IR 32

No.	Question 1	NexGen Response
32	NexGen is requested to provide further information and/or explanations and/or references to support the conditional probability of 0.1 for wind direction towards the camp worker receptor.	NexGen notes that the proposed Project camp is located to the SSW and WSW of the acid plant. According to the Project AERMET and site-observed wind rose data, the cumulative percentage of wind blowing from the ENE to NNE directions ranges from approximately 6% to 8.5% (Draft EIS Section 7.2.3.1, Figure 7.2-3). Therefore, use of a conditional probability value of 0.1, or 10%, in the overall calculation of likelihood as it concerns the exposure of the camp workers under the scenario discussed in NexGen's response to IR 32-R1 represents a reasonably conservative assumption.

No.	Question 2	NexGen Response
32	Show how Figure 2 was developed to support that indoor concentration is much less than the outdoor concentration under the accidental scenario assessed.	As noted in Section 11.4 of Draft EIS TSD VIII (Accidents and Malfunctions Report), air dispersion modeling was conducted for a 15-minute release of sulphur dioxide (SO_2) from the acid plant using the Areal Locations of Hazardous Atmospheres model, which is presented visually as Figure 11-1 of Section 11.4 of Draft EIS TSD VIII and Figure 1 in Attachment IR 32-R1. Using the results of the air dispersion model, SO_2 concentrations were estimated for both outdoor and indoor locations at a distance of 250 meters (i.e., a distance less than the closest point of the proposed camp from the proposed acid plant), which is presented as Figure 2 of Attachment IR 32-R1. Modelling showed that outdoor concentrations of SO_2 would increase to 7.3 parts per million (ppm) during the release event and decrease rapidly once the release event has ended. The indoor concentrations considered the effects the outdoor concentrations would have on a one-story building with tight construction with closed doors and windows during the release event (i.e., standard response to a shelter-in-place situation as per Project emergency response procedures). The typical air change rate for such buildings ranges from 0.2 to 0.4 air changes per hour (ACH); the calculations of the indoor concentrations at the proposed Project camp location were based on an air change rate of 0.3 ACH (ASHRE 2022). The results show that the indoor SO_2 concentration increases following initiation of the release event, reaching a maximum concentration of 0.43 ppm at approximately 15 minutes. The indoor SO_2 concentration then gradually decreases with the doors and windows remaining closed. Once deemed safe to do so, the windows and doors would be opened and air would be exchanged at a greater rate, thereby reducing SO_2 concentrations more quickly. **References** ASHRE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers). 2022. ANSI/ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality. Available at https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2.

No.	Question 2 Follow Up	NexGen Response
32	In the response to Question 2, NexGen stated that "*The typical air change rate for such buildings ranges from 0.2 to 0.4 air changes per hour (ACH); the calculations of the indoor concentrations at the proposed Project camp location were based on an air change rate of 0.3 ACH (ASHRE 2022).*" However, in the reference (ASHRE 2022), it does not contain information on ACH directly. Can NexGen indicate specifically where in the reference contain information on ACH (ranging from 0.2 to 0.4) for such buildings like a camp? If it is obtained indirectly by calculation, NexGen should provide a brief calculation to show the ACH value used in the response.	NexGen notes that while the ASHRAE (2022) standards do not explicitly set air exchange rates, the air exchange rate for the camp was derived from the minimum ventilation rates required to maintain indoor air quality, which are provided in ASHRAE (2022). Overall, there are various standards and codes, including by ASHRAE, that specify the minimum amount of outdoor air that should be supplied to a house to achieve good indoor air quality (e.g., ASHRAE 2016a, 2016b; CAN/CSA 2014; Canada National Building Code). Generally, air ventilation rates of about 5 to 10 L/s of outdoor air per occupant, or roughly a complete air change every three hours (Health Canada 2018), are required, which correspond to an air exchange rate of 0.33. In modern buildings, which are often tightly sealed, the minimum ventilation requirements are typically met through mechanical ventilation systems in bathrooms and kitchens. However, during shelter-in-place scenarios, these mechanical systems can be turned off, reducing the air exchange rate to levels much lower than 0.3 (i.e., the value used in the assessment). Therefore, the air exchange value of 0.3 represents a conservative approach used for the assessment. **References** ASHRAE (2016a) "Standard 62.1. Ventilation for Acceptable Indoor Air Quality." American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRAE (2016b) "Standard 62.2. Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings." American Society of Heating, Refrigerating and Air-Conditioning Engineers. ASHRE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers). 2022. ANSI/ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality. Available at https://www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2. CAN/CSA (2014) "F326 M91. Residential Mechanical Ventilation Systems." Canadian Standards Association. Health Canada (2018) "Ventilation and the Indoor Environment" Water and Air Quality Bureau Healthy Environments and Consumer Safety Branch, ISBN: 978-0-660-25488-3.

IR 46

No.	Justification/Rationale	Follow up Information Request	NexGen Response
46	**Justification**: The response to part one of the IR discusses, in part, runoff management for the Project airstrip and explosives storage area. Confirmation should be provided that any airstrip runoff containing glycol, fuel, or any other contaminants will be collected and managed appropriately to avoid any adverse effects on fish and fish habitat. In addition, the Proponent has committed to runoff collection and management in the explosives storage area, however, monitoring should be conducted to confirm the effective containment of explosives. The Proponent's response has not been added into the revised EIS. Parts two and three of the IR are accepted, however, ECCC reminds the Proponent that as outlined in Schedule 4 of the MDMER, subsection 4(1), all effluent, including total suspended solids, must meet the concentration-based limits, it must be within the minimum and maximum allowable pH, and it must not be acutely lethal. **Rationale**: The response to the airstrip aspect in IR part one will be accepted pending incorporation of the updates described in the response into the future revised EIS and on the Proponent adopting ECCC recommendations (next column).	1. Incorporate the updates described in the response into the future revised EIS, and; 2. Adopt the following recommendations into the Environmental Protection Plan/Program (**as a commitment in the EA Follow up**): a. Manage all potential airstrip contaminants and substances, including, but not limited to, glycol and fuel, appropriately to avoid any adverse effects to fish and fish habitat. Confirm that any airstrip runoff containing glycol, fuel, or any other contaminants will be collected and managed appropriately. b. Monitor the explosives storage area frequently for seepage and spills and to confirm effective containment of explosives. c. Identify and implement best practices for use, storage, and management of nitrogen-based explosives to avoid the introduction of explosives and their residues into the aquatic environment.	1. NexGen confirms that the requested changes associated with NexGen's response to IR 46-R1 were incorporated into the May 2024 Revised EIS. 2. NexGen understands that an EA follow up commitment may be requested by the CNSC.

IR 46-R1 (Confirmation of Information in May 2024 Revised EIS)

NexGen confirms that the requested changes associated with NexGen's response to IR 46-R1 were incorporated into the May 2024 Revised EIS. For full context, below is the follow up request part 1 received from the CNSC, the response to IR 46-R1 provided by NexGen in the Round 2 IR response package (with key EIS notes related to revisions highlighted), and Figure 2 of Attachment IR 46-R1 noted in NexGen's response to IR 46-R1:

Part 1 of the IR comment correspondence from the CNSC re: IR 46-R1 from 12 November 2024:

1. Incorporate the updates described in the response into the future revised EIS, and;

NexGen's response to IR 46-R1 from May 2024 (relevant aspects highlighted):

NexGen has provided the information below to address part 1 through part 3 of IR 46-R1. NexGen acknowledges that one figure within the Draft EIS contained a graphical error and that certain information within the Draft EIS could have been more clearly presented. These items will be addressed in the revised EIS as further described below.

1. NexGen confirms that runoff from site infrastructure not associated with mineralized waste or the mill terrace or mine terrace, which includes the Project airstrip and the site road that leads to the explosives magazine storage area, would be managed as non-mineralized contact water. To support the response to part 1 of this IR, a general representation of the local geography and drainage is shown in Figure 1 of Attachment IR 46-R1.

Project Airstrip

The Project airstrip would be positioned along a general high point in which the topography falls to the east, west, and south. The airstrip would consist of a runway and adjacent apron pad. As described in part 4 of the initial response to the original IR, the non-mineralized contact water from the apron pad would be collected and contained, while non-contact runoff from the remainder of the airstrip would naturally run off into the receiving environment.

Potential runoff from the airstrip was represented in the Site-Wide Water Balance Model by two runoff-generating elements: R50 (contained airport runoff [i.e., non-mineralized contact water collected from the apron pad]) and R51 (non-contained airport runoff [i.e., non-contact water from the maneuvering area]) (Draft EIS TSD XVIII [Site-Wide Water Balance and Water Quality Modelling Report], Figure 5). Element R50 would be a lined collection area, and runoff would be directed to an airport fueling pad sump. Water collected in the airport fueling pad sump would be periodically pumped out and trucked to the settling pond for reuse in the mill or for treatment prior to release. Runoff from Element R51 would release to the adjacent landscape, where best management practices for erosion and sediment control would be applied to minimize effects to the local environment. A visual representation of the site water management process for the Project airstrip is shown in Figure 2 of Attachment IR 46-R1. NexGen notes that as some additional context has been provided in Figure 2 that was not presented within the Draft EIS, the appropriate inset within Figure 5 of revised EIS TSD XVIII

(Site-Wide Water Balance and Water Quality Modelling Report) will be updated to include this context.

Explosives Storage Area

With respect to the explosives storage area and associated access road, no deleterious substance sources in runoff would exist; therefore, runoff would be non-mineralized contact water, which would be appropriate for collection in the west bermed runoff collection area. The potential of water quality deleterious substances from the explosives storage area would be limited to those associated with potential spills, which would be mitigated by area-specific management practices for stockpiled materials that will be developed in accordance with applicable regulatory requirements, including the *Explosives Act* and The Mines Regulations, 2018.

The potential for spills of explosive materials have been considered in the Project design. As noted in the response to IR 185, the storage of explosives is heavily regulated to minimize risks. Explosives would be managed as per the *Explosives Act*, as well as CAN/BNQ 2910-500/2015 Explosives – Magazines for Industrial Explosives. Potential spills would be contained and managed according to the Rook I Environmental Protection Program to avoid the release of any nitrogen compounds to the environment. The explosives magazine would be designed and constructed with a lined sump capable of storing a 1:100 year, 24-hour precipitation event, and water that has contacted spilled material would be collected and trucked to the settling pond for subsequent treatment and testing prior to discharge through a final discharge point (FDP).

In summary, runoff from the explosives magazine or associated access road is not expected to contain deleterious substances, and thus does not require control and management through a FDP.

NexGen notes that Figure 5 of Draft EIS TSD XVIII incorrectly shows that Element R52 would contain mineralized contact water rather than non-mineralized contact water; this will be corrected in Figure 5 of revised EIS TSD XVIII.

West Bermed Runoff Collection Area

NexGen notes that management of runoff from the west bermed runoff collection area is discussed in part 2 and part 3 of the response to this IR and the response to IR 44-R1.

2. NexGen confirms that all site mineralized contact water would be discharged through one of two FDPs: the monitoring ponds and contact water pond #2. Water treated in the effluent treatment plant (ETP) would report to the monitoring ponds. Once this water was confirmed to meet Project licenced release limits (i.e., thresholds), it would then be discharged directly to Patterson Lake via the effluent pipeline and diffuser. Water in contact water pond #2 that meets Project thresholds, other than total suspended solids (TSS), would be discharged to the west bermed runoff collection area. As the west bermed runoff collection area would not have a direct surface water flow pathway to Patterson Lake (i.e., flow would be through shallow groundwater), TSS would be settled out prior to water reporting to Patterson Lake. If water quality in contact water pond #2 did not meet Project thresholds (other than TSS), it

would be conveyed to the settling pond for treatment in the ETP. Therefore, no deleterious substances above Project threshold levels would be conveyed to Patterson Lake.

3. As noted in the part 2 response to this IR, NexGen confirms that water in contact water pond #2 that meets Project water quality thresholds, other than TSS, would be discharged to the west bermed runoff collection area. As the west bermed runoff collection area would not have a direct surface water flow pathway to Patterson Lake (i.e., flow would be through shallow groundwater), TSS would be settled out prior to water reporting to Patterson Lake. If water quality in contact water pond #2 did not meet Project thresholds (other than TSS), it would be conveyed to the settling pond for treatment in the ETP. NexGen also confirms that no water sources that could potentially require treatment would report directly to the west bermed runoff collection area. Therefore, no deleterious substances above Project thresholds would be conveyed to the receiving environment from the west bermed runoff collection area.

References

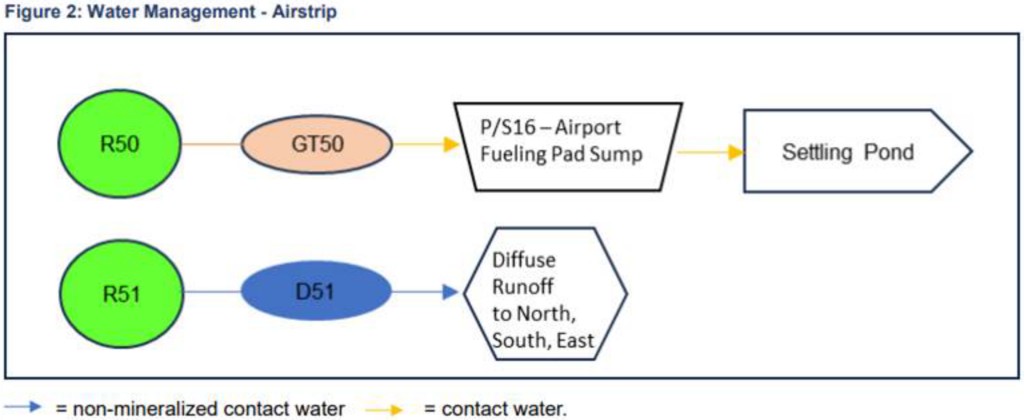
Explosives Act. RSC 1985, c E-17. Current to 28 July 2020. Available at https://laws-lois.justice.gc.ca/eng/acts/e-17/.

The Mines Regulations, 2018. RRS c S-15.1 Reg 8 under *The Saskatchewan Employment Act*. Effective April 6, 2019. Available at https://www.canlii.org/en/sk/laws/regu/rrs-c-s-15.1-reg-8/latest/rrs-c-s-15.1-reg-8.html.

SCC. 2015. CAN/BNQ 2910-510/2015: Explosives – Quantity Distances.

Figure 2 from Attachment IR 46-R1 (May Submission):

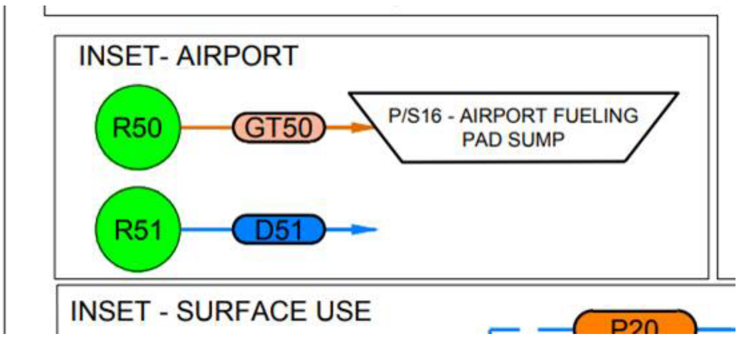
Figure 2: Water Management - Airstrip



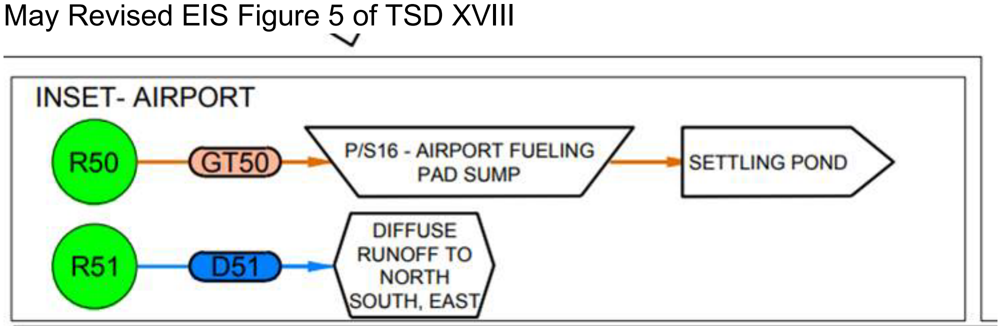
In summary, the changes committed to in the Revised EIS required the inclusion of elements of Figure 2 into Figure 5 of revised EIS TSD XVIII (Site-Wide Water Balance and Water Quality Modelling Report) and making the correction to element R52 in Figure 5 of revised EIS TSD XVIII to show non-contact water rather than contact water. The images below present where these changes have been made from Draft EIS to revised EIS.

Inclusion of information from Figure 2 of Attachment IR 46-R1 in the May Revised EIS:

Draft EIS Figure 5 of TSD XVIII

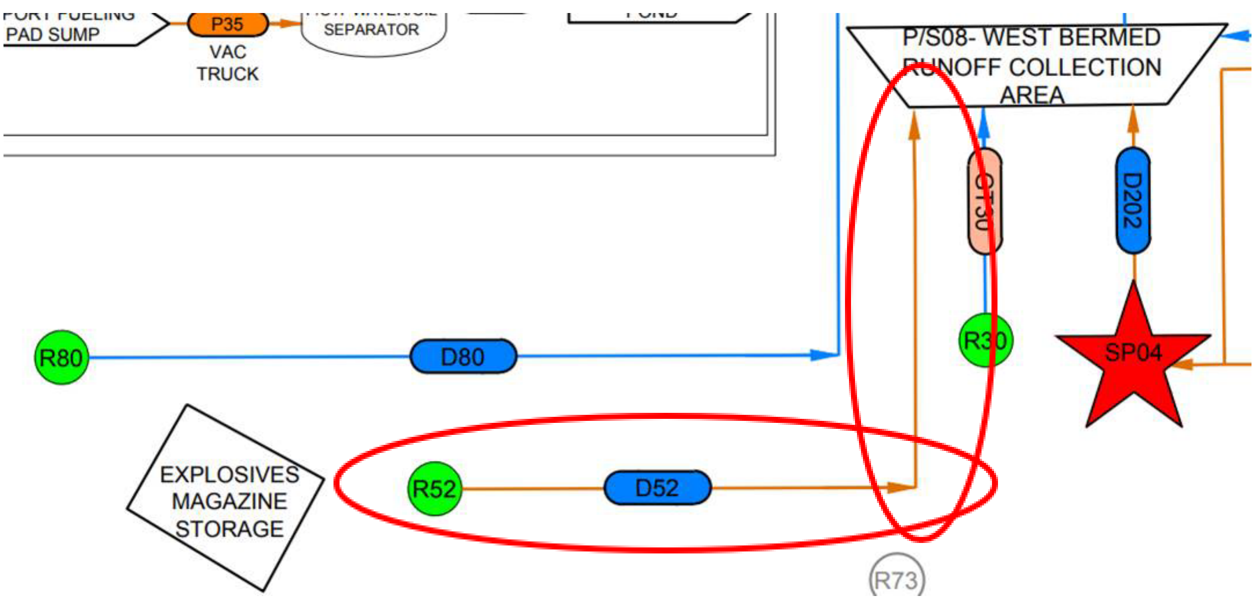


May Revised EIS Figure 5 of TSD XVIII

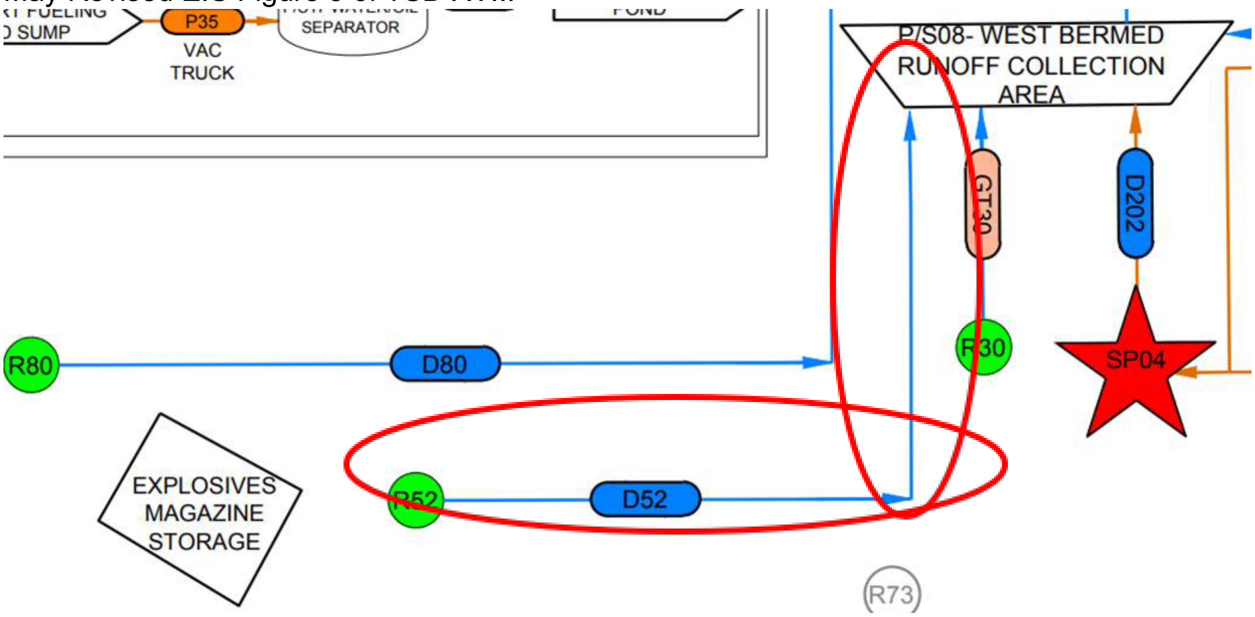


Correction for Element R52 made in the May Revised EIS:

Draft EIS Figure 5 of TSD XVIII



May Revised EIS Figure 5 of TSD XVIII



Legend items for contact water and non-contact water

IR 64

No.	Context and Rationale	Comment	NexGen Response
64	**Further discussion and monitoring are recommended due to exceedances of the Canadian Ambient Air Quality Standards (CAAQS).** Development of the CAAQS considered criteria such as environmental effects, historical trends, future projections of ambient concentrations, feasibility, and achievability and therefore are not solely base on health effects. As such, for non-threshold air pollutants (i.e., nitrogen dioxide [NO_2] and particulate matter [$PM_{2.5}$ and PM_{10}]), HC recommends using the World Health Organization (WHO)[1] global air quality guidelines for $PM_{2.5}$ and NO_2 (24-hr and annual) to compare against project predicted concentrations. These guidelines have been set at the lowest exposure level of an air pollutant above which the WHO is confident that there is an increase in adverse health effects. HC does not support the assessment regarding the potential project-related health impacts of short-term exposure to elevated NO_2 concentrations. In the response IR-65 (which references the response to IR-69-R1) and IR-69-R1, Hesterberg et al. (2009) and the WHO (2010) were cited to justify the conclusion that short-term exceedance of the NO_2 CAAQS can still be protective of human health. However, as noted in the Human Health Risk Assessment for Ambient Nitrogen Dioxide (HC, 2016), the WHO concluded that the findings for the asthmatics or individuals with mild chronic obstructive pulmonary disease are highly variable and that NO_2 exposures to 0.2 ppm (376 μg/m^3) for periods of 1 h or longer have, in some studies, produced a range of responses within the lung, suggestive of airway inflammation and immune defenses alteration in asthmatics. The WHO also noted that the results of recent systematic review and meta-analyses provided suggestive evidence that controlled exposures to NO_2 at 0.1 ppm (188 μg/m^3) are associated with small increases in airway reactivity for a range of stimuli in asthmatics.	HC recommends: a. A commitment to use all technically and economically feasible mitigation measures (e.g., use of Tier 4 engines) to minimize air pollution and potential adverse human health impacts for off-duty workers due to predicted exceedances in the CAAQS at receptor locations, including the workers camp. b. Updating the EIS to indicate the conditions under which modified or enhanced air quality mitigation measures would be triggered. c. Using WHO air quality guidelines for interpreting results from project monitoring and assessing the need for additional mitigations to protect human health.	The following information is provided in response to part a through part c of the reviewer's comment. a. NexGen will add the following commitment to Final EIS Appendix 23A (Summary of Project Environmental Design Features and Mitigation Measures): "During the Project lifespan, NexGen will continue to evaluate monitoring and mitigation measures to track and minimize air pollution and, where practical, implement any newly identified mitigation measures that are technically and economically feasible". NexGen notes that this commitment is aligned with the commitment in Draft EIS Appendix 23B (Environmental Assessment Monitoring and Follow-Up Programs Proposed for the Project), which states that an Effluent and Emissions Plan would be implemented that would evaluate the effectiveness of mitigation and identify unanticipated negative effects and the need for additional mitigation measures. NexGen further notes that Draft EIS Appendix 23B also states that the environmental risk assessment (ERA) would be refined based on the Environmental Monitoring Plan and Effluent and Emissions Plan, which would include collection of air quality, surface water, sediment, and soil samples, as well as fish tissue samples, benthic invertebrate tissue samples, and country foods such as blueberries. Monitoring would focus on collecting data to verify ERA model predictions, as well as provide data to refine and improve model predictions as the Project begins. Monitoring would support NexGen's adaptive management framework with the objective of reducing uncertainty over time through an iterative process. With respect to the reviewer's comment regarding the use of Tier 4 engines, NexGen confirms its commitment to use Tier 4 engines, to the extent that Tier 4 equipment is available. As noted in Draft EIS Appendix 23A, a commitment exists to "[u]se Tier 4 diesel mobile equipment for underground operations, whenever practical, with applicable mine ventilation airflow rates specified by Canada Centre for Mineral and Energy Technology, when available". In addition, in NexGen's responses to IR 50 and ECCC-10, NexGen has confirmed the intent to purchase and use the lower-emitting Tier 4 engines, if Tier 4 engine options are available. However, flexibility is required in case Tier 4 engine options are not available; otherwise, it may not be possible to construct or operate the Project. NexGen further notes that if new equipment is to be used, Tier 4 engines are the only option available for purchase in Canada. b. In alignment with the response to part a of the reviewer's comment, practical air quality mitigation measures that are both technically and economically feasible would be implemented for the Project as they are identified. Conditions under which modified or enhanced air quality mitigation measures would be triggered will be specified through the federal licensing processes for the Project. The process to set licensed release limits and action levels will follow a tiered approach to ensure the protection of human health and the environment and to demonstrate pollution prevention through the application of best available technology and techniques, economically available. The Project will be required to adhere to the REGDOC-2.9.1 (CNSC 2020) process for effluent and emissions control monitoring, which shall address the requirements in CSA N288.5-22 and

No.	Context and Rationale	Comment	NexGen Response
			include requirements to implement additional mitigation measures should monitoring results identify emission exceedances from the expected Project performance. Also, in alignment with REGDOC-2.9.2 (CNSC 2021), the process for establishing and implementing control measures on releases to the environment would incorporate provincial and federal standards, including the SAAQS and CAAQS. In alignment with the requirements of REGDOC-2.9.2, it is expected that the ERA, which would be required to be updated during the course of the Project lifespan and after completion of the Final EIS, would serve as a key source for determining the Project conditions under which modified or enhanced air quality mitigation measures would be triggered. In addition to the triggers to be established through the Project licensing process, adaptive management would be implemented, if required, under NexGen's adaptive management framework that is described in Draft EIS Section 23.5.3 (Adaptive Management). NexGen's adaptive management planning lays out a specific approach to minimize environmental risk and uncertainty by following an established adaptive management process that includes iterative monitoring and evaluation of results. Should adaptive management to address potential concerns to air quality or human health be required, the process would include assessing the problem, designing an adaptive management approach, engaging with Indigenous Groups and local community members, implementing actions, monitoring for effectiveness, evaluating the outcomes, and adjusting or terminating the approach, as required (Draft EIS Section 23.5.3 [Adaptive Management]). This process also aligns with REGDOC-2.9.2, which states that "adaptive management is required in response to identification of an unreasonable risk or a potential unreasonable risk through the ERA or through monitoring". As general information regarding NexGen's adaptive management process is appropriately described in Draft EIS Section 23.5.3 and specific details with respect to when enhanced air quality mitigation measures would be triggered, where required, would be defined through the Project federal licensing process, no changes to the Final EIS are proposed other than the addition of the commitment described in part a of this response. **References** CNSC. 2020. REGDOC-2.9.1, Environmental Principles, Assessments and Protection Measures, Version 1.2. September 2020. ISBN 978-0-660-06255-6. Available at http://nuclearsafety.gc.ca/eng/pdfs/REGDOCS/REGDOC-2-9-1-Environmental-Principles-Assessments-and-Protection-Measures-eng.pdf. CNSC (Canadian Nuclear Safety Commission). 2021. Environmental Protection: Controlling Releases to the Environment. DRAFT. March 2021. Available at https://www.nuclearsafety.gc.ca/eng/pdfs/regulatory-documents/regdoc2-9-2/REGDOC-2_9_2_Controlling_Releases_to_the_Environment.pdf.

No.	Context and Rationale	Comment	NexGen Response
			CSA Group (Canadian Standards Association Group). 2022. CSA N288.5-22: Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills. c. NexGen notes that CSA N288.6:22 (CSA Group 2022) recommends that the lowest of federal and provincial criteria be utilized as screening criteria for an environmental risk assessment. Therefore, NexGen maintains that following federal and provincial criteria for interpreting results from Project monitoring and assessing the need for additional mitigation measures to protect human health represents the preferred approach. However, other guidelines may be considered, as appropriate. As such, the WHO guidelines may also be used in the interpretation of Project monitoring results and the development of additional mitigation measures to protect human health as part of the processes described in part a and part b of this response. **References** CSA Group (Canadian Standards Association Group). 2022. CSA N288.6-22: Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills.

Table 23A-3: Summary of Environmental Design Features and Mitigation Measures Proposed for the Rook I Project Pertaining to Air, Noise, and Climate Change

Environmental Design Features and Mitigation	Mitigation Hierarchy of Control	Level of Mitigation Effectiveness	Mitigation Effectiveness Rationale	Discipline
Limit idling of vehicles and equipment to the extent practical.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Climate Change Surface Water Quality Fish and Fish Habitat Terrain and Soils Wildlife and Wildlife Habitat Human Health
Limit vehicle speed on unpaved site roads to reduce fugitive dust during Construction and Operations.	Minimize	High	Best management and design practice. Wide application in various industry settings.	Air Quality Surface Water Quality Terrain and Soils Vegetation Wildlife and Wildlife Habitat Human Health Cultural and Heritage Resources and Indigenous Land and Resource Use Other Land and Resource Use
Evaluate opportunities to **reduce fuel combustion requirements** of infrastructure and equipment, to the extent practical, during detailed design.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Climate Change Surface Water Quality Fish and Fish Habitat Terrain and Soils Vegetation Human Health
Use Tier 4 diesel mobile equipment for underground operations, whenever practical, with applicable mine ventilation airflow rates specified by Canada Centre for Mineral and Energy Technology, when available.	Minimize	High	Best management and design practice. Measure identified under guidance or management standard. Wide and successful application in mining industry.	Air Quality
Recover heat from the liquified natural gas power plant exhaust and use to heat other process and ancillary buildings, to the extent practical.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Climate Change
Use and maintain emissions control devices on combustion-based equipment.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings (e.g., mining, aggregate extraction, or construction).	Air Quality Climate Change Surface Water Quality Fish and Fish Habitat Terrain and Soils Vegetation Wildlife and Wildlife Habitat Cultural and Heritage Resources and Indigenous Land and Resource Use Other Land and Resource Use
Use **pollution control technology** on process plant exhaust stacks with preventative maintenance and stack testing, as well as adaptive management, if necessary.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality
Identify and implement **procurement criteria** to confirm stationary and mobile engines meet applicable performance standards.	Avoid Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Surface Water Quality Fish and Fish Habitat Climate Change Terrain and Soils Human Health Vegetation Wildlife and Wildlife Habitat

Table 23A-3: Summary of Environmental Design Features and Mitigation Measures Proposed for the Rook I Project Pertaining to Air, Noise, and Climate Change

Environmental Design Features and Mitigation	Mitigation Hierarchy of Control	Level of Mitigation Effectiveness	Mitigation Effectiveness Rationale	Discipline
Maintain mobile mining equipment and vehicles and operate the equipment within parameters for engine exhaust system design.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings (e.g., mining, aggregate extraction, or construction).	Air Quality Climate Change Surface Water Quality Terrain and Soils Vegetation Human Health
During the Project lifespan, NexGen will **continue to evaluate monitoring and mitigation measures to track and minimize air pollution** and, where practical, implement any newly identified mitigation measures that are technically and economically feasible.	Minimize	Medium	Best management and design practice.	Air Quality Human Health
Install noise dampening structures in power plant generator facilities; install silencers in surface and underground large vent fans.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Noise Cultural and Heritage Resources and Indigenous Land and Resource Use
Implement procedures to **reduce noise, dust, and light** levels such as: ▪ **enclose or dampen equipment in process buildings** where the total sound power level is expected to be more than approximately 80 A-weighted decibels, where feasible ▪ **use noise suppression (mufflers) on vehicles** and inspect regularly to make sure they are functioning properly ▪ **limit light pollution** to the extent practical for built infrastructure	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Noise Wildlife and Wildlife Habitat Cultural and Heritage Resources and Indigenous Land and Resource Use Other Land and Resource Use
Maintain roads to minimize ruts and consequently reduce noise emissions from vehicles.	Minimize	Medium	Best management and design practice. Wide application in various industry settings (e.g., mining, aggregate extraction, or construction).	Noise Cultural and Heritage Resources and Indigenous Land and Resource Use
Primarily **use liquified natural gas for power generation**.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Fish and Fish Habitat Climate Change Surface Water Quality Terrain and Soils Vegetation Wildlife and Wildlife Habitat Human Health Cultural and Heritage Resources and Indigenous Land and Resource Use
Optimize haul routes to reduce fuel consumption and emissions from equipment.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings (e.g., mining, aggregate extraction, or construction).	Air Quality Climate Change Surface Water Quality Fish and Fish Habitat Terrain and Soils Vegetation Human Health Cultural and Heritage Resources and Indigenous Land and Resource Use
Use excess steam generated from the acid plant to heat other process buildings, to the extent practical.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Climate Change
Use energy efficient LED lighting and other similar efficiencies to reduce electrical demand, where practical.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Climate Change
Where required, **remove merchantable trees and the majority of the woody debris with soils that are salvaged (where not planned for use in future reclamation activities)**, to maintain the carbon stocks and avoid release of carbon through decomposition.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Climate Change

Commented [FH1]: IR 64: added commitment stated in NexGen's response to Health Canada comment 64a

Table 23A-3: Summary of Environmental Design Features and Mitigation Measures Proposed for the Rook I Project Pertaining to Air, Noise, and Climate Change

Environmental Design Features and Mitigation	Mitigation Hierarchy of Control	Level of Mitigation Effectiveness	Mitigation Effectiveness Rationale	Discipline
Conduct **regular equipment maintenance**.	Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Air Quality Terrain and Soils Fish and Fish Habitat Vegetation Wildlife and Wildlife Habitat Human Health Climate Change Cultural and Heritage Resources and Indigenous Land and Resource Use Other Land and Resource Use
Implement **energy management strategy** for measuring and evaluating thermal and electrical energy use.	Minimize	High	Best management practice.	Climate Change
Implement **a net-zero framework** and periodically re-assess alternative technologies and practices to responsibly manage energy use and GHG emissions.	Minimize	High	Wide and successful application of the framework. Effectiveness of new technologies to be determined.	Climate Change
Implement **greenhouse gas management strategy** to reduce emissions to the extent practical.	Avoid Minimize	High	Best management and design practice. Wide and successful application in various industry settings.	Climate Change

LED = light-emitting diode; GHG = greenhouse gas.

IR 67

No.	Justification/Rationale	Follow up Information Request	NexGen Response
67	**Justification:** In Attachment IR 67-R1, the Proponent indicated that the land-use change and carbon sinks calculations are aligned with Section 4.1 of the Draft Technical Guide Related to the Strategic Assessment of Climate Change, and uses a Tier 1 approach. **Rationale:** A Tier 1 approach is suitable for project areas less than or equal to 30 ha. Given the size of this Project, a Tier 2 or Tier 3 approach should be selected.	**Information Request:** In order to resolve this IR, NexGen is required to describe the reasoning for selecting a Tier 1 approach for the assessment of carbon sinks and land-use change emissions rather than a Tier 2 or Tier 3 approach as required by the Draft Technical Guide Related to the Strategic Assessment of Climate Change.	NexGen confirms that the approach selected to develop the land use change and carbon sink calculations are justified based on the scope of the Project Environmental Assessment (EA), the Canadian Nuclear Safety Commission (CNSC) Generic Guidelines for the preparation of an EIS (CNSC 2021), and the standard of practice for applications under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). The approach selected to develop the land use change and carbon sink calculations for the EA that are further utilized in Attachment IR 67-R1 are based on Intergovernmental Panel on Climate Change (IPCC 2006), as outlined in EIS Appendix 7C (Greenhouse Gas Emissions Estimation Methodology Report). This approach is consistent with the standard of practice for applications under CEAA 2012. The IPCC (2006) approach is most closely aligned with the Tier 1 approach under Section 4.1 of the Draft Technical Guide Related to the Strategic Assessment of Climate Change (ECCC 2021). As the draft guidance does not apply to the Project, the requirements for the selection of the tier based on the size of the Project were not considered and the most analogous approach of the tiers available was highlighted. NexGen notes that the Draft Technical Guide Related to the Strategic Assessment of Climate Change (ECCC 2021), which provides guidance on land-use change and carbon sink calculation methodologies, was issued in August 2021. This date of issuance was after the greenhouse gas assessment section of the EA had been prepared, the development of which was informed by proactive engagement between NexGen and the CNSC on 14 June 2021, where the approach for the carbon sink calculations was presented by NexGen. **References** CEAA (Canadian Environmental Assessment Act). 2012. *Canadian Environmental Assessment Act, 2012*. SC 2012, c 19, s 52. *Repealed*, 2019, c 28, s 9. Available at https://laws-lois.justice.gc.ca/eng/acts/C-15.21/20170622/P1TT3xt3.html. CNSC (Canadian Nuclear Safety Commission). 2021. Generic Guidelines for the Preparation of an Environmental Impact Statement - Pursuant to the *Canadian Environmental Assessment Act, 2012*. Last amended March 2021. Avalable at https://www.cnsc-ccsn.gc.ca/eng/resources/environmental-protection/ceaa-2012-generic-eis-guidelines/. ECCC (Environment and Climate Change Canada). 2021. Draft Technical Guide Related to the Strategic Assessment of Climate Change. August 2021. Available at https://www.canada.ca/en/environment-climate-change/corporate/transparency/consultations/draft-technical-guide-strategic-assessment-climate-change.html. IPCC (Intergovernmental Panel on Climate Change). 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston HS, Buendia L, Miwa K, Ngara T, Tanabe K (eds). Published: IGES, Japan. Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/.

IR 69

No.	Context and Rationale	Comment	NexGen Response
69	The response to IR-64 confirmed that an air quality monitoring program would be implemented during all Project phases to measure ambient air concentrations and to verify the EIS predictions. It was indicated that mitigation measures would be modified or enhanced, as necessary. However, the conditions upon which these modifications and enhancements would be triggered remains unclear. **The response did not sufficiently address the inhalation risk to off-duty workers at the Camp and other human receptor locations.** The approach for assessing potential human health impacts of short-term NO_2 exposure was not consistent with HC guidance and recommended practices. Refer to IR-64 regarding comprehensive review of all relevant studies with developing health-based conclusions versus use of a single paper. The IR-69-R1 response (Annex 1) indicates that, "*The mitigation measures for the Project are expected to minimize effects to air quality such that no significant adverse effects are expected to the human health.*" Both Section 7.2.5.1.1.2 (Application Case) and 7.2.5.2.2 (Reasonably Foreseeable Development [RFD] Case) indicated moderate or highly negative impacts to air quality (when considering NO_2, $PM_{2.5}$, PM_{10}, and TSP [total suspended particulates]) during both Construction and Operations. The duration of the effect will be limited to the period when emissions are being released, which is a total of 28 years for Construction and Operations combined. Predicted exceedances of 1-h (NO_2) and 24-h CAAQS ($PM_{2.5}$ and PM_{10}) are noted for receptor locations and at the fence line in Tables 4-7 and 4-8 of the Revised Draft EIS Technical Support Document (TSD) XXI: Environmental Risk Assessment (ERA) during Construction and Operations. The greatest number of camp workers are expected to be present at HHRA3 during the Construction period (Revised Draft EIS, Section 5.4.7.1) where exceedances were estimated to be highest (Attachment IR 69-R1). There is no discussion provided on the qualitative use of moderate and high regarding effects to human health. HC also noted that the modelled concentrations for NO_2, $PM_{2.5}$, and PM_{10} in Table 7.2-12 of the Revised Draft EIS (PDF p. 1442) are different than those shown in Table 4-7 of the ERA (PDF p. 65). Although the occupational health and safety of workers falls within the jurisdiction of the Province , HC considers worker camps as "residential communities" and advises that, as off-duty workers spend a portion of their time at the camp for meals, recreation and sleeping, it would be advisable to assess the potential impacts of the project on their health, while off-	HC: recommends: a. Updating the revised EIS TSD XXI: ERA to include the key points discussed in IR-69-R1, such as: • conservative assumptions of the air dispersion modeling, • supporting rationale for the interpretation of human health-related impacts using the qualitative scale (e.g., "moderate" and "high" for air quality parameters), and; • frequency of NO2 CAAQS exceedances at receptor locations. b. Implementing a robust air quality monitoring program near the Project Development Area (and the Local Assessment Area) to inform the need for enhanced mitigation measures. It is recommended that the monitoring locations include human receptor locations where air quality exceedances are predicted in order to minimize potential human health impacts, plus additional receptor locations to validate the estimates of health effects. c. Clarifying or correcting any discrepancies between modelled concentrations of air contaminants and any associated conclusions with respect to compliance with the CAAQS (e.g., NO_2, $PM_{2.5}$ and PM_{10} values in Table 7.2-12 in Revised Draft EIS compared with Table 4.7 of the EIS TDS XXI: ERA).	The following information is provided in response to part a through part c of the reviewer's comment. a. With respect to the first item raised by the reviewer in comment a, NexGen confirms that the conservative assumptions used in the EA with respect to air quality emissions, including those stated in Draft EIS Section 7.2.8 (Prediction Confidence and Uncertainty), will be added to Section 4.3.2 of Final EIS TSD XXI (Environmental Risk Assessment). These assumptions are inclusive of those presented in NexGen's response to IR 69-R1. With respect to the second item raised by the reviewer in comment a, NexGen clarifies that the residual effects classifications for air quality and human health, which each used the criteria of direction, magnitude, geographic extent, duration, reversibility, frequency, and probability of occurrence, were conducted independently. More specifically, while information such as predicted emission results from the air quality assessment was used in the assessment of human health, the residual effects classification for the air quality intermediate component was not considered. This approach is appropriate as the manner in which residual effects classifications are completed are specific to each valued component or intermediate component (Draft EIS Section 6.9.1 [Residual Effects Classification]). Regarding the magnitude of effects for the air quality measurement indicators, the air quality assessment considered the maximum predicted concentrations in relation to the applicable regulatory criteria (i.e., Saskatchewan Ambient Air Quality Standards) (Draft EIS Section 7.2.2.9 [Residual Effects Classification]; Table 7.2-5) when a range of outcomes were possible to follow a precautionary approach (Draft EIS Section 7.2.2.10 [Prediction Confidence and Uncertainty]). Therefore, magnitude classifications of 'moderate' and 'high' were designated for the applicable measurement indicators based on the predicted maximum emission concentrations. While magnitude represents an important residual effects classification criterion, it can not be considered in isolation. To understand the overall effects to air quality measurement indicators, other criteria including geographic extent, duration, reversibility, frequency, and probability of occurrence must be considered in conjunction with the magnitude of effect. When conducting screening of constituents of potential concern (COPCs) for the human health assessment, in addition to magnitude, the frequency and duration of air emission COPC exceedances provided important context for determining potential effects to human health. The following factors represented key considerations: a. No constituents at any environmental risk assessment (ERA) receptor location exceeded associated annual screening values, indicating that unacceptable chronic effects from direct exposure to air would not be expected (Draft EIS Section 15.2.8.2 [Constituents of Potential Concern]). b. Exceedances for maximum predicted 24-hour concentrations within the Project footprint and at the fence line were identified for NO_2 and particulate matter. However, unacceptable levels of risk to people would not be expected from direct, infrequent, short-term, and highly localized exposures to these constituents in air (Draft EIS Section 15.2.8.2).

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	duty. Due to the proximity of the camp to airborne emission sources, inhalation of airborne emissions is likely to be the main route of exposure of off-duty workers to particulate matter and other air borne contaminants. Monitoring and possible mitigation measures may reduce potential health risks in cases where sensitive receptors (camps and workers' camp) are predicted to be exposed to contaminant concentrations that exceed objectives and standards.		c. With respect to NO_2, exceedance of the 1-hour short-term screening value at the camp site would be limited to Construction, and any health effects would be reversible and subside after exposure; therefore, NO_2 was not considered for further quantitative assessment (Draft EIS TSD XXI, Section 4.3.3.3.1). In summary, while predicted Project emissions resulted in moderate- or high-magnitude effects to the air quality measurement indicators, no long-term or lengthy emission exceedances would exist, and significant adverse effects to human health are not expected. With respect to the third item raised by the reviewer in comment a, information from Section 3 of Attachment IR 69-R1, including Table 1, will be added to Section 4.3.3.3.1 of Final EIS TSD XXI. b. NexGen confirms that robust monitoring of effects to air quality and human health would be implemented. As described in Draft EIS Section 7.2.8 (Monitoring, Follow-up, and Adaptive Management), "NexGen would implement the Environmental Protection Program, which describes the processes required to monitor and characterize emissions from Project facilities and activities, to monitor and characterize the quality of the environment to assess the effectiveness of mitigations, and to continually improve environmental protection performance throughout all Project phases. The Effluent and Emissions Plan and Environmental Monitoring Plan would be components of the Environmental Protection Program. Where relevant, adaptive management measures may also be proposed to address the uncertainties associated with the effects predictions and mitigation". In addition to environmental monitoring programs typically implemented for projects (as noted above), NexGen is working with local Indigenous Groups to implement independent environmental monitoring. In combination with standard Project monitoring processes, independent Indigenous monitoring would be used to verify Project performance and to determine if mitigations and controls are effective in protecting the receiving environment (Draft EIS Section 23.5.2 [Indigenous Monitoring]). Also, as described in Section of Draft EIS TSD XXI (Environmental Risk Assessment), "[m]onitoring would focus on collecting data to verify ERA model predictions as well as provide data to improve model predictions as the Project begins. Recommended monitoring would support NexGen's adaptive management framework with the goal of reducing uncertainty over time through an iterative process". Should adaptive management to address potential concerns to air quality or human health (e.g., NO_2 emission effects) be required, the process would follow NexGen's adaptive management approach, which would include assessing the problem, designing an adaptive management approach, engaging with Indigenous Groups and local community members, implementing actions, monitoring for effectiveness, evaluating the outcomes, and adjusting or terminating the approach,

No.	Context and Rationale	Comment	NexGen Response
			as required (Draft EIS Section 23.5.3 [Adaptive Management]). The specific air quality monitoring parameters, including thresholds to be considered and locations to be monitored, would be provided in the Effluent and Emissions Plan and Environmental Monitoring Plan that require approval through the federal licensing and provincial permitting processes. These plans would follow the requirements of REGDOC-2.9.1 (CNSC 2020) and REGDOC-2.9.2 (CNSC 2021), which include requirements for mitigation and monitoring in alignment with CSA N288.5-22 (CSA 2022). As a part of the ERA results verification component of monitoring, it is anticipated that human health receptor locations presented in the EIS would be considered as monitoring locations. These plans would also consider feedback from local priority area Indigenous Groups, which is primarily expected to be received through the Environmental Committees established through the Benefit Agreements. **References** CNSC. 2020. REGDOC-2.9.1, Environmental Principles, Assessments and Protection Measures, Version 1.2. September 2020. ISBN 978-0-660-06255-6. Available at http://nuclearsafety.gc.ca/eng/pdfs/REGDOCS/REGDOC-2-9-1-Environmental-Principles-Assessments-and-Protection-Measures-eng.pdf. CNSC (Canadian Nuclear Safety Commission). 2021. Environmental Protection: Controlling Releases to the Environment. DRAFT. March 2021. Available at https://www.nuclearsafety.gc.ca/eng/pdfs/regulatory-documents/regdoc2-9-2/REGDOC-2_9_2_Controlling_Releases_to_the_Environment.pdf. CSA Group (Canadian Standards Association Group). 2022. CSA N288.5-22: Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills. c. NexGen confirms that the predicted Project and Application Case emission values in comparison to the CAAQS in Table 4.7 of Section 4.3.3.2 of Draft EIS ERA TSD XXI (Environmental Risk Assessment) and Table 7.2-12 of Draft EIS Section 7.2.5.1.1.2 (Air Dispersion Modelling Predictions) are accurate. The reason for the discrepancies in values is due to the different approaches used between the ERA and the air quality assessment. With respect to the ERA, the values presented in Table 4.7 of Section 4.3.3.2 of Draft EIS ERA TSD XXI represent the maximum modelled air concentrations available from the AERMOD model results at human and ecological receptor locations. These maximum concentrations were used for screening, consistent with recommendations from Clause 6.2.5.5 of CSA N288.6:22 (CSA Group 2022). With respect to the air quality assessment, the values presented in Table 7.2-12 of Draft EIS Section 7.2.5.1.1.2 lists the maximum model predictions of air concentrations at receptors excluding those inside of the maximum disturbance area. Also, as noted in Draft EIS Section 7.2.2.8.3 (Dispersion Modelling), the Saskatchewan Air Dispersion Modelling Guideline (SAQMG) allows the elimination of a small number of model predictions expected to be caused by rare and unusual meteorological conditions that are considered outliers in the predicted concentration data. For a refined model such as AERMOD, the SAQMG

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			allows the elimination of these outliers by using the following 'nth' highest concentrations predictions for each receptor location as described below. These refinements are noted in footnotes provided in Table 7.2-12 of Draft EIS Section 7.2.5.1.1.2. a. 1-hour average – use the 9th highest concentration b. 8-hour average – use the 5th highest concentration c. 24-hour average – use the 2nd highest concentration In summary, both assessments were conducted according to their respective guidance documents and the emission values provided in the Draft EIS are accurate. **References** CSA Group (Canadian Standards Association Group). 2022. CSA N288.6-22: Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills.

4.3 Atmospheric Sources

4.3.1 Project-Related Atmospheric Releases

The Project has the potential to change air quality through the emission of gases and particulates and deposition of particulates generated by Project activities. For emission to the atmosphere, the ERA focused on Construction and Operations when effects on air quality are expected to be the greatest due to the intensity and number of Project-related activities. Additionally, atmospheric emissions during Closure are expected to be lower than during Construction and Operations; and Closure modelling was not explicitly conducted. It was conservatively assumed that Closure air quality would be similar to Construction air quality.

The Project-related atmospheric releases considered in the ERA were consistent with the air emissions inventory detailed in the Air Dispersion Modelling Report for Project Construction and Operations (EIS Section 7.2.5, Residual Effects Analysis; EIS Appendix 7A, Air Dispersion Modelling Report). The major air emission sources considered for the ERA included:

- fossil fuel combustion emissions from mobile equipment and stationary equipment (e.g., power plant, heaters);
- fugitive dust emissions from drilling and blasting, material handling, crushing, vehicle generated road dust, and wind erosion from ore and mine rock storage piles;
- air emissions released from the milling processes (e.g., calciner, acid plant, lime silo baghouses); and
- solid waste incinerators.

Project-related atmospheric releases would include criteria air contaminants (CACs; nitrogen oxides [assessed as nitrogen dioxide, sulphur dioxide, sulphuric acid, carbon monoxide, total suspended particulates [TSP], and particulate matter [PM_{10} and $PM_{2.5}$]), fugitive dust, dioxins and furans, metals and radionuclides, and radon.

Criteria air contaminants have either federal or provincial ambient air quality criteria or both. Nitrogen oxides, sulphur dioxide, carbon monoxide, and particulates (TSP, PM_{10}, and $PM_{2.5}$) would be CACs directly emitted by the Project from stationary and mobile sources. Sulphuric acid emissions would be associated with the acid plant.

Dust commonly refers to large particulate matter, such as fugitive dust, that tends to settle out of suspension in the air by gravity within a short distance from the source. It would be associated with such activities as aggregate generation, road dust, materials hauling, and construction activities. It would be measured in terms of TSP deposition or dustfall.

Dioxins and furans represent a family of toxic compounds formed during the combustion process that share a similar chemical structure and are persistent in the environment. They would be associated with waste incineration.

Metals and radionuclides would be emitted as a portion of dust and combustion emissions. Dust emissions from waste rock, special waste, ore, and aggregate were assumed to contain metals. Dust emissions from waste rock, special waste, and ore were assumed to contain radionuclides. Radionuclides associated with dust from aggregate materials were considered to be negligible. The radionuclides included in the ERA were uranium-238 series radionuclides and were assumed to be in secular equilibrium.

Radon emissions from a number of sources were included in the air quality assessment: mine vent; ore storage pile; special waste rock pile; ore handling, grinding circuit / process plant, and slurry vessels; paste tailings preparation; settling pond; waste rock storage piles and material handling; and low-level radioactive waste incinerator. Potential radon emissions from the calciner and uranium concentrate handling stacks were considered to be negligible. Radon emissions were estimated based on U_3O_8 grade for waste rock (0.03%), special waste (0.05%) and ore (4%).

4.3.2 Atmospheric Sources

In this context, sources refer to total concentrations of constituents in air at specific human and ecological receptor locations. Constituent predictions for ambient air quality were obtained from the Air Dispersion Modelling Report (EIS Appendix 7A). Air quality modelling followed the Saskatchewan Air Quality Modelling Guideline (ENV 2012) using the atmospheric dispersion model AERMOD (EIS Appendix 7A). The emissions inputs were calculated to represent the maximum reasonably foreseeable emissions from the Project after applying mitigation actions and policies to reduce emissions.

Air quality modelling included predictions for CACs, dust, dioxins and furans, metals and radionuclides, and radon at the fence line and at specific human health and ecological receptor locations as described in Section 5.2.1, Exposure Locations, Duration, and Frequency, for the human health risk assessment, and in Section 6.2.1, Exposure Locations, for the ecological risk assessment. For the purposes of the ERA, the fence line was assumed to be the nearest location outside the property boundary where there would be public access (ENV 2012). The predicted air concentrations were based on a single "maximum year" scenario modelled for each of Construction and Operations.

Predicted total maximum concentrations in ambient air from the Air Dispersion Modelling Report (EIS Appendix 7A) were used in Section 4.3.3, Screening for Atmospheric Constituents of Potential Concern, for the relevant averaging period for Construction and Operations. For metals and radionuclides associated with dust emissions, total concentrations include only Project-related sources. Background concentrations of metals in dust were assumed to be negligible and were set to zero in the air quality model because there are no other industrial sources within 100 km of the LSA. Regional background concentrations for CACs are summarized in Table 4-4.

Conservative assumptions were used to create the emissions inventory as inputs to the air dispersion model (EIS Appendix 7A). Key areas of conservatism included the following (EIS Section 7.2.8, Prediction Confidence and Uncertainty):

Commented [FH3]: IR 69: added conservative air quality modelling assumptions from EIS Section 7.2.8 and Attachment IR 69-R1

- The emissions inventory was created for the highest intensity year of Construction and Operations. Emissions in other years would have lower emissions rates for CACs.
- When applicable, conservative assumptions and approaches were used to estimate the emissions from the Project. Examples include the following:
  - The power plant was assumed to be operating at 90% load hourly and 70% load daily continuously throughout the year. The actual operating loads are expected to be lower than these rates most of the time.
  - As underground sources do not occur at the mine vent, but emit via the mine vent, the assumption that emission rates at the source are equal to emission rates at the mine vent is conservative, particularly for heavier PM that would partially settle out along lateral development and ramps before being entrained in the high velocity vertical air shaft.
  - All mobile equipment was assumed to operate simultaneously, while in reality, it is not expected that all mobile equipment would be operating at same time.
  - For most of the emission sources, the emission inventory used emission factors (e.g., USEPA AP-42 emission factors) that were developed decades ago. With the new regulations and technologies, it is expected that the application of these emission factors is conservative. For example, the assessment used Tier 2 or Tier 3 emission standard mobile equipment; however, in practice, Tier 4 engines would be used to the extent that they are available.

In addition to the conservative assumptions listed above, emissions from blasting (i.e., NO_x, CO, and SO_2) were assumed to occur every hour over the year when modelling the air concentration for the 1-hour averaging period. However, much lower emission rates from the underground mine exhaust are expected for the non-blasting hours.

To account for the variability of meteorological parameters (e.g., local wind speed and direction), a five-year meteorological dataset was used in the modelling. The five-year meteorological dataset would represent most plausible meteorological conditions, and a wide range of combinations of wind, temperature, and atmospheric stability. Thus, the maximum predictions would represent the concentrations under the worst-case meteorological conditions.

Table 4-4: Background Concentrations of Air Quality Constituents Used in The Air Quality Model

Constituent (unit)	Averaging Period	Background Concentration
Nitrogen dioxide (µg/m^3)	1 hour	11.3
	24 hours	9.4
	Annual	3.8
Sulphur dioxide (µg/m^3)	1 hour	0
	24 hours	0
	Annual	0
Carbon monoxide (µg/m^3)	1 hour	572
	8 hours	572
PM_{10} (µg/m^3)	24 hours	23.1
$PM_{2.5}$ (µg/m^3)	24 hours	6.5
	Annual	3.1
TSP (µg/m^3)	24 hours	14.4
	Annual	6.2
Radon (Bq/m^3)	Average	2.94

Note: Background concentrations were obtained from EIS Appendix 7A, Air Dispersion Modelling Report.
Bq/m^3 = becquerels per cubic metre; TSP = total suspended particulates; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less.

4.3.3 Screening for Atmospheric Constituents of Potential Concern

Constituents of potential concern for air, as defined by Health Canada (Health Canada 2016a), are chemicals whose concentration(s) may become elevated in ambient air as a result of project-related activities, and which have the potential for adverse human or ecological health effects based on documented scientific evidence or suspected causal relationships. The purpose of this subsection is to identify those Project-related constituents in air that may be of concern for human and/or ecological health and require further assessment.

The screening of air quality constituents was based on maximum predicted concentrations of CACs, dioxins and furans, radon, and 28 metals and metalloids, and maximum dust deposition, at air quality model locations that correspond with receptor locations (Table 4-5), as described in Section 5.2.1, Exposure Locations, Duration, and Frequency, for the human health risk assessment, and Section 6.2.1, Exposure Locations, for the ecological risk assessment.

Table 4-5: Concordance between Air Quality Model and Receptor Locations

Air Quality Model Location	Human and Ecological Receptor Location	Air Quality Model Coordinates	
		X (m)	Y (m)
HHRA1	Hodge Lake Reference	593,768	6,407,146
HHRA2	Broach Lake	600,359	6,398,266
HHRA3	Camp[(a)]	603,778	6,393,226
HHRA4	Patterson Lake Human Health Receptors	598,658	6,387,580
HHRA5	Patterson Lake Ecological Receptors	602,320	6,392,289
HHRA6	Forrest Lake	605,446	6,388,744
HHRA7	Forrest Lake North	605,452	6,390,021
HHRA8	Beet Lake	608,931	6,389,997
HHRA9	Naomi Lake	614,179	6,390,462
HHRA10	Clearwater River	626,340	6,380,517
HHRA11	Lloyd Lake	616,793	6,361,563

(a) HHRA3 is located at the camp; other air quality model and human and ecological receptor locations are located outside of the Project footprint.

The modelled location HHRA3 is located at the camp within the Project footprint. This location was retained for the screening as a conservative measure to ensure potential COPCs in air are captured in the ERA, since it is the closest location to the source. This location would therefore be expected to experience higher air concentrations than locations farther away.

1. Human and ecological receptors at receptor locations were assumed to be in contact with air emissions for prolonged periods of time, at intervals that may be long-term (i.e., annual average) or repeated and short-term (i.e., 24 hours or less) over a lifetime. For this reason, long-term and short-term screening values at the receptor locations were used for the screening of constituents in air at receptor locations. Screening of constituents in air for the receptor locations followed the following protocol using maximum predicted concentrations for all receptor locations for the relevant time period:

2. If the model results from the Air Dispersion Modelling Report (EIS Appendix 7A) for a constituent were below all of its relevant air quality screening values, at all receptor locations, the constituent was assumed to be below levels associated with potential human health and ecological risks and was not considered further in the ERA for direct atmospheric exposures.

3. If the model result for an air quality constituent was greater than any one of its relevant air quality screening values at any receptor location, the constituent was determined to be a potential COPC in air and was evaluated further in Section 4.3.3.3, Discussion of Air Quality Constituents that Exceed a Screening Value.

4. Potential human health and ecological risks for the air quality constituents that were determined to be COPCs in Section 4.3.4, Air Quality Constituents for Further Evaluation

in the Environmental Risk Assessment, were characterized in Section 5.4 and Section 6.4, Risk Characterization, respectively.

The ERA also considered that humans (such as the subsistence harvester) and mobile ecological receptors (e.g., birds and mammals) would be present near the fence line occasionally and for short periods (i.e., less than 24 hours) of time. Maximum predicted concentrations from the Air Dispersion Modelling Report (EIS Appendix 7A) of Project-related constituents in air at the fence line were therefore screened using short-term screening values (i.e., 1 hour, 8 hours). This screening and its results are in Section 4.3.3.2, Screening of Air Quality Constituents. If the model results were below all relevant short-term air quality screening values, the constituent was assumed to be below levels associated with potential human health and ecological risks and was not considered further in the ERA.

4.3.3.1 Screening Value Selection

Ambient air quality criteria are available for different exposure averaging periods (e.g., 1 hour, 24 hour, annual). Maximum predicted concentrations from the Air Dispersion Modelling Report (EIS Appendix 7A) of constituents in air were screened against ambient air quality criteria for the same averaging period. Ambient air quality criteria for the relevant averaging periods were selected based on the following order for selection:

- Saskatchewan Ambient Air Quality Standards (SAAQS) are maximum concentrations in ambient air from all sources as stipulated in The Clean Air Regulations (Government of Saskatchewan 2015).
- Alberta Ambient Air Quality Objectives (Alberta 2021) (AAAQO) are based on an evaluation of scientific, social, technical, and economic factors.
- Ontario Ambient Air Quality Criteria (OAAQC) are concentrations of a contaminant in air that are protective against adverse effects on health and/or the environment (MECP 2020).
- Texas effects screening levels (ESLs) are air concentrations at or below which adverse health effect in the general public, including sensitive subgroups such as children, the elderly, pregnant women, and people with pre-existing health conditions, are not likely to occur (TCEQ 2016).

Canadian Ambient Air Quality Standards (CAAQS) established under the national Air Quality Management System (CCME 2021b) were used for information purposes, but not selected as screening criteria. As indicated in the Air Quality assessment (EIS Section 7.2, Air Quality), the CAAQS achievement is determined by provinces and territories using ambient concentrations measured in the air zones for a three-year period, not by comparison of modelled predictions at or beyond a facility boundary.

Screening values for radionuclide concentrations in ambient air were not available. All relevant radionuclides were assessed in the ERA in terms of their contribution to the total radiological dose to human and ecological receptors.

A screening value for radon gas was not available from the sources identified. Health Canada's annual average corrective action trigger value of 200 becquerels per cubic metre (Bq/m^3) for indoor air was used for the screening (Health Canada 2009).

The selected ambient air quality screening values for different averaging periods, their source, and their rationale in terms of potential effects are summarized in Table 4-6. Where multiple sources recommended the same criterion value, each of the relevant sources is identified. The rationale provided in Table 4-6 for each of the selected screening values describes the sensitive effect that is the basis for the value cited by the relevant source.

Table 4-6: Screening Values for the Selection of Air Quality Contaminants of Potential Concern for the Environmental Risk Assessment

Constituent	Averaging Period	Selected Screening Value	Source	Rationale
CACs				
Nitrogen dioxide (NO_2)	1 hour	300	SAAQS/AAAQO	Respiratory effects
	24 hours	200	SAAQS/OAAQC	Human health
	Annual	45	SAAQS/AAAQO	Vegetation
Sulphur dioxide (SO_2)	1 hour	450	SAAQS/AAAQO	Pulmonary effects
	24 hours	125	SAAQS/AAAQO	Human health
	Annual	20	SAAQS/AAAQO	Ecosystem health
Carbon monoxide (CO)	1 hour	15,000	SAAQS/AAAQO	Oxygen carrying capacity of blood
	8 hours	6,000	SAAQS/AAAQO	Oxygen carrying capacity of blood
	Annual	n/v	n/a	n/a
Sulphuric acid (H_2SO_4)	1 hour	10	AAAQO	Not stated
	24 hours	5	OAAQC	Human health
	Annual	n/v	n/a	n/a
Total suspended particulates (TSP)	24 hours	100	SAAQS/AAAQO	Human health. Pulmonary effects
	Annual	60	SAAQS/OAAQC	Visibility
Particulate matter (PM_{10})	24 hours	50	SAAQS/OAAQC	Human health
	Annual	n/v	n/a	n/a
Particulate matter ($PM_{2.5}$)	24 hours	27	OAAQC/CAAQS	Human health
	Annual	8.8	OAAQC/CAAQS	Human health
Dust				
TSP deposition	Annual	4.6	OAAQC	Dustfall criterion. Aesthetics ($g/m^2/yr$)
	Monthly	5.3	AAAQO	Aesthetics ($g/m^2/30$ days)

Constituent	Averaging Period	Selected Screening Value	Source	Rationale
Dioxins and Furans				
Dioxins and furans	24 hour	0.1	OAAQC	Human health (pg TEQ/m^3)
	Annual	n/v	n/a	n/a
Radionuclides				
U-238 series radionuclides	24 hour	n/v	n/a	Addressed in terms of radiation dose in the ERA
	Annual	n/v	n/a	Addressed in terms of radiation dose in the ERA
Radon				
Radon	Annual	200	Government of Canada Radon Guideline (Health Canada 2009)	Addressed in terms of radiation dose in the ERA
Metals				
Silver (Ag)	24 hour	1	OAAQC	Human health
	Annual	n/v	n/a	n/a
Arsenic (As)	24 hour	0.3	OAAQC	Human health. Applies to arsenic and arsenic compounds
	Annual	0.01	AAAQO	Human health. Carcinogenic effects
Barium (Ba)	24 hour	10	OAAQC	Human health. Applies to total barium water-soluble fraction
	Annual	n/v	n/a	n/a
Beryllium (Be)	24 hour	0.01	OAAQC	Human health. Applies to beryllium and beryllium compounds
	Annual	n/v	n/a	n/a
Cadmium (Cd)	24 hour	0.025	OAAQC	Human health. Applies to cadmium and cadmium compounds. Converted from the annual AAQC to allow assessment of 24-hour air quality data
	Annual	0.005	OAAQC	Human health. Applies to cadmium and cadmium compounds

Constituent	Averaging Period	Selected Screening Value	Source	Rationale
Cobalt (Co)	24 hour	0.1	OAAQC	Human health
	Annual	n/v	n/a	n/a
Chromium (Cr)	24 hour	0.5	OAAQC	Human health. Applies to either chromium metallic, divalent, and trivalent, or to the percentage of chromium metallic, divalent, and trivalent relative to total chromium
	Annual	n/v	n/a	n/a
Copper (Cu)	24 hour	50	OAAQC	Human health
	Annual	n/v	n/a	n/a
Mercury (Hg)	24 hour	2	OAAQC	Human health
	Annual	n/v	n/a	n/a
Molybdenum (Mo)	24 hour	120	OAAQC	Particulate - visibility; molybdenum is more likely emitted as TSP, and therefore the AAQC for TSP is applied
	Annual	n/v	n/a	n/a
Nickel (Ni)	24 hour	0.2	OAAQC	In TSP. Human health. Applies to nickel and nickel compounds. Converted from the annual criterion to allow assessment of the 24-hour data (TSP). Intended to protect from development of chronic effects
	Annual	0.04	OAAQC	In TSP. Human health. Applies to nickel and nickel compounds
	24 hour	0.1	OAAQC	In PM_{10}. Human health. Applies to nickel and nickel compounds. Converted from the annual criterion to allow assessment of the 24-hour data (TSP). Intended to protect from development of chronic effects
	Annual	0.02	OAAQC	In PM_{10}. Human health. Applies to nickel and nickel compounds
Lead (Pb)	24 hour	0.5	OAAQC	Human health. Applies to lead and lead compounds. Converted from the 30-day AAQC to allow assessment of 24-hour air quality data

Constituent	Averaging Period	Selected Screening Value	Source	Rationale
	Monthly	0.2	OAAQC	Human health. Applies to lead and lead compounds. As arithmetic mean of a 30-day period
	Annual	n/v	n/a	n/a
Antimony (Sb)	24 hour	25	OAAQC	Human health
	Annual	n/v	n/a	n/a
Selenium (Se)	24 hour	10	OAAQC	Human health
	Annual	n/v	n/a	n/a
Tin (Sb)	24 hour	10	OAAQC	Human health
	Annual	n/v	n/a	n/a
Thorium (Th)	24 hour	n/v	n/a	n/a
	Annual	n/v	n/a	n/a
Uranium (U)	24 hour	0.3	OAAQC	In TSP. Human health. Applies to uranium and uranium compounds. Converted from the annual AAQC to allow assessment of 24-hour air quality data
	Annual	0.06	OAAQC	In TSP. Human health. Applies to uranium and uranium compounds
	24 hour	0.15	OAAQC	In PM_{10}. Human health. Applies to uranium and uranium compounds. Converted from the annual AAQC to allow assessment of 24-hour air quality data
	Annual	0.03	OAAQC	In PM_{10}. Human health. Applies to uranium and uranium compounds
Vanadium (V)	24 hour	2	OAAQC	Human health
	Annual	n/v	n/a	n/a
Zinc (Zn)	24 hour	120	OAAQC	Particulates
	Annual	n/v	n/a	n/a

Constituent	Averaging Period	Selected Screening Value	Source	Rationale
Cesium (Cs)	24 hour	n/v	n/a	n/a
	Annual	2	Texas Interim ESL	Human health
Bismuth (Bi)	24 hour	n/v	n/a	n/a
	Annual	5	Texas Interim ESL	Human health
Calcium (Ca)	24 hour	n/v	Texas ESL	Particulates
	Annual	n/v	Texas ESL	Particulates
Iron (Fe)	24 hour	4	OAAQC	Human health. Applies to metallic iron
	Annual	n/v	n/a	n/a
Magnesium (Mg)	24 hour	72	OAAQC	Human health
	Annual	n/v	n/a	n/a
Manganese (Mn)	24 hour	0.1	OAAQC	Human health. OAAQC (2020): 0.4 (TSP), 0.2 (PM_{10}) and 0.1 ($PM_{2.5}$). For manganese and manganese compounds in TSP
	Annual	0.2	AAAQO	Adopted from Texas (long-term ESL) and California (chronic reference exposure level for nervous system effects)
Sodium (Na)	24 hour	n/v	Texas ESL	Particulate
	Annual	n/v	Texas ESL	Particulate

Note: Units are µg/m^3 unless otherwise specified.
Texas ESL = Texas Commission on Environmental Quality (TCEQ 2016); AAAQO = Alberta Ambient Air Quality Objectives (Alberta 2021); CAAQS = Canadian Ambient Air Quality Standards, air quality objectives under the *Canadian Environmental Protection Act, 1999* (CCME 2021b); OAAQC = Ontario Ambient Air Quality Criteria (MECP 2020); SAAQS = Saskatchewan Ambient Air Quality Standards (Government of Saskatchewan 2015); AAQC = ambient air quality criteria; CAC = criteria air contaminant; ESL = effects screening level; Bq/m^3 = becquerels per cubic metre; TSP = total suspended particulates; ERA = environmental risk assessment; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; n/a = not applicable; n/v = no value; pg TEQ/m^3 = picogram toxic equivalency.

4.3.3.2 Screening of Air Quality Constituents

The screening of air quality constituents involved the following two types of screenings:

- Comparing the predicted maximum air concentrations from the air quality model at all human and ecological receptor locations for all (short and long-term) averaging periods against the corresponding air quality criteria (Table 4-7).
- Comparing the predicted maximum air concentrations from the air quality model at the fence line for short-term averaging periods against short-term air quality criteria (Table 4-8).

The screening of air quality constituents at the human and ecological receptor locations for short- and long-term averaging periods at receptor locations is provided in Table 4-7. Both human and ecological receptors were assumed to be present for extended periods of time at these locations and therefore susceptible to both short- and long-term exposures to airborne constituents. Constituents that had only a short-term or a long-term screening value were not considered further if the maximum predicted concentration was less than the screening value, as explained in Table 4-7.

The screening of air quality constituents at the fence line for short-term averaging periods only is provided in Table 4-8. Hypothetical visitors and mobile ecological receptors were assumed to be present for short periods of time at these locations and therefore susceptible to only short-term exposures to airborne constituents. The screening was performed using the maximum predicted concentrations for all fence line locations from the air quality model (EIS Appendix 7A) for the relevant averaging period. Note that these maximum fence line concentrations are in some cases higher than those presented in EIS Section 7.2, since the air quality assessment in the EIS followed Saskatchewan air quality dispersion modelling guidance which allows for discounting the maximum modelled concentrations.

Constituents that were predicted to exceed any of their screening values based on maximum predicted values for the relevant averaging period are further discussed in Section 4.3.3.3, to determine whether or not they should be retained as COPCs and further evaluated in terms of human health and/or ecological risk. Air quality constituents with maximum concentrations that exceeded either their short- or long-term screening value at receptor locations were nitrogen dioxide, particulate matter (TSP, PM_{10}, $PM_{2.5}$), and uranium. Dustfall exceeded its annual criterion during Construction. Air quality parameters with maximum short-term concentrations that exceed screening values at the fence line are nitrogen dioxide, particulate matter (TSP, PM_{10}, and $PM_{2.5}$), and uranium.

While no identified screening level is exceeded for radionuclides (including uranium-238 series) and radon gas, potential human health and ecological risks are discussed in Section 5.4 and Section 6.4, respectively.

Table 4-7: Air Quality Screening for Short-term and Long-term Exposures to Constituents in Air at Human and Ecological Receptor Locations

Constituent	Maximum Concentration at Receptor Locations		Screening Value	Averaging Period	Source	Is Concentration Greater than Selected Screening Value (Yes/No)	Is the Constituent Retained for Further Consideration as a COPC?
	Construction	Operations					
CACs							
Nitrogen dioxide (NO_2)	14.7	8.55	45	Annual	SAAQS/AAAQO	**Yes (1 hour)**	Yes. No exceedance of annual value but considered further because it does exceed screening value for 1 hour during Construction at HHRA3
	120	103	200	24 hours	SAAQS/OAAQC		
	374	174	300	1 hour	SAAQS/AAAQO		
Sulphur dioxide (SO_2)	0.0737	0.225	20	Annual	SAAQS/AAAQO	No	No
	1.19	6.31	125	24 hours	SAAQS/AAAQO		
	8.63	25.0	450	1 hour	SAAQS/AAAQO		
Carbon monoxide (CO)	771	994	6,000	8 hours	SAAQS/AAAQO	No	No. No annual value but not considered further because it does not exceed screening values for 8 hours or 1 hour
	1,170	1,232	15,000	1 hour	SAAQS/AAAQO		
Sulphuric acid (H_2SO_4)	n/c	0.816	5	24 hours	OAAQC	No	No. No annual value but not considered further because it does not exceed screening values for 24 hours or 1 hour
	n/c	3.19	10	1 hour	AAAQO		
TSP	15.3	10.2	60	Annual	SAAQS/OAAQC	**Yes (24 hour)**	Yes. No exceedance of annual value but considered further because it does exceed screening values for 24 hours during Construction and Operations at HHRA3
	296	**103**	100	24 hours	SAAQS/AAAQO		
PM_{10}	**164**	**70.8**	50	24 hours	SAAQS/OAAQC	**Yes (24 hour)**	Yes. No annual value but considered further because it does exceed screening values for 24 hours during Construction and Operations at HHRA3
$PM_{2.5}$	3.10	3.84	8.8	Annual	OAAQC/CAAQS	**Yes (24 hour)**	Yes. No exceedance of annual value but considered further because it does exceed screening values for 24 hours during Construction and Operations at HHRA3
	65.5	**28.0**	27	24 hours	OAAQC/CAAQS		
Dust							
TSP deposition	**87.9**	5.33	7	Annual	OAAQC Dustfall Criteria ($g/m^2/yr$)	**Yes (Annual)**	Yes. Considered further because it exceeds annual value during Construction at HHRA3
	1.61	1.08	5.3	Monthly	AAAQO (g/m^2/30 days)		
Dioxins and furans							
Dioxins and furans	0.000927	0.00186	0.1	24 hour	OAAQC (pg TEQ/m^3)	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Radon							
Radon	n/c	44.5	200	Annual	Government of Canada Radon Guideline (Bq/m^3) (Health Canada (2009)	No	Yes. Assessed in terms of radiation dose in the ERA
Metals							
Silver (Ag)	n/c	3.00×10^{-05}	1	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Arsenic (As)	n/c	3.00×10^{-05}	0.01	Annual	AAAQO	No	No
	n/c	3.90×10^{-04}	0.3	24 hour	OAAQC	No	No
Barium (Ba)	n/c	3.70×10^{-02}	10	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours

Constituent	Maximum Concentration at Receptor Locations		Screening Value	Averaging Period	Source	Is Concentration Greater than Selected Screening Value (Yes/No)	Is the Constituent Retained for Further Consideration as a COPC?
	Construction	Operations					
Beryllium (Be)	n/c	6.00×10^{-05}	0.01	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Cadmium (Cd)	n/c	5.00×10^{-05}	0.005	Annual	OAAQC	No	No
	n/c	5.50×10^{-04}	0.025	24 hour	OAAQC	No	No
Cobalt (Co)	n/c	1.05×10^{-03}	0.1	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Chromium (Cr)	n/c	1.52×10^{-02}	0.5	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Copper (Cu)	n/c	4.96×10^{-03}	50	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Mercury (Hg)	n/c	8.00×10^{-04}	2	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Molybdenum (Mo)	n/c	3.84×10^{-03}	120	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Nickel (Ni) in TSP	n/c	1.70×10^{-04}	0.04	Annual	OAAQC	No	No
	n/c	2.99×10^{-03}	0.2	24 hour	OAAQC	No	No
Nickel (Ni) in PM_{10}	n/c	1.20×10^{-04}	0.02	Annual	OAAQC	No	No
	n/c	2.75×10^{-03}	0.1	24 hour	OAAQC	No	No
Lead (Pb)	n/c	7.40×10^{-04}	0.2	Monthly	OAAQC	No	No. No annual value but not considered further because it does not exceed screening values for 24 hours and monthly
	n/c	8.20×10^{-03}	0.5	24 hour	OAAQC	No	
Antimony (Sb)	n/c	5.00×10^{-05}	25	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening values for 24 hours and monthly
Selenium (Se)	n/c	9.00×10^{-05}	10	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Tin (Sb)	n/c	1.30×10^{-04}	10	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Uranium (U) in TSP	n/c	9.38×10^{-03}	0.06	Annual	OAAQC	No	No
	n/c	2.68×10^{-01}	0.3	24 hour	OAAQC	No	No
Uranium (U) in PM_{10}	n/c	6.10×10^{-03}	0.03	Annual	OAAQC	No	Yes. Does not exceed annual value but considered further because it exceeds the 24 hours screening value during Operations at HHRA3
	n/c	**2.09×10^{-01}**	0.15	24 hour	OAAQC	**Yes (24 hour)**	
Vanadium (V)	n/c	7.82×10^{-03}	2	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Zinc (Zn)	n/c	2.85×10^{-03}	120	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Cesium (Cs)	n/c	<0.000001	2	Annual	Texas Interim ESL	No	No. No 24 hours value but not considered further because it does not exceed the annual screening value
Bismuth (Bi)	n/c	<0.000001	5	Annual	Texas Interim ESL	No	No. No 24 hours value but not considered further because it does not exceed the annual screening value

Constituent	Maximum Concentration at Receptor Locations		Screening Value	Averaging Period	Source	Is Concentration Greater than Selected Screening Value (Yes/No)	Is the Constituent Retained for Further Consideration as a COPC?
	Construction	Operations					
Iron (Fe)	n/c	$1.35 \times 10^{+00}$	4	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Magnesium (Mg)	n/c	$1.20 \times 10^{+00}$	72	24 hour	OAAQC	No	No. No annual value but not considered further because it does not exceed screening value for 24 hours
Manganese (Mn)	n/c	7.50×10^{-04}	0.2	Annual	AAAQO	No	No
	n/c	1.86×10^{-02}	0.1	24 hour	OAAQC	No	No

Notes: Air Concentrations are maximum predicted values from the Air Quality model for HHRA locations 1 through 11, inclusively, for the period indicated.
Maximum Concentration values are rounded to 3 significant figures.
For metals, where the model value was zero, the concentration was assumed to be <1.00×10^{-06} µg/m³. Units are µg/m³ unless otherwise specified.
Bold represents air quality parameters predicted to exceed screening values at receptor locations or are parameters that did not exceed the screening level but are discussed further in the ERA.
n/c = not calculated; n/v = no value; n/a = not applicable; ERA = environmental risk assessment; SAAQS = Saskatchewan Ambient Air Quality Standards (Government of Saskatchewan 2015); AAAQO = Alberta Ambient Air Quality Objectives (Alberta 2021); OAAQC = Ontario Ambient Air Quality Criteria (MECP 2020); CAAQS = Canadian Ambient Air Quality Standards (CCME 2021b); < = less than; Bq/m³ = becquerels per cubic metre; TSP = total suspended particulates; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; ESL = effects screening level; pg TEQ/m³ = picogram toxic equivalency; CAC = criteria air contaminant.

Table 4-8: Air Quality Screening for Short-term Exposures to Constituents in Air for Hypothetical Human and Ecological Receptors at the Fence Line

Constituent	Maximum Concentration at Fence Line Locations		Screening Value	Averaging Period	Source	Is Concentration Greater than Selected Screening Value (Yes/No)	Is the Constituent Retained for further Consideration as a COPC?
	Construction	Operations					
CACs							
Nitrogen dioxide (NO_2)	95	73	200	24 hours	SAAQS/AAAQO	No	Yes. Did not exceed the 24-hour value but considered further because it exceeds its 1-hour screening value
	458	205	300	1 hour	SAAQS/AAAQO	**Yes (1 hour)**	
Sulphur dioxide (SO_2)	0.79	3.10	125	24 hours	SAAQS/AAAQO	No	No
	19.74	19.7	450	1 hour	SAAQS/AAAQO	No	No
Carbon monoxide (CO)	831	792	6,000	8 hours	SAAQS/AAAQO	No	No
	2,693	8,759	15,000	1 hour	SAAQS/AAAQO	No	No
Sulphuric acid (H_2SO_4)	n/c	0.391	5	24 hours	OAAQC	No	No
	n/c	2.02	10	1 hour	AAAQO	No	No
TSP	**234**	**173**	100	24 hours	SAAQS/AAAQO	**Yes (24 hour)**	Yes
PM_{10}	**204**	**86.6**	50	24 hours	SAAQS/OAAQC	**Yes (24 hour)**	Yes
$PM_{2.5}$	**51.5**	**35.1**	27	24 hours	OAAQC/CAAQS	**Yes (24 hour)**	Yes
Dioxins and furans							
Dioxins and furans	0.00119	0.00239	0.1	24 hour	OAAQC (pg TEQ/m^3)	No	No
Metals							
Silver (Ag)	n/c	1.10×10^{-04}	1	24 hour	OAAQC	No	No
Arsenic (As)	n/c	8.70×10^{-04}	0.3	24 hour	OAAQC	No	No
Barium (Ba)	n/c	5.47×10^{-02}	10	24 hour	OAAQC	No	No
Beryllium (Be)	n/c	1.00×10^{-04}	0.01	24 hour	OAAQC	No	No
Cadmium (Cd)	n/c	6.40×10^{-04}	0.025	24 hour	OAAQC	No	No
Cobalt (Co)	n/c	1.66×10^{-03}	0.1	24 hour	OAAQC	No	Non
Chromium (Cr)	n/c	2.84×10^{-02}	0.5	24 hour	OAAQC	No	No
Copper (Cu)	n/c	1.65×10^{-02}	50	24 hour	OAAQC	No	No
Mercury (Hg)	n/c	8.00×10^{-04}	2	24 hour	OAAQC	No	No
Molybdenum (Mo)	n/c	1.34×10^{-02}	120	24 hour	OAAQC	No	No
Nickel (Ni)	n/c	3.73×10^{-03}	0.2	24 hour	OAAQC in TSP	No	No
	n/c	3.11×10^{-03}	0.1	24 hour	OAAQC in PM_{10}	No	No
Lead (Pb)	n/c	2.77×10^{-02}	0.5	24 hour	OAAQC	No	No
Antimony (Sb)	n/c	1.70×10^{-04}	25	24 hour	OAAQC	No	No
Selenium (Se)	n/c	3.10×10^{-04}	10	24 hour	OAAQC	No	No
Tin (Sb)	n/c	2.10×10^{-04}	10	24 hour	OAAQC	No	No
Uranium (U)	n/c	**8.55×10^{-01}**	0.3	24 hour	OAAQC in TSP	**Yes (24 hour)**	Yes
	n/c	**6.74×10^{-01}**	0.15	24 hour	OAAQC in PM_{10}	**Yes (24 hour)**	Yes

Constituent	Maximum Concentration at Fence Line Locations		Screening Value	Averaging Period	Source	Is Concentration Greater than Selected Screening Value (Yes/No)	Is the Constituent Retained for further Consideration as a COPC?
	Construction	Operations					
Vanadium (V)	n/c	1.30×10^{-02}	2	24 hour	OAAQC	No	No
Zinc (Zn)	n/c	3.76×10^{-03}	120	24 hour	OAAQC	No	No
Iron (Fe)	n/c	$1.85 \times 10^{+00}$	4	24 hour	OAAQC	No	No
Magnesium (Mg)	n/c	$1.56 \times 10^{+00}$	72	24 hour	OAAQC	No	No
Manganese (Mn)	n/c	3.52×10^{-02}	0.1	24 hour	OAAQC	No	No

Notes: Units are µg/m^3 unless otherwise specified.
Air Concentrations are maximum predicted values from the Air Quality model for HHRA fence line locations, for the period indicated.
Maximum Concentration values are rounded to 3 significant figures.
For metals, where the model value was zero, the concentration was assumed to be <1.00 × 10-06 µg/m^3.
Bold represents air quality constituents with maximum concentrations predicted at fence line locations that exceed screening values during Construction or Operations.
< = less than; SAAQS = Saskatchewan Ambient Air Quality Standards; AAAQO = Alberta Ambient Air Quality Objectives; OAAQC = Ontario Ambient Air Quality Criteria; CAAQS = Canadian Ambient Air Quality Standards; n/c = not calculated; n/v = no value; n/a = not applicable; pg TEQ/m^3 = picogram toxic equivalency; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; TSP = total suspended particulates; CAC = criteria air contaminant.

4.3.3.3 Discussion of Air Quality Constituents that Exceed a Screening Value

Air quality constituents that exceeded a screening value were nitrogen dioxide, particulate matter (TSP, PM_{10}, $PM_{2.5}$, and TSP deposition), and uranium (Table 4-9). These constituents were further evaluated to determine if they require further assessment in the ERA. Additionally, radionuclides were further evaluated because a relevant screening value was not available.

Table 4-9: Summary of Air Quality Constituents that Exceed a Screening Value

Constituent	Screening Criteria Exceeded		Predicted Exceedances		Number of Days Exceeding (Fence Line)	Frequency Exceeding (Fence Line)
	Short-Term	Long-Term	Maximum at Human/Ecological Locations	Maximum at Fence Line		
Nitrogen dioxide	1 h	None	Construction: exceedance of 1 hr screening value for nitrogen dioxide at the camp (HHRA3) Operations: No exceedance	Construction: exceedance of 1 hr screening value Operations: No exceedance	Construction: n/a[(a)] Operations: n/a	Construction: n/a[(a)] Operations: n/a
Particulate matter	24 h: TSP, PM_{10}, $PM_{2.5}$	Annual: TSP deposition	Construction: exceedances of 24 hr screening values for TSP, PM_{10}, $PM_{2.5}$ at the camp (HHRA3), and annual TSP deposition screening value at the camp (HHRA3) Operations: exceedance of 24 hr screening values for TSP, PM_{10}, $PM_{2.5}$ at the camp (HHRA3)	Construction: exceedance of 24 hr screening values for TSP, PM_{10}, $PM_{2.5}$ Operations: exceedance of 24 hr screening values for TSP, PM_{10}, $PM_{2.5}$	Construction: 10 (PM_{10}) 4 (TSP) Operations: 2 (PM_{10}) 2 (TSP)	Construction: 2.7% (PM_{10}) 1.1% (TSP) Operations: 0.5% (PM_{10}) 0.5% (TSP)
Uranium	24 h	none	Construction: not modelled for metals Operations: exceedance of 24 h screening value at the camp (HHRA3)	Construction: not modelled for metals Operations: exceedance of 24 h screening value for uranium in TSP and PM_{10}	Construction: n/a Operations: 4 (PM_{10}) 2 (TSP)	Construction: n/a Operations: 1.1% (PM_{10}) 0.5% (TSP)

(a) The number of days and frequency of exceeding were not available for 1-hour nitrogen dioxide since no exceedance was identified in the air quality model due to guidance from Saskatchewan that allows for removal of maximum concentrations output from AERMOD (EIS Section 7.2.2.8.3, Dispersion Modelling).
ERA = environmental risk assessment; TSP = total suspended particulates; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; n/a = not applicable.

4.3.3.3.1 Nitrogen Dioxide

Screening values were available for 1-hour, 24-hour, and annual averaging periods for nitrogen dioxide. The maximum predicted 1-hour concentrations of nitrogen dioxide during Construction exceeded the screening value of 300 micrograms per cubic metre (µg/m^3) only at the camp (374 µg/m^3) and at the fence line (458 µg/m^3). Maximum predicted short-term (i.e., 1-hour) levels of nitrogen dioxide at all other modelled human and ecological receptor locations farther away from the Project footprint were below Health Canada's maximum acceptable level and for this reason are not expected to be associated with adverse health effects. No exceedances were predicted for 24-hour and annual exposures; therefore, no adverse health effects are anticipated due to long-term exposure.

Potential adverse human and ecological effects from nitrogen dioxide are associated with direct atmospheric exposure through inhalation. Adverse health effects that are attributed to short-term exposures to ambient nitrogen dioxide include asthma exacerbations and possibly increased risk of cardiopulmonary effects, and to a lesser extent cardiovascular and respiratory mortality (Health Canada 2016b). Individuals with certain pre-existing diseases such as asthma appear to be sensitive to exposure to ambient nitrogen dioxide. If individuals are present during periods when ambient nitrogen dioxide concentrations exceed the screening value, it is possible that they could experience minor irritation of the respiratory system. These effects would be reversible and would subside after exposure.

Additionally, since potential adverse effects are associated with the inhalation pathway, nitrogen dioxide was not retained as a COPC for assessment of potential risk to human and ecological receptors through the food chain.

Overall, exceedance of the 1-hour short-term screening value for nitrogen dioxide at the camp site would be limited to Construction, and any health effects would be reversible and subside after exposure; therefore, nitrogen dioxide was not considered for further quantitative assessment in the ERA.

As noted in Section 4.3.3.1, Screening Value Selection, the CAAQS were not selected as screening criteria as CAAQS achievement is determined by provinces and territories using ambient concentrations measured in the air zones for a three-year period, not by comparison of modelled predictions at or beyond a facility boundary. Therefore, using the CAAQS as a screening guideline would not be appropriate. However, for information purposes, a comparison of Project predicted nitrogen dioxide emissions were compared to the annual and 1-hour nitrogen dioxide CAAQS at the ecological and human health receptors (Table 4-10). In summary, during Construction, there are predicted exceedances for 1-hour NO_2 CAAQS at seven of the HHRA receptor locations and no predicted exceedances for annual NO_2 CAAQS. During Operations and for the RFD Case, there are predicted exceedances for 1-hour NO_2 CAAQS at the camp location (HHRA3) and the potential ecological receptor location near Patterson Lake (HHRA5) and no predicted exceedances for annual NO_2 CAAQS. During Construction, exceedances of the 1-hour NO_2 guideline are predicted to occur less than 1% of the time at all receptor locations other than at the Camp location, where exceedances are predicted to occur approximately 7% of the time. During Operations and the RFD

Commented [FH4]: IR 69: added Table 1 from Attachment IR 69-R1, included as new Table 4-10

Commented [FH5]: IR 69: replaced text in this subsection with text in Attachment IR 69-R1 to address Health Canada's request to see information regarding CAAQS exceedances

Case, there are no predicted exceedances at receptor locations other than at the Camp location (6% of the time) and at the ecological receptor location at Patterson Lake (0.1% of the time). As noted above, there are no exceedances of the annual NO_2 CAAQS of 23 µg/m³ at any receptor location during any phase of the Project under the Application Case or the RFD Case (maximum values range from 8.55 µg/m³ to 14.7 µg/m³ at the Camp location). there are no predicted exceedances of the annual nitrogen dioxide CAAQS of 23 µg/m³ at any receptor location during any phase of the Project under the Application Case or the RFD Case. With respect to the 1-hour nitrogen dioxide CAAQS of 79 µg/m³, during Construction, exceedances are predicted to occur at the camp location approximately 7% of the time, and during Operations under both the Application Case and the RFD Case, exceedances are predicted to occur at the camp location approximately 6% of the time. Realistically, these exceedances are anticipated to occur less frequently as the predictions include multiple levels of conservatism applied in the air quality model (Section 4.3.3.24.3.3.2). To facilitate comparison against the CAAQS, the predictions referenced in this paragraph represent the annual average predicted concentrations and the 3-year average of the annual 98th percentile of the daily maximum 1-hour predicted concentrations.

Table 4-10: Summary of Annual and 1-hour Nitrogen Dioxide Concentrations at Human and Ecological Risk Assessment Receptor Locations for Construction, Operations, and the Reasonably Foreseeable Development Case

Name	Description	Location		NO_2 Annual Concentration			NO_2 1-hour Concentration (3-year Average of the Annual 98th Percentile of the Daily Maximum 1-hour Concentrations)			Frequency of Exceedance of 1-hour limit (Based on Hours with Concentrations Exceeding 79 µg/m³)		
		X (m)	Y (m)	Construction [µg/m³]	Operations [µg/m³]	RFD - Operations [µg/m³]	Construction [µg/m³]	Operations [µg/m³]	RFD - Operations [µg/m³]	Construction [µg/m³]	Operations [µg/m³]	RFD - Operations [µg/m³]
HHRA1	Hodge Lake Reference	593,768	6,407,146	3.89	3.82	3.86	46.9	29.3	31.5	n/a	n/a	n/a
HHRA2	Broach Lake	600,359	6,398,266	4.10	3.91	3.98	**113.2**	48.8	50.2	0.2%	n/a	n/a
HHRA3	Camp	603,778	6,393,226	14.67	8.55	8.63	**244.1**	**148.0**	**148.0**	7%	6%	6%
HHRA4	Patterson Lake Human Health Receptors	598,658	6,387,580	3.95	3.82	4.07	71.7	28.2	76.0	n/a	n/a	n/a
HHRA5	Patterson Lake Ecological Receptors VC	602,320	6,392,289	4.49	4.01	4.10	**129.7**	**84.6**	**84.7**	0.5%	0.1%	0.1%
HHRA6	Forrest Lake	605,446	6,388,744	4.16	3.91	3.97	**121.6**	49.5	54.0	0.3%	n/a	n/a
HHRA7	Forrest Lake North	605,452	6,390,021	4.28	3.99	4.05	**127.9**	67.0	70.4	0.3%	n/a	n/a
HHRA8	Beet Lake	608,931	6,389,997	4.12	3.90	3.95	**114.5**	39.4	44.2	0.2%	n/a	n/a
HHRA9	Naomi Lake	614,179	6,390,462	3.94	3.84	3.87	**82.9**	31.4	33.5	0.1%	n/a	n/a
HHRA10	Clearwater River	626,340	6,380,517	3.87	3.80	3.82	39.6	22.6	24.2	n/a	n/a	n/a
HHRA11	Lloyd Lake	616,793	6,361,563	3.83	3.80	3.81	25.9	22.3	23.2	n/a	n/a	n/a

Notes: **Bolded and shaded** indicate exceedance of 1-hr NO_2 CAAQS of 79 µg/m³ or annual NO_2 CAAQS of 23 µg/m³.
RFD = Reasonably Foreseeable Development Case; CAAQS = Canadian Ambient Air Quality Standard; NO_2 = nitrogen dioxide; µg/m³ = micrograms per cubic metre; n/a = not applicable.

Commented [FH6]: IR 69: added Table 1 from Attachment IR 69-R1, included as new Table 4-10

4.3.3.3.2 Particulate Matter

Particulate matter is defined as liquid or solid particles, or a mixture of both, less than 100 µm in diameter. Particulate matter includes TSP, particulate matter less that 10 µm (PM_{10}), and particulate matter less than 2.5 µm ($PM_{2.5}$). Particulate matter in the form of TSP, PM_{10}, $PM_{2.5}$, and TSP deposition were screened. Screening values were based on 24-hour and annual averaging periods for TSP, PM_{10}, $PM_{2.5}$, and on an annual averaging period for TSP deposition.

The discussion below demonstrates that the predicted exceedances of screening values for particulate matter in all of the forms assessed (i.e., TSP, PM_{10}, $PM_{2.5}$, and TSP deposition) would be short-term (i.e., 24-hour averaging period) and spatially limited to the camp and the fence line. Particulate concentrations and TSP deposition at locations outside of the Project footprint did not exceed screening values.

The predicted exceedances of screening values within the Project fence line suggest that the Project's environmental management programs would need to include measures to monitor and control particulate matter at the site during Construction and Operations.

Total Suspended Particulates and Dust Deposition

Maximum predicted concentrations of TSP exceeded its 24-hour screening value (100 µg/m^3) only at the camp site (296 µg/m^3 during Construction and 103 µg/m^3 during Operations), and at the fence line (234 µg/m^3 during Construction and 173 µg/m^3 during Operations). During Construction, the frequency of exceedance of the 24-hour TSP criterion at the fence line would be low, approximately 1.1% and during Operations, it would be 0.5%. On an annual basis, the maximum predicted concentrations for airborne TSP would not exceed screening values at any location outside of the Project footprint during any Project phase.

The 24-hour screening value for TSP is an ambient air quality standard cited by both Saskatchewan and Alberta. The 24-hour ambient air quality objective is based on potential adverse pulmonary effects (Alberta 2021). A higher 24-hour effects-based screening value of 120 µg/m^3 for TSP in ambient air is available from Ontario. The Ontario 24-hour and annual ambient air quality criteria (AAQC) are meant to be protective of chronic effects. Ontario identifies visibility as the sensitive endpoint for the TSP AAQC rather than human or ecological health. Elevated TSP concentrations are generally not considered to pose significant health risks because these particles are too large to be inhaled deep into the lungs; therefore, TSP was not considered further in the ERA.

Dust deposition (measured as dustfall) was also evaluated during this screening. Dustfall was not assessed for direct human health and ecological risks. Exceedance of the dustfall criterion is aesthetic and not health based. The maximum predicted TSP deposition rate exceeded the annual Ontario dustfall criterion of 7 g/m^2/yr only during Construction and only within the Project footprint and at the camp (87.9 g/m^2/yr), and did not extend to other human and ecological receptor locations at Patterson Lake, Beet Lake, and Lloyd Lake where country foods harvesting may occur. The maximum predicted monthly TSP deposition did not exceed its screening value of 5.3 g/m^2/30 days at any location during any Project phase. For these reasons, dustfall was not considered further in the ERA for direct human health and ecological risks. However, the potential for air quality constituents in dust to deposit to soil are considered in Section 4.3.3.4, Constituents in Soil.

Particulate Matter (PM_{10} and $PM_{2.5}$)

Maximum predicted concentrations of PM_{10} and $PM_{2.5}$ exceeded their 24-hour screening values (50 µg/m^3 and 27 µg/m^3, respectively) only within the Project footprint, at the camp (164 µg/m^3 and 65.5 µg/m^3 respectively during Construction, and 70.8 µg/m^3 and 28.0 µg/m^3 respectively during Operations), and at the fence line (204 µg/m^3 and 51.5 µg/m^3 respectively during Construction, and 86.6 µg/m^3 and 35.1 µg/m^3 respectively during Operations). During Construction, the frequency of exceedance of 24-hour PM_{10} at the fence line was low, approximately 2.7% and during Operations, it was 0.5%. The maximum predicted concentration for PM_{10} and $PM_{2.5}$ did not exceed their annual screening values at any modelled location during any Project phase.

Human health has been shown to be the most sensitive receptor for exposure to PM_{10} and $PM_{2.5}$ in ambient air (Health Canada 1998). Exposure to elevated concentrations of both PM_{10} and $PM_{2.5}$ are associated with various respiratory and cardiovascular effects in humans. The finer particles that can be inhaled deeply into the lungs are associated with greater risk because they are more chemically active and have more complex characteristics than larger particles (Health Canada 2016c). If individuals are present during short-term periods of elevated PM_{10} and/or $PM_{2.5}$, they may experience respiratory symptoms such as coughing or difficulty breathing, or asthma symptoms and chronic bronchitis. For most individuals, effects would be reversible and subside after exposure.

Overall, exceedances of the 24-hour short-term screening values for PM_{10} and $PM_{2.5}$ were predicted during Construction and Operation at the camp site and at the fence line. However, health effects would be infrequent, reversible and subside after exposure; therefore, PM_{10} and $PM_{2.5}$ were not considered for further quantitative assessment in the ERA.

4.3.3.3.3 Uranium

Maximum concentrations of uranium were estimated for Operations because sources would be associated with mining and waste management that would occur during Operations. Screening values for uranium were available for 24-hour and annual averaging periods that are associated with the TSP and PM_{10} fractions of airborne particulate matter. For both uranium in TSP and in PM_{10}, the Ontario 24-hour screening values were calculated from an effects-based annual average value to allow for assessment of the 24-hour air quality data (MECP 2020). The maximum predicted concentrations of uranium did not exceed annual screening values in TSP and PM_{10} (0.06 µg/m^3 and 0.3 µg/m^3, respectively) at any ERA location during Operations.

Uranium can be toxic to humans due to its chemical and radiological properties. The ambient air quality criteria for uranium (MOE 2011) is based on non-radiological effects of which kidney toxicity was the most sensitive endpoint associated with chronic exposure to uranium in air. Since the predicted maximum concentrations did not exceed the annual screening value, unacceptable levels of risk for human and ecological health are not expected from the occasional exceedances of the 24-hour value. Potential non-radiological risks from exposure to uranium in air were not assessed further.

Consideration of potential radiological effects for uranium, from uranium-238 series radionuclides in air, are discussed in Section 4.3.3.3.4, Radon and Uranium-238 Series Radionuclides.

4.3.3.3.4 Radon and Uranium-238 Series Radionuclides

Maximum concentrations for radon gas were estimated for the operational period because radon sources are associated with mining and waste management during Operations. A remedial action level of 200 Bq/m^3 for radon for indoor air in dwellings (Health Canada 2014) was used as a screening value for radon. The predicted maximum annual value for radon in ambient air did not exceed the annual screening value at any human or ecological receptor location.

No concentration-based screening values for uranium-238 series radionuclides in air were available. However, because radionuclides are considered of public interest, they were assessed further in the ERA. Potential risks from radiological effects were assessed through environmental exposure pathways in terms of total radiation dose, in Section 5.0, Human Health Risk Assessment, for human health risks, and in Section 6.0, Ecological Risk Assessment, for ecological risks.

4.3.3.4 Constituents in Soil

No specific COPCs were retained from the screening of atmospheric constituents; however, as a secondary check, mine-related metals of interest were identified for further assessment in soil (Table 4-11~~Table 4-10~~).

Commented [KL7]: IR 69 Cascading change from adding new Table 4-10 from Attachment IR 69-R1, Table 1

Based on soil type characterization in the Terrain and Soils section (EIS Section 12), the soil type is sand. This also aligns with observations of the Patterson Lake area by BNDN and BRDN, which was characterized as having a lot of sand and supporting jackpine (TSD II: BNDN), and mostly all pine and rock (TSD III: BRDN). A member of BNDN commented that “the north” has experienced many wildfires in recent years resulting in no topsoil and only sand, which made it challenging for trees to regenerate (TSD II: BNDN).

Predicted soil concentrations were estimated from atmospheric deposition and maximum air concentrations from the AERMOD atmospheric model at the camp site (Table 4-7), along with constituent-specific deposition rates, according to the equations defined in the IMPACT Model Report (Appendix A, Section 2.3.4, Terrestrial Pathways). The camp site is represented in the IMPACT model as the terrestrial location of Patterson Lake North Arm – West Basin, and would be considered the closest human health receptor location to the Project where harvesting of traditional foods would likely occur.

Predicted maximum concentrations of constituents in soil from atmospheric deposition were compared against soil quality guidelines. The selected soil quality guidelines were the federal CCME (CCME 1999b) soil quality guidelines for protection of human health and environmental health. Agricultural soil quality values were used for other land types, because these guidelines account for ingestion of plants by birds and mammals. As shown in Table 4-11~~Table 4-10~~, all predicted soil concentrations were below the CCME soil quality guidelines. As such, no additional COPCs were identified for further quantitative assessment in the ERA based on the soil pathway.

Commented [KL8]: IR 69 Cascading change from adding new Table 4-10 from Attachment IR 69-R1, Table 1

Table 4-11: Soil Quality Screening for the Rook I Project

Parameter	Maximum Predicted Air Concentrations[(a)]	Maximum Predicted Soil Concentration from Atmospheric Deposition[(b)]	Soil Screening Guideline[(c)]				Is Concentration Greater than Selected Screening Value? (Y/N)
			Agricultural	Residential/ Parkland	Commercial	Industrial	
Non-radionuclides	Annual average $\mu g/m^3$	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	
Arsenic	3.00×10^{-05}	0.59	**12**	12	12	12	N
Cadmium	5.00×10^{-05}	0.11	**1.4**	10	22	22	N
Cobalt	2.00×10^{-05}	0.43	**40**	50	300	300	N
Copper	1.70×10^{-03}	0.62	**63**	63	91	91	N
Lead	2.50×10^{-03}	1.71	**70**	140	260	600	N
Molybdenum	1.20×10^{-03}	0.15	**5**	10	40	40	N
Nickel	1.70×10^{-04}	1.05	**45**	45	89	89	N
Selenium	1.00×10^{-05}	0.10	**1**	1	2.9	2.9	N
Uranium	9.38×10^{-03}	1.30	**23**	23	33	300	N
Zinc	5.00×10^{-05}	2.72	**250**	250	410	410	N

Notes: **Bold** indicates soil guideline value selected for this assessment.
(a) Maximum annual average concentrations in the Project footprint, and the camp site from AERMOD (EIS Appendix 7A, Air Dispersion Modelling Report).
(b) Maximum soil concentrations estimated from maximum annual air concentrations in Table 4-7 of the HHRA and constituent-specific deposition rates (Appendix A).
(c) Canadian Environmental Quality Guidelines (CCME 1999b).
N = no; Y = yes; dw = dry weight; HHRA = human health risk assessment.

4.3.4 Air Quality Constituents for Further Evaluation in the Environmental Risk Assessment

Following the screening process for selecting air quality COPCs, none of the modelled air quality constituents were considered COPCs for further evaluation in the ERA for direct atmospheric exposure for human and ecological receptors. No constituents at any human or ecological receptor location exceeded their annual screening value, indicating that unacceptable chronic effects from direct exposure to air would not be expected.

Short-term exceedances, based on maximum predicted concentrations for the 24-hour averaging period, may occur at the camp and at the fence line, for nitrogen dioxide, and particulate matter, including uranium in TSP and PM_{10}. The predicted exceedances were infrequent, short-term, and limited to near the site. Unacceptable levels of risk would not be expected from infrequent direct short-term exposures to these constituents in air.

Air quality constituents would be monitored as part of an overall Environmental Protection Program, which would include ambient air monitoring and adaptive management. Additionally, on-Site health and safety requirements and mitigation measures would be developed to control dust emissions. Monitoring would be used to verify the air quality predictions and evaluate the effectiveness of mitigation measures.

No concentration-based screening values were available for uranium-238 series radionuclides in air. However, because radionuclides are considered of public interest, they were assessed further in the ERA. The ERA included the assessment of human and ecological risk from exposure to radionuclides as part of the total radiological dose from atmospheric and aquatic pathways combined in Section 5.4 and Section 6.4, respectively. While radon concentrations were predicted to be below the screening value, this constituent was considered further in the HHRA in Section 5.4, due to public interest.

Other air quality constituents were included in the evaluation of potential human health and ecological risk in Section 5.4 and Section 6.4, respectively, via indirect exposures, such as soil contact and through the food chain (including country foods). These parameters were selected based on a cumulative exposure pathways approach that included COPCs identified for exposures through aquatic pathways (Section 4.2.5, Water Quality Constituents for Further Evaluation in the Environmental Risk Assessment) and engagement with Indigenous and other communities and regulators.

4.4 Final List of Constituents of Potential Concern for the Environmental Risk Assessment

Based on evaluation of aqueous and atmospheric sources, including a conservative screening of maximum predicted concentrations in surface water, sediment, air and soil, the final list of COPCs to be evaluated further in the HHRA and EcoRA are listed in Table 4-12~~Table 4-11~~.

Commented [KL9]: IR 69 Cascading change from adding new Table 4-10 from Attachment IR 69-R1, Table 1

As indicated in Section 4.2.3.2, Constituents in Surface Water, radon-222 was not considered a COPC in surface water for the ERA. Radon is expected to volatilize rapidly to air. Health Canada (2020) considers that the health risk from ingesting radon-contaminated drinking water is negligible. Additionally, chloride and sulphate were identified as COPCs in the aquatic environment, but not in the terrestrial environment. As well, while deposition of COPCs from air to soil was evaluated, no COPCs in soil were identified for further evaluation; therefore, for the EcoRA, toxicity via direct contact with COPCs in soil for terrestrial plants and soil invertebrates was not quantitatively assessed.

Table 4-12: Final List of Constituents of Potential Concern for the Project Environmental Risk Assessment

Major Ions	Physical Media Where Guideline Exceeded
Chloride	Water
Sulphate	Water
Metals and Metalloids	
Arsenic	Water
Cobalt	Water
Copper	Water
Molybdenum	Water
Uranium	Water
Radionuclides	
Uranium-238	Air, Water
Uranium-234	Air, Water
Thorium-230	Air, Water
Radium-226	Air, Water
Radon-222[a]	Air
Lead-210	Air, Water
Polonium-210	Air, Water

(a) Radon-222 is evaluated as a COPC for air only.
COPC = constituent of potential concern.

IR 70

No.	Justification/Rationale	Follow up Information Request	NexGen Response
70	NexGen provided sufficient justification to exclude Geology as a valued component (VC). However, due to the importance of Geology in the hydrogeological assessment as described in NexGen's response, Geology appears to be implicitly assessed as an intermediate component. This should be explicitly reflected in the EIS.	Table 6.3.2 should be revised to include 'Geology' as an intermediate component and the title of Section 8 should be revised to 'Geology and Hydrogeology.'	In follow up to the most recent information provided by the CNSC to NexGen regarding IR 70 and the follow-up discussion between NexGen and CNSC team members held on 3 October 2024, NexGen is providing the attached document to close out IR 70. Please note, this document would become Appendix 8A of the Final EIS. From feedback received through email and NexGen/CNSC discussions during the early October videoconference, NexGen took away the following key aspects: • Geology represents an important aspect of the physical environment that has links to valued components and intermediate components assessed within the EIS (e.g., hydrogeology, which influences water quality and human health). • It is important that the geology topic have an appropriate level of prominence within the EIS. • The key aspects of geology are currently included within the EIS (e.g., no gaps have been identified); however, this information is presented across multiple sections and annexes (i.e., baseline reports). • To better highlight geology in the EIS, it would be beneficial to present geology-associated information in a consolidated form. To address these items, NexGen have created the new Appendix 8A (part of the hydrogeology assessment). As noted by CNSC reviewers, geology has key links to hydrogeology; therefore, NexGen felt it made the most sense to create this standalone document as a part of Section 8. Appendix 8A presents the key aspects of geology considered within Project design and the EA, including: • geology baseline; • geotechnical conditions and design considerations; • seismicity and design considerations; • geomorphology baseline and fluvial sediment transport assessment; • hydrogeology assessment; • terrain and soils assessment; and • geology links to valued components and intermediate components. In addition to these items, Appendix 8A also provides details regarding proposed Project monitoring that are linked to geology.

Rook I Project

Environmental Impact Statement

Appendix 8A Geology Supplement

Submitted to:
Canadian Nuclear Safety Commission
Saskatchewan Ministry of Environment

Submitted by:
NexGen Energy Ltd.
3150-1021 W Hastings St
Vancouver, BC
V6E 0C3

October 2024

Abbreviations and Units of Measure

Abbreviation	Definition
CPB	cemented paste backfill
CNSC	Canadian Nuclear Safety Commission
CPT	cemented paste tailings
EIS	Environmental Impact Statement
LSA	local study area
NBCC	National Building Code of Canada
NexGen	NexGen Energy Ltd.
NRCC	National Research Council of Canada
Project	Rook I Project
RFD	reasonably foreseeable development
RSA	regional study area
U_3O_8	triuranium octoxide
UGTMF	underground tailings management facility
VC	valued component
WRSA	waste rock storage area

Unit	Definition
%	percent
<	less than
g	a value that quantifies the seismic loading on a structure relative to its own weight
Ga	giga annum or billions of years
ha	hectare
H:V	horizontal to vertical
km	kilometre
kt	kilotonne
m	metre
m^3/d	cubic metres per day
masl	metres above sea level
Mlb	million pounds
MPa	megapascal

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8A1 INTRODUCTION

Geology represents a key feature of the physical environment, and potential changes to the geological environment as a result of a project's activities represent important considerations within the assessment of effects. For the NexGen Energy Ltd. (NexGen) Rook I Project (Project), geology has potential linkages to certain valued components and intermediate components assessed in the Environmental Impact Statement (EIS), and in this regard, geology has been appropriately considered to verify that potential effects of the Project are properly understood. To demonstrate how geology has been considered within Project design and the EIS, this Geology Supplement has been developed as Appendix 8A to support EIS Section 8, Hydrogeology.

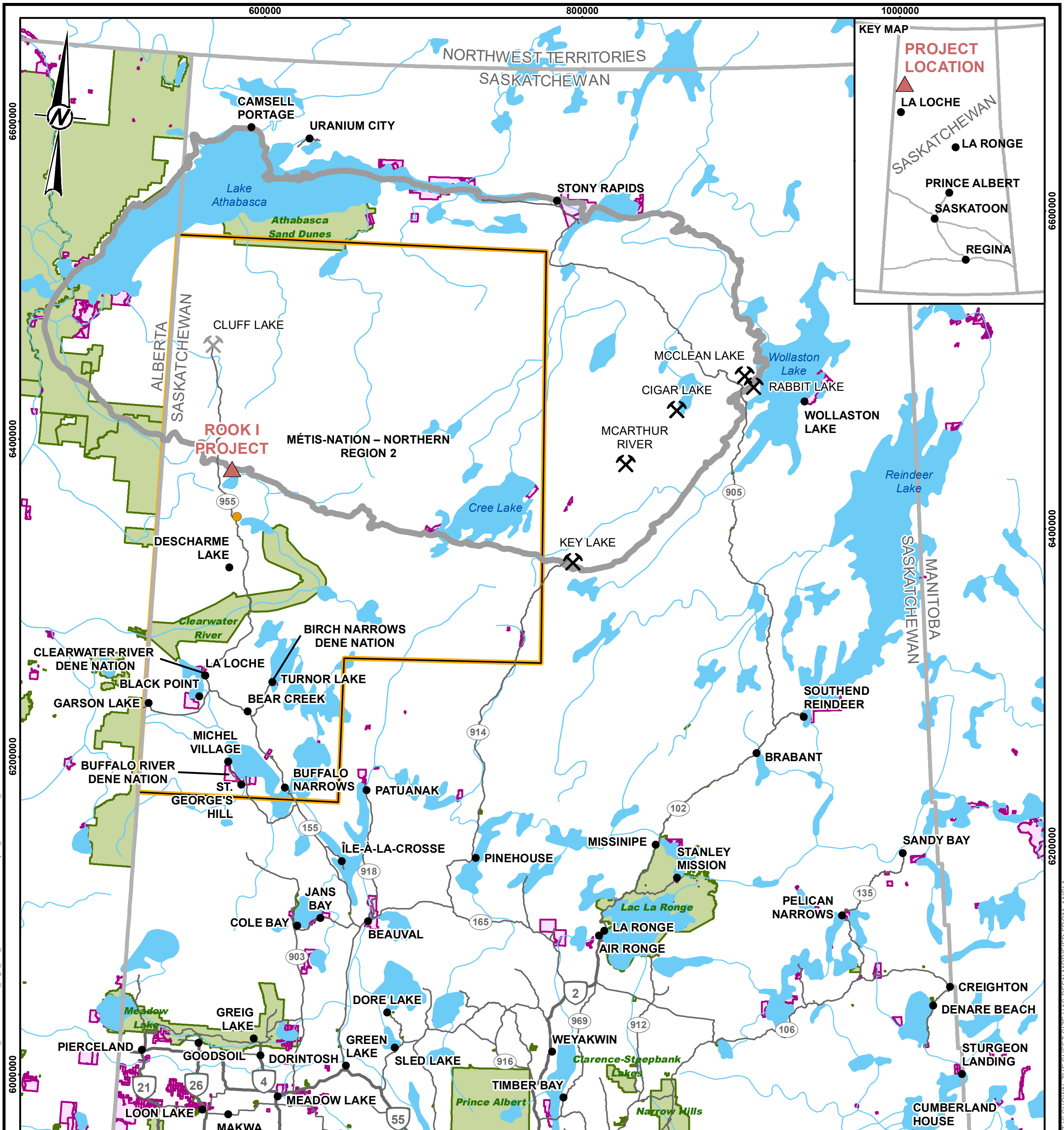
The Geology Supplement includes information on geology and geomorphology existing conditions, geotechnical conditions, an overview of seismicity at the Project location, and assessment of potential Project effects to sediment transport, hydrogeology, and terrain and soils. Where applicable, the content contained within this Geology Supplement include EIS section references where additional details are available.

8A1.1 Geology Baseline

The geology baseline report for the Project is provided in EIS Annex XI. The geology baseline study was completed to describe the existing geologic setting prior to potential development of the Project. The geology baseline includes a characterization of the geological composition of host rocks, alteration, and ore resources of the Arrow deposit, as well as the structural geology of the Arrow deposit, including geometry and characteristics of major faults and shear zones.

The proposed Project site is located in a sub-Arctic climactic region typical of mid-latitude continental areas, with elevations ranging from 583 metres above sea level (masl) on drumlins to 480 masl in lowland lakes (Figure 8A-1). The local topography around the Project site is variable with drumlins and lakes/wetlands dominating the northwest and southeast portion of the area, respectively. Lowland lakes, rivers, and muskegs dominate the central part of the study area.

The Arrow deposit is rooted in the Paleoproterozoic basement rocks of the Taltson Domain along the Patterson Lake corridor, east of the Clearwater River Domain and west of the Virgin River Domain. The bedrock geology is composed of variably silicified and metasomatized intermediate to mafic orthogneisses (Figure 8A-2). Local mafic-rich amphibolite and pyroxenite, ultrabasic and syenitic dykes, and porphyroblastic feldspar- and quartz-rich pegmatites intrude the gneissic granulite facies rocks. The main fabrics and contacts of crystalline basement rocks in the Arrow deposit area are all steeply dipping, dominantly southeast, with a northeast-southwest strike. Basement rocks are unconformably overlain by late Paleoproterozoic to Mesoproterozoic Athabasca Supergroup sandstones of variable thickness, rarely exceeding 50 m. Devonian and/or Cretaceous sedimentary rocks overlie the Athabasca sandstones, with Quaternary glacial deposits capping the geologic sequence and forming the present-day topography.



LEGEND

- POPULATED PLACE
- URANIUM MINING FACILITY (ACTIVE)
- URANIUM MINING FACILITY (DECOMMISSIONED)
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- ATHABASCA BASIN BOUNDARY
- INDIAN RESERVE
- PROVINCIAL PARKS
- WATERBODY
- PROJECT LOCATION
- PRESTON LAKE WILDLIFE REFUGE
- MÉTIS NATION-SAKSATCHEWAN NORTHERN REGION 2

0 100 200

1:3,500,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PARKS OBTAINED FROM IHS MARKIT CANADA ULC.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT

NexGen Energy Ltd.

ROOK I PROJECT

TITLE

LOCATION OF THE ROOK I PROJECT

CONSULTANT

wsp

PROJECT	20144150	SCALE AS SHOWN	REV. 0

FIGURE 8A-1

PATH: I:\CLIENTS\NexGen\20144150\Mapping\Products\FINAL_EIS_FIGURES_WSP_LOGO_UPDATED\Introduction\8_5x11\20144150_Fig1_2-1_Location-of-the-RookI-Project_NoTitleblock_Rev0.mxd PRINTED ON: 2023-02-06 AT: 3:27:30 PM

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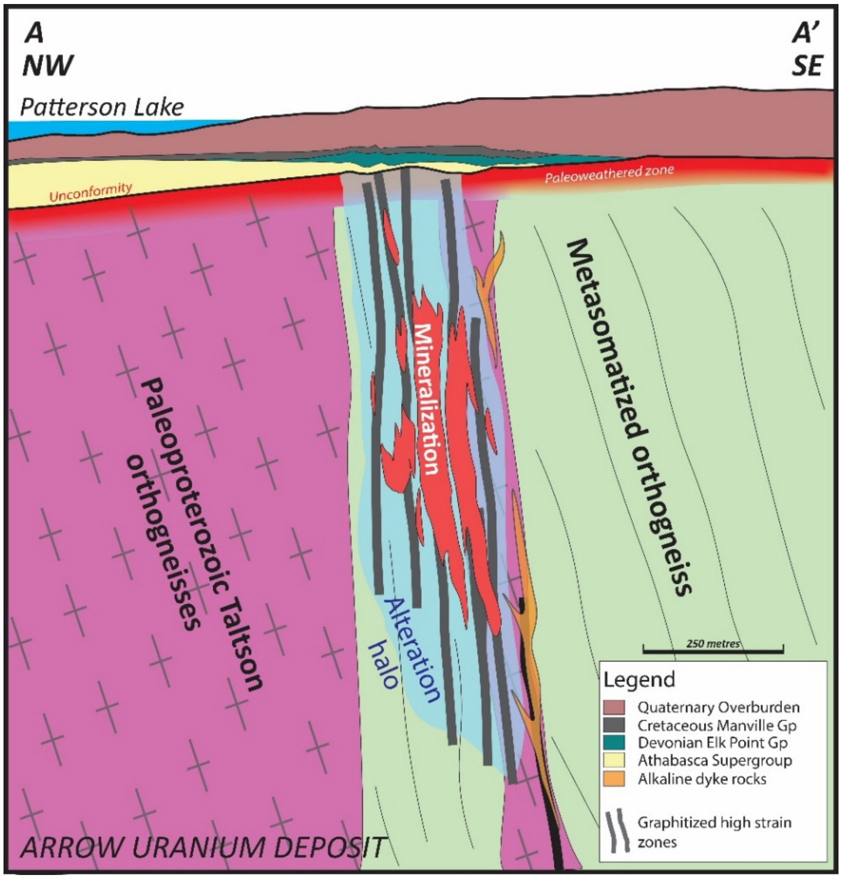
25mm

Figure 8A-2: Schematic Northwest-Southeast Cross-Section through the Arrow Deposit showing Local Study Area Geology, Structure, and Zones of Uranium Mineralization



The rocks hosting the Arrow deposit display evidence of episodic structural reactivation and exhumation (i.e., rising towards surface or surface exposure) at progressively shallower crustal levels, related to the protracted tectonic evolution of the Precambrian shield in this region spanning from the Taltson-Thelon to Hudsonian orogenic events circa 1.94 billion years (Ga) to <1.84 Ga. Structural analysis along the ore-hosting portion of the Patterson Lake corridor at the Arrow deposit indicates a sequential development of early ductile and brittle-ductile, to late brittle episodes of movement along the southeast limb of a regional northeast plunging fold complex (Hillacre et al. 2020). Structural and metamorphic relationships suggest that mylonitization was initiated in a ductile environment during D_3 deformation circa 1.92 Ga to 1.90 Ga, with subsequent overprinting by brittle-ductile and brittle faulting involving widespread cataclasis and brecciation, reflecting the progressive unroofing of the high strain zones to shallower lithospheric levels over time (Hillacre et al. 2020).

The structural system at the Arrow deposit has been interpreted to have originally developed along near vertical dipping northeast-southwest-trending brittle-ductile high strain zones (A0 to A5 shears). The stacked high strain zones at the Arrow deposit are nearly parallel and are grouped into a deformation zone approximately 200 m wide, with ore shoots defining an overall plunge to the south-southwest. The heterogeneous high strain zones hosting the Arrow deposit further evolved through episodic reactivation events creating various small-scale brittle fault linkages oblique to and connecting the main fault zone. Primary formation of the uranium veins at the Arrow deposit is related to this episodic reactivation and reuse of pre-existing structures, which formed during the late phases of orogenic events affecting the area circa 1.8 Ga and younger. Fluid flow and reactivation of mineralized structures then further concentrated, remobilized, and altered ore within previously established and newly formed subsidiary fractures, cataclasis zones, and shear and mylonite zones. Multiple phases of uranium mineralization have been identified and classified based on mineral chemistry and textural relationships (Hillacre et al. 2020). Two groups of uraniferous phases have been identified; the first comprising early euhedral, brecciated, and remobilized uraninite, and the second composed of late uranium silicates and hydroxides/oxyhydroxides, such as coffinite and uranophane.

The Arrow deposit has Measured Mineral Resources of 209.6 million pounds (Mlb) of triuranium octoxide (U_3O_8) contained in 2,183 kilotonnes (kt) grading 4.35% U_3O_8, Indicated Mineral Resources of 47.1 Mlb of U_3O_8 contained in 1,572 kt grading 1.36% U_3O_8, and Inferred Mineral Resources of 80.7 Mlb of U_3O_8 contained in 4,399 kt grading 0.83% U_3O_8 (NexGen 2021). The mineralized area is 315 m wide with an overall strike of 980 m. Mineralization occurs 100 m below surface and extends to a depth of 950 m. The individual shear zones vary in thickness from 2 m to 60 m.

The geology baseline provided characterization information that was used in Project design with regards to geotechnical conditions, as well as the assessment of hydrogeology, both of which are summarized in Section 8A1.2 and Section 8A1.5, respectively.

8A1.2 Geotechnical Conditions and Design Considerations

Geotechnical Conditions

The geotechnical conditions in the area of the Project are favourable to crown pillar stability. Geotechnical conditions are generally characterized by up to 75 m of dense to very dense sedimentary layers underlain by very competent basement rock extending to below the Arrow deposit. Overlying materials generally have a higher level of hydraulic conductivity, allowing water to flow, while basement rock has very low hydraulic conductivity, with the exception of well-understood shear or fault zones, which can be conduits for water movement.

An understanding of basement rock mass conditions is required to reliably predict rock mass responses and conditions in the Arrow deposit, which allows the appropriate design of underground development and infrastructure, and ultimately, performance of mining activities. Generally, the basement rock in which proposed Project underground infrastructure would be developed is competent ground suitable for mine development and long-term tailings storage.

Rock mass classification systems have been used to classify rock mass quality in basement rock and assess the range in anticipated rock quality in the primary areas of interest associated with the Project (e.g., mining and underground tailings management facility [UGTMF] zones). In addition to rock quality, other geotechnical parameters associated with the material types were spatially interpreted to develop geotechnical domain (i.e., units representing different material types) models to relate the geotechnical conditions to the mine plan.

Several interpreted basement shears and faults align with, and are close to, mineralization (i.e., the uranium ore body). Shear zones are closely related to the strength of the overall rock mass. Lab-measured unconfined compressive strengths at the Arrow deposit range from 10 megapascals (MPa) to nearly 250 MPa.

Further information regarding surface and underground geotechnical conditions at the Project site are provided in EIS Section 5.3.3.2, Geotechnical Conditions.

Design Considerations

NexGen would develop and operate all Project infrastructure, facilities, and systems in accordance with design standards relevant to the Project, which are based on regulatory guidance, applicable building code requirements, and best management practices as developed by applicable industry and trade associations and standards organizations (EIS Section 5.3.1, Design Standards).

The underground workings would be safely developed through appropriate consideration of geotechnical conditions (EIS Section 5.4.3.3, Underground Tailings Storage). Openings in the mine workings would include ground support and reinforcement in the roof to mitigate potential instabilities. The UGTMF would be a purpose-built underground facility with chambers dedicated to the permanent disposal of tailings. The UGTMF would be located on the north side of the Arrow deposit, and the UGTMF chamber size requirements and development schedule would be derived from, and adapted to, the ore processing schedule to provide sufficient storage for tailings. The UGTMF chambers would be developed using long hole stoping mining methods. Geomechanical modelling has confirmed that chambers with approximately 25 m by 25 m openings and 15 m wide rock pillars between chambers would create stable excavations that would remain open until they are backfilled with the cemented paste tailings (CPT).

Regarding the stability of crown pillars, or the vertical distance between the unconformity and the uppermost production and UGTMF stopes, empirical stability assessments using the scaled span method (Carter 2008; Carter 2014) were conducted. The uppermost underground production stope crown pillars are rated as either Class F (0.5% to 1.5% chance of failure; public access allowed) or Class G (<0.5% chance of failure; free public access). Probability of failure of the crown pillars above the production stopes would be further reduced as the stopes would be backfilled with cemented paste backfill (CPB), which would consist of neutralized leached residue, water, and binder mixed in various ratios to meet appropriate geotechnical strength requirements (EIS Section 5.4.3.1, Paste Plant). The UGTMF stopes would be rated as Class G as a result of the existing geotechnical conditions of the surrounding basement rock; these stopes would be backfilled with the CPB and CPT, which, as with CPB, would contain a binder to promote structural strength (EIS Section 5.5.2.3, Tailings Management). Overall, potential subsidence is not expected due to the combination of low failure probabilities and the backfilling of both underground production and UGTMF stopes, which would facilitate long-term geotechnical stability.

With respect to Project surface features, as described in EIS Section 5.5.2.4, Mine Rock Management, both the potentially acid generating waste rock storage area (WRSA) and non-potentially acid generating WRSA would be constructed with side slopes of 4H:1V, which would facilitate long-term geotechnical stability.

8A1.3 Seismicity and Design Considerations

Seismicity

Seismic activity, such as earthquakes, can trigger natural hazards including ground vibrations, landslides, liquefaction of saturated sediments, and surface rupture. These natural hazards can affect underground mine workings and surface-engineered structures such as water diversions and WRSAs. Seismic activity can also result in work delays while stability is reassessed for the safety of the employees and continued production. Detailed information on earthquakes that have occurred in Canada is contained in publications of Earthquakes Canada of Natural Resources Canada and their predecessor organizations. A seismic zoning map for Canada has been developed on the basis of these studies and is used in the National Building Code of Canada (NBCC; NRCC 2020) to help design and construct buildings that are appropriately earthquake proof for a given region.

The potential for seismic events at the Project were evaluated in a risk assessment presented in EIS Section 22.6.7, Seismic Events.

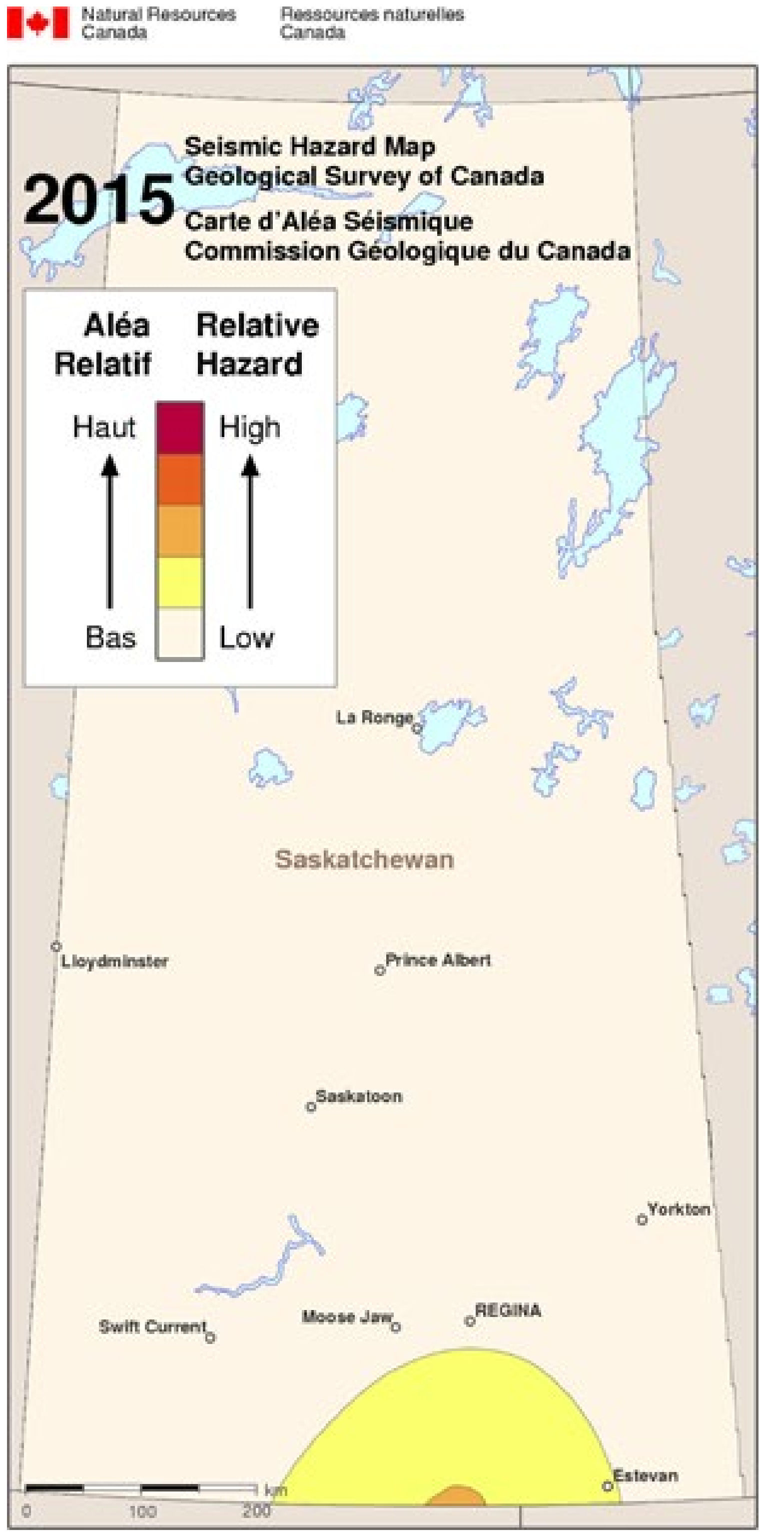
According to the Government of Canada (2021a), the seismic hazard for northern Saskatchewan is rated as low (i.e., less than 1% chance significant damage will occur in 50 years) (Figure 8A-3). The Project is located in a region of the lowest seismic activity in Canada. Moreover, in the past 400 years, there have been no earthquakes recorded with a magnitude greater than 3 in northern Saskatchewan (Government of Canada 2021b).

The Athabasca Basin is seismically inactive according to the NBCC. Numerical modelling has been completed for the Project, which included assessing the susceptibility of mine excavations and infrastructure to mine-induced stress over the Project lifespan. The estimated peak ground acceleration with a return period of 2,475 years is less than 0.036g at a probability of 2% over 50 years. The risk of naturally occurring seismic events is low. The mining would be at low to moderate depths; depths below surface range from 350 m to 710 m. Seismic events due to mining have been evaluated and are considered highly unlikely.

Design Considerations

The Project would incorporate seismic event risks into the design and operation of the mine. Project infrastructure would be designed to withstand extreme environmental conditions that pose risks to its integrity. All buildings on site would be designed according to the NBCC (NRCC 2020). The NBCC incorporates technical requirements so that buildings are protected against earthquakes based on local seismic conditions. The underground mine development, WRSAs, and UGTMF design considered geotechnical stability.

Figure 8A-3: Saskatchewan Seismic Hazard Map



8A1.4 Geomorphology Baseline and Fluvial Sediment Transport Assessment

The geomorphology characterization report for the Project is provided in EIS Annex IV.3. The geomorphology characterization report was completed as part of the hydrology program to characterize existing geomorphology of Patterson Lake's shorelines and the Clearwater River channel downstream of the Patterson Lake outlet and to identify areas that may be vulnerable to increased erosion due to proposed Project activities.

Field surveys completed for the geomorphology study included observations of landforms, shoreline slopes, bank and bed materials, and vegetation, as well as photographic documentation. Information collected during the field surveys was used to classify erosion susceptibility at the field survey sites. Erosion susceptibility at other portions of the Patterson Lake shoreline was assessed using a combination of field survey, geospatial data, and aerial imagery. Channel erosion susceptibility in the Clearwater River below Patterson Lake was also assessed based on field observations.

The results from the baseline characterization of Patterson Lake showed that several shoreline segments along Patterson Lake were observed to be subject to modification by ongoing sediment transport processes. These processes include accretion (i.e., gradual build-up of sediment) resulting from longshore drift, with historical shoreline alignments different than current shoreline locations visible in the aerial imagery, as well as likely ice thrust modification of sedimentary shorelines. The active sediment transport areas are expected to be most sensitive to possible changes in the lake hydrologic regime. The localized bank erosion sites observed along the lake shoreline in sections with ice-thrust berms were also identified as sensitive areas.

The corresponding results from the baseline characterization of Clearwater River identified a single channel upstream and multiple meandering channels farther downstream, with typical channel cross-section geometries (i.e., deep banks on the outside of the meander) and fluvial morphology (i.e., point bars). The river has an active sediment transport regime, capable of transporting mostly small size materials (i.e., fine to medium sand), as indicated by the delta feature at its mouth into Forrest Lake.

This information was applied to the assessment of fluvial sediment transport, which is a measurement indicator for hydrology (EIS Section 9.3.7, Fluvial Sediment Transport). The residual effects analysis (EIS Section 9.6.1.4, Fluvial Sediment Transport) considered predicted increases in flow downstream of the Project, which are small and not expected to result in a measurable change in the fluvial sediment transport regime under both the Application Case and Reasonably Foreseeable Development (RFD) Case. The classification of residual effects to fluvial sediment transport (Table 8A-1) is reproduced below from Table 9.7-1 of EIS Section 9.7, Residual Effects Classification.

Table 8A-1: Classification of Residual Effects for the Clearwater River Hydrology Nodes

Measurement Indicator	Criterion	Rating / Effect Size			
		Application Case	RFD Case Scenarios		
			RFD Case	Climate Change	Total (i.e., RFD Case [including Climate Change])
Fluvial sediment transport at mean annual flood	Direction	Neutral	Neutral	Neutral	Neutral
	Magnitude	Negligible	Negligible	Negligible	Negligible
	Geographic extent	Local	Local	Beyond regional	Regional[b]
	Duration[a]	Long-term: 43 years (2025 to 2068)	Medium-term: Maximum of 15 years (nominally modelled as 2025 to 2039) of temporal overlap between the Project and the Fission Patterson Lake South Property. Effect on water quantity primarily during construction and operations period of nine years (nominally modelled as 2025 to 2033)	Permanent	Permanent
	Reversibility	Reversible at the end of the Active Closure Stage as pumping to/from Patterson Lake ceases	Reversible at the end of the Active Closure Stage as pumping to/from Patterson Lake ceases	Irreversible	Irreversible
	Frequency	Continuous	Continuous	Continuous/periodic	Continuous/periodic
	Probability of occurrence	Certain	Probable	Probable	Probable

a) For the purpose of ease of reference in modelling, construction of the Project and Fission Patterson Lake South Property were assumed to start in 2025. This assumption is conservative as it assumes effects from construction of Project and Fission Patterson Lake South Property occur at the same time.
b) The geographic extent for total change under RFD Case (including climate change) is regional to represent the cumulative effect of developments rather than global climate change effects, which would have a beyond regional geographic extent.
RFD = reasonably foreseeable development.

8A1.5 Hydrogeology Assessment

The hydrogeology baseline report for the Project is provided in EIS Annex III, and the assessment of hydrogeology is provided in EIS Section 8.

The Arrow deposit consists of several high-grade uranium veins and is hosted in Paleoproterozoic basement rocks. The basement rock in the regional study area (RSA) is predominantly composed of granite or gneiss. Athabasca Supergroup sandstones of variable thickness overlie the basement rocks unconformably. Sedimentary rocks overlie the Athabasca sandstones, with glacial drift deposits (i.e., materials such as gravel, sand, silt, and clay) capping the geologic sequence and forming the present-day topography. Hydrostratigraphic units were defined based primarily on the geological units that exhibit similar hydraulic properties and structures. The basement rock was identified to have relatively low porosity and permeability, and the primary hydraulic pathways are anticipated to be fractures, faults, and shear zones. These enhanced conductivity features defined the overall hydraulic conditions of the basement rock. The layers of the overlying Athabasca sandstone bedrock are the dominant areas in which groundwater flow occurs and are considered to be the primary aquifer. Interbedded zones of clay-rich cementation act as an aquitard within the Athabasca Supergroup, inhibiting the vertical movement of water. Therefore, the vertical hydraulic conductivity in this layer is considered to be lower than the horizontal hydraulic conductivity. The overlying, unconsolidated glacial drift deposits are present throughout the RSA. Based on the relatively coarse-grained nature of the unconsolidated glacial drift deposits within the vicinity of the Project, the unit is considered to be an unconfined aquifer.

The predominant deep groundwater west to east flow direction is controlled by regional topography. Local to the proposed underground mine, deep groundwater flows north and upward towards Patterson Lake.

Shallow groundwater flow patterns mimic local topography, infiltrating in highlands and discharging in low lying water bodies and drainages. At the peninsula where the Project would be located, a shallow groundwater flow divide exists south of the proposed mine. Shallow groundwater within glacial drift flows north and south from the divide, discharging to Patterson Lake in both directions.

During baseline assessments, representative groundwater samples were collected and analysed for water chemistry. Based on the interpreted bedrock groundwater type, it was considered likely that the groundwater in bedrock is “older” and indicative of groundwater moving along a flow path as it transitions from calcium- to sodium- type with increasing depth and age of the geologic formation. In contrast, the glacial drift groundwater type was considered “young” based on calcium-type and indicative of geologically recent recharge from the surface. Limited mixing likely occurs with older water from the geologic formation below.

This understanding of the hydrogeological existing conditions provided a basis for the residual effects assessment of Project effects to hydrogeology, which is detailed in EIS Section 8. The assessment considered three measurement indicators:

- groundwater elevations;
- groundwater flow directions and rates; and
- groundwater quality.

To support the hydrogeology assessment, a 3D numerical groundwater flow model was developed and calibrated based on target groundwater elevations and baseflow (i.e., the portion of streamflow sustained between precipitation events) information. The calibrated model was used to predict the Project effects through all phases (Construction, Operations, and Closure) on groundwater inflows and the extent and magnitude of groundwater depressurization, as well as to delineate groundwater flow pathways from mine waste source areas to Patterson Lake.

The residual effects analysis measured and described the effects of the Project on hydrogeology relative to existing conditions. Residual effects are described for each of the measurement indicators for the primary pathways identified for hydrogeology (i.e., groundwater elevations, groundwater flow directions and rates, and groundwater quality) in the local study area (LSA). An RFD Case was not required as there are little to no potential for cumulative effects on hydrogeology from the Project and RFDs.

Groundwater Quantity

The main objectives of the predictive modelling with respect to groundwater quantity were to estimate the groundwater inflows to the underground development, the extent of depressurization, and the resulting potential influence on groundwater discharge to surface water features during Operations. For the far-future projection, the model was used to delineate groundwater flow pathways and flow rates through the various source areas to surface water receptors.

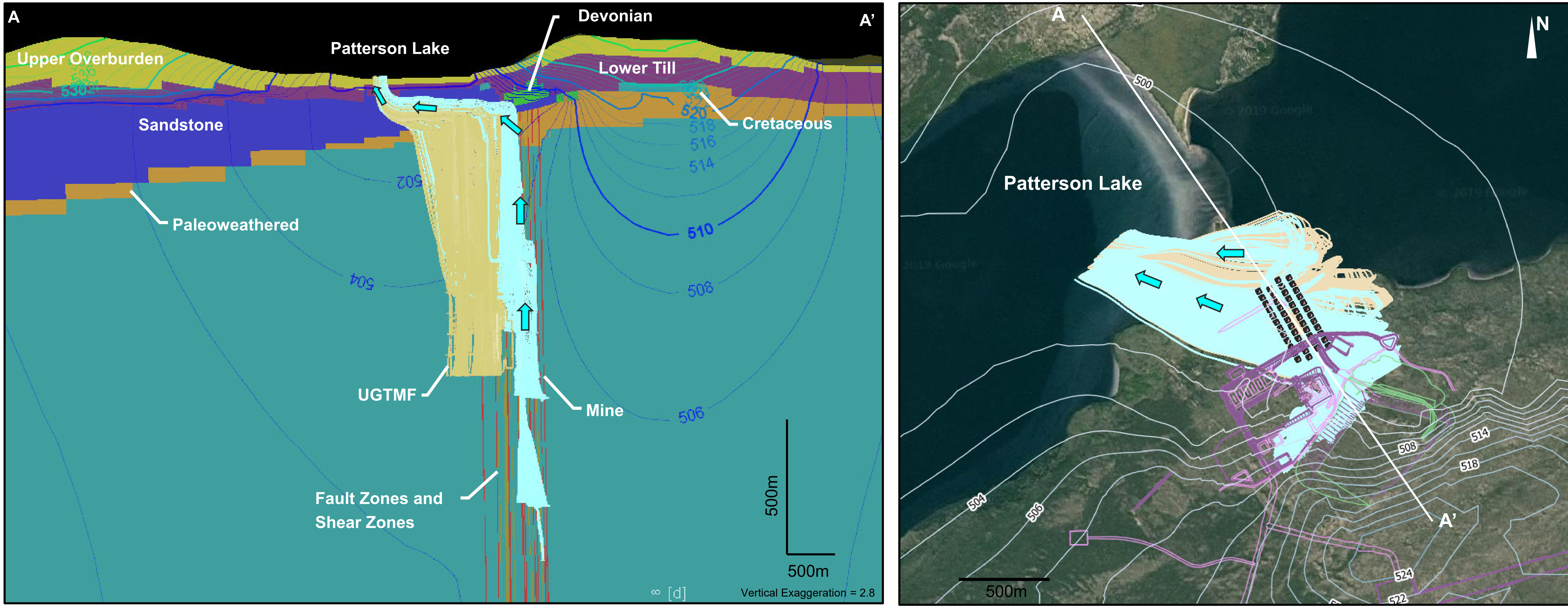
During Operations, seepage to the underground mine would result in a depressurization of the surrounding bedrock, which would be observed as a reduction in groundwater elevation at monitoring locations. The extent of the simulated groundwater drawdown in bedrock resulting from the mine dewatering at the end of Operations extends approximately 2 km to the north, 4 km to the south, and 3.5 km in both the east and west directions. Vertically, the extent of depressurization was generally limited to the basement rock, as the overlying sandstone aquifer had greater hydraulic conductivity. The maximum simulated drawdown within the sandstone was estimated to be less than 5 m in the immediate area of the mine workings.

During Construction and Operations, groundwater inflows to the underground development are predicted to range from approximately 1,200 cubic metres per day (m^3/d) to 3,900 m^3/d. These conservatively assessed inflow values were used in the surface water modelling for the Project.

During Operations, the groundwater seepage collected from the underground mine would be treated, monitored, and discharged to Patterson Lake. Assuming that all groundwater seepage collected at the underground mine originates as surface infiltration from the Patterson Lake catchment, the resulting long-term net change to the overall water balance of the surface water system was identified to be negligible.

Based on the particle tracking modelling, groundwater originating at the UGTMF and production stope backfill source areas is predicted to migrate vertically upward primarily through the fault and shear zones, then laterally through the sandstone, before discharging within Patterson Lake (Figure 8A-4). The approximate advective groundwater travel time from the upper horizon of the mine to the discharge location at Patterson Lake is estimated to be approximately 1,000 years.

Seepage from beneath the WRSAs was predicted to infiltrate vertically to the water table, then laterally towards Patterson Lake in both the northernly and southernly directions (Figure 8A-5). For the overburden groundwater flow paths, the approximate advective groundwater travel time from the WRSAs to Patterson Lake was 43 years to the north and 77 years to the south.



LEGEND

- SIMULATED GROUNDWATER HEAD CONTOUR – SECTION VIEW (m)
- SIMULATED GROUNDWATER HEAD CONTOUR – PLAN VIEW (m)
- SIMULATED GROUNDWATER FLOW PATHWAY (UGTMF)
- SIMULATED GROUNDWATER FLOW PATHWAY (BACKFILL)
- BASEMENT ROCK
- PALEOWEATHERED BASEMENT ROCK
- SANDSTONE
- DEVONIAN ROCK
- CRETACEOUS ROCK
- LOWER OVERBURDEN (TILL)
- UPPER OVERBURDEN

Notes:
1) Arrows indicate direction of groundwater flow pathway
2) Simulated groundwater head contours reflect long-term post-closure conditions.
3) UGTMF = underground tailings management facility

CLIENT
NexGen Energy Ltd.

CONSULTANT
wsp

YYYY-MM-DD	2021-07-24
PREPARED	NB
DESIGN	NB
REVIEW	SD
APPROVED	MT

PROJECT
ROOK I PROJECT

TITLE
PARTICLE TRACKING ANALYSIS – GROUNDWATER FLOW PATHWAYS FOR UNDERGROUND SOURCES

PROJECT No.	PHASE	Rev.	FIGURE
20144150	3104	0	8A-4

LEGEND

- SIMULATED GROUNDWATER FLOW CONTOUR – PLAN VIEW (m)
- SIMULATED GROUNDWATER FLOW PATHWAY
- PROPOSED SURFACE WASTE FACILITIES (SOURCE AREA)
- PROPOSED SURFACE MINE INFRASTRUCTURE

Notes:
1) Arrows indicate direction of groundwater flow pathway
2) Simulated groundwater head contours reflect long-term post-closure conditions.

CLIENT
NexGen Energy Ltd.

CONSULTANT
wsp

YYYY-MM-DD	2021-07-24
PREPARED	NB
DESIGN	NB
REVIEW	SD
APPROVED	MT

PROJECT
ROOK I PROJECT

TITLE
PARTICLE TRACKING ANALYSIS – GROUNDWATER FLOW PATHWAYS FOR ABOVE GROUND SOURCES

PROJECT No.	PHASE	Rev.	FIGURE
20144150	XXXX	B	8A-5

Groundwater Quality

The main objective of the predictive modelling with respect to groundwater quality was to estimate the solute mass loading rates from waste rock and CPT and backfill to surface receptors during Operations and in the long-term following Closure.

Based on modelling of groundwater quality, the magnitude of the effects was variable and specific to the solute being modelled. Solute-specific effects ranged from negligible effects beyond background values to multiple orders of magnitude above background values. Spatially, these effects were predicted to be limited to the groundwater discharge within Patterson Lake. The temporal scale of these effects was long term, spanning a period from the late stages of Operations to long-term following Closure (i.e., permanent).

The classifications of residual effects to groundwater quantity (Table 8A-2) and groundwater quality (Table 8A-3) are reproduced below from Table 8.5-2 and Table 8.5-3, respectively, of EIS Section 8.5.2.2, Groundwater Quality.

Table 8A-2: Classification of Residual Effects on Groundwater Quantity Measurement Indicators for the Application Case During Operations

Measurement Indicator	Criterion	Rating / Effect Size Application Case
Groundwater elevations	Direction	Negative
	Magnitude	▪ 5 m of drawdown in basement rock ▪ Vertically, the drawdown is generally limited to the basement rock, with less than 5 m estimated in the overlying sandstone
	Geographic extent	Local: within the basement rock up to 4 km from the Project
	Duration	Medium-term: during Operations (24 years)
	Reversibility	Reversible
	Frequency	Continuous
	Probability of occurrence	Certain
Groundwater flow directions and rates (seepage to the mine)	Direction	Neutral
	Magnitude	Up to approximately 3,900 m^3/d sustained groundwater inflows
	Geographic extent	Local: within underground mine workings
	Duration	Medium-term: during Operations (24 years)
	Reversibility	Reversible
	Frequency	Continuous
	Probability of occurrence	Certain
Groundwater flow directions and rates (baseflow)	Direction	Neutral
	Magnitude	▪ Treated effluent discharge to Patterson Lake would offset reduction in baseflow resulting from mine dewatering ▪ Simulated mine inflow rates represent a maximum of approximately 6% of the simulated baseflow value to Patterson Lake watershed
	Geographic extent	Local: within the Patterson Lake watershed and the LSA
	Duration	Medium-term: during Operations (24 years)
	Reversibility	Reversible
	Frequency	Continuous
	Probability of occurrence	Certain

Table 8A-2: Classification of Residual Effects on Groundwater Quantity Measurement Indicators for the Application Case During Operations

Measurement Indicator	Criterion	Rating / Effect Size
		Application Case
Groundwater flow directions and rates (groundwater flow pathways)	Direction	Neutral
	Magnitude	Groundwater flow pathway from the mine horizon to Patterson Lake through fault and shear zones and sandstone, with travel times of approximately 1,000 years
	Geographic extent	Local: between mine horizon and Patterson Lake
	Duration	Permanent: into far-future following Closure
	Reversibility	Irreversible
	Frequency	Continuous
	Probability of occurrence	Certain

LSA = local study area; m^3/day = cubic metres per day.

Table 8A-3: Classification of Long-Term Residual Effects on Groundwater Quality Measurement Indicators for the Application Case

Measurement Indicator	Criterion	Rating / Effect Size
		Application Case
Groundwater quality (solute mass loading rates from groundwater to receptors)	Direction	Negative
	Magnitude	▪ Variable and solute specific ▪ Ranges from negligible effects beyond background values to multiple orders of magnitude above background values (EIS Section 8.5.1.2.1)
	Geographic extent	Local: groundwater discharge within Patterson Lake
	Duration	Permanent: Spanning a period from the late stages of Operations and into far future following Closure
	Reversibility	Irreversible
	Frequency	Continuous with varying solute discharge rates
	Probability of occurrence	Certain

8A1.6 Terrain and Soils

Potential changes to surficial geology due to the Project were assessed in EIS Section 12, Terrain and Soils.

Terrain in the LSA is primarily undulating to hummocky upland landscape. The slope of the local terrain ranges from relatively level to slopes of 25% or greater, with an average slope of about 7%. The LSA is composed of four terrain units, which are approximately distributed as follows:

- 79% glaciofluvial deposits;
- 14% water;
- 4% fen peat (i.e., Organic); and
- 4% anthropogenic (i.e., human-derived) disturbance.

For the soil-covered areas within the LSA, mineral soils are dominant, with some Organic soils also present. Mineral soil map units consist almost entirely of Brunisols, with small amounts of Gleysols and Mesisols also present. Organic soil map units consist almost entirely of Mesisols, with small amounts of Gleysols and Brunisols also present.

A residual effects analysis was conducted to determine the potential effects of the Project on terrain and soils. The residual effects analysis considered three measurement indicators:

- quantity and distribution of terrain units;
- quantity and distribution of soil map units; and
- soil quality, which focused on soil suitability for reclamation.

Effects on terrain and soil map units covered with permanent facilities of the Project (e.g., waste rock storage areas) would be irreversible. The effects from disturbance on terrain and soil map units not covered by permanent facilities would be reversible over a long-term duration. During Operations, the Project would be progressively reclaimed. During the Active Closure Stage, non-permanent facilities and infrastructure would be fully decommissioned and reclaimed. Permanent facilities would be reclaimed to the extent possible. Reclamation is predicted to reverse effects on disturbed terrain and soils and would support the establishment and succession of vegetation communities that have a similar function to natural ecosystems. This objective would be achieved by applying best practices for soil salvage, storage, and placement. The establishment of reclaimed terrain, soils, and associated vegetation ecosystems would extend well beyond Closure (i.e., more than 60 years). A summary of residual effects to terrain and soils (Table 8A-4) is reproduced below from Table 12.5-3 of EIS Section 12.5.3, Residual Effects Classification.

Table 8A-4: Classification of Residual Effects on Terrain and Soils Measurement Indicators for the Application Case

Measurement Indicator	Criterion	Rating / Effect Size
Quantity and distribution of terrain units	Direction	▪ Negative
	Magnitude	▪ 897.8 ha of natural terrain units under existing conditions converted to the disturbance map unit (i.e., high magnitude) ▪ 82.2 ha of the disturbance map unit remain in the maximum disturbance area
	Geographic extent	▪ Maximum disturbance area
	Duration	▪ Permanent: natural terrain units covered by permanent features (e.g., WRSAs) ▪ Long-term: for reclaimed terrain units, 33 years (start of Construction to end of Active Closure Stage) or earlier with progressive reclamation, and extending well beyond Closure
	Reversibility	▪ Irreversible: natural terrain units covered by permanent features (e.g., WRSAs) ▪ Reversible: for reclaimed terrain units
	Frequency	▪ Continuous
	Probability of occurrence	▪ Certain
Quantity and distribution of soil map units	Direction	▪ Negative
	Magnitude	▪ 897.8 ha of soil map units under existing conditions converted to the disturbance map unit (i.e., high magnitude) ▪ 82.2 ha of the disturbance map unit remain in the maximum disturbance area
	Geographic extent	▪ Maximum disturbance area
	Duration	▪ Permanent: for natural soil map units covered by permanent features (e.g., WRSAs) ▪ Long-term: for disturbed soil map units, 33 years (start of Construction to end of Active Closure Stage), or earlier with progressive reclamation, and extending well beyond Closure
	Reversibility	▪ Irreversible: natural soil map units covered by permanent features (e.g., WRSAs) ▪ Reversible: for reclaimed soil map units
	Frequency	▪ Continuous
	Probability of occurrence	▪ Certain

Table 8A-4: Classification of Residual Effects on Terrain and Soils Measurement Indicators for the Application Case

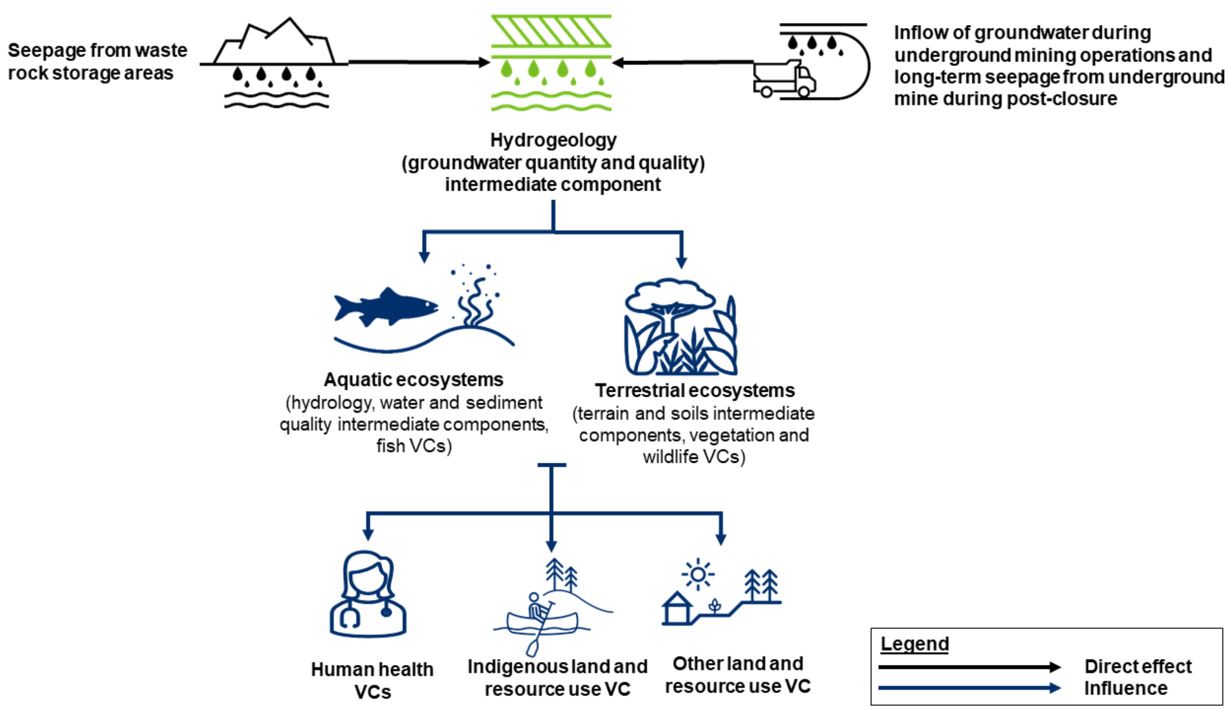
Measurement Indicator	Criterion	Rating / Effect Size
Soil quality (i.e., productivity)	Direction	▪ Negative
	Magnitude	▪ 897.8 ha of soil map units under existing conditions converted to the disturbance map unit (i.e., high magnitude) ▪ 82.2 ha of the disturbance map unit remain in the maximum disturbance area
	Geographic extent	▪ Maximum disturbance area
	Duration	▪ Long-term: for disturbed soil map units, 33 years (start of Construction to end of Active Closure Stage), or earlier with progressive reclamation, and extending well beyond Closure
	Reversibility	▪ Reversible
	Frequency	▪ Continuous
	Probability of occurrence	▪ Certain

ha = hectare; WRSAs = waste rock storage areas.

8A1.7 Linkages to Valued Components

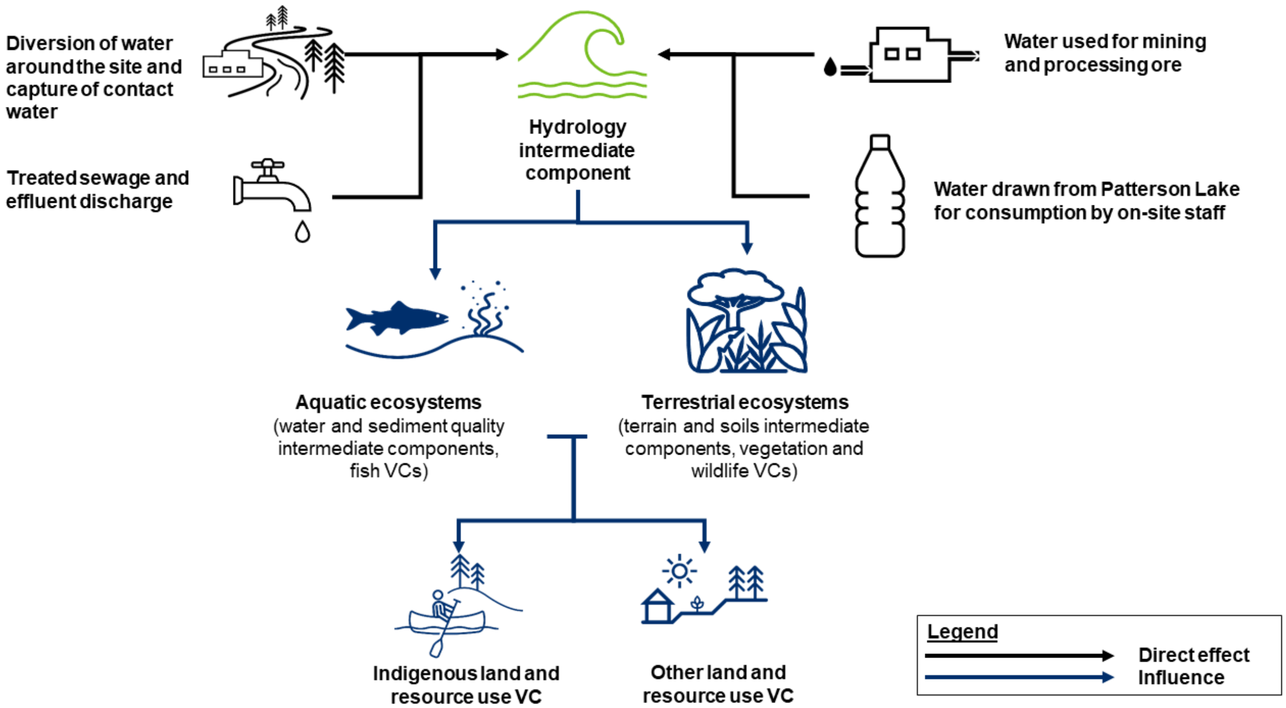
The geologically focused information used for the assessment of intermediate components listed above were linked to valued components and other intermediate components that assessed ecological and human aspects in the EIS. Linkage diagrams illustrating these relationships are reproduced below for hydrogeology (Figure 8A-6) from Figure 8.1-3 of EIS Section 8.1, Introduction; hydrology (Figure 8A-7) from Figure 9.1-3 of EIS Section 9.1, Introduction; and for terrain and soils (Figure 8A-8) from Figure 12.1-3 of EIS Section 12.1, Introduction. As these figures illustrate, the aspects of geology that could potentially result in effects to valued components (i.e., chemical loadings to the environment from the UGTMF and WRSAs, permanent changes to surficial geology, and other aspects of the geologic environment) have been assessed throughout the EIS.

Figure 8A-6: Linkage Diagram of Project Effects on Hydrogeology and Influenced Valued Components



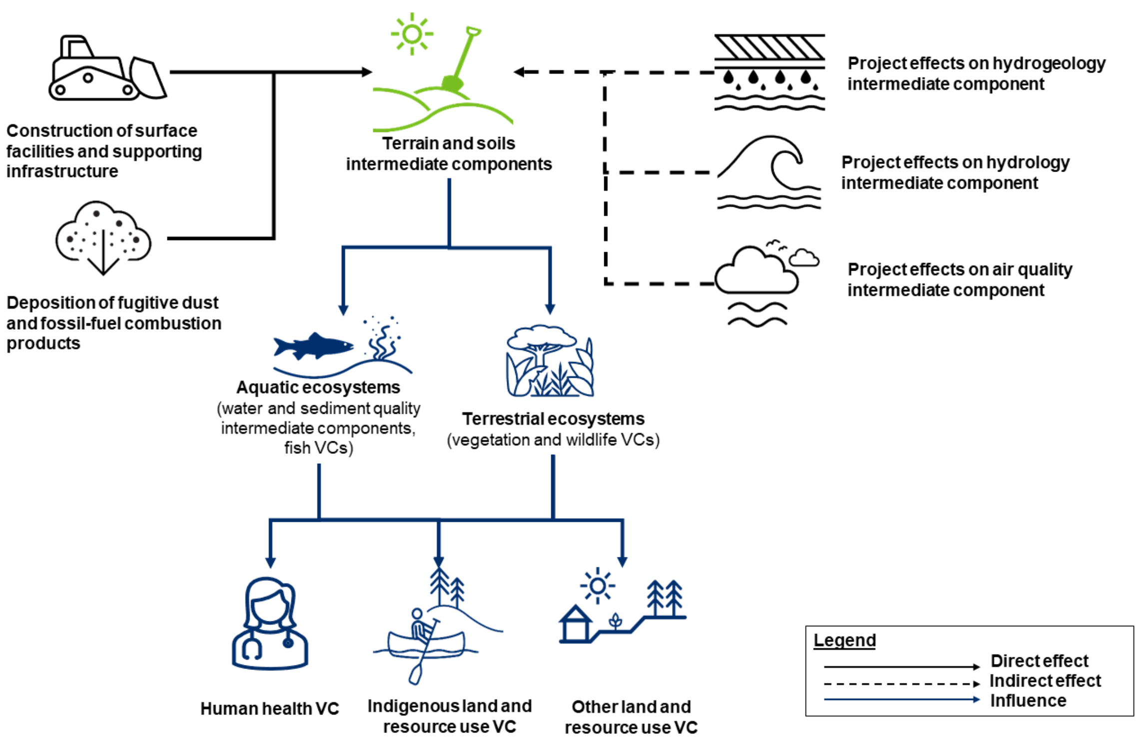
VC = valued component.

Figure 8A-7: Linkage Diagram of Project Effects on Hydrology and Influenced Valued Components



VC = valued component.

Figure 8A-8: Linkage Diagram of Project Effects on Terrain and Soils and Influenced Valued Components



VC = valued component.

8A1.8 Monitoring

As previously noted, NexGen would develop and operate all Project infrastructure, facilities, and systems in accordance with design standards relevant to the Project, which are based on regulatory guidance, applicable building code requirements, and best management practices as developed by applicable industry and trade associations and standards organizations. All Project phases from Construction through Closure would be required to satisfy licence and permitting requirements from the CNSC, Saskatchewan Ministry of Environment, and other federal and provincial regulatory bodies, and would follow NexGen management systems.

For all predicted residual effects, follow-up and monitoring programs would be used to:

- compare operational conditions with effect predictions and address uncertainty;
- monitor for changes in measurement indicators;
- evaluate the effectiveness of reclamation and other mitigation actions, and modify or enhance as necessary through monitoring and developing updated mitigation measures, if needed;
- identify unanticipated negative effects, including possible accidents and malfunctions; and
- contribute to the overall continual improvement of the Project.

With respect to geotechnical conditions, ground control measures such as observational monitoring, instrumentation installation and operation, and quality assurance and control processes for design elements would be implemented to monitor the stability of mine openings. Instrumentation would be installed to monitor water inflow, ground movement and displacement, and cemented paste performance. Instrumentation would also be used to validate and calibrate 3D numerical stress models to confirm designs (e.g., during initial development of the UGTMF, instrumentation would be used in the chamber back [i.e., roof] and pillars to monitor rock mass response to confirm design assumptions). Quality control and assurance of design components (e.g., blasting practices, ground support and reinforcement, shotcrete, backfill, instrumentation) would be complemented by observational monitoring conducted by trained and qualified operations and technical personnel. NexGen has identified proactive mitigation options to apply if rock mass conditions are locally poorer than anticipated, rock structure impacts wall/pillar stability, and/or pillar stresses are higher than anticipated (e.g., additional cable bolt support, decreasing chamber dimensions, increasing pillar thickness).

Fluvial sediment transport would be monitored as part of the hydrometric monitoring program. This continued data collection would extend the baseline monitoring period and data available. Selected hydrometric stations would also be monitored during the Project phases using remotely operated telemetry stations, which could be used to verify the receiving environment predictions of minimal changes in flows and water levels during the proposed Project duration and in the future. Proposed remotely operated stations being considered include the following:

- Clearwater River below Patterson Lake;
- Clearwater River below Beet Lake;
- Clearwater River below Naomi Lake;
- Clearwater River above the confluence with the Mirror River; and
- Clearwater River below Broach Lake.

The plan for monitoring groundwater quantity and quality for the Project would be detailed in the Environmental Monitoring Plan. The groundwater focus of this plan is the establishment of monitoring systems to evaluate the effectiveness of groundwater protection controls. Groundwater monitoring targets were selected under the plan to achieve the monitoring objectives detailed above. These targets include monitoring of groundwater elevations and quality in the bedrock and overburden to monitor the effects of the following:

- dewatering during construction and development of the shaft, underground mine, and UGTMF;
- seepage from the WRSAs;
- seepage from the process and mine terrace areas, including the fuel and reagent storage areas and equipment such as diesel fuel generators (i.e., in the event of a spill and non-routine events); and
- seepage from the area of the effluent treatment ponds (in the event of leakage).

Constituents of potential concern for the groundwater monitoring were based on an evaluation of the conceptual site model (e.g., hydrogeology, risk of effects from the Project) and the objectives of the groundwater monitoring. Details would be provided in the Environmental Monitoring Plan.

The Environmental Protection Program would be implemented to mitigate effects on terrain and soils and apply adaptive management, where necessary. Examples of monitoring activities for terrain and soils are outlined below.

For terrain stability:

- Monitor slope stability during land clearing, site preparation, and construction of facilities.
- Perform routine inspection and maintenance of containment and conveyance structures (i.e., roadside ditches and culverts) to limit the risk of road wash-out or sediment release to the environment.

For soil quality and quantity:

- Monitor site clearing, contouring, and excavation activities for signs of admixing, compaction, and erosion.
- Monitor soil transport and stockpiling activities for signs of erosion.
- Monitor dust deposition.
- Monitor soil chemistry.

The Preliminary Decommissioning and Reclamation Plan, along with monitoring, would assist in revising or adding mitigation measures to facilitate successful long-term reclamation of terrain and soils to support the establishment of vegetation communities and provide functional wildlife habitat.

In addition, Environmental Committees (i.e., one per primary Indigenous Group identified for the Project) composed of two NexGen and two Indigenous Group representatives would be established to act in an oversight manner to monitor the environmental performance of the Project and verify the parties are implementing the regulatory and environmental commitments made in respect of the Project.

The primary Indigenous Groups have made recommendations related to mitigating the effects of the Project on the environment, including community-led long-term environmental testing and monitoring during Construction and Operations of the Project. NexGen has committed to provide funding for the lifespan of the Project for a full-time independent Indigenous Monitor chosen by each primary Indigenous Group; this Indigenous Monitor would have access to conduct environmental sampling for the Project, subject to the Indigenous Monitor complying with appropriate health and safety and other reasonable site-specific policies. The Indigenous Monitor would be able to report openly and without restriction to the Environmental Committee and Indigenous Group's community members on the performance of the Project. The Indigenous Monitor would also provide regular reports to the Environmental Committee.

Further details regarding the proposed monitoring programs for the Project are presented in EIS Section 23, Summary of Mitigation, Monitoring, and Follow-up Programs.

8A1.9 Conclusions

As demonstrated in this Geology Supplement, geology represents an important feature of the physical environment that has been considered within existing conditions, Project design, valued components, intermediate components, and measurement indicators described and/or assessed within the EIS. Key aspects of geology that were presented in the EIS include the surface and subsurface geology in the area of the Project, geotechnical and seismicity conditions of the proposed mining area and how these conditions influenced Project design, fluvial sediment transport, and assessments of Project effects on terrain, soils, and hydrogeology, including both groundwater quantity and groundwater quality. In summary, geology has been appropriately considered within the EIS to verify that potential effects of the Project are properly understood, and follow-up and monitoring programs have been identified to allow for future comparison of operating conditions with effects predictions.

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IR 78

No.	Justification/Rationale	Follow up Information Request	NexGen Response
78	**Information to be addressed by NexGen now:** In order to resolve this IR, 1. NexGen must demonstrate evidence that Patterson Lake baseline data is representative of the wetland conditions, and therefore from the current modelling there are no expected impacts to wetlands in terms of surface water and sediment quality. 2. NexGen to confirm that water and sediment baseline data for wetlands are being collected now in order to have multi-year/seasonal data by the time activities start. **Commitment – to be captured in the EA follow up program:** Water and sediment Baseline data must be collected PRIOR to the start of activities that could affect the sediment and water quality (detailed commitment will include wording on the expectations for how and when this data is collected, as well as what must be done with the data in terms of re-modelling and mitigation must be added to the commitment). NexGen is expected to provide the methodology for proposed water quality baseline data collection in wetlands along with proposed statistical approaches for comparison to Patterson Lake data for CNSC staff review. Specifically, NexGen must demonstrate how the proposed methodology ensures that wetland baseline data captures within-year (seasonal) and between-year variation. The outcome of the additional data collection will require updates to the modelling to ensure that the risks were accurately captured in the EIS/ERA, and if not, then mitigation to further reduce impacts on wetland water and sediment quality will need to be added as a follow up commitment.		NexGen is providing the below supplemental information to respond to part 1 and part 2 of the reviewer's request. 1. NexGen agrees with the reviewer that there is value in verifying that riparian wetland baseline is comparable to Patterson Lake, as this could assist future monitoring and management approaches once Project activities that could affect these wetlands are initiated. Therefore, as an Environmental Assessment (EA) follow-up program, NexGen would commit to completing a comparison of water and sediment baseline data once multi-year/seasonal data is available and prior to the start of Project activities that could affect wetland water and sediment quality. Further, NexGen acknowledges the importance of having wetland-specific baseline water quality and sediment quality baseline information in advance of the commencement of Project activities to verify that environmental design features and mitigation measures are protecting the environment. For this reason, NexGen has initiated collection of additional multi-year/seasonal baseline data for wetlands, which will continue until the initiation of Project activities. Once Construction has gotten underway, wetland monitoring would be completed as defined in the Project Environmental Monitoring Plan approved through federal licensing and provincial permitting processes to verify that wetlands are being protected. Should monitoring demonstrate that Project effects on wetlands are causing significant effects, additional mitigation measures would be identified, evaluated, and implemented through NexGen's adaptive management process. Specific to the Project EA, NexGen maintains that further confirming baseline conditions for riparian wetlands immediately adjacent to Patterson Lake, re-modelling of potential effects to water quality and sediment quality in these wetlands based on additional baseline data, and the subsequent identification of additional mitigation measures are not required. The key reason for this conclusion is that primary pathways from the Project to these wetlands do not exist. Specifically, Pathway ID V-04 (fugitive dust and constituent emissions), Pathway ID V-05 (particulates and acid emissions), Pathway ID V-09 (surface water quality from runoff), Pathway ID V-10 (treated effluent discharge), and Pathway ID V-11 (surface water quality from waste rock storage areas [WRSAs] and the underground tailings management facility [UGTMF] following Closure) are all secondary pathways, and Pathway ID V-12 (radon emissions) has no pathway. Project environmental design features and mitigation measures are anticipated to result in negligible effects on wetlands (EIS Section 13.4.1 [Project Interactions and Mitigations], Table 13.4-1; EIS Section 13.4.1 [No Pathways]; EIS Section 13.4.2 [Secondary Pathways]). ▪ With respect to fugitive dust and constituent emissions, evaluation of air quality modelling predictions showed that vegetation community changes are anticipated be localized, with negligible effects beyond the maximum disturbance area (EIS Section 13.4.2). Mitigation measures, such as water and/or dust suppressants applied to the airstrip, site roads, and the access road as necessary (i.e., during dry conditions in the non-winter period) and the enforcement of speed limits, are expected to reduce the production of dust emissions (EIS Section 13.4.2). Therefore, negligible effects to the wetlands from fugitive dust and constituent emissions are expected. ▪ With respect to particulates and acid emissions, air quality modelling predictions indicate that concentrations of criteria air contaminants beyond the maximum

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			disturbance area are well within Saskatchewan Ambient Air Quality Standards during Construction and Operations, including carbon monoxide and sulphuric acid (EIS Section 7.2.5 [Residual Effects Analysis]). An exception is particulate matter less than 10 µm in diameter (PM_{10}); however, most of the PM10 exceedances beyond the maximum disturbance area would occur to the north over Patterson Lake (EIS Section 13.4.2). Therefore, negligible effects to the downstream wetlands from particulates and acid emissions are expected. ▪ With respect to non-contact water runoff, concentrations of metals and radionuclides in dust are predicted to be well below soil quality guideline values (EIS Section 12.4.2 [Secondary Pathways]). In addition, diversion ditches and perimeter berms are designed to divert clean non-contact water away from any disturbed areas, facilities, or works where water may become contaminated (EIS Section 13.4.2). Therefore, negligible effects to the downstream wetlands from runoff are expected. ▪ With respect to treated effluent discharge, site runoff (i.e., contact water) and water from the underground workings, including the UGTMF, would be collected, contained, controlled, treated (if necessary), and monitored to protect the receiving environment (i.e., Patterson Lake) (EIS Section 13.4.2). Similarly, domestic wastewater would be treated, and effluent would be discharged to Patterson Lake after meeting discharge criteria. Therefore, negligible effects to the downstream wetlands from treated effluent discharge are expected. ▪ With respect to surface water quality from the WRSAs and the UGTMF following Closure, Project designs, such as incorporating physical liners and providing a cover for waste rock storage, and the design, maintenance, and monitoring of a mine dewatering system, are anticipated to minimize changes in surface water quality in Patterson Lake (EIS Section 13.4.2). To confirm this prediction, the period following Closure was thoroughly assessed in the EA through a far-future scenario. This assessment involved regional water quality modelling, including an upper bound scenario (Section 10.2.8.1 [Water Quality Models]). Most modelled parameters remained below their respective threshold values in the far-future scenario, except for cobalt and copper. To evaluate the effects on aquatic plants, an ecological risk assessment was completed to determine the health risks to aquatic plant receptors. Results indicated that predicted changes in surface water quality for the upper bound scenario would not cause adverse effects on the health of aquatic plants (i.e., macrophytes and phytoplankton) (EIS TSD XXI [Environmental Risk Assessment], Section 6.4.1). Therefore, negligible effects to the downstream wetlands from surface water quality from the WRSAs and the UGTMF following Closure are expected. ▪ With respect to radon emissions, soils in the maximum disturbance area are not expected to absorb radon gas, as radon atoms are released through radium decay and, once released into soil pore space, are able to emanate into the atmosphere (Section 12.4.1 [No Pathways]). Therefore, there would be no effect on the vegetation ecosystems and traditional use plants, and subsequently, downstream wetlands (EIS Section 13.4.1). 2. As noted in part 1 of this IR response, NexGen confirms that water quality and sediment quality baseline data for wetlands are being collected and multi-year/seasonal data will be

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			available by the time Project activities start that could potentially affect the water quality and sediment quality of wetlands.

IR 79

No.	Justification/Rationale	Follow up Information Request	NexGen Response
79	**Justification:** The response provides the requested information regarding measured concentrations of thallium in the baseline aquatic environment and in potential effluent sources, however, this information has not yet been incorporated into the revised EIS. In addition, while statements related to thallium concentrations are provided, no data has been provided to support these statements. **Rationale:** The Proponent should incorporate the updates described in the response into the future revised EIS. The Proponent should also provide data to support the statement that "*Ongoing baseline data collection has validated these measured concentrations, with an additional 480 data points below 0.2 µg/L recorded in 2021, 2022, and 2023*", as stated in the response document titled "Attachment IR 49-R1 79-R1, and 82-R1".	**Information Request:** In order to resolve this IR, NexGen is expected to: 1) Incorporate the updates described in the IR response into the future revised EIS, and; 2) Provide data to support the statement that "Ongoing baseline data collection has validated these measured concentrations, with an additional 480 data points below 0.2 µg/L recorded in 2021, 2022, and 2023", as stated in the response document titled "Attachment IR 49-R1 79-R1, and 82-R1".	1. NexGen confirms that the updates described in the IR response (i.e., the information contained in Attachment IR 49-R1, 79-R1, and 82-R1) will be incorporated as a new Appendix 10B, Thallium Supplement in the Final EIS. A copy of EIS Appendix 10B has been provided to address IR 79-R1. 2. To address the reviewer's request in part 2, NexGen is providing Attachment IR 79-R1, which presents the data to support the statement "Ongoing baseline data collection has validated these measured concentrations, with an additional 480 data points below 0.2 µg/L recorded in 2021, 2022, and 2023".

Rook I Project

Environmental Impact Statement

Appendix 10B Thallium Supplement

Submitted to:
Canadian Nuclear Safety Commission
Saskatchewan Ministry of Environment

Submitted by:
NexGen Energy Ltd.
3150-1021 W Hastings St
Vancouver, BC
V6E 0C3

October 2024

Abbreviations and Units of Measure

Abbreviation	Definition
BATTEA	Best Available Technology and Techniques Economically Available
CCME	Canadian Council of Ministers of the Environment
COPC	constituent of potential concern
CNSC	Canadian Nuclear Safety Commission
EA	Environmental Assessment
EIS	Environmental Impact Statement
LSA	local study area
MDMER	Metal and Diamond Mining Effluent Regulations
NexGen	NexGen Energy Ltd.
Project	Rook I Project
RSA	regional study area
TSD	Technical Support Document
WSA	Saskatchewan Water Security Agency

Unit	Definition
%	percent
<	less than
µg/L	micrograms per litre

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10B1 INTRODUCTION

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan, called the Rook I Project (Project). The proposed Project is subject to both provincial and federal Environmental Assessment (EA) processes, would be licensed as a nuclear facility by the Canadian Nuclear Safety Commission (CNSC), and would be subject to various provincial and federal permits and approvals.

In support of the EA for the Project, NexGen prepared an Environmental Impact Statement (EIS). As part of the EIS, thallium was evaluated as a constituent of potential concern (COPC) but was not carried forward (i.e., was screened out) in the comprehensive list of COPCs for the surface water quality assessment as baseline concentrations were consistently low and initial model estimates of concentrations in the treated discharges were below applicable thresholds (EIS Section 10.2.8.2.1, Surface Water Quality Constituents of Potential Concern). Appendix 10B, Thallium Supplement, validates the results of the screening as presented in EIS Section 10.2.8.2.1 (i.e., confirms that thallium does not represent a COPC for the Project) through the completion of more recent baseline and geochemical test work that has been ongoing since the completion of the screening originally conducted as part of the Project EA.

The Thallium Supplement includes background on how thallium was considered in the EIS, validation of how thallium was screened as a COPC for the Project, and follow-up monitoring proposed for the Project specific to thallium.

10B2 THALLIUM IN THE ENVIRONMENTAL IMPACT STATEMENT

In EIS Section 10, Surface Water Quality and Sediment Quality, NexGen presented a multi-step process to:

- characterize existing conditions in the environment (EIS Section 10.3, Existing Conditions);
- identify potential Project interactions and mitigations (EIS Section 10.4, Project Interactions and Mitigations);
- analyze and classify residual effects (EIS Section 10.5, Residual Effects Analysis);
- describe uncertainty and prediction confidence (EIS Section 10.6, Prediction Confidence and Uncertainty); and
- based on the previous steps, identify monitoring and follow-up programs (EIS Section 10.7, Monitoring, Follow-Up, and Adaptive Management).

The methods applied to complete this multi-step process are outlined in EIS Section 10.2, Component Methods.

As described in EIS Section 10.2.2.2, Measurement Indicators, measurement indicators were used to characterize potential changes to surface water quality. Measurement indicators included:

- **Water quality constituent concentrations (i.e., risk to aquatic and terrestrial life):** includes nutrient, major ion, trace metal, and radionuclide concentrations in waterbodies and watercourses, which are compared to water quality thresholds (e.g., guidelines, objectives, standards) that apply to the protection of aquatic life and terrestrial life.

- **Drinking water quality constituent concentrations:** includes major ion, trace metal, and radionuclide concentrations in waterbodies and watercourses, which are compared to Canadian drinking water quality thresholds.
- **Productivity status constituent concentrations:** includes total phosphorus concentrations in waterbodies and watercourses, which are compared to Canadian waterbody trophic status[1] thresholds.

A series of water quality models were applied to predict constituent concentrations at various locations in the environment as described in EIS Section 10.2.8.1, Water Quality Model Development and Integration. These water quality models incorporated measured baseline data as described in EIS Section 10.2.6, Existing Conditions, and detailed in EIS Annex V.1, Aquatic Environmental Baseline Report. Project activities were included in the water quality models to predict potential effects to the receiving environment under different time frames and Project development scenarios.

The full list of constituents considered in the measurement indicators was reduced to a list of COPCs as described in EIS Section 10.2.8.2, Constituents of Potential Concern. The COPCs are a focused list of constituents determined through a screening process that potentially pose a risk to aquatic life, terrestrial life, and/or human health. Through this screening process, thallium was evaluated as a COPC but was not carried forward in the surface water quality assessment (EIS Section 10.2.8.2.1) because:

- thallium was not identified as a deleterious substance under Metal and Diamond Mining Effluent Regulations (MDMER);
- where source term data were available, thallium concentrations were generally non-detectable and below current applicable guidelines; and
- where source term data for thallium were not available, it was assumed based on the available source data that any contributions from other sources would similarly be negligible.

10B3 VALIDATION OF THALLIUM SCREENING CONDUCTED IN ENVIRONMENTAL IMPACT STATEMENT

To confirm that thallium does not represent a COPC for the Project, further details are provided in Section 10B3 regarding the original screening of thallium as a COPC. This information supplements the discussion in EIS Section 10.2.8.2 and includes a comparison against more recent baseline and geochemical test work datasets that have been ongoing since the completion of the screening originally conducted as part of the Project EA.

10B3.1 Project Thresholds

To understand the potential environmental effects associated with Project activities, the concentrations of water quality, drinking water quality, and productivity status constituents that were predicted by water quality models under development scenarios were compared to environmental thresholds. A set of Project thresholds was derived according to the hierarchy described in EIS Section 10.2.8.3.1, Water Quality Thresholds. The selected thresholds generally consisted of the most stringent chronic (i.e., long-term) water quality guidelines for the

[1] Trophic status describes and classifies waterbodies and watercourses (e.g., lakes and rivers) based on their ability to support aquatic ecosystems (i.e., primary productivity). The ability of a lake to support aquatic biota, such as plants and algae, is dependent on nutrient concentrations and physical conditions, primarily phosphorus and nitrogen nutrients and water clarity, respectively. In Canadian waters, particularly waterbodies on the Canadian Shield, phosphorus is characterized as the principal limiting factor (i.e., limiting nutrient) for primary productivity (CCME 2004).

protection of aquatic life sourced from either the Canadian Environmental Quality Guidelines for the protection of aquatic life (Canadian Council of Ministers of the Environment [CCME] 2021) or the Saskatchewan provincial objectives (Saskatchewan Water Security Agency [WSA] 2015, 2017). NexGen notes that in some cases, guidelines were not available for a given constituent and other thresholds were adopted; however, this condition is not relevant to thallium.

There is no Saskatchewan surface water quality objective for thallium; therefore, the CCME guideline of 0.8 micrograms per litre (µg/L; CCME 1999) was applied as the Project threshold.

Once derived, Project thresholds were applied in four main ways in the EIS:

- to select COPCs (EIS Section 10.2.8.2);
- to characterize existing conditions (EIS Section 10.3.1, Water Quality and EIS Annex V.1);
- to assess residual effects of the Project on surface water quality (EIS Section 10.5); and
- to derive preliminary environmental release targets (EIS Technical Support Document [TSD] XVIII, Site-Wide Water Balance and Water Quality Modelling Report, Appendix H, Section 3.0).

10B3.1.1 Metal and Diamond Mining Effluent Regulations Limits

In addition to the Project thresholds, environmental release targets are limited to the lowest value of those derived from Project thresholds and end-of-pipe limits, including limits described in Schedule 4 (Maximum Authorized Concentrations of Prescribed Deleterious Substances) of the Metal and Diamond Mining Effluent Regulations (MDMER) (Government of Canada 2023). The MDMER Schedule 4 limits exist for Prescribed Deleterious Substances listed in Section 3 (Analytical Requirements for Metal or Diamond Mining Effluent) of the MDMER.

Thallium is not a Prescribed Deleterious Substance under Section 3 of the MDMER; thus, the MDMER Schedule 4 does not apply to thallium. However, thallium is listed in Schedule 5 (Environmental Effects Monitoring Studies) of the MDMER as required for effluent monitoring and thus would be applicable to effluent monitoring for the Project, as explained in Section 10B4 of this memorandum.

10B3.2 Baseline Concentrations

Baseline concentrations of thallium in rivers and lakes within the Project local study area (LSA) and regional study area (RSA) are provided in EIS Annex V.1. As listed in Table 3.2-2 of EIS Annex V.1, total and dissolved thallium were measured at all aquatic baseline stations in 2018, 2019, and 2020. Detailed water chemistry results are provided in Appendix C of EIS Annex V.1; the results demonstrate that thallium was consistently below the detection limit of 0.2 µg/L (i.e., at least 4 times lower than the CCME guideline) in all rivers and lakes in the area of the Project. The baseline dataset included 415 measured values from 4 watercourses and 11 waterbodies (EIS Annex V.1, Table 3.2-1). Ongoing baseline data collection has validated these measured concentrations, with an additional 480 data points below 0.2 µg/L recorded in 2021, 2022, and 2023.

10B3.3 Rook I Project Sources to Effluent

As noted in the CCME fact sheet on thallium:

> Thallium is rarely present as large ore deposits, but can be recovered from sulphide ores of lead, copper, and zinc and may also be associated with cadmium, iron, and potassium minerals such

as feldspars and micas. Thallium minerals such as crookesite, hutchinsonite, lorandite, and avicennite occur naturally but are rare (CCME 1999).

As these minerals were not detected in the Arrow deposit mineralogy (see Section 5.1.1 and 5.2.1 of the Rook I Project – Geochemical Characterization of Waste Rock [SRK 2023] and EIS Annex XI, Geology Baseline Report), thallium is not expected to be present in quantities that pose a potential environmental risk. The CCME (1999) fact sheet further states that "*[n]atural inputs of thallium to aquatic environments occur by weathering processes and are not considered toxicologically significant*". As there are no imports of thallium to Project for industrial use, there is no conceptual pathway for thallium enrichment or contamination at the Project site.

The lack of a conceptual pathway for a source of thallium to the environment from Project activities is confirmed by monitoring data from all types of materials that could contribute to effluent during Construction, Operations, Decommissioning and Reclamation (i.e., Closure), and post-closure. Relevant environmental media have been sampled and analyzed for a suite of metals to screen and assess environmental risk, including data presented in the EIS and ongoing characterization work, as presented in Table 10B3-1.

Table 10B3-1: Summary of Measured Water Concentrations of Thallium in Receiving Environment and Potential Future Sources of Effluent

Environmental Medium	Reported in Draft EIS	Validation Data Measured Since Draft EIS
Baseline data from waterbodies and watercourses in the LSA and RSA	415 values from 4 watercourses and 11 waterbodies measured from 2018 to 2020 reported as <0.2 µg/L. **Reference:** EIS Annex V.1, Appendix C.	480 values from 4 watercourses and 14 waterbodies measured from 2021 to 2023 reported as <0.2 µg/L.
Site runoff	-	9 measured values from 3 stations in 2023, all 9 reported as <0.2 µg/L.
Groundwater in glacial drift and bedrock monitoring wells	142 of 147 values measured in 2017 to 2020 below 0.8 µg/L. The five samples above 0.8 µg/L were all from the first sample collected in each well, likely reflecting well development conditions and not local groundwater concentrations. **Reference:** EIS Annex III (Hydrogeology Baseline Report).	130 samples collected in 2021 to 2023, all below <0.2 µg/L, confirming that: (1) thallium is not measurable in groundwater in the LSA; and (2) first samples from each well likely was not representative.
Groundwater in Westbay well GAR-19-035 (i.e., representing mine development area)	1 measurement from each of 10 depth zones in 2020, all reported as <20 µg/L. **Reference**: EIS Annex III.	7 seasonal samples from each of 10 depths (i.e., 70 samples) from 2020 to 2023, all reported as <0.2 µg/L to <20 µg/L, as detection limits improved with time.
Humidity cells of UGTMF and mine development area for waste rock characterization	262 samples measured in leachate from 13 humidity cells over 56 weeks; all values <0.8 µg/L, with most values reported as <0.005 µg/L. **Reference:** Raw data to support EIS TSD XVII (Waste Rock and Underground Wall Rock Source Term Predictions Report); data not presented in TSD XVII.	304 samples measured in leachate from 9 humidity cells over subsequent 179 weeks; all values <0.8 µg/L, with most values <0.005 µg/L.
Overburden and cover materials	Shake flask extraction leachate of four samples of borrow material in 2021; all four were <0.2 µg/L. **Reference:** Okane (2020) that is referenced in TSD XVIII.	20 samples measured from each of 3 humidity cells over 35 weeks. All 60 values are <0.02 µg/L (52/60 are <0.005 µg/L).

µg/L = micrograms per litre; < = less than; LSA = local study area; RSA = regional study area; TSD = Technical Support Document; UGTMF = underground tailings management facility.

10B3.4 Conclusions of Constituent of Potential Concern Screening

Data gathered for the EIS and more recent data measured from 2021 to 2023 validate the exclusion of thallium as a COPC for the EIS. Reported values are below detection limits. While detection limits vary, the vast majority of data points are below the CCME guideline and, in many cases, orders of magnitude below the CCME guideline. Therefore, there is negligible potential for adverse effects to surface water quality as a result of inputs of thallium to the receiving environment from the Rook I Project.

By extension, there is no need to develop environmental release targets for thallium. According to REGDOC-2.9.2, *Environmental Protection, Controlling Releases to the Environment* (CNSC 2021), which would be applied to Project effluents during licensing to guide the development of the Best Available Technology and Techniques Economically Available (BATTEA) and licensed release limits, thallium would not be defined as a substance that requires control because the data indicate no potential for environmental risk.

10B4 FOLLOW-UP MONITORING

Schedule 5, Part 1, Section 4(1) of the MDMER requires that thallium concentrations be measured as part of effluent characterization. Additionally, Schedule 3 of the MDMER prescribes analytical precision, accuracy, and detection limits for mine effluents; this schedule applies to thallium. The required detection limit for thallium is 0.4 µg/L, which is 50% of the CCME guideline value.

Compliance with the MDMER is a key consideration in the development of the Project effluent monitoring plan that will be applied to treated effluents, assuming approval by the CNSC, as part of licensing for each phase of the Project. Thallium would be monitored in the Project effluent treatment plant as per the requirements outlined in Schedule 3 and Schedule 5 of the MDMER. If monitoring detects increasing trends or values of thallium above the CCME guideline, thallium would be added as a COPC to the next update of the Environmental Risk Assessment, which would occur every five years.

REFERENCES

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WSA. 2017. Saskatchewan Water Quality Objective for the Protection of Aquatic Life – Molybdenum. Fact Sheet. Report No. WSA 514.

Attachment IR 79-R1

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Beet Creek	2021-09-26	0	0	M	Thallium	< 0.0002	mg/L	Surface	613276.118	6390620.513	492.577
Beet Creek	2021-09-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	613276.118	6390620.513	492.577
Beet Lake area 1	2021-09-26	13	13	M	Thallium	< 0.0002	mg/L	Above Thermocline	611777.475	6391464.59	497.567
Beet Lake area 1	2021-09-26	13	13	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	611777.475	6391464.59	497.567
Beet Lake area 1	2021-09-26	28	28	M	Thallium	< 0.0002	mg/L	Below Thermocline	611777.475	6391464.59	497.567
Beet Lake area 1	2021-09-26	28	28	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	611777.475	6391464.59	497.567
Broach Lake area 2	2021-09-25	9	9	M	Thallium	< 0.0002	mg/L	Below Thermocline	598288.982	6397872.037	522.773
Broach Lake area 2	2021-09-25	9	9	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	598288.982	6397872.037	522.773
Broach Lake area 2	2021-09-25	50	50	M	Thallium	< 0.0002	mg/L	Below Thermocline	598288.982	6397872.037	522.773
Broach Lake area 2	2021-09-25	50	50	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	598288.982	6397872.037	522.773
Clearwater River area 1	2021-09-26	0	0	M	Thallium	< 0.0002	mg/L	Surface	616448.766	6390527.542	489.073
Clearwater River area 1	2021-09-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	616448.766	6390527.542	489.073
Forrest Lake area 1	2021-09-29	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	605664.989	6390516.56	493.877
Forrest Lake area 1	2021-09-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	605664.989	6390516.56	493.877
Forrest Lake area 2	2021-09-29	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	605809.63	6387523.886	503.447
Forrest Lake area 2	2021-09-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	605809.63	6387523.886	503.447
Hodge Lake area 1	2021-09-23	8	8	M	Thallium	< 0.0002	mg/L	Above Thermocline	595269.693	6407954.583	521.359
Hodge Lake area 1	2021-09-23	8	8	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	595269.693	6407954.583	521.359
Hodge Lake area 1	2021-09-23	27	27	M	Thallium	< 0.0002	mg/L	Below Thermocline	595269.693	6407954.583	521.359
Hodge Lake area 1	2021-09-23	27	27	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	595269.693	6407954.583	521.359
Jed Creek	2021-09-27	0	0	M	Thallium	< 0.0002	mg/L	Surface	607823.07	6396403.029	499.503
Jed Creek	2021-09-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607823.07	6396403.029	499.503
Lake D	2021-09-25	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	600695.973	6385796.344	505.87
Lake D	2021-09-25	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	600695.973	6385796.344	505.87
Lake G area 1	2021-09-27	0	0	M	Thallium	< 0.0002	mg/L	Surface	607646.445	6393995.009	502.42
Lake G area 1	2021-09-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607646.445	6393995.009	502.42
Lake H area 1	2021-09-27	0	0	M	Thallium	< 0.0002	mg/L	Surface	608528.734	6394927.602	501.831
Lake H area 1	2021-09-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	608528.734	6394927.602	501.831
Lake J	2021-09-23	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	595099.825	6393248.155	551.98
Lake J	2021-09-23	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	595099.825	6393248.155	551.98
Lloyd Lake Inlet	2021-09-24	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	625179.06	6360323.134	484.705
Lloyd Lake Inlet	2021-09-24	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	625179.06	6360323.134	484.705
Lloyd Lake Outlet	2021-09-24	0	0	M	Thallium	< 0.0002	mg/L	Surface	634276.449	6356745.582	488.193
Lloyd Lake Outlet	2021-09-24	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	634276.449	6356745.582	488.193
Naomi Lake	2021-09-26	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	614066.527	6392176.65	488.182
Naomi Lake	2021-09-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	614066.527	6392176.65	488.182
Patterson Lake north arm east basin area 1	2021-09-27	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	605544.751	6395584.459	496.862
Patterson Lake north arm east basin area 1	2021-09-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	605544.751	6395584.459	496.862
Patterson Lake north arm west basin area 1	2021-09-28	8	8	M	Thallium	< 0.0002	mg/L	Above Thermocline	601406.24	6393701.341	490.959
Patterson Lake north arm west basin area 1	2021-09-28	8	8	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	601406.24	6393701.341	490.959
Patterson Lake north arm west basin area 1	2021-09-28	24	24	M	Thallium	< 0.0002	mg/L	Below Thermocline	601406.24	6393701.341	490.959
Patterson Lake north arm west basin area 1	2021-09-28	24	24	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	601406.24	6393701.341	490.959
Patterson Lake north arm west basin area 3	2021-09-28	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602974.257	6394338.074	496.542
Patterson Lake north arm west basin area 3	2021-09-28	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602974.257	6394338.074	496.542
Patterson Lake south arm area 1	2021-09-28	10	10	M	Thallium	< 0.0002	mg/L	Above Thermocline	602009.858	6389961.574	499.138
Patterson Lake south arm area 1	2021-09-28	10	10	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	602009.858	6389961.574	499.138
Patterson Lake south arm area 1	2021-09-28	33	33	M	Thallium	< 0.0002	mg/L	Below Thermocline	602009.858	6389961.574	499.138
Patterson Lake south arm area 1	2021-09-28	33	33	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	602009.858	6389961.574	499.138
Warner Rapids	2021-09-30	0	0	M	Thallium	< 0.0002	mg/L	Surface			
Warner Rapids	2021-09-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface			
Beet Creek	2021-06-01	0	0	M	Thallium	< 0.0002	mg/L	Surface	613276.792	6390613.515	494.099

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Beet Creek	2021-06-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	613276.792	6390613.515	494.099
Beet Lake area 1	2021-06-01	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	611778.816	6391480.89	495.359
Beet Lake area 1	2021-06-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	611778.816	6391480.89	495.359
Broach Lake area 2	2021-05-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	598288.516	6397874.031	524.222
Broach Lake area 2	2021-05-29	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	598288.516	6397874.031	524.222
Clearwater River area 1	2021-06-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	616452.941	6390521.535	486.968
Clearwater River area 1	2021-06-01	0	0	M	Thallium	< 0.0002	mg/L	Surface	616452.941	6390521.535	486.968
Forrest Lake area 1	2021-06-02	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	605666.807	6390513.266	492.41
Forrest Lake area 1	2021-06-02	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	605666.807	6390513.266	492.41
Forrest Lake area 2	2021-06-02	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	605808.392	6387525.525	495.682
Forrest Lake area 2	2021-06-02	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	605808.392	6387525.525	495.682
Hodge Lake area 1	2021-05-28	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	595282.14	6407956.214	530.958
Hodge Lake area 1	2021-05-28	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	595282.14	6407956.214	530.958
Jed Creek	2021-06-06	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607821.142	6396403.757	502.774
Jed Creek	2021-06-06	0	0	M	Thallium	< 0.0002	mg/L	Surface	607821.142	6396403.757	502.774
Lake D	2021-05-31	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	600695.589	6385804.576	510.643
Lake D	2021-05-31	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	600695.589	6385804.576	510.643
Lake G area 1	2021-06-03	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607626.626	6393990.806	507.162
Lake G area 1	2021-06-03	0	0	M	Thallium	< 0.0002	mg/L	Surface	607626.626	6393990.806	507.162
Lake H area 1	2021-06-03	0	0	M	Thallium	< 0.0002	mg/L	Surface	608527.836	6394927.69	507.529
Lake H area 1	2021-06-03	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	608527.836	6394927.69	507.529
Lake J	2021-05-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	595104.9	6393245.49	547.365
Lake J	2021-05-29	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	595104.9	6393245.49	547.365
Lloyd Lake Inlet	2021-05-30	1	1	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	625177.787	6360329.333	468.699
Lloyd Lake Inlet	2021-05-30	1	1	M	Thallium	< 0.0002	mg/L	Above Thermocline	625177.787	6360329.333	468.699
Lloyd Lake Inlet	2021-05-30	4	4	M	Thallium	< 0.0002	mg/L	Below Thermocline	625177.787	6360329.333	468.699
Lloyd Lake Inlet	2021-05-30	4	4	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	625177.787	6360329.333	468.699
Lloyd Lake Outlet	2021-05-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	634275.439	6356743.321	477.399
Lloyd Lake Outlet	2021-05-30	0	0	M	Thallium	< 0.0002	mg/L	Surface	634275.439	6356743.321	477.399
Naomi Lake	2021-06-02	2	2	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	614069.88	6392182.649	500.421
Naomi Lake	2021-06-02	2	2	M	Thallium	< 0.0002	mg/L	Above Thermocline	614069.88	6392182.649	500.421
Naomi Lake	2021-06-02	4	4	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	614069.88	6392182.649	500.421
Naomi Lake	2021-06-02	4	4	M	Thallium	< 0.0002	mg/L	Below Thermocline	614069.88	6392182.649	500.421
Patterson Lake north arm east basin area 1	2021-06-03	2	2	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	602973.076	6394337.598	497.834
Patterson Lake north arm east basin area 1	2021-06-03	2	2	M	Thallium	< 0.0002	mg/L	Above Thermocline	602973.076	6394337.598	497.834
Patterson Lake north arm east basin area 1	2021-06-03	12	12	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	602973.076	6394337.598	497.834
Patterson Lake north arm east basin area 1	2021-06-03	12	12	M	Thallium	< 0.0002	mg/L	Below Thermocline	602973.076	6394337.598	497.834
Patterson Lake north arm west basin area 1	2021-06-04	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	601407.698	6393697.925	498.464
Patterson Lake north arm west basin area 1	2021-06-04	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	601407.698	6393697.925	498.464
Patterson Lake north arm west basin area 3	2021-06-04	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602973.076	6394337.598	497.834
Patterson Lake north arm west basin area 3	2021-06-04	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602973.076	6394337.598	497.834
Patterson Lake south arm area 1	2021-06-02	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602010.434	6389967.158	497.254
Patterson Lake south arm area 1	2021-06-02	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602010.434	6389967.158	497.254
Warner Rapids	2021-06-05	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	623077	6307920	373.672
Warner Rapids	2021-06-05	0	0	M	Thallium	< 0.0002	mg/L	Surface	623077	6307920	373.672
Beet Creek	2021-07-25	0	0	M	Thallium	< 0.0002	mg/L	Surface	613276.084	6390623.854	500.345
Beet Creek	2021-07-25	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	613276.084	6390623.854	500.345
Beet Lake area 1	2021-07-28	5	5	M	Thallium	< 0.0002	mg/L	Above Thermocline	611773.174	6391466.81	495.145
Beet Lake area 1	2021-07-28	5	5	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	611773.174	6391466.81	495.145
Beet Lake area 1	2021-07-28	23	23	M	Thallium	< 0.0002	mg/L	Below Thermocline	611773.174	6391466.81	495.145
Beet Lake area 1	2021-07-28	23	23	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	611773.174	6391466.81	495.145

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Broach Lake area 2	2021-07-21	4	4	M	Thallium	< 0.0002	mg/L	Above Thermocline	598290.796	6397873.418	527.094
Broach Lake area 2	2021-07-21	4	4	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	598290.796	6397873.418	527.094
Broach Lake area 2	2021-07-21	46	46	M	Thallium	< 0.0002	mg/L	Below Thermocline	598290.796	6397873.418	527.094
Broach Lake area 2	2021-07-21	46	46	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	598290.796	6397873.418	527.094
Clearwater River area 1	2021-07-25	0	0	M	Thallium	< 0.0002	mg/L	Surface	616451.374	6390526.169	501.334
Clearwater River area 1	2021-07-25	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	616451.374	6390526.169	501.334
Forrest Lake area 1	2021-07-28	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	605665.522	6390519.024	499.817
Forrest Lake area 1	2021-07-28	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	605665.522	6390519.024	499.817
Forrest Lake area 2	2021-07-25	5	5	M	Thallium	< 0.0002	mg/L	Above Thermocline	605809.638	6387523.552	473.42
Forrest Lake area 2	2021-07-25	5	5	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	605809.638	6387523.552	473.42
Forrest Lake area 2	2021-07-25	18	18	M	Thallium	< 0.0002	mg/L	Below Thermocline	605809.638	6387523.552	473.42
Forrest Lake area 2	2021-07-25	18	18	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	605809.638	6387523.552	473.42
Hodge Lake area 1	2021-07-23	4	4	M	Thallium	< 0.0002	mg/L	Above Thermocline	595269.403	6407934.195	528.703
Hodge Lake area 1	2021-07-23	4	4	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	595269.403	6407934.195	528.703
Hodge Lake area 1	2021-07-23	25	25	M	Thallium	< 0.0002	mg/L	Below Thermocline	595269.403	6407934.195	528.703
Hodge Lake area 1	2021-07-23	25	25	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	595269.403	6407934.195	528.703
Jed Creek	2021-07-26	0	0	M	Thallium	< 0.0002	mg/L	Surface	607821.258	6396403.871	497.184
Jed Creek	2021-07-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607821.258	6396403.871	497.184
Lake D	2021-07-23	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	600691.687	6385795.569	511.149
Lake D	2021-07-23	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	600691.687	6385795.569	511.149
Lake G area 1	2021-07-26	0	0	M	Thallium	< 0.0002	mg/L	Surface	607687.328	6393994.761	483.857
Lake G area 1	2021-07-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607687.328	6393994.761	483.857
Lake H area 1	2021-07-26	0	0	M	Thallium	< 0.0002	mg/L	Surface	608527.363	6394923.11	498.51
Lake H area 1	2021-07-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	608527.363	6394923.11	498.51
Lake J	2021-07-21	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	595102.883	6393252.57	554.176
Lake J	2021-07-21	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	595102.883	6393252.57	554.176
Lloyd Lake Inlet	2021-07-22	0	0	M	Thallium	< 0.0002	mg/L	Above Thermocline	625183.779	6360324.281	473.861
Lloyd Lake Inlet	2021-07-22	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	625183.779	6360324.281	473.861
Lloyd Lake Outlet	2021-07-22	0	0	M	Thallium	< 0.0002	mg/L	Surface	634274.815	6356736.616	526.899
Lloyd Lake Outlet	2021-07-22	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	634274.815	6356736.616	526.899
Naomi Lake	2021-07-25	0	0	M	Thallium	< 0.0002	mg/L	Above Thermocline	614070.813	6392177.106	497.923
Naomi Lake	2021-07-25	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	614070.813	6392177.106	497.923
Patterson Lake north arm east basin area 1	2021-07-27	5	5	M	Thallium	< 0.0002	mg/L	Above Thermocline	605550.482	6395579.708	528.713
Patterson Lake north arm east basin area 1	2021-07-27	5	5	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	605550.482	6395579.708	528.713
Patterson Lake north arm east basin area 1	2021-07-27	18	18	M	Thallium	< 0.0002	mg/L	Below Thermocline	605550.482	6395579.708	528.713
Patterson Lake north arm east basin area 1	2021-07-27	18	18	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	605550.482	6395579.708	528.713
Patterson Lake north arm west basin area 1	2021-07-27	5	5	M	Thallium	< 0.0002	mg/L	Above Thermocline	601399.072	6393699.267	495.515
Patterson Lake north arm west basin area 1	2021-07-27	5	5	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	601399.072	6393699.267	495.515
Patterson Lake north arm west basin area 1	2021-07-27	22	22	M	Thallium	< 0.0002	mg/L	Below Thermocline	601399.072	6393699.267	495.515
Patterson Lake north arm west basin area 1	2021-07-27	22	22	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	601399.072	6393699.267	495.515
Patterson Lake north arm west basin area 3	2021-07-24	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602972.519	6394338.364	496.651
Patterson Lake north arm west basin area 3	2021-07-24	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602972.519	6394338.364	496.651
Patterson Lake south arm area 1	2021-07-27	6	6	M	Thallium	< 0.0002	mg/L	Above Thermocline	602009.317	6389959.333	494.149
Patterson Lake south arm area 1	2021-07-27	6	6	M	Thallium, dissolved	< 0.0002	mg/L	Above Thermocline	602009.317	6389959.333	494.149
Patterson Lake south arm area 1	2021-07-27	31	31	M	Thallium	< 0.0002	mg/L	Below Thermocline	602009.317	6389959.333	494.149
Patterson Lake south arm area 1	2021-07-27	31	31	M	Thallium, dissolved	< 0.0002	mg/L	Below Thermocline	602009.317	6389959.333	494.149
Warner Rapids	2021-07-29	0	0	M	Thallium	< 0.0002	mg/L	Surface			
Warner Rapids	2021-07-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface			
Beet Creek	2021-04-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	613199.242	6390755.258	496.315
Beet Creek	2021-04-01	0	0	M	Thallium	< 0.0002	mg/L	Surface	613199.242	6390755.258	496.315
Beet Lake area 1	2021-03-31	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	611770.926	6391468.196	491.373

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Beet Lake area 1	2021-03-31	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	611770.926	6391468.196	491.373
Broach Lake area 2	2021-03-26	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	598291.933	6397870.773	517.655
Broach Lake area 2	2021-03-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	598291.933	6397870.773	517.655
Clearwater River area 1	2021-04-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	615129.151	6390834.652	496.861
Clearwater River area 1	2021-04-01	0	0	M	Thallium	< 0.0002	mg/L	Surface	615129.151	6390834.652	496.861
Forrest Lake area 1	2021-03-31	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	605666.399	6390519.715	501.148
Forrest Lake area 1	2021-03-31	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	605666.399	6390519.715	501.148
Forrest Lake area 2	2021-03-31	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	605806.462	6387517.009	502.813
Forrest Lake area 2	2021-03-31	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	605806.462	6387517.009	502.813
Hodge Lake area 1	2021-03-25	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	595273.411	6407953.223	538.689
Hodge Lake area 1	2021-03-25	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	595273.411	6407953.223	538.689
Jed Creek	2021-03-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	607816.974	6396416.9	490.767
Jed Creek	2021-03-30	0	0	M	Thallium	< 0.0002	mg/L	Surface	607816.974	6396416.9	490.767
Lake D	2021-03-28	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	600695.417	6385799.449	516.911
Lake D	2021-03-28	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	600695.417	6385799.449	516.911
Lake G area 2	2021-03-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Mid Depth	607352.072	6393300.843	498.214
Lake G area 2	2021-03-30	0	0	M	Thallium	< 0.0002	mg/L	Mid Depth	607352.072	6393300.843	498.214
Lake H area 2	2021-03-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	609835.648	6395024.62	500.416
Lake H area 2	2021-03-30	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	609835.648	6395024.62	500.416
Lake J	2021-03-26	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	595099.732	6393244.478	555.685
Lake J	2021-03-26	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	595099.732	6393244.478	555.685
Lloyd Lake Inlet	2021-03-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	625176.325	6360322.047	466.124
Lloyd Lake Inlet	2021-03-27	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	625176.325	6360322.047	466.124
Lloyd Lake Outlet	2021-03-27	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface	628710.365	6356274.321	468.201
Lloyd Lake Outlet	2021-03-27	0	0	M	Thallium	< 0.0002	mg/L	Surface	628710.365	6356274.321	468.201
Naomi Lake	2021-04-01	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	614069.258	6392181.406	500.589
Naomi Lake	2021-04-01	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	614069.258	6392181.406	500.589
Patterson Lake north arm east basin area 1	2021-03-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	605544.908	6395583.015	481.231
Patterson Lake north arm east basin area 1	2021-03-29	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	605544.908	6395583.015	481.231
Patterson Lake north arm west basin area 1	2021-03-29	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	601472.746	6393750.01	492.23
Patterson Lake north arm west basin area 1	2021-03-29	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	601472.746	6393750.01	492.23
Patterson Lake north arm west basin area 3	2021-03-30	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602973.346	6394341.058	490.138
Patterson Lake north arm west basin area 3	2021-03-30	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602973.346	6394341.058	490.138
Patterson Lake south arm area 1	2021-03-28	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Top+Middle+Bottom	602008.75	6389962.883	491.149
Patterson Lake south arm area 1	2021-03-28	0	0	M	Thallium	< 0.0002	mg/L	Top+Middle+Bottom	602008.75	6389962.883	491.149
Warner Rapids	2021-04-05	0	0	M	Thallium, dissolved	< 0.0002	mg/L	Surface			
Warner Rapids	2021-04-05	0	0	M	Thallium	< 0.0002	mg/L	Surface			
Beet Creek	2022-09-16	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	613276.667	6390622.782	491.657
Beet Creek	2022-09-16	0	0	M	Thallium	< 0.0020	µg/L	Surface	613276.667	6390622.782	491.657
Beet Lake area 1	2022-09-16	6	6	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	611774.264	6391468.983	496.635
Beet Lake area 1	2022-09-16	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	611774.264	6391468.983	496.635
Beet Lake area 1	2022-09-16	25	25	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	611774.264	6391468.983	496.635
Beet Lake area 1	2022-09-16	25	25	M	Thallium	< 0.0020	µg/L	Below Thermocline	611774.264	6391468.983	496.635
Broach Lake area 2	2022-09-15	6	6	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	598293.946	6397877.088	518.428
Broach Lake area 2	2022-09-15	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	598293.946	6397877.088	518.428
Broach Lake area 2	2022-09-15	30	30	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	598293.946	6397877.088	518.428
Broach Lake area 2	2022-09-15	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	598293.946	6397877.088	518.428
Clearwater River area 1	2022-09-16	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	616455.106	6390525.633	498.802
Clearwater River area 1	2022-09-16	0	0	M	Thallium	< 0.0020	µg/L	Surface	616455.106	6390525.633	498.802
Forrest Lake area 1	2022-09-18	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	605663.36	6390520.109	494.208
Forrest Lake area 1	2022-09-18	0	0	M	Thallium	< 0.0020	µg/L	Surface	605663.36	6390520.109	494.208

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Forrest Lake area 2	2022-09-18	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	605808.098	6387523.651	494.757
Forrest Lake area 2	2022-09-18	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605808.098	6387523.651	494.757
Hodge Lake area 1	2022-09-15	6	6	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	595282.733	6407957.26	521.234
Hodge Lake area 1	2022-09-15	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	595282.733	6407957.26	521.234
Hodge Lake area 1	2022-09-15	25	25	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	595282.733	6407957.26	521.234
Hodge Lake area 1	2022-09-15	25	25	M	Thallium	< 0.0020	µg/L	Below Thermocline	595282.733	6407957.26	521.234
Jed Creek	2022-09-17	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607825.041	6396403.554	490.697
Jed Creek	2022-09-17	0	0	M	Thallium	< 0.0020	µg/L	Surface	607825.041	6396403.554	490.697
Lake G area 1	2022-09-17	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607270.399	6393858.064	493.179
Lake G area 1	2022-09-17	0	0	M	Thallium	< 0.0020	µg/L	Surface	607270.399	6393858.064	493.179
Lake H area 1	2022-09-17	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	608529.659	6394929.325	491.983
Lake H area 1	2022-09-17	0	0	M	Thallium	< 0.0020	µg/L	Surface	608529.659	6394929.325	491.983
Lloyd Lake Inlet	2022-09-14	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	625178.406	6360328.931	462.524
Lloyd Lake Inlet	2022-09-14	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625178.406	6360328.931	462.524
Lloyd Lake Outlet	2022-09-14	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Mid Depth	634274.081	6356771.931	465.026
Lloyd Lake Outlet	2022-09-14	0	0	M	Thallium	< 0.0020	µg/L	Mid Depth	634274.081	6356771.931	465.026
Naomi Lake	2022-09-16	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	614064.522	6392180.518	492.06
Naomi Lake	2022-09-16	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	614064.522	6392180.518	492.06
Patterson Lake north arm east basin area 1	2022-09-17	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605542.804	6395579.757	490.278
Patterson Lake north arm east basin area 1	2022-09-17	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	605542.804	6395579.757	490.278
Patterson Lake north arm west basin area 1	2022-09-17	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	601403.347	6393700.851	489.95
Patterson Lake north arm west basin area 1	2022-09-17	6	6	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	601403.347	6393700.851	489.95
Patterson Lake north arm west basin area 1	2022-09-17	22	22	M	Thallium	< 0.0020	µg/L	Below Thermocline	601403.347	6393700.851	489.95
Patterson Lake north arm west basin area 1	2022-09-17	22	22	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	601403.347	6393700.851	489.95
Patterson Lake north arm west basin area 3	2022-09-18	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602973.031	6394337.736	488.14
Patterson Lake north arm west basin area 3	2022-09-18	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	602973.031	6394337.736	488.14
Patterson Lake south arm area 1	2022-09-18	8	8	M	Thallium	< 0.0020	µg/L	Above Thermocline	602006.979	6389962.755	488.476
Patterson Lake south arm area 1	2022-09-18	8	8	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	602006.979	6389962.755	488.476
Patterson Lake south arm area 1	2022-09-18	31	31	M	Thallium	< 0.0020	µg/L	Below Thermocline	602006.979	6389962.755	488.476
Patterson Lake south arm area 1	2022-09-18	31	31	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	602006.979	6389962.755	488.476
Warner Rapids	2022-09-19	0	0	M	Thallium	< 0.0020	µg/L	Surface	623063.364	6307903.193	426.727
Warner Rapids	2022-09-19	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	623063.364	6307903.193	426.727
Beet Creek	2022-06-09	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	613275.531	6390622.279	497.814
Beet Creek	2022-06-09	0	0	M	Thallium	< 0.0020	µg/L	Surface	613275.531	6390622.279	497.814
Beet Lake area 1	2022-06-08	2	2	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	611773.551	6391468.269	500.837
Beet Lake area 1	2022-06-08	2	2	M	Thallium	< 0.0020	µg/L	Above Thermocline	611773.551	6391468.269	500.837
Beet Lake area 1	2022-06-08	17	17	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	611773.551	6391468.269	500.837
Beet Lake area 1	2022-06-08	17	17	M	Thallium	< 0.0020	µg/L	Below Thermocline	611773.551	6391468.269	500.837
Broach Lake area 2	2022-06-06	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	598292.908	6397869.906	528.6
Broach Lake area 2	2022-06-06	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	598292.908	6397869.906	528.6
Clearwater River area 1	2022-06-07	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	616450.271	6390520.902	486.166
Clearwater River area 1	2022-06-07	0	0	M	Thallium	< 0.0020	µg/L	Surface	616450.271	6390520.902	486.166
Forrest Lake area 1	2022-06-08	0	0	M	Thallium	< 0.0020	µg/L	Mid Depth	605664.684	6390516.775	502.28
Forrest Lake area 1	2022-06-08	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Mid Depth	605664.684	6390516.775	502.28
Forrest Lake area 2	2022-06-09	1	1	M	Thallium	< 0.0020	µg/L	Above Thermocline	605804.614	6387521.416	499.748
Forrest Lake area 2	2022-06-09	1	1	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	605804.614	6387521.416	499.748
Forrest Lake area 2	2022-06-09	13	13	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	605804.614	6387521.416	499.748
Forrest Lake area 2	2022-06-09	13	13	M	Thallium	< 0.0020	µg/L	Below Thermocline	605804.614	6387521.416	499.748
Hodge Lake area 1	2022-06-06	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	595275.813	6407959.74	524.773
Hodge Lake area 1	2022-06-06	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	595275.813	6407959.74	524.773
Jed Creek	2022-06-08	0	0	M	Thallium	< 0.0020	µg/L	Surface	607822.671	6396404.577	500.483

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Jed Creek	2022-06-08	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607822.671	6396404.577	500.483
Lake G area 1	2022-06-08	0	0	M	Thallium	< 0.0020	µg/L	Surface	607659.79	6393993.582	510.163
Lake G area 1	2022-06-08	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607659.79	6393993.582	510.163
Lake H area 1	2022-06-08	0	0	M	Thallium	0.0028	µg/L	Surface	608528.218	6394926.809	504.261
Lake H area 1	2022-06-08	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	608528.218	6394926.809	504.261
Lloyd Lake Inlet	2022-06-05	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	625180.746	6360325.079	479.642
Lloyd Lake Inlet	2022-06-05	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625180.746	6360325.079	479.642
Lloyd Lake Outlet	2022-06-05	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	634274.409	6356747.187	481.704
Lloyd Lake Outlet	2022-06-05	0	0	M	Thallium	< 0.0020	µg/L	Surface	634274.409	6356747.187	481.704
Naomi Lake	2022-06-07	1	1	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	614069.343	6392178.401	494.198
Naomi Lake	2022-06-07	1	1	M	Thallium	< 0.0020	µg/L	Above Thermocline	614069.343	6392178.401	494.198
Naomi Lake	2022-06-07	4	4	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	614069.343	6392178.401	494.198
Naomi Lake	2022-06-07	4	4	M	Thallium	0.0042	µg/L	Below Thermocline	614069.343	6392178.401	494.198
Patterson Lake north arm east basin area 1	2022-06-08	3	3	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	605546.652	6395582.503	497.178
Patterson Lake north arm east basin area 1	2022-06-08	3	3	M	Thallium	< 0.0020	µg/L	Above Thermocline	605546.652	6395582.503	497.178
Patterson Lake north arm east basin area 1	2022-06-08	14	14	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	605546.652	6395582.503	497.178
Patterson Lake north arm east basin area 1	2022-06-08	14	14	M	Thallium	< 0.0020	µg/L	Below Thermocline	605546.652	6395582.503	497.178
Patterson Lake north arm west basin area 1	2022-06-08	2	2	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	601402.961	6393703.597	492.506
Patterson Lake north arm west basin area 1	2022-06-08	2	2	M	Thallium	< 0.0020	µg/L	Above Thermocline	601402.961	6393703.597	492.506
Patterson Lake north arm west basin area 1	2022-06-08	18	18	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	601402.961	6393703.597	492.506
Patterson Lake north arm west basin area 1	2022-06-08	18	18	M	Thallium	< 0.0020	µg/L	Below Thermocline	601402.961	6393703.597	492.506
Patterson Lake north arm west basin area 3	2022-06-07	3	3	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	602971.437	6394338.67	478.808
Patterson Lake north arm west basin area 3	2022-06-07	3	3	M	Thallium	< 0.0020	µg/L	Above Thermocline	602971.437	6394338.67	478.808
Patterson Lake north arm west basin area 3	2022-06-07	10	10	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	602971.437	6394338.67	478.808
Patterson Lake north arm west basin area 3	2022-06-07	10	10	M	Thallium	< 0.0020	µg/L	Below Thermocline	602971.437	6394338.67	478.808
Patterson Lake south arm area 1	2022-06-08	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	602001.648	6389965.043	496.561
Patterson Lake south arm area 1	2022-06-08	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602001.648	6389965.043	496.561
Warner Rapids	2022-06-10	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface			
Warner Rapids	2022-06-10	0	0	M	Thallium	< 0.0020	µg/L	Surface			
Beet Creek	2022-07-25	0	0	M	Thallium	< 0.0020	µg/L	Surface	613279.71	6390618.6	495.882
Beet Creek	2022-07-25	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	613279.71	6390618.6	495.882
Beet Lake area 1	2022-07-25	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	611778.262	6391464.749	498.736
Beet Lake area 1	2022-07-25	5	5	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	611778.262	6391464.749	498.736
Beet Lake area 1	2022-07-25	22	22	M	Thallium	< 0.0020	µg/L	Below Thermocline	611778.262	6391464.749	498.736
Beet Lake area 1	2022-07-25	22	22	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	611778.262	6391464.749	498.736
Broach Lake area 2	2022-07-22	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	598304.189	6397884.799	519.555
Broach Lake area 2	2022-07-22	5	5	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	598304.189	6397884.799	519.555
Broach Lake area 2	2022-07-22	48	48	M	Thallium	< 0.0020	µg/L	Below Thermocline	598304.189	6397884.799	519.555
Broach Lake area 2	2022-07-22	48	48	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	598304.189	6397884.799	519.555
Clearwater River area 1	2022-07-25	0	0	M	Thallium	< 0.0020	µg/L	Surface	614074.28	6392177.6	496.523
Clearwater River area 1	2022-07-25	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	614074.28	6392177.6	496.523
Forrest Lake area 1	2022-07-23	0	0	M	Thallium	< 0.0020	µg/L	Mid Depth	605662.42	6390512.9	491.65
Forrest Lake area 1	2022-07-23	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Mid Depth	605662.42	6390512.9	491.65
Forrest Lake area 2	2022-07-23	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	605799.194	6387521.302	502.036
Forrest Lake area 2	2022-07-23	4	4	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	605799.194	6387521.302	502.036
Forrest Lake area 2	2022-07-23	18	18	M	Thallium	< 0.0020	µg/L	Below Thermocline	605799.194	6387521.302	502.036
Forrest Lake area 2	2022-07-23	18	18	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	605799.194	6387521.302	502.036
Hodge Lake area 1	2022-07-23	3	3	M	Thallium	< 0.0020	µg/L	Above Thermocline	595277.047	6407956.345	537.266
Hodge Lake area 1	2022-07-23	3	3	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	595277.047	6407956.345	537.266
Hodge Lake area 1	2022-07-23	25	25	M	Thallium	< 0.0020	µg/L	Below Thermocline	595277.047	6407956.345	537.266
Hodge Lake area 1	2022-07-23	25	25	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	595277.047	6407956.345	537.266

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Jed Creek	2022-07-24	0	0	M	Thallium	< 0.0020	µg/L	Surface	607827.27	6396404.8	501.773
Jed Creek	2022-07-24	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607827.27	6396404.8	501.773
Lake G area 1	2022-07-24	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607659.92	6393993.8	525.786
Lake G area 1	2022-07-24	0	0	M	Thallium	< 0.0020	µg/L	Surface	607659.92	6393993.8	525.786
Lake H area 1	2022-07-24	0	0	M	Thallium	< 0.0020	µg/L	Surface	608530.03	6394926.8	508.713
Lake H area 1	2022-07-24	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	608530.03	6394926.8	508.713
Lloyd Lake Inlet	2022-07-21	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625176.4	6360313.7	537.176
Lloyd Lake Inlet	2022-07-21	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	625176.4	6360313.7	537.176
Lloyd Lake Outlet	2022-07-21	0	0	M	Thallium	< 0.0020	µg/L	Surface	634270.98	6356761.7	471.197
Lloyd Lake Outlet	2022-07-21	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	634270.98	6356761.7	471.197
Naomi Lake	2022-07-25	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	614074.28	6392177.6	496.523
Naomi Lake	2022-07-25	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	614074.28	6392177.6	496.523
Patterson Lake north arm east basin area 1	2022-07-24	4	4	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	605557.443	6395597.069	499.14
Patterson Lake north arm east basin area 1	2022-07-24	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	605557.443	6395597.069	499.14
Patterson Lake north arm east basin area 1	2022-07-24	16	16	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	605557.443	6395597.069	499.14
Patterson Lake north arm east basin area 1	2022-07-24	16	16	M	Thallium	< 0.0020	µg/L	Below Thermocline	605557.443	6395597.069	499.14
Patterson Lake north arm west basin area 1	2022-07-24	5	5	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	601408.825	6393708.451	493.881
Patterson Lake north arm west basin area 1	2022-07-24	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	601408.825	6393708.451	493.881
Patterson Lake north arm west basin area 1	2022-07-24	21	21	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	601408.825	6393708.451	493.881
Patterson Lake north arm west basin area 1	2022-07-24	21	21	M	Thallium	< 0.0020	µg/L	Below Thermocline	601408.825	6393708.451	493.881
Patterson Lake north arm west basin area 3	2022-07-26	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Top+Middle+Bottom	602978.105	6394337.643	494.819
Patterson Lake north arm west basin area 3	2022-07-26	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602978.105	6394337.643	494.819
Patterson Lake south arm area 1	2022-07-25	5	5	M	Thallium, dissolved	< 0.0020	µg/L	Above Thermocline	602004.817	6389965.597	495.091
Patterson Lake south arm area 1	2022-07-25	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	602004.817	6389965.597	495.091
Patterson Lake south arm area 1	2022-07-25	30	30	M	Thallium, dissolved	< 0.0020	µg/L	Below Thermocline	602004.817	6389965.597	495.091
Patterson Lake south arm area 1	2022-07-25	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	602004.817	6389965.597	495.091
Warner Rapids	2022-07-27	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface			
Warner Rapids	2022-07-27	0	0	M	Thallium	< 0.0020	µg/L	Surface			
Beet Creek	2022-02-27	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Surface	613256.92	6390753.753	509.819
Beet Creek	2022-02-27	0	0	M	Thallium	< 0.0000010	mg/L	Surface	613256.92	6390753.753	509.819
Beet Lake area 1	2022-02-27	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	611771.691	6391466.435	502.725
Beet Lake area 1	2022-02-27	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	611771.691	6391466.435	502.725
Broach Lake area 2	2022-02-25	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	598294.655	6397871.619	527.234
Broach Lake area 2	2022-02-25	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	598294.655	6397871.619	527.234
Clearwater River area 1	2022-02-27	0	0	M	Thallium	0.0000011	mg/L	Surface	615132.801	6390834.422	493.403
Clearwater River area 1	2022-02-27	0	0	M	Thallium, dissolved	0.0000010	mg/L	Surface	615132.801	6390834.422	493.403
Forrest Lake area 1	2022-02-26	0	0	M	Thallium	< 0.0000010	mg/L	Mid Depth	605671.03	6390518.5	496.23
Forrest Lake area 1	2022-02-26	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Mid Depth	605671.03	6390518.5	496.23
Forrest Lake area 2	2022-02-28	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	605808.878	6387516.07	491.872
Forrest Lake area 2	2022-02-28	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	605808.878	6387516.07	491.872
Hodge Lake area 1	2022-02-25	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	595275.396	6407957.28	521.944
Hodge Lake area 1	2022-02-25	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	595275.396	6407957.28	521.944
Jed Creek	2022-02-26	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Surface	607847.608	6396408.696	487.164
Jed Creek	2022-02-26	0	0	M	Thallium	< 0.0000010	mg/L	Surface	607847.608	6396408.696	487.164
Lake G area 2	2022-02-26	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Mid Depth	607351.577	6393303.726	444.109
Lake G area 2	2022-02-26	0	0	M	Thallium	< 0.0000010	mg/L	Mid Depth	607351.577	6393303.726	444.109
Lake H area 2	2022-02-26	0	0	M	Thallium, dissolved	0.0000015	mg/L	Top+Middle+Bottom	609834.476	6395026.036	492.32
Lake H area 2	2022-02-26	0	0	M	Thallium	0.0000014	mg/L	Top+Middle+Bottom	609834.476	6395026.036	492.32
Lloyd Lake Inlet	2022-02-24	0	0	M	Thallium	0.0000011	mg/L	Top+Middle+Bottom	625181.485	6360322.54	473.394
Lloyd Lake Inlet	2022-02-24	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	625181.485	6360322.54	473.394
Naomi Lake	2022-02-27	0	0	M	Thallium, dissolved	0.0000010	mg/L	Top+Middle+Bottom	614067.601	6392176.681	492.259

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Naomi Lake	2022-02-27	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	614067.601	6392176.681	492.259
Patterson Lake north arm east basin area 1	2022-03-01	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	605548.623	6395580.105	495.115
Patterson Lake north arm east basin area 1	2022-03-01	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	605548.623	6395580.105	495.115
Patterson Lake north arm west basin area 1	2022-03-01	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	601407.885	6393702.384	487.028
Patterson Lake north arm west basin area 1	2022-03-01	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	601407.885	6393702.384	487.028
Patterson Lake north arm west basin area 3	2022-03-01	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	602967.59	6394337.458	493.716
Patterson Lake north arm west basin area 3	2022-03-01	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	602967.59	6394337.458	493.716
Patterson Lake south arm area 1	2022-02-28	0	0	M	Thallium	< 0.0000010	mg/L	Top+Middle+Bottom	602010.435	6389969.497	499.026
Patterson Lake south arm area 1	2022-02-28	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Top+Middle+Bottom	602010.435	6389969.497	499.026
Warner Rapids	2022-03-02	0	0	M	Thallium	< 0.0000010	mg/L	Surface	623077	6307920	
Warner Rapids	2022-03-02	0	0	M	Thallium, dissolved	< 0.0000010	mg/L	Surface	623077	6307920	
Beet Creek	2023-09-17	0	0	M	Thallium	< 0.0020	µg/L	Surface	613286.969	6390728.444	490.8
Beet Lake area 1	2023-09-17	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	611772.555	6391468.156	495.346
Beet Lake area 1	2023-09-17	25	25	M	Thallium	< 0.0000020	mg/L	Below Thermocline	611772.555	6391468.156	495.346
Broach Lake area 2	2023-09-16	9	9	M	Thallium	< 0.0000020	mg/L	Above Thermocline	598293.353	6397869.611	523.6
Broach Lake area 2	2023-09-16	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	598293.353	6397869.611	523.6
Clearwater River area 1	2023-09-17	0	0	M	Thallium	< 0.0020	µg/L	Surface	616453.594	6390528.374	500.96
Forrest Lake area 1	2023-09-19	0	0	M	Thallium	< 0.0020	µg/L	Surface	605670.48	6390519.627	488.857
Forrest Lake area 2	2023-09-19	8	8	M	Thallium	< 0.0020	µg/L	Above Thermocline	605805.818	6387512.565	498.134
Forrest Lake area 2	2023-09-19	19	19	M	Thallium	< 0.0020	µg/L	Below Thermocline	605805.818	6387512.565	498.134
Hodge Lake area 1	2023-09-15	6	6	M	Thallium	< 0.0000020	mg/L	Above Thermocline	595275.888	6407960.105	528.442
Hodge Lake area 1	2023-09-15	22	22	M	Thallium	< 0.0020	µg/L	Below Thermocline	595275.888	6407960.105	528.442
Jed Creek	2023-09-18	0	0	M	Thallium	< 0.0000020	mg/L	Surface	607826.34	6396404.034	496.101
Lake G area 1	2023-09-18	0	0	M	Thallium	< 0.0020	µg/L	Surface	607663.606	6393996.607	498.502
Lake H area 1	2023-09-18	0	0	M	Thallium	< 0.0020	µg/L	Surface	608533.42	6394935.886	500.129
Lloyd Lake Inlet	2023-09-13	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625179.712	6360323.624	463.829
Lloyd Lake Outlet	2023-09-13	0	0	M	Thallium	< 0.0020	µg/L	Surface	634265.725	6356754.835	469.518
Naomi Lake	2023-09-17	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	614067.25	6392176.919	498.373
NexGen site runoff area 1	2023-09-12	0	0	M	Thallium	0.0078	µg/L	Surface	604623.739	6393955.994	513.711
NexGen site runoff area 2	2023-09-12	0	0	M	Thallium	0.0103	µg/L	Surface	604575.812	6394044.08	509.724
NexGen site runoff area 3	2023-09-12	0	0	M	Thallium	0.0037	µg/L	Surface	604480.377	6394072.687	508.541
Patterson Lake north arm east basin area 1	2023-09-18	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605545.065	6395582.266	488.332
Patterson Lake north arm west basin area 1	2023-09-18	22	22	M	Thallium	< 0.0000020	mg/L	Below Thermocline	601406.287	6393702.595	486.733
Patterson Lake north arm west basin area 1	2023-09-18	7	7	M	Thallium	< 0.0000020	mg/L	Above Thermocline	601406.287	6393702.595	486.733
Patterson Lake north arm west basin area 3	2023-09-19	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602967.585	6394336.038	486.544
Patterson Lake south arm area 1	2023-09-16	10	10	M	Thallium	< 0.0020	µg/L	Above Thermocline	602011.54	6389968.996	498.471
Patterson Lake south arm area 1	2023-09-16	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	602011.54	6389968.996	498.471
Warner Rapids	2023-09-11	0	0	M	Thallium	< 0.0020	µg/L	Surface	623073.89	6307912.08	408.103
Beet Creek	2023-06-09	0	0	M	Thallium	< 0.0020	µg/L	Surface	613259.894	6390746.176	494.283
Beet Lake area 1	2023-06-09	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	611771.718	6391466.017	498.539
Beet Lake area 1	2023-06-09	20	20	M	Thallium	< 0.0020	µg/L	Below Thermocline	611771.718	6391466.017	498.539
Broach Lake area 2	2023-06-07	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	598294.601	6397869.753	521.491
Broach Lake area 2	2023-06-07	15	15	M	Thallium	< 0.0020	µg/L	Below Thermocline	598294.601	6397869.753	521.491
Clearwater River area 1	2023-06-09	0	0	M	Thallium	< 0.0020	µg/L	Surface	616449.655	6390528.261	497.312
Forrest Lake area 1	2023-06-10	0	0	M	Thallium	< 0.0020	µg/L	Surface	605671.185	6390517.752	495.217
Forrest Lake area 2	2023-06-10	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	605807.628	6387514.172	496.663
Forrest Lake area 2	2023-06-10	20	20	M	Thallium	< 0.0020	µg/L	Below Thermocline	605807.628	6387514.172	496.663
Hodge Lake area 1	2023-06-08	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	595279.755	6407959.973	527.34
Hodge Lake area 1	2023-06-08	20	20	M	Thallium	< 0.0020	µg/L	Below Thermocline	595279.755	6407959.973	527.34
Jed Creek	2023-06-11	0	0	M	Thallium	< 0.0020	µg/L	Surface	607825.637	6396405.797	498.926
Lake G area 1	2023-06-11	0	0	M	Thallium	< 0.0020	µg/L	Surface	607661.885	6393993.999	497.775

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Lake H area 1	2023-06-11	0	0	M	Thallium	< 0.0020	µg/L	Surface	608531.272	6394927.029	497.606
Lloyd Lake Inlet	2023-06-07	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625183.168	6360320.834	475.106
Lloyd Lake Outlet	2023-06-07	0	0	M	Thallium	< 0.0020	µg/L	Surface	634274.732	6356746.552	469.499
Naomi Lake	2023-06-09	1	1	M	Thallium	< 0.0020	µg/L	Above Thermocline	614069.976	6392177.664	493.348
Naomi Lake	2023-06-09	4	4	M	Thallium	< 0.0020	µg/L	Below Thermocline	614069.976	6392177.664	493.348
NexGen site runoff area 1	2023-06-15	0	0	M	Thallium	0.0067	µg/L	Surface			
NexGen site runoff area 2	2023-06-15	0	0	M	Thallium	0.0051	µg/L	Surface			
NexGen site runoff area 3	2023-06-15	0	0	M	Thallium	0.0112	µg/L	Surface			
Patterson Lake north arm east basin area 1	2023-06-11	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	605548.578	6395580.242	495.058
Patterson Lake north arm east basin area 1	2023-06-11	16	16	M	Thallium	< 0.0020	µg/L	Below Thermocline	605548.578	6395580.242	495.058
Patterson Lake north arm west basin area 1	2023-06-10	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	601409.229	6393701.889	498.553
Patterson Lake north arm west basin area 1	2023-06-10	20	20	M	Thallium	< 0.0020	µg/L	Below Thermocline	601409.229	6393701.889	498.553
Patterson Lake north arm west basin area 3	2023-06-12	4	4	M	Thallium	< 0.0020	µg/L	Above Thermocline	602966.719	6394337.241	504.31
Patterson Lake north arm west basin area 3	2023-06-12	10	10	M	Thallium	< 0.0020	µg/L	Below Thermocline	602966.719	6394337.241	504.31
Patterson Lake south arm area 1	2023-06-11	5	5	M	Thallium	< 0.0020	µg/L	Above Thermocline	602010.867	6389969.647	514.956
Patterson Lake south arm area 1	2023-06-11	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	602010.867	6389969.647	514.956
Warner Rapids	2023-06-13	0	0	M	Thallium	< 0.0020	µg/L	Surface	623069.997	6307909.738	398.774
Beet Creek	2023-07-29	0	0	M	Thallium	< 0.0000020	mg/L	Surface	613256.605	6390746.307	
Beet Lake area 1	2023-07-29	4	4	M	Thallium	< 0.0000020	mg/L	Above Thermocline	611773.373	6391466.619	
Beet Lake area 1	2023-07-29	23	23	M	Thallium	< 0.0000020	mg/L	Below Thermocline	611773.373	6391466.619	
Clearwater River area 1	2023-07-29	0	0	M	Thallium	< 0.0020	µg/L	Surface	616452.601	6390523.444	
Forrest Lake area 1	2023-07-31	0	0	M	Thallium	< 0.0000020	mg/L	Surface	605670.461	6390518.067	
Forrest Lake area 2	2023-07-31	4	4	M	Thallium	< 0.0000020	mg/L	Above Thermocline	605811.358	6387517.833	
Forrest Lake area 2	2023-07-31	20	20	M	Thallium	< 0.0000020	mg/L	Below Thermocline	605811.358	6387517.833	
Jed Creek	2023-07-30	0	0	M	Thallium	< 0.0000020	mg/L	Surface	607826.203	6396404.699	
Lake G area 1	2023-07-30	0	0	M	Thallium	< 0.0020	µg/L	Surface	607659.735	6393996.281	
Lake G area 1	2023-07-30	0	0	M	Thallium, dissolved	< 0.0020	µg/L	Surface	607659.735	6393996.281	
Lake H area 1	2023-07-30	0	0	M	Thallium	0.0030	µg/L	Surface	608531.546	6394932.383	
Lloyd Lake Inlet	2023-07-28	0	0	M	Thallium	< 0.0000020	mg/L	Top+Middle+Bottom	625180.672	6360321.76	
Lloyd Lake Outlet	2023-07-28	0	0	M	Thallium	< 0.0000020	mg/L	Surface	634273.395	6356748.736	
Naomi Lake	2023-07-29	0	0	M	Thallium	< 0.0000020	mg/L	Top+Middle+Bottom	614067.969	6392176.828	
NexGen site runoff area 1	2023-07-27	0	0	M	Thallium	0.0070	µg/L				
NexGen site runoff area 2	2023-07-27	0	0	M	Thallium	0.0091	µg/L				
NexGen site runoff area 3	2023-07-27	0	0	M	Thallium	0.0070	µg/L				
Patterson Lake north arm east basin area 1	2023-07-30	4	4	M	Thallium	< 0.0000020	mg/L	Above Thermocline	605549.252	6395581.819	
Patterson Lake north arm east basin area 1	2023-07-30	16	16	M	Thallium	< 0.0000020	mg/L	Below Thermocline	605549.252	6395581.819	
Patterson Lake north arm west basin area 1	2023-08-01	6	6	M	Thallium	< 0.0000020	mg/L	Above Thermocline	601404.921	6393702.338	
Patterson Lake north arm west basin area 1	2023-08-01	22	22	M	Thallium	< 0.0000020	mg/L	Below Thermocline	601404.921	6393702.338	
Patterson Lake north arm west basin area 3	2023-08-01	0	0	M	Thallium	< 0.0000020	mg/L	Top+Middle+Bottom	602967.642	6394338.49	
Patterson Lake south arm area 1	2023-07-31	5	5	M	Thallium	< 0.0000020	mg/L	Above Thermocline	602011.521	6389969.775	
Patterson Lake south arm area 1	2023-07-31	30	30	M	Thallium	< 0.0020	µg/L	Below Thermocline	602011.521	6389969.775	
Warner Rapids	2023-07-26	0	0	M	Thallium	< 0.0020	µg/L	Surface	623069.141	6307909.824	
Beet Creek	2023-03-31	0	0	M	Thallium	< 0.0020	µg/L	Surface	613255.008	6390750.05	495.469
Beet Lake area 1	2023-03-31	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	611775.717	6391472.588	492.644
Clearwater River area 1	2023-03-31	0	0	M	Thallium	< 0.0020	µg/L	Surface	615133.421	6390834.131	493.993
Forrest Lake area 1	2023-04-01	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605672.685	6390515.229	484.776
Forrest Lake area 2	2023-04-01	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605804.229	6387520.766	500.379
Jed Creek	2023-03-30	0	0	M	Thallium	< 0.0020	µg/L	Surface	607830.641	6396408.27	494.042
Lake G area 2	2023-03-30	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	607349.265	6393306.031	494.461
Lake H area 2	2023-03-30	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	609833.183	6395025.916	497.065
Lloyd Lake Inlet	2023-03-23	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	625183.795	6360321.967	461.339

SUBFACILITY_NAME	SAMPLE_DATE	START_DEPTH	END_DEPTH	DEPTH_UNIT	CHEMICAL_NAME	REPORT_RESULT_TEXT	REPORT_RESULT_UNIT	METHOD_DESC	x_coord	y_coord	z_coord
Naomi Lake	2023-03-31	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	614069.241	6392174.079	497.885
Patterson Lake north arm east basin area 1	2023-03-30	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	605562.239	6395575.587	490.397
Patterson Lake north arm west basin area 1	2023-04-01	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	601408.252	6393702.756	487.976
Patterson Lake north arm west basin area 3	2023-04-02	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602969.275	6394339.98	491.905
Patterson Lake south arm area 1	2023-04-01	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602008.73	6389971.487	497.178
Warner Rapids	2023-04-03	0	0	M	Thallium	< 0.0020	µg/L	Surface			
Harrison Lake	2023-09-22	0	0	M	Thallium	< 0.0020	µg/L	Surface	591361.348	6411911.253	528.161
Harrison Lake area 1 shallow	2023-09-22	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	592259.755	6411993.931	526.249
Harrison Lake area 2 deep	2023-09-23	12	12	M	Thallium	< 0.0020	µg/L	Above Thermocline	591895.981	6411219.472	525.175
Harrison Lake area 2 deep	2023-09-23	24	24	M	Thallium	< 0.0020	µg/L	Below Thermocline	591895.981	6411219.472	525.175
Murison Lake	2023-10-02	0	0	M	Thallium	< 0.0020	µg/L	Surface	594268.67	6412767.949	557.873
Murison Lake area 1 shallow	2023-10-02	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	595948.865	6413654.299	526.498
Murison Lake area 2 deep	2023-10-01	10	10	M	Thallium	< 0.0020	µg/L	Above Thermocline	595452.494	6414631.251	533.15
Murison Lake area 2 deep	2023-10-01	24	24	M	Thallium	< 0.0020	µg/L	Below Thermocline	595452.494	6414631.251	533.15
Patterson Lake	2023-09-18	0	0	M	Thallium	< 0.0020	µg/L	Surface	602530.306	6393096.317	492.263
Patterson Lake deep	2023-09-19	6	6	M	Thallium	< 0.0020	µg/L	Above Thermocline	602640.806	6394322.046	496.214
Patterson Lake deep	2023-09-19	22	22	M	Thallium	< 0.0020	µg/L	Above Thermocline	602640.806	6394322.046	496.214
Patterson Lake shallow	2023-09-20	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	602757.929	6393490.914	484.881
Preston Lake	2023-09-23	0	0	M	Thallium	< 0.0020	µg/L	Surface	609328.904	6364040.785	470.334
Preston Lake area 1 shallow	2023-09-28	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	609384.801	6363468.681	498.783
Preston Lake area 2 deep	2023-09-28	0	0	M	Thallium	< 0.0020	µg/L	Top+Middle+Bottom	613515.599	6365084.824	466.995

IR 81

No.	Justification/Rationale	Follow up Information Request	NexGen Response
81	**Justification:** The Proponent confirms that if a constituent of potential concern (COPC) exceeds screening criterion in one medium, it should be assessed for all media that are likely to contribute to exposure points (CSA N288.6-22, Section 7.2.5.4.2 [CSA Group 2022]). The Proponent also confirms that if there's exceedances for iron FEQG (Federal Environmental Quality Guideline), it would be required to be added as a COPCs and further assessed in the sediment quality modelling and the Environmental Risk Assessment. The Proponent has provided the rationale for using the Federal Environmental Quality Guideline (FEQG) over the CCME Guidelines for iron but has used the outdated formula to calculate the iron FEQG. The iron FEQG may not simply be represented by a single equation. This is because the toxicity endpoints included in the Species Sensitivity Distribution (SSD) were adjusted (or normalized) for water chemistry using three different normalization equations depending on the taxa of the endpoint. The iron calculator can be found in the Annex of the iron FEQG website to assist with this calculation. The Proponent has preferred the FEQG but has not updated the selected screening value for iron in Table 4-1 and 4-2 (Draft EIS Section XXI [Environmental Risk Assessment], Section 4.2.3.2). **Rationale:** Assessment on water quality thresholds cannot be determined until iron FEQG calculations are corrected.	**Information Request:** In order to resolve this IR, NexGen is required to recalculate iron FEQG based on the latest guidance from FEQG to determine if there would be baseline exceedances. If baseline exceedances occur, iron should be included in the exposure assessment portion of the ERA and the sediment quality modelling for the sediment quality assessment and tables should be updated accordingly.	As requested for both IR 81-R1 and IR 254-R1, NexGen has completed an iron exposure assessment, which will be incorporated as a new Appendix D to the EIS Technical Support Document XXI (Environmental Risk Assessment). A copy of Appendix D has been provided to address IR 81-R1 and IR 254-R1. In the new iron exposure assessment (i.e., Appendix D), NexGen used recalculated iron Federal Environmental Quality Guideline (FEQG) values, which are now adjusted for water chemistry based on the latest FEQG guidelines using the online calculator referenced in the reviewer's follow-up comment. Water and sediment modelling have been updated accordingly in the assessment. Based on this modelling, the assessment confirmed that there are no exceedances when comparing the predicted maximum iron concentrations to their available quality guidelines in different environmental media, and therefore there are no anticipated risks to ecological and human health with regards to iron inputs from the Project.

APPENDIX D IRON EXPOSURE ASSESSMENT

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25 October 2024

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APPENDIX D IRON EXPOSURE ASSESSMENT

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1.0 Introduction

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan, called the Rook I Project (Project). The proposed Project is subject to both provincial and federal Environmental Assessment (EA) processes, would be licensed as a nuclear facility by the Canadian Nuclear Safety Commission (CNSC), and would be subject to various provincial and federal permits and approvals.

In support of the EA for the Project, NexGen prepared an Environmental Impact Statement (EIS), which included baseline studies and development of an Environmental Risk Assessment (ERA) (EIS TSD XXI). Baseline studies conducted for water and sediment included sampling for concentrations of iron, which were then further considered within EIS TSD XXI.

Iron is the fourth most common of elements in the Earth's continental crust. It is an essential element for living organisms and is well regulated in the body. It is not considered to be a toxicant of concern, except to aquatic biota in specific circumstances (ECCC 2024). It is well understood that iron exerts its toxicological effects on aquatic biota through precipitation when receiving water pH is higher than the pH in a discharge. Such precipitation on the gills or on fish eggs can cause respiratory stress or smothering (Brix et al. 2023; ECCC 2024). While iron can affect aquatic biota, there is no risk associated with the quality of the food source and potential accumulation of iron in biological tissues (ECCC 2024).

From baseline studies conducted for the Project, iron concentrations were identified as exceeding water quality guidelines in baseline surface water quality throughout the local study area (LSA), with exceedances of the water quality guideline of 0.3 mg/L from the Canadian Council of Ministers of the Environment (CCME) in eight waterbodies and watercourses and in the reference lakes. As part of EIS TSD XXI, iron was evaluated as a constituent of potential concern (COPC) but was not carried forward (i.e., was screened out), as the predicted upper bound concentrations of iron released to Patterson Lake in treated effluent, sewage, and groundwater, as well as the predicted upper bound concentrations of iron at the boundary of the mixing zone were lower than the selected water quality guideline of 0.3 mg/L from the CCME. Thus, it was concluded that there would be no potential for Project releases to increase iron concentrations in the receiving environment above the CCME guideline. Iron concentrations in sediment were not screened against any sediment quality guidelines (SQGs) in EIS TSD XXI, because there are no federal or provincial guidelines for iron in sediment.

Since the completion of the screening originally conducted as part of the Project EA, an updated Federal Environmental Quality Guideline (FEQG) was published in May 2024 (ECCC 2024), which is more stringent than the previous CCME water quality guideline (Table 1-1). The scope of EIS TSD XXI Appendix D, Iron Exposure Assessment, is to provide the exposure assessment of iron consistent with requirements of CSA N288.6-22 Section 7.2.5.4.2 to determine the Project-related effects to sediment quality and aquatic biota and to support the assessment performed in the TSD XXI, using the new FEQG water quality guidelines.

Table 1-1: Measured Baseline Surface Water Iron Concentrations (mg/L) in the Local Study Area

Water body / Water course	# of Samples	% Above FEQG Water Quality Threshold for Aquatic Life	% Above CCME Water Quality Threshold for Drinking Water Quality	Min.	25th Percentile	Average[(a)]	95th Percentile	Max.
Broach Lake	19	0	0	0.0030	0.012	0.028	0.090	0.12
Lake H	11	27%	27%	0.056	0.087	**0.43**	**1.73**	**2.08**
Lake G	11	73%	73%	0.15	**0.31**	**0.69**	**2.08**	**2.44**
Patterson Lake North Arm – East Basin	19	10%	10%	0.0085	0.085	0.19	**0.59**	**0.79**
Patterson Lake North Arm – West Basin	19	5%	5%	0.0068	0.012	0.051	0.19	**0.47**
Patterson Lake South Arm	19	0	0	0.0012	0.013	0.016	0.025	0.031
Forrest Lake – North Basin	15	0	0	0.0016	0.029	0.043	0.089	0.11
Forrest Lake – South Basin	18	6%	0	0.00020	0.0059	0.024	0.062	**0.26**
Beet Lake	17	6%	6%	0.0039	0.020	0.11	**0.30**	**0.85**
Naomi Lake	12	100%	100%	**0.35**	**0.65**	**0.83**	**1.01**	**1.02**
Clearwater River below Beet Lake	11	0	0	0.0220	0.048	0.09	0.18	0.19
Reference Lake	33	3%	3%	0.0046	0.015	0.12	0.63	1.58

Notes: **Shaded grey and bold** indicates that the value is greater than both the minimum FEQG water quality guideline for protection of aquatic life of 0.23 mg/L calculated for baseline water samples (samples with pH 7.3 – 7.4 and dissolved organic carbon of 1.5 mg/L, see Table 5-1; ECCC, 2024) and the CCME water quality guideline for aquatic life and drinking water quality of 0.3 mg/L (CCREM, 1987; ECCC, 2019). **Shaded black, and bold white font** indicates that the value is greater than the minimum FEQG water quality guideline for protection of aquatic life of 0.23 mg/L but not greater than the CCME guideline.

a) Calculated using half detection limit for any non-detectable samples.

2.0 Development of Model Parameters for Iron

The details on the IMPACT modelling approach applied for the iron assessment are the same as those reported in the main body of EIS TSD XXI and the associated Appendix A of EIS TSD XXI. Section 2.1 and Section 2.2 of EIS TSD XXI Appendix D provide the iron-specific parameters used in the IMPACT model.

2.1 Baseline Water Quality and Sediment Quality

This subsection describes how the baseline water quality and sediment quality were set up in the IMPACT model. The local inflow to each waterbody represents the local watershed inputs to assessed waterbodies (excluding the upstream inflow). The calibrated local inflow values of iron were used in the model to predict stable concentrations in water and sediment within the range of observed values of baseline conditions.

A summary of the modelling assumptions and adjustments is included below:

- The waterbodies included in the calculation of a regional baseline concentration were Patterson Lake (i.e., North Arm – East Basin, North Arm – West Basin, and South Arm), all measurement stations along the Clearwater River, Lake H, Lake G, Forrest Lake, Beet Lake, Naomi Lake, Mirror River, and Lloyd Lake.
- The local inflow concentrations were calculated from the baseline concentrations (Table 1-1), the residence time within each respective waterbody, sedimentation rate, and water-to-sediment partitioning coefficient.
- Since sedimentation processes remove metals from the inflow, the local inflow concentrations for each waterbody were assigned values higher than the baseline concentrations.

Metals in water are expected to interact with sediment. Iron concentrations in sediment were modelled based on concentrations in water using the water-to-sediment partitioning coefficients (K_d). The K_d value for iron used in the IMPACT model is $4.97x10^{+05}$ L/kg (dw), which was calibrated using the measured water and sediment quality data from baseline studies completed from 2018 to 2020.

The measured geometric mean (geomean) and modelled-average baseline concentrations are in agreement (Table 2-1).

Table 2-1: Baseline Water and Sediment Concentrations of Iron Used in the IMPACT Model

Parameter	Water Baseline Concentration	Sediment Baseline Concentration
	mg/L	mg/kg dw
Measured Baseline (Geomean)	$7.25x10^{-2}$	$1.81x10^{4}$
Modelled Baseline	$7.25x10^{-2}$	$1.81x10^{4}$

2.2 Baseline Air Quality and Soil Quality

Risk through air exposure pathways is considered during Operations, because the highest predicted iron concentrations occur during this phase. For the baseline, it is assumed that none of the considered COPCs are present in air. Consequently, any risk increase through the air pathway is due to the operation of the mine. Regional background soil chemistry was derived from baseline data collected in 2019. Table 2-2 presents the selected air and soil baseline concentrations used in the IMPACT model.

Table 2-2: Baseline Air and Soil Concentrations of Iron Used in the IMPACT Model

Air Baseline Concentration	Soil Baseline Concentration
mg/m^3	mg/kg dw
0.0	$1.61x10^{3}$

3.0 Aqueous and Atmospheric Sources for Iron

Similar to other COPCs, the Project-related aqueous releases to Patterson Lake would include releases from the effluent treatment plant, sewage treatment plant, and groundwater as well as non-contact site runoff. The Project-related atmospheric releases considered in the ERA were consistent with the air emissions inventory detailed in the Air Dispersion Modelling Report for Project Construction and Operations (EIS Section 7.2.5, Residual Effects Analysis; EIS Appendix 7A, Air Dispersion Modelling Report).

More details regarding the source terms were reported in Section 4.2 and Section 4.3 of EIS TSD XXI.

4.0 Exposure Point Concentrations in Environmental Media

The estimated maximum iron concentrations in environmental media, including water, sediment, air, and soil, at different locations during Operations for the Application Case and the Upper Bound Scenario are shown in Table 4-1. These values represent the model baseline plus Project effects. The maximum iron concentration in water was predicted at Patterson Lake North Arm – West Basin, which is 0.0726 mg/L for both the Application Case and the Upper Bound Scenario. The predicted values are less than 0.1% above model baseline, indicating the Project has a minimal contribution to the total concentration.

The maximum iron concentration in sediment was predicted at Patterson Lake North Arm – East Basin, which is 1.81×10^{4} mg/kg dw for both the Application Case and the Upper Bound Scenario, again only marginally above the model baseline concentration of 1.81×10^{4} mg/kg dw, indicating the Project contribution to iron in sediment is minimal.

The maximum iron concentrations in air and soil were predicted at Patterson Lake North Arm – West Basin, which are 3.55×10^{-5} mg/m^3 and 1.62×10^{3} mg/kg dw, respectively, for both the Application Case and the Upper Bound Scenario. The model baseline for iron in air was assumed to be 0.0 mg/m^3, and the model baseline for soil was 1.62×10^{3} mg/kg dw.

Table 4-1: Estimated Maximum Iron Concentrations in Environmental Media for the Application Case and Upper Bound Scenario - Project Lifespan

Environmental Media	Location	Maximum Concentration during Project Lifespan	
		Application Case	Upper Bound Scenario
Water (mg/L)	Reference (Broach Lake)	7.25×10^{-2}	7.25×10^{-2}
	Clearwater River downstream of Broach Lake	7.25×10^{-2}	7.25×10^{-2}
	Patterson Lake North Arm – East Basin	7.26×10^{-2}	7.26×10^{-2}
	Patterson Lake North Arm – West Basin	**7.26×10^{-2}**	**7.26×10^{-2}**
	Patterson Lake South Arm	7.25×10^{-2}	7.25×10^{-2}
	Forrest Lake – North Basin	7.25×10^{-2}	7.25×10^{-2}
	Beet Lake	7.25×10^{-2}	7.25×10^{-2}
	Naomi Lake	7.25×10^{-2}	7.25×10^{-2}
	Clearwater River upstream Mirror River Confluence	7.25×10^{-2}	7.25×10^{-2}
	Clearwater River downstream Mirror River Confluence	7.25×10^{-2}	7.25×10^{-2}
	Lloyd Lake Inlet	7.25×10^{-2}	7.25×10^{-2}

Environmental Media	Location	Maximum Concentration during Project Lifespan	
		Application Case	Upper Bound Scenario
Sediment (mg/kg dw)	Reference (Broach Lake)	$1.81x10^4$	$1.81x10^4$
	Patterson Lake North Arm – East Basin	**$1.81x10^4$**	**$1.81x10^4$**
	Patterson Lake North Arm – West Basin	$1.81x10^4$	$1.81x10^4$
	Patterson Lake South Arm	$1.81x10^4$	$1.81x10^4$
	Beet Lake	$1.81x10^4$	$1.81x10^4$
	Naomi Lake	$1.81x10^4$	$1.81x10^4$
	Lloyd Lake Inlet	$1.81x10^4$	$1.81x10^4$
Air (mg/m^3)	Reference (Broach Lake)	0.00	0.00
	Patterson Lake North Arm – West Basin	**$3.55x10^{-5}$**	**$3.55x10^{-5}$**
	Patterson Lake South Arm	$5.04x10^{-6}$	$5.04x10^{-6}$
	Beet Lake	$1.86x10^{-6}$	$1.86x10^{-6}$
	Clearwater River and Mirror River Confluence	$1.10x10^{-7}$	$1.10x10^{-7}$
	Lloyd Lake	$6.00x10^{-8}$	$6.00x10^{-8}$
Soil (mg/kg dw)	Reference (Broach Lake)	$1.61x10^3$	$1.61x10^3$
	Patterson Lake North Arm – West Basin	**$1.62x10^3$**	**$1.62x10^3$**
	Patterson Lake South Arm	$1.61x10^3$	$1.61x10^3$
	Beet Lake	$1.61x10^3$	$1.61x10^3$
	Clearwater River and Mirror River Confluence	$1.61x10^3$	$1.61x10^3$
	Lloyd Lake	$1.61x10^3$	$1.61x10^3$

Notes: The **bold** values indicate the maximum concentrations in each environmental media.
Project lifespan includes Construction, Operations, and Closure phases (43 years in total).

5.0 Comparison to the Available Media Quality Guidelines

The considered media quality guidelines are reported in Section 4.2.3 of Draft EIS TSD XXI for water and sediment and Section 4.3.3 of Draft EIS TSD XXI for air and soil.

From a human health perspective, iron is an essential element with no evidence for toxic effects unless large quantities of iron are ingested. Accordingly, Health Canada has not set a maximum acceptable concentration for iron; the current guideline for drinking water of 0.3 mg/L represents an aesthetic objective.

With respect to iron in water, it is important to note that an updated FEQG was published in May 2024, which follows the CCME (2007) species sensitivity distribution protocol (ECCC 2024). It is more stringent than the previous FEQG (ECCC 2019). FEQG guidelines are dependent on dissolved organic carbon (DOC) and pH. Table 5-1 shows the calculated FEQG values for iron in freshwater using the 2024 guideline equations and pH and DOC values obtained from the water quality baseline studies (EIS Annex V.1, Aquatic Environment Baseline Report). The calculated FEQG values for iron range from 0.23 mg/L to 0.76 mg/L, which is in the same range as the 1987 CCME guideline of 0.3 mg/L (CCREM 1987).

There are no federal or provincial guidelines for iron in sediment; therefore, the lowest effect level (LEL) of 2.00×10^{4} mg/kg dw for the protection and management of aquatic sediment quality in Ontario was applied (MOEE 1993). The only available air quality guideline for iron is the 24-hour Ontario Ambient Air Quality Criteria (OAAQC), which is 4.00×10^{-3} mg/m^3. There are no federal or provincial guidelines for iron in soil.

As shown in Table 5-2, there is no exceedance when comparing the predicted maximum iron concentrations to the available quality guidelines in different environmental media. Therefore, no effects from iron on the environment are expected.

Table 5-1: Summary Statistics of Calculated FEQG Values for Iron in Freshwater and pH and Dissolved Organic Carbon (DOC) Values in Baseline Water Samples Associated with each FEQG Value

Statistical Parameter	Calculated FEQG Values (mg/L)	Associated Sample Values[(a)]	
		DOC (mg/L)	pH
Minimum	0.23	1.5	7.4
		1.5	7.3
25th Percentile	0.26	-	-
50th Percentile	0.38	3.5	6.7
		3.4	6.7
95th Percentile	0.67	-	-
Maximum	0.76	10	7.3
Arithmetic Mean	0.42	-	-
Geometric Mean	0.40	-	-

Notes: Cell with dashes "-" indicate that these FEQG values were computed using all calculated FEQG values (they reflect the distribution of the calculated FEQG values) and are therefore not associated with specific water samples. Although the 50th percentile is computed in this way, the resulting FEQG value of 0.38 mg/L was associated with specific water samples; therefore, associated DOC and pH values are shown.

Only samples with pH 6.0 – 8.5 and DOC 0.3 – 10.9 were used for FEQG calculations, as this is the range of pH and DOC values within which the CCME's water quality guideline conversion table for iron is valid (ECCC 2024). Sub-setting to these pH and DOC ranges omitted one water sample.

a) From measured water baseline data

Table 5-2: Comparison of Maximum Iron Concentrations to Available Quality Guidelines

Maximum Predicted Concentration	Available Quality Guidelines		Is Concentration Greater than Available Quality Guidelines (Yes/No)
Water (mg/L)	**CCME Protection of Aquatic Life, Long Term (a)**	**Federal Environmental Quality Guidelines (FEQG) (b)**	
7.26×10^{-2} (Application Case) 7.26×10^{-2} (Upper Bound Scenario)	0.30	0.23 - 0.76	No
Sediment (mg/kg dw)	**The lowest effect level (LEL) from Ontario (c)**		
1.81×10^{4}	2.00×10^{4}		No
Air (mg/m³)	**Ontario Ambient Air Quality Criteria (OAAQC), 24-hour (d)**		
3.55×10^{-5}	4.00×10^{-3}		No
Soil (mg/kg dw)	**Soil Quality Guidelines Unavailable**		
1.62×10^{3}	No Data		Not applicable

Notes:
a) CCREM (1987); ECCC (2019).
b) ECCC (2024).
c) MOEE (1993).
d) MECP (2020).

6.0 Discussion of Potential Risk to Ecological And Human Health

Since there are no exceedances when comparing the predicted maximum iron concentrations to their available quality guidelines in different environmental media, there are no anticipated risks to ecological and human health with regards to iron inputs from the Project.

7.0 References

Brix, K.V., L., Tear, D.K. DeForest, W.J. Adams. 2023. Development of multiple linear regression models for predicting chronic iron toxicity to aquatic organisms. Environmental Toxicology and Chemistry. 42(6): 1386-1400.

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

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Environmental Quality Guidelines: A protocol for the derivation of water quality guidelines for the protection of aquatic life. Winnipeg, MB. 37 pp. Available at **https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines**.

ECCC (Environment and Climate Change Canada). 2019. Federal environmental quality guidelines – Iron. May. Available at **https://www.canada.ca/content/dam/eccc/documents/pdf/pded/feqg-iron/Federal-Environmental-Quality-Guidelines-Iron.pdf**.

ECCC (Environment and Climate Change Canada). 2024. Federal environmental quality guidelines – Iron. May. Available at **https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/federal-environmental-quality-guidelines-iron.html**.

MECP (Ontario Ministry of the Environment, Conservation and Parks). 2020. Technical Assessment and Standards Development Branch, 2020. Ambient Air Quality Criteria.

MOEE (Ontario Ministry of Environment and Energy). 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Available at **https://atrium.lib.uoguelph.ca/server/api/core/bitstreams/d662f9f3-49b4-403e-95ce-8c481224cd1a/content**.

IR 82

No.	Justification/Rationale	Follow up Information Request	NexGen Response
82	**Justification:** The Proponent has addressed parts one and two of the IR and provided a commitment to address inaccuracies in the Draft EIS and will make revisions and include updates in the revised EIA. The status of parts three and four of the IR is consistent with the status of IR-79-R1 (parts one and two), respectively. See IR-79-R1. **Rationale:** Parts one and two will be accepted pending the incorporation of the updates described in the response into the future revised EIS.	**Information Request** ECCC asks that the CNSC request that the Proponent incorporate the updates described in the response into the future revised EIS.	NexGen confirms that the requested changes associated with NexGen's response to IR 82-R1 were incorporated into the May 2024 Revised EIS.

IR 82-R1 (Confirmation of Information in May 2024 Revised EIS)

NexGen confirms that the requested changes associated with NexGen's response to IR 82-R1 were incorporated into the May 2024 Revised EIS. For full context, below is the follow up request received from the CNSC, the original request for IR 82-R1, and the response to IR 82-R1 provided by NexGen in the Round 2 IR response package (with key EIS notes related to revisions highlighted):

Most recent ECCC comment (requests highlighted)

82	ECCC	Section 10.2.8.3.1 Section 10.3.1.2 Appendix 10A-2	**Not Accepted**	**Not Accepted**	**Justification:** The Proponent has addressed parts one and two of the IR and provided a commitment to address inaccuracies in the Draft EIS and will make revisions and include updates in the revised EIA. The status of parts three and four of the IR is consistent with the status of IR-79-R1 (parts one and two), respectively. See IR-79-R1. **Rationale:** Parts one and two will be accepted pending the incorporation of the updates described in the response into the future revised EIS.	**Information Request** ECCC asks that the CNSC request that the Proponent incorporate the updates described in the response into the future revised EIS.	

<u>From Round 2, the following represents the ECCC request specific to IR 82-R1 parts 1 and 2:</u>

82-R1	1. Provide the calculations used to determine the calculated value for cobalt in Table 10.2-5. 2. Provide the revised Table 10.2-5 for review. **3.** Provide baseline receiving environment surface water quality data and predicted effluent characterization concentrations of thallium. **4.** Update the surface water quality assessment and modelling as needed to incorporate data on thallium and confirm predictions of no negative effects to the aquatic receiving environment and receptors.

<u>In response to the ECCC request, NexGen's provided the following responses (May 2024 Submission):</u>

Part 1 (key points summarized)

NexGen confirms that the Project cobalt threshold was calculated according to the equation below from the Federal Environmental Quality Guideline (Environment Canada 2017):

$$FWQG = \exp\{(0.414[\ln(\text{hardness})] - 1.887\}$$

where:

FWQG = Federal Water Quality Guideline (µg/L)

hardness = ambient hardness (mg/L $CaCO_3$)

. . .

As a result, the Project cobalt threshold is calculated as follows:

$$FWQG = \exp\{(0.414[\ln(52)] - 1.887\} = 0.78\ \mu g/L$$

. . .

To address inaccuracies within the Draft EIS related to the 0.46 µg/L Project cobalt threshold, NexGen will make revisions reflective of the updated Project cobalt threshold (i.e., 0.78 µg/L) in revised EIS Section 10 (Surface Water Quality and Sediment Quality), revised EIS Section 11 (Fish and Fish Habitat), revised EIS Section 13 (Vegetation), revised EIS Section 14 (Wildlife and Wildlife Habitat), revised EIS Section 16 (Cultural and Heritage Resources and Indigenous Land and Resource Use), revised EIS Section 17 (Other Land and Resource Use), and revised EIS TSD XXI (Environmental Risk Assessment).

Part 2

2. NexGen confirms that Table 10.2-5 of revised EIS Section 10.2.8.3.1 (Water Quality Thresholds) will be updated to include the cobalt threshold and molybdenum provincial objective and threshold as well as broaden the discussion of assumptions regarding pH, temperature, hardness, alkalinity, and specific conductivity, as necessary.

<u>To follow up on the commitments provided in the IR 82-R1 response, the following information was provided as part of the May 2024 Revised EIS:</u>

Part 1 specific

For brevity, screenshots have not been included for all areas in Section 10 or Section 11, Section 13, Section 14, Section 16, Section 17, or TSD XXI where edits in this regard were made, though through NexGen's review, the updated cobalt thresholds and associated contextual change requirements have been made. Below is an example from Section 16, with further context associated with Section 10 shown further below to support the response for both part 1 and part 2:

Draft EIS Section 16.4.1:

April 2022 16-63 GOLDER

Rook I Project
Environmental Impact Statement
Section 16 Cultural and Heritage Resources and Indigenous Land and Resource Use

(Mine Waste Management Plan). Engineered paste tailings would be used to permanently store tailings in the underground tailings management facility to control sources of COPCs.

The far-future scenario was assessed using the regional surface water quality model and included an upper bound scenario (Section 10.2.8, Residual Effects Analysis). Most water quality parameters remained below their respective threshold values in the far-future scenario, except for cobalt and copper. In this scenario, cobalt exceedances were predicted for Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake North Basin, and Beet Lake. Copper exceedances were predicted for Patterson Lake North Arm – West Basin (Section 10.5.1.2, Regional Surface Water Quality Model). For the upper bound scenario, cobalt exceedances were predicted for Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake North Basin, Beet Lake, and Naomi Lake. Copper exceedances in the upper bound scenario were predicted for Patterson Lake North Arm – West Basin and Patterson Lake South Arm (Section 10.5.2.1, Regional Surface Water Quality Model).

May Revised EIS Section 16.4.1:

(Mine Waste Management Plan). Engineered paste tailings would be used to permanently store tailings in the underground tailings management facility to control sources of COPCs.

The far-future scenario was assessed using the regional surface water quality model and included an upper bound scenario (Section 10.2.8, Residual Effects Analysis). Most water quality parameters remained below their respective threshold values in the far-future scenario, except for cobalt and copper. In this scenario, cobalt exceedances were predicted for Patterson Lake North Arm – West Basin and Patterson Lake South Arm. Copper exceedances were predicted for Patterson Lake North Arm – West Basin (Section 10.5.1.2, Regional Surface Water Quality Model). For the upper bound scenario, cobalt exceedances were predicted for Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake North Basin, and Beet Lake. Copper exceedances in the upper bound scenario were predicted for Patterson Lake North Arm – West Basin and Patterson Lake South Arm (Section 10.5.2.1, Regional Surface Water Quality Model).

Part 1 and Part 2

Updated cobalt information (including calculation) and molybdenum provincial and selected threshold in Table 10.2-5 of May Revised EIS:

Ammonia as N (total)	mg/L	Function of un-ionized ammonia, pH, and temperature[f]				
Nitrate (as N)	mg/L	3.0		n/a		3.0
Total Metals (unless otherwise noted, all metals are reported as total)						
Aluminum	mg/L	<6.5 pH ≥6.5 pH	0.005 mg/L 0.1 mg/L	<6.5 pH, <4 mg/L Ca, <2 mg/L DOC ≥6.5 pH, ≥4 mg/L Ca, ≥2 mg/L DOC	0.005 mg/L 0.1 mg/L	0.1[g]
Arsenic	mg/L	0.005		0.005		0.005
Cadmium	mg/L	<17 mg/L as $CaCO_3$ 17 - 280 mg/L as $CaCO_3$ >280 mg/L as $CaCO_3$	0.00004 mg/L $10^{0.83(\log(hardness))-2.46}$ 0.00037 mg/L	<17 mg/L as $CaCO_3$ 17 - 280 mg/L as $CaCO_3$ >280 mg/L as $CaCO_3$	0.00004 mg/L $10^{0.83(\log(hardness))-2.46}$ 0.00037 mg/L	0.00004[h]
Chromium	mg/L	Chromium, hexavalent: 0.001 mg/L Chromium, trivalent: 0.0089 mg/L		Chromium, hexavalent: 0.001 mg/L		0.001
Cobalt	mg/L	n/a		exp{(0.414[ln(hardness)] – 1.887}[i]		0.00078[i]
Copper	mg/L	<82 mg/L as $CaCO_3$ 82 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.002 mg/L $0.2*e^{0.8545[\ln(hardness)]-1.465}$ 0.004 mg/L	<120 mg/L as $CaCO_3$ 120 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.002 mg/L 0.003 mg/L 0.004 mg/L	0.002[h]
Iron	mg/L	0.3		0.3		0.3
Lead	mg/L	≤60 mg/L as $CaCO_3$ 60 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.001 mg/L $0.2*e^{1.273[\ln(hardness)]-4.705}$ 0.007 mg/L	≤60 mg/L as $CaCO_3$ 60 - 120 mg/L as $CaCO_3$ 120 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.001 mg/L 0.002 mg/L 0.004 mg/L 0.007 mg/L	0.001[h]
Manganese	mg/L	Calculated using the CCME calculator for manganese in Appendix B and is based on hardness and pH (CCME 2019)		n/a		0.26[h][j]

Table 10.2-5: Canadian Council of Ministers of the Environment Guidelines, Saskatchewan Provincial Objectives, and Selected Water Quality Project Thresholds Based on Protection of Aquatic Life Chronic Guidelines

COPC	Unit	CCME: Long-Term (Chronic)[a]		Provincial Objectives (Chronic)[b]		Selected Project Threshold (Chronic)
Mercury	mg/L	0.000026		0.000026		0.000026
Molybdenum	mg/L	0.073		7.6[d]		7.6[d]
Nickel	mg/L	≤60 mg/L as $CaCO_3$ 60 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.025 mg/L $0.2*e^{0.76[\ln(hardness)]+1.06}$ 0.150 mg/L	≤60 mg/L as $CaCO_3$ 60 - 120 mg/L as $CaCO_3$ 120 - 180 mg/L as $CaCO_3$ >180 mg/L as $CaCO_3$	0.025 mg/L 0.065 mg/L 0.110 mg/L 0.150 mg/L	0.025[h]

Part 2

Broadened discussion regarding ETMFs in Section 10.2.3.8.1 of May Revised EIS:

Table 10.2-5 provides a summary of the CCME guidelines, provincial water quality objectives, and the selected chronic (i.e., long-term) thresholds for the COPCs. The CCME water quality objectives for total ammonia for the protection of aquatic life used as the Project threshold are provided in Table 10.2-6. Table 10.2-5 is limited to presenting the selected chronic (i.e., long-term) Project thresholds for the COPCs that apply specifically to the protection of aquatic life. Thus, other surface water quality constituents such as pH, temperature, hardness, alkalinity, and specific conductivity have not been included in the table because they were not identified as COPCs. However, where the potential for toxicity by specific COPCs is modified based on these additional constituents defined as ETMFs (e.g., pH, temperature, hardness), assumptions regarding their influence on the selected Project threshold for those COPCs are presented as footnotes to Table 10.2-5 and linked to the relevant constituent to which they apply. These additional constituents have been included in baseline monitoring datasets and tables and would be included in monitoring programs during the life of the Project, including reporting under the MDMER.

As noted in Table 10.2-5, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project.

IR 89

No.	Justification/Rationale	Follow up Information Request	NexGen Response
89	**Justification:** The Proponent has provided some of the requested information for part one and committed to incorporating it into the revised EIS. However, most of the requested information was not provided, as the Proponent has not addressed all EIS sections identified by ECCC as requiring further information. Overall, the information provided is high-level and does not contain the details necessary to assess the residual effect analysis within the EIS. In the Proponent's response to part two, they confirmed that sulphate is the only COPC where the modelled concentrations in the receiving environment would potentially be higher than the Project threshold, should the Project threshold be derived using baseline hardness concentrations. Further, the Proponent indicated that these higher concentrations would be limited to occur during Project operations when there would be treated effluent discharged to Patterson Lake. However, the response did not include any analysis or data to support these statements. **Rationale:** The Proponent's response to part one should be supplemented with additional detail related to the residual effects analysis including specific details on how anticipated project-induced increases in hardness result in changes to the water quality guidelines and how the predicted concentrations of COPC's compare to these hardness-dependent guidelines. Their response to part two requires the provision of analysis or data (e.g. the maximum predicted concentrations as compared to the guidelines calculated with baseline hardness) to support the statements made in their response.	**Information Requests:** In order to resolve this IR, NexGen is required to: • Address part one of IR-89-R1. Provide detailed information for all EIS sections requested by ECCC, including specifics on how much the hardness increases, how this subsequently changes the guidelines, and how the concentrations of the COPCs compare to these guidelines. Graphs depicting this information would strengthen the response and the revised EIS. Provide analysis or data (e.g. the maximum predicted concentrations as compared to the guidelines calculated with **Information Requests:** The Proponent is also required to: • Address part one of IR-89-R1. Provide detailed information for all EIS sections requested by ECCC, including specifics on how much the hardness increases, how this subsequently changes the guidelines, and how the concentrations of the COPCs compare to these guidelines. Graphs depicting this information would strengthen the response and the revised EIS. • Provide analysis or data (e.g. the maximum predicted concentrations as compared to the guidelines calculated with baseline hardness) to support the statements made in the response to part 2 of the IR.	The following information is provided by NexGen to address part 1 of IR 89-R1 as described in the reviewer's follow-up comment, which requested that additional information is included in the EIS. 1. NexGen confirms that the information committed to be included in the May 2024 response to IR 89-R1 (i.e., additional context regarding increases in hardness from Project effluent and how increases in hardness influences the calculation of certain constituents of potential concern [COPCs]) was included in the revised EIS submitted in May 2024. For ease of review, this information can be found in EIS Section 10.2.8.3.1 (Water Quality Thresholds) on page 10-43, and in the first paragraph of Section 10.5.1.2 (Regional Surface Water Quality Model) on page 10-88. NexGen further confirms that timeseries graphs of hardness concentrations in Patterson Lake and downstream waterbodies are already included in Attachment 10A-2 of EIS Appendix 10A (Surface Water Quality Modelling Report) and can be found on PDF page 394 for the Application Case and PDF page 395 for the Reasonably Foreseeable Development (RFD) Case. 2. In addition to the updates NexGen committed to and subsequently made in the May 2024 revised EIS (i.e., EIS Section 10.2.8.3.1 and EIS Section 10.5.1.2), the following changes will be made to the Final EIS to provide the requested detailed information for all EIS sections requested by Environment and Climate Change Canada (ECCC), which include EIS Section 10.4.3 (Primary Pathways), EIS Section 10.5 (Residual Effects Analysis), EIS Section 10.6 (Prediction Confidence and Uncertainty), and EIS Section 10.7 (Monitoring, Follow-up, and Adaptive Management): **EIS Section 10.4.3 (Primary Effects Pathway) for effects for discharge of treated effluent** The text on Page 10-78 under Pathway ID SWQ-03 (Project components/activities that may change surface water and sediment quality through treated effluent discharges during Construction, Operations, and Closure) will be modified to read "Direct discharge of treated effluent during Construction, Operations, and Closure may affect surface water quality, including hardness, in Patterson Lake and in waterbodies and watercourses farther downstream". Pathway ID SWQ-03 in Table 10.4-1 will also be updated to be consistent with this text. **EIS Section 10.5 (Residual Effects Analysis)** *EIS Section 10.5.1.2 (Regional Surface Water Quality Model)* The following text will be added to the first paragraph of this subsection: "Changes to hardness in the receiving environment are illustrated in Attachment 10A-2 of Appendix 10A. As shown in these figures, the hardness in Patterson Lake North Arm – West Basin is predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to approximately 100 mg/L as $CaCO_3$ during Operations. Increased hardness levels are also predicted in downstream waterbodies, but to a lesser extent with distance downstream. In downstream waterbodies, hardness levels are predicted to increase from less than 20

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			mg/L as $CaCO_3$ under existing conditions to maximum values of approximately 60 mg/L as $CaCO_3$ in Forrest Lake North Basin and 50 mg/L as $CaCO_3$ in Beet Lake and Naomi Lake." The first sentence of the second paragraph of this subsection will be modified to read as follows: "In the far future, hardness is predicted to return to baseline levels, and most COPC concentrations remained below their respective thresholds, except cobalt and copper (Section 10.5.1.2.3, Trace Metals)." *Figure 10.5-6 and Figure 10.5-16* These existing figures illustrate how the sulphate guidelines change in response to hardness over time and how the predicted concentrations of sulphate compare to these guidelines. For improved clarity, the footnote for Figure 10.5-6 and Figure 10.5-16 will be modified to read as follows: "Note: The sulphate threshold is calculated based on the projected hardness concentration in the waterbody, with threshold values ranging from 128 mg/L to 309 mg/L; see Section 10.2.8.3 for more detail." *Figure 10.5-8, Figure 10.5-13, and Figure 10.5-18* These existing figures illustrate how the cobalt guidelines change in response to hardness over time, and how the predicted concentrations of cobalt compare to these guidelines. For improved clarity, the footnote for Figure 10.5-8, Figure 10.5-13, and Figure 10.5-18 will be modified to read as follows: "Note: The cobalt threshold is calculated based on the projected hardness concentration in the waterbody, with threshold values ranging from 0.00078 mg/L to 0.0010 mg/L; see Section 10.2.8.3 for more detail." **EIS Section 10.6 (Prediction Confidence and Uncertainty)** The following text will be added to this subsection after the bulleted list describing factors affecting confidence in predictions: "Additionally, confidence in the assessment of predicted sulphate concentrations relied on the scientific understanding that increasing hardness is a modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023, BC MECCS 2019)." **EIS Section 10.7 Monitoring, Follow-up and Adaptive Management** The third bullet in this subsection will be modified to read: "monitor for changes in water quality, including hardness, in the receiving environment as a result of Project activities;" The following analysis is provided by NexGen to support the statements made in response to part 2 of NexGen's response to IR 89-R1 (i.e., "that sulphate is the only COPC where the modelled concentrations in the receiving environment would potentially be higher than the Project threshold should the Project threshold be derived using baseline hardness concentrations"). As shown in Table 10.2-5 of EIS Section 10.2.8.3.1 (Water Quality Thresholds), the following seven water quality constituents have thresholds that are based on hardness-dependent guidelines: sulphate, cadmium, cobalt, copper, lead, manganese, and nickel.

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			The cadmium, lead, and nickel thresholds were not adjusted to reflect changes to ambient hardness over time because concentrations of these constituents remain below the unadjusted threshold during all Project phases. Graphs illustrating constituent concentrations compared to the unadjusted thresholds are already included in Attachment 10A-2 of EIS Appendix 10A and can be found on PDF pages 384-385 (cadmium), PDF pages 398-399 (lead), and PDF pages 408-409 (nickel). As shown in Table 10.2-5 of EIS Section 10.2.8.3.1, the manganese threshold depends on both hardness and pH, and as stated in footnote j to Table 10.2-5, this threshold is variable per lake (i.e., varies from lake to lake). However, this adjustment only accounted for differences in the measured pH of each lake as manganese concentrations would be well below the thresholds derived using baseline hardness concentrations. The pH adjustment resulted in a range of manganese thresholds from 0.23 mg/L to 0.26 mg/L, and predicted concentrations of manganese are an order of magnitude below the threshold derived using baseline hardness concentrations at all times in all lakes, as shown in the graphs in Attachment 10A-2 to EIS Appendix 10A on PDF pages 402-403. Copper concentrations are predicted to exceed water quality thresholds after Closure, as described in EIS Section 10.5.1.2.3 and illustrated in graphs in Figure 10.5-9, Figure 10.5-14, and Figure 10.5-19 of EIS Section 10.5. However, the copper threshold was not adjusted for hardness because ambient hardness is predicted to remain below 120 mg/L as $CaCO_3$ (i.e., the lower bound for hardness adjustment, as shown in Table 10.2-5) in any lake at any time. Cobalt concentrations are predicted to exceed water quality thresholds after Closure, as described in EIS Section 10.5.1.2.3 and illustrated in graphs in Figure 10.5-8, Figure 10.5-13, and Figure 10.5-18 of EIS Section 10.5. This threshold was adjusted to better understand potential risks to biota. However, as shown in these figures, the hardness adjustment only affected the threshold during Operations when hardness is predicted to increase in Patterson Lake. As illustrated in these three figures, the threshold returns to baseline levels during Closure, which is when the threshold is predicted to be exceeded. Therefore, the adjustment for hardness does not affect the assessment. Nonetheless, as noted below, these graphs have been reproduced with a threshold that assumes baseline hardness and provided in Attachment IR 89-R1 in support of this IR response. The above analysis, which relies on data that has been provided in the EIS, confirms that sulphate is the only COPC where the modelled concentrations in the receiving environment would potentially be higher than the Project threshold should the Project threshold be derived using baseline hardness concentrations. As noted above, only the cobalt and sulphate water quality thresholds were adjusted for hardness in the surface water quality assessment in the EIS. To illustrate the degree to which the hardness adjustment changed the thresholds, Figure 10.5-6, Figure 10.5-8, Figure 10.5-13, Figure 10.5-16, and Figure 10.5-18 from EIS Section 10.5 have been reproduced showing both adjusted and unadjusted thresholds. These reproduced figures are provided in Attachment IR 89-R1. These figures also confirm that that hardness adjustment is only relevant to the assessment during Project Operations.

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			References Adams WJ and ER Garman. 2023. Recommended updates to the USEPA Framework for Metals Risk Assessment: Aquatic ecosystems. Integrated Environmental Assessment Management. Available at https://setac.onlinelibrary.wiley.com/doi/full/10.1002/ieam.4827. BC MECCS (British Columbia Ministry of the Environment and Climate Change Strategy). 2019. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Summary Report. Ministry of the Environment and Climate Change Strategy: Water Protection & Sustainability Branch. Available at https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf.

IR 89-R1 (Confirmation of Information in May 2024 Revised EIS)

NexGen confirms that the requested changes associated with NexGen's response to IR 89-R1 were incorporated into the May 2024 Revised EIS. In response to FIRT IR 89-R1, NexGen committed to making two changes to the EIS (Section 10.2.8.3.1 and 10.5.1.2), as highlighted below in a screenshot from the IR response table and the sections where the changes were made.

89	ECCC	Fish and fish habitat Change to an environmental component due to hazardous contaminants	Section 10.5.1.1.1	**Context**: Table 10.5-1 pg. 1657 depicts the chloride and sulphate concentrations in surface water at the edge of the proposed mixing zone for the Application Case. The water quality threshold for Aquatic and Terrestrial Life for sulphate is predicted to change from 128 mg/L at the beginning of operations to 429 mg/L near the end of operations due to changes in hardness levels in Patterson Lake surface water. It is unclear why hardness levels are expected to change over the lifespan of the Project and if this is a Project-related effect. **Rationale**: If Constituents of Potential Concern (COPC) water quality thresholds are dependent on other water quality parameters, such as hardness, and are predicted to change over the	1. Clarify if changes to hardness in surface water quality of Patterson Lake is an expected effect of the proposed Project. 2. Confirm if changes to hardness levels will affect any other COPC thresholds such as cobalt over the course of the Project. 3. Confirm if there are any other general water quality parameters that are expected to change over the course of the Project lifespan that may change COPC thresholds? 4. Include, in the potential COPC exceedances, an evaluation against thresholds that are calculated using baseline condition data during assessments of risk if threshold changes are caused by Project effects.	Responses to part 1 through part 4 of this IR are provided below. 1. NexGen clarifies that the changes to hardness in Patterson Lake are an expected effect of the proposed Project (i.e., from treated effluent discharge during Operations). As presented to the CNSC during early engagement meetings (e.g., 24 August 2021), the increase in hardness in the receiving environment (i.e., Patterson Lake and farther downstream in the local study area [LSA]) is an expected change because the primary ions that contribute to hardness (i.e., calcium and magnesium) are elevated in the treated effluent discharge as counter ions to chloride and sulphate. The projected changes to the major ions over the life of the Project and in the far-future projection are presented in Attachment 10A-2 of Draft EIS Appendix 10A (Surface Water Quality Modelling Report). The plots for hardness, chloride, and sulphate in this attachment show a corresponding temporal increase in Patterson Lake North Arm – West Basin due to the Project discharges during Operations, which attenuate downstream through	n/a	**Context:** While the Proponent provided information on all parts of the original IR, the information needs to be incorporated into the EIS. Where COPCs and their derived guidelines will be affected by sulphate should be outlined. In their response the Proponent states: "NexGen clarifies that the changes to hardness in Patterson Lake are an expected effect of the proposed Project (i.e., from treated effluent discharge during Operations)." However, this effect is not explicitly outlined within the project pathways within Section 10.4 Project Interactions and Mitigations or within Section 10.5 Residual Effects Analysis. Section 10.5.1.1 Application Case does not describe the increasing hardness due to effluent deposition as a Project	89-R1	1. Incorporate information into the Draft EIS regarding the effects from projected increases in hardness in the receiving environment into the following sections: Section 10.4.3 Primary Effects Pathway for effects for discharge of treated effluent, Section 10.5 Residual Effects Analysis, Section 10.6 Predictions of Confidence and Uncertainty, and Section 10.7 Monitoring, Follow-up and Adaptive Management. 2. Identify any COPCs with hardness-derived thresholds that would exceed their respective guidelines during operations if those guidelines were derived with respect to baseline hardness concentration of the receiving environment.	Responses to part 1 and part 2 of this IR are provided below. 1. NexGen maintains that Project thresholds for constituents of potential concern (COPCs) that possess a hardness-dependent toxicity modifying factor should be calculated using ambient hardness in the receiving environment to appropriately assess COPC changes in the receiving environment resulting from the discharge of treated effluent and to reflect the relevant ambient conditions to which biological receptors would be exposed. The assessment of the potential risk of adverse effects to aquatic life in the Draft EIS used water quality guidelines for the protection of aquatic life from the Canadian Council of Ministers of the Environment (CCME 2023), Environment and Climate Change Canada (Environment Canada 2017, Government of Canada 2021), and British Columbia Ministry of the Environment and Climate Change Strategy (BCMECCS 2019) that incorporated toxicity modifying factors, including hardness, in their derivation. The application of toxicity modifying factors such as hardness in the receiving environment is an appropriate and technically defensible site-specific application of the setting of	Section 10.2.8.3.1; Section 10.5.1.2

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Rook I Project
Environmental Impact Statement
Federal Indigenous Review Team Information Request Responses – Annex 1: Round 2

Environmental Impact Statement – Federal Indigenous Review Team Information Request Responses – Round 2

No.	Department	Project Effects Link	Reference to EIS, appendices, or supporting documentation (if applicable)	Context and Rationale	Information Requirement	NexGen Response	Section in EIS	Justification/Rationale	Follow up IR #	Follow up Information Request	NexGen Response	Section in EIS
				course of the Project lifespan, an explanation of why these changes occur must be provided with clarification whether it is a Project-related effect.		the rest of Patterson Lake and the downstream lakes in the LSA. These elevated major ion concentrations also diminish in parallel when treated effluent discharge ceases at the end of Operations. 2. As discussed with the CNSC during early engagement (i.e., prior to submission of the Draft EIS), the change in hardness during the life of the Project and the far-future projection was accounted for in all other constituents of potential concern (COPCs) that have hardness-dependent guidelines (e.g., sulphate, cadmium, cobalt, copper, lead, nickel) because hardness is an exposure- and toxicity-modifying factor (ETMF) for these constituents. Based on projected change to hardness in Patterson Lake and the downstream lakes, and the magnitude of change to hardness, specifically in Operations during treated effluent discharge, changes to the Project thresholds for these hardness-dependent COPCs only applied to sulphate and cobalt. These changes are illustrated in the modelled projections presented for sulphate, cadmium, cobalt, copper, lead, and nickel in Attachment 10A-2 of Draft EIS Appendix 10A. 3. The Project thresholds that have ETMFs other than hardness include: • ammonia, where the ETMFs are pH and temperature; and • aluminum, where the ETMFs are pH, dissolved organic carbon (DOC), and calcium. For ammonia, threshold modifications were based on measured monthly water temperature and pH as the Project is not expected to measurably change the water temperature and pH in Patterson Lake or any downstream waterbody. For total aluminum, the threshold was set as the uppermost threshold concentration (i.e., 100 µg/L) due to the background DOC concentration being greater than 2 mg/L (i.e., DOC was not modelled as the Project is not expected to be a material source of DOC [see NexGen's response to IR 79]) and the projected calcium concentrations are greater than 4 mg/L over the duration of the Project and into the far future. The resulting total aluminum threshold was the same as the upper-bound Canadian		effect. It also does not explain how the increased hardness was factored in when considering water quality thresholds for other contaminants of potential concern (COPCs) that have guidelines that vary based on the hardness of receiving waters. Section 10.5.1.1 Application Case does not describe the increasing hardness in the receiving aquatic environment due to effluent deposition as a Project effect. Additionally, this section does not describe how the increasing hardness concentrations influence the calculation of water quality thresholds for Contaminants of Potential Concern (COPCs) that have hardness-derived guidelines. **Rationale:** The Proponent indicated that Project discharges to the receiving environment will increase hardness concentrations causing the water quality thresholds for other COPCs to increase, allowing for higher discharge levels of these COPCs. To understand how the thresholds for relevant COPCs will be impacted by increasing hardness concentrations in receiving waters and the potential for related impacts to aquatic receptors such as fish and fish habitat, a dedicated discussion should be provided within the draft EIS. This discussion should outline how hardness derived guidelines for COPCs are influenced throughout the Project lifecycle and how this impacts the concentrations of COPCs within the nearfield receiving environment and aquatic receptors. This information should capture the full scope of potential effects and anticipated changes to the receiving environment			Project thresholds. Further, CCME (2003) acknowledges the use of exposure and toxicity modifying factors such as hardness in the derivation of Project thresholds to account for site-specific water quality conditions that will maintain the protection of aquatic life in the receiving environment. NexGen agrees with the reviewer that the revised EIS would benefit from additional context regarding increasing hardness from Project effluent and how increases in hardness influences the calculation of water quality thresholds for certain COPCs. To provide these details, the following context will be added in revised EIS Section 10.2.8.3.1 (Water Quality Thresholds): "As noted in Table 10.2-5, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project." In addition, the first paragraph in revised EIS Section 10.5.1.2 (Regional Surface Water Quality Model) will be modified to read as follows: "Regional surface water quality model results from the Application Case indicated that despite COPC concentrations increasing in the receiving environment due to the Project, concentrations remained below their	

EIS Section 10.2.8.3.1 (Water Quality Thresholds) in May Revised EIS:

As noted in Table 10.2-5, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project.

EIS Section 10.5.1.2 (Regional Surface Water Quality Model) in May Revised EIS:

adaptive management of effluent treatment if concentrations trend in this direction over the course of Operations.

- Concentrations of COPC nutrients (i.e., ammonia, phosphorus, nitrate) remained below thresholds at the edge of the RMZs.
- Concentrations of COPC metals remained below thresholds at the edge of the RMZs. Results showed that the concentration of most parameters increased to the end of Operations.
- Concentrations of COPC radionuclides (i.e., lead-210, polonium-210, radium-226, thorium-230) remained below thresholds at the edge of the RMZs.

10.5.1.2 Regional Surface Water Quality Model

Regional surface water quality model results from the Application Case indicated that despite COPC concentrations increasing in the receiving environment due to the Project, concentrations remained below their respective thresholds throughout the lifespan of the Project. In addition, water hardness in the receiving environment is expected to increase during the lifespan of the Project, with a return to baseline conditions following Closure. The increase in COPC concentrations and water hardness in the receiving environment is primarily the result of the active ETP and STP discharges to Patterson Lake during Operations.

In the far future, most COPC concentrations remained below their respective thresholds, except cobalt and copper. Water quality projections for the far future (i.e., after Closure) indicated that COPC concentrations are influenced by climate where concentrations are generally higher during dry years and lower during wet years. Since trends in the far future are closely tied to climate, the trends in the model results are cyclical when the 43-year climate dataset repeats in the RSWQM.

Predicted changes to COPC groups, and specific COPCs, in the regional environment for the Application Case and in the far future are summarized in the following subsections and all concentrations are reported as monthly averages. Time-series trends for all COPCs are plotted in Appendix 10A.

Concentrations of COPCs in Forrest Lake – North Basin tend to fluctuate more than they do in the other waterbodies. This is because Forrest Lake – North Basin contains a relatively small volume of water; therefore, this waterbody is more sensitive to dilutional effects from precipitation and concentration effects from evaporation.

10.5.1.2.1 Major Ions

Concentrations of COPC major ions (i.e., chloride and sulphate) are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and in the far future. Concentrations of the COPC major ions would notably increase in Patterson Lake in 2029 at the beginning of Operations when the active discharge of treated effluent commences (e.g., sulphate; Figure 10.5-6). The magnitude of the increase was greatest for sulphate because of the large difference between the baseline sulphate concentration (i.e., 1.5 mg/L) and the average discharge concentration from the ETP (i.e., 2,900 mg/L). The sulphate concentrations entering the ETP are strongly influenced by processing activities (e.g., milling process water). An increase in major ion concentration was noted in all downstream lakes in the LSA, which diminishes with distance downstream. Peak concentrations for all major ions are projected in Patterson Lake North Arm – West Basin at the end of Operations, after slowly increasing throughout the time span when the ETP would be actively discharging.

Table 10.4-1: Potential Effects Pathways for Surface Water Quality and Sediment Quality

Pathway ID	Project Components/Activities	Effects Pathway	Environmental Design Features and Mitigation	Pathway Assessment
SWQ-01	Project components/activities that contribute to emissions and deposition of fugitive dust during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ handling and storage of waste rock, special waste rock, and ore ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure ▪ site traffic ▪ transportation of personnel and materials to and from the site	**Deposition of fugitive dust emissions on waterbodies:** ▪ Deposition of fugitive dust emissions (e.g., particulate matter, metals, radionuclides) on local and regional waterbodies and watercourses may adversely affect surface water quality	▪ **Optimize haul routes** to reduce fuel consumption and emissions from equipment ▪ **Apply water and/or suppressants to site roads, access road, and airstrip**, as necessary. Use dust suppressants that minimize environmental risk and are government approved for use ▪ **Limit vehicle speed** on unpaved site roads to reduce fugitive dust during Construction and Operations ▪ **Establish and enforce speed limits** on site and access roads to reduce dust production ▪ Implement Project-specific monitoring programs (e.g., **Effluent and Emissions Plan, Environmental Monitoring Plan**) that includes ambient air monitoring, surface water quality monitoring and adaptive management, if necessary ▪ Implement a Project-specific **Environmental Protection Program**	Primary pathway
SWQ-02	Project components/activities that contribute to CAC emissions during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ additional infrastructure (e.g., camp, maintenance shop, offices) ▪ power generation ▪ handling and storage of waste rock, special waste rock, and ore ▪ non-hazardous waste incineration ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure ▪ site traffic ▪ transportation of personnel and materials to and from the site	**Deposition of CAC emissions on waterbodies:** ▪ Deposition of CAC emissions (e.g., particulate matter, sulphur, nitrogen oxides) on local and regional waterbodies and watercourses may adversely affect surface water quality	▪ Evaluate opportunities to **reduce fuel combustion requirements** of infrastructure and equipment, to the extent practical, during detailed design ▪ Primarily **use liquified natural gas** for power generation ▪ **Optimize haul routes** to reduce fuel consumption and emissions from equipment ▪ **Use and maintain emissions control devices** on combustion-based equipment ▪ **Limit idling of vehicles and equipment** to the extent practical ▪ Identify and implement **procurement criteria** to confirm stationary and mobile engines meet applicable performance standards ▪ **Maintain mobile mining equipment** and vehicles and operate the equipment within parameters for engine exhaust system design ▪ Implement Project-specific monitoring programs (e.g., **Effluent and Emissions Plan, Environmental Monitoring Plan)** that includes ambient air monitoring, surface water quality monitoring and adaptive management if necessary ▪ Implement a Project-specific **Environmental Protection Program**	Primary pathway
SWQ-03	Project components/activities that may change surface water and sediment quality through treated effluent discharges during **Construction, Operations, and Closure**: ▪ underground shaft/mine development ▪ dewatering the underground mine ▪ process plant buildings and underground operations ▪ handling and storage of waste rock, special waste rock, and ore ▪ effluent treatment	**Discharge of treated effluent:** ▪ Direct discharge of treated effluent during Construction, Operations, and Closure may affect surface water quality, including hardness, in Patterson Lake and in waterbodies and watercourses farther downstream	▪ **Recycle and reuse process water** to reduce freshwater intake and release to Patterson Lake, to the extent practical ▪ Design the treated effluent diffuser to **provide effective mixing and dilution of the effluent** to limit the area of the receiving environment affected by mine discharge ▪ Develop a **site-specific ETP** to treat COPCs to **appropriate release limits** in accordance with provincial standards and licence/permit conditions ▪ Design diffuser/outfall such that discharged **flow does not interact with sediment** ▪ Locate proposed treated effluent diffuser **away from sensitive or unique habitats**, to the extent practical ▪ Collect, store and routinely **monitor contact water** to confirm discharge water meets water quality criteria appropriate for release ▪ **Monitor treated effluent flow and quality** ▪ Implement an **Environmental Code of Practice** that defines actions levels and documents steps to be taken to mitigate elevated concentrations of chemical and radiological constituents in treated effluent discharge to acceptable levels ▪ Implement Project-specific monitoring programs (e.g., **Effluent and Emissions Plan, Environmental Monitoring Plan)** that includes monitoring treated effluent, surface water and sediment quality and applying adaptive management if necessary ▪ Implement a Project-specific **Mine Waste Management Plan** and site water management procedures. ▪ Implement a Project-specific **Environmental Protection Program** ▪ Develop and implement a **Detailed Decommissioning and Reclamation Plan** to decommission and transfer the site to the Province under the Institutional Control Program	Primary pathway

Commented [FH25]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

Table 10.4-1: Potential Effects Pathways for Surface Water Quality and Sediment Quality

Pathway ID	Project Components/Activities	Effects Pathway	Environmental Design Features and Mitigation	Pathway Assessment
SWQ-04	Project components/activities that may change surface water and sediment quality through treated sewage discharges during **Construction, Operations, and Closure**: ▪ domestic waste water and sewage treatment	**Discharge of treated sewage:** ▪ Direct discharge of treated sewage during Construction, Operations, and Closure may affect surface water quality in Patterson Lake and in waterbodies and watercourses farther downstream	▪ Design the treated sewage outfall to **provide effective mixing and dilution of the effluent** to limit the area of the receiving environment affected by mine discharge ▪ Design discharge(s) such that discharged **flow does not interact with sediment** ▪ Treat sewage to **appropriate release limits** in accordance with provincial standards and licence/permit conditions ▪ **Monitor treated sewage flow and quality** ▪ Implement a Project-specific **Environmental Monitoring Plan** that includes monitoring surface water and sediment quality and applying adaptive management if necessary ▪ Implement a Project-specific **Environmental Protection Program** ▪ Develop and implement a **Detailed Decommissioning and Reclamation Plan** to decommission and transfer the site to the Province under the Institutional Control Program	Primary pathway
SWQ-05	Project components/activities that potentially change groundwater quality during **Construction and Operations**: ▪ handling and storage of waste rock, special waste rock, and ore	**Seepage from the WRSAs during Construction and Operations:** ▪ Seepage from the WRSAs during Construction and Operations may affect groundwater quality and affect surface water quality in Patterson Lake and in waterbodies and watercourses farther downstream	▪ **Segregate PAG material** from NPAG material and store separately ▪ **Contain and divert runoff and seepage from PAG** waste rock, special waste rock, and ore to the effluent treatment plant ▪ Implement a Project-specific **Environmental Monitoring Plan** that includes monitoring groundwater, surface water, and sediment quality and applying adaptive management, if necessary ▪ Implement a Project-specific **Mine Waste Management Plan** and site contact water management procedures ▪ Implement a Project-specific **Environmental Protection Program** ▪ Develop and implement a **Detailed Decommissioning and Reclamation Plan** to decommission and transfer the site to the Province under the Institutional Control Program	Primary pathway
SWQ-06	Project components/activities that potentially change groundwater quality **following Closure and in the far future**: ▪ handling and storage of waste rock in the WRSAs ▪ storage of tailings in the UGTMF and backfilled stopes	**Runoff and seepage from the WRSAs and UGTMF following Closure:** ▪ Runoff and seepage from the WRSAs and groundwater flow from the UGTMF may affect groundwater quality and affect surface water quality in Patterson Lake after Closure	▪ **Use engineered cemented paste backfill and tailings** to control source concentrations ▪ **Apply binder** to reduce permeability in backfill and tailings ▪ Install **engineered cover system** on PAG and NPAG material ▪ Develop and implement a **Detailed Decommissioning and Reclamation Plan** to decommission and transfer the site to the Province under the Institutional Control Program	Primary pathway
SWQ-07	Project components/activities that contribute to CAC emissions during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ additional infrastructure (e.g., camp, maintenance shop, offices) ▪ power generation ▪ handling and storage of waste rock, special waste rock, and ore ▪ non-hazardous waste incineration ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure ▪ site traffic ▪ transportation of personnel and materials to and from the site	**Deposition of CAC emissions on land:** ▪ Deposition of CAC emissions (e.g., particulate matter, sulphur, nitrogen oxides) on terrestrial components of local and regional watersheds may adversely affect surface water quality	▪ Evaluate opportunities to **reduce fuel combustion requirements** of infrastructure and equipment, to the extent practical, during detailed design ▪ Primarily **use liquified natural gas** for power generation ▪ **Optimize haul routes** to reduce fuel consumption and emissions from equipment ▪ **Use and maintain emissions control devices** on combustion-based equipment ▪ **Limit idling** of vehicles and equipment to the extent practical ▪ Identify and implement **procurement criteria** to confirm stationary and mobile engines meet applicable performance standards ▪ **Maintain and monitor mobile mining equipment and vehicles** to confirm emissions are within designed operating parameters for engine exhaust systems ▪ Implement a Project-specific **Effluent and Emissions Plan** ▪ Implement a Project-specific **Environmental Monitoring Plan** that includes ambient air monitoring, and surface water quality monitoring and adaptive management if necessary ▪ Implement a Project-specific **Environmental Protection Program**	Secondary pathway
SWQ-08	Project components/activities that may change surface water and sediment quality through direct site runoff during **Construction and Operations**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ infrastructure (e.g., roads, airstrip, camp, maintenance shop, offices) ▪ handling and storage of waste rock, special waste rock, and ore	**Site drainage and runoff during Construction and Operations:** ▪ Altered site drainage and runoff from the site during Construction and Operations may cause changes to water levels and flows, stream channel/bank stability, and sediment and constituent loading, affecting surface water quality in local waterbodies and watercourses	▪ **Limit the Project footprint** to the extent practical using practices such as: o optimizing use of existing cleared areas for Project activity o using existing road infrastructure, including existing access road and bridge crossing o storing tailings underground o designing an efficient infrastructure footprint (e.g., buildings clustered together) ▪ Provide **adequate contact water storage capacity** to manage runoff and seepage from Project infrastructure and disturbed areas ▪ **Minimize areas of vegetation clearing and soil disturbance**	Secondary pathway

Table 10.4-1: Potential Effects Pathways for Surface Water Quality and Sediment Quality

Pathway ID	Project Components/Activities	Effects Pathway	Environmental Design Features and Mitigation	Pathway Assessment
SWQ-09	Project components/activities that may change surface water and sediment quality through direct site runoff during **Closure and in the far future**: ▪ storage of waste rock ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure	**<u>Site drainage and runoff during and following Closure:</u>** ▪ Altered site drainage and runoff from site during Closure and following may cause changes to water levels and flows, stream channel/bank stability, and sediment and constituent loading, affecting surface water quality in local waterbodies and watercourses	▪ **Limit steepness and length of slopes** of disturbed areas and stockpiled soils ▪ **Avoid placing soil stockpiles near waterbodies** (i.e., maintaining 150 m buffer from waterbodies and watercourses), and near natural drainage features, unless required for temporary storage ▪ **Use erosion control measures** as required ▪ To the extent practical, **work in sensitive areas** (i.e., erosive soils, wetland features, and fish habitats) would be scheduled **to avoid periods that may result in high flow volumes and/or increase erosion and sedimentation** (e.g., spring freshet) ▪ Implement **progressive reclamation and revegetation** of disturbed areas no longer required ▪ **Reclaim and revegetate** areas where non-permanent Project facilities have been decommissioned ▪ Perform routine inspection and maintenance of **water containment and conveyance structures** (i.e., roadside ditches and culverts) to limit the risk of road wash-out or sediment release to the environment ▪ Implement a Project-specific **Environmental Monitoring Plan** that includes monitoring surface water and sediment quality and applying adaptive management if necessary ▪ Implement a Project-specific **Mine Waste Management Plan** and site contact water management procedures under the **Environmental Protection Program** ▪ Implement a Project-specific Environmental Protection Program ▪ Develop and implement a Detailed **Decommissioning and Reclamation Plan** to decommission and transfer the site to the Province under the Institutional Control Program	Secondary pathway
SWQ-10	Project components/activities that contribute to TSS loadings through treated effluent discharge and treated sewage release during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ handling and storage of waste rock, special waste rock, and ore ▪ effluent treatment ▪ domestic waste water and sewage treatment ▪ additional infrastructure (e.g., roads, airport fuel pad, camp) ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure	**<u>TSS loadings:</u>** ▪ Direct discharge of treated effluent and treated sewage during Construction, Operations, and Closure can contribute to TSS loadings and may affect surface water quality in Patterson Lake and in waterbodies and watercourses farther downstream	▪ **Recycle and reuse process water** to reduce freshwater intake and release to Patterson Lake, to the extent practical ▪ Design the treated effluent diffuser and treated sewage outfall to **provide effective mixing and dilution of the effluent** to limit the area of the receiving environment affected by mine discharge ▪ Design discharge(s) such that discharged **flow does not interact with sediment** ▪ Locate proposed treated effluent diffuser **away from sensitive or unique habitats, to the extent practical** ▪ Collect, store, and routinely **monitor contact water** to confirm discharge water meets water quality criteria appropriate for release ▪ **Treat effluent and sewage** prior to release ▪ **Monitor treated effluent and treated sewage** flow and quality ▪ Implement a Project-specific **Environmental Monitoring Plan** that includes monitoring water and sediment quality and applying adaptive management if necessary ▪ Implement a Project-specific **Mine Waste Management Plan** and site contact water management procedures under the **Environmental Protection Program** ▪ Implement a Project-specific **Environmental Protection Program**	Secondary pathway
SWQ-11	Project components/activities that contribute to TSS loadings through treated effluent discharge and treated sewage release during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ handling and storage of waste rock, special waste rock, and ore ▪ effluent treatment ▪ domestic waste water and sewage treatment ▪ additional infrastructure (e.g., roads, airstrip, camp) ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure	**<u>Treated effluent and sewage affecting sediment quality:</u>** ▪ Direct discharge of treated effluent and treated sewage during Construction, Operations, and Closure can contribute to changes in sediment quality in Patterson Lake and in waterbodies and watercourses farther downstream		Secondary pathway
SWQ-12	Project components/activities that contribute to emissions and deposition of fugitive dust during **Construction, Operations, and Closure**: ▪ land clearing, site preparation, and construction of facilities and infrastructure ▪ underground shaft/mine development ▪ process plant buildings and underground operations ▪ handling and storage of waste rock, special waste rock, and ore ▪ removal of infrastructure ▪ reclamation and revegetation of facilities and infrastructure ▪ site traffic ▪ transportation of personnel and materials to and from the site	**<u>Deposition of fugitive dust emissions on land:</u>** ▪ Deposition of fugitive dust emissions (e.g., particulate matter, metals, radionuclides) on terrestrial components of local and regional watersheds may adversely affect surface water quality	▪ **Optimize haul routes** to reduce fuel consumption and emissions from equipment ▪ **Apply water and/or suppressants to site roads, access road, and airstrip**, as necessary. Use dust suppressants that minimize environmental risk and are government approved for use ▪ **Limit vehicle speed** on unpaved site roads to reduce fugitive dust during Construction and Operations ▪ **Establish and enforce speed limits** on site and access roads to reduce dust production ▪ Implement a Project-specific **Effluent and Emissions Plan** ▪ Implement Project-specific monitoring programs (i.e., **Environmental Monitoring Plan**) that include ambient air monitoring, surface water quality monitoring and adaptive management, if necessary ▪ Implement a Project-specific **Environmental Protection Program**	No pathway

Bolded text represents the key topic of the environmental design features and mitigation.

PAG = potentially acid generating; UGTMF = underground tailings management facility; WRSAs = waste rock storage areas; ETP = effluent treatment plant; COPC = constituents of potential concern; TSP = total suspended particulates; TSS = total suspended solids; CAC = criteria air contaminant.

Table 10.4-2: Sediment Quality Screening for the Rook I Project

Constituent	Units	Predicted Sediment Concentrations (Patterson Lake North Arm – West Basin) [(a)]			
		Maximum - Application Case	Maximum - Upper Bound	Maximum - Application Case (Far Future)	Maximum - Upper Bound (Far Future)
Non-radiological COPCs					
Arsenic	**µg/kg dw**	**30.50**	**31.00**	**10.60**	**10.93**
Cadmium	µg/kg dw	0.27	0.27	0.29	0.30
Cobalt	µg/kg dw	1.88	1.90	3.56	4.68
Copper	µg/kg dw	2.93	2.94	6.51	8.52
Lead	µg/kg dw	10.16	10.16	10.33	11.27
Molybdenum	**µg/kg dw**	**1.74**	**3.97**	**14.53**	**53.94**
Nickel	µg/kg dw	5.67	5.74	7.39	9.79
Selenium	µg/kg dw	0.56	0.57	0.95	1.37
Uranium	µg/kg dw	6.33	14.20	19.30	19.32
Zinc	µg/kg dw	11.57	11.63	15.71	18.03
Radiological COPCs					
Uranium-234	Bq/kg dw	62	47	39	67
Uranium-238	Bq/kg dw	62	47	39	66
Thorium-230	Bq/kg dw	116	76	76	22
Radium-226	Bq/kg dw	104	106	85	83
Lead-210	**Bq/kg dw**	**492**	**984**	**402**	**376**
Polonium-210	**Bq/kg dw**	**500**	**1,002**	**409**	**382**

Source: TSD XXI.
Note:
Shaded row indicates sediment concentration exceeds the REF or LEL value.
Bold indicates sediment guideline value selected for this assessment.
a) Sediment concentrations predicted based on release of aqueous source terms to Patterson Lake North Arm – West Basin and interaction with sediment. Modelling performed in IMPACT according to the equations outlined in the IMPACT Model Report (TSD XXI, Appendix A).
REF = reference; NE2 = no-effect; LEL = lowest effect level; SEL = severe effect level; CCME = Canadian Council of Ministers of the Environment; ISQG = interim Sediment Quality Guideline; PEL = probable effect level; n/d = no guideline or data available; dw = dry weight; Bq/kg = becquerels per kilogram.

10.4.3 Primary Pathways

The following Project interactions were predicted to be primary pathways to surface water quality and were advanced for further assessment of residual effects (Section 10.5):

SWQ-01: Deposition of fugitive dust emissions on waterbodies:

- Deposition of fugitive dust emissions (e.g., particulate matter, metals, radionuclides) on local and regional waterbodies and watercourses may adversely affect surface water quality.

SWQ-02: Deposition of CAC emissions on waterbodies:

- Deposition of CAC emissions (e.g., particulate matter, sulphur, nitrogen oxides) on local and regional waterbodies and watercourses may adversely affect surface water quality.

SWQ-03: Discharge of treated effluent:

- Direct discharge of treated effluent during Construction, Operations, and Closure may affect surface water quality, including hardness, in Patterson Lake and in waterbodies and watercourses farther downstream.

Commented [FH28]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

SWQ-04: Discharge of treated sewage:

- Direct discharge of treated sewage during Construction, Operations, and Closure may affect surface water quality in Patterson Lake and in waterbodies and watercourses farther downstream.

SWQ-05: Seepage from the WRSAs during Construction and Operations:

- Seepage from the WRSAs during Construction and Operations may affect groundwater quality and affect surface water quality in Patterson Lake and in waterbodies and watercourses farther downstream.

SWQ-06: Runoff and seepage from the WRSAs and UGTMF following Closure:

- Runoff and seepage from the WRSAs and groundwater flow from the UGTMF may affect groundwater quality and affect surface water quality in Patterson Lake after Closure.

The protection of water from Project effects is extremely important for Indigenous Groups and LPA communities (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD V.2: CRDN; BNDN-JWG 2019; BRDN-JWG 2019a; MN-S-JWG 2019b; NexGen 2019). Indigenous Groups have expressed concerns regarding potential Project effects on water quality, and have indicated they are already experiencing the adverse effects from industrial developments, including mineral exploration activities and the Cluff Lake Mine, which they believe has impacted the health of the land and resources (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; BNDN-JWG 2019; BRDN-JWG 2020; BRDN-JWG 2021a; BRDN-JWG 2021b; CRDN-JWG 2020; CRDN-JWG 2021; MN-S-JWG 2019a; MN-S-JWG 2019b).

Patterson Lake is considered by Indigenous Groups to be an integral part of the Clearwater River system and Indigenous Groups expressed concerns that Project activities, including discharge could pollute Patterson Lake and other nearby lakes, and by extension, downstream the Clearwater River and the entire Clearwater River watershed (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD V.2: CRDN).

The CRDN, MN-S, BNDN, and BRDN raised concerns about Project-related contaminants entering the food chain within the Clearwater River watershed through effects to water quality in Patterson Lake, and adversely affecting the health of fish, plants and wildlife, and in turn human health (TSD II: BNDN; TSD III: BRDN; TSD IV: MN-S; TSD V.1: CRDN; TSD V.2: CRDN; BRDN-JWG 2019b; BRDN-JWG 2020; BRDN-JWG 2021b; CRDN-JWG 2020; CRDN-JWG 2021). Trappers from the 2021 Fur Block N-19 trapper's workshop and LPA community members also commented on the potential Project effects on water quality, fish, and wildlife in the area of the Project (NexGen 2019).

> Most important thing because we drink that water and the fish lives on water. Creatures, they drink the water. You know, like moose, caribou, everything, you know. That's the most important thing . . . we drink a lot of water ourselves, you know. (TSD II: BNDN)

Indigenous Groups, trappers, and LPA community members also expressed concerns about potential effects to drinking water at Patterson Lake and the Clearwater River from Project related changes to water quality (TSD II: BNDN; TSD III: BRDN; TSD V.2: CRDN; BRDN-JWG 2020; MN-S-JWG 2019b; NexGen 2019).

Indigenous Groups expressed concerns about the potential effects of Project related air and dust emissions on water quality (TSD II: BNDN; TSD IV: MN-S). For example, MN-S members noted concerns about environmental heath risks from windblown dust dispersal and airborne contamination of water (TSD IV: MN-S). Specific concerns were expressed by Indigenous Groups related to the adverse effects of uranium dust, or radioactive materials in air emissions affecting water, vegetation, and wildlife (TSD II: BNDN; TSD IV: MN-S; TSD V.2: CRDN; MN-S-JWG 2019b).

The concerns raised by Indigenous Groups and LPA community members about surface water quality that are related to potential Project effects identified as primary pathways are assessed in Section 10.5, Residual Effects Analysis. Potential Project effects on the health of fish, vegetation, and wildlife from changes in surface water quality are assessed in the ecological risk assessment completed for the Project (TSD XXI). Potential Project effects on human health are assessed in the human health assessment (Section 15). Potential Project effects on underground water quality are assessed in the hydrogeology assessment (Section 8).

10.5 Residual Effects Analysis

This subsection assesses the predicted changes to receiving environment water quality from the primary pathways identified in Section 10.4.3, Primary Pathways. Since sediment quality was assessed to have no primary pathways, only surface water quality effects pathways are discussed.

The residual effects analysis was completed to evaluate incremental changes to water quality as a result of the Project (i.e., Application Case) and cumulative effects of the Project and Fission Patterson Lake South Property (i.e., RFD Case) in comparison to existing conditions (i.e., the Base Case) and Project thresholds. Sensitivity scenarios were also evaluated for each case. The residual effects analysis considered the spatial boundaries outlined in Section 10.2.3 and the temporal boundaries outlined in Section 10.2.4.

The effects of primary pathways on surface water quality were calculated numerically by integrating these pathways into surface water quality models developed for each phase (Section 10.2.8). The results presented are the net result of Project-related changes associated with the identified primary pathways. Project and cumulative effects were discussed in terms of changes to COPCs within the LSA, which is the predicted spatial limit or boundary of where direct and indirect effects on surface water quality are likely to be detectable. Farther downstream of the Clearwater River and Mirror River confluence, changes to surface water quality were considered not likely to be greater-than-negligible.

The residual effects analysis for the Application Case is structured using separate subsections for the NFWQM and the RSWQM following the methods described in Section 10.2.8; the residual effects analysis for the RFD Case is focused on the RSWQM as it was not considered for the NFWQM because there is no cumulative effect within the near-field zone. Predicted COPC trends are described for nutrients, major ions, trace metals, and radionuclides. These predicted trends are used to classify residual effects for the three measurement indicators for surface water quality at key waterbodies within the LSA (Section 10.5.3). Figures are provided in subsequent subsections showing trends over time for representative COPCs, with figures for all COPCs at the key waterbodies within the LSA available in Appendix 10A.

adaptive management of effluent treatment if concentrations trend in this direction over the course of Operations.

- Concentrations of COPC nutrients (i.e., ammonia, phosphorus, nitrate) remained below thresholds at the edge of the RMZs.
- Concentrations of COPC metals remained below thresholds at the edge of the RMZs. Results showed that the concentration of most parameters increased to the end of Operations.
- Concentrations of COPC radionuclides (i.e., lead-210, polonium-210, radium-226, thorium-230) remained below thresholds at the edge of the RMZs.

10.5.1.2 Regional Surface Water Quality Model

Regional surface water quality model results from the Application Case indicated that despite COPC concentrations increasing in the receiving environment due to the Project, concentrations remained below their respective thresholds throughout the lifespan of the Project. In addition, water hardness in the receiving environment is expected to increase during the lifespan of the Project, with a return to baseline conditions following Closure. Changes to hardness in the receiving environment are illustrated in the Hardness figures in Attachment 10-A2 of Appendix 10A-2. As shown in these figures, the hardness in Patterson Lake North Arm – West Basin is predicted to increase from less than 20 mg/L as $CaCO_3$ under baselineexisting conditions to approximately 100 mg/L as $CaCO_3$ during Operations. Increased hardness levels are also predicted in downstream waterbodies, but to a lesser extent with distance downstream. In downstream waterbodies, hardness levels are predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to maximum values of approximately 60 mg/L as $CaCO_3$ in Forrest Lake North Basin and 50 mg/L as $CaCO_3$ in Beet Lake and Naomi Lake. The increase in COPC concentrations and water hardness in the receiving environment is primarily the result of the active ETP and STP discharges to Patterson Lake during Operations.

Commented [FH32]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

In the far future, hardness is predicted to return to baseline levels, and most COPC concentrations remained below their respective thresholds, except cobalt and copper (Section 10.5.1.2.3, Trace Metals). Water quality projections for the far future (i.e., after Closure) indicated that COPC concentrations are influenced by climate where concentrations are generally higher during dry years and lower during wet years. Since trends in the far future are closely tied to climate, the trends in the model results are cyclical when the 43-year climate dataset repeats in the RSWQM.

Commented [FH33]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

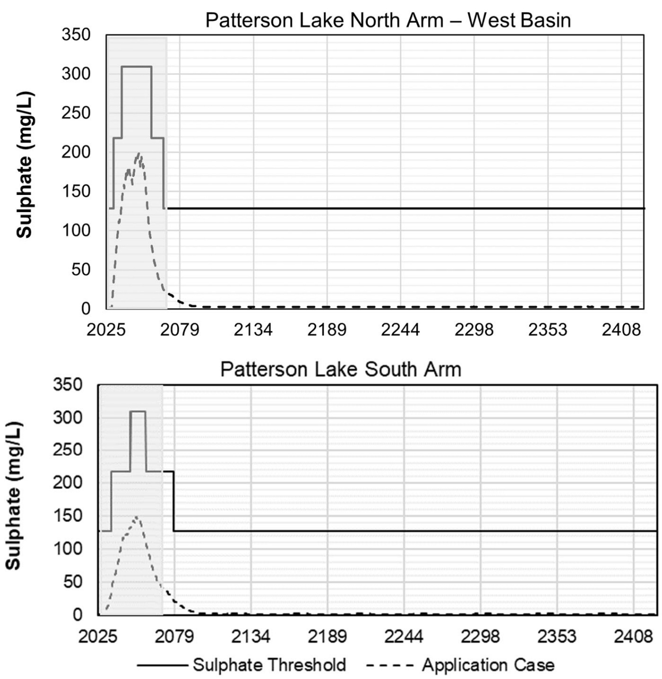
Predicted changes to COPC groups, and specific COPCs, in the regional environment for the Application Case and in the far future are summarized in the following subsections and all concentrations are reported as monthly averages. Time-series trends for all COPCs are plotted in Appendix 10A.

Concentrations of COPCs in Forrest Lake – North Basin tend to fluctuate more than they do in the other waterbodies. This is because Forrest Lake – North Basin contains a relatively small volume of water; therefore, this waterbody is more sensitive to dilutional effects from precipitation and concentration effects from evaporation.

10.5.1.2.1 Major Ions

Concentrations of COPC major ions (i.e., chloride and sulphate) are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and in the far future. Concentrations of the COPC major ions would notably increase in Patterson Lake in 2029 at the beginning of Operations when the active discharge of treated effluent commences (e.g., sulphate; Figure 10.5-6). The magnitude of the increase was greatest for sulphate because of the large difference between the baseline sulphate concentration (i.e., 1.5 mg/L) and the average discharge concentration from the ETP (i.e., 2,900 mg/L). The sulphate concentrations entering the ETP are strongly influenced by processing activities (e.g., milling process water). An increase in major ion concentration was noted in all downstream lakes in the LSA, which diminishes with distance downstream. Peak concentrations for all major ions are projected in Patterson Lake North Arm – West Basin at the end of Operations, after slowly increasing throughout the time span when the ETP would be actively discharging. Concentrations would subsequently decrease with the cessation of active mine discharges (e.g., sulphate; Figure 10.5-6). Pseudo-steady-state conditions in the far future would be achieved by approximately 2100.

Figure 10.5-6: Application Case Sulphate Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm



Note: The sulphate threshold is calculated based on the projected hardness concentration in the waterbody, with threshold values ranging from 128 mg/L to 309 mg/L; see Section 10.2.8.3 for more detail.
The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

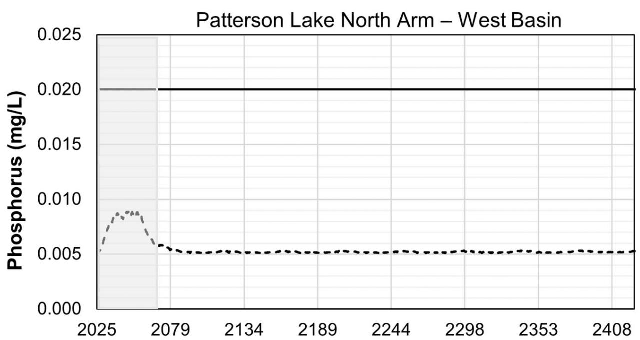
Commented [LM34]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

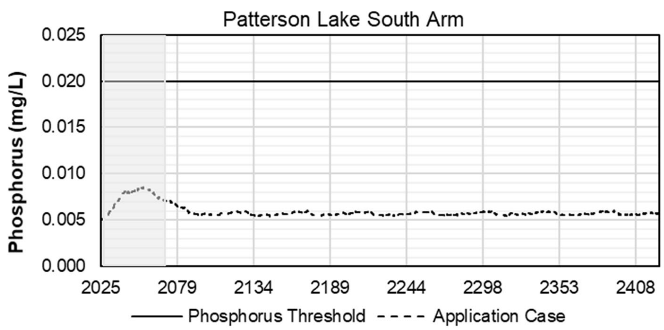
10.5.1.2.2 Nutrients

Concentrations of COPC nutrients (i.e., ammonia, nitrate, phosphorus) are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and in the far future. An increase in COPC nutrient concentration is noted in Patterson Lake at the beginning of Construction when the discharge of treated sewage effluent would commence in Patterson Lake North Arm – West Basin. Incremental increases in nutrient concentrations are noted in all downstream lakes in the LSA, with concentrations attenuating with distance downstream. Peak nutrient concentrations are observed in Patterson Lake North Arm – West Basin at the end of Operations (e.g., phosphorus; Figure 10.5-7) and concentrations subsequently decrease to Base Case concentrations following the cessation of Project discharges from the ETP and STP. Although concentrations of nutrients would be higher in the treated sewage discharge, the ETP would also provide a relatively high load of nutrients as a result of surface runoff from site sources. With the cessation of nutrient loading following the end of the Project, pseudo-steady-state conditions in the far future would be achieved by approximately 2100. Some residual loading of nutrients associated with site runoff and groundwater inputs to Patterson Lake would remain in the far-future projection.

Peak phosphorus concentrations approach 0.009 mg/L in Patterson Lake North Arm – West Basin at the end of Operations, which attenuates farther through the downstream basins in Patterson Lake, and farther downstream through the waterbodies in the LSA. Patterson Lake South Arm phosphorus concentrations peak near 0.006 mg/L in the far-future projection. Patterson Lake therefore remains oligotrophic with respect to phosphorus and does not change trophic status as a result of the Project.

Figure 10.5-7: Application Case Phosphorus Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm





Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

10.5.1.2.3 Trace Metals

Concentrations of COPC trace metals are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project. Except for cobalt and copper, all other COPC metals are predicted to remain below their thresholds in the far future.

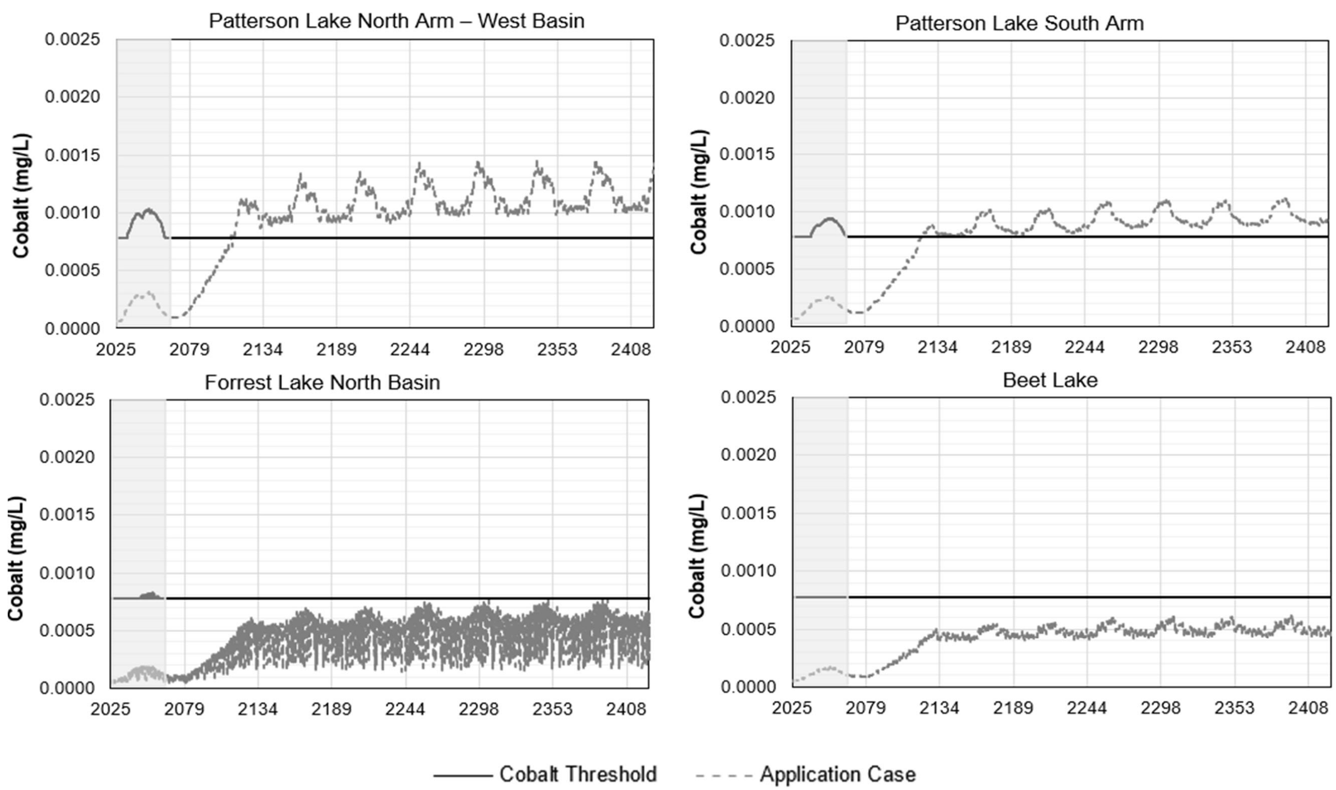
Concentrations of COPC metals would begin to increase in Patterson Lake in 2029 when active Project discharge commences at the start of Operations, which attenuates through the downstream waterbodies in the LSA. The primary source of metal loading to Patterson Lake would be the process plant via the treated effluent discharge from the ETP. As noted for COPC major ions and nutrients, COPC metal concentrations would peak in Patterson Lake North Arm – West Basin at the end of Operations.

In the far future, COPC metal concentrations would either increase or decrease compared to the Project phases before reaching a pseudo-steady-state concentration. For example, aluminum, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, uranium, and zinc concentrations would be higher in the far future compared to their concentrations during the lifespan of the Project. The primary sources of mass loading of COPC metals in the far future would be the seepage load from the reflooded mine workings, primary backfill, secondary backfill, and UGTMF (i.e., underground workings) and PAG WRSA to groundwater inflows. Since the model input climate dataset cycles every 43 years (Section 10.2.8.1.3, Regional Surface Water Quality Model), the far-future metal trends in the model output also demonstrate cyclical trends that repeat throughout each climate cycle. Metal concentrations would generally be greatest during dry climate years and lowest during wet climate years when there would be higher natural runoff into the lake.

Although some metals are predicted to increase in concentration in the far future (i.e., after Closure), cobalt and copper are the only COPC metals that are anticipated to exceed thresholds. In the far future, the average monthly cobalt concentrations are predicted to consistently exceed the threshold value in Patterson Lake North Arm – West Basin and Patterson Lake South Arm (i.e., peaking at 0.0015 mg/L and 0.0011 mg/L, respectively: Figure 10.5-8). Cobalt concentrations would begin to increase in these basins following Closure when the ETP stops actively discharging and mass loadings from the groundwater increase. It would take approximately 50 years for the concentrations to exceed the threshold in Patterson Lake North Arm – West Basin and approximately 60 years to exceed the threshold in Patterson Lake South Arm. As noted in Section 10.2.4, the modelling timeframe for the far-future projection consists of a 157-year period that considers the hydrogeological processes from the site followed by 200 years where the hydrogeological mass load inputs are artificially increased in the RSWQM to incorporate maximum loadings in a timeframe that is more readily modelled.

In the far future, copper threshold exceedances are predicted periodically in Patterson Lake North Arm – West Basin (Figure 10.5-9). Similar to the trends noted for cobalt, the copper concentration in Patterson Lake would begin to increase after Closure due to influx of mass load inputs from groundwater that has been primarily affected by seepage inputs from the PAG WRSA. It would take approximately 90 years before an exceedance in copper is anticipated in Patterson Lake North Arm – West Basin (i.e., 2159) and the predicted concentrations fluctuate above and below the threshold for the remainder of the far-future projection as the climate dataset cycles through the model (peaking at 0.0024 mg/L; Figure 10.5-9). The duration of the exceedances increases in the 200-year interval after the maximum groundwater loadings are applied to the model. No copper exceedances are predicted in the waterbodies downstream of Patterson Lake North Arm – West Basin. As described further in Section 10.7, the predicted concentrations of cobalt and copper are thought to result from conservative assumptions and form the basis for an Adaptive Management Plan that would be applied throughout Operations to protect aquatic health in Patterson Lake and downstream lakes at Closure.

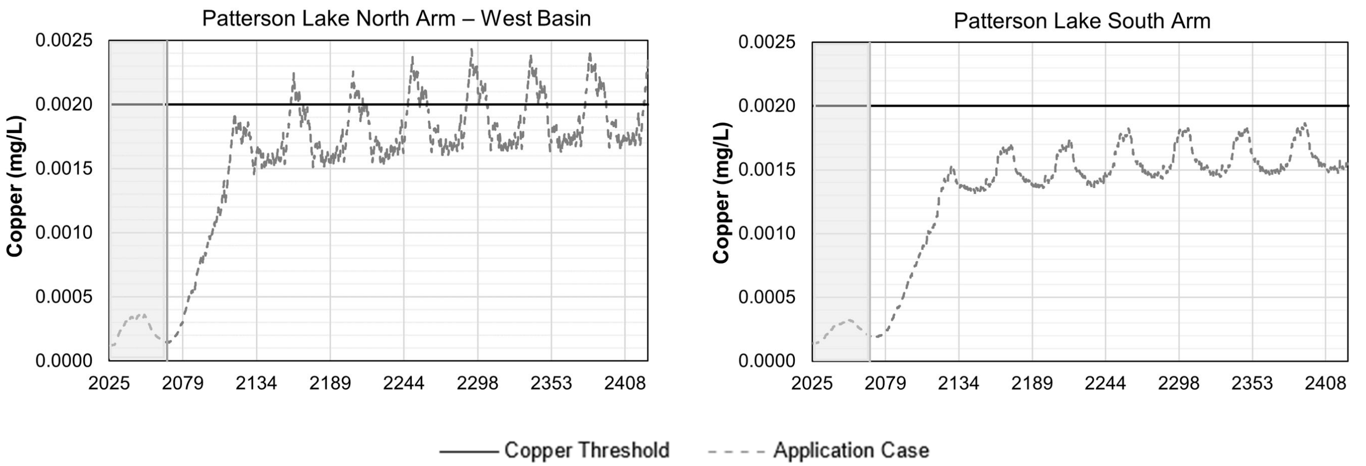
Figure 10.5-8: Application Case Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin, and Beet Lake



Note: The cobalt threshold is calculated based on the projected hardness concentration in each waterbody, with threshold values ranging from 0.000–78 mg/L to 0.0010 mg/L; see Section 10.2.8.3 for more detail.
The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Commented [LM35]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

Figure 10.5-9: Application Case Copper Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm

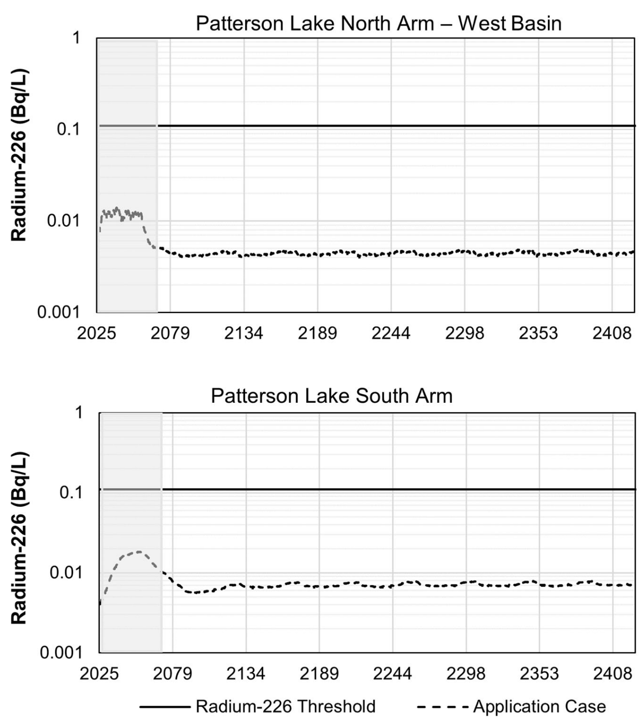


Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

10.5.1.2.4 Radionuclides

Concentrations of COPC radionuclides (i.e., lead-210, polonium-210, radium-226, thorium-230) are predicted to remain below Project thresholds in all waterbodies throughout the Project phases and in the far future. Radionuclide concentrations were predicted to increase in Patterson Lake in 2029 when active Project discharges commence at the beginning of Operations. The occurrence of peak concentrations at this time would propagate downstream through the waterbodies in the LSA (i.e., to Naomi Lake) but diminish in relative magnitude. The primary source of radionuclides to Patterson Lake would be the treated effluent discharge associated with groundwater pumped to surface from mining activities and collection of contact water from the PAG WRSA and ore storage stockpile at the surface. Peak COPC radionuclide concentrations are noted in Patterson Lake in 2052 in the final year of discharge, after which concentrations decrease in Patterson Lake and all downstream waterbodies reach a pseudo-steady-state concentration by approximately 2100 (e.g., radium-226; Figure 10.5-10).

Figure 10.5-10: Application Case Radium-226 Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Bq/L = becquerels per litre.

10.5.1.2.5 Atmospheric Deposition

Results from the atmospheric deposition assessment (Appendix 7A) for the Application Case indicate that effects solely from air deposition would be localized and result in minor changes to COPC concentrations and TSP in Lake C, Lake E, Unnamed Lake 1, and Unnamed Lake 2. These effects were limited to the lifespan of the Project and associated with Project air emissions during Operations.

The increase in COPC concentrations in Lake C, Lake E, Unnamed Lake 1, and Unnamed Lake 2 from air deposition in the Application Case relative to the Base Case was minor and did not result in any COPC threshold exceedances (Table 10.5-5). The COPCs with the greatest predicted concentration increase relative to the Base Case were mercury, polonium-210, radium-226, thorium-230, and uranium (Table 10.5-5). The largest increases in COPC concentration based on maximum predicted monthly average concentrations were observed in Unnamed Lake 2, followed by Lake E, Lake C, and Unnamed Lake 1. The larger increases predicted in Unnamed Lake 2 were attributed to this waterbody being in the predominant downwind direction from the Project site. The mercury air deposition concentration calculated from the air quality dispersion model was below the detection limit for all lakes, so the source input to the deposition assessment for mercury was set at the detection limit, meaning there is some uncertainty with mercury concentration projections; however, these concentrations are likely to be lower than predicted (i.e., a conservative assumption).

Additional context regarding the air quality dispersion model is provided in Section 7.2, Air Quality. Detailed results of the atmospheric deposition assessment in the RSWQM are presented in Appendix 10A.

Table 10.5-5: Maximum Predicted Water Quality Concentrations as a Result of Atmospheric Deposition in Lake C, Lake E, Unnamed Lake 1, and Unnamed Lake 2 for the Application Case

Constituent	Units	COPC Threshold	Base Case Concentration	Maximum Predicted Monthly Average Concentration during Lifespan of the Project			
				Lake C	Lake E	Unnamed Lake 1	Unnamed Lake 2
Mercury	mg/L	0.000026	0.0000015	0.0000031	0.0000035	0.0000034	0.0000053
Uranium	mg/L	0.015	0.000056	0.00015	0.00024	0.00014	0.00027
Lead-210	Bq/L	22	0.012	0.013	0.015	0.013	0.015
Polonium-210	Bq/L	13.5	0.0043	0.0078	0.012	0.0094	0.013
Radium-226	Bq/L	0.11	0.0033	0.0047	0.0062	0.0041	0.0062
Thorium-230	Bq/L	95	0.0052	0.0066	0.0081	0.0060	0.0081

COPC = constituent of potential concern; Bq/L = becquerels per litre.

The results of the desktop analysis undertaken to estimate the average annual incremental increase in TSS due to the aerial deposition (Section 10.2.8.1.3.1, Atmospheric Deposition) showed that the maximum predicted incremental increase in TSS concentration in Lake C, Lake E, Unnamed Lake 1, and Unnamed Lake 2 during the lifespan of the Project is well under 0.1 mg/L and therefore not expected to be measurable. The estimated incremental TSS increase in the small lakes are as follows:

- Lake C – 0.01 mg/L
- Lake E – 0.031 mg/L
- Unnamed Lake 1 – 0.013 mg/L
- Unnamed Lake 2 – 0.033 mg/L

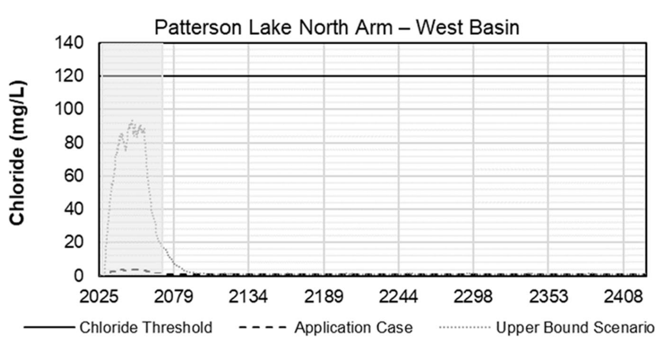
These results suggest that the deposition of TSP from the air emissions from the Project to small lakes in the LSA near the Project is expected to have negligible effects on ambient TSS concentrations.

10.5.1.2.6 Sensitivity Analysis

The reasonable upper bound sensitivity scenario used upper bound inputs from the integrated models supporting the RSWQM and was completed to provide a sensitivity assessment to model inputs for the Application Case. Results from the reasonable upper bound sensitivity scenario in the RSWQM indicated that all modelled COPCs remained below thresholds throughout the lifespan of the Project when the ETP and STP would be active. In the far-future projection, COPCs remained below their respective thresholds, except cobalt and copper. Cobalt exceedances are noted throughout the LSA (i.e., Patterson Lake North Arm – West Basin to Beet Lake). Copper exceedances are only noted in Patterson Lake North Arm – West Basin and Patterson Lake South Arm. Detailed results and time series plots of COPCs for the RSWQM are presented in Appendix 10A.

Concentrations of COPC major ions in the reasonable upper bound sensitivity scenario are predicted to be below thresholds throughout the Project lifespan and in the far-future projection. The modelled differences in sulphate concentrations and hardness (i.e., primarily calcium and magnesium) values between the modelled Application Case and the upper bound scenario are small because their primary source of loading is from the process plant and this input does not vary between the Application Case and reasonable upper bound sensitivity scenario. However, the modelled differences in chloride concentrations between the modelled Application Case and the upper bound scenario was large. Average monthly predicted chloride concentrations during Operations for the Patterson Lake North Arm – West Basin are 22 times higher in the reasonable upper bound sensitivity scenario compared to the Application Case (Figure 10.5-11). The primary loading source of chloride to the North Arm – West Basin would be from groundwater collected from the underground, transferred to the surface and treated, and subsequently discharged as treated effluent to Patterson Lake during Operations, and the chloride concentration input from this source varies between the Application Case and reasonable upper bound sensitivity scenario.

Figure 10.5-11: Chloride Concentration in Patterson Lake North Arm – West Basin for the Application Case and Reasonable Upper Bound Sensitivity Scenario

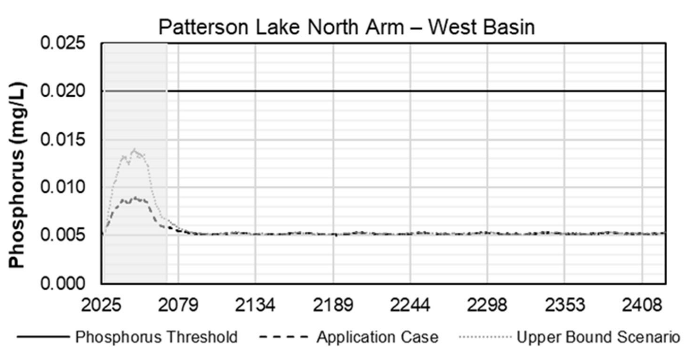


Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

In the reasonable upper bound sensitivity scenario, COPC nutrient concentrations are predicted to remain below thresholds in all waterbodies in the LSA throughout the Project lifespan and in the far future. Concentration trends over time for COPC nutrients are similar to the Application Case, where an increase in concentration is noted in Patterson Lake at the start of Construction (i.e., nominally 2025 for the purpose of modelling), which propagates to all downstream waterbodies in the LSA. Total ammonia and nitrate concentration trends are similar between the modelled Application Case and the reasonable upper bound sensitivity scenario. This similarity is because the primary sources of these COPCs (i.e., treated sewage and explosive blasting residuals) and their source term concentrations in the Application Case and the reasonable upper sensitivity scenario are similar. However, peak average monthly phosphorus concentrations in Patterson Lake during Operations in the reasonable upper bound sensitivity scenario are approximately 1.4 times higher than the Application Case (Figure 10.5-12) because of the increase in source term concentrations used for the WRSAs, ore stockpile, and special waste stockpile in the SWWBM.

For the reasonable upper bound sensitivity scenario, Patterson Lake North Arm – West Basin and Patterson Lake South Arm may temporarily shift trophic state from oligotrophic to mesotrophic during the lifespan of the Project. The maximum phosphorus concentration in the North Arm – West Basin and South Arm of Patterson Lake is predicted to be 0.014 mg/L and 0.012 mg/L, respectively. The downstream waterbodies would remain oligotrophic throughout all the Project phases (i.e., productivity status does not change). The North Arm – West Basin and South Arm of Patterson Lake are projected to be in a mesotrophic status for 27 years (2033 to 2060) and 25 years (2040 to 2065), respectively. The productivity status in all waterbodies would return to oligotrophic in the far future. Note, however, that the modelling did not account for uptake by algae, so basin-wide concentrations have a high likelihood of being overestimated by this approach – changes to trophic status are unlikely.

Figure 10.5-12: Phosphorus Concentration in Patterson Lake North Arm – West Basin for the Application Case and Reasonable Upper Bound Sensitivity Scenario

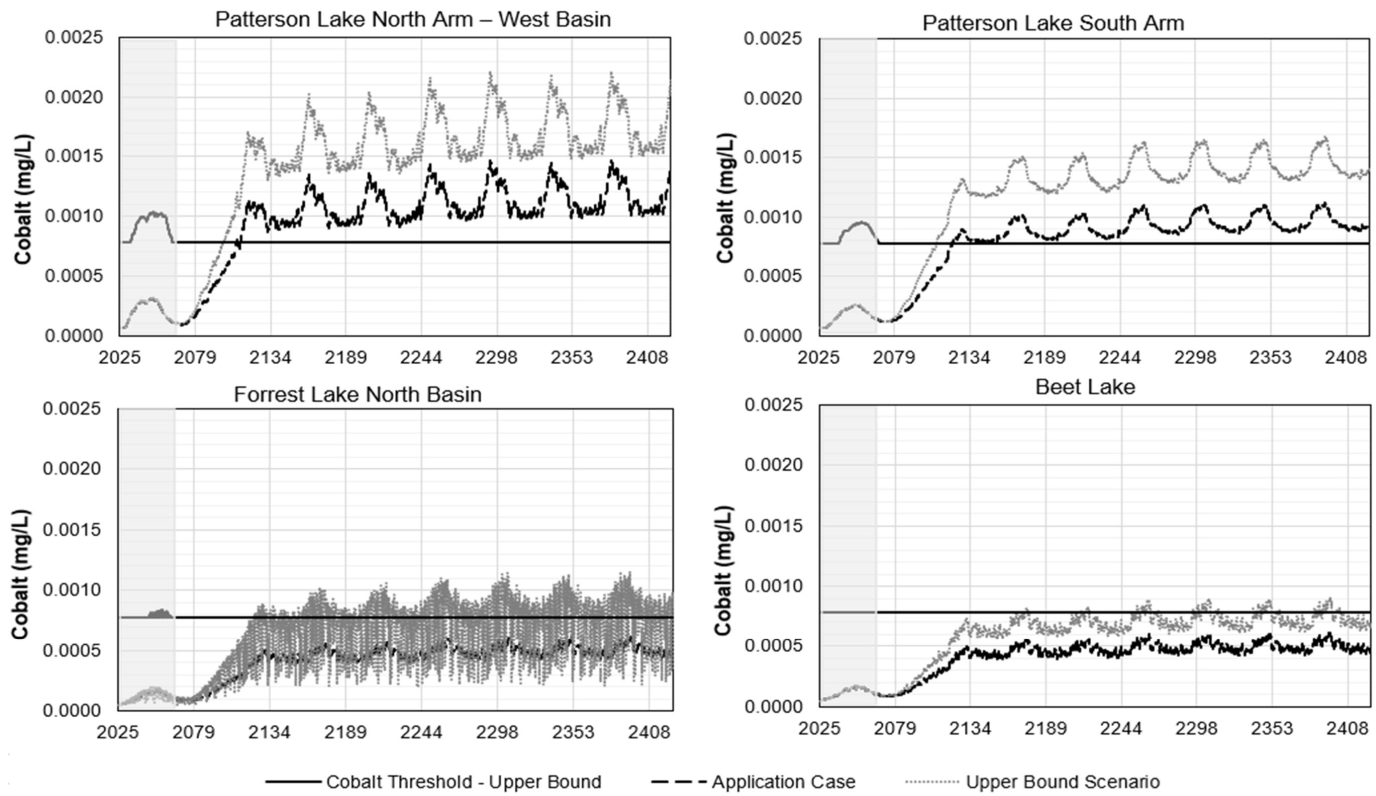


Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Concentrations of COPC metals in the reasonable upper bound sensitivity scenario are predicted to remain below thresholds in all waterbodies in the LSA throughout the lifespan of the Project. Most COPC metals remained below thresholds in the far-future projection, except cobalt and copper. In general, COPC metal concentrations and trends during the lifespan of the Project under the reasonable upper bound sensitivity scenario were similar to those in the Application Case. This similarity is because the primary source of metals in ETP discharges to Patterson Lake would be from the process plant and metals concentrations are similar between the Application Case and reasonable upper bound scenario (TSD XVIII). One notable exception is uranium, where the average monthly uranium concentration in Patterson Lake North Arm – West Basin is approximately two times higher in the reasonable upper bound sensitivity scenario. This increase is primarily due to the difference in source term concentration for contact water from the ore storage stockpile between the Application Case and the reasonable upper bound sensitivity scenario.

In the far-future projection, COPC metal concentrations in the reasonable upper bound sensitivity scenario were predicted to be up to 3.8 times higher, depending on the COPC metal, than the projected concentrations in the Application Case. The greatest differences were noted for lead and molybdenum. Similar to the Application Case, aluminum, cadmium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, uranium, and zinc concentrations would increase in the waterbodies downstream of the Project through the LSA in the far future before reaching a pseudo-steady-state. Although these COPC metal concentrations are predicted to be higher in the far future in the reasonable upper bound scenario, cobalt and copper remained the only COPCs that exceeded thresholds. The magnitude of the cobalt and copper exceedances in downstream waterbodies is greater in the reasonable upper bound sensitivity scenario compared to the Application Case (Figure 10.5-13 and Figure 10.5-14). Peak cobalt and copper concentrations in Patterson Lake and downstream waterbodies were 1.4 to 1.5 greater in the reasonable upper bound scenario compared to the Application Case.

Figure 10.5-13: Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin, and Beet Lake for the Application Case and Reasonable Upper Bound Sensitivity Scenario

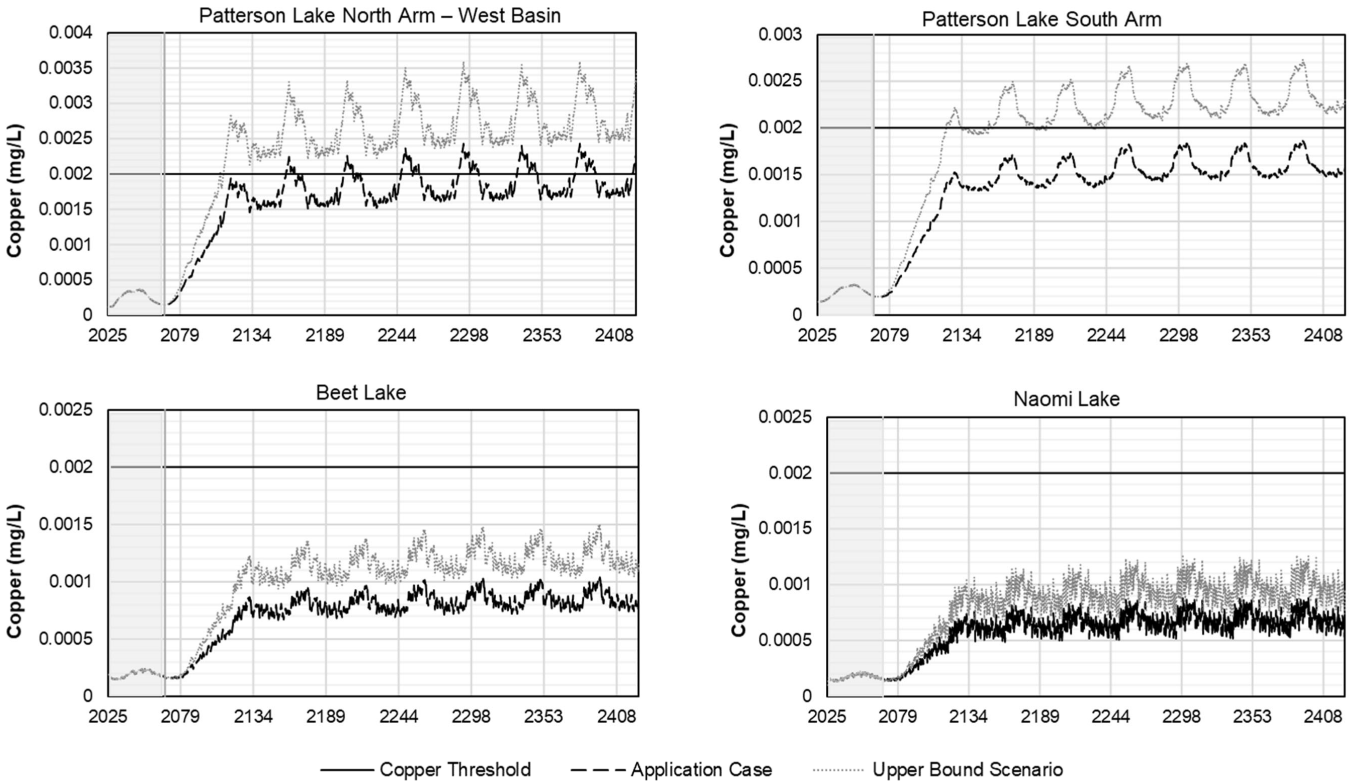


Note: The cobalt threshold is calculated based on the projected hardness concentration in the waterbody, with threshold values ranging from 0.000–78 mg/L to 0.0010 mg/L; see Section 10.2.8.3 for more detail.

Commented [LM36]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

The shaded area of the plot is representative of the Project lifespan, and the un-shaded area is representative of the far future.

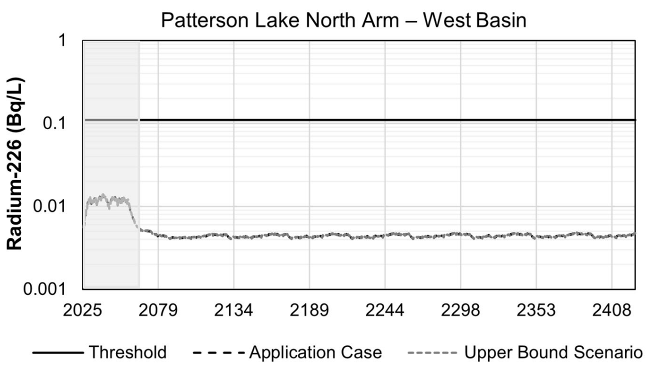
Figure 10.5-14: Copper Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Beet Lake, and Naomi Lake for the Application Case and Reasonable Upper Bound Sensitivity Scenario



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Concentrations of COPC radionuclides in the reasonable upper bound sensitivity scenario are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and in the far-future projection. Concentration trends for radionuclides in the reasonable upper bound sensitivity scenario are similar to the Application Case, where concentrations increased steadily throughout Operations and peak concentrations occurred in Patterson Lake North Arm – West Basin in 2051 near the end of Operations (Figure 10.5-15). The changes to COPC concentrations are propagated downstream and attenuate through downstream waterbodies in the LSA (i.e., to Naomi Lake). Concentrations for all COPC radionuclides decreased in the far future and achieved pseudo-steady-state concentrations by approximately 2100.

Figure 10.5-15: Radium-226 Concentration in Patterson Lake North Arm – West Basin for the Application Case and Reasonable Upper Bound Sensitivity Scenario



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Bq/L = becquerels per litre.

10.5.2 Reasonably Foreseeable Development Case

The RFD Case includes the Application Case plus the planned Fission Patterson Lake South Property. This reasonably foreseeable mining development would be located on the west shore of Patterson Lake at the most westerly point where the North Arm and South Arm meet and would withdraw fresh water from Patterson Lake North Arm – West Basin and discharge treated effluent and treated sewage to Patterson Lake South Arm (Fission 2019, 2021). Surface runoff from a covered waste rock storage facility and an above-ground tailings management facility would be directed to the North Arm – West Basin and South Arm, respectively. The Fission Patterson Lake South Property is assumed to commence in 2025, with a three-year construction period followed by a six-year operations period and a five-year closure/decommissioning period (Section 10.2.5).

The RFD Case includes an assessment of effects on surface water quality from direct discharges to Patterson Lake from the ETP and STP from the Project and the Fission Patterson Lake South Property, and site surface runoff and deposition of aerial emissions from both developments. The effects of seepages from the UGTMF to groundwater associated with the Project during the lifespan of the Fission Patterson Lake South Property is also included in the assessment. Detailed results and time series plots for all COPCs for the RFD Case are presented in Appendix 10A.

10.5.2.1 Regional Surface Water Quality Model

Results from the RSWQM for the RFD Case indicate that there are no additional COPC threshold exceedances beyond cobalt and copper during the lifespan of the Project and in the far-future projection as a result of the cumulative effects from the Project and the Fission Patterson Lake South Property. Like the Application Case, all modelled COPCs remain below their respective thresholds throughout the Project phases, with cobalt and copper modelled above thresholds in the far future.

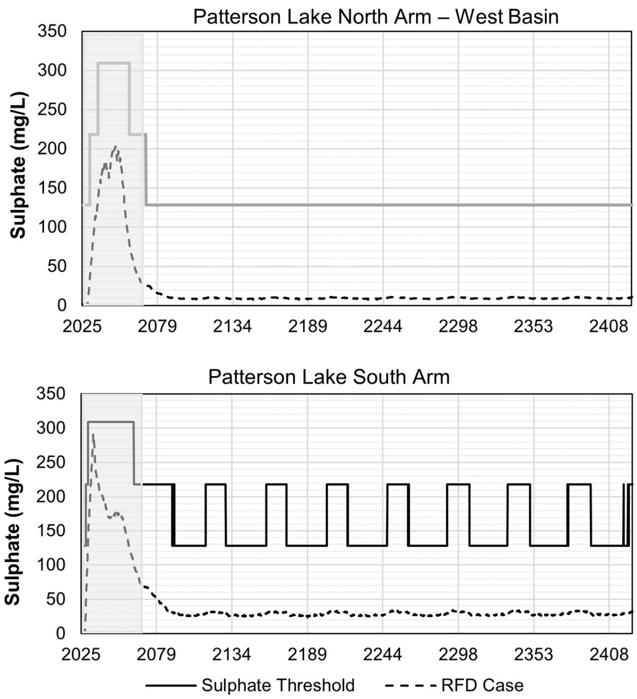
Predicted COPC concentrations in the regional environment are summarized in the following subsections, and all concentrations are presented as monthly averages.

10.5.2.1.1 Major Ions

In the RFD Case, concentrations of COPC major ions are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and in the far-future projection. As in the Application Case, modelled concentrations of the COPC major ions would increase in Patterson Lake in 2029 at the beginning of Project Operations when the active discharge of treated effluent commences (e.g., sulphate; Figure 10.5-16). No substantial changes are predicted in Patterson Lake North Arm – East Basin and West Basin in the RFD Case compared to the Application Case. Peak concentrations for all major ions are predicted in Patterson Lake North Arm – West Basin at the end of Project Operations, after slowly increasing throughout the time span when the ETP would be actively discharging. Concentrations would subsequently decrease with the cessation of active mine discharges (e.g., sulphate; Figure 10.5-16). Pseudo-steady-state conditions in the far future would be achieved by approximately 2100. The concentrations of COPC major ions in Patterson Lake in the far future would be slightly higher in the RFD Case compared to the Application Case. This increase is due to the addition of major ion loadings to Patterson Lake South Arm from the Fission Patterson Lake South Property above-ground tailings management facility and covered waste rock storage facility site runoff, which would attenuate downstream in the LSA.

Concentrations of major ions in Patterson Lake South Arm, in terms of magnitude and timing, would differ from the Application Case because of effects from the Fission Patterson Lake South Property. Concentrations are predicted to be greatest in Patterson Lake South Arm during the Fission Patterson Lake South Property operational period, where treated effluent discharge and runoff from the above-ground tailings management facility would be directed. A distinct initial peak in COPC major ion concentrations is noted in 2033 in Patterson Lake South Arm at the end of the Fission Patterson Lake South Property operations when site discharges are expected to cease (e.g., sulphate, up to 290 mg/L; Figure 10.5-16). The initial peak is predicted to occur at this time because combined inputs from both projects accumulate loads and concentrations in the lake over time, which then begin to briefly decline as soon as the Fission Patterson Lake South Property operations ceases discharge. Compared to the Application Case, this peak is due to the additional influence on COPC major ion concentrations in Patterson Lake North Arm – West Basin as a result of surface runoff from the Fission Patterson Lake South Property covered waste rock storage facility. A smaller, secondary peak is noted in 2052 for all COPC major ions; the timing of this peak is consistent with the Application Case, coinciding with the end of Project Operations (Figure 10.5-16). The influence of the Fission Patterson Lake South Property on this peak with respect to sulphate is predicted to be an incremental increase of approximately 25 mg/L. The cumulative effects from the Project and the Fission Patterson Lake South Property would be propagated downstream and would be noted in all downstream lakes in the LSA (i.e., to Naomi Lake) but diminish in relative magnitude with both distance and time.

Figure 10.5-16: Reasonably Foreseeable Development Case Sulphate Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm



Note: The sulphate threshold is calculated based on the projected hardness concentration in the waterbody, with threshold values ranging from 128 mg/L to 309 mg/L; see Section 10.2.8.3 for more detail.
The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.
RFD = reasonably foreseeable development.

Commented [LM37]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

10.5.2.1.2 Nutrients

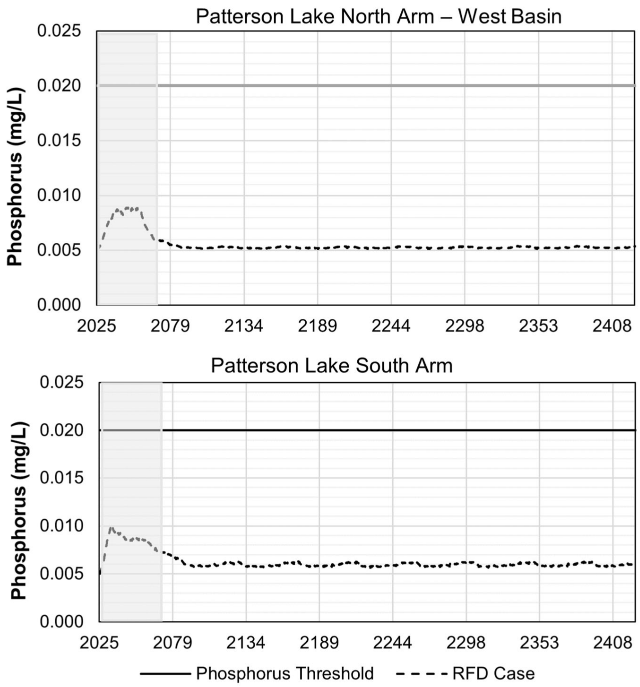
In the RFD Case, concentrations of COPC nutrients (i.e., ammonia, nitrate, phosphorus) are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project and the far-future projection. As in the Application Case, an increase in COPC nutrient concentration is noted in Patterson Lake at the beginning of Project Construction when the discharge of treated sewage effluent is anticipated to commence in Patterson Lake North Arm – West Basin. Peak nutrient concentrations are noted at the end of Project Operations (phosphorus; Figure 10.5-17) and concentrations are subsequently expected to decrease to Base Case concentrations following the cessation of Project discharges from the ETP and STP. Incremental increases in nutrient concentrations are predicted to be noted in all downstream lakes in the LSA, with concentrations attenuating with distance downstream. Like the Application Case, pseudo-steady-state conditions in the far-future projection would be achieved by approximately 2100.

In terms of magnitude and timing, concentrations of COPC nutrients in Patterson Lake South Arm differ from the Application Case because of effects from the treated effluent and treated domestic sewage discharges from Fission Patterson Lake South Property into this region of Patterson Lake. Concentrations are expected to be greatest in Patterson Lake South Arm during the Fission Patterson Lake South Property operational period. An initial peak in COPC nutrient concentrations is noted at the end of the Fission Patterson Lake South Property operations period at the point when the treated effluent and treated sewage discharges from the Fission Patterson Lake South Property is anticipated to cease (e.g., phosphorus; Figure 10.5-17). A smaller, secondary peak is noted in 2052 at the end of Project Operations, consistent with the predicted trends for the Application Case (Figure 10.5-17). The elevated COPC nutrient concentration effects would be propagated downstream through all downstream lakes in the LSA (i.e., to Naomi Lake), but attenuate in relative magnitude.

The peak phosphorus concentration in Patterson Lake South Arm at the end of the Fission Patterson Lake South Property operations period is anticipated to briefly reach the oligotrophic/mesotrophic trophic status boundary (i.e., 0.010 mg/L; Figure 10.5-17). Despite the peak concentration in Patterson Lake South Arm briefly reaching the phosphorus threshold, Patterson Lake and the downstream LSA waterbodies are projected to remain oligotrophic during the lifespan of the Project.

Similar to the COPC major ion trends, COPC nutrient concentrations in the far-future projection are predicted to be slightly higher in the RFD Case compared to the Application Case, but the increase is small. For example, pseudo-steady-state phosphorus concentrations are consistently less than 0.001 mg/L higher in Patterson Lake South Arm in the far future in the RFD Case compared to the Application Case, with concentrations peaking near 0.006 mg/L. The slight increase in COPC concentrations in the far future is because of the anticipated additional nutrient loadings to Patterson Lake from the Fission Patterson Lake South Property above-ground tailings management facility and covered waste rock storage facility site runoff after closure. Despite the small increase in phosphorus concentrations in the far future, the trophic state of Patterson Lake would remain oligotrophic.

Figure 10.5-17: Reasonably Foreseeable Development Case Phosphorus Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

RFD = reasonably foreseeable development.

10.5.2.1.3 Trace Metals

In the RFD Case, concentrations of COPC trace metals are predicted to remain below thresholds in all waterbodies throughout the lifespan of the Project. All COPC metals, except for cobalt and copper, are predicted to remain below their thresholds in the far-future projection. Similar to the Application Case, COPC metal concentrations are predicted to begin to increase in Patterson Lake North Arm – West Basin in 2029 when active Project discharge commences, and peak at the end of Operations.

The projected cobalt and copper concentrations and trends in the far future are very similar to the Application Case because the primary loading source of these constituents in the far future would be from the groundwater inflows to Patterson Lake from the Project.

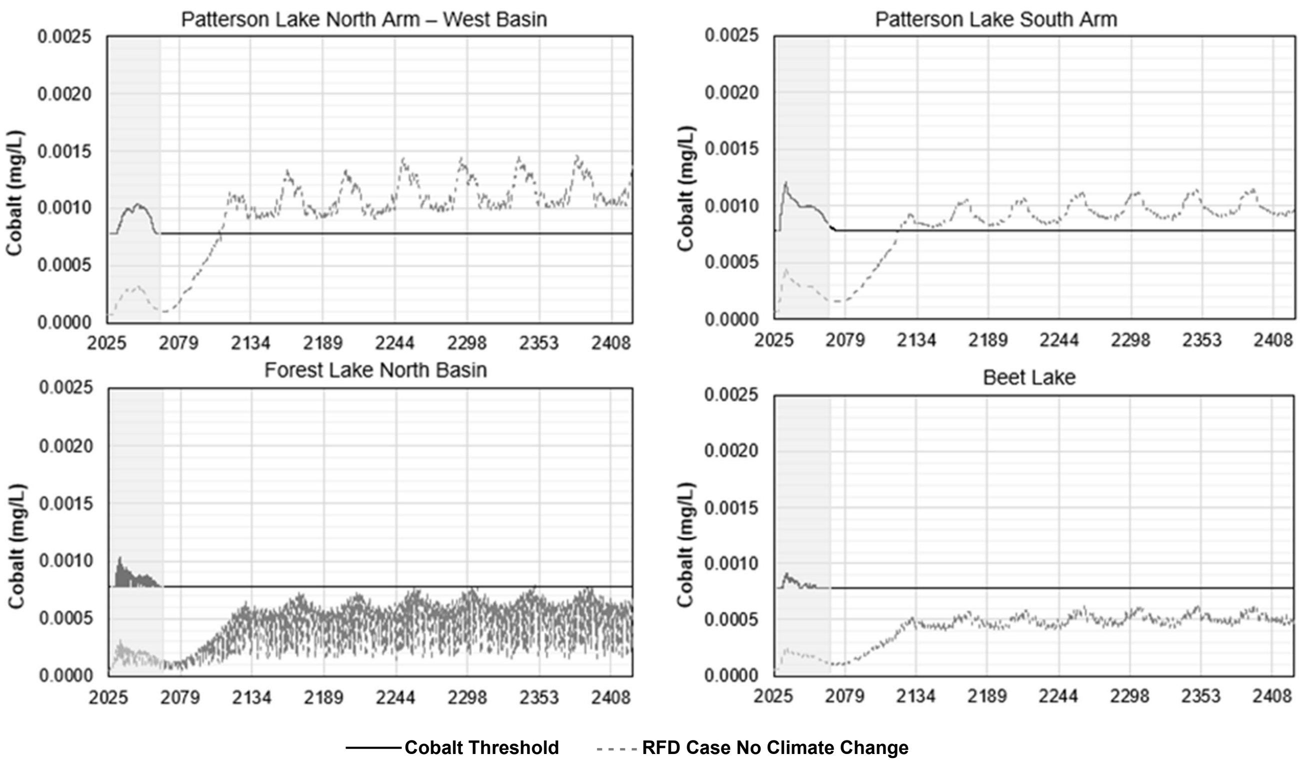
Similar to the COPC nutrient and major ion trends in the RFD Case during the life of the Project, a distinct increase in COPC metal concentrations in Patterson Lake South Arm is predicted to occur due to the treated effluent discharge from the Fission Patterson Lake South Property. Concentrations would steadily increase starting at the beginning of Project and Fission Patterson Lake South Property construction (i.e., nominally 2025 for the purposes of modelling) and reach a peak at the end of the operational period of the Fission Patterson Lake South Property (i.e., 2033). Concentrations in the South Arm would decrease slightly until reaching a smaller, secondary peak at the end of Project Operations.

As with the Application Case, the COPC metal concentrations in the far-future projection are predicted to either increase or decrease before reaching a pseudo-steady-state concentration, with aluminum, cobalt, copper, iron, manganese, molybdenum, nickel, selenium, uranium, and zinc concentrations being greater in the far future than during the lifespan of the Project. The primary loading source for metals in the far future would be from groundwater influenced by seepage from the underground workings and PAG WRSA. Despite the primary contribution of COPC metals from loading to groundwater from the Project, COPC metal concentrations are slightly elevated in the RFD Case compared to the Application Case (e.g., cobalt; Figure 10.5-18). This increase is because the Fission Patterson Lake South Property above-ground tailings management facility and covered waste rock storage facility site runoff is predicted to supply an additional mass load of metals to Patterson Lake. Since the model input climate dataset cycles every 43 years (Section 10.2.8.1.3, Regional Surface Water Quality Model), the far-future metal trends also demonstrate cyclical trends that repeat throughout each climate cycle. Metals concentrations are generally predicted to be highest during dry climate years and lowest during wet climate years when there would be higher natural runoff into the lake.

In the far future, the average monthly cobalt concentrations are predicted to consistently exceed the threshold value in Patterson Lake North Arm – West Basin and Patterson Lake South Arm, peaking at 0.0015 mg/L and 0.0011 mg/L, respectively (Figure 10.5-18). Similar to the COPC major ion and nutrient trends, cobalt concentrations in the far-future projection are predicted to be slightly higher in the RFD Case compared to the Application Case, but the increase is small. Cobalt concentrations would begin to increase in these basins following Project Closure when the ETP stops actively discharging and mass loadings from the groundwater increase. It takes approximately 50 years for the concentrations to exceed the threshold in the North Arm – West Basin and 60 years for the South Arm. As noted in Section 10.2.4, the modelling timeframe for the far-future projection consists of a 157-year period that considers the hydrogeological processes from the site followed by 200 years where the hydrogeological mass load inputs are artificially increased in the RSWQM to incorporate maximum loadings in an earlier than anticipated timeframe. Cobalt exceedances are limited to Patterson Lake with the maximum monthly cobalt concentrations in Forrest Lake – North Basin (i.e., 0.00077 mg/L) predicted to be just below the Project threshold. The cobalt concentrations in the far future would attenuate through the downstream waterbodies (Figure 10.5-18).

In the far future, copper threshold exceedances are predicted periodically in Patterson Lake North Arm – West Basin but remain below the threshold in Patterson Lake South Arm (Figure 10.5-19). As with cobalt in the RFD Case, copper concentrations in the far-future projection are predicted to be slightly higher compared to the Application Case, but the increase is small. Similar to the trends noted for cobalt, the copper concentration in Patterson Lake would begin to increase after Project Closure due to influx of mass load inputs from groundwater that has been affected by seepage from the PAG WRSA. It takes approximately 90 years before an exceedance in copper is predicted in Patterson Lake North Arm – West Basin (i.e., 2159), and the predicted concentrations fluctuate above and below the threshold for the remainder of the far-future projection as the climate dataset cycles through the model, peaking at 0.0024 mg/L (Figure 10.5-19). The duration of the exceedances increases in the 200-year interval after the maximum groundwater loadings are applied to the model. No copper exceedances are predicted in the waterbodies downstream of Patterson Lake North Arm – West Basin. As described further in Section 10.7, the predicted concentrations of cobalt and copper are thought to result from conservative assumptions; these results form the basis for an Adaptive Management Plan that would be applied throughout Operations to protect aquatic health in Patterson Lake and downstream lakes at Closure.

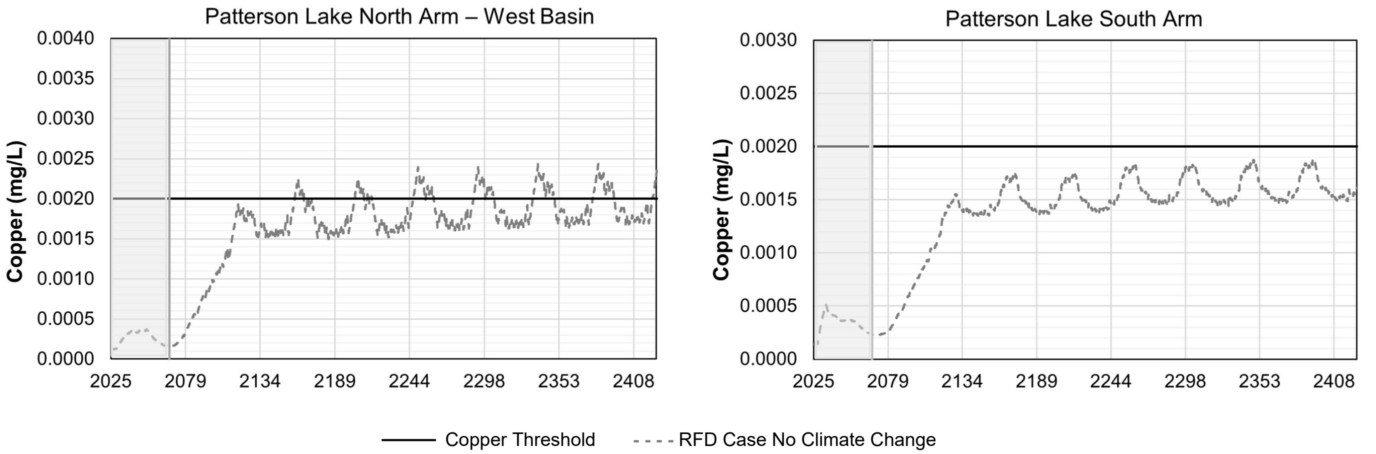
Figure 10.5-18: Reasonably Foreseeable Development Case Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin and Beet Lake



Note: The cobalt threshold is calculated based on the projected hardness concentration in each waterbody, with threshold values ranging from 0.000–78 mg/L to 0.0010 mg/L; see Section 10.2.8.3 for more detail.
The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.
RFD = reasonably foreseeable development.

Commented [LM38]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

Figure 10.5-19: Reasonably Foreseeable Development Case Copper Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.
RFD = reasonably foreseeable development.

10.6 Prediction Confidence and Uncertainty

As a consequence of the approach to complete the surface water quality assessment for this Project, which includes an understanding of the existing surface water quality and sediment quality conditions, the proposed mine plan at the time of the assessment, and the conservatism associated with the modelling tasks (and those of the other component assessments that provided inputs to the surface water quality models), NexGen is confident that the assessment has not underestimated the potential effects of the Project to the surface water quality. This conclusion includes the cumulative effects assessment incorporating RFDs. As the assessment includes both the expected water quality effects of the Project in the Application Case, as well as a reasonable upper bound scenario, the results of the assessment represent the range of water quality effects that can be expected from the Project.

Scientific inference is associated with uncertainty, and prediction confidence depends on the level of uncertainty and the way it is addressed. Primary factors affecting confidence in the predictions made in the surface water and sediment quality assessment include:

- availability and accuracy of baseline data;
- level of understanding of baseline conditions and range of natural and seasonal variation;
- accuracy and certainty in the source terms;
- accuracy and certainty of the models and modelling software;
- level of understanding of the strength of primary pathways (i.e., mechanisms) in terms of the effects they are likely to have on water and sediment quality;
- level of certainty associated with the effectiveness of proposed mitigations, where applicable; and
- level of understanding of the cumulative drivers of change in measurement indicators and associated effects on water and sediment quality.

Additionally, confidence in the assessment of predicted sulphate concentrations relied on the scientific understanding that increasing hardness is a modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023, BC MECCS 2019).

Commented [LM62]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

Uncertainty was managed by:

- reviewing historical data and relevant studies completed in the LSA and RSA;
- completing quality assurance and quality control of baseline data;
- incorporating conservative estimates, inputs, and assumptions;
- using known constituent concentrations for similar site analogues when the information was unknown;
- calibrating the models to measured data; and
- conducting sensitivity analysis on key parameters.

The foundation of the surface water quality assessment for the Project is the use of modelling to project future conditions of surface water quality in the receiving environment (i.e., waterbodies in the LSA) under the Application Case, and in the RFD Case, which includes the addition of the Fission Patterson Lake South Property. As with all modelling approaches to project future water quality conditions, the predictions made in this assessment incorporate some degree of uncertainty. As a result, the assessment applied the precautionary approach to address uncertainty by identifying the greatest magnitude, duration, and geographic extent of potential adverse effects when a range of possible outcomes was possible. Consequently, uncertainty was addressed in a manner that increased the level of confidence that the assessed residual effects on surface water quality in the receiving environment did not underestimate potential effects from Project interactions. The components of the surface water quality assessment where key uncertainties are considered include:

- baseline water quality data;
- SWWBM;
- RSWQM; and
- NFWQM.

10.7 Monitoring, Follow-Up, and Adaptive Management

This subsection presents a summary of the identified monitoring and follow-up proposed to monitor the Project interactions with potential adverse effects as well as validate the residual effects predictions, as described in Section 10.4 and Section 10.5, respectively. The monitoring program would be used to address the prediction uncertainties per Section 10.6.

Specifically, follow-up and monitoring programs would be used to:

- verify that the site contact water management infrastructure is operating as designed and evaluate the effectiveness of the surface water protection controls in place;
- monitor for changes in water quality, including hardness, ~~changes~~ in the receiving environment as a result of Project activities;
- verify the predictions of the EIS and confirm that the aquatic ecosystem in the receiving environment is protected;
- confirm the adequacy of the study areas (i.e., confirm that effects do not extend beyond boundaries);
- track the trajectories of constituents that were identified in sensitivity analyses, such as chloride, phosphorus, cobalt, and copper so that these constituents can be proactively and adaptively managed;
- evaluate the effectiveness of reclamation and other mitigation actions, and modify or enhance as necessary through monitoring and developing updated mitigation, if needed;
- identify unanticipated negative effects, including possible accidents and malfunctions; and
- contribute to the overall continual improvement of the Project.

Commented [LM63]: Change related to IR 89-R1 from 22 October 2024 comment table from CNSC.

Water quality monitoring for the Project may be divided into two parts:

- site contact water monitoring, which includes the Project processes as well as the area directly affected by the Project footprint, and monitoring of treated effluent to verify discharge criteria is met prior to batch discharge and release to Patterson Lake (i.e., upstream of the final point of control); and
- the surface water receiving environment monitoring (i.e., Patterson Lake and downstream).

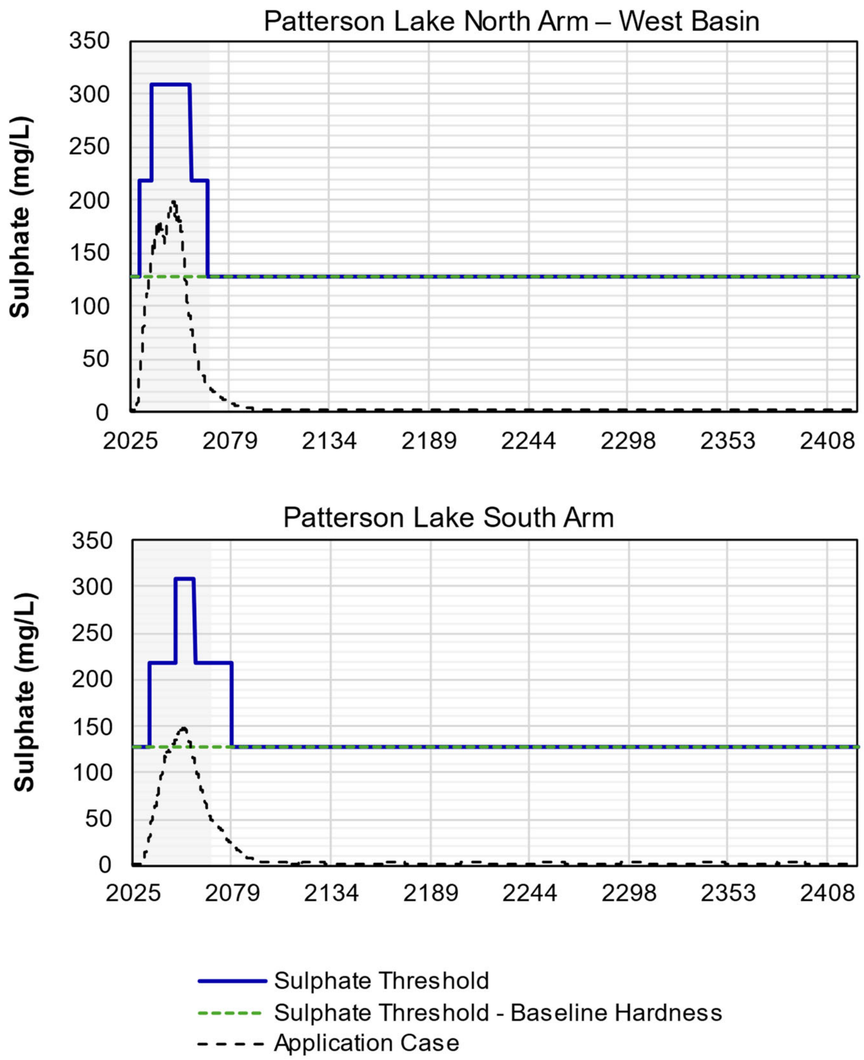
Preliminary treated effluent release targets have been used for this assessment; through continued Project engineering and optimization, final treated effluent release targets would be proposed as part of the licence application submission to CNSC to meet REGDOC-2.9.2 requirements (CNSC 2021c). The follow-up work would also include an analysis of best available technology and techniques, economically achievable (BATEA). Additionally, an Environmental Code of Practice documenting action levels and corresponding management response measures for treated effluent would be in place based as per REGDOC-2.9.2. If the measurements in the Effluent and Emissions Plan or Environmental Monitoring Plan trend away from the EIS predictions and/or towards the COPC Project thresholds, response plans, and/or adaptive management actions would be triggered.

In addition, Environmental Committees (i.e., one per primary Indigenous Group) composed of two NexGen and two Indigenous Group representatives would be established to act in an oversight manner to monitor the environmental performance of the Project and verify the parties are implementing the regulatory and environmental commitments made in respect of the Project.

Indigenous Groups have made recommendations related to mitigating the effects of the Project on the environment, including community-led long-term environmental testing and monitoring during Construction and Operations of the proposed Project (TSD IV: MN-S; TSD V.2: CRDN; YNLRO 2019). NexGen has committed to provide funding for the lifespan of the Project for a full-time independent Indigenous Monitor chosen by each primary Indigenous Group; this Indigenous Monitor would have access to conduct environmental sampling for the Project, subject to the Indigenous Monitor complying with appropriate health and safety and other reasonable site-specific policies. The Indigenous Monitor would be able to report openly and without restriction to the Environmental Committee and Indigenous Group's community members on the performance of the Project. The Indigenous Monitor would also provide regular reports to the Environmental Committee.

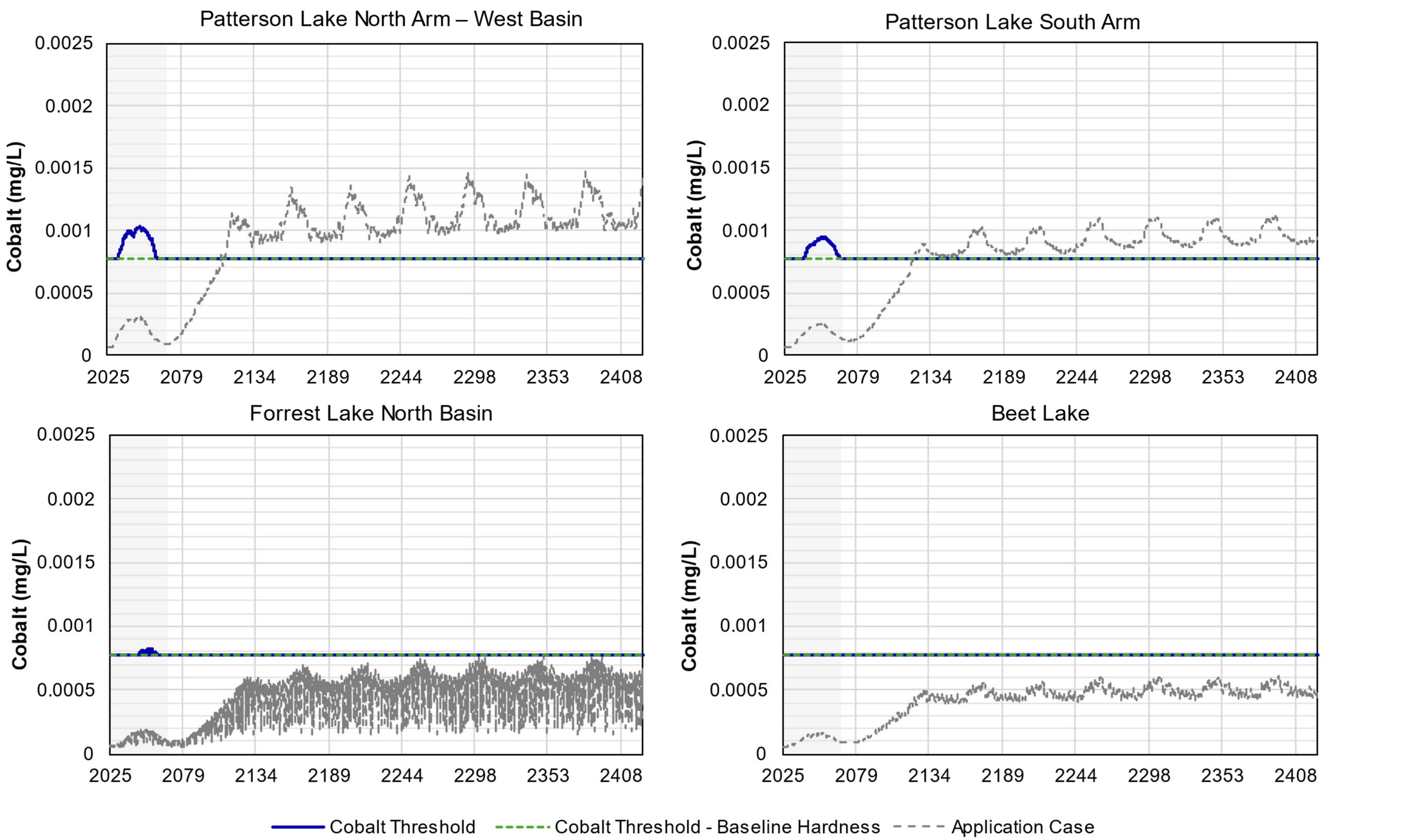
Attachment IR 89-R1

Figure 1: Application Case Sulphate Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm (Replicated from Figure 10.5-6 [Section 10.5.1.2.1] using Baseline Hardness Values to Calculate the Threshold)



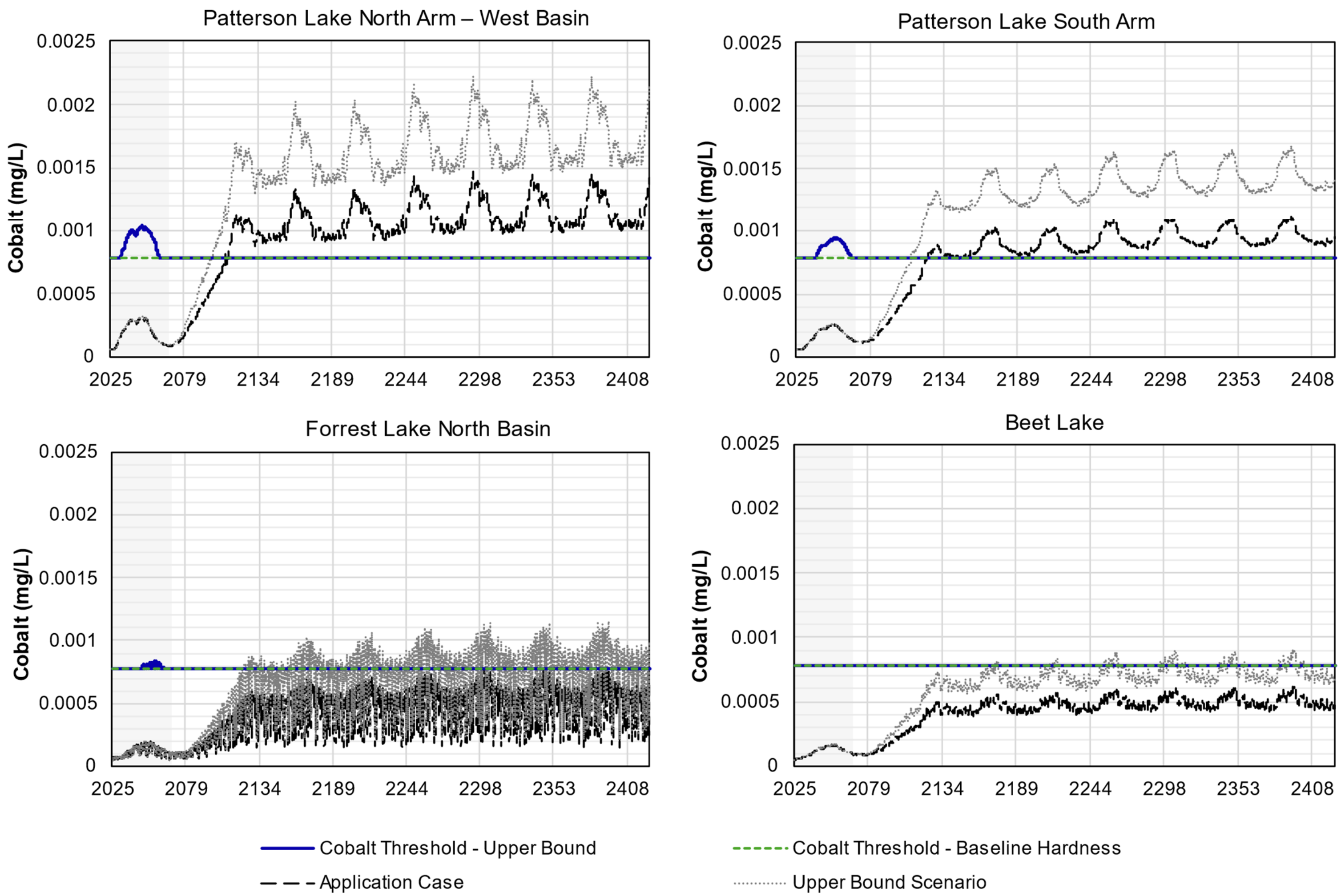
Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Figure 2: **Application Case Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin, and Beet Lake (Replicated from Figure 10.5-8 [Section 10.5.1.2.3] using Baseline Hardness Values to Calculate the Threshold)**



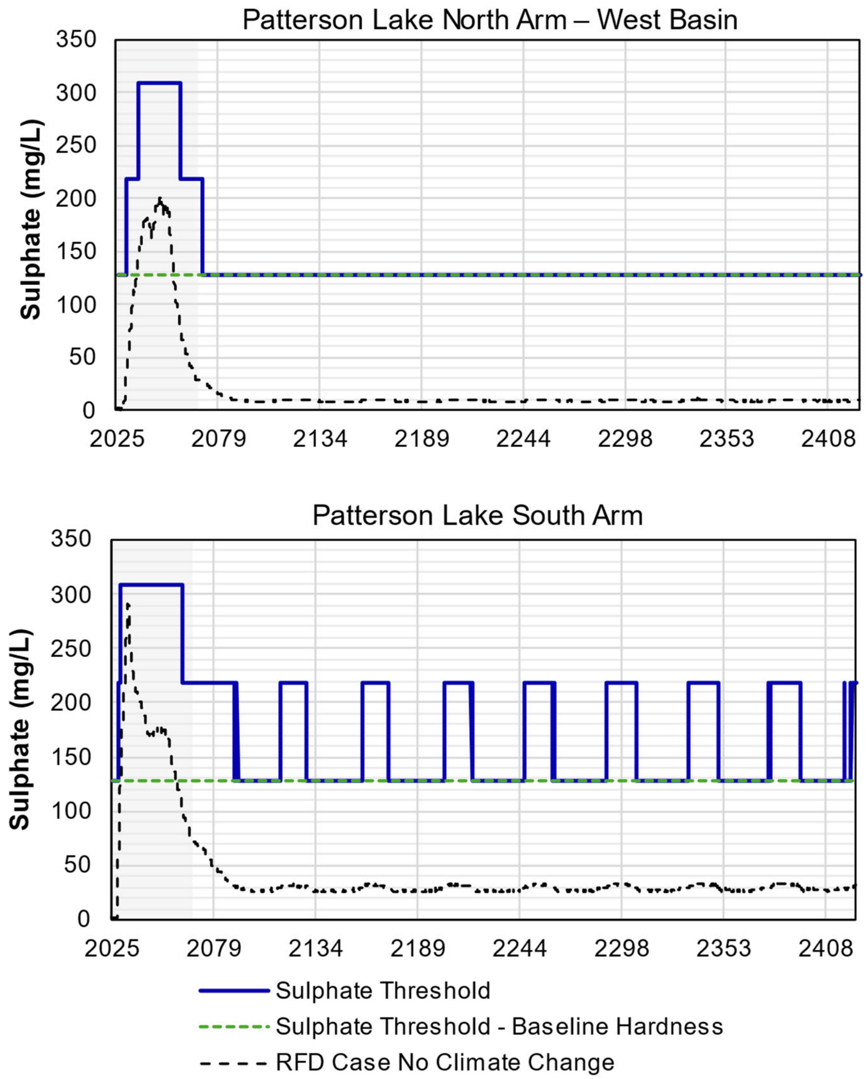
Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Figure 3: Application Case and Reasonable Upper Bound Sensitivity Scenario Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin, and Beet Lake (Replicated from Figure 10.5-13 [Section 10.5.1.2.6] using Baseline Hardness Values to Calculate the Threshold)



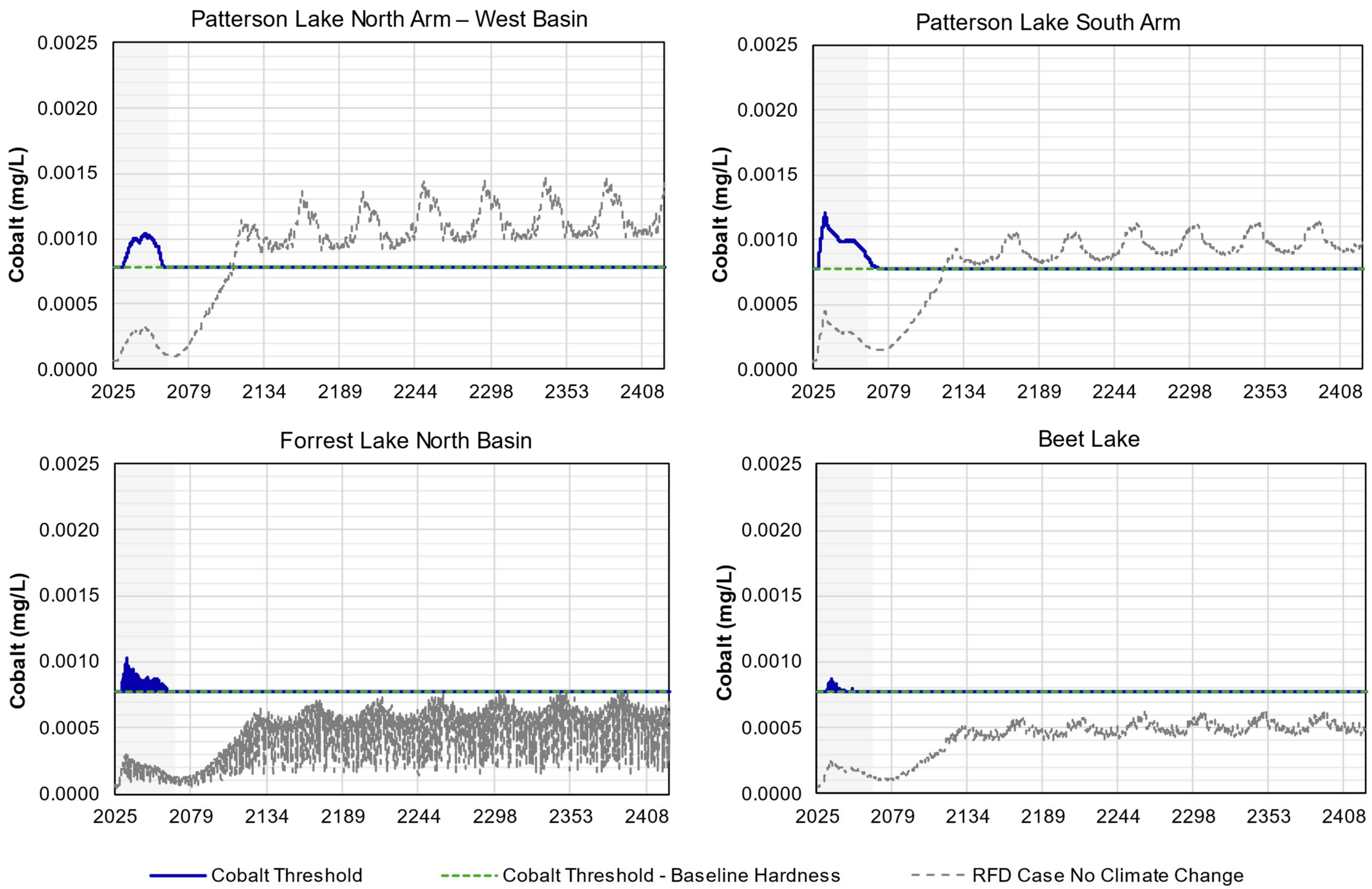
Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Figure 4: **Reasonably Foreseeable Development Case Sulphate Concentration in Patterson Lake North Arm – West Basin and Patterson Lake South Arm (Replicated from Figure 10.5-16 [Section 10.5.2.1.1] using Baseline Hardness Values to Calculate the Threshold)**



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

Figure 5: Reasonably Foreseeable Development Case Cobalt Concentration in Patterson Lake North Arm – West Basin, Patterson Lake South Arm, Forrest Lake – North Basin, and Beet Lake (Replicated from Figure 10.5-18 [Section 10.5.2.1.3] using Baseline Hardness Values to Calculate the Threshold)



Note: The shaded area of the plot is representative of the lifespan of the Project, and the unshaded area is representative of the far-future projection.

IR 96

No.	Justification/Rationale	Follow up Information Request	NexGen Response
96	**Justification:** In the response to part one of this IR, The Proponent has confirmed that Table 10A-34 in Section 10A7.4.1 of revised EIS Appendix 10A (Surface Water Quality Modelling Report) will be updated to provide clarification and corrections. Also, text will be added to Section 10A7.4.1 in revised EIS Appendix 10A (Surface Water Quality Modelling Report) to provide further clarification regarding Table 10A-34. However, these changes were not present in the revised EIS. In the response for part two, the Proponent commits to incorporating additional context into the revised EIS and has provided some text. It is noted that some of the provided text to be added to the EIS is the same as was provided in the response to IR-89-R1, but references a different table and different section of the EIS. **Rationale:** The response to part one of the IR will be accepted pending the incorporation of the updates described in the response into the future revised EIS. The response provided for part two is high-level and does not contain sufficient information to demonstrate how project-induced increases in hardness result in changes to the water quality guidelines, and how the predicted concentrations of COPC's compare to these hardness-dependent guidelines.	**Information Request:** In order to resolve this IR, NexGen is required to: 1. Incorporate the updates described in the responses into the future revised EIS. 2. Address Part 2 of IR-96-R1. Provide a greater level of detail, including specifics on how much the hardness increases, how this subsequently changes the guidelines, and how the concentrations of the COPCs compare to these guidelines. Graphs depicting this information would strengthen the response and the revised EIS.	The following information is provided by NexGen to address part 1 of IR 96-R1 as described in the reviewer's follow-up comment, which requested that updates described in NexGen's May 2024 response to part 1 of IR 96-R1 be included in the EIS. NexGen confirms that the information committed to be included in the May 2024 response to part 1 of IR 96-R1 was included in the revised EIS submitted in May 2024. For ease of review, that information can be found in: **Table 10A-34 in Section 10A7.4.1 of revised EIS Appendix 10A (Surface Water Quality Modelling Report)** ▪ Footnotes c, d, and e were added to Table 10A-34 on page 10A-72. ▪ Corrections to the bolded sulphate concentrations were completed in Table 10A-34 on page 10A-71. **Section 10A7.4.1 of revised EIS Appendix 10A** ▪ The second paragraph was added in this subsection on page 10A-70. The following information is provided by NexGen to address part 2 of IR 96-R1 as described in the reviewer's follow-up comment, which both requested that updates described in NexGen's May 2024 response to IR 96-R1 be included in the EIS and requested that additional information be included in the EIS. 1. NexGen confirms that the information committed to be included in the May 2024 response to part 2 of IR 96-R1 was included in the revised EIS submitted in May 2024. For ease of review, that information can be found in: **Section 10A4.1 of revised EIS Appendix 10A** ▪ A paragraph was added below Table 10A-4 on page 10A-15 and page 10A-16. **Section 10A6.4.1.2 of revised EIS Appendix 10A** ▪ The third paragraph in this subsection was modified on page 10A-29. 2. In addition to the updates NexGen committed to and subsequently made in the May 2024 revised EIS (i.e., Section 10A4.1 of EIS Appendix 10A and Section 10A6.4.1.2 of EIS Appendix 10A), the following two paragraphs will be added at the end of Section 10A4.1 of Appendix 10A in the Final EIS to provide the greater level of detail requested: "During this period, the hardness in Patterson Lake North Arm – West Basin is predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to approximately 100 mg/L as $CaCO_3$ during Operations. Increased hardness levels are also predicted in downstream waterbodies, but to a lesser extent with distance downstream. In downstream waterbodies, hardness levels are predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to maximum values of approximately 60 mg/L as $CaCO_3$ in Forrest Lake North Basin and 50 mg/L as $CaCO_3$ in Beet Lake and Naomi Lake. These changes to hardness in the receiving environment are illustrated in the Hardness figures in Attachment 10-A2.

No.	Justification/Rationale	Follow up Information Request	NexGen Response
			As also illustrated in Attachment 10-A2, maximum predicted concentrations of cadmium, copper, lead, manganese, and nickel remain below thresholds that are derived using baseline hardness concentrations. Consequently, adjustment for ambient hardness was not required to assess potential effects related to these metals. In contrast, the sulphate threshold is calculated based on the projected hardness concentration and varies over time, with threshold values ranging from 128 mg/L to 309 mg/L. The cobalt threshold also varies with ambient hardness over time, with threshold values ranging from 0.00078 mg/L to 0.0010 mg/L. These variable thresholds are illustrated in Attachment 10-A2, which also shows how the predicted concentrations of sulphate and cobalt compare to these thresholds.”

IR 96-R1 (Confirmation of Information in May 2024 Revised EIS)

NexGen confirms that the requested changes associated with NexGen's response to IR 96-R1 were incorporated into the May 2024 revised EIS. In response to FIRT IR 96-R1, NexGen committed to making four changes to the EIS (Section 10A7.4.1 and Table 10A-34 of Section 10A7.4.1, Section 10A4.1, and Section 10A6.4.1), as highlighted below in a screenshot from the IR response table and the sections where the changes were made.

96	ECCC	Fish and fish habitat Change to an environmental component due to hazardous contaminants	Section Appendix 10A7.4.1	**Context**: It is incorrectly stated that only chloride concentrations exceed water quality thresholds at the edge of the mixing zone from the Effluent Treatment Plant (ETP). Table 10A-34 pg. 1777 demonstrates that both sulphate and chloride exceed water quality thresholds at the edge of the mixing zone. Additionally, this table should be updated to include all parameters of interest from the *Metal and Diamond Mining Effluent Regulations* (MDMER) and their respective water quality thresholds. **Rationale**: ECCC advice is to include the general water quality parameters that influence water quality thresholds in this table and parameters in Schedule 4 of the MDMER, so that any changes over	1. Include all general water quality parameters (ex. pH, temperature, hardness, total suspended solids, etc.) and un-ionized ammonia in Table 10A-34. 2. Include all water quality thresholds for each parameter in Table 10A-34. 3. Update the conclusions on water quality threshold exceedances at the edge of the mixing zone in this section to address sulphate exceedances and any other changes to general water quality parameters over the Project lifespan.	Responses to part 1, part 2, and part 3 of this IR are provided below. 1. and 2. The mixing zone modelling results shown in Table 10A-34 in Section 10A7.4.1 of Draft EIS Appendix 10A (Surface Water Quality Modelling Report) are limited to the constituents that screened in as constituents of potential concern (COPCs) in the assessment. Therefore, general constituents such as pH, temperature, hardness, and total suspended solids are not included in this table as these constituents were not identified as COPCs. However, in response to the meeting with the CNSC and Environment and Climate Change Canada (ECCC) on 9 June 2023, NexGen will update Table 10A-34 in Section 10A7.4.1 of revised EIS Appendix 10A to clarify assumptions for constituents flagged as exceeding Project thresholds where the value or concentration of other measured constituents (e.g., pH, temperature, hardness) contributed to the exceedances. These added assumptions will assist the CNSC and ECCC in verifying the identification	Appendix 10A, Section 10A7.4.1	**Context:** The Proponent has agreed to update Table 10A-34 to include general water quality parameters (ex. pH, temperature, hardness, total suspended solids, etc.) and un-ionized ammonia to address parts one and two of the original IR but has not provided the updated table for review. Additionally, in their response to part three of the original IR, the Proponent confirmed that sulphate concentrations in the nearfield receiving environment are not considered a threshold exceedance because the sulphate water quality threshold will increase from 128 mg/L to 429 mg/L over the course of the Project lifecycle due to increases in hardness concentrations from effluent deposition. However, the Proponent has not fully addressed and updated conclusions regarding	96-R1	1. Provide updated Table 10A-34 for review of proposed changes. 2. Within Appendix 10A Surface Water Quality Modelling Report include a discussion on how changes to receiving aquatic environment hardness concentrations are a Project-related effect. Discuss the implications of this effect to hardness-derived water quality guidelines and calculated concentrations of COPCs for nearfield water quality modelling results.	The following response is provided to address both part 1 and part 2 of the IR. 1. NexGen confirms that, as noted in the initial response to the original IR, NexGen will update Table 10A-34 in Section 10A7.4.1 of revised EIS Appendix 10A (Surface Water Quality Modelling Report) to both clarify assumptions for constituents flagged as exceeding Project thresholds where the value or concentration of other measured constituents (e.g., pH, temperature, hardness) contributed to the exceedances and correct the bolded sulphate concentrations. To also support the reviewer's request in the original IR, NexGen will add the following text in Section 10A7.4.1 in revised EIS Appendix 10A (Surface Water Quality Modelling Report): "Table 10A-34 is limited to presenting the selected COPCs that apply specifically to protection of aquatic life, drinking water quality, and primary productivity. Constituents that are ETMFs to specific COPCs, such as pH, temperature, and hardness, have not been included because they were not identified as COPCs. However, the determination of a threshold exceedance for COPCs	Section 10A.6.4.1.2; Section 10A7.4.1

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No.	Department	Project Effects Link	Reference to EIS, appendices, or supporting documentation (if applicable)	Context and Rationale	Information Requirement	NexGen Response	Section in EIS	Justification/Rationale	Follow up IR #	Follow up Information Request	NexGen Response	Section in EIS
				the lifespan of the Project can be reviewed.		of the Project thresholds. NexGen also notes this broader range of constituents would be included in monitoring programs during the life of the Project. 3. With respect to the constituent exceedances identified by ECCC in the near-field mixing model results tables, the identification of sulphate in Table 10A-34 in Section 10A7.4.1 of Draft EIS Appendix 10A for the 'End' period of Operations for the ETP [effluent treatment plant] Reasonable Upper Bound Sensitivity Scenario and the STP [sewage treatment plant] Application Case exceeding its Project threshold at the edge of the mixing zone was an error. During this time, the Project threshold for sulphate would be 429 mg/L in the mixing zone because of the associated higher hardness; the maximum predicted sulphate concentrations at this time for both the ETP Reasonable Upper Bound Sensitivity Scenario and the STP Application Case are below the Project threshold.		changes to other water quality parameters over the Project lifespan. **Rationale:** An updated Table 10A-34 should be reviewed to validate the additional information and confirm all the requested information was included. Additionally, as described in IR-89 (CIAR doc #79) changes in hardness of the receiving aquatic environment causes an increase to the water quality thresholds of certain COPCs, which should be discussed as a Project effect within the Draft EIS and relevant appendices.			based on their projection takes into account the associated projection of any ETMF as applicable to a COPC. Where the potential for toxicity by specific COPCs is modified based on additional constituents defined as ETMFs (e.g., pH, temperature), assumptions regarding their influence on the selected Project threshold for those COPCs are provided as footnotes to Table 10A-34." 2. NexGen agrees with the reviewer that the revised EIS would benefit from additional context regarding increasing hardness from Project effluent and how increases in hardness influences the calculation of water quality thresholds for certain COPCs. To provide these details, the following context will be added in Section 10A4.1 of revised EIS Appendix 10A (Surface Water Quality Modelling Report): "As noted in Table 10A-2, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and	

						Sensitivity Scenario and the STP Application Case are below the Project threshold. For this reason, the only predicted exceedance at the edge of the mixing zone is chloride. NexGen notes that the highlighted exceedance of chloride at the edge of the mixing zone is limited to the upper bound modelling scenario, which represents a conservative modelling case. Further, the maximum predicted chloride concentration (i.e., 134 mg/L) is just above the Project threshold (i.e., 120 mg/L), so any aquatic risk associated with exposure to that concentration is considered negligible. This conclusion is additionally supported by recent work by Elphick et al. (2011), which showed hardness is an effective exposure and toxicity modifying factor for chloride, meaning that any possible risk of exposure to the maximum predicted concentration would be mitigated by the corresponding elevated hardness at the edge of the mixing zone at this time. With respect to part 3 of this IR, NexGen will update Table 10A-34 in Section 10A7.4.1 of the revised EIS Appendix 10A to correct the bolded sulphate concentrations. NexGen confirms no other changes to conclusions for general water quality constituents over the Project lifespan are required to address part 3 of this IR. __References__ Elphick JRF, Bergh KD, Bailey HC. 2011. Chronic toxicity of chloride to freshwater species: effects of hardness and implications for water quality guidelines. Environmental Toxicology and Chemistry. 30, 239-246.					"As noted in Table 10A-2, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project." In addition, the third paragraph in Section 10A.6.4.1.2 of revised EIS Appendix 10A will be modified to read as follows: "Predicted concentrations of selected constituents are summarized for the Project lifespan and far future in Table 10A-11 and Table 10A-12, respectively, and are illustrated in Attachment 10A-2. An increase from existing conditions for all modelled constituents as well as hardness is predicted in the three basins during Operations (i.e., 2029 to 2052). In general, COPC concentrations and hardness gradually increase throughout the Project lifespan in the three basins with the highest concentrations of COPCs observed in the North Arm – West Basin, which receives the Project discharges, followed by the South Arm and the North Arm – East Basin. Peak COPC concentrations during the Project lifespan are noted in the final years of Operations (i.e., 2051 in the North Arm – East Basin and North Arm – West Basin, and in 2052 in the South Arm), after which they steadily decline as the COPC mass loads are dispersed downstream after Operations discharges cease. Hardness is also expected to return to baseline conditions following Closure. The modelled projections do not show a discernible seasonal effect in the basins, likely due to their large volumes." __References__	

Section 10A7.4.1 (Regional Surface Water Quality Model Modelled Constituents) in May Revised EIS

10A7.4 Estimated Concentrations at the Edge of the Regulated Mixing Zones

The concentrations of water quality constituents at the edge of the RMZs were calculated based on the dilution factors predicted by the NFWQM. The following formula was used to estimate the water quality concentrations at various distances from the outfall/diffuser including the edge of the mixing zone.

$$C_x = \frac{C_{eff}}{D_x} + (1 - \frac{1}{D_x}) \times C_{lake}$$

Where:

- C_x concentration at a distance from the outfall/diffuser (mg/L);
- x distance from outfall/diffuser (m);
- C_{eff} effluent concentration predicted by SWWBM (mg/L);
- C_{lake} lake-wide concentration predicted by RSWQM (mg/L); and
- D_x dilution factor at distance x.

The dilution factors at the edge of the RMZs for the ETP diffuser and STP outfall were calculated by averaging the predicted dilution factors at 100 m for all scenarios modelled for the Application Case. As the sensitivity analysis showed that the ETP diffuser performance was not predicted to change under the reasonable upper bound sensitivity scenario, a dilution factor of 29.9:1 was also used for the ETP diffuser for the reasonable upper bound sensitivity scenario.

The following subsection provides the predictions of concentrations at the edge of the RMZs for the COPCs represented in the RSWQM. Additional water quality parameters not represented in the RSWQM, specifically, water temperature, DO, and TSS, are discussed in Section 10A7.4.2, Additional Water Quality Constituents in the Near-field Area.

10A7.4.1 Regional Surface Water Quality Model Modelled Constituents

Predicted COPC concentrations at the edge of the mixing zone are summarized in Table 10A-34, based on average treated effluent concentrations discharged from the STP and ETP over Project Operations, as predicted by the SWWBM and the lake-wide concentrations predicted by the RSWQM. As the Project is expected to alter the water quality in Patterson Lake, results are provided for predicted conditions at the beginning of Operations (i.e., 2029) and near the end of Operations where the concentrations are highest at the edge of the mixing zone (i.e., 2048).

Table 10A-34 is limited to presenting the selected COPCs that apply specifically to protection of aquatic life, drinking water quality, and primary productivity. Constituents that are ETMFs to specific COPCs, such as pH, temperature, and hardness, have not been included because they were not identified as COPCs. However, the determination of a threshold exceedance for COPCs based on their projection takes into account the associated projection of any ETMF as applicable to a COPC. Where the potential for toxicity by specific COPCs is modified based on additional constituents defined as ETMFs (e.g., pH, temperature), assumptions regarding their influence on the selected Project threshold for those COPCs are provided as footnotes to Table 10A-34.

The near-field modelling results for the STP and ETP discharges show that concentrations of COPCs remain below water quality thresholds at the edge of the mixing zones, except for chloride from the ETP for the reasonable upper bound sensitivity scenario, at near the end of Operations.

Table 10A-34: Predicted Constituent of Potential Concern Concentrations at the Edge of the Regulated Mixing Zones

Constituent	Units	Effluent Concentration							
		ETP Application Case		ETP Reasonable Upper Bound Sensitivity Scenario		STP Application Case		STP Reasonable Upper Bound Sensitivity Scenario	
		Start[(a)]	End[(b)]	Start[(a)]	End[(b)]	Start[(a)]	End[(b)]	Start[(a)]	End[(b)]
Major Ions									
Calcium	mg/L	20	48	20	48	5.1	33	5.1	34
Chloride	mg/L	2.9	5.5	67	**130**	0.8	3.9	6.7	91
Sulphate	mg/L	108	290	110	290	12	190	12	200
Nutrients									
Total ammonia (as nitrogen)[(c)]	mg/L	0.26	0.47	0.26	0.47	0.18	0.43	0.18	0.44
Un-ionized ammonia (as nitrogen)[(d,e)]	mg/L	0.00022	0.00040	0.0002	0.00040	0.00016	0.00038	0.00016	0.00038
Nitrate (as nitrogen)	mg/L	0.27	0.46	0.28	0.49	0.070	0.32	0.080	0.34
Total phosphorus	mg/L	0.0070	0.010	0.010	0.017	0.0080	0.011	0.0090	0.016
Total Metals (unless otherwise noted, all metals are reported as total)									
Aluminum	mg/L	0.007	0.017	0.0070	0.017	0.004	0.014	0.004	0.014
Arsenic	mg/L	0.0014	0.0038	0.0014	0.0039	0.0002	0.0026	0.0002	0.0027
Cadmium	mg/L	0.000007	0.000009	0.000007	0.000009	0.000007	0.000009	0.000007	0.000009
Chromium	mg/L	0.00026	0.00028	0.00026	0.00028	0.00026	0.00027	0.00026	0.00027
Cobalt	mg/L	0.00019	0.00042	0.00020	0.00044	0.00008	0.00031	0.00008	0.00032
Copper	mg/L	0.00024	0.00047	0.00025	0.00047	0.00014	0.00036	0.00014	0.00036
Iron	mg/L	0.053	0.050	0.053	0.050	0.054	0.051	0.054	0.051
Lead	mg/L	0.000059	0.000076	0.000059	0.000076	0.000059	0.000076	0.000059	0.000076
Manganese	mg/L	0.018	0.023	0.018	0.023	0.019	0.024	0.019	0.024
Mercury	mg/L	0.0000052	0.0000125	0.0000067	0.0000159	0.0000031	0.0000103	0.0000035	0.0000127
Molybdenum	mg/L	0.0003	0.0007	0.0010	0.0020	0.0001	0.0005	0.0004	0.0014
Nickel	mg/L	0.00042	0.00104	0.00042	0.00106	0.00013	0.00074	0.00013	0.00075
Selenium	mg/L	0.00007	0.00010	0.00007	0.00011	0.00005	0.00009	0.00005	0.00009
Strontium	mg/L	0.042	0.056	0.537	1.057	0.031	0.048	0.077	0.723
Uranium	mg/L	0.00072	0.00183	0.00164	0.00348	0.00033	0.00152	0.00074	0.00271
Vanadium	mg/L	0.00013	0.00027	0.00013	0.00027	0.00007	0.00021	0.00007	0.00021
Zinc	mg/L	0.00080	0.00088	0.00081	0.00090	0.00078	0.00085	0.00078	0.00086

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Table 10A-34: Predicted Constituent of Potential Concern Concentrations at the Edge of the Regulated Mixing Zones

Constituent	Units	Effluent Concentration							
		ETP Application Case		ETP Reasonable Upper Bound Sensitivity Scenario		STP Application Case		STP Reasonable Upper Bound Sensitivity Scenario	
		Start[(a)]	End[(b)]	Start[(a)]	End[(b)]	Start[(a)]	End[(b)]	Start[(a)]	End[(b)]
Radionuclides									
Lead-210	Bq/L	1.8	2.6	5.3	8.2	1.1	2.1	2.6	5.9
Polonium-210	Bq/L	0.03	0.044	0.092	0.14	0.019	0.036	0.045	0.10
Radium-226	Bq/L	0.011	0.023	0.011	0.023	0.0068	0.019	0.0069	0.02
Thorium-230	Bq/L	0.043	0.085	0.043	0.086	0.011	0.062	0.011	0.063

a) Start of Project Operations (2029).
b) Near end of Project Operations (2048).
c) Project threshold for ammonia considers the proportion of total ammonia that is un-ionized ammonia.
d) Function of total ammonia, pH, and temperature.
e) The average seasonal pH and average monthly temperature of samples were used to calculate the fraction factor.
Bold values indicate exceedances of selected water quality COPC thresholds.
Bq/L = becquerels per litre; COPC = constituent of potential concern; ETP = effluent treatment plant; STP = sewage treatment plant.

Section 10A4.1 (Water Quality Project Thresholds – Constituents of Potential Concern) in May Revised EIS

Table 10A-4: Drinking Water Quality Guidelines and Water Quality Thresholds Selected for Constituents of Potential Concern

Parameter	Unit	Health Canada[a,b]	World Health Organization[c]	Selected Project Threshold
Major Ions				
Chloride	mg/L	250[d]	n/a	250
Sulphate	mg/L	500[d]	n/a	500
Nutrients				
Nitrate (as nitrogen)	mg/L	10	11	10
Total Metals (unless otherwise noted, all metals are reported as total)				
Aluminum	mg/L	0.1	n/a	0.1
Arsenic	mg/L	0.01	0.01	0.01
Cadmium	mg/L	0.007	0.003	0.007
Chromium[e]	mg/L	0.05	0.05	0.05
Copper	mg/L	2	2	2
Iron	mg/L	0.3[d]	n/a	0.3
Lead	mg/L	0.005	0.01	0.005
Manganese	mg/L	0.12	n/a	0.12
Mercury	mg/L	0.001	0.006	0.001
Nickel	mg/L	n/a	0.07	0.07
Selenium	mg/L	0.05	0.04	0.05
Strontium	mg/L	7	n/a	7
Uranium	mg/L	0.02	0.03	0.02
Zinc	mg/L	5	n/a	5
Radionuclides				
Lead-210	Bq/L	0.2	0.1	0.2
Polonium-210	Bq/L	n/a	0.1	0.1
Radium-226	Bq/L	0.5	0.1	0.5
Thorium-230	Bq/L	n/a	1	1

a) Health Canada 2020.
b) Maximum acceptable concentration provided unless otherwise indicated.
c) WHO 2017.
d) Guideline is an aesthetic objective.
e) Guidelines are for total chromium.
Bq/L = becquerels per litre; n/a = not applicable.

As noted in Table 10A-2, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation

of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project.

10A4.2 Regulatory Mixing Zones

A mixing zone is a transitional area within a waterbody in which a treated discharge is gradually mixed with the ambient water. The size of the mixing zone is influenced by the difference in water quality and density between the treated effluent and the receiving waterbody, and the receiving waterbody size and volume. The RMZ is an area defined by regulators to accommodate mixing and dispersion of the treated effluent after being discharged, where water quality objectives need to be met accounting for various discharge and receiving environment conditions. In this respect, Project water quality thresholds should not be exceeded outside of the outer edge of the mixing zone. Regulated mixing zones are applicable to both the ETP and STP discharge locations.

The regulatory framework applicable to the Project RMZ is from the Saskatchewan Water Security Agency

Section 10A6.4.1.2 (Patterson Lake) in May Revised EIS

10A6.4.1.2 Patterson Lake

In the Application Case, the three Patterson Lake basins are predicted to be affected by surface discharges and, to a lesser extent, atmospheric deposition from the Project; however, modelled COPCs in Patterson Lake remain below their respective thresholds throughout the Project lifespan. Modelled COPCs remain below their respective thresholds throughout the far future, except for cobalt and copper (Table 10A-11 and Table 10A-12). The model predicts cobalt and copper concentrations in Patterson Lake above their thresholds due to groundwater mass loading in the far future.

During the Project lifespan, the North Arm – East Basin is affected by the surface runoff (i.e., non-contact and contact with borrow material) from the Project. The North Arm – West Basin receives the ETP and STP discharges, west surface runoff discharge, and groundwater seepage from the Project. The South Arm does not receive any direct discharges from the Project. Water in the North Arm – West Basin occasionally flows into the North Arm – East Basin and South Arm, as dictated by water surface elevation in the basin.

Predicted concentrations of selected constituents are summarized for the Project lifespan and far future in Table 10A-11 and Table 10A-12, respectively, and are illustrated in Attachment 10A-2. An increase from existing conditions for all modelled constituents as well as hardness is predicted in the three basins during Operations (i.e., 2029 to 2052). In general, COPC concentrations and hardness gradually increase throughout the Project lifespan in the three basins with the highest concentrations of COPCs observed in the North Arm – West Basin, which receives the Project discharges, followed by the South Arm and the North Arm – East Basin. Peak COPC concentrations during the Project lifespan are noted in the final years of Operations (i.e., 2051 in the North Arm – East Basin and North Arm – West Basin, and in 2052 in the South Arm), after which they steadily decline as the COPC mass loads are dispersed downstream after Operations discharges cease. Hardness is also expected to return to baseline conditions following Closure. The modelled projections do not show a discernible seasonal effect in the basins, likely due to their large volumes. The primary source of the increases in major ions and nutrients in the Patterson Lake basins during the Project lifespan is the treated effluent discharge and treated sewage discharge. Following the cessation of these discharges, modelled concentrations of major ions and nutrients start to decline. All modelled major ions and nutrients remain below thresholds during the Project lifespan and in the far future in the three basins. Concentrations of metals and radionuclides also increase in the three basins during the Project lifespan, which is due to the treated effluent discharge. Following the cessation of these discharges, modelled concentrations of metals and radionuclides start to decline. All metal and radionuclide concentrations remain below threshold values during the Project lifespan.

In the far future, the primary load contribution to the North Arm – West Basin is from groundwater inflows that are influenced by surface water infiltration and constituent mobilization from Project infrastructure (i.e., WRSAs and underground workings). The COPCs that are influenced by this input and are modelled to increase in concentration are primarily metals and radionuclides. While the majority of COPCs remain below thresholds, cobalt and copper are the only COPCs projected to be higher than their respective thresholds in the far future. Cobalt concentrations consistently exceed the threshold value (i.e., 0.00078 mg/L) in the North Arm – West Basin and the South Arm, and copper concentrations periodically exceed the threshold value (0.0020 mg/L) in the North Arm – West Basin (Attachment 10A-2). During the far future, the highest concentrations correspond to years with low natural inflows to the lake and the lowest concentrations correspond to years with high natural inflows to the lake. Additional context regarding the modelled threshold exceedances of cobalt and copper is provided in the environmental risk assessment (TSD XXI, Environmental Risk Assessment).

10A4 APPLICABLE WATER QUALITY OBJECTIVES AND REGULATIONS

This subsection presents the applicable water quality objectives, defined as Project thresholds, and guidelines and regulations for mixing zones.

10A4.1 Water Quality Project Thresholds – Constituents of Potential Concern

As outlined in the surface water quality assessment methods (Section 10.2.8.3, Development of Thresholds), predicted water quality concentrations in the LSA were compared to project-specific water quality thresholds for all COPCs. The rationale for the development of the COPC list is provided in Section 10.2.8.2, Constituents of Potential Concern.

The water quality chronic (long-term) thresholds for the protection of aquatic life were generally based on the Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (CCME 2019, 2023) and Saskatchewan's provincial objectives (WSA 2015). Where no guidelines or objectives were available from the Canadian Council for Ministers of the Environment (CCME) or Saskatchewan, provincial objectives from British Columbia (BC MWLAP 2004; BC MOE 2019), Ontario (MOEE 1994), and the Federal Environmental Quality Guidelines (Environment Canada 1999) were used. The thresholds for the radionuclides were provided by the environmental risk assessment for the Project (TSD XXI, Environmental Risk Assessment), as neither CCME nor provincial guidelines are available.

Table 10A-2 provides a summary of the CCME guidelines, provincial water quality objectives, and the selected chronic (i.e., long-term) thresholds for the COPCs. These thresholds were carried forward for use in the surface water quality assessment and were used to compare modelled data for each of the measurement indicators used in the surface water quality assessment: water quality, drinking water quality, and productivity status. Table 10A-3 provides a summary of the CCME objectives for total ammonia for the protection of aquatic life, which accounts for the toxicity modifying factors of pH and temperature.

The thresholds for the drinking water quality constituent concentrations measurement indicator for the modelled COPCs in the assessment were developed based on Health Canada's guidelines for Canadian drinking water quality (Health Canada 2019, 2020). For parameters with no federal guidelines, the World Health Organization guidelines for drinking water quality were selected (WHO 2017). Table 10A-4 provides a summary of the water quality guidelines as well as the selected threshold.

Table 10A-2: Canadian Council of Ministers of the Environment Guidelines, Saskatchewan Provincial Objectives, and Selected Water Quality Thresholds

Parameter	Unit	CCME: Long Term (Chronic)[a][c]	Provincial Objectives (Chronic)[b][c]		Selected Constituent Project Threshold
General Parameters					
pH	n/u	6.5 – 9.0	6.5 – 9.0		6.5 – 9.0
Temperature	°C	Thermal additions should not alter thermal stratification or turnover dates, exceed maximum weekly average temperatures, nor exceed maximum short-term temperatures			
TSS	mg/L	Background + 5	n/a		Background + 5
Major Ions					
Chloride	mg/L	120	n/a		120
Sulphate	mg/L	n/a	<30 mg/L $CaCO_3$ 31 – 75 mg/L	128 mg/L[d] 218 mg/L[d]	128[e]

Table 10A-2: Canadian Council of Ministers of the Environment Guidelines, Saskatchewan Provincial Objectives, and Selected Water Quality Thresholds

Parameter	Unit	CCME: Long Term (Chronic)(a)(c)		Provincial Objectives (Chronic)(b)(c)		Selected Constituent Project Threshold
				$CaCO_3$ 76 – 180 mg/L $CaCO_3$ 181 – 250 mg/L $CaCO_3$ >250 mg/L $CaCO_3$	309 mg/L(d) 429 mg/L(d) site-specific(d)	
Nutrients						
Ammonia (un-ionized as N)	µg/L	15.6				
Ammonia as N (total)	mg/L	Function of un-ionized ammonia, pH, and temperature(f)				
Nitrate (NO_3 as N)	mg/L	3.0		n/a		3.0
Total phosphorus	mg/L	Ultra-oligotrophic <0.004 mg/L Oligotrophic: 0.004 – 0.01 mg/L Mesotrophic: 0.01 – 0.02 mg/L Meso-eutrophic: 0.02 – 0.035 mg/L Eutrophic: 0.035 – 0.1 mg/L Hyper-eutrophic: >0.1 mg/L		0.02(g)		0.02(g)
Total Metals (unless otherwise noted, all metals are reported as total)						
Aluminum	mg/L	<6.5 pH ≥6.5 pH	0.005 mg/L 0.1 mg/L	<6.5 pH, <4 mg/L calcium, <2 mg/L dissolved organic carbon ≥6.5 pH, ≥4 mg/L calcium, ≥2 mg/L dissolved organic carbon	0.005 mg/L 0.1 mg/L	0.1(h)
Arsenic	mg/L	0.005		0.005		0.005
Cadmium	mg/L	<17 mg/L $CaCO_3$ 17 – 280 mg/L $CaCO_3$ >280 mg/L $CaCO_3$	0.00004 mg/L $10^{\{0.83(\log(hardness))-2.46\}}$ 0.00037 mg/L	<17 mg/L $CaCO_3$ 17 – 280 mg/L $CaCO_3$ >280 mg/L $CaCO_3$	0.00004 mg/L $10^{\{0.83(\log(hardness))-2.46\}}$ 0.00037 mg/L	0.00004(i)
Chromium	mg/L	Chromium, hexavalent: 0.001 mg/L Chromium, trivalent: 0.0089 mg/L		Chromium, hexavalent: 0.001 mg/L		0.001
Cobalt	mg/L	n/a		exp{(0.414[ln(hardness)] – 1.887}(j)		0.00078(i)
Copper	mg/L	<82 mg/L $CaCO_3$ 82 – 180 mg/L $CaCO_3$ >180 mg/L $CaCO_3$	0.002 mg/L $0.2 * e^{\{0.8545[\ln(hardness)]-1.465\}}$ 0.004 mg/L	<120 mg/L $CaCO_3$ 120 – 180 mg/L $CaCO_3$ >180 mg/L $CaCO_3$	0.002 mg/L 0.003 mg/L 0.004 mg/L	0.002(i)
Iron	mg/L	0.3		0.3		0.3
Lead	mg/L	≤60 mg/L $CaCO_3$ 60 – 180 mg/L	0.001 mg/L $0.2 * e^{\{1.273[\ln(hardness)]-4.705\}}$ 0.007 mg/L	≤60 mg/L $CaCO_3$ 60 – 120 mg/L $CaCO_3$ 120 – 180 mg/L	0.001 mg/L 0.002 mg/L 0.004 mg/L 0.007 mg/L	0.001(i)

Table 10A-2: Canadian Council of Ministers of the Environment Guidelines, Saskatchewan Provincial Objectives, and Selected Water Quality Thresholds

Parameter	Unit	CCME: Long Term (Chronic)[a][c]		Provincial Objectives (Chronic)[b][c]		Selected Constituent Project Threshold
		$CaCO_3$ >180 mg/L $CaCO_3$		$CaCO_3$ >180 mg/L $CaCO_3$		
Manganese	mg/L	Calculated using the CCME calculator for manganese in Appendix B and is based on hardness and pH (CCME 2019)		n/a		0.26[i][k]
Mercury	mg/L	0.000026		0.000026		0.000026
Molybdenum	mg/L	0.073		7.6[d]		7.6[d]
Nickel	mg/L	≤60 mg/L $CaCO_3$ 60 – 180 mg/L $CaCO_3$ >180 mg/L $CaCO_3$	0.025 mg/L $0.2*e^{\{0.76[\ln(hardness)]+1.06\}}$ 0.150 mg/L	≤60 mg/L $CaCO_3$ 60 – 120 mg/L $CaCO_3$ 120 – 180 mg/L $CaCO_3$ >180 mg/L $CaCO_3$	0.025 mg/L 0.065 mg/L 0.110 mg/L 0.150 mg/L	0.025[i]
Selenium	mg/L	0.001		0.001		0.001
Strontium	mg/L	n/a		7[l]		7[l]
Uranium	mg/L	0.015		0.015		0.015
Vanadium	mg/L	n/a		0.12[m]		0.12[m]
Zinc	mg/L	0.007		0.03		0.007
Radionuclides						
Lead-210	Bq/L	n/a		n/a		22[n]
Polonium-210	Bq/L	n/a		n/a		13.5[n]
Radium-226	Bq/L	n/a		n/a		0.11[n]
Thorium-230	Bq/L	n/a		n/a		95[n]

a) CCME 2023.
b) WSA 2015.
c) Long-term exposure or inputs lasting between 24 hours to 30 days.
d) BC MOE 2021.
e) 128 mg/L for all lakes excluding Patterson Lake based on hardness in the study areas that is consistently 21 mg/L as $CaCO_3$ or less. Patterson Lake's guideline would vary over time, based on the measured hardness in the lake.
f) Total ammonia based on un-ionized ammonia guideline that is adjusted for ambient pH and water temperature as provided in Table 10A-3.
g) MOEE 1994.
h) Based on the average pH range across all surface waterbodies (6.5 to 7.4 pH), except for Lake J with an average pH of 6.4.
i) Based on hardness in the study areas that is consistently 21 mg/L as $CaCO_3$ or less, except for cobalt. For cobalt, the water quality guideline shown is based on a hardness value of 52 mg/L as $CaCO_3$, which is the lowest hardness applicable to the guideline (Environment Canada 2017; Government of Canada 2021).
j) Environment Canada 2017; Government of Canada 2021.
k) Guideline is variable per lake. Example based on the pH guideline range of approximately 6.3 to 6.9 for Patterson Lake.
l) Health Canada 2019.
m) Environment Canada 2016; Government of Canada 2021.
n) TSD XXI, Environmental Risk Assessment.
< = less than; > = greater than; ≤ = less than or equal to; ≥ = greater than or equal to; COPC = constituent of potential concern; $CaCO_3$ = calcium carbonate; Bq/L = becquerels per litre; CCME = Canadian Council of Ministers of the Environment; N = nitrogen; TSS = total suspended solids; WSA = Water Security Agency; n/u = no unit; n/a = no guideline.

Table 10A-3: Canadian Council for Ministers of the Environment Water Quality Objectives for Total Ammonia for the Protection of Aquatic Life (in mg/L as Nitrogen)

Temperature (°C)	pH							
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
0	231	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

mg/L as N = milligrams per litre as nitrogen.

Table 10A-4: Drinking Water Quality Guidelines and Water Quality Thresholds Selected for Constituents of Potential Concern

Parameter	Unit	Health Canada[a,b]	World Health Organization[c]	Selected Project Threshold
Major Ions				
Chloride	mg/L	250[d]	n/a	250
Sulphate	mg/L	500[d]	n/a	500
Nutrients				
Nitrate (as nitrogen)	mg/L	10	11	10
Total Metals (unless otherwise noted, all metals are reported as total)				
Aluminum	mg/L	0.1	n/a	0.1
Arsenic	mg/L	0.01	0.01	0.01
Cadmium	mg/L	0.007	0.003	0.007
Chromium[e]	mg/L	0.05	0.05	0.05
Copper	mg/L	2	2	2
Iron	mg/L	0.3[d]	n/a	0.3
Lead	mg/L	0.005	0.01	0.005
Manganese	mg/L	0.12	n/a	0.12
Mercury	mg/L	0.001	0.006	0.001
Nickel	mg/L	n/a	0.07	0.07
Selenium	mg/L	0.05	0.04	0.05
Strontium	mg/L	7	n/a	7
Uranium	mg/L	0.02	0.03	0.02
Zinc	mg/L	5	n/a	5
Radionuclides				
Lead-210	Bq/L	0.2	0.1	0.2
Polonium-210	Bq/L	n/a	0.1	0.1
Radium-226	Bq/L	0.5	0.1	0.5
Thorium-230	Bq/L	n/a	1	1

a) Health Canada 2020.
b) Maximum acceptable concentration provided unless otherwise indicated.
c) WHO 2017.
d) Guideline is an aesthetic objective.
e) Guidelines are for total chromium.
Bq/L = becquerels per litre; n/a = not applicable.

As noted in Table 10A-2, sulphate, cadmium, copper, lead, manganese, and nickel have guidelines and Project thresholds that incorporate hardness as a toxicity modifying factor. For these COPCs, aquatic health studies have shown that their toxicity potential is influenced by hardness; specifically, increasing hardness has been identified as the key modifying factor in the water that can reduce the potential for metal uptake and toxicity (Adams and Garman 2023). In addition to COPCs, effluent can contain base cations (e.g., calcium, magnesium) that contribute to a water's hardness. Increases in hardness reduces the toxicity potential for hardness-dependent COPCs to aquatic organisms, so long as the increasing COPC concentrations remain below their hardness-dependent Project threshold. Therefore, applying ambient hardness concentration in the calculation of the Project threshold for these COPCs in the receiving environment provides a standardization in the surface water quality and aquatic health assessment. This standardization accounts for the changes in hardness concentration in the receiving environment during the period of discharge of treated effluent from the Project.

During this period, the hardness in Patterson Lake North Arm – West Basin is predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to approximately 100 mg/L as $CaCO_3$ during Operations. Increased hardness levels are also predicted in downstream waterbodies, but to a lesser extent with distance downstream. In downstream waterbodies, hardness levels are predicted to increase from less than 20 mg/L as $CaCO_3$ under existing conditions to maximum values of approximately 60 mg/L as $CaCO_3$ in Forrest Lake North Basin and 50 mg/L as $CaCO_3$ in Beet Lake and Naomi Lake. These changes to hardness in the receiving environment are illustrated in the Hardness figures in Attachment 10-A2.

As also illustrated in Attachment 10-A2, maximum predicted concentrations of cadmium, copper, lead, manganese, and nickel remain below thresholds that are derived using baseline hardness concentrations. Consequently, adjustment for ambient hardness was not required to assess potential effects related to these metals. In contrast, the sulphate threshold is calculated based on the projected hardness concentration and varies over time, with threshold values ranging from 128 mg/L to 309 mg/L. The cobalt threshold also varies with ambient hardness over time, with threshold values ranging from 0.00078 mg/L to 0.0010 mg/L. These variable thresholds are illustrated in Attachment 10-A2, which also shows how the predicted concentrations of sulphate and cobalt compare to these thresholds.

Commented [LM7]: Additional information added in response to IR 96-R1 based on 22 October 2024 table received from CNSC.

10A4.2 Regulatory Mixing Zones

A mixing zone is a transitional area within a waterbody in which a treated discharge is gradually mixed with the ambient water. The size of the mixing zone is influenced by the difference in water quality and density between the treated effluent and the receiving waterbody, and the receiving waterbody size and volume. The RMZ is an area defined by regulators to accommodate mixing and dispersion of the treated effluent after being discharged, where water quality objectives need to be met accounting for various discharge and receiving environment conditions. In this respect, Project water quality thresholds should not be exceeded outside of the outer edge of the mixing zone. Regulated mixing zones are applicable to both the ETP and STP discharge locations.

The regulatory framework applicable to the Project RMZ is from the Saskatchewan Water Security Agency (WSA). The WSA has published a set of effluent mixing zone guidelines to prescribe the general characteristics that a mixing zone should have in larger surface waterbodies, such as Patterson Lake (WSA 2015). The WSA (2015) general objectives of the RMZ are presented in Table 10A-5.

Table 10A-5: Applicable General Objectives for Effluent Discharges

ID	Description
1	Effluent should be free from substances in concentrations or combinations, which are acutely toxic or may be harmful to human, animal, or aquatic life.
2	Effluent should be free from substances that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl.
3	Effluent should be free from debris, oil, grease, scum, or other materials in amounts sufficient to be noticeable in the receiving water.
4	Effluent should be free from colour, turbidity, or odour-producing materials that would adversely affect aquatic life or waterfowl, significantly alter the natural colour of the receiving water, or directly or through interaction among themselves or with chemicals used in water treatment, result in undesirable taste or odour in treated water.

IR 187

No.	Justification/Rationale	Follow up Information Request	NexGen Response
187	Table 21.6-1 and Table 21.6-3 have not been revised for NPAG WRSA (in Table 21.6-1) that has no liner and for Traffic accident (chemical) (in Table 21.6-3) that hydrogen peroxide should be 11,350 L to 18,900 L, not 18,900 t.	Correct information in Tables 21.6-1 and Table 21.6-3	NexGen commits to making the changes associated with NexGen's response to IR 187 in the Final EIS.

IR 187 (Edits Made for Final EIS)

Upon review, NexGen confirms that two items associated with NexGen's response to IR 187 were not corrected in the May Revised EIS. NexGen is providing the following information to address the IR. Specifically, please find below two screenshots that show the edits that will be made in the Final EIS.

For reference, below is the most recent comment submitted for IR 187:

187	CNSC	CNSC-AM-02		Section 21.6 TSD VIII	**Conditionally Accepted**	Not Accepted	Table 21.6-1 and Table 21.6-3 have not been revised for NPAG WRSA (in Table 21.6-1) that has no liner and for Traffic accident (chemical) (in Table 21.6-3) that hydrogen peroxide should be 11,350 L to 18,900 L, not 18,900 t.	Correct information in Tables 21.6-1 and Table 21.6-3	

In response to this comment, please see below the changes that have been made in Table 21.6-1 and Table 21.6-3 of EIS Section 21. The specific edits are shown as tracked changes in Microsoft Word format.

Table 21.6-1: Summary of Hazard Scenario Identification Results

Project Component or Activity	Number of Hazard Scenarios	Accident or Malfunction
Mine dewatering system	2	Main underground dewatering system failure and high flow – groundwater ingress and surface flooding
System, process plant buildings	11	Ore spill, process vessel and piping system failure, clarifier overflow, belt filter air exhaust to atmosphere, hydrogen peroxide spill, facility fire, process containment and gas cleaning and filtration system failure, calciner wet scrubber failure, hydrogen buildup in the in the leach tanks, and paste plant mixing error
Solvent extraction circuit	4	Process vessel and piping system failure, solvent fire/explosion, and dump tank leak
UGTMF and mining stopes	2	Failure of tailings cell containment and failure of reclaim water pipes and pumps
NPAG WRSA	4	Stockpile slope failure, stockpile erosion, and uncontrolled leachate/seepage release through runoff~~, and uncontrolled leachate/seepage release through lining failure~~
Special waste rock, ore stockpiles, and PAG WRSA	4	Stockpile slope failure, stockpile erosion, uncontrolled leachate/seepage release through runoff, and uncontrolled leachate/seepage release through lining failure
ETP	3	Equipment/piping failure, effluent clarifier overflow, equipment, and control system failure
Site runoff ponds and retention berms	4	Pond overtopping, pond containment or embankment failure, pond lining failure and leakage, and surface flooding
Gypsum precipitation, washing, and storage	2	Loaded strip piping leakage and gypsum reactor failure
Acid plant	5	Truck, tanks, reactor, and storage vessels failure, sulphur spill during offloading, piping and piping component failure, sulphur burner and piping system failure, scrubber, absorber failure, and sulphur dioxide gas emission during plant start-up that spreads to other process plant areas
Electrical system and power plant	3	Substation transformer leak, transformer, turbine, generator fire/explosion, transformer, turbine, and generator fire/explosion
Fire protection system	2	Failure of fire pump or foam system and loss or lack of fire water
Low-level radioactive waste management system / incinerator	2	Hazardous waste spill and incinerator fire
LNG power plant	6	LNG transportation accident, LNG storage failure and release of gas, piping and piping component failure and release for gas, vaporization unit failure and release of gas, and pumps failure and release of gas
Mine ventilation system	3	Power outage, ventilation fans failure, and mine air heater fire

Note: Some accidents or malfunctions were associated with more than one hazard scenario.
UGTMF = underground tailings management facility; NPAG WRSA = non-potentially acid generating waste rock storage area; PAG WRSA = potentially acid generating waste rock storage area; ETP = effluent treatment plant; LNG = liquified natural gas.

Table 21.6-3: Summary of Release Characterization and Probability Assessment Results for Bounding Scenarios Considered in the Accidents and Malfunctions Assessment

	Bounding Scenario	Release Characterization	Assessment of Probability
1	Traffic accident (uranium concentrate and radioactivity)	Release of uranium concentrate: 5,625 kg	Between 5.3×10^{-05} and 1.7×10^{-04} per year
2	Traffic accident (chemical)	Release of fuel or other hazardous materials: ▪ diesel or gasoline = 30 m^3 ▪ organic solvents = 40 t ▪ LNG = 48 m^3 ▪ hydrogen peroxide = 11,350 L to 18,900 tL ▪ molten sulphur = 25 t	Between 3.1×10^{-04} and 1.0×10^{-03} per year
3	Solvent extraction fire or explosion	Release of uranium for a confined fire: ▪ uranium concentrate = 2.4 g/s ▪ uranium = 2.05 g/s Release of uranium for an unconfined fire: ▪ uranium concentrate = 18.9 g/s ▪ uranium = 16 g/s	6×10^{-03} per year
4	Tailings transfer pipe or pump failure	Release of paste tailings: ▪ total volume = 14.9 m^3, containing: ▪ uranium concentrate = 3.8 kg ▪ radium-226 = 9.83 GBq	2×10^{-02} per year
5	Untreated effluent transfer pipe failure	Release of untreated effluent: ▪ total volume = 150 m^3, containing: ▪ uranium concentrate = 7.6 kg ▪ radium-226 = 90 MBq	2×10^{-02} per year
6	Acid plant tail gas scrubber failure	Release of sulphur dioxide gas: ▪ sulphur dioxide = 47 kg	1×10^{-01} per year

Note: Details on methods and information sources used to generate the summary values presented are included in TSD VIII and TSD IX.
GBq = gigabecquerel; MBq = megabecquerel; TSD = technical support document; LNG = liquified natural gas.

IR 217

No.	Justification/Rationale	Follow up Information Request	NexGen Response
217	The terms “very severe” and “low” used for consequence rating have not been corrected as committed, e.g., in sections 2.1 (page 2.2) and 3.2 (page 3.2) of TSD VIII, and section 2.1 (page 2.3) and Tables of Appendix A where the term “low consequence” is still used.	Correct the terms so that they are consistent with those in Table 3-2.	NexGen will make the necessary changes requested by the reviewer in association with NexGen’s response to IR 217 in the Final EIS.

HAZARD IDENTIFICATION FOR THE ACCIDENTS AND MALFUNCTIONS ASSESSMENT – APPENDIX A - NEXGEN ROOK I PROJECT

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1 April 2024

Ecometrix | Environmental INTELLIGENCE

HAZARD IDENTIFICATION FOR THE ACCIDENTS AND MALFUNCTIONS ASSESSMENT – APPENDIX A - NEXGEN ROOK I PROJECT

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EXECUTIVE SUMMARY

Ecometrix Incorporated (Ecometrix) was retained by NexGen Energy Ltd. (NexGen) to complete the accidents and malfunctions assessment for the NexGen Rook I Project (Project), a proposed uranium mining and milling operation in northwestern Saskatchewan. For reference, the assessment of accidents and malfunctions is intended to provide a clear identification of the potential Project-associated hazards that fall outside the range of "typical" day-to-day events. This report details the Hazard Identification (HI) that has been completed to support the Environmental Assessment in the EIS. The HI is used to identify potential hazard scenarios, screen these scenarios as to potential environmental risks and, based on this screening, recommend scenarios that would be carried forward for more detailed consideration in the completion of the Accidents and Malfunctions Assessment.

Scope and Applicability

The scope of the HI included consideration across the following Project phases: Construction, Operations, and Decommissioning and Reclamation (i.e., Closure).

The spatial extent of the evaluation included the Project site and associated access road to its junction with Highway 955.

The evaluation focused on potential environmental risks associated with identified hazard scenarios. Although some hazards related to worker safety were identified, worker safety (risks and consequences) is out of the scope of this assessment.

Methods

The hazard identification process is a systematic approach to identify possible hazards associated with all components (physical system) and activities in a work process. A hazard can be defined as a physical event or condition that has the potential for causing damage to people, property, or the environment (e.g., fire, explosion, release of chemicals, or radioactivity). The components and activities for hazard identification were selected through the review of Project-related components. The hazard scenarios were identified by investigating the components and activities individually. The evaluation considered the sources of the hazard (e.g., presence of hazardous materials), hazardous situations (e.g., height or extreme heat), and initiating events (e.g., natural causes, technical failure, human error), that in combination, present a risk to the biophysical environment. A screening evaluation was applied to each scenario by qualitatively evaluating consequence and likelihood to determine a risk level (low, moderate, or high).

The following nodes were considered in the HI:
- site preparation;
- shaft sinking;

- access road / land transportation;
- airstrip;
- mining;
- hoisting;
- mine dewatering system;
- processing plant;
- solvent extraction building;
- tailings transfer pipe and underground tailings management facility (UGTMF) and mining stopes;
- non-potentially acid generating (NPAG) waste rock stockpile;
- ore, special waste, and potentially acid generating (PAG) waste rock stockpiles;
- effluent treatment system;
- ponds and retention berms;
- gypsum precipitation, washing, and storage;
- acid plant;
- electrical system and power plant;
- fire protection system;
- low-level radioactive waste management system / incinerator;
- liquified natural gas (LNG) power plant; and
- mine ventilation system.

Recommended Scenarios for Further Consideration

Based on the HI process, the hazard scenarios that were selected for more detailed risk analysis are listed below.

Node	Accident or Malfunction Scenario	Location	Effect pathway
3.1	Traffic accident (uranium concentrate)	Access road at bridge crossing	Aquatic release of uranium concentrate
3.3	Traffic accident (chemical)	Access road at bridge crossing	Aquatic release of fuel, hazardous chemicals
9.3	Solvent extraction fire or explosion	Solvent extraction building	Atmospheric release of uranium concentrate (chemical toxicity)
10.2	Tailings transfer pipe or pump failure	Tailings release to surface within secondary containment	Terrestrial release of radioactivity
13.3	Untreated effluent transfer pipe failure	Effluent treatment system	Terrestrial release of radioactivity
16.3	Acid plant tail gas scrubber failure	Acid plant	Atmospheric release of sulphur dioxide

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ABBREVIATIONS AND UNITS OF MEASURE

Abbreviations

Acronym	Definition
ALARP	As Low as Reasonably Practicable
EIS	Environmental Impact Statement
HI	Hazard Identification
ID	identification
LNG	liquified natural gas
NexGen	NexGen Energy Ltd.
NPAG	non-potentially acid generating
PAG	potentially acid generating
Project	Rook I Project
UGTMF	underground tailings management facility

Units of Measure

Units	Definition
%	percent
>	greater than
km	kilometres
t	tonne

1.0 INTRODUCTION

The NexGen Energy Ltd. (NexGen) Rook I Project (Project) is a proposed new uranium mining and milling operation that is 100% owned by NexGen. The Project would be located in northwestern Saskatchewan, approximately 40 km east of the Saskatchewan-Alberta border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon. The Project would reside within Treaty 8 territory and within the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake and along the upper Clearwater River system. Access to the Project would be from an existing road off Highway 955.

Ecometrix Incorporated (Ecometrix) was retained by NexGen to complete the accidents and malfunctions assessment for the Project, a proposed uranium mining and milling operation in northwestern Saskatchewan. For reference, the assessment of accidents and malfunctions is intended to provide a clear identification of the potential Project-associated hazards that fall outside the range of "typical" day-to-day events. This report details the Hazard Identification (HI) that has been completed to support the Environmental Assessment in the EIS. The HI is used to identify potential hazard scenarios, screen these scenarios as to potential environmental risks and, based on this screening, recommend scenarios that would be carried forward for more detailed consideration in the completion of the Accidents and Malfunctions Assessment.

1.1 Project Information

The Project includes the Construction, Operations, Decommissioning and Reclamation (i.e., Closure) of a uranium mine and processing plant, including associated infrastructure to support the extraction and processing of uranium ore. Key Project details are summarized in Table 1-1~~Table 1-1~~. The timeline for the Project from the initiation of Construction to the completion of Closure (and subsequent transfer of the property to Institutional Control) is anticipated to be 43 years.

Table 1-1: Key Rook I Project Details

Terms	Details
Scope of the Project	• NexGen is proposing a new uranium mining and milling operation located adjacent to Patterson Lake in the southwestern Athabasca Basin in northern Saskatchewan • The proposed Project would include underground and surface facilities to support the mining and milling of uranium ore from the Arrow deposit • The Project would include an underground mine, a process plant, and additional infrastructure including a camp for personnel, an airstrip, an ETP, and supporting waste and water management facilities
Rook I Project	• The Rook I Project is a new uranium mining and milling operation located on the Patterson Lake peninsula in the southwestern Athabasca Basin in northern Saskatchewan • The Rook I Project is 100% owned and managed by NexGen • The mineral resource basis for the proposed Project is the Arrow deposit, a land-based, 100% basement-hosted, high-grade uranium deposit

Table 1-1: Key Rook I Project Details

Terms	Details
Arrow deposit	• A land-based, basement-hosted, high-grade uranium deposit that is 100% owned by NexGen
Underground mine development	• The Project would use long hole stoping mining methods to extract the ore, including primarily transverse stope mining and longitudinal retreat stope mining • The underground mine development would include a number of key activities, including shaft sinking, lateral development, vertical development, installation of mine services, and development of the UGTMF
Uranium concentrate	• The Project term for triuranium octoxide (U_3O_8) once the material has been processed and is ready for shipment
Process plant	• Process plant throughput is designed for 1,300 tonnes of ore per day • Total net uranium recovery from the milling process is estimated to be 97.6% based on the results of the metallurgical test programs completed in 2018 and 2019 • The process plant consists of the technologies and infrastructure used to transform uranium ore into uranium concentrate
UGTMF	• Purpose-built, underground facility with chambers dedicated to the storage and progressive decommissioning for tailings and other waste streams generated through mining and processing • Three UGTMF cavities are planned for initial development during Construction to provide adequate storage capacity to support the start of mining and milling operations
Mine rock	• Includes all material sourced from underground, including ore (equal or greater than 0.26% U_3O_8 and waste rock (less than 0.26% U_3O_8)
Waste rock	• Includes non-potential acid generating mine rock, potentially acid generating mine rock, and special waste
NPAG	• The NPAG waste rock is clean mine rock with less than 0.03% U_3O_8 and less than 0.1% sulphur. All NPAG mine rock would either be stockpiled for use as construction material at site or become NPAG waste rock that is stored in the NPAG WRSA
PAG	• The PAG waste rock is mine rock with less than 0.03% U_3O_8 and greater than or equal to 0.1% sulphur. All PAG mine rock would become PAG waste rock that is stored in the PAG WRSA
Special waste	• Special waste is mine rock with insufficient grade to be considered ore (i.e., greater than 0.03% of U_3O_8 and less than 0.26% U_3O_8). All special waste would be temporarily stored in the special waste rock stockpile
NPAG WRSA	• The NPAG WRSA permanently stores clean mine rock at surface and would not be lined
PAG WRSA	• The PAG WRSA permanently stores PAG mine rock at surface and would be fully lined with HDPE and have self-contained water collection
Special waste rock stockpile	• The separate stockpile where special waste would be temporarily stored at surface and would be fully lined with HDPE and have self-contained water collection • Special waste would be processed throughout Operations and then transferred to the UGTMF for permanent storage
Ore storage stockpile	• The separate stockpile on surface where ore would be temporarily stored until transferred to the process plant. This stockpile includes four piles with differing grades and would be fully lined with HDPE and have self-contained water collection

Table 1-1: Key Rook I Project Details

Terms	Details
ETP	• The Project facility that treats contact water from the Project. The treated effluent is pumped to the monitoring ponds, tested, and then discharged to the environment, after meeting discharge criteria
Sewage treatment plant	• The Project facility that treats sewage from the Project. The treated sewage discharge is released to the environment, after meeting discharge criteria
Mine water	• Water that flows into the underground workings
Contact water	• Water that may have been physically or chemically altered by Project activities. This water may be diverted and require management (e.g., treatment) before release to the environment. This includes dewatering of mine water from underground mining activities as well as all runoff on surfaces disturbed by the Project
Non-contact water	• Water that has not been physically or chemically altered by Project activities. This water is typically diverted when practical and allowed to discharge directly to the receiving environment
Fresh water	• Water sourced from Patterson Lake for use by the Project
Release water	• Contact water that has been treated in the ETP and is discharged to the environment, after meeting discharge criteria
Waste water (or treated sewage discharge)	• Water that has been treated in the sewage treatment plant and is ready for discharge to the environment, after meeting discharge criteria
Sewage	• Waste water from toilets, sinks, showers, laundry, kitchen, and other domestic sources and facilities at the Project, including but not limited to sanitary liquid waste of human origin
Supporting infrastructure	• Includes all Project surface facilities including but not limited to waste management infrastructure, water management and treatment infrastructure, administration and camp facilities, utilities, airstrip, and site roads

UGTMF = underground tailings management facility; PAG WRSA= potentially acid generating waste rock storage area; NPAG WRSA= non-potentially acid generating waste rock storage area; U_3O_8 = triuranium octoxide; ETP = effluent treatment plant; HDPE = high density polyethylene.

1.2 Scope and Applicability of the Hazard Identification Process

The regulations governing the EIS requires that the effects of Accidents and Malfunctions related to the Project components be assessed. As a step towards the Accidents and Malfunctions assessment, an HI evaluation needs to be completed. The objective of HI is to identify all scenarios that have a potential to present a risk to the biophysical environment. The HI includes a screening assessment of the scenarios to identify those that require more detailed assessment of the probabilities and the severity of their consequences. The screening evaluation is applied to a given scenario by qualitatively evaluating consequence and likelihood to determine an overall risk ranking (Section 2.0, Hazard Identification Methodology). The evaluations of the probabilities and severity of the consequences, as well as the characterization of the risk of the selected scenarios, are included in the Accidents and Malfunctions assessment.

The scope of the HI included consideration of the following Project phases: Construction, Operations, and Decommissioning and Closure. The spatial extent of the evaluation included the Project site and associated access road to its junction with Highway 955.

The evaluation focused on potential environmental risks associated with identified hazard scenarios. Although some hazards related to worker safety were identified, worker safety (risks and consequences) is out of the scope of this assessment.

1.3 Information Sources

Information used to complete this evaluation has been provided by NexGen. Key information has been drawn from the Project's Feasibility Report, as well as reports that have been generated by NexGen's risk review and management process. The list of information sources is provided in the reference section of this report.

2.0 HAZARD IDENTIFICATION METHODOLOGY

The HI evaluation was performed to identify hazard scenarios associated with the Project that may result in consequences to the biophysical environment. The hazard scenarios were subsequently assessed at a screening level as to potential risks to the biophysical environment, and to identify scenarios that should be carried forward for more detailed evaluation.

2.1 Process Hazards Analysis

The hazard identification process is a systematic approach to identify possible hazards associated with all components (physical system) and activities in a work process. A hazard can be defined as a physical event or condition that has the potential for causing damage to people, property, or the environment (e.g., fire, explosion, release of chemicals, or radioactivity).

The hazard identification evaluation was used to identify a comprehensive list of potential Project-related accident and malfunction scenarios, screen these scenarios as to potential risks, and, based on the initial screening results, select a number of high or moderate-risk scenarios as bounding scenarios. These bounding scenarios were carried forward for more detailed risk assessment. The hazard identification evaluation focussed on risks to the human health and biophysical environment.

The hazard identification involved the consideration of the following three elements that, in combination, present a risk to the human health and biophysical environment:

a) the sources of hazard (e.g., presence of hazardous materials);

b) hazardous situations (e.g., presence of ignition source); and

c) initiating events (e.g., natural causes, technical failure, or human error).

A screening evaluation was applied to all accident and malfunction scenarios by qualitatively evaluating the likelihood and consequence to determine a risk level.

The likelihood index is derived from the qualitative estimation of the probability of the scenarios. While there are standards and regulatory documents (e.g., REGDOC-2.4.2, Safety Analysis, Probabilistic Safety Assessment [PSA] for Reactor Facilities (CNSC n.d.[1]) that govern the assessment of the probability of the hazard scenarios for nuclear reactors, no such documents exist for non-reactor facilities. The focus of these documents is design-basis and beyond design-basis accidents that affect the integrity of the reactor core. The annual probability of releases from these accidents can be $1x10^{-6}$ and lower, while the consequence of these accidents

[1] CNSC (Canadian Nuclear regulatory Commission). n.d. REGDOC-2.4.2, Safety Analysis Probabilistic Safety Assessment (PSA) for Reactor Facilities, Version 2. Available at **https://www.nuclearsafety.gc.ca/eng/pdfs/regulatory-documents/regdoc2-4-2/REGDOC-2_4_2__Probabilistic_Safety_Assessment_(PSA)_for_Reactor_Facilities_Version_2.pdf.**

could be very severe (i.e., catastrophic). In contrast, the probability of accidents and malfunctions at non-reactor facilities such as mines and process plants can be higher, as derived from the operating experience of similar installations. The International Atomic Energy Agency's TECDOC-1267 (IAEA 2002[2]) states that while a plant-specific qualitative risk analysis should be conducted for a nuclear reactor facility, for non-nuclear facilities hazard identification and screening, evaluation of selected accident scenarios, and a combination of qualitative and quantitative analysis should be conducted. This document does not prescribe what probabilities should be considered.

Commented [FH1]: IR 217: added the term 'catastrophic' to provide the specific consequence rating

Based on the operating experience of similar facilities considered in this assessment, a range of probabilities were considered. On a scale of increasing likelihood, scenarios were categorized as highly unlikely, unlikely, likely, very likely, and almost certain as shown in Table 2-1~~Table 2-1~~.

Table 2-1: Likelihood Index

Rating	Likelihood	Description
1	Highly unlikely	<1 occurrence in 1,000 years
2	Unlikely	≤1 occurrence in 100 years and >1 occurrence in 1,000 years
3	Likely	≤1 occurrence in 10 years and >1 occurrence in 100 years
4	Very likely	≤1 occurrence in 1 year and >1 occurrence in 10 years
5	Almost certain	>1 occurrence in 1 year

< = less than; ≤ = less than or equal to; > = greater than.

On a scale of increasing consequence, scenarios were categorized as negligible, minor, moderate, major, and catastrophic as shown in Table 2-2~~Table 2-2~~.

Table 2-2: Consequence Index

Rating	Consequence	Description
1	Negligible	No measurable biophysical environmental effects, or medical treatment not required
2	Minor	Short-term (less than one month in duration) minor effect on small area, or minor first aid injuries with no lost time
3	Moderate	Reversible or repairable (i.e., less than one year in duration) effect off site, or reversible injuries with lost time
4	Major	Extended-range, long-term (i.e., between 1 and 10 years in duration) effect off site, or severe injuries with long-lasting effects and/or disability
5	Catastrophic	Long-lasting (more than 10 years) or irreversible environmental effects, fatalities, or multiple disabilities

[2] IAEA (International Atomic Energy Agency). 2002. Procedures for conducting probabilistic safety assessment for non-reactor nuclear facilities, IAEA-TECDOC-1267, January 2002, ISSN 1011–4289. Available at **https://www-pub.iaea.org/MTCD/Publications/PDF/te_1267_prn.pdf.**

The resulting risk levels are defined according to the hazard analysis risk matrix shown in Figure 2-1~~Figure 2-1~~.

For the purpose of the assessment, risks were identified as being low (i.e., coloured green in the matrix) where the screening evaluation considered the risk as generally being acceptable, as the likelihood of these scenarios can be effectively managed through application of planned controls and/or the consequence of the effect would be low. Low-risk scenarios have a consequence of negligible to moderate, with the likelihood ranging from highly unlikely to almost certain.

Commented [FH2]: IR 217: this was flagged in Grant's review as something that should be changed; however, the term 'low' is correct here as it is stating a qualitative range and is specifically defined in the following sentence

No change proposed

Risks are identified as being moderate (i.e., coloured yellow in the matrix) where the screening evaluation considers the risk as generally being tolerable. In some cases, a moderate-risk scenario can encompass the risk of several screened scenarios for each effect category (e.g., toxic release, fire). In these cases, a moderate-risk scenario can be carried forward as a bounding scenario for more detailed analysis. Moderate-risk scenarios have a consequence of minor to catastrophic, with the likelihood ranging from highly unlikely to almost certain. In many cases, risk-reduction activities would reduce the risk associated with these scenarios to as low as reasonably practicable (ALARP). Under this condition, the risk may be characterized as tolerable.

Risks were identified as being high (i.e., coloured red in the matrix) where the screening evaluation considered the risk as generally being unacceptable. High-risk scenarios have a consequence of major to catastrophic, with the likelihood ranging from unlikely to almost certain. As the evaluation of the risk at this hazard identification stage was qualitative and subject to some uncertainty, the hazard scenarios identified as high risk were advanced for further detailed assessment so that a more detailed evaluation of risk and potential management activities could be considered.

Figure 2-1: Hazard Analysis Risk Matrix

Likelihood		**Consequence**				
		1	**2**	**3**	**4**	**5**
		Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
5	**Almost Certain**	Low	Moderate	Moderate	High	High
4	**Very Likely**	Low	Low	Moderate	High	High
3	**Likely**	Low	Low	Moderate	Moderate	High
2	**Unlikely**	Low	Low	Low	Moderate	High
1	**Highly Unlikely**	Low	Low	Low	Moderate	Moderate

2.2 Definition of Project Components and Activities

Based on the review of key Project components and activities, the following nodes were considered in the HI evaluation:

- site preparation;
- shaft sinking;
- access road / land transportation;
- airstrip;
- mining;
- hoisting;
- mine dewatering system;
- process plant;
- solvent extraction building;
- tailings transfer pipe and underground tailings management facility (UGTMF);
- non-potentially acid generating (NPAG) waste rock stockpile;
- ore, special waste, and potentially acid generating (PAG) waste rock stockpiles;
- effluent treatment system;
- ponds and retention berms;
- gypsum precipitation, washing, and storage;
- acid plant;
- electrical system and power plant;
- fire protection system;
- low-level radioactive waste management system / incinerator;
- liquified natural gas (LNG) power plant; and
- mine ventilation system.

3.0 EVALUATION OF NODES

For each of the nodes, HI evaluations are shown in Table 3-1~~Table 3-1~~ through Table 3-21~~Table 3-21~~. In each case, the evaluation considers consequence(s), existing safeguards and design features, and the qualitative evaluation of likelihood and severity of consequences.

The following notations are provided in support of the HI tables:

- "CO" is Construction;
- "OP" is Operations;
- "ADR" is Active Decommissioning and Reclamation Stage;
- "TM" is Transitional Monitoring Stage;
- "L" is likelihood;
- "S" is severity of the consequences; and
- "RR" is risk ranking.

With consideration of sources of hazard and initiating events, a total of 93 hazard scenarios were identified and evaluated.

Six of the hazard scenarios characterized as high-risk (3) or ALARP-moderate (3) scenarios require further detailed assessment for more accurate characterization of the risk.

Six high-risk scenarios that were not recommended for further detailed assessment are associated with major injuries and/or occupational fatalities. These scenarios have not been advanced since it is assumed that the NexGen health and safety program will be best practice and therefore in these cases the risk is ALARP.

Thirty-three of the scenarios evaluated were characterized as moderate-risk scenarios. Generally, the moderate-risk scenarios were deemed to represent a tolerable level of risk in consideration of proposed safeguards and design features that reduce the risk level to ALARP. As noted above, three moderate-risk scenarios are recommended for further detailed assessment. Each of these is associated with a contaminant release to the environment. A further six moderate-risk scenarios were also considered for further detailed assessment; however, they were deemed to be bounded by other scenarios and therefore no further analyses were completed.

The balance of the scenarios evaluated (51) were characterized as low-risk scenarios, based on low likelihood of occurrence and/or consequence in consideration of planned existing safeguards and design features.

Commented [FH3]: IR 217: this was flagged in Grant's review as something that should be changed; however, the term 'low' is correct here as it is stating a qualitative range and not a specific classification

No change proposed

Site preparation: For site preparation, nine hazard scenarios were identified, and each have the potential to occur during all phases and stages of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-1: Hazard Identification Evaluation – Site Preparation

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
1.1	Fall/slip	CO / OP / ADR / TM	Occupational major injuries	Occupational health and safety program Personnel training and orientation Personal protection equipment	5	4	ALARP, High	Best practice in worker health and safety program resulting in ALARP, no further assessment
1.2	Fall/slip	CO / OP / ADR / TM	Occupational fatalities	Occupational health and safety program Personnel training and orientation Personal protection equipment	2	5	ALARP, High	Best practice in worker health and safety program resulting in high but ALARP, no further assessment
1.3	Vehicle and construction equipment accident	CO / OP / ADR / TM	Occupational major injuries	Occupational health and safety program Personnel training and orientation Preventive and routine maintenance	4	4	ALARP, High	Best practice in worker health and safety program resulting in ALARP, no further assessment
1.4	Vehicle and construction equipment accident	CO / OP / ADR / TM	Occupational fatalities	Occupational health and safety program Personnel training and orientation Preventive and routine maintenance	2	5	ALARP, High	Best practice in worker health and safety program resulting in high but ALARP, no further assessment
1.5	Vehicle accident	CO / OP / ADR / TM	Hazardous materials spill	Site traffic control, speed limit, signage Personnel training and orientation Spill and emergency response plan	4	2	Low	Risk level is low, minor consequences, no further assessment
1.6	Fuel storage failure	CO / OP / ADR / TM	Hydrocarbon release	Storage inspection, maintenance Double-walled fuel storage and or secondary containment Spill and emergency response plan	1	3	Low	Risk level is low, highly unlikely event, no further assessment
1.7	Refuelling accident	CO / OP / ADR / TM	Hydrocarbon release	Personnel training Containment Spill and emergency response plan	4	2	Low	Risk level is low, ~~low~~ minor consequence event, no further assessment
1.8	Fuel storage and transfer fire and explosion	CO / OP / ADR / TM	Occupational major injuries	Fire safety plan and firefighting system Personal protection equipment Personnel training and orientation	2	4	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment
1.9	Fuel storage and transfer fire and explosion	CO / OP / ADR / TM	Occupational fatalities	Fire safety plan and firefighting system Buried pipes Personal protection equipment Personnel training and orientation	1	5	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; TM = Transitional Monitoring; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Commented [FH4]: IR 217: specific consequence level update

Shaft sinking: For shaft sinking, four hazard scenarios were identified, which have the potential to occur during the Construction of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-2: Hazard Identification Evaluation – Shaft Sinking

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
2.1	Shaft wall failure	CO	Occupational major injuries	Occupational health and safety program Personnel training and orientation Personal protection equipment	5	4	ALARP, High	Best practice in worker health and safety program resulting in ALARP, no further assessment
2.2	Shaft wall failure	CO	Occupational fatalities	Occupational health and safety program Personnel training and orientation Personal protection equipment	1	5	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment
2.3	Groundwater ingress	CO	Underground flooding and potential for groundwater contamination	Temporary ground freeze Mine construction procedure based on geotechnical analysis Engineered shaft liner design where required Emergency response procedure Groundwater monitoring	3	2	Low	Risk level is low, ~~low~~ minor consequence event, no further assessment
2.4	Surface flood	CO	Underground flooding and potential for groundwater contamination	Surface water and flood management, shaft opening protection and structure Emergency response procedure Groundwater monitoring	2	2	Low	Risk level is low, minor ~~low~~ consequence event, no further assessment

CO = Construction; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Commented [FH5]: IR 217: specific consequence level update

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Access road / land transportation: For access road / land transportation, eight hazard scenarios were identified, which have the potential to occur during the Construction, Operations, and Closure of the Project. The screening assessment shows that two hazard scenarios may be high risk and further assessment is required to characterize the risk in more detail. Other hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-3: Hazard Identification Evaluation – Access Road / Land Transportation

ID#	Accident/Malfunction	Phase or Stage	Consequences	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
3.1	Traffic accident at bridge crossing (uranium concentrate)	CO / OP / ADR	Aquatic release of radioactivity	Traffic control measures Travel management plan Spill and emergency response plan Personnel training	3	5	High	Further assessment recommended
3.2	Vehicle accident including rollover, collision, run off road	CO / OP / ADR	Terrestrial release of radioactivity	Traffic control measures Travel management plan Spill and emergency response plan Personnel training	3	4	ALARP, Moderate	Best practice in terrestrial spill containment and cleanup resulting in ALARP, no further assessment
3.3	Traffic accident at bridge crossing (chemical)	CO / OP / ADR	Aquatic release of fuel, hazardous, chemicals and reagents	Traffic control measures Travel management plan Spill and emergency response plan Personnel training	3	5	High	Further assessment recommended
3.4	Vehicle accident including rollover, collision, run off road	CO / OP / ADR	Terrestrial release of fuel, hazardous, chemicals and reagents	Traffic control measures Travel management plan Spill and emergency response plan Personnel training	3	4	ALARP, Moderate	Best practice in terrestrial spill containment and cleanup resulting in ALARP, no further assessment
3.5	Vehicle fire	CO / OP / ADR	Release of hydrocarbons and fuel	Travel management plan Spill and emergency response plan Fire safety plan and firefighting systems Personnel training	1	4	ALARP, Moderate	Best practice in terrestrial spill containment and cleanup resulting in ALARP, no further assessment
3.6	Vehicle fire	CO / OP / ADR	Atmospheric release of particulate and combustion by-products	Travel management plan Spill and emergency response plan Fire safety plan and firefighting systems Personnel training Ambient air monitoring	1	3	Low	Low risk, ~~low~~ highly unlikely ~~probability~~ event. Reversible and transient effect. No further assessment
3.7	Vehicle fire	CO / OP / ADR	Uncontrolled explosion of explosives	Explosives management plan Fire safety plan and firefighting systems Personnel training	1	5	ALARP, Moderate	Best practice in explosive management resulting in ALARP, no further assessment
3.8	Vehicle – wildlife collision	CO / OP / ADR	Wildlife injury/fatality	Traffic control measures Travel management plan	4	2	Low	Individual level effect, reversible and nonsignificant effect, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Commented [FH7]: IR 217: specific likelihood level update

Airstrip: For the airstrip, four hazard scenarios were identified, which have the potential to occur during the Construction, Operations, and Closure of the Project. The hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-4: Hazard Identification Evaluation – Airstrip

ID#	Accident/Malfunction	Phase of Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
4.1	Fuel storage failure	CO / OP / ADR	Hydrocarbon release	Storage inspection and maintenance Secondary containment Spill and emergency response plan	1	3	Low	Risk level is low, highly unlikely event, no further assessment
4.2	Refuelling accident	CO / OP / ADR	Hydrocarbon release	Personnel training Containment Spill and emergency response plan	4	2	Low	Risk level is low, ~~low~~ minor consequence event, no further assessment
4.3	Airplane crash	CO / OP / ADR	Occupational major injuries / fatality Atmospheric release of particulate and combustion by-products Release of hydrocarbons and fuel Damage to mine infrastructure structure	Travel management plan Spill and emergency response plan Fire safety plan and firefighting systems Personnel training	1	5	ALARP, Moderate	Highly unlikely event, ALARP, no further assessment
4.4	Plane de-icing chemical release	CO / OP / ADR	Terrestrial release of reagent; possible aquatic release of reagent	Personnel training Containment Spill and emergency response plan	3	2	Low	Risk level is low, ~~low~~ minor consequence event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Mining: For mining, ten hazard scenarios were identified, which have the potential to occur during the Operations of the Project. The screening assessment shows that one hazard scenario requires further assessment to characterize the risk in more detail. All other hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-5: Hazard Identification Evaluation – Mining

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
5.1	Mine back or wall failure	OP	Release of hazardous materials (corrosive, toxic, and flammable materials including chemicals and reagents) and potential for groundwater contamination	Mine water management and containment Monitoring Spill and emergency response plan	1	3	Low	Low risk, highly unlikely event, no further assessment
5.2	Mine back or wall failure	OP	Occupational major injuries	Occupational health and safety program Personnel training and orientation Refuge stations	1	4	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment
5.3	Mine back or wall failure	OP	Occupational fatalities	Occupational health and safety program Personnel training and orientation Mining procedure Geotechnical investigation and analysis Refuge stations	1	5	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
5.4	Personnel falls into open ore/waste pass	OP	Occupational major injuries/fatality	Adequate lighting and signage and indicator lights Wheel stop barriers Vent plug on empty passes Occupational health and safety program Personnel training and orientation Mining procedures	1	5	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment
5.5	Uncontrolled explosion	OP	Damage to mine structure due to blast over pressure and potential for release of hazardous materials Occupational injuries/fatality	Best practice in mine development Explosives management Engineered blast designs	1	5	ALARP, Moderate	Best practice in mine development and highly unlikely event resulting in ALARP, no further assessment
5.6	Vehicle accident	OP	Release of fuel and groundwater contamination	Mine water management and containment Monitoring Spill and emergency response plan	2	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
5.7	Mine fire by any cause	OP	Atmospheric release of radioactive materials Occupational injuries/fatalities	Emergency response plan Fire safety plan and firefighting systems Fire fighting system Self rescuer units carried by personnel Ambient air monitoring Air monitoring in underground mine Remote ventilation control Underground refuge stations	2	5	ALARP, High	Best practice in worker health and safety program, the environmental consequences are limited, no further assessment
5.8	Fuel storage failure	OP	Hydrocarbon release underground and potential groundwater contamination	Storage inspection and maintenance Secondary containment Spill and emergency response plan	1	3	Low	Risk level is low, highly unlikely event, no further assessment
5.9	Refuelling accident	OP	Hydrocarbon release underground and potential groundwater contamination	Personnel training Containment Spill and emergency response plan	4	2	Low	Risk level is low, minor~~low~~ consequence event, no further assessment
5.10	Failure of pipes and pumps for tailings transfer	OP	Release of radioactivity to the environment	Mine water management Groundwater monitoring Routine inspection and maintenance Emergency response plan	2	4	ALARP, Moderate	Best practice in tailings management and moderate consequence event resulting in ALARP; however, due to unknown consequence at the screening level this scenario is recommended for further assessment and is considered in Scenario 10.2

OP = Operations; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Commented [FH10]: IR 217: specific consequence level update

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Hoisting: For hoisting, one hazard scenario was identified, which has the potential to occur during the Construction, Operations, and Closure of the Project. The hazard scenario has appropriate safeguards and design features to minimize the risk such that no further assessment is required for this hazard.

Table 3-6: Hazard Identification Evaluation – Hoisting

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
6.1	Hoist failure	CO / OP / ADR	Release of hazardous materials (chemicals and reagents) and potential for groundwater contamination	Hoist Safety Systems Mine water management and containment Monitoring Spill and emergency response plan	1	3	Low	Low risk, highly unlikely event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking.

Mine dewatering system: For the mine dewatering system, two hazard scenarios were identified, which have the potential to occur during the Construction, Operations, and Closure of the Project. The hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-7: Hazard Identification Evaluation – Mine Dewatering System

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
7.1	Main Underground Dewatering System failure	CO / OP / ADR	Mine flooding and potential for groundwater contamination	Redundancy Preventive and routine maintenance System monitoring Mine water management Emergency response plan	3	2	Low	Risk level is low, ~~low~~ minor consequence event, no further assessment
7.2	High flow – groundwater ingress, surface flooding	CO / OP / ADR	Mine flooding and potential for groundwater contamination	Appropriate design and pump capacity Mine water management Emergency response plan	2	2	Low	Risk level is low, minor~~low~~ consequence event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking.

Commented [FH12]: IR 217: specific consequence level update

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Processing plant: For the processing plant (excluding the solvent extraction circuit), eleven hazard scenarios were identified, which have the potential to occur in the Operations of the Project. The screening assessment shows that three hazard scenarios involving release of uranium are moderate risk. All these scenarios were bounded by a large solvent fire scenario. All other hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-8: Hazard Identification Evaluation – Process Plant

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
8.1	Ore spill	OP	Release of radioactivity	Ambient monitoring Spill and emergency response plan	2	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
8.2	Process vessel and piping system failure	OP	Release of sulphuric acid	Ambient monitoring Secondary containment Process sumps Mill building is contained Redundant temperature/reagent controls on leach tanks to protect liners from high temperature Spill and emergency response plan	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
8.3	Process vessel and piping system failure, clarifier overflow	OP	Release of pregnant aqueous solution	Ambient monitoring Secondary containment Process sumps Mill building is contained Redundant temperature/reagent controls on leach tanks to protect liners from high temperature Spill and emergency response plan	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
8.4	Process vessel and piping system failure	OP	Release of acidic fume and radon in leaching building	Ambient monitoring Building ventilation Redundant temperature/reagent controls on leach tanks to protect liners from high temperature	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment

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ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
				Spill and emergency response plan				
8.5	Belt filter air exhaust to atmosphere	OP	Not expecting particulate in this exhaust stream. Could be radon, sulphuric acid	Filter bed exhaust to be scrubbed before atmospheric release	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
8.6	Hydrogen peroxide spill	OP	Potential for fire	Separate and contained hydrogen peroxide system (separation from organics) Spill and emergency response plan	2	3	Low	Low risk, ~~low~~ moderate consequence event, no further assessment
8.7	Facility fire	OP	Release of uranium concentrate powder to atmosphere	Ambient air monitoring Fire safety plan and firefighting systems Emergency response plan	2	4	ALARP, Moderate	The consequence is bounded by Scenario 9.3
8.8	Process containment and gas cleaning and filtration system failure	OP	Release of uranium concentrate powder to atmosphere	Regular and preventive inspection, testing, and maintenance program Ambient air monitoring	3	4	ALARP, Moderate	The consequence is bounded by Scenario 9.3
8.9	Calciner wet scrubber failure	OP	Release of uranium dust and residual fluorine gas to atmosphere	Regular and preventive inspection, testing, and maintenance program Ambient air monitoring The release is short-term as the operation will stop upon failure of the scrubber	3	3	ALARP, Moderate	The consequence is bounded by Scenario 9.3
8.10	Hydrogen buildup in the in the leach tanks	OP	Hydrogen evolution may result in formation of explosive atmosphere in the leach tanks. It may explode upon presence of ignition source	The results of hydrogen evolution quantification tests performed on samples with different grades showed no hydrogen gas was detected during the leaching of a different grade ore; as a precaution, the installation of hydrogen detectors may be investigated	2	3	Low	The energy content of hydrogen gas mixture (within explosive limits) inside the tanks are low. The explosion energy is therefore low and may result in localized damage. Low risk, ~~low~~ moderate consequence event, no further assessment
8.11	Paste plant mixing error	OP	Low moisture content paste may set prematurely inside the underground pipe causing the blockage of the piping system	Operator training Quality control Operating procedures Maintenance program for the control systems	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment

OP = Operations; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Commented [FH19]: IR 217: specific consequence level update

Commented [FH20]: IR 217: specific consequence level update

Commented [FH21]: IR 217: specific consequence level update

Solvent extraction building: For the solvent extraction circuit, four hazard scenarios were identified, which have the potential to occur in the Operations of the Project. The screening assessment shows that one hazard scenario, involving a solvent extraction fire and/or explosion (Scenario 9.3), may require further assessment to characterize the risk in more detail. A second scenario involving a solvent extraction fire and/or explosion, Scenario 9.2, is bounded by this former scenario. The additional two scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-9: Hazard Identification Evaluation – Solvent Extraction Building

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
9.1	Process vessel and piping system failure	OP	Release of organic solvent	Concrete mixer-settler to facilitate visual leak inspection Regular and preventive inspection, testing, and maintenance program Secondary containment Mill building is contained Ambient monitoring Spill and emergency response plans	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
9.2	Solvent fire and/or explosion	OP	Atmospheric release of radioactivity	Dump tanks and fast-acting valves to transfer SX mixer/settlers in case of fire. Fire detection Regular and preventive inspection, testing, and maintenance program Fire safety plan and firefighting systems Ambient air monitoring Emergency response plan	2	4	ALARP, Moderate	The consequence is bounded by Scenario 9.3
9.3	Solvent extraction fire and/or explosion	OP	Domino effect and process plant fire resulting in release of radioactivity	Dump tanks and fast-acting valves to transfer SX mixer/settlers in case of fire. Fire detection Regular and preventive inspection, testing, and maintenance program Fire safety plan and firefighting systems Ambient air monitoring Emergency response plan	1	5	High	Further assessment recommended
9.4	Dump tank leak	OP	Leakage from the dump tank following a fire scenario and groundwater contamination	The dump tank is a concrete underground tank that is normally empty; the tank will be inspected regularly for any visual sign of structural defects	2	3	Low	Low risk, ~~low~~ moderate consequence event, no further assessment

OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Tailings transfer pipe and UGTMF: For the UGTMF, as well as the mining stopes, two hazard scenarios were identified, which have the potential to occur during the Operations and Closure of the Project. The screening assessment shows that one hazard scenario requires further assessment to characterize the risk in more detail. For the second hazard scenario, appropriate safeguards and design features would be in place to minimize the risk such that no further assessment is required.

Table 3-10: Hazard Identification Evaluation – Tailings Transfer Pipe and UGTMF

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
10.1	Failure of tailings cell containment	OP / ADR	Potential for groundwater contamination	Engineered Design Groundwater monitoring	1	5	ALARP, Moderate	Best practice in tailings management and highly unlikely event resulting in ALARP, Inherent Safety, no further assessment
10.2	Tailings transfer pipe or pump failure	OP / ADR	Potential for soil / groundwater contamination	The pipe is in a secondary containment Groundwater monitoring Routine inspection and maintenance Emergency response plan	3	3	ALARP, Moderate	Further assessment recommended

OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

NPAG waste rock stockpile: For the NPAG Waste Rock Stockpile, four hazard scenarios were identified, which have the potential to occur during the Construction, Operations, and Closure of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-11: Hazard Identification Evaluation – Non-Potentially Acid Generating Waste Rock Stockpile

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
11.1	Stockpile slope failure	CO / OP / ADR	Release of material into surrounding environment	Regular inspection	2	2	Low	Low risk, unlikely event, no further assessment
11.2	Stockpile erosion	CO / OP / ADR	Blockage or diversion of ditches or surface water and discharge of materials into the environment	Containment being designed to accommodate a 24-hour, 1 in 100 year event Regular inspection	1	3	Low	Low risk, unlikely event, no further assessment
11.3	Uncontrolled leachate / seepage release through runoff	CO / OP / ADR	Discharge of materials into the environment	NPAG stockpile containment being designed to accommodate a 24-hour, 1 in 100 year event Regular inspection Ambient monitoring Surface water management Spill response plan	1	2	Low	Low risk, unlikely event, no further assessment
11.4	Uncontrolled leachate / seepage release	CO / OP / ADR	Discharge of materials into the environment	NPAG stockpile containment being designed to accommodate a 24-hour, 1 in 100 year event Regular inspection and maintenance of facility Groundwater monitoring Spill response plan	2	3	Low	Low risk, unlikely event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; NPAG = non-potentially acid generating.

Ore, special waste, and PAG waste rock stockpiles: For ore, special waste, and PAG waste rock stockpiles, four hazard scenarios were identified, which have the potential to occur during the Construction, Operations, and Closure of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-12: Hazard Identification Evaluation – Ore, Special, and Potentially Acid Generating Waste Rock Stockpiles

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
12.1	Stockpile slope failure	CO / OP / ADR	Release of contaminants into surrounding environment	Containment being designed to accommodate a 24-hour, 1 in 100 year event Single-lined pad with leak detection system Regular inspection The slope of the stockpile is designed to provide stability	1	4	ALARP, Moderate	Best management practice results in ALARP, highly unlikely event, no further assessment
12.2	Stockpile erosion	CO / OP / ADR	Blockage or diversion of ditches or surface water and discharge of materials into the environment	Containment being designed to accommodate a 24-hour probable maximum precipitation event Single-lined pad with leak detection system Regular inspection	1	3	Low	Low risk, unlikely event, no further assessment
12.3	Uncontrolled leachate / seepage release through runoff	CO / OP / ADR	Discharge of contaminants into the environment	Regular inspection Ambient monitoring Surface water management Spill response plan	1	3	Low	Low risk, unlikely event, no further assessment
12.4	Uncontrolled leachate / seepage release through lining failure	CO / OP / ADR	Discharge of contaminants into the environment	Regular inspection and maintenance of lining Groundwater monitoring Spill response plan	1	4	ALARP, Moderate	Best management practice results in ALARP, highly unlikely event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Effluent treatment system: For the effluent treatment system, three hazard scenarios were identified, which have the potential to occur during the Operations and Closure of the Project. The screening assessment shows that one hazard scenario requires further assessment to characterize the risk in more detail. Other hazard scenario would have appropriate safeguards and design features in place to minimize the risk such that no further assessment is required.

Table 3-13: Hazard Identification Evaluation – Effluent Treatment System

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
13.1	Equipment/piping failure	OP / ADR	Contaminant and radioactivity release	Routine and preventive testing, inspection, and maintenance program Piping design pressure higher than pumps shutoff pressure Process monitoring Secondary containment for clarifier Spill response plan	2	3	Low	Low Risk, no further assessment
13.2	Effluent clarifier overflow	OP / ADR	Contaminant and radioactivity release	Secondary containment Spill response plan	2	3	Low	Low Risk, no further assessment
13.3	Untreated effluent transfer pipe failure	OP / ADR	Release of reagents, occupational exposure, and environmental contamination	Routine and preventive testing, inspection, and maintenance program Process monitoring Controls to maintain barium chloride below its maximum solubility Spill response plan	3	3	ALARP, Moderate	Further assessment recommended

OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

Ponds and retention berms: For ponds and retention berms, four hazard scenarios were identified, which have the potential to occur during the Operations and Closure of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-14: Hazard Identification Evaluation – Ponds and Retention Berms

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
14.1	Pond overtopping	OP / ADR	Contaminant and radioactivity release	Ponds to have capacity for a 24-hour probable maximum precipitation or 1 in 100 year event Process control Surface water management Ambient monitoring Spill and emergency response plan	2	3	Low	Low risk, ~~low probability~~unlikely event, no further assessment
14.2	Pond containment or embankment failure	OP / ADR	Contaminant and radioactivity release	Regular inspection and maintenance program Surface water management Ambient monitoring Spill and emergency response plan	1	5	ALARP, Moderate	Best engineering practice in maintenance and inspection of the containment systems and berms, no further assessment
14.3	Pond lining failure and leakage	OP / ADR	Contaminant and radioactivity release	Groundwater monitoring Hydraulic containment with a separate well	3	4	ALARP, Moderate	Best engineering practice in maintenance, no further assessment
14.4	Surface flooding	OP / ADR	Contaminant and radioactivity release	Ponds to have capacity for a 24-hour probable maximum precipitation event Process control Surface water management Ambient monitoring Spill and emergency response plan	1	3	Low	Low risk, ~~low probability~~highly unlikely event, no further assessment

OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Gypsum precipitation, washing, and storage: For gypsum precipitation, washing, and storage, two hazard scenarios were identified, which have the potential to occur in the Operations of the Project. These hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-15: Hazard Identification Evaluation – Gypsum Precipitation, Washing, and Storage

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
15.1	Loaded strip piping leakage	OP	Contaminant release	Secondary containment for piping between buildings	2	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
15.2	Gypsum reactor failure	OP	Contaminant release	Secondary containment Spill and emergency response plan	2	3	Low	Low risk, ~~low probability~~unlikely event, no further assessment

OP = Operation; L = likelihood; S = severity; RR = risk ranking.

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Acid plant: For the acid plant, five hazard scenarios were identified that have the potential to occur in the Operations of the Project. The screening assessment shows that one hazard scenario requires further assessment to characterize the risk in more detail. Two of the scenarios were bounded by an acid plant tail gas scrubber failure scenario. Two other hazard scenarios would have appropriate safeguards and design features in place to minimize the risk such that no further assessment is required.

Table 3-16: Hazard Identification Evaluation – Acid Plant

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
16.1	Truck, tanks, reactor, and storage vessels failure, sulphur spill during offloading (this is very common)	OP	Release of sulphur and acid	Housekeeping procedure Secondary containment Routine and preventive inspection, testing, and maintenance program Acid plant building is contained Spill and emergency response plans	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
16.2	Piping and piping component failure	OP	Release of acid	Acid resistant lined secondary containment with leak detection Sumps Routine and preventive inspection, testing, and maintenance program Acid plant building is contained Spill and emergency response plans	2	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
16.3	Acid plant tail gas scrubber failure	OP	Release of acid gas to the atmosphere, worker exposure, environmental damage	Sulphur dioxide and hydrogen sulphide monitors Routine and preventive inspection, testing, and maintenance program Ambient air monitoring	2	4	ALARP, Moderate	Further assessment recommended
16.4	Scrubber, absorber failure	OP	Release of acid gas to the atmosphere, worker exposure, environmental damage	Sulphur dioxide and hydrogen sulphide monitors Routine and preventive inspection, testing, and maintenance program Ambient air monitoring	2	4	ALARP, Moderate	This scenario is bounded by Scenario 16.3
16.5	Sulphur dioxide gas emission during plant start-up that spreads to other process plant area	OP	Release of acid gas to the atmosphere Worker inhalation of sulphur dioxide fume causing respiratory acid burn, Environmental damage	Sulphur dioxide and hydrogen sulphide monitors Routine and preventive inspection, testing, and maintenance program Ambient air monitoring	2	4	ALARP, Moderate	~~Relatively low likelihood~~Unlikely event. Scenario is bounded from a biophysical environment perspective by Scenario 16.3

OP = Operation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Electrical system and power plant: For the electrical system and power plant, three hazard scenarios were identified, which have the potential to occur during Construction, Operations, and Closure of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-17: Hazard Identification Evaluation – Electrical System and Power Plant

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
17.1	Substation transformer leak	CO / OP / ADR	Release of mineral oil and potential for groundwater contamination	Spill and emergency response plan Secondary containment and gravel pit	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
17.2	Transformer, turbine, generator fire/explosion	CO / OP / ADR	Occupational major injuries	Fire safety plan and firefighting systems Occupational health and safety program Personnel training and orientation Personal protection equipment Fire detection and alarm Emergency response plan	2	4	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment
17.3	Transformer, turbine, generator fire/explosion	CO / OP / ADR	Occupational fatalities	Fire safety plan and firefighting systems Occupational health and safety program Personnel training and orientation Personal protection equipment Emergency response plan	1	5	ALARP, Moderate	Best practice in worker health and safety program resulting in ALARP, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

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Fire protection system: For the fire protection system, two hazard scenarios were identified, which have the potential to occur during Construction, Operations, and Closure of the Project. These hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-18: Hazard Identification Evaluation – Fire Protection System

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
18.1	Failure of fire pump or foam system	CO / OP / ADR	Loss of firefighting capacity	Redundancy Regular and preventive testing, maintenance, and inspection Fire safety plan and firefighting systems Emergency response plan	1	3	Low	Low risk, highly unlikely event, no further assessment
18.2	Loss or lack of fire water	CO / OP / ADR	Loss of firefighting capacity	Fire safety plan and firefighting systems	1	3	Low	Low risk, highly unlikely event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking.

Low-level radioactive waste management system / incinerator: For the low-level radioactive waste management system / incinerator, two hazard scenarios were identified, which have the potential to occur during Construction, Operations, and Closure of the Project. These hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-19: Hazard Identification Evaluation – Low-Level Radioactive Waste Management System / Incinerator

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
19.1	Hazardous waste spill	CO / OP / ADR	Potential for surface water and soil contamination	Waste management plan On-site monitoring Emergency response plan	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
19.2	Incinerator fire	CO / OP / ADR	Uncontrolled release of hazardous material	Fire safety plan and firefighting systems Operate incinerator within design parameters Ambient air monitoring Radiation Protection personal protective equipment, such as powered air purifying respirator or self-contained breathing apparatus Emergency response plan	2	3	Low	Low risk, ~~low~~moderate consequence event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking.

LNG power plant: For the LNG power plant, six hazard scenarios were identified that have the potential to occur during Construction, Operations, and Closure of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-20: Hazard Identification Evaluation – Liquified Natural Gas Power Plant

ID#	Accident/Malfunction	Phase or Stage	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
20.1	LNG transportation accident	CO / OP / ADR	Fire or explosion resulting major injuries	Regular truck inspection and maintenance Travel management plan Fire safety plan and firefighting systems Emergency response plan	3	4	ALARP, Moderate	Regular truck inspection and maintenance resulting in ALARP, no further assessment
20.2	LNG transportation accident	CO / OP / ADR	Fire or explosion resulting fatalities	Regular truck inspection and maintenance Travel management plan Fire safety plan and firefighting systems Emergency response plan	1	5	ALARP, Moderate	Regular truck inspection and maintenance resulting in ALARP, no further assessment
20.3	LNG storage failure and release of gas	CO / OP / ADR	Fire or explosion	Regular storage facility inspection and maintenance Fire safety plan and firefighting systems Emergency response plan	1	5	ALARP, Moderate	Regular storage facility inspection and maintenance resulting in ALARP, no further assessment
20.4	Piping and piping component failure and release for gas	CO / OP / ADR	Fire or explosion	Regular storage facility inspection and maintenance Fire safety plan and firefighting systems Emergency response plan	3	2	Low	Low risk, ~~low~~ minor consequence event, no further assessment
20.5	Vaporization unit failure and release of gas	CO / OP / ADR	Fire or explosion	Regular piping inspection and maintenance Fire safety plan and firefighting systems Emergency response plan	3	2	Low	Low risk, minor~~low~~ consequence event, no further assessment
20.6	Pump failure and release of gas	CO / OP / ADR	Fire or explosion	Regular pumps inspection and maintenance Fire safety plan and firefighting systems Emergency response plan	3	2	Low	Low risk, minor~~low~~ consequence event, no further assessment

CO = Construction; OP = Operation; ADR = Active Decommissioning and Reclamation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable; LNG = liquified natural gas.

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Mine ventilation system: For the mine ventilation system, three hazard scenarios were identified, which have the potential to occur during Construction and Operations of the Project. All hazard scenarios have appropriate safeguards and design features to minimize the risk such that no further assessment is required for any of these hazards.

Table 3-21: Hazard Identification Evaluation – Mine Ventilation System

ID#	Accident/Malfunction	Phase	Consequence	Existing Safeguards / Design Features	L	S	RR / Significance	Screening Decision / Rationale
21.1	Power outage	CO / OP	Loss of ventilation and accumulation of radon, toxic fumes	Radiation protection plan Occupational health and safety program Refuge stations Equipment monitoring and alarms Second egress from Exhaust Shaft Emergency response plan	2	3	Low	Risk level is low, highly unlikely event, no further assessment
21.2	Ventilation fans failure	CO / OP	Loss of ventilation and accumulation of radon, toxic fumes	Radiation protection plan Occupational health and safety program Equipment monitoring and alarms Refuge stations Emergency response plan	2	3	Low	Risk level is low, highly unlikely event, no further assessment
21.3	Mine air heater fire	CO / OP	Smoke release into the mine	Preventive maintenance of the heating equipment Fire safety plan and firefighting systems and firefighting systems Equipment monitoring and alarms Engineered safety systems Air monitoring in underground mine Refuge stations Emergency response plan	3	4	ALARP, Moderate	Regular and preventive inspection and maintenance resulting in ALARP, no further assessment

CO = Construction; OP = Operation; L = likelihood; S = severity; RR = risk ranking; ALARP = As Low as Reasonably Practicable.

4.0 SELECTION OF ACCIDENT SCENARIOS FOR FURTHER ASSESSMENT

Based on the HI process presented in the previous section, six hazard scenarios have been selected for more detailed risk analysis (Table 4-1~~Table 4-1~~). This further assessment will include the calculation of the likelihood and consequences of each of these selected scenarios. This will result in more in-depth and representative characterization of the risk of these scenarios, as the estimation of the risk in this current report was preliminary and at the screening level.

Table 4-1: Hazard Scenarios Identified for Further Assessment by the Hazard Identification Process

Node	Accident or Malfunction Scenario	Location	Effect Pathway
3.1	Traffic accident (uranium concentrate)	Access road at bridge crossing	Aquatic release of uranium concentrate
3.3	Traffic accident (chemical)	Access road at bridge crossing	Aquatic release of fuel, hazardous chemicals
9.3	Solvent extraction fire or explosion	Solvent extraction building	Atmospheric release of uranium concentrate (chemical toxicity)
10.2	Tailings transfer pipe or pump failure	Tailings release to surface within secondary containment	Terrestrial release of radioactivity
13.3	Untreated effluent transfer pipe failure	Effluent treatment system	Terrestrial release of radioactivity
16.3	Acid Plant tail gas scrubber failure	Acid plant	Atmospheric release of sulphur dioxide

5.0 REFERENCES

5.1 References Cited

CNSC (Canadian Nuclear regulatory Commission). n.d. REGDOC-2.4.2, Safety Analysis Probabilistic Safety Assessment (PSA) for Reactor Facilities, Version 2. Available at **https://www.cnsc-ccsn.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc2-4-2/.**

IAEA (International Atomic Energy Agency). 2002. Procedures for conducting probabilistic safety assessment for non-reactor nuclear facilities, IAEA-TECDOC-1267, January 2002, ISSN 1011–4289. Available at **https://www-pub.iaea.org/MTCD/Publications/PDF/te_1267_prn.pdf.**

5.2 Information Sources

Mine Site Plan & Surface Utilities Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 5000-DY00-RPT-0001. Dated 29 October 2019.

Communications Systems Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 5800-DY00-RPT-0001. Dated 29 October 2019.

Underground Mine Facilities Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 1500-DY00-RPT-0001. Dated 29 October 2019.

Production Shaft Hoisting and Shaft Systems Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 1900-DY00-RPT-0001. Dated 29 October 2019.

Underground Mine Ventilation Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 1600-DY00-RPT-0001. Dated 24 October 2019.

Transportation and Logistics Study Traffic Impact Study Report (Revision B). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 0000-DY00-RPT-0010. Dated 15 October 2019.

Underground Mine Design Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 1300-DY00-RPT-0001. Dated 1 October 2019.

Underground Material Handling Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 1700-DY00-RPT-0001. Dated 1 October 2019.

Power Plant Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 5100-DY00-RPT-0001. Dated 1 October 2019.

Power Distribution System Risk Review (Revision 0). NexGen Energy Ltd. Rook I Project Feasibility Study Project No. 169519543. Document No. 5200-DY00-RPT-0001. Dated 1 October 2019.

Foam Fore Suppression System. NexGen Energy Ltd. Rook I Project Feasibility Study Project DOC: 0000-DE40-DSC-0002. Date 15 July 2019.

Civil Design Criteria. NexGen Energy Ltd. Rook I Project Feasibility Study Project. Document No. 0000-DD10-DSC-0001. Dated 4 November 2020.

IR 217 (Edits Made for Final EIS)

As a follow up to requests made pertaining to IR 217, NexGen is providing the following information to address the IR. For reference, here is the most recent comment submitted for IR 187:

217	CNSC	CNSC-AM-08		TSD VIII	**Conditionally Accepted**	Not Accepted (Grant)	The terms "very severe" and "low" used for consequence rating have not been corrected as committed, e.g., in sections 2.1 (page 2.2) and 3.2 (page 3.2) of TSD VIII, and section 2.1 (page 2.3) and Tables of Appendix A where the term "low consequence" is still used.	Correct the terms so that they are consistent with those in Table 3-2.	

In response to these comments, NexGen provided a copy of an edited version of Appendix A in TSD VIII (Accidents and Malfunctions) on 9 September 2024.

As a follow up to the information provided in the edited version of Appendix A in TSD VIII, in response to NexGen's 9 September 2024 submission, two additional edits were requested by the CNSC reviewer. NexGen is providing the following information to address the IR. Please see below the changes that have been made in Section 3.2 of TSD VIII (p 3.3) and Section 2.1 of Appendix A of TSD VIII (p 2.3), respectively.

The resulting risk levels are defined according to the hazard analysis risk matrix shown in Figure 3-1.

For the purpose of the assessment, risks were identified as being low (i.e., coloured green in the matrix) where the screening evaluation considered the risk as generally being acceptable, as the likelihood of these scenarios can be effectively managed through application of planned controls and/or the consequence of the effect would be low (i.e., negligible to moderate). Low-risk scenarios have a consequence of negligible to moderate, with the likelihood ranging from highly unlikely to almost certain.

Frank Halliday 33 minutes ago
IR 217: added the term 'negligible to moderate' to provide the specific consequence rating
Reply Resolve

Risks are identified as being moderate (i.e., coloured yellow in the matrix) where the screening evaluation considers the risk as generally being tolerable. In some cases, a moderate-risk scenario

The resulting risk levels are defined according to the hazard analysis risk matrix shown in Figure 2-1.

For the purpose of the assessment, risks were identified as being low (i.e., coloured green in the matrix) where the screening evaluation considered the risk as generally being acceptable, as the likelihood of these scenarios can be effectively managed through application of planned controls and/or the consequence of the effect would be low (i.e., negligible to moderate). Low-risk scenarios have a consequence of negligible to moderate, with the likelihood ranging from highly unlikely to almost certain.

Frank Halliday August 30, 2024
IR 217: added the term 'negligible to moderate' to provide the specific consequence rating
Reply Resolve

Risks are identified as being moderate (i.e., coloured yellow in the matrix) where the screening

IR 220 and 221

No.	Question	NexGen Response
220/221	IR-220: In response to IR-220, NexGen committed to providing as estimate of doses due to Bounding scenario 3 (Solvent extraction fire or explosion) The result of the dose estimate is provided in Table 15A2-9 of the EIS, however details of the estimate were not provided, i.e., how the dose for this scenario was derived, including the assumptions in the calculations. IR-221: In response to IR-221 NexGen committed to providing as estimate of doses due to Bounding scenario 4 (Tailings transfer pipe of pump failure). After reviewing Section 15 of the EIS as well as the Accidents and Malfunctions Technical Support document, I was not able to locate an estimate of the radiological doses resulting from bounding scenario 4.	NexGen confirms that the information that was required from the response to IR 220 and IR 221 was provided in the May 2024 revised EIS.

IR 220/221(Confirmation of Information in May 2024 Revised EIS)

In response to the follow-up comments provided by the CNSC, NexGen confirms that the information that was required from the response to IR 220 and IR 221 was provided in the revised EIS. Specifically, Table 15A2-9 of Appendix 15A shows the predicted dose to workers with respect to bounding scenario 3 (IR 220) and bounding scenario 4 (IR 221) as shown below (highlighted for visibility):

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Rook I Project
Environmental Impact Statement
Appendix 15A Radiological and Non-Radiological Worker Effects Summary

Table 15A2-9: Summary of Assessment Results for Bounding Scenarios

No.	Accident or Malfunction Scenario	Location	Likelihood	Predicted Worker Dose	Estimated Effects Consequence	Overall Risk Rating[(a)]
1	Vehicle accident including rollover, collision, resulting in fire and dusting	Access road	Likely	0.70 mSv	Moderate	Moderate risk
2	Process vessel including leach tanks and piping system failure	Mill processing facility	Highly unlikely	0.048 mSv	Negligible	Low risk
3	Solvent extraction fire or explosion	Solvent extraction building	Unlikely	2.17 mSv	Minor	Low risk
4	Failure of tailings / paste pipes and pumps	Paste plant and paste delivery / UGTMF	Likely	0.017 mSv	Negligible	Low risk
5	Ventilation disruption and radon accumulation in the mine	Underground mine	Unlikely	4.92 mSv[(b)]	Negligible	Low risk

a) Based on Table 15A2-8.
b) Conservative value provided. Values range from 0.000034 mSv to 4.92 mSv.
UGTMF = underground tailings management facility; mSv = millisievert.

With respect to the reviewer's comment on IR 220 "however details of the estimate were not provided, i.e., how the dose for this scenario was derived, including the assumptions in the calculations", NexGen notes that in the conditionally accepted responses to these items, it was stated that "Revised EIS Section 15 will be updated to include a summary of the radiological exposure assessment for accidents and malfunctions conducted in support of Project licensing", which was provided at the appropriate level. Consistent with what was stated in NexGen's IR response, the more detailed radiological exposure assessment of accidents and malfunctions from which this information is summarized was provided to the CNSC as part of Project licensing. This information formed part of NexGen's 30 June 2023 complete licence application submission provided to and reviewed by the CNSC, and for which NexGen received confirmation from the CNSC of sufficiency being achieved on 1 September 2023. Should the reviewer wish to familiarize themselves with this more detailed information, the specific report "Rook I Project– Radiological Exposure Assessment of Occupational Accidents and Malfunctions" is available within Annex A of the Rook I Project Mining and Mill Facility Description Manual.

IR 230

No.	Justification/Rationale	Follow up Information Request	NexGen Response
230	**Justification:** The Proponent has indicated in their response that the net-zero framework continues to be advanced in accordance with section 3.5.2 of the Draft Technical Guide Related to the Strategic Assessment of Climate Change. The purpose of this section of the Technical Guide is to develop a credible plan for the Project to achieve net-zero emissions by 2050. **Rationale:** The Proponent's net-zero framework focuses on identifying "alternative technologies and practices that could be implemented by the Project to reduce GHG emissions". ECCC is seeking clarity on whether the intention of the Proponent's net-zero framework is to: a) Reduce Project GHG emissions, or b) Achieve Project net-zero emissions by 2050.	**Information Request:** In order to resolve this IR, NexGen to confirm if the net-zero framework is being developed with a goal to reduce project GHG emissions, or to achieve net-zero Project emissions by 2050.	NexGen confirms that the net-zero framework is being developed with a goal to reduce Project greenhouse gas emissions.

IR 244

No.	Justification/Rationale	Follow up Information Request	NexGen Response
244	**Justification:** Part two is accepted. ECCC reminds the Proponent that as outlined in Schedule 4 of the MDMER, subsection 4(1), all effluent, including total suspended solids, must meet the concentration-based limits, it must be within the minimum and maximum allowable pH, and it must not be acutely lethal. Parts one and three were responded to adequately, however no changes were made to the revised EIS. **Rationale:** The response to parts one and three will be accepted pending the incorporation of the updates described in the response into the future revised EIS.	**Information Request:** Incorporate the updates described in the response into the future revised EIS.	NexGen confirms that the requested changes associated with NexGen’s response to IR 244-R1 were incorporated into the May 2024 revised EIS. NexGen also believes that the reviewer is actually suggesting that they need to see the changes for part 1 and part 2 of the IR rather than part 1 and part 3. NexGen understands that part 3 should be resolved as a result of the context provided in part 1 and part 2 of the NexGen response to IR 244-R1.

IR 244-R1 (Confirmation of Information in May 2024 Revised EIS)

NexGen confirms that the requested changes associated with NexGen's response to IR 244-R1 were incorporated into the May 2024 Revised EIS. NexGen also believes that the parts referenced by the reviewer as unresolved are not entirely accurate.

For context, included below is the reviewer's IR for IR 244-R1, NexGen's response to IR 244-R1, and the follow-up comment from the reviewer, highlighting the key aspects:

IR 244-R1

1. Provide an updated site water management plan that includes management of the site infrastructure runoff water (i.e. non-contact water) from the west bermed runoff collection area.
2. Propose a new FDP location downstream of the west bermed runoff collection area outflow that would allow for sampling and monitoring for COPCs required for effluent characterization.
3. Provide design specifications for the west bermed runoff collection area that would prevent seepage of potentially deleterious substance containing non- contact water to confirm the protection of the receiving environment.

NexGen Response to IR 244-R1 (from May Submission)

Responses to part 1 through part 3 of IR 244-R1 are provided below.

1. NexGen confirms that, with respect to the context provided by the reviewer regarding the explosives storage area and associated access road, no deleterious substance sources in runoff would exist; therefore, runoff would be non-mineralized contact water, which would be appropriate for collection in the west bermed runoff collection area. The potential of water quality deleterious substances from the explosives storage area would be limited to those associated with potential spills, which would be mitigated by area-specific management practices for stockpiled materials that will be developed in accordance with applicable regulatory requirements, including the *Explosives Act* and The Mines Regulations, 2018.

   The potential for spills of explosive materials have been considered in the Project design. As noted in the response to IR 185, the storage of explosives is heavily regulated to minimize risks. Explosives would be managed as per the *Explosives Act*, as well as CAN/BNQ 2910-500/2015 Explosives – Magazines for Industrial Explosives. Potential spills would be contained and managed according to the Rook I Environmental Protection Program to avoid the release of any nitrogen compounds to the environment. The explosives magazine would be designed and constructed with a lined sump capable of storing a 1:100 year, 24-hour precipitation event, and water that has contacted spilled material would be collected and trucked to the settling pond for subsequent treatment and testing prior to discharge through a final discharge point (FDP).

In summary, runoff from the explosives magazine or associated access road is not expected to contain deleterious substances, and thus does not require control and management through a FDP.

NexGen notes that Figure 5 of Draft EIS TSD XVIII incorrectly shows that Element R52 would contain mineralized contact water rather than non-mineralized contact water; this will be corrected in Figure 5 of revised EIS TSD XVIII.

2. NexGen maintains that an additional FDP downstream of contact water pond #2 (e.g., a FDP downstream of the west bermed runoff area) is not required as, under the currently proposed surface water management system, water released to the receiving environment would not contain deleterious substances above Project thresholds.

   As noted in NexGen's initial response to the original IR 244, water reporting to contact water pond #2 (i.e., site runoff pond #2) is considered the final point of control and would be tested to confirm that effluent release criteria other than total suspended solids (TSS), including requirements under the Metal and Diamond Mining Effluent Regulations, are met prior water being released to the west bermed runoff collection area, where this water would diffuse passively (i.e., to ground; there would be no overland path for water containing TSS to travel to Patterson Lake). In other words, contact water pond #2 represents FDP (i.e., control point) where water would be monitored prior to release to the environment. Should water quality in contact water pond #2 not meet Project thresholds, water would be pumped to the settling pond for treatment in the effluent treatment plant and re-tested to confirm compliance prior to discharge to Patterson Lake (Draft EIS Section 5.4.5.2 [Surface Water Management]).

   NexGen further notes that the monitoring ponds that receive water from the effluent treatment plant also represent an FDP where water would be monitored prior to release to the environment.

   These two FDPs (i.e., contact water pond #2 and the monitoring ponds) would represent monitoring locations/points of control for all Project site contact water.

   NexGen acknowledges that the statement "[t]he west bermed runoff collection area would be located on the west side of the Project site. This collection area would receive runoff from the local contributing area as well as overflow from contact water pond #2, if required" (Draft EIS Section 5.4.5.2, Table 5.4-4) could be interpreted as there is a possibility that water not meeting Project threshold criteria could be discharged into the west bermed runoff collection area. For this reason, Table 5.4-4 in revised EIS Section 5.4.5.2 (Surface Water Management) will be updated to state "[t]he west bermed runoff collection area would be located on the west side of the Project site. This collection area would receive runoff from the local contributing area as well as discharges from contact water pond #2 (i.e., a final point of control), provided Project discharge criteria are met". In addition, NexGen will also update

Figure 5 of Section 3.4 of revised EIS TSD XVIII (Site-Wide Water Balance and Water Quality Modelling Report) to show the Project site water process flow more clearly.

3. As described in part 1 and part 2 of this response, other than TSS, no deleterious substances would be released to the west bermed runoff collection area. With respect to TSS, releases to the west bermed runoff collection area would be directly to ground, with no overland pathway to Patterson Lake. Therefore, TSS would settle out prior to water diffusing to Patterson Lake through the shallow groundwater pathway.

   As the west bermed runoff collection area would not receive potentially deleterious substances above Project thresholds other than TSS, the provision of design factors to control the release of deleterious substances is not required.

References

Explosives Act. RSC 1985, c E-17. Current to 28 July 2020. Available at https://laws-lois.justice.gc.ca/eng/acts/e-17/.

The Mines Regulations, 2018. RRS c S-15.1 Reg 8 under *The Saskatchewan Employment Act*. Effective April 6, 2019. Available at https://www.canlii.org/en/sk/laws/regu/rrs-c-s-15.1-reg-8/latest/rrs-c-s-15.1-reg-8.html.

SCC. 2015. CAN/BNQ 2910-510/2015: Explosives – Quantity Distances.

Reviewer follow-up comment

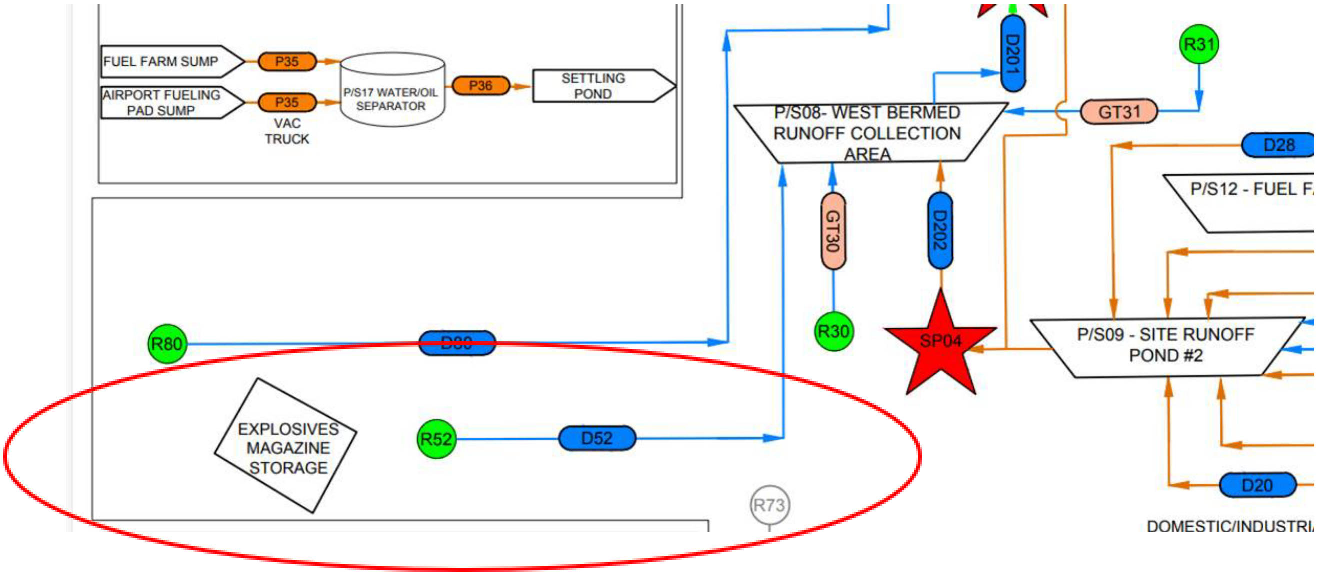
244	ECCC	TSD XVIII, Section 4.1.2	**Not Accepted**	**Not Accepted**	**Justification:** Part two is accepted. ECCC reminds the Proponent that as outlined in Schedule 4 of the MDMER, subsection 4(1), all effluent, including total suspended solids, must meet the concentration-based limits, it must be within the minimum and maximum allowable pH, and it must not be acutely lethal. Parts one and three were responded to adequately,	**Information Request:** Incorporate the updates described in the response into the future revised EIS.	**No**

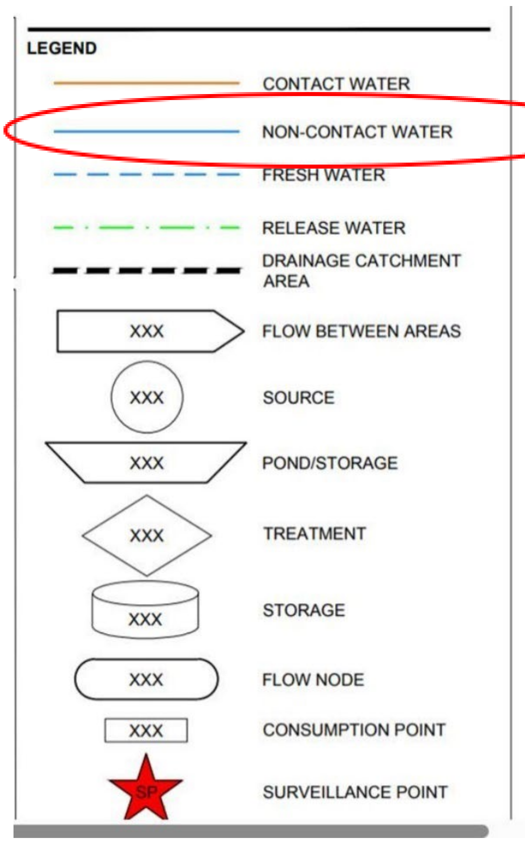
					however no changes were made to the revised EIS. **Rationale:** The response to parts one and three will be accepted pending the incorporation of the updates described in the response into the future revised EIS.		

From the justification provided by the reviewer in the table above, it was noted all aspects were adequately addressed in order to be accepted (pending confirmation of edits being made in the revised EIS, which NexGen have confirmed they were as per the below). Therefore, it is assumed that the reviewer is actually stating that they need to see the changes for part 1 and part 2 of the IR rather than part 1 and part 3. NexGen understands that part 3 should be resolved as a result of the context provided in part 1 and part 2 of the NexGen response.

With respect to changes in the EIS to address part 1 and part 2 of IR 244-R1, NexGen confirms that edits were already incorporated in the May Revised EIS. Please see below the changes that were presented in the May Revised EIS, with identifiers (i.e., circles, highlighting, text box) included to show the necessary aspects.

Part 1





As presented, element R52 has been updated to show that non-contact water would flow from the explosives facility to the west bermed runoff collection area. NexGen understands this resolves part 1 as the information is currently presented in the May Revised EIS.

Part 2

Table 5.4-4: Rook I Project Water Management Structure Summary

Water Management Structure	Description
Monitoring ponds	These four lined ponds, each with a capacity of 5,000 m^3, would be located north of the mill terrace and would receive water after treatment in the ETP. Water would be tested and discharged if appropriate criteria are met; if criteria are not met, the water would be pumped to the settling pond for additional treatment.
West bermed runoff collection area	The west bermed runoff collection area would be located on the west side of the Project site. This collection area would receive runoff from the local contributing area as well as discharges from contact water pond #2 (i.e., a final point of control), provided Project discharge criteria are met. This bermed area would prevent suspended solids entrained in runoff water from entering Patterson Lake by natural filtration through an unlined berm.

PAG = potentially acid generating; HDPE = high-density polyethylene; ETP = effluent treatment plant; WRSA = waste rock storage area.

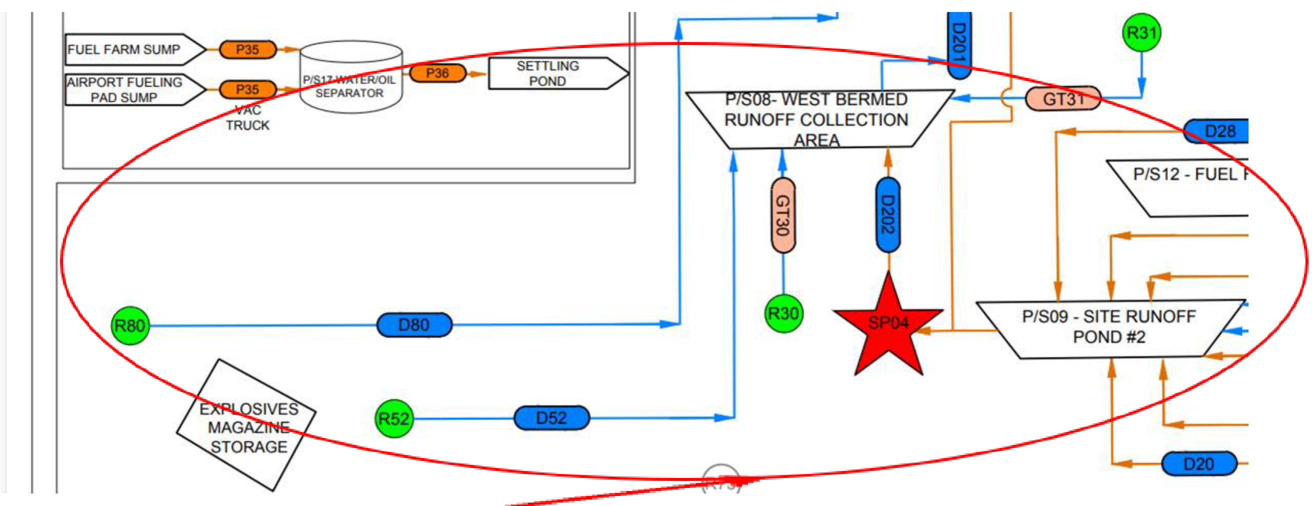


Figure shows that all water inputs to the west bermed runoff collection area that do not go through a Final Discharge Point represent non-contact water. The only contact water input to the west bermed runoff collection area is from site runoff pond #2, which as shown, would go through a surveillance point (in this case a Final Discharge Point Surveillance Point)

As shown above, the text has been updated in Table 5.4-4 of Section 5.4 and the process diagram shows the accurate inputs to the west bermed runoff collection area. NexGen understands this resolves part 2 as the information is currently presented in the May Revised EIS.

IR 254

No.	Justification/Rationale	Follow up Information Request	NexGen Response
254	**Justification:** The Proponent confirms that if a constituent of potential concern (COPC) exceeds screening criterion in one medium, it should be assessed for all media that are likely to contribute to exposure points (CSA N288.6-22, Section 7.2.5.4.2 [CSA Group 2022]). The Proponent also confirms that if there's exceedances for iron FEQG, it would be required to be added as a COPC and further assessed in the sediment quality modelling and the Environmental Risk Assessment. The Proponent has provided the rationale for using the Federal Environmental Quality Guideline (FEQG) over the CCME Guidelines for iron but has used the outdated formula to calculate the iron FEQG. The iron FEQG may not simply be represented by a single equation. This is because the toxicity endpoints included in the Species Sensitivity Distribution (SSD) were adjusted (or normalized) for water chemistry using three different normalization equations depending on the taxa of the endpoint. The iron calculator can be found in the Annex of the iron FEQG website to assist with this calculation. The Proponent has preferred the FEQG but has not updated the selected screening value for iron in Table 4-1 and 4-2 (Draft EIS Section XXI [Environmental Risk Assessment], Section 4.2.3.2). **Rationale:** Assessment on water quality thresholds cannot be determined until iron FEQG calculations are corrected.	**Information Request:** In order to resolve this IR, NexGen is required to recalculate iron FEQG based on the latest guidance from FEQG in order to determine if there would be baseline exceedances. If baseline exceedances occur, then iron should be included in the exposure assessment portion of the ERA and the sediment quality modelling for the sediment quality assessment and tables should be updated accordingly.	As requested for both IR 81-R1 and IR 254-R1, NexGen has completed an iron exposure assessment, which will be incorporated as a new Appendix D to the EIS Technical Support Document XXI (Environmental Risk Assessment). A copy of Appendix D has been provided to address IR 81-R1 and IR 254-R1. In the new iron exposure assessment (i.e., Appendix D), NexGen used recalculated iron Federal Environmental Quality Guideline (FEQG) values, which are now adjusted for water chemistry based on the latest FEQG guidelines using the online calculator referenced in the reviewer's follow-up comment. Water and sediment modelling have been updated accordingly in the assessment. Based on this modelling, the assessment confirmed that there are no exceedances when comparing the predicted maximum iron concentrations to their available quality guidelines in different environmental media, and therefore there are no anticipated risks to ecological and human health with regards to iron inputs from the Project.

APPENDIX D IRON EXPOSURE ASSESSMENT

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APPENDIX D IRON EXPOSURE ASSESSMENT

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1.0 Introduction

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan, called the Rook I Project (Project). The proposed Project is subject to both provincial and federal Environmental Assessment (EA) processes, would be licensed as a nuclear facility by the Canadian Nuclear Safety Commission (CNSC), and would be subject to various provincial and federal permits and approvals.

In support of the EA for the Project, NexGen prepared an Environmental Impact Statement (EIS), which included baseline studies and development of an Environmental Risk Assessment (ERA) (EIS TSD XXI). Baseline studies conducted for water and sediment included sampling for concentrations of iron, which were then further considered within EIS TSD XXI.

Iron is the fourth most common of elements in the Earth's continental crust. It is an essential element for living organisms and is well regulated in the body. It is not considered to be a toxicant of concern, except to aquatic biota in specific circumstances (ECCC 2024). It is well understood that iron exerts its toxicological effects on aquatic biota through precipitation when receiving water pH is higher than the pH in a discharge. Such precipitation on the gills or on fish eggs can cause respiratory stress or smothering (Brix et al. 2023; ECCC 2024). While iron can affect aquatic biota, there is no risk associated with the quality of the food source and potential accumulation of iron in biological tissues (ECCC 2024).

From baseline studies conducted for the Project, iron concentrations were identified as exceeding water quality guidelines in baseline surface water quality throughout the local study area (LSA), with exceedances of the water quality guideline of 0.3 mg/L from the Canadian Council of Ministers of the Environment (CCME) in eight waterbodies and watercourses and in the reference lakes. As part of EIS TSD XXI, iron was evaluated as a constituent of potential concern (COPC) but was not carried forward (i.e., was screened out), as the predicted upper bound concentrations of iron released to Patterson Lake in treated effluent, sewage, and groundwater, as well as the predicted upper bound concentrations of iron at the boundary of the mixing zone were lower than the selected water quality guideline of 0.3 mg/L from the CCME. Thus, it was concluded that there would be no potential for Project releases to increase iron concentrations in the receiving environment above the CCME guideline. Iron concentrations in sediment were not screened against any sediment quality guidelines (SQGs) in EIS TSD XXI, because there are no federal or provincial guidelines for iron in sediment.

Since the completion of the screening originally conducted as part of the Project EA, an updated Federal Environmental Quality Guideline (FEQG) was published in May 2024 (ECCC 2024), which is more stringent than the previous CCME water quality guideline (Table 1-1). The scope of EIS TSD XXI Appendix D, Iron Exposure Assessment, is to provide the exposure assessment of iron consistent with requirements of CSA N288.6-22 Section 7.2.5.4.2 to determine the Project-related effects to sediment quality and aquatic biota and to support the assessment performed in the TSD XXI, using the new FEQG water quality guidelines.

Table 1-1: Measured Baseline Surface Water Iron Concentrations (mg/L) in the Local Study Area

Water body / Water course	# of Samples	% Above FEQG Water Quality Threshold for Aquatic Life	% Above CCME Water Quality Threshold for Drinking Water Quality	Min.	25th Percentile	Average[(a)]	95th Percentile	Max.
Broach Lake	19	0	0	0.0030	0.012	0.028	0.090	0.12
Lake H	11	27%	27%	0.056	0.087	**0.43**	**1.73**	**2.08**
Lake G	11	73%	73%	0.15	**0.31**	**0.69**	**2.08**	**2.44**
Patterson Lake North Arm – East Basin	19	10%	10%	0.0085	0.085	0.19	**0.59**	**0.79**
Patterson Lake North Arm – West Basin	19	5%	5%	0.0068	0.012	0.051	0.19	**0.47**
Patterson Lake South Arm	19	0	0	0.0012	0.013	0.016	0.025	0.031
Forrest Lake – North Basin	15	0	0	0.0016	0.029	0.043	0.089	0.11
Forrest Lake – South Basin	18	6%	0	0.00020	0.0059	0.024	0.062	**0.26**
Beet Lake	17	6%	6%	0.0039	0.020	0.11	**0.30**	**0.85**
Naomi Lake	12	100%	100%	**0.35**	**0.65**	**0.83**	**1.01**	**1.02**
Clearwater River below Beet Lake	11	0	0	0.0220	0.048	0.09	0.18	0.19
Reference Lake	33	3%	3%	0.0046	0.015	0.12	0.63	1.58

Notes: **Shaded grey and bold** indicates that the value is greater than both the minimum FEQG water quality guideline for protection of aquatic life of 0.23 mg/L calculated for baseline water samples (samples with pH 7.3 – 7.4 and dissolved organic carbon of 1.5 mg/L, see Table 5-1; ECCC, 2024) and the CCME water quality guideline for aquatic life and drinking water quality of 0.3 mg/L (CCREM, 1987; ECCC, 2019). **Shaded black, and bold white font** indicates that the value is greater than the minimum FEQG water quality guideline for protection of aquatic life of 0.23 mg/L but not greater than the CCME guideline.

a) Calculated using half detection limit for any non-detectable samples.

2.0 Development of Model Parameters for Iron

The details on the IMPACT modelling approach applied for the iron assessment are the same as those reported in the main body of EIS TSD XXI and the associated Appendix A of EIS TSD XXI. Section 2.1 and Section 2.2 of EIS TSD XXI Appendix D provide the iron-specific parameters used in the IMPACT model.

2.1 Baseline Water Quality and Sediment Quality

This subsection describes how the baseline water quality and sediment quality were set up in the IMPACT model. The local inflow to each waterbody represents the local watershed inputs to assessed waterbodies (excluding the upstream inflow). The calibrated local inflow values of iron were used in the model to predict stable concentrations in water and sediment within the range of observed values of baseline conditions.

A summary of the modelling assumptions and adjustments is included below:

- The waterbodies included in the calculation of a regional baseline concentration were Patterson Lake (i.e., North Arm – East Basin, North Arm – West Basin, and South Arm), all measurement stations along the Clearwater River, Lake H, Lake G, Forrest Lake, Beet Lake, Naomi Lake, Mirror River, and Lloyd Lake.
- The local inflow concentrations were calculated from the baseline concentrations (Table 1-1), the residence time within each respective waterbody, sedimentation rate, and water-to-sediment partitioning coefficient.
- Since sedimentation processes remove metals from the inflow, the local inflow concentrations for each waterbody were assigned values higher than the baseline concentrations.

Metals in water are expected to interact with sediment. Iron concentrations in sediment were modelled based on concentrations in water using the water-to-sediment partitioning coefficients (K_d). The K_d value for iron used in the IMPACT model is $4.97x10^{+05}$ L/kg (dw), which was calibrated using the measured water and sediment quality data from baseline studies completed from 2018 to 2020.

The measured geometric mean (geomean) and modelled-average baseline concentrations are in agreement (Table 2-1).

Table 2-1: Baseline Water and Sediment Concentrations of Iron Used in the IMPACT Model

Parameter	Water Baseline Concentration	Sediment Baseline Concentration
	mg/L	mg/kg dw
Measured Baseline (Geomean)	7.25×10^{-2}	1.81×10^{4}
Modelled Baseline	7.25×10^{-2}	1.81×10^{4}

2.2 Baseline Air Quality and Soil Quality

Risk through air exposure pathways is considered during Operations, because the highest predicted iron concentrations occur during this phase. For the baseline, it is assumed that none of the considered COPCs are present in air. Consequently, any risk increase through the air pathway is due to the operation of the mine. Regional background soil chemistry was derived from baseline data collected in 2019. Table 2-2 presents the selected air and soil baseline concentrations used in the IMPACT model.

Table 2-2: Baseline Air and Soil Concentrations of Iron Used in the IMPACT Model

Air Baseline Concentration	Soil Baseline Concentration
mg/m^3	mg/kg dw
0.0	1.61×10^{3}

3.0 Aqueous and Atmospheric Sources for Iron

Similar to other COPCs, the Project-related aqueous releases to Patterson Lake would include releases from the effluent treatment plant, sewage treatment plant, and groundwater as well as non-contact site runoff. The Project-related atmospheric releases considered in the ERA were consistent with the air emissions inventory detailed in the Air Dispersion Modelling Report for Project Construction and Operations (EIS Section 7.2.5, Residual Effects Analysis; EIS Appendix 7A, Air Dispersion Modelling Report).

More details regarding the source terms were reported in Section 4.2 and Section 4.3 of EIS TSD XXI.

4.0 Exposure Point Concentrations in Environmental Media

The estimated maximum iron concentrations in environmental media, including water, sediment, air, and soil, at different locations during Operations for the Application Case and the Upper Bound Scenario are shown in Table 4-1. These values represent the model baseline plus Project effects. The maximum iron concentration in water was predicted at Patterson Lake North Arm – West Basin, which is 0.0726 mg/L for both the Application Case and the Upper Bound Scenario. The predicted values are less than 0.1% above model baseline, indicating the Project has a minimal contribution to the total concentration.

The maximum iron concentration in sediment was predicted at Patterson Lake North Arm – East Basin, which is $1.81\text{x}10^{4}$ mg/kg dw for both the Application Case and the Upper Bound Scenario, again only marginally above the model baseline concentration of $1.81\text{x}10^{4}$ mg/kg dw, indicating the Project contribution to iron in sediment is minimal.

The maximum iron concentrations in air and soil were predicted at Patterson Lake North Arm – West Basin, which are $3.55\text{x}10^{-5}$ mg/m^3 and $1.62\text{x}10^{3}$ mg/kg dw, respectively, for both the Application Case and the Upper Bound Scenario. The model baseline for iron in air was assumed to be 0.0 mg/m^3, and the model baseline for soil was $1.62\text{x}10^{3}$ mg/kg dw.

Table 4-1: Estimated Maximum Iron Concentrations in Environmental Media for the Application Case and Upper Bound Scenario - Project Lifespan

Environmental Media	Location	Maximum Concentration during Project Lifespan	
		Application Case	Upper Bound Scenario
Water (mg/L)	Reference (Broach Lake)	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Clearwater River downstream of Broach Lake	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Patterson Lake North Arm – East Basin	$7.26\text{x}10^{-2}$	$7.26\text{x}10^{-2}$
	Patterson Lake North Arm – West Basin	**$7.26\text{x}10^{-2}$**	**$7.26\text{x}10^{-2}$**
	Patterson Lake South Arm	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Forrest Lake – North Basin	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Beet Lake	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Naomi Lake	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Clearwater River upstream Mirror River Confluence	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Clearwater River downstream Mirror River Confluence	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$
	Lloyd Lake Inlet	$7.25\text{x}10^{-2}$	$7.25\text{x}10^{-2}$

Environmental Media	Location	Maximum Concentration during Project Lifespan	
		Application Case	Upper Bound Scenario
Sediment (mg/kg dw)	Reference (Broach Lake)	1.81×10^{4}	1.81×10^{4}
	Patterson Lake North Arm – East Basin	**1.81×10^{4}**	**1.81×10^{4}**
	Patterson Lake North Arm – West Basin	1.81×10^{4}	1.81×10^{4}
	Patterson Lake South Arm	1.81×10^{4}	1.81×10^{4}
	Beet Lake	1.81×10^{4}	1.81×10^{4}
	Naomi Lake	1.81×10^{4}	1.81×10^{4}
	Lloyd Lake Inlet	1.81×10^{4}	1.81×10^{4}
Air (mg/m^3)	Reference (Broach Lake)	0.00	0.00
	Patterson Lake North Arm – West Basin	**3.55×10^{-5}**	**3.55×10^{-5}**
	Patterson Lake South Arm	5.04×10^{-6}	5.04×10^{-6}
	Beet Lake	1.86×10^{-6}	1.86×10^{-6}
	Clearwater River and Mirror River Confluence	1.10×10^{-7}	1.10×10^{-7}
	Lloyd Lake	6.00×10^{-8}	6.00×10^{-8}
Soil (mg/kg dw)	Reference (Broach Lake)	1.61×10^{3}	1.61×10^{3}
	Patterson Lake North Arm – West Basin	**1.62×10^{3}**	**1.62×10^{3}**
	Patterson Lake South Arm	1.61×10^{3}	1.61×10^{3}
	Beet Lake	1.61×10^{3}	1.61×10^{3}
	Clearwater River and Mirror River Confluence	1.61×10^{3}	1.61×10^{3}
	Lloyd Lake	1.61×10^{3}	1.61×10^{3}

Notes: The **bold** values indicate the maximum concentrations in each environmental media.
Project lifespan includes Construction, Operations, and Closure phases (43 years in total).

5.0 Comparison to the Available Media Quality Guidelines

The considered media quality guidelines are reported in Section 4.2.3 of Draft EIS TSD XXI for water and sediment and Section 4.3.3 of Draft EIS TSD XXI for air and soil.

From a human health perspective, iron is an essential element with no evidence for toxic effects unless large quantities of iron are ingested. Accordingly, Health Canada has not set a maximum acceptable concentration for iron; the current guideline for drinking water of 0.3 mg/L represents an aesthetic objective.

With respect to iron in water, it is important to note that an updated FEQG was published in May 2024, which follows the CCME (2007) species sensitivity distribution protocol (ECCC 2024). It is more stringent than the previous FEQG (ECCC 2019). FEQG guidelines are dependent on dissolved organic carbon (DOC) and pH. Table 5-1 shows the calculated FEQG values for iron in freshwater using the 2024 guideline equations and pH and DOC values obtained from the water quality baseline studies (EIS Annex V.1, Aquatic Environment Baseline Report). The calculated FEQG values for iron range from 0.23 mg/L to 0.76 mg/L, which is in the same range as the 1987 CCME guideline of 0.3 mg/L (CCREM 1987).

There are no federal or provincial guidelines for iron in sediment; therefore, the lowest effect level (LEL) of 2.00×10^{4} mg/kg dw for the protection and management of aquatic sediment quality in Ontario was applied (MOEE 1993). The only available air quality guideline for iron is the 24-hour Ontario Ambient Air Quality Criteria (OAAQC), which is 4.00×10^{-3} mg/m^{3}. There are no federal or provincial guidelines for iron in soil.

As shown in Table 5-2, there is no exceedance when comparing the predicted maximum iron concentrations to the available quality guidelines in different environmental media. Therefore, no effects from iron on the environment are expected.

Table 5-1: Summary Statistics of Calculated FEQG Values for Iron in Freshwater and pH and Dissolved Organic Carbon (DOC) Values in Baseline Water Samples Associated with each FEQG Value

Statistical Parameter	Calculated FEQG Values (mg/L)	Associated Sample Values[(a)]	
		DOC (mg/L)	pH
Minimum	0.23	1.5	7.4
		1.5	7.3
25th Percentile	0.26	-	-
50th Percentile	0.38	3.5	6.7
		3.4	6.7
95th Percentile	0.67	-	-
Maximum	0.76	10	7.3
Arithmetic Mean	0.42	-	-
Geometric Mean	0.40	-	-

Notes: Cell with dashes "-" indicate that these FEQG values were computed using all calculated FEQG values (they reflect the distribution of the calculated FEQG values) and are therefore not associated with specific water samples. Although the 50th percentile is computed in this way, the resulting FEQG value of 0.38 mg/L was associated with specific water samples; therefore, associated DOC and pH values are shown.

Only samples with pH 6.0 – 8.5 and DOC 0.3 – 10.9 were used for FEQG calculations, as this is the range of pH and DOC values within which the CCME's water quality guideline conversion table for iron is valid (ECCC 2024). Sub-setting to these pH and DOC ranges omitted one water sample.

a) From measured water baseline data

Table 5-2: Comparison of Maximum Iron Concentrations to Available Quality Guidelines

Maximum Predicted Concentration	Available Quality Guidelines		Is Concentration Greater than Available Quality Guidelines (Yes/No)
Water (mg/L)	**CCME Protection of Aquatic Life, Long Term (a)**	**Federal Environmental Quality Guidelines (FEQG) (b)**	
7.26×10^{-2} (Application Case) 7.26×10^{-2} (Upper Bound Scenario)	0.30	0.23 - 0.76	No
Sediment (mg/kg dw)	**The lowest effect level (LEL) from Ontario (c)**		
1.81×10^{4}	2.00×10^{4}		No
Air (mg/m³)	**Ontario Ambient Air Quality Criteria (OAAQC), 24-hour (d)**		
3.55×10^{-5}	4.00×10^{-3}		No
Soil (mg/kg dw)	**Soil Quality Guidelines Unavailable**		
1.62×10^{3}	No Data		Not applicable

Notes:
a) CCREM (1987); ECCC (2019).
b) ECCC (2024).
c) MOEE (1993).
d) MECP (2020).

6.0 Discussion of Potential Risk to Ecological And Human Health

Since there are no exceedances when comparing the predicted maximum iron concentrations to their available quality guidelines in different environmental media, there are no anticipated risks to ecological and human health with regards to iron inputs from the Project.

7.0 References

Brix, K.V., L., Tear, D.K. DeForest, W.J. Adams. 2023. Development of multiple linear regression models for predicting chronic iron toxicity to aquatic organisms. Environmental Toxicology and Chemistry. 42(6): 1386-1400.

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

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Environmental Quality Guidelines: A protocol for the derivation of water quality guidelines for the protection of aquatic life. Winnipeg, MB. 37 pp. Available at **https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines**.

ECCC (Environment and Climate Change Canada). 2019. Federal environmental quality guidelines – Iron. May. Available at **https://www.canada.ca/content/dam/eccc/documents/pdf/pded/feqg-iron/Federal-Environmental-Quality-Guidelines-Iron.pdf**.

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MECP (Ontario Ministry of the Environment, Conservation and Parks). 2020. Technical Assessment and Standards Development Branch, 2020. Ambient Air Quality Criteria.

MOEE (Ontario Ministry of Environment and Energy). 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Available at **https://atrium.lib.uoguelph.ca/server/api/core/bitstreams/d662f9f3-49b4-403e-95ce-8c481224cd1a/content**.

IR 258

No.	Context and Rationale	Advice to Proponent	NexGen Response
258	While the IR was accepted in Oct 2023, CNSC had provided follow-up advice to NexGen for this IR including proposed changes to the text of TSD XXI. It appears that NexGen has not responded to the advice and the text has not been updated.	Regarding item #1, for accuracy and completeness, please consider revision to Table 6-1 of the ERA (TSD XXI), to indicate that the macrophyte sampling was conducted in Lloyd Lake, Broad Lake, Jed Creek, Patterson Creek, Beet Creek, and Clearwater River. Currently, the Table 6-1 only indicates sampling in Lloyd Lake.	NexGen will make the changes requested as part of the 'advice to proponent' portion of IR 258 in the Final EIS, noting this was not previously addressed in the May Revised EIS as it had not been included in the 'advice to proponent' table provided to NexGen.

IR 258 (Edits Made for Final EIS)

As a follow up to the information provided by the CNSC showing feedback from the reviewer of IR 258 that noted an expected change in the revised EIS was not made, NexGen is providing the following information to address the IR. NexGen note that the reason this item was not included in the May Revised EIS is because a request was not formally made in the form of a Round 2 IR or advice item; rather, the comment was placed in the summary table as an item for consideration and the IR was classified as accepted. For context, please find below the most recent comment submitted for IR 258 and the original comment, respectively:

258	CNSC	CNSC-AQ-02		TSD XXI: ERA, Table 6-1	**Accepted**	While the IR was accepted in Oct 2023, CNSC had provided follow-up advice to NexGen for this IR including proposed changes to the text of TSD XXI. It appears that NexGen has not responded to the advice and the text has not been updated.		(capture recommendation here?)	

258.	CNSC	TSD XXI: ERA, Table 6-1	**Accepted**	**Follow-up Advice to Proponent:** Regarding item #1, for accuracy and completeness, please consider revision to Table 6-1 of the ERA (TSD XXI), to indicate that macrophyte sampling was conducted in Lloyd Lake, Broach Lake, Jed Creek, Patterson Creek, Beet Creek, and Clearwater River. Currently, the Table 6-1 only indicates sampling in Lloyd Lake.		

In response to this comment, please see below the changes that have been made in Table 6-1 of EIS TSD XXI. The specific edit is shown as tracked changes in Microsoft Word format.

Table 6-1: Rationale for Selection of Ecological Receptors for the Rook I Project Ecological Risk Assessment

Organism Category	Representative Species	Selection Criteria				Other Species Represented[a]
		1	2	3	4	
		Major Plant or Animal Group	Presence in the Site, LSA, or RSA	Socioeconomic or Ecological Value and Value to Indigenous Communities	Exposed to and/or Sensitive to Stressor	
Terrestrial invertebrates	Earthworm (*Lumbricus terrestris*)	Soil-dwelling detritivore	Ubiquitous in the environment.	Food source for other ecological receptors.	Exposed to atmospheric release through soil.	Assessed as a group.
Terrestrial vegetation	Lichen	Lichen	Observed in the LSA and RSA. Samples collected for analysis of metals and radionuclides.	Primary winter food source for woodland caribou. Some lichen species are provincially rare.	Exposed to atmospheric release through soil and atmospheric deposition.	Represents all terrestrial and arboreal lichen species.
	Blueberry (*Vaccinium myrtilloides*)	Shrub	Observed in the study areas. Fruit, leaves, and stems collected and analyzed for metals and radionuclides.	Food source for other ecological receptors. Harvested by people for consumption.		Represents all terrestrial vegetation species, including jackpine, black spruce, and common ericaceous shrub species (e.g., bearberry, Labrador tea, blueberry, mountain cranberry, green alder).
	Labrador tea (*Rhododendron groenlandicum*)	Shrub	Present in study areas.	Food source for other ecological receptors. Medicinal plant harvested by Indigenous Peoples.		
Aquatic invertebrates	Zooplankton (general category)	Zooplankton	Present in lakes / potential discharge locations.	Food source for other ecological receptors.	Exposed to aquatic release through surface water.	Assessed as a group.
	Benthic invertebrates (i.e., Chironomidae)	Benthic invertebrates (infaunal)	Most abundant taxon found in areas surveyed.	Food source for other ecological receptors.	Exposed to aquatic release through sediment.	Assessed as a group.
	Benthic invertebrates (i.e., Ephemeroptera)	Benthic invertebrates (epifaunal)	Represents relatively large fraction of biomass in Patterson Lake and other areas.	Food source for other ecological receptors.	Exposed to aquatic release through surface water and sediment.	Assessed as a group.
Aquatic vegetation	Macrophyte (e.g., *Carex* sp.)	Aquatic macrophyte	Present in downstream surface waterbodies. Shoot, root, and sediment samples collected at Lloyd Lake, Broach Lake, Jed Creek, Patterson Creek, Beet Creek, and the Clearwater River Nearfield for analysis of metals and radionuclides.	Food source for other ecological receptors. Provides spawning substrate for some fish species (e.g., Northern Pike).	Exposed via surface water and sediment.	Assessed as a group.
	Phytoplankton	Phytoplankton	Present in lakes / potential discharge locations.	Food source for other ecological receptors.	Exposed through aquatic release to surface water.	Assessed as a group.