.090	0.18
Maximum	mg N/L	0.055	0.076	0.106	0.094	0.090	0.18

(a) The Perch Lake existing baseline nitrate concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline nitrate concentrations in Perch Lake were only available from 2018 (average = 0.121 mg N/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; mg N/L = milligrams per litre as nitrogen; EDT = treated effluent discharge target; RB = risk benchmark.

Nitrite

The maximum projected wastewater concentration for nitrite (0.09 mg/L as Nitrogen; mg N/L) is higher than the treated effluent discharge target (0.06 mg N/L), so treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet this discharge concentration.

Existing baseline concentration data for nitrite in the Perch Creek and Perch Lake Watershed and Ottawa River were not available. A background concentration of zero was assigned to each node. As a result, modelling results for the Ottawa River are limited to only providing an indication of the projected incremental increase.

In all scenarios, modelled nitrite concentrations at all assessment nodes in the Perch Creek and Perch Lake Watershed remain below the treated effluent discharge target of 0.06 mg/L. It is acknowledged that these modelled projections for nitrite may not represent the most conservative case due to lacking existing baseline information; however, results indicate that nitrite concentrations are rapidly assimilated through the watershed and have a non-discernible overall net effect on Ottawa River. Nitrite concentrations in the Ottawa River expressed as below the method detection limit (MDL) indicate no measurable incremental increase above background. The water quality modelling results for nitrite are presented in Table 3-22.

Table 3-22: Water Quality Modeling Results for Nitrite

Nitrite	Units	ESW[a]	PL2[a]	PL[a]	PCW[a]	PCO[a]	OR[a]
Criteria	mg N/L	EDT: 0.06; RB: Narrative[b]					
Existing Baseline Concentration	mg N/L	No data	No data	No data	No data	No data	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg N/L	0.037	0.002	0.002	0.002	0.002	NCB
95th Percentile	mg N/L	0.106	0.008	0.003	0.002	0.002	NCB
Maximum	mg N/L	0.108	0.008	0.003	0.002	0.002	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg N/L	<MDL	<MDL	0.002	0.002	0.002	NCB
95th Percentile	mg N/L	<MDL	<MDL	0.003	0.002	0.002	NCB
Maximum	mg N/L	<MDL	<MDL	0.003	0.002	0.002	NCB

Note: Shading = concentration higher than the treated effluent discharge target

(a) All Perch Lake and OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(b) The risk benchmark varies with chloride (AESRD 2014). For chloride concentrations greater than 10 mg/L, the risk benchmark nitrite concentration = 0.6 mg N/L.

A modelled result showing 'NCB' indicates that an incremental increase in nitrite is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; mg N/L = milligrams per litre as nitrogen; EDT = treated effluent discharge target; RB = risk benchmark.

Phosphorus

The maximum projected wastewater concentration for phosphorus (0.221 mg/L) is higher than the treated effluent discharge target (0.01 mg/L), so treatment of this constituent prior to discharge is required. The treatability of phosphorus in the wastewater is considered high. Therefore, there is confidence in the ability to meet the treated effluent discharge target for phosphorus.

This specific treated effluent discharge target is not toxicity- or risk-based but is associated with the transition between lake and steam productivity (or trophic status) characteristics (Environment Canada 2014). Limiting the load of phosphorus in a discharge to a receiving environment is a mitigation tool to manage the risk of increasing productivity in a receiving environment. Increasing the potential for productivity can increase plankton and fish biomass, but can also result in changes to oxygen regimes and diel cycling and, which can indirectly affect aquatic habitat.

Existing baseline phosphorus concentrations at the assessment nodes in the Perch Creek and Perch Lake Watershed and the Ottawa River ranged from 0.04 to 0.06 mg/L. According to Environment Canada (2004), the assessment nodes within the Perch Creek and Perch Lake Watershed can thus be characterized as eutrophic, and the Ottawa River as meso-eutrophic.

All modelled concentrations were above the treated effluent discharge target. Higher projected phosphorus concentrations are shown at ESW in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Increases in phosphorus at ESW will not result in any direct risk to aquatic biota, but it suggests that productivity has the potential to increase in the wetland systems upstream of Perch Lake. Except for the modelled phosphorus concentrations at ESW during operations for the combined discharge, modelled concentrations at all other downstream assessment nodes, including Perch Lake, remained similar to existing baseline concentrations.

The modelling indicated that incremental changes to phosphorus concentrations in the Ottawa River as a result of the NSDF Project are expected not to be measurable. The water quality modelling results for phosphorus are presented in Table 3-23.

Table 3-23: Water Quality Modeling Results for Phosphorus

Phosphorus	Units	ESW	PL2	PL[a]	PCW	PCO	OR
Criteria	mg/L	EDT: 0.01; RB: No data					
Existing Baseline Concentration	mg/L	0.06	0.05	0.06	0.04	0.04[b]	0.05
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	0.08	0.06	0.04	0.03	0.03	0.05
95th Percentile	mg/L	0.12	0.06	0.05	0.04	0.04	0.05
Maximum	mg/L	0.12	0.06	0.05	0.04	0.04	0.05
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	0.06	0.06	0.04	0.03	0.03	0.05
95th Percentile	mg/L	0.06	0.06	0.05	0.04	0.04	0.05
Maximum	mg/L	0.06	0.06	0.05	0.04	0.04	0.05

Note: Shading = concentration higher than the treated effluent discharge target

(a) The Perch Lake existing baseline phosphorus concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline phosphorus concentrations in Perch Lake were only available from 2018 (average = 0.21 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Potassium

The maximum projected wastewater concentration for potassium (26 mg/L) is lower than the treated effluent discharge target (53 mg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline potassium concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 0.912 to 1.012 mg/L. No baseline data were available for the Ottawa River.

Modelled potassium concentrations at all assessment nodes for each discharge scenario remained below the treated effluent discharge target. Higher potassium concentrations are projected for ESW and PL2 in the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled potassium concentrations at ESW and PL2 during operations for the combined discharge, and Perch Lake under both scenarios, all other modelled concentrations were similar to existing baseline concentrations.

The incremental increase in potassium to the Ottawa River as a result of the NSDF Project is expected not to be measurable. The water quality modelling results for potassium are presented in Table 3-24.

Table 3-24: Water Quality Modeling Results for Potassium

Potassium	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	mg/L	EDT: 53; RB: No data					
Existing Baseline Concentration	mg/L	1.001	0.912	0.949	1.012	1.012[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	7.355	1.379	1.090	0.845	0.761	NCB
95th Percentile	mg/L	19.386	2.336	1.189	1.097	1.054	NCB
Maximum	mg/L	19.661	2.367	1.190	1.097	1.055	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	1.001	0.959	1.090	0.845	0.761	NCB
95th Percentile	mg/L	1.001	0.959	1.189	1.097	1.054	NCB
Maximum	mg/L	1.001	0.959	1.190	1.097	1.055	NCB

(a) The Perch Lake existing baseline potassium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline potassium concentrations in Perch Lake were only available from 2018 (average = 1.021 mg/L) The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in potassium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Selenium

The maximum projected wastewater concentration for selenium (0.048 µg/L) is lower than the treated effluent discharge target (1 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline selenium concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 0.3 to 0.9 µg/L. No existing baseline data were available for the Ottawa River.

Modelled concentrations remained similar to existing baseline concentrations and below the treated effluent discharge target, except for PL2 under both scenarios. Exceedances to the effluent discharge target discharge limit at PL2 under both discharge scenarios are attributed to an elevated concentration of 1.333 µg/L at MSC measured in 2018, which was incorporated into the flow-weighted background concentration calculations for PL2.

This elevated source was also seen for chloride, copper, and lead. The projected selenium concentration at PL2 was well below the risk benchmark (20 µg/L).

Downstream of Perch Lake, selenium concentrations showed a discernible attenuation. Any incremental increases in selenium as a result of the NSDF Project to the Ottawa River are expected not to be measurable. The water quality modelling results for selenium are presented in Table 3-25.

Table 3-25: Water Quality Modeling Results for Selenium

Selenium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 1; RB: 20					
Existing Baseline Concentration	µg/L	0.614	0.900	0.791	0.300	0.300[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.661	1.281	0.827	0.640	0.576	NCB
95th Percentile	µg/L	0.751	1.283	0.893	0.810	0.778	NCB
Maximum	µg/L	0.753	1.283	0.893	0.810	0.778	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.614	1.283	0.827	0.640	0.576	NCB
95th Percentile	µg/L	0.614	1.283	0.893	0.810	0.778	NCB
Maximum	µg/L	0.614	1.283	0.893	0.810	0.778	NCB

Notes: Shading = concentration higher than the treated effluent discharge target.

(a) The Perch Lake existing baseline selenium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline selenium concentrations in Perch Lake were only available from 2018 (average = 0.300 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in selenium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Silver

The maximum projected wastewater concentration for silver (0.0032 µg/L) is lower than the treated effluent discharge target (0.1 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline silver concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations were consistently 1 µg/L, which is above the treated effluent discharge target, but below the risk benchmark (4.1 µg/L). No background data were available for the Ottawa River.

Modelled concentrations at all assessment nodes and each scenario are projected to remain within existing baseline concentrations. Further, with distance downstream, the modelled projections indicated some attenuation. As a consequence, any incremental changes to silver concentrations in the Ottawa River as a result of the NSDF

Project are expected not to be measurable. The water quality modelling results for silver are presented in Table 3-26.

Table 3-26: Water Quality Modeling Results for Silver

Silver	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	µg/L	EDT: 0.1; RB: 4.1					
Existing Baseline Concentration	µg/L	1.000	1.000	1.000	1.000	1.000[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.890	1.040	0.740	0.573	0.516	NCB
95th Percentile	µg/L	1.000	1.047	0.798	0.728	0.699	NCB
Maximum	µg/L	1.000	1.047	0.798	0.728	0.700	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	1.000	1.047	0.740	0.573	0.516	NCB
95th Percentile	µg/L	1.000	1.047	0.798	0.728	0.699	NCB
Maximum	µg/L	1.000	1.047	0.798	0.728	0.700	NCB

Note: Shading = concentration higher than the treated effluent discharge target.

(a) The Perch Lake existing baseline silver concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline silver concentrations in Perch Lake were only available from 2018 (average = 1.000 µg/L), which was consistent with the flow-weighted calculation.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in silver is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Sodium

The maximum projected wastewater concentration for sodium (100 mg/L) is lower than the treated effluent discharge target (680 mg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline concentrations for sodium in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 8.4 to 24.6 mg/L. No background data were available for the Ottawa River.

Sodium concentrations at all assessment nodes in the Perch Creek and Perch Lake Watershed remained below the treated effluent discharge target. Higher projected sodium concentrations are modelled in ESW and PL2 in the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. As expected, incremental increases in Perch Lake are evident and consistent in both modelled discharge scenarios. Attenuation of sodium through the Perch Creek and Perch Lake Watershed is discernible, with incremental changes in concentration as a result of the NSDF Project unlikely to be measurable in the Ottawa. The water quality modelling results for sodium are presented in Table 3-27.

Table 3-27: Water Quality Modeling Results for Sodium

Sodium	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	mg/L	EDT: 680; RB: No data					
Existing Baseline Concentration	mg/L	8.4	24.6	19.3	12.3	12.3[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	90.5	30.3	20.7	16.0	14.4	NCB
95th Percentile	mg/L	245.9	42.3	22.3	20.6	19.8	NCB
Maximum	mg/L	249.4	42.7	22.3	20.6	19.8	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	8.4	25.0	20.7	16.0	14.4	NCB
95th Percentile	mg/L	8.4	25.0	22.3	20.6	19.8	NCB
Maximum	mg/L	8.4	25.0	22.3	20.6	19.8	NCB

(a) The Perch Lake existing baseline sodium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline sodium concentrations in Perch Lake were only available from 2018 (average = 14.0 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in sodium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Strontium

The maximum projected wastewater concentration for strontium (100 µg/L) is lower than the treated effluent discharge target (1,500 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline strontium concentrations in the Perch Creek and Perch Lake Watershed ranged from 39.5 to 45 µg/L. The existing baseline concentration for the Ottawa River was 28.3 µg/L.

All modelled concentrations were below the treated effluent discharge target and were below the risk benchmark (15,000 µg/L), indicating strontium is a low-priority COPC where organism-level effects are unlikely. Higher strontium concentrations are projected in ESW and PL2 under the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Under Scenario 2, the 100% discharge to Perch Lake, an incremental increase in strontium was evident at PL2; like chloride, copper, lead, and selenium, this increase is attributable to an elevated concentration at MSC measured in 2018, which was incorporated into the flow-weighted background concentration calculations for PL2.

Attenuation of strontium through the Perch Creek and Perch Lake Watershed is discernible, with modelled concentrations around background at PCW. Any incremental changes in concentration as a result of the NSDF Project in the Ottawa River are expected not to be measurable. The water quality modelling results for strontium are presented in Table 3-28.

Table 3-28: Water Quality Modeling Results for Strontium

Strontium	Units	ESW	PL2	PL(a)	PCW	PCO	OR
Criteria	µg/L	EDT: 1,500; RB: 15,000					
Existing Baseline Concentration	µg/L	39.5	44.5	45.0	43.4	43.4(b)	28.3
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	218.0	73.2	53.4	41.3	37.2	28.3
95th Percentile	µg/L	555.9	99.7	57.4	53.1	51.0	28.3
Maximum	µg/L	563.6	100.5	57.4	53.1	51.0	28.3
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	39.5	61.6	53.4	41.3	37.2	28.3
95th Percentile	µg/L	39.5	61.6	57.4	53.1	51.0	28.3
Maximum	µg/L	39.5	61.6	57.4	53.1	51.0	28.3

(a) The Perch Lake existing baseline strontium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline strontium concentrations in Perch Lake were only available from 2018 (average = 41.0 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Sulphate

The maximum projected wastewater concentration for sulfate (634 mg/L) is higher than the treated effluent discharge target (128 mg/L) so treatment of this constituent prior to discharge is required. The mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet this discharge concentration.

Existing baseline sulfate concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to the assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged between 1.25 to 2.79 mg/L. No background data were available for the Ottawa River; modelled projections for the river are limited to only providing an estimate of the incremental increase of sulfate.

Modelled concentrations at all assessment nodes were below the treated effluent discharge target except for the 95th Percentile and Maximum concentrations at ESW. This treated effluent discharge target is linked to the British Columbia Ministry of the Environment guideline for sulphate (BC MOE 2013), which is hardness dependent. The sulphate effluent discharge limit of 128 mg/L is applicable to waters with a hardness of 0 to 30 mg/L; the corresponding 95th Percentile and Maximum projected hardness values at ESW for the combined discharge scenario is 164 and 166 mg/L, so the Sulphate 'guideline' increases to 429 mg/L. Therefore, effects to biota are not anticipated if these upper bound conditions occur.

Higher projected sulphate concentrations are modelled in ESW and PL2 in the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Incremental increases in sulphate in Perch Lake are evident and consistent in both modelled discharge scenarios. Further attenuation of sulphate through the Perch Creek and Perch Lake Watershed is discernible, with incremental changes in concentration as a result of the NSDF Project unlikely to be measurable in the Ottawa. The water quality modelling results for sulphate are presented in Table 3-29.

Table 3-29: Water Quality Modeling Results for Sulphate

Sulfate	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	mg/L	EDT: 128; RB: No data					
Existing Baseline Concentration	mg/L	1.99	1.41	1.25	2.79	2.79[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	mg/L	79.22	6.60	5.69	4.41	3.97	0.000
95th Percentile	mg/L	225.45	18.23	6.93	5.88	5.65	0.001
Maximum	mg/L	228.79	18.61	6.94	5.89	5.65	0.001
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	mg/L	1.99	1.50	5.69	4.41	3.97	0.000
95th Percentile	mg/L	1.99	1.50	6.93	5.88	5.65	0.001
Maximum	mg/L	1.99	1.50	6.94	5.89	5.65	0.001

Note: Shading = concentrations higher than treated effluent discharge target.

(a) The Perch Lake existing baseline sulphate concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline sulphate concentrations in Perch Lake were only available from 2018 (average = 2.33 mg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; EDT = treated effluent discharge target; RB = risk benchmark.

Thallium

The maximum projected wastewater concentration for thallium (0.0038 µg/L) is lower than the treated effluent discharge target (0.3 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline thallium concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, and PCW. The measured concentrations were consistently 0.020 µg/L, which is well below the treated effluent discharge target. No existing baseline data were available for the Ottawa River.

All modelled concentrations were below the treated effluent discharge target, indicating thallium is a relatively low-priority COPC where organism-level effects are unlikely. Higher thallium concentrations are modelled in ESW and PL2 in the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled thallium concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations remained similar to existing baseline concentrations, including Perch Lake.

Any incremental changes in concentration in the Perch Creek and Perch Lake Watershed as a result of the NSDF Project are expected not to be measurable in the Ottawa River. The water quality modelling results for thallium are presented in Table 3-30.

Table 3-30: Water Quality Modeling Results for Thallium

Thallium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 0.3; RB: No data					
Existing Baseline Concentration	µg/L	0.020	0.020	0.020	0.020	0.020[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.054	0.023	0.017	0.013	0.012	NCB
95th Percentile	µg/L	0.119	0.028	0.018	0.017	0.016	NCB
Maximum	µg/L	0.120	0.028	0.018	0.017	0.016	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.020	0.021	0.017	0.013	0.012	NCB
95th Percentile	µg/L	0.020	0.021	0.018	0.017	0.016	NCB
Maximum	µg/L	0.020	0.021	0.018	0.017	0.016	NCB

(a) The Perch Lake existing baseline thallium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline thallium concentrations in Perch Lake were only available from 2018 (average = 0.020 µg/L), which were consistent with the flow-weighted average.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in thallium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Tin

The maximum projected wastewater concentration for tin (0.58 µg/L) is lower than the treated effluent discharge target (73 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline tin concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, and PCW. The measured concentrations were consistently 0.002 µg/L, which is well below the treated effluent discharge target and the risk benchmark (2,700 µg/L). No background data were available for the Ottawa River.

All modelled tin concentrations showed incremental increases through the Perch Creek and Perch Lake Watershed but remained below the treated effluent discharge target and the risk benchmark. Tin concentrations in ESW and PL2 were substantially higher under the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. In both modelled discharge scenarios, elevated incremental increases in Perch Lake relative to existing baseline concentrations were evident and consistent between scenarios.

Tin concentrations attenuated downstream to the confluence with the Ottawa River. Any incremental changes to tin concentrations in the Ottawa River are expected not to be measurable. The water quality modelling results for tin are presented in Table 3-31.

Table 3-31: Water Quality Modeling Results for Tin

Tin	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR[(b)]
Criteria	µg/L	EDT: 73; RB: 2,700					
Existing Baseline Concentration	µg/L	0.002	0.002	0.002	0.002	0.002[(c)]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	8.922	0.591	0.544	0.422	0.380	NCB
95th Percentile	µg/L	25.811	1.932	0.687	0.568	0.546	NCB
Maximum	µg/L	26.198	1.976	0.688	0.569	0.546	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.002	0.002	0.544	0.422	0.380	NCB
95th Percentile	µg/L	0.002	0.002	0.687	0.568	0.546	NCB
Maximum	µg/L	0.002	0.002	0.688	0.569	0.546	NCB

(a) The Perch Lake existing baseline tin concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline tin concentrations in Perch Lake were only available from 2018 (average = 0.002 µg/L), which were consistent with the flow-weighted average.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in tin is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Uranium

The maximum projected wastewater concentration for uranium is 0.61 µg/L (based on U-238 activity of 0.0076 Bq/L), which is lower than the treated effluent discharge target (5 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline uranium concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, PCW, and the Ottawa River. The measured concentrations in the Perch Creek and Perch Lake Watershed ranged from 0.039 to 0.08 µg/L, and 0.094 µg/L in the Ottawa River.

Modelled concentrations at each assessment node under both discharge scenarios were below the treated effluent discharge target and the risk benchmark (33 µg/L). Uranium concentrations in ESW and PL2 were higher under the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake.

In both modelled discharge scenarios, slight incremental increases in Perch Lake were evident and consistent between scenarios. Downstream of Perch Lake, modelled concentrations remained similar to background concentrations; therefore, any incremental changes in concentration in the Ottawa River as a result of the NSDF Project are expected not to be measurable. The water quality modelling results for uranium are presented in Table 3-32.

Table 3-32: Water Quality Modeling Results for Uranium

Uranium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 5; RB: 33					
Existing Baseline Concentration	µg/L	0.059	0.039	0.047	0.080	0.080[(b)]	0.094
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	0.663	0.084	0.070	0.054	0.049	0.094
95th Percentile	µg/L	1.806	0.175	0.079	0.071	0.068	0.094
Maximum	µg/L	1.832	0.178	0.079	0.071	0.068	0.094
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	0.059	0.044	0.070	0.054	0.049	0.094
95th Percentile	µg/L	0.059	0.044	0.079	0.071	0.068	0.094
Maximum	µg/L	0.059	0.044	0.079	0.071	0.068	0.094

(a) The Perch Lake existing baseline uranium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline uranium concentrations in Perch Lake were only available from 2018 (average = 0.080 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Vanadium

The maximum projected wastewater concentration for vanadium (0.43 µg/L) is lower than the treated effluent discharge limit (6 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline vanadium concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, and PCW. The measured concentrations ranged from 0.843 to 1.629 µg/L. No background vanadium data were available for the Ottawa River.

Projected concentrations of vanadium at each of the assessment nodes for both operational discharge scenarios were below the effluent discharge limit and risk benchmark (2,300 µg/L). Vanadium in ESW and PL2 were slightly higher under the combined discharge scenario compared to the direct discharge to Perch Lake, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Except for the modelled vanadium concentrations at ESW and PL2 during operations for the combined discharge, all other modelled concentrations remained consistent with existing baseline concentrations, including Perch Lake.

Any incremental changes in concentration in the Ottawa River as a result of the NSDF Project are expected not to be measurable. The water quality modelling results for vanadium are presented in Table 3-33.

Table 3-33: Water Quality Modeling Results for Vanadium

Vanadium	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	µg/L	EDT: 6; RB: 2,300					
Existing Baseline Concentration	µg/L	1.629	0.843	0.881	1.050	1.050[c]	No data
Scenario 1 - Nine Closed Cells, One Active Cell, 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	2.163	1.020	0.732	0.567	0.510	NCB
95th Percentile	µg/L	3.174	1.112	0.784	0.723	0.694	NCB
Maximum	µg/L	3.197	1.115	0.784	0.723	0.695	NCB
Scenario 2 - Nine Closed Cells, One Active Cell, 100% Direct Discharge to Perch Lake							
Mean	µg/L	1.629	0.979	0.732	0.567	0.510	NCB
95th Percentile	µg/L	1.629	0.979	0.784	0.723	0.694	NCB
Maximum	µg/L	1.629	0.979	0.784	0.723	0.695	NCB

(a) The Perch Lake existing baseline vanadium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline vanadium concentrations in Perch Lake were only available from 2018 (average = 1.000 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in vanadium is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Zinc

The maximum projected wastewater concentration for zinc (1.6 µg/L) is lower than the treated effluent discharge target (20 µg/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline zinc concentrations in the Perch Creek and Perch Lake Watershed were limited to 2018 monitoring data, and to assessment nodes ESW, PL2, PL, and PCW, and to the Ottawa River. The measured concentrations ranged from 5.99 to 7.91 µg/L.

Modelled concentrations at all assessment nodes and each scenario are projected to remain within existing baseline concentrations, indicating zinc is a low-priority COPC. Further, with distance downstream, the modelled projections indicated some attenuation. As a consequence, any incremental changes to zinc concentrations in the Ottawa River as a result of the NSDF Project are expected not to be measurable. The water quality modelling results for zinc are presented in Table 3-34.

Table 3-34: Water Quality Modeling Results for Zinc

Zinc	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	µg/L	EDT: 20; RB: 120					
Existing Baseline Concentration	µg/L	6.12	5.99	5.99	6.86	6.86[(b)]	7.91
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	µg/L	6.23	6.60	4.76	3.69	3.32	7.91
95th Percentile	µg/L	6.43	6.60	5.13	4.68	4.50	7.91
Maximum	µg/L	6.44	6.60	5.13	4.69	4.51	7.91
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	µg/L	6.12	6.59	4.76	3.69	3.32	7.91
95th Percentile	µg/L	6.12	6.59	5.13	4.68	4.50	7.91
Maximum	µg/L	6.12	6.59	5.13	4.69	4.51	7.91

(a) The Perch Lake existing baseline zinc concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline zinc concentrations in Perch Lake were only available from 2018 (average = 10 µg/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; µg/L = micrograms per litre; EDT = treated effluent discharge target; RB = risk benchmark.

3.2 Radiological Model Results

Carbon-14

The maximum projected wastewater concentration for carbon-14 (3.1 Bq/L) is lower than the treated effluent discharge target (200 Bq/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Currently, carbon-14 is not detected in the surface waters in the Perch Creek and Perch Lake Watershed (CNL 2014); for modelling purposes, the existing baseline input concentration was set to the MDL (0.037 Bq/L). No background data were available for the Ottawa River.

In all scenarios, carbon-14 concentrations at all assessment nodes in the Perch Creek and Perch Lake Watershed remained well below the risk benchmark (164 Bq/L). Results indicate that carbon-14 concentrations sourced from the treated effluent discharge rapidly assimilate through the watershed and have a non-discernible overall net effect on Ottawa River (i.e., no discernible increase in carbon-14 concentrations in the Ottawa River). The water quality modelling results for carbon-14 are presented in Table 3-35.

Table 3-35: Water Quality Modeling Results for Carbon-14

Carbon-14	Units	ESW[(a)]	PL2[(a)]	PL[(a)]	PCW[(a)]	PCO[(a)]	OR
Criteria	Bg/L	EDT: 200; RB: 164					
Measured Background Concentration	Bg/L	<MDL	<MDL	<MDL	<MDL	<MDL	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	Bg/L	24.4	1.61	1.49	1.15	1.04	NCB
95th Percentile	Bg/L	70.7	5.29	1.88	1.55	1.49	NCB
Maximum	Bg/L	71.8	5.41	1.88	1.55	1.49	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	Bg/L	<MDL	<MDL	1.49	1.15	1.04	NCB
95th Percentile	Bg/L	<MDL	<MDL	1.88	1.55	1.49	NCB
Maximum	Bg/L	<MDL	<MDL	1.88	1.55	1.49	NCB

(a) Assessment node results are based on an assumed existing baseline concentration equal to the MDL due to carbon-14 being below detection limits at all of the assessment nodes. A Carbon-14 MDL of 0.037 Bq/L (converted from the Required Detection Limit of 1 pCi/L) is reported from US EPA Method 901.1 (US EPA 2017).

A modelled result showing 'NCB' indicates that an incremental increase in carbon-14 is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; Bq/L = Becquerels per litre; MDL = method detection limit; EDT = treated effluent discharge target; RB = risk benchmark.

Caesium-137

The maximum projected wastewater concentration for caesium-137 (0.93 Bq/L) is lower than the treated effluent discharge target (10 Bq/L), so treatment of this constituent prior to discharge is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target.

Existing baseline caesium-137 concentrations in the Perch Creek and Perch Lake Watershed ranged from 0.007 to 0.152 Bq/L; the existing baseline concentration for the Ottawa River was 0.005 Bq/L.

Modelled caesium-137 concentrations at all assessment nodes in the Perch Creek and Perch Lake Watershed remained below the effluent discharge limit and the risk benchmark (73 Bq/L). Higher concentrations are projected in ESW and PL2 under the combined discharge scenario (especially at ESW), suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Further attenuation of caesium-137 through the Perch Creek and Perch Lake Watershed downstream of PL2 in each modelling scenario is discernible.

Modelled concentrations in the Ottawa River remained consistent with the existing baseline concentration, indicating that any incremental changes in concentration as a result of the NSDF Project in the Ottawa River are expected not to be measurable. The water quality modelling results for caesium- 137 are presented in Table 3-36.

Table 3-36: Water Quality Modeling Results for Caesium-137

Caesium-137	Units	ESW	PL2	PL[a]	PCW	PCO	OR
Criteria	Bg/L	EDT: 10; RB: 73					
Existing Baseline Concentration	Bg/L	0.152	0.010	0.010	0.007	0.007[b]	0.005
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	Bg/L	1.356	0.099	0.086	0.067	0.060	0.005
95th Percentile	Bg/L	3.634	0.282	0.106	0.089	0.086	0.005
Maximum	Bg/L	3.686	0.288	0.106	0.089	0.086	0.005
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	Bg/L	0.152	0.018	0.086	0.067	0.060	0.005
95th Percentile	Bg/L	0.152	0.018	0.106	0.089	0.086	0.005
Maximum	Bg/L	0.152	0.018	0.106	0.089	0.086	0.005

(a) The Perch Lake existing baseline caesium-137 concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline caesium-137 concentrations in Perch Lake were only available from 2018 (average = 0.028 Bq/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; Bq/L = Becquerels per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Cobalt-60

The maximum projected wastewater concentration for cobalt-60 (1,300 Bq/L) is higher than the treated effluent discharge target (40 Bq/L), so treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the treated effluent discharge target and assumed that treated discharge will consistently meet the effluent discharge limit criterion.

Existing baseline cobalt-60 concentrations in the Perch Creek and Perch Lake Watershed ranged between 0.009 to 0.340 Bq/L. No background data were available for the Ottawa River.

Modelled concentrations were below the treated effluent discharge target and well below risk benchmark (135 Bq/L) at all assessment nodes in the Perch Creek and Perch Lake Watershed. Higher cobalt-60 concentrations were projected in ESW and PL2 under the combined discharge scenario, suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Attenuation of cobalt-60 is discernible through the Perch Creek and Perch Lake Watershed after Perch Lake.

Any incremental changes in concentration as a result of the NSDF Project in the Ottawa River are not expected to result in any adverse effects. The water quality modelling results for cobalt- 60 are presented in Table 3-37.

Table 3-37: Water Quality Modeling Results for Cobalt-60

Cobalt-60	Units	ESW	PL2	PL[a]	PCW	PCO	OR[b]
Criteria	Bg/L	EDT: 40; RB: 135					
Existing Baseline Concentration	Bg/L	0.340	0.022	0.017	0.009	0.009[c]	No data
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	Bg/L	5.186	0.361	0.319	0.248	0.223	NCB
95th Percentile	Bg/L	14.362	1.095	0.398	0.332	0.319	NCB
Maximum	Bg/L	14.572	1.119	0.398	0.332	0.319	NCB
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	Bg/L	0.340	0.038	0.319	0.248	0.223	NCB
95th Percentile	Bg/L	0.340	0.038	0.398	0.332	0.319	NCB
Maximum	Bg/L	0.340	0.038	0.398	0.332	0.319	NCB

(a) The Perch Lake existing baseline cobalt-60 concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline cobalt-60 concentrations in Perch Lake were only available from 2018 (average (0.031 Bq/L). The flow-weighted average concentration for PL was preferentially used in the modelling assessment over the lake-specific measured data.

(b) All OR results are based on an assumed zero existing baseline concentration due to absent measured existing baseline concentration data.

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

A modelled result showing 'NCB' indicates that an incremental increase in cobalt-60 is expected not to be measurable, so the projection is no change from existing baseline concentrations.

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River; Bq/L = Becquerels per litre; EDT = treated effluent discharge target; RB = risk benchmark.

Gross Beta

Gross beta is assumed to consist primarily of strontium-90 and its daughter, Yttrium-90 (CNL 2017).

The maximum projected wastewater concentration for gross beta (8.97 Bg/L, as strontium-90) is higher than the effluent discharge target discharge limit (5 Bq/L), so targeted treatment of this constituent prior to discharge is required. Mass loading inputs to the water quality model for the operational discharge scenarios used the effluent discharge target concentration and assumed that treated discharge will consistently meet the effluent discharge target discharge limit criterion.

Background gross beta (as strontium-90) concentrations in the Perch Lake watershed ranged from 9 to 293 Bq/L; the background concentration for the Ottawa River was 0.041 Bq/L. The baseline concentration at ESW was higher than the No Effects Concentration. The elevated gross beta (as strontium-90) concentrations in the Perch Lake and Perch Creek watershed, especially at ESW, are due to strontium-90 releases to surface water from legacy waste management areas.

Modelled concentrations of gross beta (as strontium-90) at each assessment node in the Perch Lake watershed for each modelling scenario remained above the effluent discharge target, primarily due to background concentrations. However, modelled concentrations in the Ottawa River remained below the effluent discharge target and similar to background concentrations. Concentrations are also well below the no effects concentration for protection of biota, except at East Swamp Stream where concentrations remained consistent with baseline concentrations. The water quality modelling results for gross beta (as strontium-90) are presented in Table 3-38.

Table 3-38: Water Quality Modeling Results for Gross Beta (as Strontium-90)

Gross Beta (as Strontium-90)	Units	ESW	PL2	PL(a)	PCW	PCO	OR
Criteria	Bg/L	EDT: 5; NEC: 183(b)					
Measured Background Concentration	Bg/L	**293**	17	11	9	9(c)	0.041
Scenario 1 - Nine Closed Cells, One Active Cell, 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	Bg/L	**258**	37	28	22	20	0.043
95^{th} Percentile	Bg/L	**293**	37	30	28	26	0.046
Maximum	Bg/L	**293**	37	30	28	26	0.046
Scenario 2 - Nine Closed Cells, One Active Cell, 100% Direct Discharge to Perch Lake							
Mean	Bg/L	**293**	37	28	22	20	0.043
95^{th} Percentile	Bg/L	**293**	37	30	28	26	0.046
Maximum	Bg/L	**293**	37	30	28	26	0.046

Notes: Shading = exceedance of effluent discharge target discharge limit.

Shading and bold = concentration higher than the Effluent Discharge Limit and No Effects Concentration

ESW = East Swamp weir; PL2 = Perch Lake Inlet #2; PL = Perch Lake; PCW = Perch Creek weir; PCO = Perch Creek outlet; OR = Ottawa River

(a) Perch Lake existing baseline concentration as-modelled is based on a flow-weighted calculation using all available upstream data sources. Existing baseline Gross Beta (as strontium-90) concentration specifically in Perch Lake only available from 2018 (average = 14 Bq/L). The flow weighted average data for PL used in the modelling assessment over the lake specific measured data.

(b) The no effect concentration for strontium-90 of 183 Bq/L where strontium-90 is the only contributor to gross beta (as strontium-90).

(c) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

Bq/L = Becquerels per litre; EDT = treated effluent discharge target; NEC = no effects concentration

Tritium

The maximum projected wastewater concentration for tritium (140,000 Bq/L) is lower than the treated effluent discharge target (230,000 Bq/L), so treatment of this constituent is not required. However, for conservatism, mass loading inputs to the water quality model for the operational discharge scenario used the treated effluent discharge target.

Existing baseline tritium concentrations in the Perch Creek and Perch Lake Watershed ranged between 355 to 3,600 Bq/L. A lower existing baseline concentration at ESW (355 Bq/L) relative to the other assessment nodes in the Perch Creek and Perch Lake Watershed was evident (2,565 to 3,600 Bq/L). The existing baseline concentration for the Ottawa River was 6.6 Bq/L.

Modelled tritium concentrations at all assessment nodes for each discharge scenario in the Perch Creek and Perch Lake Watershed remained below the treated effluent discharge target, and well below the risk benchmark (17,400,000 Bq/L). Higher concentrations were projected in ESW and PL2 under the combined discharge scenario (especially at ESW), suggesting the assimilation of the treated effluent through the exfiltration gallery is not as pronounced as the direct discharge of all treated effluent to Perch Lake. Also, tritium is elevated in Perch Lake under both modelling scenarios, which attenuates consistently with distance downstream through Perch Creek. With the exception of ESW and PL2 (for the 95^{th} Percentile and Maximum projections) under the combined discharge scenario, projected concentrations in the Perch Creek and Perch Lake Watershed, including Perch Lake were all below the Canadian Drinking Water Guideline of 7,000 Bq/L (Health Canada 2017).

Modelled concentrations in the Ottawa River remained similar to background, indicating that any incremental changes in concentration as a result of the NSDF Project in the Ottawa River are expected not to be measurable. The water quality modelling results for tritium are presented in Table 3-39.

Table 3-39: Water Quality Modeling Results for Tritium

Tritium	Units	ESW	PL2	PL[(a)]	PCW	PCO	OR
Criteria	Bg/L	EDT: 230,000; RB: 17,400,000					
Measured Background Concentration	Bg/L	355	2,729	2,565	3,600	3,600[(b)]	6.6
Scenario 1 - 50% to Exfiltration Gallery, 50% Direct Discharge to Perch Lake							
Mean	Bg/L	28,417	4,634	3,526	2,733	2,459	6.9
95^{th} Percentile	Bg/L	81,549	8,811	3,981	3,562	3,423	7.3
Maximum	Bg/L	82,764	8,947	3,984	3,563	3,424	7.3
Scenario 2 - 100% Direct Discharge to Perch Lake							
Mean	Bg/L	355	2,802	3,526	2,733	2,459	6.9
95^{th} Percentile	Bg/L	355	2,802	3,981	3,562	3,423	7.3
Maximum	Bg/L	355	2,802	3,984	3,563	3,424	7.3

(a) The Perch Lake existing baseline tritium concentration is based on a flow-weighted calculation using all available upstream data sources. Existing baseline tritium concentrations in Perch Lake were only available from 2018 (average = 131 Bq/L). The flow-weighted average concentration for PL was preferentially used for the modelling assessment over the lake-specific measured data for conservatism.

(b) PCO existing baseline concentrations were assigned PCW existing baseline concentrations since the PCO location is just downstream of the PCW location.

Bq/L = Becquerels per litre; EDT = treated effluent discharge target; RB = risk benchmark.

4.0 PREDICTION CONFIDENCE AND UNCERTAINTY

Predicted residual effects are not expected to be underestimated due to the following factors that have contributed to conservatism in the modelling projections:

- Mass loading inputs to the surface water quality model for all constituents (except hardness) conservatively used the effluent discharge targets
- For the majority of the COPCs in the assessment, the maximum projected wastewater concentration was lower than the effluent discharge target:
  - For a subset of the COPCs (i.e., aluminum, cobalt, iron, manganese, nitrate, nitrite, phosphorus, sulphate, and cobalt-60), the maximum projected wastewater concentration was higher than the treated effluent discharge trigger (e.g., aluminum: wastewater concentration = 150 µg/L; treated effluent discharge trigger = 50 µg/L).
  - In a few COPC instances (e.g., ammonia, phosphorus, uranium), the maximum projected wastewater concentration was not available. In these cases, the treated effluent discharge target was assigned to the modelling assessment.
- In each discharge scenario, the water quality model was run without decay or sorption mechanisms, whereas in actuality concentrations may be subject to chemical, physical, radioactive decay, and biological processes that can remove them from the mass balance as they progress downstream.
- Background concentrations obtained from existing environmental monitoring reports were typically presented as averages from 2010 to 2018, which included data measured below detection. For data measured below detection, the detection level was used in the averaging calculation; the true existing baseline concentrations may not have been as high as used. Nonetheless, these as-stated averages used in the model were considered to be a conservative estimate of the existing baseline concentrations.

A limitation in the water quality model was that existing baseline data were not available for all parameters at all assessment nodes. Where these data were not available, the modelling results were limited in that they only provided an indication of the incremental increases of that parameters. In some cases, this lack of data applied to all assessment nodes (e.g., ammonia, fluoride, and nitrite), and in many cases there were no available existing environment data for the Ottawa River (e.g., antimony, barium, calcium, chloride, cobalt, magnesium, manganese, molybdenum, potassium, selenium, silver, sodium, sulphate, thallium, tin, and cobalt-60).

A further limitation in the water quality model rests with the lack of daily or monthly water quantity and water quality data for each model node. Furthermore, the model was run with annual flow averages from 1969 to 1980, with background water quality concentrations for the Perch Creek and Perch Lake Watershed sourced from 2010 to 2018 measured data. If high temporal resolution (daily) flow data are available in the future and for long-term overlapping time periods, GoldSim will be able produce more accurate results inclusive of seasonal variation and long-term annual trends. Additionally, current point-estimate concentration results may be presented with their respective confidence intervals should high temporal resolution (daily) water quality data becomes available. The lack of readily available existing baseline concentrations for the Ottawa River limited model performance in assessing the resultant fully mixed conditions at the Ottawa River.

Near-field modelling of the mixing zone from the treated effluent discharge to Perch Lake was assessed in the technical memorandum *Design Configuration of Submerged Diffuser in Perch Lake* (Golder 2019). The diffuser design that was assessed in this modelling resulted in the minimum dilution factor of 10 at the edge of the mixing zone at 100 metres being met for the range of total dissolved solids concentrations in the treated effluent in Perch Lake. This indicated that treated effluent discharge would be dispersed and assimilated into Perch Lake very effectively, satisfying the modelling assumption of a well-mixed Perch Lake. The surface water quality modelling of the Perch Creek and Perch Lake Watershed assumed that this diffuser configuration would be adopted for the treated effluent discharge in Perch Lake.

The above discussion focuses on uncertainty in surface water quality modelling. An additional source of uncertainty is in the predicted contaminant concentrations in wastewater influent and predicted effluent discharge concentrations. The WWTP design provides flexibility to adjust treatment processes, for example addition of ion exchange columns to selectively remove contaminants from wastewater. This flexibility provides further assurance that treated effluent discharge targets can be met and surface water quality protected.

5.0 CONCLUSIONS

The GoldSim surface water quality mass balance model assessment resulted in the following key projections for operational discharge to the Perch Creek and Perch Lake Watershed:

- Incremental changes to water quality during discharges under both discharge scenarios resulting from the operation of the NSDF Project are not expected to result in adverse effects throughout the Perch Creek and Perch Lake Watershed.
- The Ottawa River is expected to rapidly assimilate all discharge from the Perch Creek and Perch Lake Watershed under both discharge scenarios. COPCs from the discharge are expected not to be measurable beyond existing baseline conditions in Ottawa River after the Perch Creek confluence. Aquatic life and drinking water sources are unlikely to be affected.
- Aluminum, copper and gross beta (as strontium-90) are predicted to exceed risk benchmarks or no effects concentrations for the operations phase. However, modelled exceedances of aluminum and copper are due to baseline concentrations at the East Swamp Weir, Perch Lake, Perch Creek Weir, Perch Creek Outlet, and in the Ottawa River, which were measured above risk benchmarks in baseline conditions. Modelled concentrations of gross beta (as strontium-90) above no effects concentrations are limited to East Swamp Weir, which is due to elevated baseline concentrations above No Effects Concentrations.
- There were no incremental changes to barium, cadmium, iron, lead, and silver concentrations resulting from the operation of the NSDF Project throughout the Perch Creek and Perch Lake Watershed during discharges under both discharge scenarios.
- Baseline and modelled aluminium, barium, copper, iron, lead, silver, and gross beta (as strontium-90) were present in concentrations above the treated effluent discharge target and/or the risk benchmark/no effects concentration (i.e., aluminium, copper), and will remain so during the operation of the NSDF Project.
- Incremental changes were projected under Scenario 1 (50% discharge via the exfiltration gallery and 50% direct discharge to Perch Lake) in East Swamp Weir (ESW) and Perch Lake Inlet #2 (PL2) to varying levels for most of the COPCs, with no change at these locations in Scenario 2 (direct discharge to Perch Lake). These COPCs include ammonia, antimony, boron, calcium, chloride, cobalt, fluoride, magnesium, manganese, mercury, molybdenum, nickel, nitrate, nitrite, phosphorus, potassium, selenium, sodium, strontium, sulphate, thallium, tin, uranium, vanadium, zinc, carbon-14, caesium-137, cobalt-60, and tritium. However, most of the COPC concentrations in Scenario 1 remained below treated effluent discharge targets and risk benchmarks/no effects concentrations. Any incremental COPC changes under Scenario 1 attenuated downstream of Perch Lake to the Ottawa River, with the incremental changes to the COPCs for Scenario 2 generally consistent with those for Scenario 1.
- Projected chloride, nitrate, selenium, strontium, and gross beta (as strontium-90) concentrations at Perch Lake Inlet 2 (PL2) under both scenarios indicated a non-Project related elevation in concentration at this location. This elevation was attributed to high existing baseline concentrations at MSC, which was incorporated into the flow-weighted concentration calculations for PL2. These COPCs remained below treated effluent discharge targets and risk benchmarks and no effect concentrations, except for selenium, which was above the treated effluent discharge target at PL2 for both discharge scenarios.

Signature Page

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