Marathon Palladium Project Environmental Impact Statement Addendum

VOLUME 2 OF 2

6.2.3 Water Quantity and Quality

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Date: April 2021
Environmental Assessment by Review Panel under CEAA 2012
Reference Number 54755

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Abbreviations

AIRs	Additional Information Requests
APV	Aquatic Protection Value
CIAR	Canadian Impact Assessment Registry
CNWA	Canadian Navigable Waters Act
CWQG-FAL	Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life
DFO	Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
EPA	*Environmental Protection Act*
GCDWQ	Guidelines for Canadian Drinking Water Quality
IR	Information Request
LEL	Lowest effect level
LSA	local study area
m	metre
m/s	metre per second
Masl	Metres above sea-level
MAF	mean annual flow
MDMER	Metal and Diamond Mining Effluent Regulations
MECP	Ministry of the Environment, Conservation and Parks
MMER	Metal Mining Effluent Regulations

MMF	mean monthly flow
MNRF	Ontario Ministry of Natural Resources and Forestry
MRSA	Mine Rock Storage Area
O. Reg.	Ontario Regulation
ODWQS	Ontario Drinking Water Quality Standards
OWRA	*Ontario Water Resources Act*
PAG	Potentially Acid Generating
PEL	probable effect level
PSMF	Process Solids Management Facility
PTTW	Permit To Take Water
PWQO	Ontario Provincial Water Quality Objectives
RSA	Regional Study Area
SEL	Strongest effect level
SIRs	Supplemental Information Requests
SSA	site study area
SWM	Stormwater Management
TEL	threshold effect level
TLRU	Traditional Land Resource Use
TSS	total suspended solids
VEC	Valued Ecosystem Component
WMP	water management pond
WSC	Water Survey of Canada

6.2.3 Water Quantity and Quality

6.2.3.1 Summary of Original Water Quantity and Quality Environment Assessment

6.2.3.1.1 Assessment of Residual Effects in Original EIS

Section 6.2.3 of the original EIS (2012) and subsequent responses to information requests from the Panel provided an assessment of the following effects to water quantity and quality as result of the Project:

- Change in groundwater quantity: changes in groundwater levels and flow to surface water features resulting from Project-related activities beyond the range of natural variability.
- Change in groundwater quality: changes to groundwater quality (constituent concentrations) resulting from project-related activities beyond appropriate numerical criteria (e.g. drinking water quality) that could restrict water use(s).
- Change in surface water quantity: changes in mean flows, peak flows, low flows, and water levels, resulting from changes to project-related activities beyond the range of natural variability.
- Change in surface water quality: changes in water quality (constituent concentrations) resulting from project-related activities beyond appropriate numerical criteria (e.g., water quality objectives for the protection of aquatic life) that could restrict water use(s).
- Change to sediment quality: changes in sediment quality (constituent concentrations) resulting from project-related activities beyond appropriate numerical criteria.

Additional information on the assessment of effects on water quantity and quality was provided in responses to the following information requests (IRs):

- Responses to IR12.7, IR2.8, IR12.9.1, IR12.10.2, IR12.11, IR13.5.2, IR24.1, IR24.2, IR24.3, IR24.4, IR24.5, IR24.6.1, IR24.6.2, IR24.7, IR24.8, IR24.13, IR24.14, IR24.15, IR24.16, and IR24.17 (CIAR #396, 445, 424, 408, 409, 399, 380, 468, 449, and 470)
- Responses to AIR6, AIR7, AIR8, and AIR19 (CIAR #651, 652, 653 and 662)
- Response to SIR4, SIR5 and SIR6 (CIAR #578, 583 and 574)

As it concerns groundwater, potential project-related changes to groundwater quantity were primarily related to the dewatering of the open pits, which resulted in lowering of the groundwater table and changes in groundwater flow patterns. However, due to the low hydraulic conductivity of the bedrock and steep topography of the area, the drawdown was not predicted to extend beyond the local watershed. There were no groundwater supply users located within the predicted area for project-related changes to groundwater quantity. As there were no groundwater supply users located within the predicted potential project-related changes to groundwater quality area, the primary effect of project-related changes to groundwater quality were related to water recharging the groundwater flow systems beneath the Mine

Rock Storage Area (MRSA) and Process Solids Management Facility (PSMF) that would discharge to nearby surface water bodies.

As it concerns surface water quantity, potential project-related changes to surface water flow and water level were primarily associated to changing contributing subwatershed areas during construction, operation and closure phases, as well as discharge from the Project to the environment during operation of the mine. Due to centralized water management, construction of the PSMF, MRSA, open pits, Process Plant, and other mine components were expected to reduce contributing subwatershed areas in subwatersheds where the construction will take place and have a reduction in low flows, mean flows, and peak flows during construction and operation as a result. Excess water collected from the Project footprint within the open pits, PSMF, and Process Plant not used as process water was to be discharged to Hare Lake during operations, with increases to peak flows, low flows, and mean flows expected. The effect on Hare Lake was expected to be a decrease in the frequency of low lake levels during mine operation, with no change to natural high water levels. Catchment basins for the collection of runoff from the MRSA were anticipated to discharge directly to the Pic River. No effect from the Project was anticipated for the flow regime of the Pic River throughout Project life as affected subwatersheds from the Project within the Pic River watershed consisted of less than 1% of the total Pic River watershed and had a negligible effect to overall flows. During closure, changes to flows and water levels were expected to recover with the restoration of the natural drainage routes and with the discontinuation of discharge to Hare Lake.

As it concerns water quality, potential Project-related changes to water quality were primarily associated with discharges from the site and were considered to be applicable to all project phases. During site preparation and construction, potential effects were related to the mobilization of suspended material into natural surface water features as a result of land disturbance and clearing. Such effects were considered to be mitigatable through the application of standard sedimentation control and water management practices. During operations, excess water from the PSMF and MRSA beyond that which was needed as process water at the Process Plant, or could be stored safely within the water management infrastructure associated with each was to be released to the environment. Surplus water from the PSMF was to be released to Hare Lake; whereas, surplus water associated with the MRSA was to be released to the Pic River. Predictive modeling of the influence of these discharges was undertaken to assess their potential influence on water quality in the two receiving environments. The results of the predictive modeling indicated that the discharges increased the concentrations of constituents relative to background, but in no instances did the constituent concentrations exceed a water quality assessment benchmark equivalent to a concentration of a given constituent that is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure. Site closure involved the restoration of natural site drainage to the extent possible and the cessation of discharge to Hare Lake. For the PSMF, that involved directing runoff from the PSMF to the Stream 106 subwatershed once the PSMF had been rehabilitated. In this case, it was expected that water quality in the Stream 106 subwatershed would be similar to the pre-development condition. For the MRSA, that involved allowing runoff to drain into the Pic River, as well as eventually allowing the water in the open pits to overflow naturally, once filled, into Pic River associated subwatersheds. No exceedances of water quality assessment benchmarks in the Pic River were noted for in the closure phase.

As it concerns sediment quality, potential project-related changes to sediment quality were primarily associated with discharges from the site and were considered to be applicable to all Project phases. During site preparation and construction potential effects were related to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing. The suspended material would settle on bottom substrates, changing the substrates physical and chemical nature. Such effects were considered to be mitigatable through the application of standard sedimentation control and water management practices. The release of excess water (effluent) from the PSMF during operations was assessed as a potential pathway for changes in sediment quality due to the depositional nature of the environment. The results of the predictive modeling indicated that the concentrations of constituents in sediments increased incrementally over time, relative to background, but the concentrations did not reach levels that were expected to adversely affect aquatic life or other potential uses of Hare Lake. Site closure involved the restoration of natural site drainage to the extent possible and the cessation of discharge to Hare Lake. Following the cessation of discharge to Hare Lake a commensurate reduction in the concentrations of constituents was predicted since the source loading was removed.

Key mitigation measures originally proposed to avoid, reduce and/or offset potential effects of the Project on water quantity and quality (including sediment) included:

- Providing for industry best practice sediment control practices during site preparation and construction activities (isolating disturbed areas with sediment curtains or similar structures, maintaining appropriate work area setbacks from surface water features, grading and/or covering surfaces to reduce erosion potential, controlling runoff from erosion-sensitive features, providing settling ponds or basins in which solids can be collected)
- Reclaiming disturbed areas as soon as was practical so as not to leave areas prone to erosion and sediment release and to restore natural drainage
- Monitoring and management/treatment as required to ensure water discharge objectives were achieved, including the contingency to develop specific water treatment capacity as might be needed
- Develop and implement appropriate operating practices for explosives and blasting operations to minimize nitrogen residuals in water

6.2.3.1.2 Determination of Significance in Original EIS

For the water quantity and quality, the original EIS (2012) concluded that there would be no significant adverse effect.

For groundwater quantity and quality, the residual effect was limited to drawdown in the vicinity of the open pits and seepage from the MRSA and PSMF to surface water features during operation and closure. The residual effect on groundwater quantity and quality did not affect nearby water well users and therefore concluded no significant adverse effect.

For surface water quantity during construction, the residual effect was limited to Stream 6 (subwatershed 106) and the effect was expected to be reversible at closure when drainage from the PSMF will be restored to subwatershed 106. For surface water quantity during operation, the residual effect was limited to Streams 2 and 3 and the effect was reversible at closure when drainage will be restored.

For surface water, quality residual effects were limited to changes in water quality relative to background, but not beyond assessment benchmarks for all Project phases. In this context the residual effect was small in both magnitude and spatial extent and deemed not significant.

For sediment quality, residual effects were limited to changes in constituent concentrations in Hare Lake sediments relative to background during operations, but not beyond assessment benchmarks. In this context the residual effect was small in both magnitude and spatial extent. In addition, following the cessation of discharge to Hare Lake sediments were predicted to recover to baseline conditions and therefore the effect was reversible. The residual effects on sediment quality were deemed to be not significant.

6.2.3.2 Approach to Update the Assessment

The following subsections provide an update to the assessment of residual environmental effects of the Project, including a determination of their significance based on the following:

- Updated environmental conditions within the SSA, LSA and RSA, as appropriate
- Recognition of updated standards, criteria, guidelines, or other thresholds that inform the determination of significance
- Consideration and recognition of Project refinements, including changes to the Project components and activities, that may affect potential Project interactions, mitigation measures and residual effects.

Any changes to the results of the previous assessment have been highlighted and discussed below, as appropriate. Supplementary rationale and explanation for the conclusions of the assessment have been provided based on the previous responses to the information requests (IRs, SIRs, AIRs) and additional input from the various technical discipline leads based on the current assessment.

6.2.3.3 Scope of the Assessment

6.2.3.3.1 Regulatory and Policy Setting

Since preparation of the original baseline reports and completion of the original EIS (2012), some regulatory changes or updates have been implemented by federal and provincial authorities. The most current standards, criteria or guidelines have been applied as part of this review to characterize existing conditions, are presented herein.

Environmental Impact Statement Guidelines

The environmental effects assessment addendum for water quality and quantity has been prepared in accordance with the requirements of the EIS Guidelines (Appendix B of this EIS Addendum [Vol 2]). Concordance tables, indicating how EIS Guidelines have been addressed are provided in Appendix A of this EIS Addendum (Vol 2).

Fisheries Act (Federal)

The *Fisheries Act* focuses on protecting the productivity and sustainability of commercial, recreational, and Indigenous fisheries and restricts or controls the deposit of deleterious substances into waters or locations frequented by fish unless authorized by regulation.

A number of regulations have been made to carry out the purposes and provisions of the *Fisheries Act*. The Metal and Diamond Mining Effluent Regulations (MDMER) defines effluent concentration limits, monitoring parameters, minimum flow thresholds for applicability, and environmental effects monitoring requirements for metal and diamond mines. The MDMER defines unionized ammonia, arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids (TSS), and radium 226 as deleterious substances and Schedule 4 of the MDMER imposes limits on their concentrations in effluent at the final discharge point to the receiving body of water. With respect to groundwater, the MDMER defines effluent as seepage containing any deleterious substance that flows over, through, or out of the site of a mine. The MDMER Schedule 4 criteria are used as thresholds for effluent discharge and to screen the quality of seepage from waste rock and tailings associated with the Project.

The MDMER came into effect on June 1, 2018 and replaces the Metal Mining Effluent Regulations (MMER). The MDMER includes the phasing in of more stringent effluent discharge limits than the previous MMER for deleterious substances for new and existing mines, a new effluent discharge limit for unionized ammonia, and the requirement that effluent be non-acutely lethal to Daphnia magna, all of which come into force on June 1, 2021. The more stringent future effluent limits (Schedule 4, Table 2, Column 2 maximum authorized monthly mean concentrations) have been considered in this assessment based on the assumption that the Project will not be in commercial operation before June 1,2021.

Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life (Federal)

The Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life (CWQG-FAL) are established by the Canadian Council of Ministers of the Environment (CCME 2018). These guidelines are developed collaboratively among provincial, territorial, and federal jurisdictions and regularly updated to reflect current toxicology information and guideline derivation approaches. The CWQG-FAL are used to compare to surface water quality. For the parameters analyzed as part of the Project, the CWQG-FAL generally have the same values as the Ontario Provincial Water Quality Objectives (PWQO). Where the criteria for the CWQG-FAL and PWQO differed, the criteria based on most recent update was used for comparison to the data.

Guidelines for Canadian Drinking Water Quality (Federal)

The Guidelines for Canadian Drinking Water Quality (GCDWQ) are established by Health Canada in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water and other federal government departments and are published by Health Canada (2019). These guidelines are based on current published scientific research related to health effects, aesthetic effects, and operational conditions of various parameters in drinking water.

In 2019, a health based maximum acceptable concentration for manganese was introduced of 0.12 mg/L that was not considered as part of the original EIS (2012). For the parameters analyzed as part of the Project, the GCDWQ generally have the same values as the Ontario Drinking Water Quality Standards (ODWQS). Where the criteria for the GCDWQ and ODWQS differed, the criteria based on the most recent update was used for comparison to the data.

The GCDWQ are used conservatively as a screening criteria for areas where groundwater is anticipated to flow beyond the spatial boundary of the SSA prior to discharging to a surface water feature.

Canadian Sediment Quality Guidelines

Sediment quality guidelines for the protection of aquatic life are derived from the available toxicological information on the biological effects of sediment-associated chemicals on aquatic organisms. The resulting guidelines provide scientific benchmarks to be used as a basis for the evaluation, protection, and enhancement of sediment quality. The guidelines consist of threshold effect levels (TELs) and probable effect levels (PELs). The TELs and PELs are used to identify the following three ranges of chemical concentrations with regard to biological effects: below the TEL; the minimal effect range within which adverse effects rarely occur; between the TEL and PEL; the possible effect range within which adverse effects occasionally occur; and above the PEL; the probable effect range within which adverse effects frequently occur.

Canadian Navigable Waters Act (Federal)

The Navigation Protection Act, administered by Transport Canada, was amended to the Canadian Navigable Waters Act (CNWA) in 2019. The amendment to the CNWA included the addition of an online registry for projects and approvals, introduced a public notification system, consideration of Indigenous knowledge and traditional use of the waters, and expanded the Act to regulate major works and obstructions on all navigable waters. Approval from the Minister of Transport is required for construction of any structure in, over, under or through navigable water that would interfere with navigation (e.g., bridge, boom, pipeline, outfall, effluent diffuser or dam).

Mining Act (Provincial)

The *Mining Act* and *Ontario Regulation 240/00* (O. Reg. 240/00), *Mine Development and Closure under Part VII of the Act* sets out standards and criteria for mine closure. These statutes and regulations identify surface water and groundwater quality parameters to be monitored from mines, as well as monitoring and certification requirements for assessing the success of closure activities in protecting surface water and groundwater from potential mining effects. Additionally, these statutes and regulations provide guidance and direction regarding progressive rehabilitation to accelerate mine site rehabilitation in advance of close out activities. The monitoring requirements for the Project related to surface water and groundwater will be developed to meet the requirements under O. Reg. 240/00.

Environmental Protection Act (Provincial)

The *Environmental Protection Act* (EPA) is the principal pollution control statute in Ontario and is used in conjunction with the *Ontario Water Resources Act* (OWRA) to address sources of water pollution. The EPA contains general provisions that can be used to protect surface water and groundwater quality.

Under the EPA, O. Reg. 560/94 (Effluent Monitoring and Effluent Limits – Metal Mining Sector) prescribes criteria for the quality of effluent discharged from a mine. It applies to facilities that discharge a total volume of process water, cooling water, and overflow effluent of more than 50 m^3/d, for those mines that began to discharge on or after August 25, 1994. Process effluent limits and monitoring frequency are specified to comply with Schedule 1 of O. Reg. 560/94. The discharge limits in O. Reg. 560/94 are the same as the historical MMER and less stringent than the updated MDMER. Therefore, the more stringent MDMER are used as thresholds for effluent discharge and to screen the quality of seepage from waste rock and tailings associated with the Project.

The EPA sets out requirements regarding discharges to the environment and environmental remediation. Part XV.1 of the EPA and O. Reg. 153/04 pertain to the remediation of contaminated properties. O. Reg. 153/04 applies to properties that are being re-developed from a less sensitive land use (e.g., industrial) to a more sensitive land use (e.g., residential). In addition, O. Reg. 153/04 can also be applied when there is a request for a Record of Site Condition to be filed on the Ministry of Environment, Conservation, and Parks (MECP) Brownfield Environmental Site Registry to support other types of approvals (e.g., municipal zone changes, site plan approvals, etc.). However, in practice, the regulation is applied to the assessment and management of soil, groundwater, and sediment contamination.

Surface water resources may be affected by brownfield properties as a result of the discharge of impacted groundwater to surface water receivers. Under O. Reg. 153/04, the MECP has developed Aquatic Protection Values (APVs) to protect aquatic biota from migration of impacted groundwater to surface water (MOE 2011). The APVs are designed to provide a scientifically defensible and reasonably conservative level of protection for aquatic organisms from the migration of contaminated groundwater to surface water resources. The APVs are the established water quality criteria in surface water and are used to determine the acceptable concentrations in groundwater (GW-3 values) by back-calculating through a defined modelling process that considers a ten times dilution in the receiving environment. For this Project, the APVs are used as a direct comparison where groundwater is anticipated to discharge to surface water features. The use of the APVs in this EIS Addendum provides a conservative approach for assessing potential groundwater quality effects to surface water as it assumes no attenuation during discharge, nor mixing and assimilation within the receiving water body.

Safe Drinking Water Act (Provincial)

The *Safe Drinking Water Act*, 2002, is an Act to protect existing and future sources of drinking water in Ontario. A number of drinking water regulations have been made under the *Safe Drinking Water Act*, including *O. Reg.*169/03 (ODWQS), which set out prescribed drinking water quality standards in Schedule 1 (microbiological), Schedule 2 (chemical), and Schedule 3 (radiological).

Since the original EIS (2012), there have been amendments to the ODWQS that came into effect between January 1, 2017 and January 1, 2020. The changes included more stringent standards for substances including arsenic, less stringent standards for substances including selenium, the revoking of standards for nitrate + nitrite, and the adoption of standards for substances that were not previously listed under O. Reg. 169/03.

For the parameters analyzed as part of the Project, the GCDWQ and ODWQS generally have the same values as the ODWQS except for pH, colour, barium, copper, cadmium, lead, and manganese with the ODWQS the more stringent criteria except for lead and manganese. In addition, the GCDWQ has criteria for strontium, where the ODWQS does not and the ODWQS has criteria for alkalinity and DOC where the GCDWQ does not.

The ODWQS are used where potential effects of groundwater on drinking water quality are anticipated. There are no groundwater supply users or active groundwater Permit To Take Water (PTTW) holders identified within the SSA. Therefore, the ODWQS are used as a screening criteria for areas where groundwater is anticipated to flow beyond the boundary of the PDA prior to discharging to a surface water feature.

Ontario Water Resources Act

The OWRA is the principal statute governing water quality and quantity in Ontario. It is a general management statute that applies to groundwater and surface water. Administered by the MECP, the OWRA contains important regulations that protect water resources, including:

- The *Water Taking and Transfer Regulation* (O. Reg. 387/04), which requires a permit for water takings of more than a total of 50,000 L/d (with some exceptions). Section 34 of the OWRA requires the proponent to obtain a PTTW and Section 9 of O. Reg. 387/04 requires all permit holders to collect, record and report data on daily volumes of water withdrawals.
- Guideline B-7: Reasonable Use (MOEE 1994): The Reasonable Use guideline establishes procedures for determining what constitutes the “reasonable use” of groundwater on properties adjacent to sources of contaminants and for establishing levels of parameter discharges considered acceptable by the MECP.

Provincial Water Quality Objectives

The PWQOs developed by MECP through its responsibilities under the OWRA and EPA, along with management policies and guidelines, were developed for the protection of aquatic life for recreational uses; they are numerical and narrative ambient surface water quality criteria that represent a desirable level of surface water quality. PWQOs for the protection of aquatic life are conservative values that, when met, are intended to be protective of all forms of aquatic life and all aspects of the aquatic life cycle during an indefinite exposure to water (MOE 1999). Applicable PWQOs and Interim PWQOs for selected chemical and physical parameters were used to compare to surface water quality. For the parameters analyzed as part of the Project, the PWQO generally have the same values as the CWQG-FAL. Where the criteria for the PWQO and CWQG-FAL differed, the criteria based on most recent update was used for comparison to the data.

Provincial Sediment Quality Guidelines

The purpose of the Provincial Sediment Quality Guidelines is to protect the aquatic environment by setting safe levels for metals, nutrients (substances which promote the growth of algae) and organic compounds.

The guidelines establish three levels of effect - No Effect Level, Lowest Effect Level and Severe Effect Level. The Lowest Effect Level and Severe Effect Level are based on the long-term effects which the contaminants may have on the sediment-dwelling organisms. The No Effect Level is based on levels of chemicals which are so low that significant amounts of contaminants are not expected to be passed through the food chain.

Lakes and Rivers Improvement Act (Provincial)

The Lakes and Rivers Improvement Act (LRIA), administered by the Ministry of Natural Resources and Forestry (MNRF), applies to the design, construction, operation, maintenance, and safety of waterbodies and watercourses in Ontario. For the purposes of the LRIA, this includes online dams, channelizations, water crossings, enclosures, and pipeline installations. Approval is required from the Minister of Natural Resources and Forestry for the construction of dams which may alter fish habitat, natural amenities, and riparian owner rights.

6.2.3.3.2 Influence of Consultation and Engagement on the Assessment

Consultation for the Project has been ongoing since 2004 and will continue throughout the life of the Project. Chapter 4 of the original EIS (2012) and Chapter 5 of this EIS Addendum (Vol 2) covers the consultation process and activities undertaken by GenPGM and formerly by Stillwater. Comments and feedback received throughout the consultation process pertaining to water quantity and quality are summarized below:

- Concerns relating to the potential effects that the Project may have with respect to water quality (including nutrient loading), specifically within subwatersheds of the Pic River.

- Identified importance of Hare Creek (Subwatershed 105) and Angler Creek (Subwatershed 106) and Pic River
- Desire for PSMF to not discharge to Pic River or Bamoos Lake
- Information was requested on the mitigation measures to protect surface and ground water, specifically as it relates to process solids discharge and Type 2 material storage
- Information requested on anticipated changes to water quality and quantity, monitoring programs and drainage design
- Information requested on chemicals present within contact water and Type 2 materials
- Information on mitigation measures for Type 2 material
- Information on mitigation measures to ensure ground water quality and seepage from the MRSA and PSMF
- Information on potential effects to groundwater levels as a result of dewatering activities
- Concerns relating to the identification of groundwater springs that may be affected by project activities and monitoring of these features during the life of the Project to assess project-related effects

Feedback related to the water quantity and quality has been addressed through updates to the EIS Addendum and supporting materials, responses and meetings with communities and stakeholders, as appropriate. Section 6.2.12 of this report provides details on how TLRU and traditional knowledge have been incorporated into the assessment.

6.2.3.3.3 Potential Effects, Pathways and Measurable Parameters

Table 6.2.3-1 summarizes the potential environmental effects of the Project on water quantity and quality and the measurable parameters. These potential environmental effects and measurable parameters are consistent with the original EIS (2012), which provided a qualitative description. For the purposes of the EIS Addendum quantitative measures have been included, where possible. The potential environmental effects and measurable parameters were selected based on professional judgement, other EAs for mining projects in Ontario, and comments provided during consultation.

Table 6.2.3-1: Potential Effects, Effects Pathways and Measurable Parameters for Water Quality and Quantity

Potential Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in groundwater quantity	• Project activities will result in changes in groundwater recharge and changes in groundwater levels and flow. A decrease in groundwater levels may result in loss of yield to dug or drilled wells, reducing their ability to meet water supply requirements. • As a pathway to surface water and wetlands, a decrease in groundwater levels and changes in the natural groundwater flow could affect discharge to nearby surface water bodies and water levels within wetlands.	• Changes in shallow and deep groundwater levels as measured in monitoring wells (m) and baseflow to surface water bodies (m^3/day) directly related to Project activities.
Change in groundwater quality	• Changes in groundwater levels and flow direction and change in recharge or infiltration from the Project activities may alter groundwater quality in dug or drilled wells, reducing their ability to meet water supply requirements without treatment. • As a pathway to surface water and wetlands, recharge or infiltration from Project activities may result in changes to groundwater quality discharging to surface water.	• Change in concentration of physical and chemical parameters in groundwater directly related to Project activities in mg/L
Change in surface water quantity	• Project activities will result in changes to local hydrology. A reduction or increase in flows and/or water levels may result due to elimination or redirection of subwatershed area and through Project water management (e.g. Project water use and effluent discharge).	• Change in Hare Lake water level from existing natural variation (in cm) directly related to Project activities • Changes in flow rates for subwatersheds within the LSA (m^3/s) directly related to Project activities.
Change in surface water quality	• Introduction of constituents, as a result of the Project, into receiving waterbodies and watercourses that are of a magnitude to negatively affect aquatic biota and non-aquatic biota associated with those waters and/or potential water uses in the study area.	• Changes in the concentrations of constituents that are directly related to Project activities as measured as a mass of a chemical per unit volume of water (e.g., mg/L).
Change to sediment quality	• Introduction of constituents into the sediments of water bodies and watercourses that are of magnitude to negatively affect aquatic biota, non-aquatic biota, or other potential uses of those waterbodies.	• Swamping bottom habitats with settled solids or changes in the concentrations of constituents directly related to Project activities.

6.2.3.3.4 Assessment Boundaries

In general, the spatial boundaries for the assessment of environmental effects are presented in Section 2.4. while the LSA and RSA are defined based on the extent of potential effects specific to each Valued Ecosystem Component (VEC).

- **Site Study Area**: The SSA is the direct footprint of the Project and is consistent across all VEC's. The SSA has been revised from the original EIS to reflect changes and refinements to the Project design.
- **Local Study Area**: The water quantity and quality LSAs, as well as the sediment quality LSA, represent the maximum area within which water quantity and quality and sediment quality changed from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. Separate LSAs have been created for groundwater, surface water quantity, surface water quality and sediment quality to best reflect the extent of VEC-specific effects. These LSAs consist of the SSA and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information and professional judgment. This definition of the LSA is consistent with the original EIS.

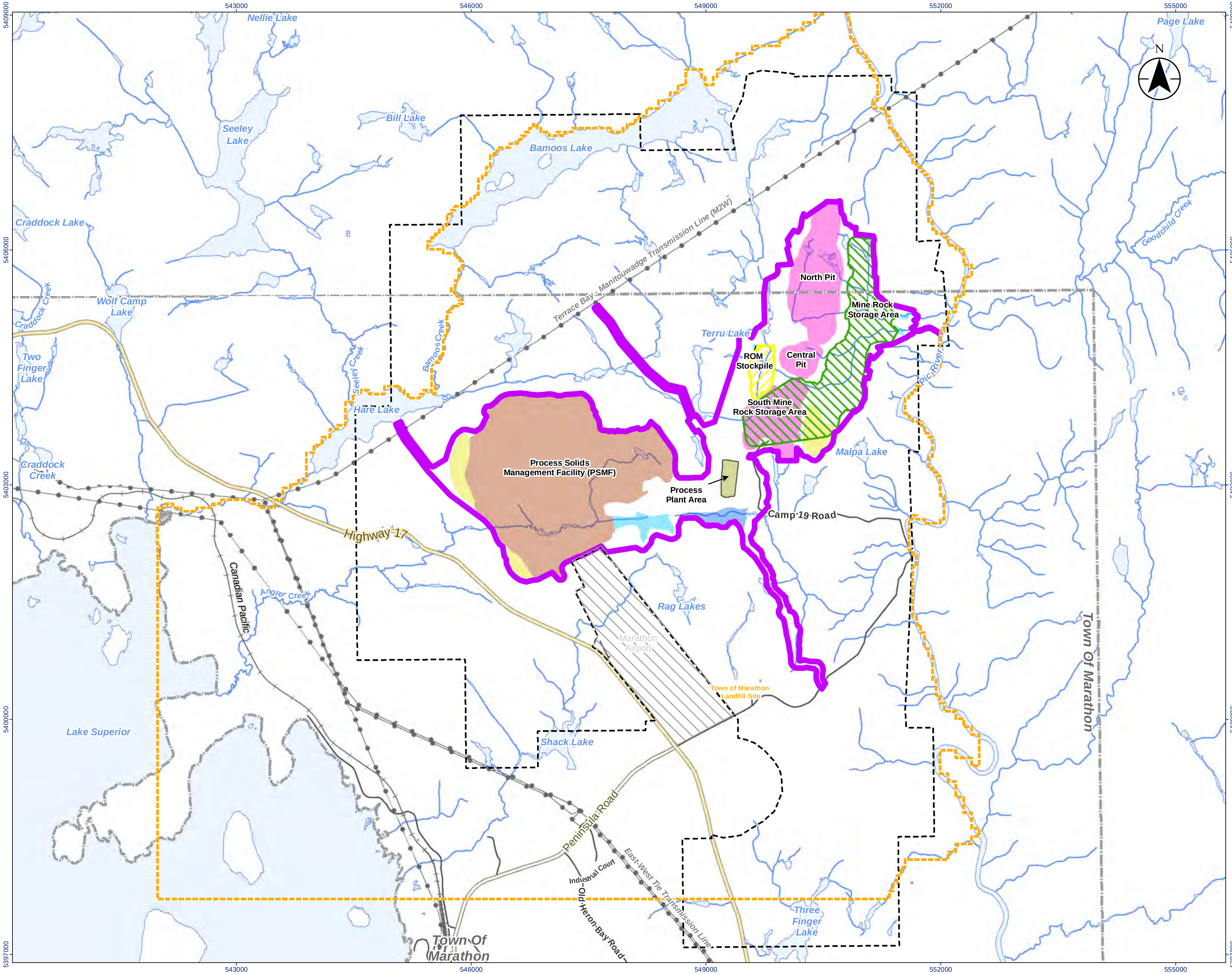
  A LSA was not defined specifically for groundwater as part of the original EIS. A LSA for groundwater has been defined for the EIS amendment based on the likely extent of drawdown from open pit dewatering and changes to flow or groundwater quality due to recharge from the process solids management facility (PSMF) and mine rock storage area (MRSA). The LSA for groundwater is consistent with the boundaries of the baseline three dimensional numerical groundwater flow model used in the original Hydrogeology Baseline Report (CIAR #227) prepared by True Grit Consulting Ltd. (2012a).

  The LSA for surface water quantity was revised from the original EIS to include additional subwatersheds that may potentially be affected by Project activities, including groundwater discharge to surface water features. The LSA for surface water quantity was extended to include the Pic River along the east border and extends approximately 9 km downstream from the subwatershed 116 confluence with the Pic River. This extension of the surface water quality and quantity LSA downstream from the location where any direct discharge from the Project would occur allows for sufficient area to consider potential Project related effects in recognition of the intrinsic value of the Pic River to BN, whose community is located at the mouth of the river at Lake Superior.
- **Regional Study Area**: The water quantity and quality and sediment quality RSA is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present and future (i.e., certain or reasonably foreseeable) physical activities. The RSA is based on the potential for interactions between the Project and other existing or future potential projects in regard to water quantity and quality. Separate RSAs have been created for groundwater, surface water quantity, surface water quality, and sediment quality to best reflect the extent of VEC-specific effects. These RSAs includes the SSA and LSA.

With respect to groundwater quantity and quality, the RSA is coincident with the LSA due to the localized nature of potential Project effects on groundwater. With respect to surface water quantity, the RSA was defined to be consistent with the LSA, with the RSA extending just past the LSA within the ultimate receivers. For surface water quality and sediment quality, the RSA comprises the northwest basin of Lake Superior and associated drainages and the lower reaches of the Pic River and Hare Creek, extending to its confluence with Lake Superior. The extent of the surface water quality RSA considers a more explicit acknowledgement of the intrinsic value of the Pic River to BN and of Hare Creek to PRFN, as well as the overall community concern for potential effects on the northwest basin of Lake Superior.

The LSA and RSA boundaries for groundwater are included on Figure 6.2.3-1. The LSA and RSA for surface water quantity and quality on Figure 6.2.3-2 and Figure 6.2.3-3 respectively.

The temporal boundaries for the Project that have been considered in the determination of environmental effects are described in Section 2.5 of the EIS Addendum (Vol 1) (CIAR #727). The assessment of water quantity and water quality and sediment quality spans all Project phases. For groundwater and surface waters, the closure phase extends to the time where the open pit has filled with water and begins to drain (overflow) naturally into the local watershed.



Stantec

Legend

- Regional / Local Assessment Area (Groundwater)
- Approximate Limit of Surface Rights (current and/ or planned)
- Site Study Area Boundary
- Highway
- Major Road
- Minor Road
- Hydro Line
- Railway
- Watercourse
- Airport
- Municipal Boundary, Lower Tier
- Waterbody

Proposed Mine Features

- Mine Rock Storage Area (MRSA)
- Process Plant Area
- ROM Stockpile
- Stormwater Management Pond
- Open Pit
- Overburden Stockpile
- Process Soilds Manadement Facility (PSMF)
- Water Management Pond

0 1 2 km

1:50,000 (At original document size of 11x17)

Notes
1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.

Project Location: Ontario, Minnesota, Wisconsin, Michigan, Lake Superior, Lake Michigan, Lake Huron, Georgian Bay

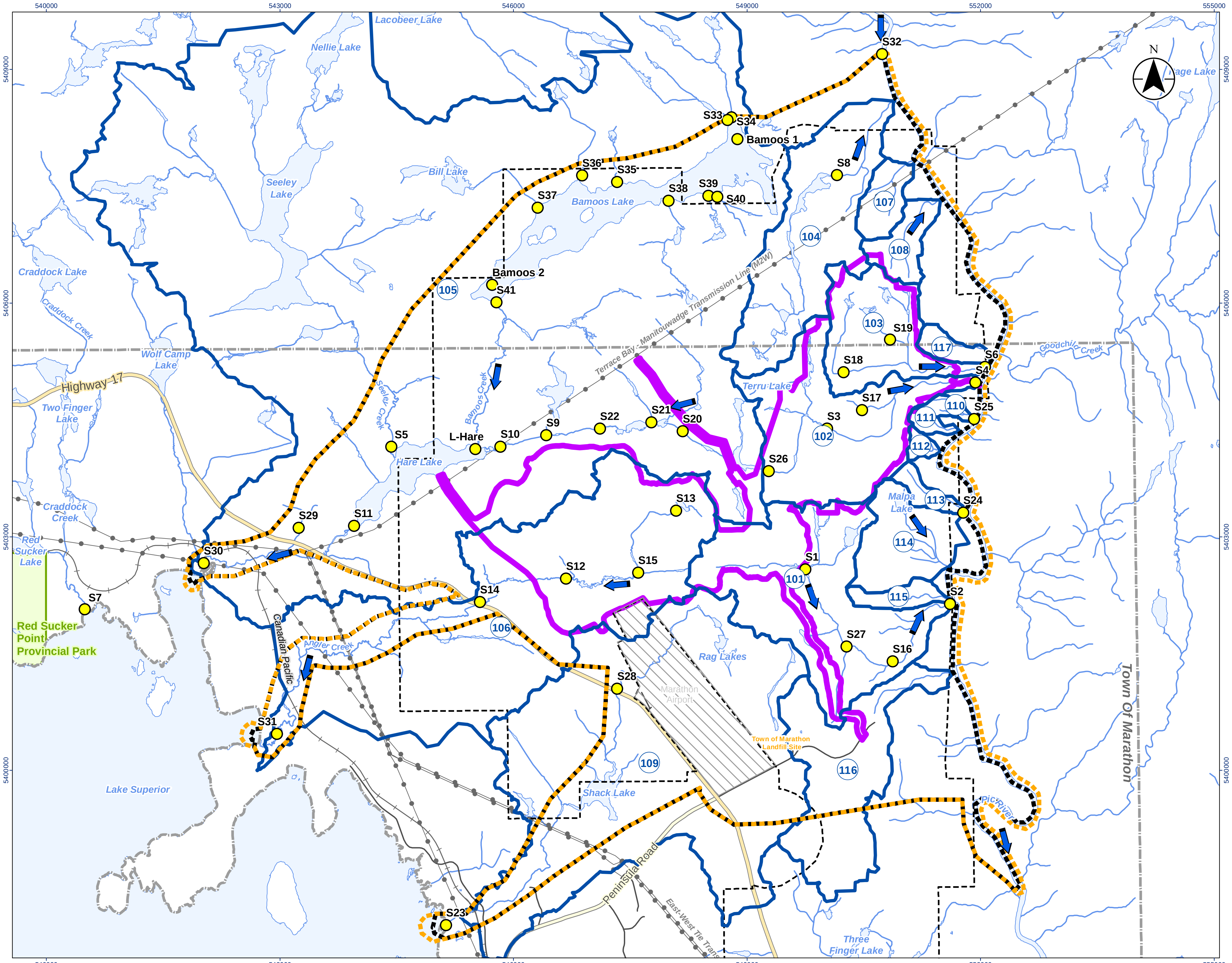
Project Location
Marathon

129673006 REVA
Prepared by DH on 2021-01-17

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
6.2.3-1

Title
Site, Local and Regional Study Areas - **Groundwater**



Stantec

Legend

Type

- Local Study Area
- Regional Study Area
- Approximate Limit of Surface Rights (current and/ or planned)
- Site Study Area Boundary
- Surfacewater Quantity Sampling Station
- Surface Water Flow Direction
- Highway
- Major Road
- Minor Road
- Hydro Line
- Railway
- Watercourse
- Airport
- Municipal Boundary, Lower Tier
- Provincial Park
- Waterbody
- Watershed Boundary

0 1 2 km

1:50,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.

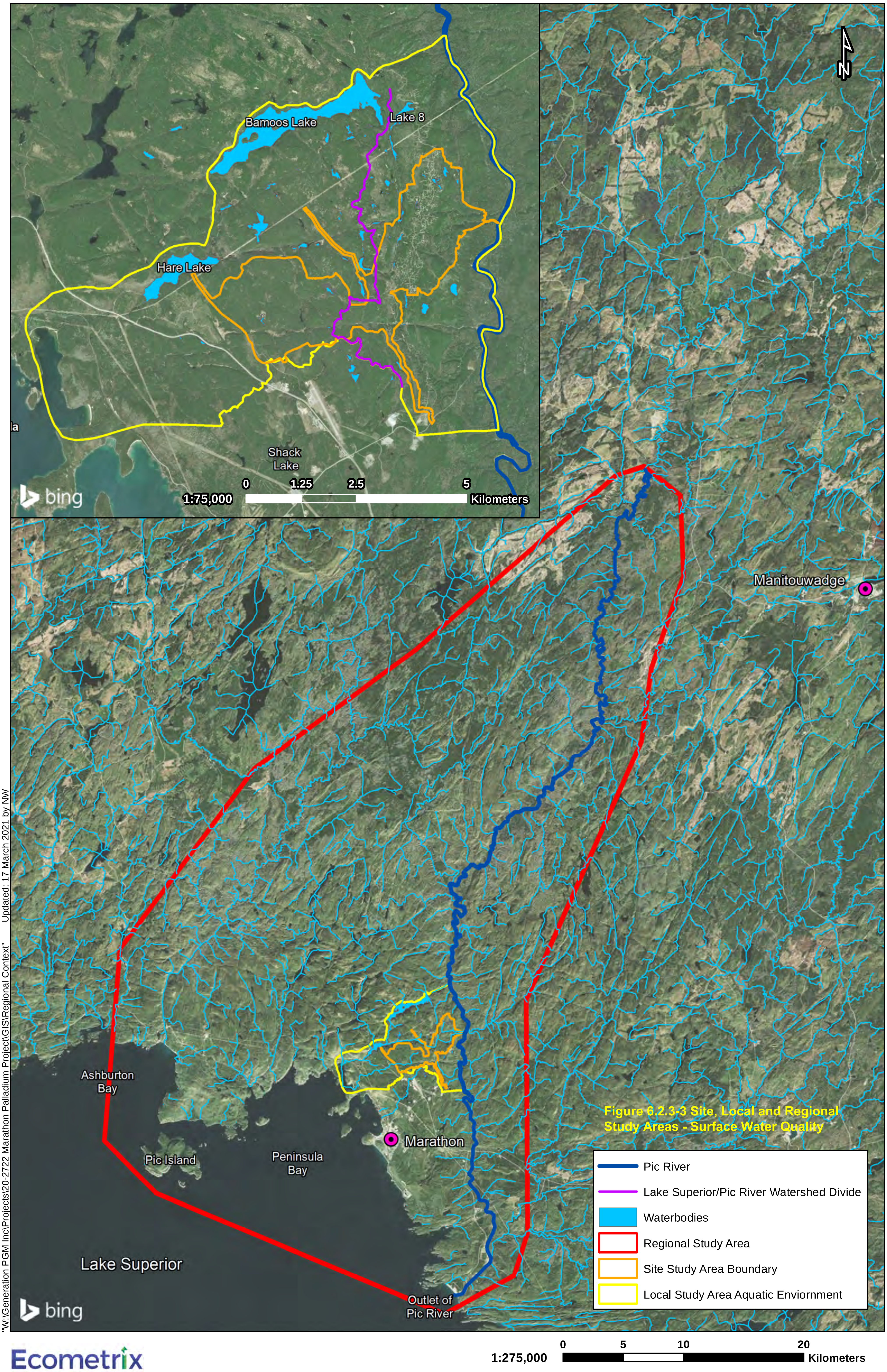
Project Location
Marathon

129673006 REVA
Prepared by DH on 2020-11-11
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
GENERATION MINING LTD.
MARATHON PALLADIUM PROJECT

Figure No.
6.2.3-2

Title
Site, Local and Regional Study Areas **-**
Surface Water Quantity



"W:\Generation PGM Inc\Projects\20-2722 Marathon Palladium Project\GIS\Regional Context" Updated: 17 March 2021 by NW

Ecometrix

6.2.3.3.5 Residual Effects Characterization

Table 6.2.3-2 summarizes how residual environmental effects are characterized in terms of direction, magnitude, geographic extent, timing, frequency, duration, reversibility, and ecological and socio-economic context. The characterization of residual effects has been further defined to included quantitative measures based on the qualitative definitions provided in the original EIS (2012), where applicable, as part of this EIS Addendum.

Table 6.2.3-2: Characterization of Residual Effects on Water Quantity and Quality

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive** – Effect moves measurable parameters in a direction beneficial to water quantity and quality relative to baseline conditions. For example: • Groundwater: a Project-caused increase in groundwater level or well yield, and/or improvement in water quality in comparison to baseline conditions and trends. • Surface Water: a Project-caused reduction in flooding events and related peak flows / surface water levels resulting from flooding events, and/or improvement in water quality in comparison to baseline conditions and trends. • Sediment Quality: a Project-caused improvement in sediment quality in comparison to baseline conditions and trends. **Adverse** – Effect moves measurable parameters in a direction detrimental to water quantity and quality relative to baseline conditions. • Groundwater: a Project-caused decrease in groundwater level, well yield, and/or water quality in comparison to baseline conditions and trends. • Surface Water: a Project-caused increase in surface water levels and flows during flooding, a decrease in surface water flows below environmental flow requirements, and/or an increase in constituent concentrations in comparison to baseline conditions and trends. • Sediment Quality: a Project-caused increase in constituent concentrations in comparison to baseline conditions and trends.
Magnitude	The amount of change in measurable parameters of the VEC relative to existing conditions	**For Groundwater Quantity** **Negligible –** no measurable change in groundwater level due to the Project. **Low –** a change in groundwater level due to the Project that is predicted to be less than 1 m. **Medium –** a change in groundwater level due to the Project that is predicted to be between 1 m and 5 m. **High –** a change in groundwater level due to the Project that is predicted to be greater than 5 m.

Table 6.2.3-2: Characterization of Residual Effects on Water Quantity and Quality

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		For Groundwater Quality **Negligible –** no measurable change in groundwater quality due to the Project. **Low –** a Project-related measurable change in groundwater quality, but within normal variability of baseline groundwater quality. **Medium –** a Project-related measurable change in groundwater quality but quality remains within regulatory criteria and/or objectives. **High –** a Project-related measurable change in groundwater quality that results in an exceedance of health-based regulatory criteria and/or objectives for one or more parameters to the extent that a water supply well no longer meets the needs of current users or landowners beyond the SSA. **For Surface Water Quantity** **Negligible –** no measurable change from baseline conditions. **Low –** a Project-related change in hydrology (flows or levels) compared to baseline conditions, but where change is <10% from baseline conditions. **Medium –** a Project-related change in hydrology (flows or levels) that is greater than 10% relative from baseline conditions. Measurable effects on water levels and flow velocities may occur. **High –** a Project-related change in hydrology (flows or levels) that results in surface water levels and flows above existing flood maximums, or change in surface water quantity within a watercourse that is less than the environmental flow threshold, which may affect the aquatic ecosystem. **For Surface Water Quality** **Negligible –** no measurable change from baseline conditions. **Low –** a measurable change that is not within the variability of baseline conditions but below relevant water quality objectives and criteria. **Medium –** a measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirement, and/or federal and provincial management objectives and therefore could have an adverse effect on water uses in the LSA **High –** a measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirement, and/or federal and provincial management objectives and is likely to have an

Table 6.2.3-2: Characterization of Residual Effects on Water Quantity and Quality

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
		adverse effect on water uses in the LSA with the effect extending beyond the LSA. **For Sediment Quality** **Negligible –** no measurable change from baseline conditions. **Low –** a measurable change that is within the variability of baseline conditions but below relevant sediment quality objectives and criteria. **Medium –** a measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirement, and/or federal and provincial management objectives and therefore could have an adverse effect in the LSA. **High –** a measurable change that is not within the variability of baseline conditions and not within applicable guidelines, legislated requirement, and/or federal and provincial management objectives and is likely to have an adverse effect in the LSA with the effect extending beyond the LSA.
Geographic Extent	The geographic area in which a residual effect occurs	**Negligible (SSA) –** residual effect is limited to the SSA. **Low –**residual effect is restricted to the SSA or immediate surroundings. **Medium (LSA) –**residual effect extends into the LSA. **High (RSA) –** residual effect extends into the RSA.
Timing (VEC specific)	Considers when the residual effect is expected to occur, where relevant to the VEC.	**Not Applicable (N/A)** – seasonal aspects are unlikely to affect residual effect on water quantity and/or quality. **Applicable** – Seasonal aspects may affect residual effect on water quantity and/or quality.
Duration	The time required until the measurable parameter or the VEC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	**Negligible –** residual effect is limited to a single event. **Low (short-term) –** the residual effect is limited to short term events (a few years or less). **Medium –** the residual effect is limited to the operational and/or decommissioning phases (years to decades). **High (Long-term) –** the residual effect extends beyond the life of the project (centuries).
Frequency	Considers whether the residual effect is expected to occur once, at regular or irregular intervals or continuously	**Negligible –** the condition of phenomena causing the effect rarely occurs. **Low (Multiple irregular event) –** occurs at no set schedule and are unlikely to occur. **Medium (Multiple regular event) –** occurs at regular intervals (i.e. >1% of the time). **High (Continuous) –** occurs continuously.

Table 6.2.3-2: Characterization of Residual Effects on Water Quantity and Quality

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Reversibility	Considers whether the residual effect is reversible or irreversible.	**Negligible –** effect ceases immediately once source or stressor is removed**.** **Low –** effect ceases gradually once source or stressor is removed. **Medium –** effect persists for some time after source or stressor is removed. **High (Irreversible) –** the residual effect is unlikely to be reversed.
Ecological/Societal Value	Considers the magnitude that the residual effect is expected to have on the ecological or societal community, as determined through consultation and engagement.	**Negligible –** the VEC has no value from a cultural or societal context. **Low –** the VEC is common in the LSA and/or has little to no value from a cultural or societal context. **Medium –** the VEC is abundant in the RSA, though may be less so in the LSA, and/or has moderate cultural or societal value. **High –** the VEC is rare and/or of high cultural or societal value.

Note: Timing was not included in the original EIS.

6.2.3.3.6 Significance Definition

The following thresholds have been established to define a significant residual adverse environmental effect on water quantity and/or quality. The definitions of significance are consistent with the original EIS (2012) and have been further defined to be specific to this VEC and associated disciplines.

Groundwater Quantity

A significant adverse residual environmental effect on groundwater quantity is a Project-caused reduction in the groundwater level of an existing groundwater supply well located beyond the SSA such that, following the application of mitigation, the groundwater supply well no longer meets the needs of the current users.

Groundwater Quality

A significant adverse residual environmental effect to a change in groundwater quality is one resulting in a Project-caused degradation of the quality of groundwater by exceeding one or more of the health-based standards specified in the ODWQS or GCDWQ to the extent that a water supply well located beyond the SSA limits no longer meets the needs of current users or landowners. It is typical in northern Ontario for groundwater to naturally exceed a number of ODWQS and GCDWQ (e.g., hardness). For parameters with baseline concentrations that exceed the health-based standards specified in the ODWQS and GCDWQ, the determination of significance will be such that the quality of those parameters for an existing groundwater supply well will not be further impaired by the Project.

Surface Water Quantity

For surface water quantity, a significant adverse residual effect is defined as a measurable change in hydrological regime that results in surface water quantity (flow or water levels) within the LSA that exceed existing flood maximums or is below the minimum environmental flow required to sustain aquatic ecosystems during fish spawning seasons.

Surface Water Quality

A significant residual adverse effect to surface water quality is one that results in a measurable change in the concentrations of a water quality parameter (or parameters) that exceed relevant water quality assessment benchmarks that represent concentrations that are protective of aquatic biota and water uses in watercourse and water bodies that receive mine-affected drainage.

Sediment Quality

A significant residual adverse effect to sediment water quality is one that results in a measurable change in the concentrations of a sediment quality parameter (or parameters) that exceed relevant sediment quality assessment benchmarks that represent concentrations that are protective of aquatic biota and other uses in watercourse and water bodies that receive mine-affected drainage.

6.2.3.4 Existing Conditions for Water Quantity and Quality

Existing conditions are described in Section 4 of the EIS Addendum (Vol 1). The updated baseline reports for hydrogeology, surface water hydrology, and surface water quality (Stantec 2020e; Stantec 2020d; Ecometrix 2020C) (CIAR #722) provides an overview of how baseline conditions have changed since the original EIS and/or how the understanding of the baseline conditions has evolved. A summary of groundwater conditions was also included in the Hydrogeology Updated Effects Assessment Report (Appendix D4 of this EIS Addendum [Vol 2]) based on the updated hydrogeological model.

6.2.3.5 Determining Project Interactions with Water Quantity and Quality

Table 6.2.3-3 identifies, for each potential effect, the project's physical activities that might interact with the VEC and result in the identified effect. This table is based on a similar table from the original EIS and has been updated to reflect changes to the Project.

Table 6.2.3-3: Project Interactions with Water Quantity and Quality

Physical Activities	Effects				
	Change in groundwater quantity	Change in groundwater quality	Change in surface water quantity	Change in surface water quality	Change to sediment quality
Site Preparation/ Construction					
Clearing, grubbing and stripping of vegetation, topsoil and other organic material	✓	–	✓	✓	✓
Grading with topsoil	✓	–	✓	✓	✓
Drilling and blasting to develop the open pits and plant site area	✓	–	✓	✓	✓
Excavation and pre-stripping to remove mine rock and overburden	✓	–	✓	✓	✓
Preparation of construction surfaces and installation of temporary construction facilities	✓	–	✓	✓	✓
Site preparation for waste management	✓	–	✓	✓	✓
Construction of administration buildings, storage buildings, other ancillary structures and site services such as parking lots, area fencing, and security systems	✓	–	✓	✓	✓
Construction of explosives facilities	✓	–	✓	–	–
Construction of PSMF containment dams and MRSA	✓	–	✓	✓	✓
Management of surface water and groundwater on the site, including seepage and runoff	✓	✓	✓	✓	✓
Maintenance and management of mine rock stockpiles, overburden, and PSMF	✓	✓	✓	✓	✓
Construction of water management facilities and drainage works (including but not limited to pipelines, dewatering facilities, stormwater management, control ponds and water management pond	✓	–	✓	✓	✓
Dewatering of natural water bodies in the project area	✓	–	✓	✓	✓
Construction of new mine site access and haul roads, including any water crossings and water body shoreline works or undertaking	✓	–	✓	✓	✓
Upgrading of the existing mine access road(s) and entrance(s) to the project area including any water crossings and water body shoreline works or undertakings	✓	–	✓	✓	✓
Construction of a 115kV electrical transmission line within a new right-of-way from the M2W transmission corridor	–	–	–	–	–
Aggregate sources and amounts	–	–	–	–	–
Management of waste	–	–	–	–	–
Any works or undertakings associated with upgrading a rail load-out facility for mine concentrate and off-site accommodations complex	–	–	–	–	–
Operating vehicles	–	–	–	–	–

Table 6.2.3-3: Project Interactions with Water Quantity and Quality

Physical Activities	Effects				
	Change in groundwater quantity	Change in groundwater quality	Change in surface water quantity	Change in surface water quality	Change to sediment quality
Hiring and management of workforce	–	–	–	–	–
Taxes, contracts and purchases	–	–	–	–	–
Operation					
Drilling, blasting, loading and hauling of mine rock from the pits to ROM stockpile pad, crusher or the MRSAmine rock storage areas and the ore to the crusher	✓	✓	✓	✓	✓
Operation of explosives facilities	–	–	–	–	–
Handling, transportation, use and disposal of explosives	✓	✓	✓	✓	✓
Transportation of crushed run-of-mine material to coarse ore stockpile	–	–	–	–	–
Transportation of mill feed (ore) to the grinding section of the Process Plant	–	–	–	–	–
Process Plant operation	✓	✓	✓	✓	✓
Transportation of filtered concentrate	–	–	–	–	–
Management and maintenance of the entire mine waste stream, including but not limited to process solids and mine rock	✓	✓	✓	✓	✓
Decommissioning of the temporary process water pond (proposed during mine operations), including removal or breaching of dams	✓	✓	✓	✓	✓
Dewatering activities (e.g. open pit)	✓	–	✓	✓	✓
Management of surface water and groundwater on the site; including seepage, runoff, contact water, process water and storm water	✓	✓	✓	✓	✓
Management of surface water on site during dam removal or breaching	✓	✓	✓	✓	✓
Management of domestic waste from the mine site	–	–	–	–	–
Management of hazardous waste	–	–	–	✓	–
Environmental safety procedures	–	–	–	–	–
Operating vehicles	–	–	–	–	–
Hiring and management of workforce	–	–	–	–	–
Taxes, contracts and purchases	–	–	–	–	–
Decommissioning and Closure/Post-Closure					
Installation of barriers around the pit perimeters	–	–	–	–	–

Table 6.2.3-3: Project Interactions with Water Quantity and Quality

Physical Activities	Effects				
	Change in groundwater quantity	Change in groundwater quality	Change in surface water quantity	Change in surface water quality	Change to sediment quality
Management of inputs from groundwater and surface water runoff into pits	✓	✓	✓	✓	✓
Decommissioning, dismantling and/or disposal of equipment	–	–	–	–	–
Demolition/removal of surface buildings and associated infrastructure and disposal of resulting rubble	✓	–	✓	✓	✓
Decommissioning/removal of explosives facilities	–	–	–	–	–
Removal of power lines and electrical equipment	✓	–	–	–	–
Decommissioning of the potable water and sewage treatment systems (e.g. settling ponds associated with mine rock storage, roads and plant site)	✓	✓	✓	✓	✓
Maintenance and management of mine rock stockpiles and PSMF	✓	✓	✓	✓	✓
Following removal of infrastructure, soil, groundwater, and surface water testing for residual contamination, and disposal of contaminated soils and treatment of groundwater and surface water, as required	✓	✓	✓	✓	✓
Reclamation and restoration of landscape (including water bodies) to productive capacity including management and monitoring	✓	✓	✓	✓	✓
Management of flooded pits to protect groundwater and surface water quality during flooding and pit overflow	✓	✓	✓	✓	✓
Operating vehicles	–	–	–	–	–
Hiring and management of workforce	–	–	–	–	–
Taxes, contracts and purchases	–	–	–	–	–

Notes:
✓ = Potential interaction
– = No interaction
* minor wording changes to the physical activities list have been made to better align with the updated Project description covered in Chapter 1 (EIS Addendum [Vol 1])

Project components and activities that will not directly change the water quantity or quality (including sediment quality) include:

- employment and expenditure will not directly result in changes to the physical environment, including water quantity and quality, during any Project phase.
- aggregate sources during construction and operation are not expected to result in a change in surface water or groundwater quality because there are no known sources of constituents arising from activities associated with the use of aggregate sources
- management of domestic waste from the mine site is not anticipated to affect water quantity or quality as it will be stored in the PSMF. During operations, the domestic waste is estimated at around 35,000 m^3 compared to the PSMF storage capacity of 78 M m^3 and therefore the effect of seepage from the landfill compared to the overall PSMF is anticipated to be negligible.
- the construction of buildings and infrastructure is not expected to interact with a change in groundwater quality or surface water quality because there are no constituents sources associated with such construction activities, except for an accidental spill.
- ancillary facilities during construction, including fuel storage and dispensing, are not predicted to interact with groundwater quality or quantity other than from an accidental fuel spill. Accidental events are assessed separately in Section 6.3 of this EIS Addendum (Vol 2).

6.2.3.6 Assessment of Residual Effects on Water Quantity and Quality

6.2.3.6.1 Change in Groundwater Quantity

Analytical Assessment Techniques

The environmental effects analysis for groundwater quantity, is carried out using a number of analytical methods and tools, and field hydraulic measurements and testing and three-dimensional numerical groundwater flow modelling. The techniques are described in detail in the SID #14 – Baseline Report – Hydrogeology (CIAR #227) (True Grit 2012a), SID #15 – Impact Assessment – Hydrogeology (CIAR #227) (True Grit 2012b) and the Hydrogeology Baseline Update (Stantec 2020e) (CIAR #722) and the Hydrogeology Updated Effects Assessment Report (Appendix D4 of this EIS Addendum [Vol 2]).

The numerical, three-dimensional finite difference groundwater flow model developed for the simulation of baseline conditions, described in SID #14 – Baseline Report – Hydrogeology (CIAR #227) (True Grit 2012a), was modified to assist in the evaluation of potential effects of the Project on groundwater quantity. The model provides quantitative predictions about changes in groundwater levels and flow under the operation and closure Project phases for the following:

- Operation:
  - Dewatering rates from staged development of the open pits, and associated changes to groundwater levels and baseflow to surrounding water bodies.
  - Changes in groundwater levels, flow, and discharge resulting from the development and operation of the MRSA, ore stockpile, and PSMF.
- Closure:
  - Groundwater inflow rates to the open pits at progressive stages during filling with water to form a pit lake.
  - Interactions of the pit lakes with groundwater levels and baseflow to surrounding water bodies.
  - Changes in groundwater levels, flow, and discharge resulting from the closure of the MRSA, ore stockpile, and PSMF.

Project Pathways

During construction, in the absence of mitigation, groundwater quantity and/or flow could be affected by: temporary dewatering for the installation of foundations for buildings and utilities and changes to infiltration rates resulting from the construction of roads and initial development of various mine components (e.g. open pit, PSMF, MRSA, ore stockpile etc.).

Of these Project components and activities, groundwater quantity and/or flow are anticipated to be primarily affected by the temporary lowering of groundwater levels through temporary dewatering for the installation of foundations. The initial development of the MRSA, ore stockpile, and PSMF also have the potential to affect groundwater recharge and consequently groundwater quantity and/or flow.

During operation, in the absence of mitigation, open pit mining, ore stockpiling, waste rock storage and water management have the potential to affect groundwater quantity and/or flow.

Groundwater quantity and/or flow during Project operation will primarily be affected by the lowering of water levels through the dewatering of the open pits. Drawdown resulting from open pit dewatering may affect local groundwater users if located within the predicted zone of influence.

Groundwater flow patterns will be altered by open pit dewatering, operation of the water management pond (WMP), and construction of the MRSA and the PSMF. The resulting change in groundwater flow pattern and recharge rates may affect groundwater discharge to surface water features and wetlands.

Potential effects to surface water features and wetlands from the lowering of groundwater levels and changes to baseflow are further assessed in Sections 6.2.3.6.3 (surface water quantity) of this report and Section 6.2.6.6.2 (Change in Non-Forest Cover) of this EIS Addendum (Vol 2), respectively.

During closure, as surface water runoff from the Project is directed to the open pits and as the open pits fill, groundwater levels will slowly rise and changes to groundwater flow direction and discharge locations are expected. Closure of water management facilities will result in the removal of contact water collection systems that may result in groundwater originating from the MRSA and PSMF, discharging to the natural environment. These changes will extend into the post-closure phase and reach a steady-state condition once the open pits are filled.

At closure, the removal and rehabilitation of the ore stockpile and WMP and changes in moisture content and rehabilitation for the MRSA and PSMF, have the potential to change groundwater recharge rates. These changes will affect groundwater flow patterns and discharge to surface water features and wetlands. Potential effects to surface water features and wetlands are further assessed in Sections 6.2.3.6.3 (surface water quantity) of this report and Section 6.2.6.6.2 (Change in Non-Forest Cover) of this EIS Addendum (Vol 2), respectively.

Collection Pond 1 and the SWM Pond were not included as a pathway for groundwater quantity. Collection Pond 1 is a transfer pond for water pumped from the open pit to the WMP. Collection Pond 1 will be constructed above the water table and lined and therefore no interactions with groundwater are predicted and, consistent with the original EIS (2012), has not been included as a pathway for groundwater. The SWM Pond will receive runoff from the process plant area, truck shop and warehouse area, and aggregate plant area. The amount of water in the SWM Pond at a given time will be based on precipitation events and temporary as water collected in the SWM Pond will be transferred to the WMP or directly to the water treatment plant for discharge to Hare Lake. Therefore, interactions of the SWM Pond with groundwater are anticipated to be limited and temporary and not included in the EIS Addendum as a pathway for groundwater, which is consistent with the original EIS (2012).

Mitigation and Enhancement Measures

The following mitigation measures are proposed to avoid or reduce Project-related effects on groundwater quantity.

- Limit construction footprint (i.e., SSA) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the SSA
- Use standard management practices throughout the Project, including drainage control and excavation and open pit dewatering
- Use standard construction methods, such as seepage cutoff collars, where trenches extend below the water table to mitigate preferential flow paths
- Install contact water and seepage collection ditches around the perimeter of the MRSA and ore stockpile to mitigate the migration of seepage

- Consider accelerating open pit filling at closure to return groundwater levels to post closure steady-state conditions in a shorter timeframe
- Completion of a water well survey within and adjacent to the SSA to confirm the presence of nearby water supply wells

In addition to the mitigation measures to reduce potential effects, GenPGM is also committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of this EIS Addendum (Vol 2).

Project Residual Effect

A detailed analysis of the residual effects of the Project on groundwater quantity is provided in the Hydrogeology Updated Effects Assessment Report (Appendix D4 of this EIS Addendum [Vol 2]). The following provides a summary for each phase of the Project.

Construction

During construction, the Project activities and components that might interact with groundwater quantity and result in an environmental effect (Table 6.2.3-3) include: site preparation, construction of mine components, utilities, and infrastructure.

Local changes in infiltration rates through compaction of ground surfaces or construction of infrastructure such as, but not limited to, buildings and soil and waste rock storage areas may result in reduced infiltration within the SSA. Stripping of topsoil, timber harvesting, and removal of vegetation in the SSA will result in changes in evapotranspiration rates and runoff and may result in decreased infiltration rates where impervious surfaces will remain or increased infiltration rates where vegetation is removed. These changes in infiltration rates are considered to have a limited effect on groundwater resources.

Construction earthworks have the potential to encounter groundwater and require water management such as temporary dewatering (i.e., to maintain dry working conditions) and/or contact water collection. Temporary dewatering and/or contact water collection could result in limited local changes to groundwater flow direction, and/or lowering of groundwater levels and a potential decrease in discharge to surface water features. Dewatering for foundations and installation of infrastructure will be completed under a PTTW if pumping in excess of 50 m^3/day is required. The pumping will be short-term on an as-needed basis and may be required for minor supporting infrastructure for equipment storage and maintenance, and preparation of foundations for the ore stockpile, MRSA, and PSMF.

With the construction mitigation measures presented in the previous section (in particular limiting construction footprint and use of standard management practices including drainage control and excavation), changes to groundwater quantity and/or flow due to temporary construction dewatering are characterized as adverse, low frequency, short-term (e.g., limited to the construction phase and on an as-needed basis), reversible and will be confined to the SSA. The magnitude is expected to be low as dewatering for typical foundations is expected to be less than 1 m below ground surface. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates, particularly during the spring when higher groundwater levels are expected; however, these variations would not be considered a

Project-related effect. The groundwater quantity in the SSA is high with respect to ecological/societal context and dewatering is not expected to change that context.

Operation

During operation, the Project activities and components that might interact with groundwater quantity and result in an environmental effect (Table 6.2.3-3) include: open pit mining, stockpiling of mine rock and ore, and water management.

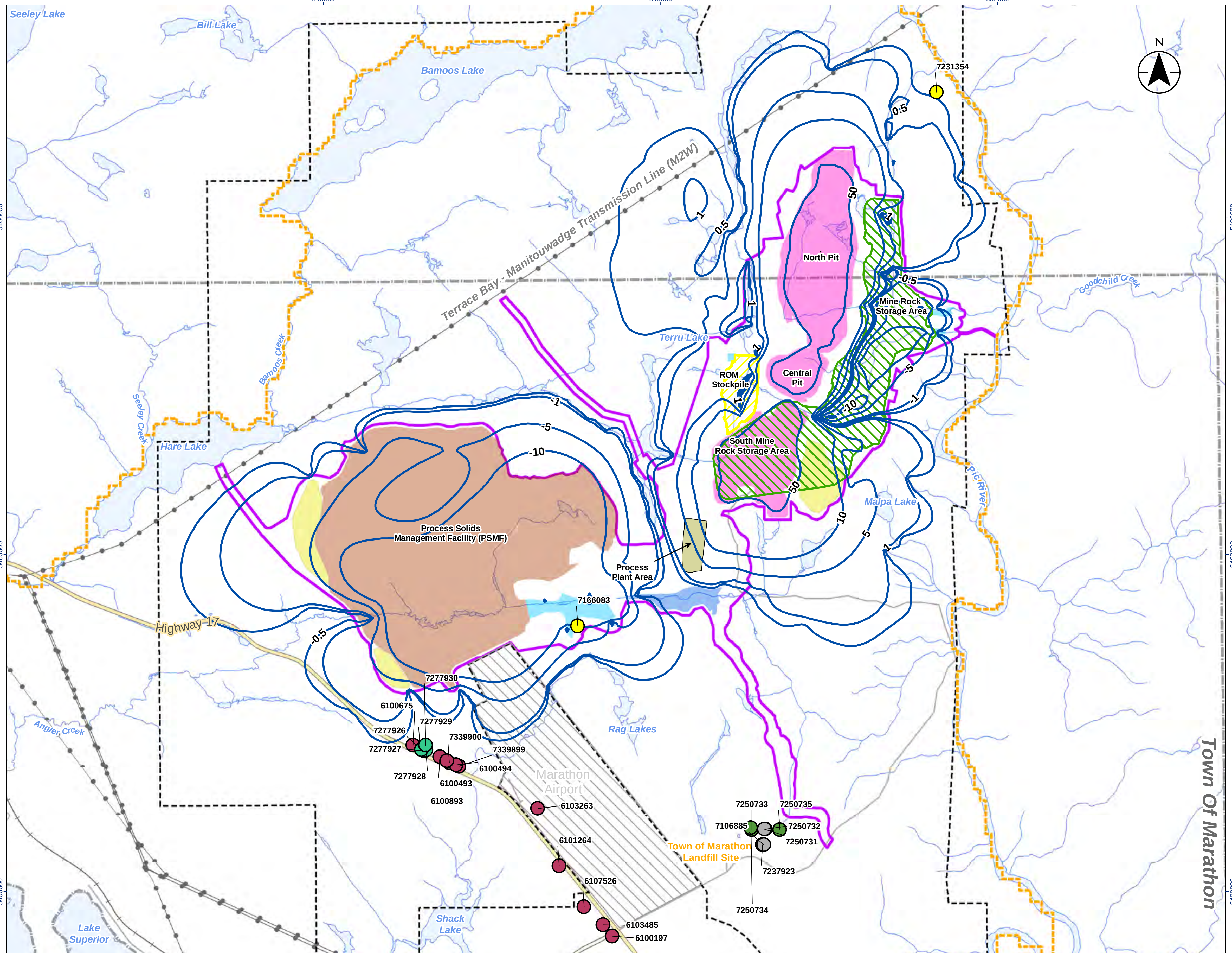
The primary Project effect on groundwater quantity and/or flow during operation is the lowering of water levels through continued dewatering of the open pits and mounding of the water table through stockpiling of waste rock and operation of the PSMF. Water pumped from the open pits will be sent to the WMP, via Collection Pond 1. Water from the WMP may be sent to the Process Plant where it will be used in mill processing prior to being sent to the PSMF or be treated, as required, prior to discharge to Hare Lake.

The North, Central, and South pits will be developed over a 12-year mine life. The North Pit will be developed progressively over the 12-year life of mine. The South pit will be developed progressively from the start of mining with the maximum extent of the pit developed by year 6 of mine life. The maximum groundwater inflow into the South pit is predicted as 457 m^3/day (year 6 of mine life) and occurs prior to the development of the Central Pit. Development of the Central Pit will commence after year 6 of mine life and the progressive development and dewatering of the Central Pit will result in a portion of groundwater that was previously reporting to the South Pit to be redirected to the Central Pit resulting in a decrease in the groundwater inflow to the South Pit. The predicted groundwater inflow rates at the end of mine life (year 12) for the North, Central, and South pits is 481 m^3/day, 136 m^3/day, and 377 m^3/day, respectively, for a combined groundwater inflow rate of 994 m^3/day.

The drawdown, or change in water level elevation, at the end of operation (year 12) in comparison to baseline conditions, within the overburden and shallow bedrock is presented on Figure 6.2.3-4. These changes include the maximum extent of the open pits in the fully dewatered state at the end of life of mine. Dewatering of the open pits will lower the water table by up to 0.5 m in the overburden and shallow bedrock over an area of approximately 900 m to the north, east, and south and 500 m to the west of the open pit. Local mounding of the water table of up to 10 m within the MRSA, located adjacent to the eastern boundary of the open pits, limits the extent of drawdown due to dewatering of the open pits. The mounding of the MRSA is a reflection of the size of the pile and the four order of magnitude difference between the hydraulic conductivity of the MRSA (hydraulic conductivity of 10^{-3} m/s) versus the underlying hydrostratigraphic unit (hydraulic conductivity of 10^{-7} m/s).

Figure 6.2.3-4 also presents the predicted zone of influence of the PSMF on groundwater levels at the end of operation compared to baseline conditions. As identified by the -0.5 m drawdown contour, mounding of the water table within the area of the PSMF is predicted to extend up to 1,200 m and generally less than 800 m, from the limits of the PSMF.

There are no known water supply wells or active groundwater PTTWs that supply potable water within the 1.0 m overburden/shallow bedrock drawdown contour of the open pits (Figure 6.2.3-4). A water well survey will be undertaken prior to construction to confirm the status and location of the water wells identified in the MECP database. As a result, no environmental effect to groundwater quantity and/or flow is predicted from the Project on water supply wells.



Stantec

Legend

- Regional / Local Assessment Area (Groundwater)
- Approximate Limit of Surface Rights (current and/ or planned)
- Site Study Area Boundary
- Groundwater Drawdown Contours [3]
- Highway
- Major Road
- Hydro Line
- Railway
- Watercourse
- Airport
- Municipal Boundary, Lower Tier
- Waterbody

Water Well Records (Final Status, MECP)

- Abandoned-Other
- Monitoring and Test Hole
- Observation Wells
- Water Supply
- Unknown

Proposed Mine Features

- Mine Rock Storage Area (MRSA)
- Process Plant Area
- ROM Stockpile
- Stormwater Management Pond
- Open Pit
- Overburden Stockpile
- Process Soilds Management Facility (PSMF)
- Water Management Pond

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Notes
1. Coordinate System: NAD 1983 UTM Zone 16N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2018.
3. Groundwater drawdown is displayed in metres below surface.
4. The proposed mine features depicted on this drawing are intended to represent a generalized and conceptual overview of the major mine components at the end of operations stage of mine life.

Project Location
Marathon

129673006 REVA
Prepared by DH on 2021-01-18

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
6.2.3-4

Title
Simulated Water Table Drawdown at End of Operation

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Changes in groundwater flow and discharge to surface water features due to dewatering of the open pits and mounding of the water table associated with the MRSA and PSMF are presented in Figure 6.2.3-4.

Table 6.2.3-4: Groundwater Discharge to Watercourses and Lakes Under Dewatered (Year 12), Pit Lake (Post Closure), and Baseline Conditions (m^3/day)

Subwatershed	Baseline Discharge Rate	End of Mining (Year 12)	Post Closure
101	1,252	1,506	1,517
102	1,002	47	47
103	287	28	30
104	478	734	769
105	1,959	2,467	2,418
106	2,244	1,894	1,894
107	114	105	107
108	100	72	32
109	1,674	2,092	2,092
110	4.8	14	16
111	8.7	18	22
112	25	123	133
113	49	65	68
114	143	212	218
115	14	20	21
116	126	154	154
117	35	46	50
Pic River	1,301	1,724	1,727

Notes:

1. Positive value represents flow from groundwater to surface water
2. Negative value represents flow from surface water to groundwater

The overall groundwater discharge at the end of operations compared to baseline conditions for subwatersheds 102, 103, 107, and 108 decreases as a result of open pit development.

Mounding of the water table in the vicinity of the MRSA results in an increase in groundwater discharge to adjacent subwatersheds 110, 111, 112, 113, 114, 117, and the Pic River. The PSMF will have a lower hydraulic conductivity than the original ground surface resulting in lower recharge and subsequently groundwater discharge to surface water features within subwatershed 106 during operations. However, mounding of the water table within the vicinity of the PSMF will result in an increase in groundwater discharge to subwatersheds 101, 105, and 109.

Generally, the groundwater discharge rates for each watershed represents a small component of total flow for the given watershed. The effect of changes in groundwater discharge rates on surface water receivers is summarized in Section 6.2.3.6.3 of this report, with the detailed evaluation provided in the Surface Water Hydrology Updated Effects Assessment Report (Appendix D3 of this EIS Addendum [Vol 2]).

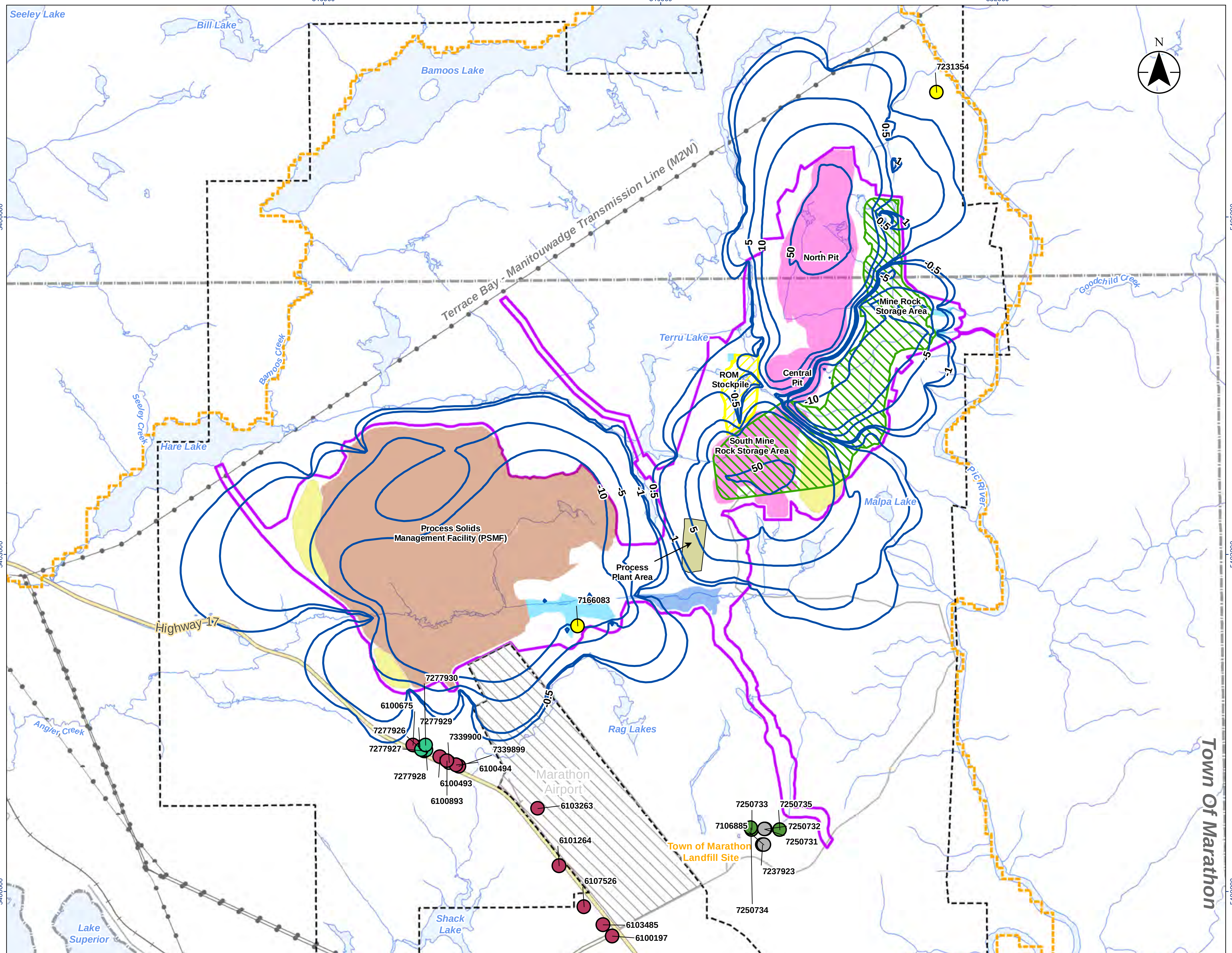
Dewatering of the open pits during operation will result in a change in groundwater quantity and flow within the overburden and bedrock aquifer system. This change is characterized as adverse, long-term, continuous, and will be confined to the LSA. The magnitude is high within the SSA and extends into the northern portion of the LSA/RSA. The magnitude will be reduced during closure as the open pits fill to form a pit lake and/or are backfilled with waste rock and tailings; however, some local drawdown will remain in the area of the open pits during closure as discussed in the subsequent section. Therefore, the effect is considered to be reversible and of medium duration for the operational phase of the Project. Within the area of the PSMF, the effect is characterized as positive, long-term, continuous, irreversible, and will be confined to the LSA/RSA. The magnitude is high within the SSA and decreasing to low within the LSA. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates due to natural seasonal variations, particularly during the spring period when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect. The groundwater quantity in the SSA is high with respect to ecological/societal context, and operation of the Project would not be expected to change that context.

Closure

Following completion of operation, dewatering of the open pits will cease and water levels will begin to rise within the open pits. The North Pit lake would discharge naturally at an elevation of approximately 262 metres above sea-level (masl) through a constructed stream channel with overland drainage to the Pic River (via subwatershed 103). The Central Pit would be backfilled to an elevation of 254 masl with a combination of process solids and mine rock with Type 2 material which would be flooded to form a pit lake with the surface water level of the pit lake controlled by a drainage channel with an elevation of 271 masl. Above an elevation of 271 masl, water would discharge from the Central Pit to the North Pit. The South Pit will be backfilled with mine rock material to above the water table, forming the southern portion of the MRSA in closure. A drainage channel with an elevation of 271 masl will be constructed at the northern edge of the South Pit to allow groundwater discharge from the South Pit to the Central Pit.

Figure 6.2.3-5 provides the simulated drawdown in closure in comparison to baseline conditions with the open pits backfilled, as applicable, and water level of the pit lakes at the design elevations stated above. As shown, residual drawdown of the water table is predicted to extend about 500 m west, 800 m east, and 900 m north and south of the open pits. Mounding of the water table is predicted to extend up to 1,300 m and 800 m from the limits of the PSMF and MRSA, respectively.

There are no known water supply wells or active groundwater PTTWs that supply potable water within the 1.0 m overburden/shallow bedrock drawdown contour of the open pits (Figure 6.2.3-5). A water well survey will be undertaken prior to construction to confirm the status and location of the water wells identified in the MECP database. As a result, no environmental effect to groundwater quantity and/or flow is predicted from the Project on water supply wells.



Stantec

Legend

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4. The proposed mine features depicted on this drawing are intended to represent a generalized and conceptual overview of the major mine components at the end of operations stage of mine life.

Project Location
Marathon

129673006 REVA
Prepared by DH on 2021-01-18

Client/Project
GENERATION PGM INC.
MARATHON PALLADIUM PROJECT

Figure No.
6.2.3-5

Title
Simulated Water Table Drawdown at Post Closure (Pit Lakes)

Changes in groundwater flow and discharge to surface water features resulting from the effect of the pit lakes and closure of the PSMF on surface water features were evaluated in the groundwater flow model and presented in Table 6.2.3-4. The overall groundwater discharge during closure compared to baseline conditions for subwatersheds 102, 103, 107, and 108 remains less than baseline in closure due to the permanent lowering of the groundwater table in the vicinity of the open pits.

The effect of mounding of the water table in the vicinity of the MRSA and the corresponding increase in groundwater discharge to adjacent subwatersheds 110, 111, 112, 113, 114, 117, and the Pic River remains in closure. The termination of open pit dewatering and the formation of the pit lakes results in a further increase in groundwater discharge for these watersheds in closure compared to operations. The changes to groundwater discharge to subwatershed 106 (decrease) and 101, 105, 109 (increase) as a result of the PSMF remains in closure.

The changes in groundwater levels in the areas of the open pit and PSMF are characterized as long-term, continuous, irreversible, and will be confined to the LSA/RSA. In the area of the PMSF, the effect is positive and the magnitude will be high within the SSA, decreasing to low just outside the SSA. In the area of the open pits, the effect is adverse and the magnitude will be high within the SSA and extending slightly into the LSA north and south of the open pits before decreasing to moderate and low. Timing may affect water levels (i.e., natural seasonal variations), particularly during the spring period when higher groundwater levels are expected, but this is not considered a Project-related effect. The groundwater quantity in the SSA is high with respect to ecological/societal context and the Project is not expected to change that context.

Determination of Significance

Consistent with the original EIS (2012), the main adverse residual environmental effect on groundwater quantity and flow identified in the groundwater quantity assessment is the lowering of the water table as a consequence of dewatering the open pits. This effect will be most notable during the operation phase and to a lesser extent during closure as the open pits fill and groundwater levels recover to some degree.

The threshold for significance as defined in Section 6.2.3.3.6 of this report relates to a reduction in the water level of a water supply well currently used to service commercial, industrial, recreational, institutional, municipal, or residential areas located beyond the SSA, such that it no longer meets the needs of the current users. There are no groundwater users within the area of the 1.0 m drawdown contour for the shallow overburden and bedrock aquifer. Groundwater discharge to surface water features will decrease slightly as a result of open pit dewatering. Effects to surface water features as a result of a reduction in groundwater discharge are assessed in Sections 6.2.3.6.3 (surface water quantity) of this report and Section 6.2.6.6.2 (Change in Non-Forest Cover) of this EIS Addendum (Vol 2).

With the proposed mitigation and environmental protection measures (outlined in this section), the adverse residual environmental effects of the Project on a change in groundwater quantity and/or flow from routine activities carried out during each phase of the Project are considered to be not significant. This determination is supported by the fact that there are no known groundwater users within the area of drawdown in the LSA/RSA, and no new groundwater users will be permitted within the SSA, or within the lands owned or leased by GenPGM within the LSA/RSA. This determination of not significant is consistent with the original EIS (2012).

6.2.3.6.2 Change in Groundwater Quality

Analytical Assessment Techniques

The environmental effects analysis for groundwater quality, is carried out using a number of analytical methods and tools, and includes laboratory analytical data, three-dimensional numerical groundwater flow modelling and water quality modelling. The techniques are described in detail in the SID #14 – Baseline Report – Hydrogeology (CIAR #227) (True Grit 2012a), SID #15 – Impact Assessment – Hydrogeology (CIAR #227) (True Grit 2012b), and the Environmental Hydrogeology Updated Baseline Report (Stantec 2020e) (CIAR #722) and Hydrogeology Updated Effects Assessment (Appendix D4 of this EIS Addendum [Vol 2]).

The numerical, three-dimensional finite difference groundwater flow model developed for the simulation of baseline conditions, described in SID #14 – Baseline Report – Hydrogeology (CIAR #227) (True Grit 2012a), was modified to assist in the evaluation of potential effects of the Project on groundwater. The model provides quantitative predictions about changes in groundwater levels and flow under the operation and closure Project phases. With respect to groundwater quality, the groundwater flow model was used to estimate the amount of groundwater recharge originating from the development, operation, and closure of the MRSA, ore stockpile, PSMF, and WMP. For the assessment, groundwater recharge originating from the MRSA, ore stockpile, PSMF, and WMP did not consider physical flow or chemical processes and was assumed to discharge to the natural environment to provide a conservative assessment of groundwater loading to the receiving environment.

Geochemical testing and modelling were completed to predict the source concentrations of various mine components and is described in detail in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). In addition, a water quality model was built that couples water quantity and mass transfer of selected parameters from different Project components and is described in SID #6 – Water Quality and COPC Fate Modelling (CIAR #234) (Ecometrix 2012f) and was updated as part of the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The results of the models were used to predict the water quality and recharge associated with the MRSA, ore stockpile, PSMF, and WMP during operation and decommissioning/post closure. The predicted water quality for each mine source was then used, together with the groundwater discharge rates predicted with the groundwater flow model, to estimate potential effects of Project activities on groundwater quality and loading to surface water receivers. The predicted effect of the Project on the quantity and quality of groundwater users was evaluated.

Project Pathways

During construction and/or operation, in the absence of mitigation, groundwater recharge from the MRSA, ore stockpile, PSMF as well as water management facilities have the potential to affect groundwater and surface water quality where groundwater discharges to surface water. Groundwater inflow to the open pits will be pumped to the WMP, via Collection Pond 1, where it will be sent to the process plant and used for mill processing prior to being sent to the PSMF with tailings. Treatment will be implemented, if required, to meet regulatory discharge criteria. Potential effects to surface water features and wetlands from the change in quality of groundwater discharge are assessed in Sections 6.2.3.6.4 of this report and 6.2.6.6.2 of this EIS Addendum (Vol 2), respectively.

Changes to groundwater quality resulting from groundwater recharge from the MRSA, ore stockpile, PSMF as well as water management facilities may affect local groundwater users if users are located within the predicted zone of influence.

During closure, as the open pit fills, groundwater levels are predicted to slowly recover and the effect of the open pits on groundwater flow and discharge will be less than during operation. Changes to groundwater flow patterns has the potential to affect surface water quality where groundwater recharge originating from the PSMF and MRSA discharges to surface water. Potential effects to surface water features and wetlands from the change in quality of groundwater discharge are assessed in Sections 6.2.3.6.4 of this report and 6.2.6.6.2 of this EIS Addendum (Vol 2), respectively.

Collection Pond 1 and the SWM Pond were not included as a pathway for groundwater quality. Collection Pond 1 is a transfer pond for water pumped from the open pit to the WMP. Collection Pond 1 will be constructed above the water table and lined and therefore no interactions with groundwater are predicted and, consistent with the original EIS (2012), has not been included as a pathway for groundwater. The SWM Pond will receive runoff (non-contact water) from the process plant area, truck shop and warehouse area, and aggregate plant area. The amount of water in the SWM Pond at a given time will be based on precipitation events and temporary as water collected in the SWM Pond will be transferred to the WMP or directly to the water treatment plant for discharge to Hare Lake. Therefore, interactions of the SWM Pond with groundwater are anticipated to be limited and temporary and not included in the EIS Addendum as a pathway for groundwater, which is consistent with the original EIS (2012).

Mitigation and Enhancement Measures

The following mitigation measures are proposed to avoid or reduce Project-related effects on groundwater quality:

- Limit construction footprint (i.e., SSA) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the SSA.
- Use standard management practices throughout the Project, including drainage control and excavation and open pit dewatering.
- Use standard construction methods, such as seepage cutoff collars, where trenches extend below the water table to mitigate preferential flow paths.
- Design of the MRSA to increase the amount of runoff and reduce the amount of infiltration through the MRSA, thereby reducing the recharge and loading to groundwater.
- Install contact water and seepage collection ditches around the perimeter of the MRSA and ore stockpile to mitigate the migration of seepage.

- Implementation of progressive rehabilitation (placement of vegetated soil cover) to reduce infiltration into the MRSA and PSMF, thereby reducing the amount of water and loading to groundwater and improvements to groundwater quality.
- Consider accelerating open pit filling at closure to return groundwater levels to post closure steady-state conditions in a shorter timeframe.
- Completion of a water well survey within and adjacent to the SSA to confirm the presence of nearby water supply wells.

In addition to the mitigation measures to reduce potential effects, GenPGM is also committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of this EIS Addendum (Vol 2).

Project Residual Effect

A detailed analysis of the residual effects of the Project on groundwater quality is provided in the Hydrogeology Updated Effects Assessment Report (Appendix D4 of this EIS Addendum [Vol 2]). The following provides a summary for each phase of the Project.

Construction

During construction, the Project activities and components that might interact with groundwater quality and result in an environmental effect (Table 6.2.3-5) include: maintenance and management of the MRSA and PSMF.

The PSMF will be built through construction but will not receive tailings until the operation phase of the Project. Therefore, seepage from the PSMF and subsequently effects to groundwater quality resulting from recharge through the PSMF, is not predicted during the construction phase of the Project. The duration of time for the MRSA to reach a steady-state saturation condition, where the volume of water infiltrating into the MRSA from precipitation will result in an equal amount of seepage or recharge out the base of the MRSA, is expected to be longer than the duration of the construction phase of the Project. Therefore, seepage from the MRSA and subsequently effects to groundwater quality resulting from recharge through the MRSA, is not predicted during the construction phase of the Project.

Operation

During operation, the MRSA, ore stockpile, PSMF, and WMP have the potential to affect groundwater quality. The groundwater concentrations of seepage from the MRSA, ore stockpile, PSMF, and WMP were updated as part of the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum (Vol 2). Groundwater concentrations of seepage from these facilities were incorporated into the updated surface water quality model for the Project presented in the updated surface water effects assessment and are summarized in Table 6.2.3-5. The fate of groundwater that recharges beneath the MRSA, ore stockpile, PSMF, and WMP was determined through particle tracking. The particle traces were used to quantify inflow rates to the open pits and discharge to surface water features from the MRSA, ore stockpile, PSMF, and WMP.

Table 6.2.3-5 Predicted Geomean Concentrations (mg/L) of Groundwater Recharge from Project Components

Parameter	Units	GCDWQ / ODWQS		APV	MRSA		PSMF	Ore Stockpile	Water Management Pond	
					Operation	Closure	Operation / Closure	Operation	Operation	Closure
General Chemistry										
Ammonia (as N)	mg/L	n/v		n/v	8.6	7.3	-	0.28	10	8
Nitrate (as N)	mg/L	10		n/v	**68**	**58**	0.060	2.2	**77**	**66**
Nitrite (as N)	mg/L	1		n/v	**1.6**	**1.3**	0.030	0.050	**1.8**	**1.5**
Dissolved Metals										
Aluminum	mg/L	0.1	**	n/v	**0.13**	**0.13**	0.087	0.020	**0.13**	**0.13**
Arsenic	mg/L	0.010		0.15	**0.054**	**0.062**	0.00060	0.00055	**0.061**	**0.070**
Cadmium	mg/L	0.005	**	0.00021	0.00014	0.00016	0.000033	0.000025	0.00016	0.00018
Cobalt	mg/L	n/v		0.0052	0.0037	0.0042	0.000060	0.0014	0.0042	0.0048
Copper	mg/L	1	**	0.0069	0.026	0.029	0.00050	0.012	0.029	0.033
Iron	mg/L	0.3		n/v	0.0044	0.0044	0.076	0.0044	0.0044	0.0044
Lead	mg/L	0.005	*	0.0020	0.0014	0.0016	0.000020	0.000078	0.0016	0.0018
Molybdenum	mg/L	n/v		0.73	0.012	0.014	0.028	0.00014	0.014	0.015
Nickel	mg/L	n/v		0.039	0.010	0.012	0.0030	0.0055	0.011	0.013
Selenium	mg/L	0.05		0.005	0.020	0.023	0.00057	0.00056	0.022	0.026
Uranium	mg/L	0.02		0.033	0.0059	0.0067	0.00015	0.00018	0.0066	0.0076
Vanadium	mg/L	n/v		0.02	0.040	0.046	0.0011	0.000089	0.046	0.052
Zinc	mg/L	5		0.089	0.041	0.047	0.0020	0.0017	0.046	0.053

Notes:
Grey highlight: Parameter exceeds APV
Bold: Parameter exceeds GCDWQ / ODWQS
GCDWQ: Guidelines for Canadian Drinking Water Quality (Federal)
ODWQS: Ontario Drinking Water Quality Standards (Provincial)
APV: Aquatic Protection Values (Provincial) from Ground Water and Sediment Standards for Use under Part XV.1 of the Ontario Environmental Protection Act
n/v: no guideline
ND: not detectable
OB overburden
BR bedrock
*: the provincial and federal criteria differed so the federal criteria is presented as it is more stringent and/or developed based on more recent science, or there is no provincial objective
**: the provincial and federal criteria differed so the provincial criteria is presented as it is more stringent and/or developed based on more recent science, or there is no federal guideline

Groundwater recharge from the MRSA during operation is predicted to exceed the ODWQS and/or GCDWQ for nitrate, nitrite, aluminum, and arsenic and the APVs for copper, selenium, and vanadium. The concentration of aluminum in background groundwater quality exceeds the ODWQS and GCDWQ operational guidelines. The groundwater recharge from the MRSA is predicted to be below the MDMER. Groundwater recharge from the MRSA is predicted to discharge primarily to the open pits (78%) with the remainder of discharge to subwatershed 101 (17%) and 102 (5%).

Groundwater recharge from the ore stockpile during operation is predicted to be less than the ODWQS and/or GCDWQ and exceed the APV for copper. The groundwater recharge from the ore stockpile is predicted to be below the MDMER. Groundwater recharge from beneath the ore stockpile is captured by the dewatering associated with the Central and South pits where it will be pumped to Collection Pond 1 prior to being transferred to the WMP for use as process water or treated, if required, and discharged to Hare Lake.

Groundwater recharge from the PSMF during operation is predicted to be less than the ODWQS, GCDWQ, and APVs. The groundwater recharge from the PSMF is predicted to be below the MDMER. Groundwater recharge from beneath the PSMF discharges primarily to subwatershed 106 (68%) with the remainder of discharge to subwatershed 105 (32%).

Groundwater recharge from the WMP during operation is predicted to exceed the ODWQS and/or GCDWQ for nitrate, nitrite, aluminum, and arsenic and the APVs for copper, selenium, and vanadium. The concentration of aluminum in background groundwater quality exceeds the ODWQS and GCDWQ operational guidelines. The groundwater recharge from the WMP is predicted to be below the MDMER. Groundwater recharge from beneath the WMP discharges to subwatershed 101, a tributary of the Pic River.

No groundwater supply wells are known to be located in the SSA and groundwater originating from the MRSA, ore stockpile, PSMF, and WMP is predicted to discharge to the open pit and/or surface water and not to areas where groundwater supply users are known to be located. As a result, no environmental effect to groundwater quality is predicted from the Project on water supply wells. The effect of the changes in mass loading to surface water receivers on surface water quality is assessed in Section 6.2.3.6.4 of this report.

The effect on groundwater quality during operation are characterized as adverse, long-term, continuous, irreversible, and extends into the LSA/RSA. The magnitude is high because water quality for some parameters are predicted to increase above a regulatory criteria and/or objective for drinking water. No existing or foreseeable groundwater users are located in the areas with groundwater quality that exceeds the GCDWQ or ODWQS. The groundwater quality in the LSA/RSA is high with respect to ecological/societal context (abundant with high societal value within LSA/RSA) and operation of the Project would not be expected to change that context.

Closure

The primary activity during closure that will affect groundwater quality is the filling of the open pit and change of groundwater flow and discharge conditions. Rehabilitation of the MRSA and PSMF by installation of soil covers is expected to reduce infiltration and improve water quality over time. In the effects assessment, reductions in recharge due to installation of the soil covers has not been included for the MRSA or PSMF to provide a conservative assessment of effects on groundwater quality. The particle traces were used to quantify the inflow rates and travel times to the open pits and discharge to surface water features from the MRSA, PSMF, and WMP, 100 years of travel after the start of post-closure (pit lakes full). The ore stockpile would be exhausted and rehabilitated in post-closure and, therefore, seepage from the ore stockpile in post-closure is not considered.

Groundwater recharge from the MRSA during closure is predicted to exceed the ODWQS and/or GCDWQ for nitrate, nitrite, aluminum, and arsenic and the APVs for copper, selenium, and vanadium, which is consistent with seepage quality during operation. The concentration of aluminum in background groundwater quality exceeds the ODWQS and GCDWQ operational guidelines. The groundwater recharge from the MRSA is predicted to be below the MDMER. Groundwater recharge from beneath the MRSA discharges primarily to the subwatershed 101 (62%), a tributary of Pic River. The remainder of groundwater recharge from beneath the MRSA discharges to the North and Central Pits (25%) and subwatershed 102 (13%).

Groundwater recharge from the PSMF during closure is predicted to be less than the ODWQS, GCDWQ, and APVs, consistent with seepage quality during operation. The groundwater recharge from the PSMF is predicted to be below the MDMER. Groundwater recharge from beneath the PSMF discharges primarily to subwatershed 106 (70%) with the remainder of discharge to subwatershed105 (30%).

Groundwater recharge from the WMP during closure is predicted to exceed the ODWQS and/or GCDWQ for nitrate, nitrite, aluminum, and arsenic and the APVs for copper, selenium, and vanadium. The concentration of aluminum in background groundwater quality exceeds the ODWQS and GCDWQ operational guidelines. The groundwater recharge from the WMP is predicted to be below the MDMER. Groundwater recharge from beneath the WMP discharges to subwatershed 101, a tributary of the Pic River. The WMP will be decommissioned in closure, once water quality meets criteria for discharge to the environment.

No groundwater supply wells are known to be located in the SSA and groundwater originating from the MRSA, PSMF, and WMP is predicted to discharge to the open pit and/or surface water and not to areas where groundwater supply users are known to be located. As a result, no environmental effect to groundwater quality is predicted from the Project on water supply wells. The effect of the changes in mass loading to surface water receivers on surface water quality is assessed in Section 6.2.3.6.4 of this report.

The effect on groundwater quality during operation are characterized as adverse, long-term, continuous, irreversible, and extends into the LSA/RSA. The magnitude is high because water quality for some parameters are predicted to increase above a regulatory criteria and/or objective for drinking water. No existing or foreseeable groundwater users are located in the areas with groundwater quality that exceeds the GCDWQ or ODWQS. The groundwater quality in the LSA/RSA is high with respect to ecological/societal context (abundant with high societal value within LSA/RSA) and closure of the Project would not be expected to change that context.

Determination of Significance

Consistent with the original EIS (2012), the main residual environmental effect on groundwater quality identified in this assessment is the increase in concentration of constituents above the drinking water guidelines and/or APVs along the groundwater flow path from the MRSA and PSMF to the ultimate receiver relative to baseline conditions. This effect will be most notable later in mine life and into closure because the predicted mean advective travel times of seepage from the Project components through the aquifer are generally decades to centuries. The effect is to the SSA, with a portion of the groundwater flow paths from the MRSAs and PSMF extending into the LSA/RSA.

The threshold for significance as defined in Section 6.2.3.3.6 of this report relates to a change in groundwater quality resulting in a Project-caused degradation of the quality of groundwater by exceeding one or more of the health-based standards specified in the GCDWQ or ODWQS for drinking water to the extent that a water supply well no longer meets the needs of current users or land owners beyond the SSA. Typical in Ontario, groundwater naturally exceeds a number of water quality objectives (e.g., hardness). For parameters with baseline concentrations that exceed the health-based standards specified in the GCDWQ or ODWQS, the determination of significance will be such that the quality of those parameters for an existing water supply well will not be further impaired by the Project. No groundwater users are known within the area of influence of Project components with the groundwater recharge from the MRSA and PSMF discharging to surface water. Therefore, the adverse residual environmental effects of the Project on a change in groundwater quality during each Project phase are not significant. The effect of the groundwater quality discharging to surface water features is evaluated in Section 6.2.3.6.4 of this report. This determination of not significant is consistent with the original EIS (2012).

6.2.3.6.3 Change in Surface Water Quantity

Analytical Assessment Techniques

Flows and water levels under pre-development conditions were used as the baseline against which Project-related changes during the construction, operation and decommissioning, rehabilitation and closure phases were assessed. Subwatershed areas during pre-disturbance (baseline) conditions, operations phase, closure phase, and post-closure phase were determined for assessed subwatersheds. The changes in subwatershed areas are primarily a result of the construction of mine infrastructure and the implementation of the water management plan (see the Site Water Balance Summary (Appendix D5 of this EIS Addendum [Vol 2]). The surface water quantity assessment was conducted by using regression equations developed in the Environmental Hydrology Updated Baseline Report (Stantec 2020d) (CIAR #722) for mean annual flows (MAFs), mean monthly flows (MMFs), low, environmental, and peak flows. Flows within the SSA throughout mine life were modelled in a GoldSim water balance model and used in the surface water quantity assessment. Changes to baseline flows resulting from varying groundwater discharge rates to surface water over mine life assessed in the Hydrogeology Updated

Effects Assessment Report (Appendix D4 of this EIS Addendum [Vol 2]) were added or subtracted as appropriate to/from the MAFs, MMFs, and peak flows accordingly for assessed subwatersheds, as detailed in the Updated Hydrology Effects Assessment Report (Appendix D3 of this EIS Addendum [Vol 2]) for each mine phase.

Change in MAF from pre-disturbance (baseline) conditions was used as a screening threshold to determine whether further assessment of changes in flow were required. Watersheds with an expected change in MAF of greater than 10% were carried forward to subsequent assessment steps. The ±10% threshold was selected based on case studies presented by Richter et al. (2011), which indicate that a high level of ecological protection is provided when flow alterations are within 10% of the natural flow,

- For watersheds with an expected MAF decrease of over 10%, the MMF was compared with monthly baseline environmental flows. The residual effect was considered to not be significant if the predicted MMF was greater than the baseline environmental flows. If the expected MMF was lower than the baseline environmental flows, a locally significant surface water quantity residual effect is expected within the LSA
- For watersheds with an expected increase in MAF of over 10%, expected flood flows (Q100) were compared with baseline conditions to assess the potential for flooding and erosion

Rating curves developed in the Hydrology Baseline Update Report (Stantec 202d) (CIAR #722) were used to determine changes to water levels in Hare Lake throughout mine life due to changing inflow rates as a result of Project activities.

Project Pathways

Project activities are expected to affect surface water quantity (flows and levels) during the construction, operation, closure, and post-closure phases of the Project.

During construction, changes to flow and water levels in subwatersheds within the LSA may result from: site deforestation, the construction of site infrastructure and mine components, and water management for the collection, use, treatment, and discharge of mine contact water. Surface water levels and/or flows are expected to be affected by the reduction of contributing subwatershed areas through the collection of mine contact water within the SSA, and the overprinting of existing watercourses and lakes from site infrastructure and mine components. Water management of the collected water will divert water previously contributing to baseline flow to the WMP, where it will be recycled as process water or discharged to Hare Lake (subwatershed 105) during ice-free periods (April to November). Contact water from the MRSA will be collected within catch basins in subwatershed 102 and 103 and sent to the WMP, a departure from the original EIS in which the catch basins were allowed to overflow to the Pic River.

During operation, changes to flow and water levels in subwatersheds within the LSA may result from ongoing water management for the collection, use, treatment, and discharge of contact water, the dewatering of the open pits, and the build-up of mine rock in the MRSA. Surface water levels and/or flows affected by the reduction of contributing subwatershed area during construction are expected to persist through operations. Increased discharge rates from the WMP to Hare Lake during ice-free periods will affect surface water levels and flows to a greater extent than during construction. Changes to groundwater discharge to surface water (baseflow) may also affect surface water level and/or flows as detailed in Section 6.2.3.6.1 of this report.

During closure, changes to flow and water levels in subwatersheds within the LSA may result from the decommissioning and removal of site infrastructure, the rehabilitation of the MRSA and other disturbed areas, pumping from the PSMF and other mine components to the open pits to accelerate pit filling, and removal of the catch basin dams east of the MRSA. The removal of site infrastructure and rehabilitation of mine components will restore contributing subwatershed area to the MAFs of subwatersheds within the LSA. Contact water from the MRSA will be collected in catch basins and pumped to the open pit to accelerate pit filling, along with contact water in the PSMF, which will maintain the reduction of water discharge to associated subwatersheds from construction and operations. Following the acceptability of water quality in the rehabilitated PSMF, transfer of water to the open pit will cease and surface water runoff from the PSMF will discharge to the environment (which may occur during closure or post-closure) via a closure swale and channel. The emergency overflow spillway constructed during operations will be reconfigured to establish the closure swale and channel. Discharge of surface water runoff will restore surface water flows in subwatershed 106 post-closure.

If the PSMF and MRSA catch basin discharge water quality is acceptable to discharge to the environment, the PSMF dam and MRSA catch basins will be breached post-closure following the filling of the open pits and allowed to drain through subwatershed 106 and subwatersheds 102 and 103, respectively.

Mitigation and Enhancement Measures

The mitigation measures presented below are proposed to avoid or reduce Project-related effects on surface water quantity.

- Limit and stage construction footprint (SSA) to the extent practicable
- Maintain existing drainage patterns with the use of culverts
- Inspect culverts periodically. Remove accumulated material and debris upstream and downstream of the culverts to prevent erosion, flooding, habitat damage, property damage, and mobilization of sediment
- Maintain access roads by periodically regrading and ditching to improve water flow, reduce erosion, and manage vegetation growth
- Attenuate peak discharges and augment baseflows to the environment through use of Project water storage features (i.e., catch basins, collection ponds, SWM ponds)
- Collection of runoff and groundwater seepage from the open pits and run-of-mine stockpile within Collection Pond 1
- Excess water pumped from Collection Pond 1 to the WMP for treatment and discharge to Hare Lake

- Recycling of contact water for use as process water
- Construction and use of existing subwatershed boundaries to divert fresh water away from Project components
- assessment of the downstream watercourse in subwatershed 103 and 112 to implement erosion control measures to reduce the potential for scour and erosion to occur, as needed

Project Residual Effect

A detailed analysis of the residual effects of the Project on surface water levels and flow is provided in the Updated Hydrology Effects Assessment Report (Appendix D3 of this EIS Addendum [Vol 2]). The following provides a summary for each phase of the Project.

Construction

The Project components that effect surface water quantity include site preparation, construction of roads and mine infrastructure, and effluent discharge to the environment.

Construction of the access road is expected to have no effect on the existing subwatershed areas and is not considered to be a subwatershed area loss due to the installation of culverts. Overland flow will be directed downgradient via culverts below the access road and runoff on the road will also drain by gravity to remain within the respective subwatershed. Culverts will be placed at topographic lows along the road corridor to facilitate the passage of water below the road. Culvert locations will use existing defined channel paths to the extent feasible. The access road is expected to increase the imperviousness along its pathway, which will result in a marginal change in flow as less evapotranspiration will occur and less water will infiltrate the groundwater system.

Site preparation is expected to change surface water quantity by changing the infiltration rate and runoff contributing to flow. The subsequent construction of Project infrastructure and mining components (MRSA, PSMF, Process Plant, open pits, ore stockpile) will overprint existing streams and small lakes within the SSA subwatersheds and reduce the contributing subwatershed area with the collection of runoff and seepage. Collected water will be sent to the WMP for reuse in the Process Plant or to be treated and discharged to Hare Lake. No discharge is anticipated during construction. The reduction in subwatershed area, and therefore MAF, of subwatershed 105 is expected to decrease the water level by 0.25 cm from baseline conditions, a decrease of 1% is considered to be insignificant. No changes to baseflow due to changes in groundwater are expected during construction, as discussed in Section 6.2.3.6.1 of this report.

Of the seventeen subwatersheds assessed, four subwatersheds associated with construction of the MRSA, PSMF, open pits, or process plant (subwatersheds 101, 102, 103, and 106) are expected to have MAFs decrease from baseline conditions by more than 10% (-33%, -98%, -96%, and -36%, respectively) and trigger further assessment. Subwatershed 102 is expected to undergo permanent changes commencing at construction and extending to post-closure. When the pits overflow and subwatershed 102 discharges to the Pic River, the permanent reductions in catchment area result in permanent reductions in flow with MMFs below environmental flows. Project residual effects for subwatershed 102 are characterized as adverse. The magnitude is expected to be high as MMFs are below baseline environmental flows and are irreversible due to permanent watershed loss, which is an update from the original EIS (2012). Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of effects will be high (permanent), the frequency of effects is high as effects will be continuous throughout construction, and effects will be irreversible. The ecological/societal effect is high as water is used for cultural and societal context within the LSA.

In subwatershed 101, six months of the year during construction do not maintain environmental flows but flows are expected to recover to less than the 10% threshold for MAF during closure and post-closure. Subwatershed 103 is predicted to have MMFs that do not maintain environmental flows during construction, with recovery expected above environmental flows once the open pit fills and contributes to the subwatershed MAF during post-closure. In subwatershed 106, during winter and sometimes during summer, lower flow periods extending from construction to the time in post-closure where the PSMF commences discharge to subwatershed 106, MMFs do not maintain environmental flows. However, when the PSMF commences discharge to subwatershed 106, flows will recover and flow change will be less than the 10% MAF screening threshold. Project residual effects for subwatersheds 101, 103, and 106 are characterized as adverse. The magnitude is expected to be high as MAFs exceed the 10% trigger threshold and MMFs are below baseline environmental flows during construction, although flows are expected to recover during closure and/or post-closure. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to operation and/or decommissioning (medium), and the frequency of effects is high as effects will be continuous throughout construction. Reversibility will be low as flows are expected to recover during closure and/or post-closure. The ecological/societal effect is high as cultural and societal value is considered high by Indigenous communities.

Five subwatersheds (104, 105, 107, 108, and 109) are expected to have a change in MAF of less than 5% (-1%, -2%, -1%, -4%, and 2%, respectively) due to minor watershed loss from mine components but do not trigger further assessment as they remain below the 10% threshold. Project residual effects for subwatersheds 104, 105, 107, 108, and 109 are characterized as adverse. The magnitude is expected to be low as MAFs are below the 10% threshold change from baseline conditions. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to operation and/or decommissioning (medium), and the frequency of effects is high as effects will be continuous throughout construction. Reversibility will be low as flows are expected to recover during closure and/or post-closure. The ecological/societal effect is low for subwatersheds 104, 107, 108, and 109 as water is not used for cultural or societal context within the LSA. The ecological/societal effect for subwatershed 105 is high as cultural and societal value is considered high by Indigenous communities.

The remaining eight subwatersheds (110 through 117) are not directly influenced by the Project footprint and are not expected to have a change in MAF. The resulting change in the Pic River MAF from Project activities is expected to be negligible (-0.15%) due to the small percentage of Pic River watershed affected by the Project. Project residual effects for subwatersheds 110, 111, 112, 113, 114, 115, 116, and 117 are characterized as negligible.

Operation

During operation, the Project components that effect surface water quantity include ongoing water management and effluent discharge, stockpiling of mine rock and ore, and dewatering of the open pits.

Changes to contributing subwatersheds during operation is expected to be consistent with the subwatershed areas during construction. Dewatering of the open pits is expected to lower the groundwater levels and reduce groundwater contribution to surface water within the vicinity of the open pits. Mounding of the groundwater table is expected as a result of stockpiling of waste rock and operation of the PSMF and is expected to increase groundwater contribution to surface water for some subwatersheds. Groundwater changes were included in the calculated changes to the MAFs for assessed subwatersheds and are detailed in Section 6.2.3.6.1 of this report. Dewatering of the open pits is anticipated to increase the maximum discharge rate for the average-year return period to Hare Lake during operation to 0.092 m^3/s. The increased discharge rates are expected to increase Hare Lake water levels during operation by 1.16 cm compared to baseline conditions, an increase of 4%, considered to be insignificant. The increase in Hare Lake water level is also well below than the 1 m rise identified in the archaeological resources VEC (Section 6.2.11.6.1 of this EIS Addendum [Vol 2]) required to affect potential archaeological sites along the shoreline of Hare Lake.

Considering the changes of groundwater contribution to MAF and the increased discharge to Hare Lake during operation, four subwatersheds associated with construction of the MRSA, PSMF, open pits, or Process Plant (subwatersheds 101, 102, 103, and 106) are expected to have MAFs decrease from baseline conditions by more than 10% (-22%, -97%, -95%, and -33%, respectively) and trigger further assessment. In subwatershed 101, two months of the year during operation do not maintain environmental flows but flows are expected to recover to less than the 10% threshold for MAF during closure and post-closure. As noted previously, subwatershed 102 is expected to undergo permanent changes commencing in construction and extending to post-closure. Subwatershed 103 is predicted to have MMFs that do not maintain environmental flows during operation, with recovery expected above environmental flows once the open pits fill and contributes to the subwatershed flows during post-closure. In subwatershed 106, during winter lower flow periods extending to post-closure when the PSMF commences discharge to subwatershed 106, MMFs do not maintain environmental flows. However, when the PSMF commences discharge to subwatershed 106, flows will recover and be less than the 10% MAF screening threshold. Project residual effects for subwatershed 101, 102, 103, and 106 are characterized as adverse. The magnitude is expected to be high as the MAFs exceed the 10% trigger threshold and MMFs are not expected to maintain environmental flows during operation. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to operation and/or decommissioning (medium) for subwatershed 101, 103, and 106, while subwatershed 102 residual effects will recover slightly during post-closure but maintain MMFs below the environmental flows permanently (high). The frequency of effects is high as effects will be continuous throughout operation. Reversibility will be low for subwatersheds 101, 103, and 106, as flows are expected to recover during closure and/or post-closure, while reversibility is high (irreversible) for subwatershed 102 due to permanent watershed area loss. The ecological/societal effect is low for subwatershed 101 as water is not used for cultural or societal context within the LSA. The ecological/societal effect for subwatersheds 102, 103, and 106 is high as cultural and societal value is considered high by Indigenous communities.

Two subwatersheds (105 and 112) are expected to have an increase in MAF greater than 10% (12% and 53%, respectively), triggering additional assessment for Q100 flood flows. The analysis of flood flows resulted in subwatersheds 105 and 112 having a maximum flood flow increase of -1% and 1% compared to baseline flood flow estimates as the discharge to Hare Lake in subwatershed 105 and the change in groundwater contribution to subwatershed 112 during flood flow conditions are minor compared to the overall flow. The increase in MAF for subwatershed 105 is expected to recover during closure and post-closure conditions when the discharge to Hare Lake discontinues. The groundwater change triggering the increase in MAF to subwatershed 112 is expected to be non-reversible due to the mounding from the filled pit lake. Therefore, Project residual effects for subwatersheds 105 and 112 are characterized as adverse. The magnitude is expected to be medium as MAFs exceed the 10% trigger threshold but additional assessment considers changes to flood flows to be insignificant. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to operation and/or decommissioning (medium) for subwatershed 105 and will be irreversible for subwatershed 112 (high), and the frequency of effects is high as effects will be continuous throughout operation. The ecological/societal effect is low for subwatershed 112 as water is not used for cultural or societal context within the LSA. The ecological/societal effect is high for subwatershed 105 as cultural and societal value is considered high by Indigenous communities.

Eleven subwatersheds (104, 107, 108, 109, 110, 111, 113, 114, 115, 116, and 117) are expected to have a change in MAF of less than 10% (4%, -1%, -7%, 4%, 4%, 5%, 4%, 3%, 1%, 1%, and 3%, respectively) due to minor baseflow changes from groundwater contribution and/or subwatershed loss from Project components. Further assessment was not completed as the eleven subwatersheds remain below the 10% change in baseline MAF threshold. Project residual effects are characterized as adverse. The magnitude is expected to be low as MAFs do not exceed the 10% trigger threshold. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be irreversible (high), and the frequency of effects is high as effects will be continuous throughout operation. The ecological/societal effect is low as water is not used for cultural or societal context within the LSA.

The resulting change in the Pic River MAF from Project activities is expected to be negligible (-0.13%) due to the small percentage of Pic River subwatershed affected by the Project.

Closure

During closure, the Project components that effect surface water quantity include decommissioning and removal of Project infrastructure, rehabilitation of disturbed areas, and pit filling.

The removal of Project infrastructure and rehabilitation of disturbed areas will recover some of the contributing subwatershed area changes seen during construction and operation. Contact water associated with the ore stockpile, open pits, and MRSA will continue to be sent to the open pits to accelerate pit filling and will not contribute to applicable subwatershed MAFs. If the MRSA catch basins and PSMF effluent discharge quality meets effluent requirements for discharge to the environment in the sixth year of closure, collected water within MRSA stream 2 catch basin will no longer be pumped to the stream 3 catch basin, which will no longer be pumped to the open pit. The PSMF will no longer be sent to the WMP and pumped to the open pit to assist in pit filling. Instead, the stream 2 and 3 catch basin dams will be breached to allow discharge to the existing watercourse within subwatershed 102 and 103, respectively. The PSMF Cell 1 wall will also be breached to allow discharge into the existing watercourse in subwatershed 106. If the MRSA catch basins and PSMF effluent discharge quality does not meet effluent requirements, they will continue to be sent to the open pit to accelerate pit filling until post-closure.

Mounding of the groundwater table is expected to occur as a result of stockpiling of waste rock and the filling of the open pits with water. Groundwater contribution to surface water is therefore expected to increase for some subwatersheds as detailed in Section 6.2.3.6.1 of this report. Discontinuation of effluent discharge into Hare Lake combined with the subwatershed area changes from baseline conditions is expected to result in a 0.2 cm decrease to water levels during closure, a decrease of -0.7%.

Two scenarios were assessed for subwatersheds 102 and 103: MRSA catch basins discharge to subwatersheds 102 and 103, respectively, if effluent discharge quality met effluent criteria during Year 6 of closure, or continued MRSA discharge to the open pits if effluent criteria was not met. If subwatershed 102 and 103 meet discharge criteria and the catch basin walls are breached to allow discharge to the environment, the MAF is expected to be reduced from baseline conditions by 66% and 73%, respectively. If subwatershed 102 and 103 do not meet discharge criteria and continue to get pumped to the open pits, the MAF is expected to be reduced from baseline conditions by 98% and 95%, respectively Subwatershed 102 is expected to undergo permanent changes commencing in construction and extending to post-closure, with MMFs not maintaining environmental flows during both closure scenarios. Subwatershed 103 is predicted to have MMFs that do not maintain environmental flows during both scenarios of closure, with recovery of the MAF not exceeding the 10% trigger threshold once the open pits fill and contributes to the subwatershed. Project residual effects for subwatershed 102 and 103 are characterized as adverse. The magnitude is expected to be high as MAFs exceed the 10% trigger threshold and MMFs are below baseline environmental flows during construction, although flows are expected to recover during post-closure for subwatershed 103. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to closure (medium) for subwatershed 103 and are irreversible for subwatershed 102 (high), and the frequency of effects is high as effects will be continuous throughout closure. The ecological/societal effect is high as cultural and societal value is considered high by Indigenous communities in subwatershed 102 and 103.

Two scenarios were assessed for subwatershed 106: PSMF discharge to subwatershed 106 if effluent discharge quality met effluent criteria during Year 6 of closure, or continued PSMF discharge to the open pits if effluent criteria was not met. The closure concept for the PSMF is covering Type 1 process solids and submergence of Type 2 process solids. Runoff from the surface of the PSMF will be routed to internal constructed wetlands prior to release. When discharge from the PSMF to subwatershed 106 proceeds, the change to the MAF for subwatershed 106 is anticipated to be a 4% reduction and not triggering further assessment. If discharge from the PSMF continues to be pumped to the open pit, the change in MAF for subwatershed 106, is expected to be maintained at a -33% reduction from operation. MMFs assessed for the -33% reduction in MAF indicated MMFs were not expected to maintain the environmental flows during closure, however recovery was expected during post-closure. Project residual effects if the PSMF discharges to subwatershed 106 are characterized as low magnitude, low frequency, confined to the watershed (medium geographic extent), and irreversible. As Indigenous communities consider subwatershed 106 culturally significant, the ecological/societal effect is high. Project residual effects if the PSMF discharges to the open pit to accelerate pit filling are characterized as high magnitude as environmental flows are not maintained during closure with recovery expected during post-closure for MAFs to be below the 10% trigger threshold. The frequency is expected to be high, with effects confined to the LSA, and reversible. The ecological/societal effect would be high as cultural and societal value is considered high by Indigenous communities.

One subwatershed (112) is expected to have an increase in MAF of 58%, triggering additional assessment for Q100 flood flows. The analysis of flood flows resulted in subwatershed 112 having a maximum flood flow increase of 1% compared to baseline flood flow estimates as the change in groundwater contribution to subwatershed 112 during flood flow conditions are minor compared to the overall flow. The groundwater change triggering the increase in MAF to subwatershed 112 is expected to be non-reversible due to the mounding from the filled pit lake. Project residual effects for subwatershed 112 are characterized as adverse. The magnitude is expected to be medium as the MAFs exceed the 10% trigger threshold but additional assessment considers changes to flood flows to be insignificant. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be long-term (high) and are irreversible, and the frequency of effects is high as effects will be continuous throughout closure. The ecological/societal effect is low as water is not used for cultural or societal context within the LSA.

Thirteen subwatersheds (101, 104, 105, 107, 108, 109, 110, 111, 113, 114, 115, 116, and 117) are expected to have a change in MAF of less than 10% (8%, 5%, -1%, -1%, -8%, 5%, 5%, 6%, 5%, 4%, 1%, 1%, and 4%, respectively) due to minor baseflow changes from groundwater contribution and/or subwatershed loss from mine components. Further assessment was not completed as the thirteen subwatersheds remain below the 10% change in baseline MAF threshold. Project residual effects are characterized as adverse. The magnitude is expected to be low as the MAFs do not exceed the 10% trigger threshold. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be long-term (high) and are irreversible, and the frequency of effects is high as effects will be continuous throughout closure. The ecological/societal effect is low for the thirteen subwatersheds with the exception of watershed 105, as water is not used for cultural or societal context within the LSA. The ecological/societal effect is high for subwatershed 105 as cultural and societal value is considered high by Indigenous communities.

The resulting change in the Pic River MAF from Project activities is expected to be negligible (-0.10%) due to the small percentage of Pic River subwatershed affected by the Project.

Post-Closure

During post-closure, the Project components that effect surface water quantity include the breaching of the MRSA catch basins following the completion of pit filling and the subsequent overflow of the filled pit into subwatershed 103.

Mounding of the groundwater table is expected to continue from closure as a result of stockpiling of waste rock and the filling of the open pit with water. Increased groundwater contribution to surface water is therefore expected to be maintained from closure conditions for some subwatersheds as detailed in Section 6.2.3.6.1 of this report. Subwatershed area changes contributing to Hare Lake from baseline conditions is expected to result in a 0.2 cm decrease to water levels during closure, a decrease of -0.7%.

During post-closure the pit lake will have been filled and water will overflow from the north pit lake under the MRSA within subwatershed 103, where it will be discharge to the existing stream within subwatershed 103. The resulting change in natural subwatershed area due to the redirection of water from the south and central pits previously associated with subwatershed 102 increases the subwatershed area in 103. The resulting change in MAF is expected to be an increase of 74%, triggering additional assessment for flood flows (Q100) which estimated an 88% increase compared to baseline Q100 conditions. The discharge channel downstream of the Stream 3 catch basin should be checked as part of closure planning to determine if it can withstand increased flow and erosion forces under the post-closure pit overflow condition. Project residual effects for subwatershed 103 are characterized as adverse. The magnitude is expected to be high as MAFs exceed the 10% trigger threshold and flood flow calculations show significant change from the baseline flood flow. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be limited to long-term (high) and irreversible, and the frequency of effects is high as effects will be continuous. The ecological/societal effect is high as cultural and societal value is considered high by Indigenous communities. This residual effect is an update from previously presented in the original EIS which indicated no residual effects would be maintained through closure.

During post-closure the PSMF will discharge to subwatershed 106. The MAF for subwatershed 106 is anticipated to be a consistent with the discharge scenario during closure, of a 4% reduction from baseline flows. Therefore, Project residual effects to subwatershed 106 are characterized as low magnitude, low frequency, confined to the watershed (medium geographic extent), and irreversible. As Indigenous communities consider subwatershed 106 culturally significant, the ecological/societal effect is high.

Consistent with closure, subwatershed 112 is expected to have an increase in MAF of 58%, triggering additional assessment for Q100 flood flows. The analysis of flood flows resulted in subwatershed 112 having a maximum flood flow increase of 1% compared to baseline flood flow estimates as the change in groundwater contribution to subwatershed 112 during flood flow conditions are minor. The groundwater change triggering the increase in MAF to subwatershed 112 is expected to be non-reversible due to the mounding from the filled pit lake. Therefore, Project residual effects for subwatershed 112 are characterized as adverse. The magnitude is expected to be medium as the MAFs exceed the 10% trigger threshold but additional assessment considers changes to flood flows to be insignificant. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be long-term (high) and are irreversible, and the frequency of effects is high as effects will be continuous throughout closure. The ecological/societal effect is low as water is not used for cultural or societal context within the LSA.

Subwatershed 102 is expected to have MAFs permanently decrease from baseline conditions by 66% and trigger further assessment. MMFs are expected to be below baseline environmental flows for eight months of the year. Project residual effects for subwatershed 102 are characterized as adverse. The magnitude is expected to be high as the MAFs exceed the 10% trigger threshold are not expected to maintain environmental flows for all months of the year. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be long-term (high) and are irreversible, and the frequency of effects is high as effects will be continuous. The ecological/societal effect is high as cultural and societal value is considered high by Indigenous communities.

Consistent with closure conditions, thirteen subwatersheds (101, 104, 105, 107, 108, 109, 110, 111, 113, 114, 115, 116, and 117) are expected to have a change in MAF of less than 10% (8%, 5%, -1%, -1%, -8%, 5%, 5%, 6%, 5%, 4%, 1%, 1%, and 4%, respectively) due to minor baseflow changes from groundwater contribution and/or changes to subwatersheds due to rehabilitation of mine components. Further assessment was not completed as the thirteen subwatersheds remain below the 10% change in baseline MAF threshold. Project residual effects are characterized as adverse. The magnitude is expected to be low as the MAFs do not exceed the 10% trigger threshold. Effects will be confined within the watershed (medium geographical extent), timing (seasonal aspects) will be applicable, the duration of residual effects will be long-term (high) and are irreversible, and the frequency of effects is high as effects will be continuous throughout closure. The ecological/societal effect is low as water is not used for cultural or societal context within the LSA with the exception of subwatersheds 101 and 105. The ecological/societal effect for subwatersheds 101 and 105 is high as cultural and societal value is considered high by Indigenous communities.

The resulting change in the Pic River MAF from Project activities is expected to be negligible (0.05%) due to the small percentage of Pic River subwatershed affected by the Project.

Determination of Significance

Consistent with the original EIS (2012), the main adverse residual environmental effect on surface water quantity is the change in contributing subwatershed area due to the construction of Project infrastructure and resulting water management, as well as Project related effluent discharge. The change in subwatershed area will affect subwatersheds within the RSA through all Project phases, with a lesser extent during closure and post-closure once contributing subwatershed areas recover.

The threshold for significance as defined in Section 6.2.3.3.6 of this report relates to a change in surface water levels or flow within the LSA that exceed existing flood maximums or is below the minimum environmental flow required to sustain aquatic ecosystems during fish spawning seasons. Changes to surface water levels are not expected to be above a 5% difference during any phase of the Project. Surface water MAFs are expected to be within the 10% threshold in assessed subwatersheds except for subwatershed 101, 102, 103, 106, and 112.

As explained above, reductions in the MAF greater than the 10% threshold were predicted for subwatersheds 101, 102, 103, and 106. In subwatershed 101, six months of the year during construction and two months of the year during operations do not maintain environmental flows but flows recover to less than the 10% threshold for MAF during closure and post-closure. Subwatershed 102 is expected to undergo permanent changes commencing in construction and extending to post-closure. When the pit overflows and subwatershed 102 discharges to the Pic River, the permanent reductions in catchment area result in permanent reductions in flow. Subwatershed 103 is predicted to have MMFs that do maintain environmental flows during the construction, operation, and closure periods until the pit is filled and overflow commences. When the pit overflows, net flow through subwatershed 103 will increase. In subwatershed 106, during winter and sometimes during summer, lower flow periods extending from construction to the time in post-closure where the PSMF commences discharge to subwatershed 106, MMFs do not maintain environmental flows. However, when the PSMF commences discharge to subwatershed 106, flows will recover and be less than the 10% MAF screening threshold.

Increases to the MAF greater than the 10% threshold were predicted for subwatersheds 103, 105, and 112. The analysis of flood flows (Q100) resulted in subwatersheds 105 and 112 having a maximum flood flow increase of -1% and 1% compared to baseline flood flow estimates. Subwatershed 103, due to a net increase in subwatershed size, was found to have a Q100 with an 88% increase compared to baseline conditions.

With the proposed mitigation and environmental protection measures (outlined in this section), the adverse residual environmental effects of the Project on a change in surface water level and/or flow from routine activities carried out during each phase of the Project are considered to be not significant. This determination is supported by the fact that significant reductions to surface water flow will recover during closure and post-closure except in subwatershed 102. The ecological community within subwatershed 102 is expected to adjust to the reduction in flows and useable habitat. Habitat losses throughout Project life will be offset by measures that will be implemented via the Fish and Fish Habitat Offsetting Plan (Appendix D6 of this EIS Addendum [Vol 2]). Increased flow in subwatershed 103 and subwatershed 112 can be mitigated throughout the assessment of the downstream watercourse to implement erosion control measures to reduce the potential for scour and erosion to occur. This determination of not significant is consistent with the original EIS (2012).

6.2.3.6.4 Change in Surface Water Quality

It is anticipated that residual effects to surface water may accrue as the result of the Project since there will be routine releases of surface water (run off, stormwater, effluent) to the LSA that will in all likelihood increase the concentrations of select constituents in local watercourse and waterbodies.

Analytical Assessment Techniques

The analysis of potential effects on surface water quality that may be associated with Project activities are assessed by both qualitative and quantitative techniques, depending on the nature of the Project-environment interaction. For some interactions, such as those related to Project-pathways that are well understood in terms of mode of effect and mitigation strategies, the assessment can be conducted in a qualitative manner and still provide and high level of certainty of outcome. For other interactions, such as those related to Project-pathways that can be numerically characterized, a quantitative assessment approach is employed. The quantitative approach to assessing water quality is discussed in more detail below.

The quantitative approach to the assessment of potential surface water quality effects uses numerical modeling to predict water quality (that is, the concentrations of individual water quality constituents) in watercourses and water bodies that receive Project related discharges. Detailed information associated with the assessment is provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The water quality model integrates, and was developed in consideration various factors as described below. The assessment has been carried out in a manner similar to that described in the original EIS (2012), incorporating updated information as available. The predictive assessment covers all Project phases.

As indicated above, information to complete the predictive water quality assessment relies on and incorporates information associated with a variety of factors including:

- Background water quality information as derived from the Water Quality Baseline Update (Ecometrix 2020c) (CIAR #722). This information provides the basis upon which predicted incremental changes in constituent concentrations are based
- Background hydrological information as derived from the Hydrology Baseline Update (Stantec 2020d) (CIAR #722). This information ensures that natural flow regimes and changes therein that may be associated with the project are accurately represented in the water quality predictions
- The site water balance that describes the manner by which water is managed (used, collected, diverted) on the site and in the mining and milling processes (Appendix D5 of this EIS Addendum [Vol 2]). This information is overlain on the natural hydrological system in the study area and ultimately provides estimates of the quantities of water that will be released from the site to the environment
- Geochemical testing and modelling results that characterize the geochemical source terms and loadings profiles that are associated with mine components, such as the MRSA and PSMF (Appendix D11 of this EIS Addendum [Vol 2]). This information is used as an input to the water quality model and represents the incremental change in water quality beyond background upon which final water quality predictions are based

As part of surface water quality assessment predicted constituent concentrations are compared to assessment benchmarks to understand the significance of any predicted changes. These assessment benchmarks represent published water quality thresholds that represent constituent concentrations that are protective of aquatic life, as well as other water uses. It is noted that the aquatic life benchmarks that are relevant to this assessment are the same as, or lower than those associated with drinking water standards (see Table 6.2.3-6), and therefore where a constituent concentration is below an aquatic life benchmark the drinking water use is protected.

The benchmarks used in the assessment are presented in Table 6.2.3-6. In some cases, the benchmarks are associated with ambient water quality and are therefore waterbody/watercourse specific. This is the case, for example, for constituents that are hardness-dependent – that is, their toxicological effects are influence by water hardness. Accordingly, independent benchmarks are shown for Hare Lake, the primary receiver into which site drainage has planned discharge during Project life and the Pic River, which has no planned discharge during operations but could be a receiver for storm events (see Section 6.3.2 of this EIS Addendum [Vol 2]) and will receive surface runoff post closure.

Table 6.2.3-6: Assessment Benchmarks for the Surface Water Quality Assessment

Constituent	Hare Lake		Pic River	
	PWQO (mg/L)	CCME (mg/L)	PWQO (mg/L)	CCME (mg/L)
Aluminum (filtered)	0.075	0.1	0.075	0.1
Antimony	0.02	-	0.02	-
Arsenic	0.005	0.005	0.005	0.005
Boron	0.2	1.5	0.2	1.5
Cadmium	0.0001	0.00005	0.0001	0.0002
Chromium	0.0089	0.0089	0.0089	0.0089
Cobalt	0.0009	-	0.0009	-
Copper	0.005	0.002	0.005	0.003
Iron	0.3	0.3	0.3	0.3
Lead	0.001	0.001	0.005	0.005
Manganese	-	0.32	-	0.26
Mercury (filtered)	0.0002	0.000026	0.0002	0.000026
Molybdenum	0.04	0.073	0.04	0.073
Nickel	0.025	0.025	0.025	0.12
Selenium	0.1	0.001	0.1	0.001
Silver	0.0001	0.00025	0.0001	0.00025
Thallium	0.0003	0.0008	0.0003	0.0008
Uranium	0.005	0.005	0.005	0.005
Vanadium	0.006	-	0.006	-
Zinc	0.02	0.008	0.02	0.041
Nitrite (N)	-	0.06	-	0.06
Nitrate (N)	-	3.0	-	3.0
Total Ammonia (N)	-	1.04	-	1.04
Phosphorous	0.02	0.01 to 0.02	0.02	0.01 to 0.02

Notes:

Total concentrations unless denoted.

PWQO is Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.

CCME is Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

Project Pathways

As indicated above, Project activities may interact with surface water quality in all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site. During site preparation and construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing. During operations, excess water from the PSMF and MRSA beyond that which was needed as process water at the Process Plant, or could be stored safely within the associated water management infrastructure, will be released to the environment. Routine discharge of this sort will be directed to Hare Lake only; this is a significant departure from the original EIS (2012) as water associated with the MRSA was to be released to the Pic River. In the updated Project design, drainage associated with the MRSA will be pumped to, and managed within the WMP. Site closure will involve the restoration of natural site drainage to the extent possible and the cessation of discharge to Hare Lake. For the PSMF, this involves directing runoff from the rehabilitated PSMF to the Stream 106 subwatershed. Runoff associated with the water management ponds for the PSMF will be directed to the Stream 101 subwatershed. For the MRSA, this involves allowing runoff to drain into the Pic River, as well as eventually allowing the water in the open pits to overflow naturally, once filled, into Pic River subwatersheds (Stream 102 and 103 subwatersheds).

Mitigation and Enhancement Measures

To mitigate adverse effects on surface water quality, GenPGM will:

- Develop and implement a site-wide water management plan that provides an integrated framework to manage water quality that includes provision for water management practices for each of the primary site aspects, as well as areas of the site where there is contact water
- Develop and implement a mine waste management plan that is keeping with the principals of the mine waste management strategy that has been presented in the original EIS based on the geochemical characterization on the mine waste materials. Of note, assessments of mine waste storage alternatives (KP, 2012) (SID #11) (CIAR #227) and Best Available Technologies (BATs) and Best Available Practices (BAPs) (Appendix D12 of this EIS Addendum [Vol 2]) have been completed. The latter provides the basis for the selection of the preferred locations for the long-term storage of mine waste streams (process solids and mine rock). The latter provides the foundation for the selection of the preferred process solids management technology. Together they provide the basis for a cohesive, project-specific strategy to manage mine wastes to ensure, in this circumstance, a robust water quality management scheme is employed.
- For operations, develop and implement appropriate operating practices for explosives and blasting operations to reduce nitrogen residuals in mine water
- For operations, collect surface water drainage associated with the MRSA and management of these waters so that there will not be a routine discharge to the Pic River

- Maintain the water management system in place during the closure phase of the Project until such time that water quality is suitable to release to the environment
- Monitor and manage effluent, including contingency for effluent treatment as may be required, so that water discharge objectives are achieved as defined in applicable provincial and federal regulatory instruments
- Develop and implement focused monitoring programs on waterbodies such as the Pic River extending downstream of the SSA to the mouth of Lake Superior, the outlet of Hare Creek at Port Munro and Stream 6 (Angler Creek) and the outlet at Sturdee Cove that have significance to Indigenous communities
- Work with the associated communities to develop and implement the program and develop a framework to share the results for the purpose of assessing the performance of the water management system.

Project Residual Effects

A detailed analysis of the residual effects of the project on surface water quality is provided in the Surface Water Hydrology Updated Effects Assessment (Appendix D3 of this EIS Addendum [Vol 2]). The following provides a summary for each phase of the Project.

Construction

The primary potential water quality change associated with this phase of the Project is the mobilization of suspended material into natural surface water features as the result of land clearing activities. According to the site water balance (Appendix D5 of this EIS Addendum [Vol 2]), there is no planned discharge to Hare Lake during construction, though the potential influence of such discharge, if it were to occur, would be bounded by the analysis of water quality in Hare Lake during the operations phase.

The mitigation of potential the mobilization of suspended material into natural surface water features is readily mitigatable by virtue of the mine development plan and through the implementation of standard water management and sediment control practices. Water management infrastructure (collection ditches, ponds, pumping, stations), as well as various aspects of the water management and sediment control management systems will be put into place coincident with the initiation of construction activities. Waters (e.g., runoff) associated with areas under development will be collected and either stored within management infrastructure (e.g., PSMF water management ponds) or potentially released into natural surface water features once it is safe to do so – that is, suspended solids levels in the water would be at acceptable levels. No downstream effects to local surface waters are expected.

The potential effects on surface water quality during construction in consideration of proposed mitigations are characterized as: adverse (since changes that may occur could degrade water quality); of negligible magnitude (change that is within the variability of baseline conditions); of medium geographical extent (change limited to the LSA), of medium duration (occurs within the mine phase); of high frequency (occurs continuously within the mine phase); reversible (effect the ceases once source or stressor is removed); and, of high value (due to the importance of water quality both from and ecological and societal perspective as expressed though consultation with Indigenous people and interested parties).

Operations

During operations the primary potential water quality effect from the project is the discharge of excess water from the site water management system to Hare Lake. Discharge to Hare Lake has the potential to change the concentrations of water quality constituents from background.

For planning purposes, the water balance has assumed discharge will occur between April and November. Rates of discharge vary within and among years according to the development of the site and Process Plant needs. In general, it is expected that between ~ 1 and 2 M m^3 of treated mine water will be discharged from the site to Hare Lake per year of the operations phase of the mine.

No other routine mine-related discharges to other receiving environments are proposed during operations. Water management infrastructure will collect and divert all site aspect influenced water (often referred to as contact water), as well as water associated with the PSMF, through the WMP. Water quantities that exceed the needs of the Process Plant, and that cannot be stored within the operational limits of water management system will be released to Hare Lake. The excess treated water that will be discharged from the site, or effluent, will be comprised of three primary streams that are all managed through the WMP. The effluent stream will comprise a mix of process water from the PSMF, drainage (runoff and shallow seepage) associated with the MRSA that will be collected by ditching, catch basins and pumps to the WMP and contact water from the developed portion of the site (including for example, mine dewatering water, runoff from temporary stockpiles, Process Plant site) that will be collected by ditching and basins and pumped or gravity fed to the WMP. Effluent will be conveyed to Hare Lake in the same manner as proposed in the original EIS (2012) – that is, effluent will be conveyed from the WMP via a surface pipeline to a multi-port diffuser in the south side of the lake.

As describe above the predictive assessment of water quality relies on and incorporates information associated with a variety of factors including, background water quality and hydrology the site water balance and geochemical testing results. The following provides some specific context to the water quality predictions derived for the operations phase for Hare Lake.

Based on the mine waste testing programs completed to date, phosphorus, as well as total suspended solids (TSS), have been identified as potential management needs. The geochemical source terms derived from mine waste testing indicate that low levels of metals/metalloids will be generated and that overall were not expected to represent a potential risk to water quality receiving environment. Moreover, there is an effective management strategy for Type 2 (PAG) materials that will mitigate the likelihood of ARD associated water quality issues. Nitrogen species, as blasting residues, will be actively managed and also were not identified as likely water quality risk.

With respect to phosphorus, it is noted that a phosphorus (phosphate) based reagent is planned to be used in the floatation circuit. Taking a very conservative view, it can be assumed that this phosphorus will remain in the dissolved form within the process water stream. In this case, the dissolved phosphorus would be at levels at end of pipe that could result in phosphorus concentrations that are greater than background and exceeding relevant receiver water quality objectives, without appropriate management. Therefore, there is potential for nutrient enrichment (increased primary productivity) in Hare Lake if not mitigated. Local Indigenous communities have expressed direct concern for possible nutrient enrichment related effects. In consideration of the potential risk and local Indigenous community concern, phosphorus levels in the final discharge to Hare Lake will be managed via treatment as needed. Treatment technologies are readily available to reduce phosphorus levels at end of pipe (MEND, 2014) to ensure that phosphorus concentrations in Hare Lake remain at or below PWQO, which are protective of aquatic ecosystems to mitigate the potential risk of nutrient enrichment. GenPGM is committed to implementing such a management/system and the water quality predictions presented herein for Hare Lake reflect this commitment.

With respect to TSS, it has been recognized as a general management priority. Management of TSS levels in the final discharge will ensure expected discharge quality can be maintained consistently. To this end, GenPGM will employ active means (e.g., filtering), if required to achieve low TSS levels in discharge, in addition to passive means such as settling and clarification in the WMP to manage TSS in the effluent stream to low levels.

Predictions of water quality in Hare Lake under the expected discharge scenario[1] are shown in Table 6.2.3-7. Time series graphs showing the constituent concentrations over the operations phase of the project are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The concentrations shown represent the maximum predicted concentrations in Hare Lake over the operations phase of the Project. The predictions reflect whole-lake constituent concentrations following mixing, the physical process whereby the effluent mixes with the lake water. It is noted that previous characterization of the mixing zone using CORMIX based on a configuration of a multi-port diffuser in Hare Lake indicated a mixing ratio of 30:1 within 50 m of discharge.

As shown in Table 6.2.3-7, maximum predicted concentrations are not expected to exceed relevant water quality benchmarks in Hare Lake during operations. Overall, the results of the updated water quality analysis for Hare Lake are very similar with those presented in the original EIS (2012). In many cases constituent concentrations are not predicted to change from background levels. In some cases (e.g., molybdenum, nitrate) constituents in Hare Lake show small incremental increases in predicted concentrations relative to background during periods of discharge but, as indicated the concentrations remain below water quality benchmark values. For a small number of constituents (e.g., iron, aluminum), it is noted that background concentrations exceed the water quality benchmark values upon which the water quality assessment is based. In this case, the predicted concentrations of these constituents are compared to their respective background concentrations – that is the background concentration becomes the de facto water quality benchmark to confirm that no further changes in water quality are predicted. For each of these constituents no change, or a reduction from background levels is predicted.

[1] Sensitivity analyses for different discharge conditions (discharge rates, receiving environment conditions) are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2])

As described above, the site-wide water management strategy involves care and control of all site aspect influenced water and no discharge is proposed beyond that to Hare Lake. In practice, it may be necessary at times to manage runoff from disturbed areas that are either outside the water management system, or are yet to be integrated into the water management system. In these cases, the areas would be isolated and specific water and sediment control management practices would be implemented to ensure that any water released to natural surface water drainages would be suitable for release and that water quality in these natural surface water drainages would be protected.

The potential effects on surface water quality during operations in consideration of proposed mitigations are characterized as: adverse (since changes that may occur could degrade water quality); of low magnitude (change that is outside the variability of baseline conditions, but below water quality benchmarks); of medium geographical extent (change limited to the LSA), of medium duration (occurs within the mine phase); of high frequency (occurs continuously within the mine phase); reversible (effect the ceases once source or stressor is removed); and, of high value (due to the importance of water quality both from and ecological and societal perspective as express though consultation with Indigenous people and interested parties).

Table 6.2.3-7: Maximum predicted constituent concentrations in Hare Lake during the operations phase

Constituent	Benchmarks		Background WQ	Avg. Conc. Prediction (Ops)	Max. Conc. Prediction (Ops)
	PWQO (mg/L)	CCME (mg/L)	(mg/L)	(mg/L)	(mg/L)
Aluminum (filtered)	0.075	0.1	0.17	0.17	0.17
Antimony	0.02	-	0.005	0.005	0.005
Arsenic	0.005	0.005	0.001	0.001	0.001
Boron	0.2	1.5	0.05	0.05	0.05
Cadmium	0.0001	0.00005	0.00009	0.00009	0.00009
Chromium	0.0089	0.0089	0.0005	0.0005	0.0006
Cobalt	0.0009	-	0.0005	0.0004	0.0005
Copper	0.005	0.002	0.001	0.001	0.001
Iron	0.3	0.3	0.9	0.9	0.9
Lead	0.001	0.001	0.001	0.0009	0.0001
Manganese	-	0.32	0.08	0.08	0.09
Mercury (filtered)	0.0002	0.000026	0.000005	0.000005	0.000006
Molybdenum	0.04	0.073	0.001	0.001	0.002
Nickel	0.025	0.025	0.002	0.002	0.002
Selenium	0.1	0.001	0.001	0.001	0.001
Silver	0.0001	0.00025	0.0001	0.0009	0.001
Thallium	0.0003	0.0008	0.0003	0.0002	0.0003
Uranium	0.005	0.005	0.005	0.004	0.005
Vanadium	0.006	-	0.001	0.002	0.002
Zinc	0.02	0.008	0.006	0.006	0.007
Hardness	-	-	20	20	20
Sulphate	-	-	3.5	4.5	5.9
Nitrate (N)	-	3.0	0.11	0.3	0.6
Total Ammonia (N)	-	1.04	0.06	0.08	0.11
Phosphorous	0.02	0.01 to 0.02	0.01	0.02	0.02

Notes:
Total concentrations unless denoted.
PWQO is Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.
CCME is Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

Closure

Following the cessation of mining operations, the discharge to Hare Lake will cease. Water quality in Hare Lake is expected to return to background, pre-mining conditions at that time.

The site wide water management system will continue to operate such that GenPGM will remain in control of site aspect affected water via the WMP. At that time, water (runoff and shallow seepage) from the PSMF, drainage (runoff and shallow seepage) associated with the MRSA and contact water from the developed portion of the site (including for example, mine dewatering water, runoff from temporary stockpiles, Process Plant site) will continue to be collected and diverted to the WMP. From the WMP, the water will be directed to the open pit complex, where there are decades worth of water storage capacity. For planning purposes, it is assumed that these diversions will continue for a period of five years following the cessation of mining operations. This strategy ensures control of water quality on and off site while site decommissioning and rehabilitation activities are implemented, allowing the water quality associated with these site aspects to stabilize. Following this five-year period, it is expected that natural surface water drainages will be restored.

For the PSMF, that means surface runoff and seepage will be re-directed into the subwatershed 106. Predictions of water quality in subwatershed 106 are shown in Table 6.2.3-8. Time series graphs showing the constituent concentrations during this period are provided Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol2]). The predictions provided in Table 6.2.3-8 are average long-term concentrations that are expected during, and following, mine closure and the restoration of pre-development drainage patterns. As indicated the predictions, consider both expected seepage and runoff sources that will report into subwatershed 106. Small incremental increases in the concentrations of a number of constituents are predicted, relative to background, but no constituents are predicted to exceed their respective water quality benchmarks. For example, arsenic concentrations are predicted to increase from 0.001 mg/L (75^{th} percentile of background data) to on average 0.002 mg/L, but will remain less than the water quality benchmark of 0.005 mg/L. Similarly, nitrate concentrations are predicted to increase from on 0.11 mg/L (75^{th} percentile of background data) to on average 0.3 mg/L, but will remain less than the water quality benchmark of 3.0 mg/L. No incremental change in concentration is predicted for many constituents.

Table 6.2.3-8: Long-Term Predicted Constituent Concentrations (Average) in the Stream 106 Subwatershed Post-Closure Following Restoration of Pre-Development Surface Water Drainage Patterns

Constituent	Benchmarks		Background WQ	Avg. Conc. Prediction (Post-Closure)
	PWQO (mg/L)	CCME (mg/L)	(mg/L)	(mg/L)
Aluminum (filtered)	0.075	0.1	0.17	0.17
Antimony	0.02	-	0.005	0.003
Arsenic	0.005	0.005	0.001	0.002
Boron	0.2	1.5	0.05	0.05
Cadmium	0.0001	0.00005	0.00009	0.00009
Chromium	0.0089	0.0089	0.0005	0.0007
Cobalt	0.0009	-	0.0005	0.0004
Copper	0.005	0.002	0.001	0.001
Iron	0.3	0.3	0.9	0.7
Lead	0.001	0.001	0.001	0.001
Manganese	-	0.32	0.08	0.07
Mercury (filtered)	0.0002	0.000026	0.000005	0.000005
Molybdenum	0.04	0.073	0.001	0.003
Nickel	0.025	0.025	0.002	0.002
Selenium	0.1	0.001	0.001	0.001
Silver	0.0001	0.00025	0.0001	0.0001
Thallium	0.0003	0.0008	0.0003	0.0002
Uranium	0.005	0.005	0.005	0.004
Vanadium	0.006	-	0.001	0.002
Zinc	0.02	0.008	0.006	0.006
Hardness	-	-	20	20
Sulphate	-	-	3.5	7.2
Nitrate (N)	-	3.0	0.11	0.30
Total Ammonia (N)	-	1.04	0.06	0.28
Phosphorous	0.03	0.01 to 0.02	0.01	0.03

Notes:
Total concentrations unless denoted.
PWQO is Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.
CCME is Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

Runoff from the area of the WMPs associated with the PSMF will be directed to the Stream 101 subwatershed. Following closure, these ponds will be rehabilitated (e.g., dredged of deposited solids) such that the chemistry of any surface runoff from this area will reflect uninfluenced con-contact water. It is expected therefore that water quality will be similar to existing baseline conditions once the natural flow regime in subwatershed 101 has been restored.

For the MRSA, drainage (runoff and shallow seepage) that will be collected by ditching and catch basins will be allowed to flow to the Pic River, rather than diverting it to the water management system. Predictions of water quality in the Pic River during this phase of site closure are shown in Table 6.2.3-9. Time series graphs showing the constituent concentrations during this period are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The predictions provided in Table 6.2.3-9 are maximum concentration predictions during this period. Generally, no incremental change in concentration relative to background is noted for the majority of constituents. No exceedances of water quality benchmarks in the Pic River as the result of drainage from the MRSA during this period are predicted. In the few instances where background water quality exceeds water quality benchmark levels (e.g., aluminum, iron) no incremental increase in concentration relative to background is noted.

Table 6.2.3-9: Predicted constituent concentrations in the Pic River during the initial phase of post-closure following initial restoration of drainage from MRSA (post-five years after operations have ceased)

Constituent	Pic River		Background WQ	Max. Conc. Prediction (Post-Closure)
	PWQO (mg/L)	CCME(mg/L)	(mg/L)	(mg/L)
Aluminum (filtered)	0.075	0.1	0.5	0.5
Antimony	0.02	-	<0.005	0.005
Arsenic	0.005	0.005	<0.001	0.001
Boron	0.2	1.5	<0.05	0.05
Cadmium	0.0001	0.0002	<0.00009	0.00009
Chromium	0.0089	0.0089	0.004	0.005
Cobalt	0.0009	-	0.001	0.001
Copper	0.005	0.003	0.004	0.004
Iron	0.3	0.3	2.7	2.7
Lead	0.005	0.005	0.001	0.001
Manganese	-	0.26	0.08	0.09
Mercury (filtered)	0.0002	0.000026	<0.0001	0.0001
Molybdenum	0.04	0.073	<0.001	0.001
Nickel	0.025	0.12	0.004	0.004
Selenium	0.1	0.001	<0.001	0.001
Silver	0.0001	0.00025	<0.0001	0.0001
Thallium	0.0003	0.0008	<0.0003	0.0003
Uranium	0.005	0.005	<0.005	0.005
Vanadium	0.006	-	0.005	0.005
Zinc	0.02	0.041	0.009	0.009
Hardness	-	-	138	138
Sulphate	-	-	2.6	2.8
Nitrate (N)	-	3.0	0.08	0.2
Total Ammonia (N)	-	1.04	0.03	0.04
Phosphorous	0.03	0.01 to 0.02	0.08	0.08

Notes:

Total concentrations unless denoted.

PWQO is Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.

CCME is Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

The pit complex is expected to fill with water approximately 30 years following mine closure. At this time water from the pits will drain into subwatershed 103, through the MRSA and subsequently into the Pic River. This scenario represents the long-term configuration of the mine site from surface water drainage perspective. Long term post-closure predictions of water quality in the Pic River, inclusive of the contributions from the open pit are shown in Table 6.2.3-10. Time series graphs showing the constituent concentrations during this period are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The predictions provided in Table 6.2.3-10 are maximum concentration predictions during this period. Generally, no incremental change in concentration relative to background is noted for the majority of constituents. No exceedances of water quality benchmarks in the Pic River as the result of drainage from the MRSA during this period are predicted. In the few instances where background water quality exceeds water quality benchmark levels (e.g., aluminum, iron) no incremental increase in concentration relative to background is noted.

Table 6.2.3-10: Predicted constituent concentrations in the Pic River over the long term post-closure following controlled release of water from the open pit (post- thirty years after operations have ceased)

Constituent	Pic River		Background WQ	Max. Conc. Prediction (Post-Closure)
	PWQO (mg/L)	CCME(mg/L)	(mg/L)	(mg/L)
Aluminum (filtered)	0.075	0.1	0.5	0.5
Antimony	0.02	-	<0.005	0.005
Arsenic	0.005	0.005	<0.001	0.001
Boron	0.2	1.5	<0.05	0.05
Cadmium	0.0001	0.0002	<0.00009	0.00009
Chromium	0.0089	0.0089	0.004	0.005
Cobalt	0.0009	-	0.001	0.001
Copper	0.005	0.003	0.004	0.004
Iron	0.3	0.3	2.7	2.7
Lead	0.005	0.005	0.001	0.001
Manganese	-	0.26	0.08	0.09
Mercury (filtered)	0.0002	0.000026	<0.0001	0.0001
Molybdenum	0.04	0.073	<0.001	0.001
Nickel	0.025	0.12	0.004	0.004
Selenium	0.1	0.001	<0.001	0.001
Silver	0.0001	0.00025	<0.0001	0.0001
Thallium	0.0003	0.0008	<0.0003	0.0003
Uranium	0.005	0.005	<0.005	0.005
Vanadium	0.006	-	0.005	0.005
Zinc	0.02	0.041	0.009	0.010
Hardness	-	-	138	138
Sulphate	-	-	2.6	2.9
Nitrate (N)	-	3.0	0.08	0.3
Total Ammonia (N)	-	1.04	0.03	0.06
Phosphorous	0.03	0.01 to 0.02	0.08	0.08

Notes:

Total concentrations unless denoted.

PWQO is Provincial Water Quality Objectives. Where interim PWQOs are available the interim value is used.

CCME is Canadian Council of Ministers of the Environment; values shown are federal water quality benchmarks.

It is noted that, the predictions provided for the post-closure phase, though conservative in nature, are provided for planning purposes. GenPGM will not release water to the environment from its care and control until such time as monitoring data demonstrate it is safe to do so. In practice, this could entail continuing to divert all or some site aspect affected water to the WMP and subsequently to the open pits for a period of longer than 5 years. The storage capacity in the open pits is such that the diversions could be in place for many more years providing sufficient time to develop alternative long term water quality management strategies. If all site aspect water was diverted to the open pits for storage indefinitely it would take approximately 17 years to fill to the elevation where controlled release would be required to mitigate uncontrolled overtopping.

The potential effects on surface water quality during closure in consideration of proposed mitigations are characterized as: adverse (since changes that may occur could degrade water quality); of low magnitude (change that is outside the variability of baseline conditions, but below water quality benchmarks); of medium geographical extent (change limited to the LSA), of medium duration (occurs within the mine phase); of high frequency (occurs continuously within the mine phase); reversible (effect the ceases once source or stressor is removed); and, of high value (due to the importance of water quality both from and ecological and societal perspective as express though consultation with Indigenous people and interested parties).

Determination of Significance

Consistent with the original EIS (2012), the main adverse residual environmental effect on surface water quality relates to the incremental change in concentrations of constituents relative to background in water bodies and watercourses into which mine waters will be released. The potential effect extends to all phases of the Project since water will be released to for the site to the environment during all phases.

The threshold for significance as defined in Section 6.2.3.3.6 of this report relates to measurable (or predicted) change in the concentrations of a water quality parameter (or parameters) that exceed relevant water quality assessment benchmarks that represent concentrations that are protective of aquatic biota and water uses in watercourse and water bodies that receive mine-affected drainage.

With the proposed mitigation and environmental protection measures (outlined in this section), the adverse residual environmental effects of the Project on a change in surface water quality from routine activities carried out during each phase of the Project are considered to be not significant. This determination is supported by the fact that the predicted changes in water quality do not result in exceedances of assessment benchmarks in the LSA and no effects on aquatic biota or water uses will accrue. This determination of not significant is consistent with the original EIS (2012).

6.2.3.6.5 Change in Sediment Quality

It is anticipated that residual effects to sediment may occur as a result of Project-related activities that have the potential to release sediment into local water sources (e.g. runoff over disturbed ground) and/or through the discharge of mine effluent. These activities may increase the concentrations of select constituents in local watercourses that could result in accumulation of these constituents in bottom sediments.

Analytical Assessment Techniques

The analysis of potential effects on sediment quality that may be associated with Project activities are assessed by both qualitative and quantitative means, depending on the nature of the Project-environment interaction.

Interactions associated with the release of sediment as the result of erosion of disturbed ground are considered in a qualitative way. It is difficult to assess the magnitude of such interactions in a quantitative manner with a greater level of certainty; moreover, standard mitigation practices are available to effectively managed such interactions.

Interactions that are associated with the release of contact water to the LSA, such as the release of effluent from the WMP to Hare Lake, can be evaluated quantitatively. It is possible in this circumstance to use predictive numerical modelling to assess the incremental change in sediment quality. Partitioning of constituents to the sediments is a natural process in depositional habitats and is a function of the partition coefficient Kd (the partitioning of a constituent between the solid and aqueous phases at equilibrium). Water quality predictions derived for the period of discharge to Hare Lake are used in combination with existing background data in consideration of constituent specific Kd values to track changes in sediment quality. The predicted changes to sediment quality are dynamic and tracked through time in consideration of the discharge regime to Hare Lake and also extend beyond the period of discharge to assess sediment recovery (i.e., decreases in constituent concentrations in response to the cessation of the effluent discharge). It is noted that this predictive assessment is limited in this case to Hare Lake since the analysis would not be appropriate for non-depositional watercourses.

As part of sediment water quality assessment, predicted constituent concentrations are compared to assessment benchmarks to understand the significance of any predicted changes. These assessment benchmarks represent published sediment quality thresholds provided by the provincial and federal governments. The provincial guidelines establish three levels of effect - No Effect Level, Lowest Effect Level and Severe Effect Level. The Lowest Effect Level and Severe Effect Level are based on the long-term effects which the contaminants may have on the sediment-dwelling organisms. The No Effect Level is based on levels of chemicals which are so low that significant amounts of contaminants are not expected to be passed through the food chain. The federal guidelines consist of threshold effect levels (TELs) and probable effect levels (PELs).

The TELs and PELs are used to identify the following three ranges of chemical concentrations with regard to biological effects:

- below the TEL - the minimal effect range within which adverse effects rarely occur
- between the TEL and PEL - the possible effect range within which adverse effects occasionally occur
- above the PEL - the probable effect range within which adverse effects frequently occur.

The assessment benchmarks used in the assessment are presented in Table 6.2.3-11.

Table 6.2.3-11: Assessment Benchmarks for the Sediment Quality Assessment

Constituent	Provincial Sediment Quality Guidelines		Federal Sediment Quality Guidelines	
	LEL (mg/kg)	SEL (mg/kg)	TEL (mg/kg)	PEL (mg/kg)
Aluminum	-	-	-	-
Antimony	-	-	-	-
Arsenic	6	33	5.9	17
Boron	-	-	-	-
Cadmium	0.6	10	0.6	3.5
Chromium	26	110	37.3	90
Cobalt	-	-	-	-
Copper	16	110	35.7	197
Iron	20,000	40,000	-	-
Lead	31	250	35	91.3
Manganese	460	1,110	-	-
Mercury	0.2	2.0	0.17	0.486
Molybdenum	-	-	-	-
Nickel	16	75		
Selenium				
Silver				
Thallium				
Uranium				
Vanadium				
Zinc	120	820	123	315
Nitrite (N)				
Nitrate (N)				
Total Ammonia (N)				
Phosphorous	600	2,000		

Project Pathways

As indicated above, Project activities may interact with surface water quality in all Project phases. In general, the interactions can be characterized as being primarily associated with controlled, routine discharges from the site. During site preparation and construction, the primary effect pathway relates to the mobilization of suspended material into natural surface water features as the result of land disturbance and clearing. During operations, excess water from the PSMF and MRSA beyond that which was needed as process water at the Process Plant, or could be stored safely within the associated water management infrastructure will be released to the environment. Routine discharge of this sort from the site will be directed to Hare Lake only; this is a significant departure from the original EIS (2012) as water associated with the MRSA was to be released to the Pic River. In the updated Project design, drainage associated with the MRSA will be pumped to and managed within the WMP. Site closure will involve the restoration of natural site drainage to the extent possible and the cessation of discharge to Hare Lake. For the PSMF, this involves directing runoff from the rehabilitated PSMF to the Stream 106 subwatershed. For the MRSA, this involves allowing runoff to drain into the Pic River, as well as eventually allowing the water in the open pits to overflow naturally, once filled, into Pic River subwatersheds.

Mitigation and Enhancement Measures

The following mitigation measures are proposed to avoid or reduce Project-related effects on sediment quality. Many of these are the same as those proposed for the management of water quality since the effect pathways associated with each are similar.

- Reduce the level of interaction between aquatic habitat features and Project infrastructure
- Comply with water discharge requirements as defined in the Metal and Diamond Mining Effluent Regulations (MDMER) and Environmental Compliance Approval (provincial)
- Employ standard management practices for erosion control such as:
    - Isolating disturbed areas with sediment fences or similar structures
    - Maintaining appropriate work area setbacks from surface water features
    - Grading and/or covering surfaces to reduce erosion potential
    - Controlling runoff from erosion-sensitive features
    - Providing settling ponds or basins in which solids can be collected (i.e., WMP and SWM Pond)

In addition to the mitigation measures to reduce potential effects, GenPGM is also committed to follow-up monitoring and adaptive management as outlined in Chapter 7 of this EIS Addendum (Vol 2).

Project Residual Effect

The following provides a summary of potential Project-related residual effects on sediment quality for each phase of the Project.

Construction

During construction, the Project activities and components that might interact with sediment quality and result in an environmental effect (Table 6.2.3-3) primarily include those associated with land disturbance for the purpose of developing mine infrastructure. Within this context changes in sediment quality could occur as the result of transport of solids to watercourses or water bodies through erosion in work-related areas and the subsequent deposition of the solids on top of existing sediments. Such potential effects are readily mitigatable by the implementation of standard sediment and erosion control measures.

According to the site water balance (see Appendix D5 of this EIS Addendum [Vol 2]), there is no planned discharge to Hare Lake during construction and therefore no changes in sediment quality in Hare Lake will occur. The potential influence of such discharge on sediment quality, if it was to occur, would be bounded by the analysis of sediment quality in Hare Lake during the operations phase.

The potential effects on sediment quality during construction in consideration of proposed mitigations are characterized as: adverse (since changes that may occur could degrade sediment quality); of negligible magnitude (change that is within the variability of baseline conditions; of medium geographical extent (change limited to the LSA), of medium duration (occurs within the mine phase); of low frequency (sedimentation events could occur at no set schedule and are unlikely to occur); reversible (effect the ceases once source or stressor is removed); and, of medium value (it is a pathway to other environmental compartments).

Operations

During operations the primary potential sediment quality effect from the Project is the discharge of excess water from the water management system to Hare Lake. There continues to be some risk of transport of solids to watercourses or water bodies through erosion of disturbed areas, though the risk is low and the potential effects are readily mitigatable.

The discharge to Hare Lake has the potential to change the concentrations of water quality constituents from background, and in turn this could affect sediment quality. Higher constituent concentrations in water can lead to higher constituent concentrations in sediment as a new equilibrium is reached between the water column and the sediments. Predictions of sediment quality in Hare Lake during operations are shown in Table 6.2.3-12. These predictions represent the maximum concentrations predicted during operations. Time series graphs showing the constituent concentrations over the operations phase of the project are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]).

The incremental increases seen in sediment constituent concentrations in Hare Lake are generally within the background variability seen for individual constituents in Hare Lake based on baseline data and therefore are essentially indistinguishable from existing constituent levels. The exceptions to this pattern are molybdenum and vanadium, for which greater relative increases in concentrations are predicted than for other constituents. There are no sediment quality objectives provided for molybdenum or vanadium by the provincial and federal governments. Thompson et al. (2005) has derived equivalent lowest effect level (LEL) and strongest effect level (SEL) concentrations for a number of metals, including molybdenum or vanadium, and radionuclides associated with uranium mining and milling. For molybdenum, the LEL and SEL are 13.8 mg/kg and 1,239 mg/kg, respectively. For vanadium, the LEL and SEL are 35.2 mg/kg and 160 mg/kg, respectively. The maximum predicted molybdenum level in Hare Lake is about is about half the LEL, and therefore no effects on aquatic biota would be expected. For vanadium, the average and maximum predicted concentrations are 39.6 mg/kg and 49.6 mg/kg, respectively. The maximum predicted vanadium concentration is greater than the LEL but well below the SEL. The range of background vanadium levels in lake sediments also exceeds the LEL. In this context, no Project-related effects on aquatic biota would be expected as the result of vanadium. Overall, the results of the updated sediment quality analysis for Hare Lake are very similar with those presented in the original EIS (2012).

The potential effects on sediment quality during operations in consideration of proposed mitigations are characterized as: adverse (since changes that may occur could degrade sediment quality); of negligible to low magnitude (change that is within the variability of baseline conditions, with the exception of molybdenum and vanadium); of medium geographical extent (change limited to the LSA), of medium duration (occurs within the mine phase); of high frequency (discharge to Hare Lake will occur throughout operations); reversible (effect the ceases once source or stressor is removed); and, of medium value (it is a pathway to other environmental compartments).

Table 6.2.3-12: Average and maximum predicted constituent concentrations in Hare Lake sediments during operations

Constituent	PSQG		FSQO		Background (mg/kg)		Avg Predicted Conc. (mg/kg)	Max Predicted Conc. (mg/kg)
	LEL (mg/kg)	SEL (mg/kg)	TEL (mg/kg)	PEL (mg/kg)	Min	Max		
Aluminum	-	-	-	-	10,400	26,000	18,127	18,410
Arsenic	6	33	5.9	17	2.5	18	9.3	10.2
Cadmium	0.6	10	0.6	3.5	0.7	4.9	2.4	2.4
Copper	16	110	35.7	197	10.1	38.6	27.1	28.6
Iron	20,000	40,000	-	-	13,100	65,500	33,019	40,000
Lead	31	250	35	91.3	12.5	84.9	40.9	41.7
Molybdenum	-	-	-	-	<1.0	2.2	2.1	2.6
Nickel	16	75			12.7	20.3	16.3	16.7
Selenium					<1.0	3.0	1.9	2.0
Uranium					<1.0	<1.0	1.0	1.0
Vanadium					20.7	40.4	39.6	49.6
Zinc	120	820	123	315	164	422	271.4	273.5
Notes: PSQG, Provincial Sediment Quality Guidelines FSQO, Federal Sediment Quality Guidelines								

Closure

Following the cessation discharge to Hare Lake, it would be expected that water quality will return to background levels and a new water-sediment equilibrium will be reached over time that sees sediment recovery to pre-discharge conditions. Time series graphs showing the sediment constituent concentrations following the cessation of discharge to Hare Lake are provided in the Surface Water Quality Effects Assessment Update (Appendix D11 of this EIS Addendum [Vol 2]). The predictions reflect sediment recovery as indicated. The predicted time to recovery is constituent specific and relates the incremental increase in concentration that has been predicted. There were only two constituents, molybdenum and vanadium, where the predicted change in concentration exceeded the measured background range. In these cases, it is estimated that concentrations would be within the range of measured background levels within 10 to 15 years following the cessation of discharge.

Overall, the potential effects on sediment water quality during closure are characterized as positive since sediment recovery is indicated.

Determination of Significance

Consistent with the original EIS (2012), the main adverse residual environmental effects on sediment quality could occur as the result of transport of solids to watercourses or water bodies through erosion of disturbed areas and changes in concentrations of constituents relative to background. The former effects could accrue during all Project phases, while the latter are associated with operations and associated with discharge of mine water to Hare Lake.

The threshold for significance as defined in Section 6.2.3.3.6 of this report relates to measurable (or predicted) change in the concentrations of a sediment quality parameter (or parameters) that exceed relevant assessment benchmarks. With the proposed mitigation and environmental protection measures (outlined in this section), the adverse residual environmental effects of the Project on a change in sediment water quality from routine activities carried out during each phase of the Project are considered to be not significant. This determination is supported by the fact that the predicted changes in sediment quality are generally not expected to result in changes in sediment quality beyond background variability in the LSA. This determination of not significant is consistent with the original EIS (2012).

6.2.3.7 Prediction Confidence

The assessment of baseline conditions and the inferred conceptualization of surface water and groundwater processes are based on applying industry standard industry practices under QA/QC programs which are applied to both field and laboratory procedures.

Groundwater Quantity

The effects to groundwater levels and baseflow as a result of the Project are based on a steady-state groundwater flow model, which predicts the long-term average annual effects on flow, and conservatively overestimates the drawdown effects on water levels. Prediction confidence is high because the groundwater flow model was calibrated to within an acceptable range of error for groundwater levels and groundwater discharge to surface water features. Predictions made using the model are based on several conservative assumptions to reduce the influence of uncertainty in the predictions as follows:

- The groundwater recharge rates from the MRSA, ore stockpile, PSMF, and WMP to the receiving environment are conservatively “over predicted”. Recharge applied within the MRSA, ore stockpile, PSMF, and WMP over the life of the mine is assumed to be carried through to the final receptor. The prediction of recharge rates and seepage from the PSMF is based on the final elevation of the PSMF dams and PSMF reclaim pond at the end of operation. This model approach imposes the highest vertical hydraulic gradient from the PSMF reclaim pond and results in a conservative prediction of seepage rates from the PSMF during operation of the Project.

- Groundwater inflow rates and effects on groundwater levels and discharge are over predicted for the end of operations. The results from modelling conducted for the end of operation assumes a dewatered state for each of the three open pits, whereas the mine plan indicates the South and Central Pits will be backfilled with Type 2 mine rock and/or process solids and the water level in the pits will be allowed to rise to submerge the mine rock and/or process solids prior to the end of operation which would result in less dewatering and smaller extent of drawdown and smaller change in discharge to nearby surface water features compared to that modelled.

Groundwater Quality

The effects to groundwater quality as a result of the Project are based on a water balance and water quality model that was developed based on field data and geochemical characterization of overburden, ore, waste rock, and tailings. Prediction confidence in groundwater quality effects is high because reductions in groundwater discharge to the natural environment did not consider the attenuation of groundwater quality along the groundwater flow path from the source to the receptor. Furthermore, conservative estimates of groundwater recharge beneath the MRSA and PSMF are applied in the groundwater modelling, which overestimate the loadings to groundwater. Groundwater quality predictions made are based on several conservative assumptions to reduce the influence of uncertainty in the predictions as follows:

- The water quality infiltrating to groundwater from beneath the MRSA, ore stockpile, PSMF, and WMP was assumed to be representative of the water quality at the predicted discharge location to the receiving environment. This approach provides a conservative estimate of groundwater quality discharging to surface water and does not consider physical or chemical attenuation processes along the groundwater flow path.
- Particle tracking was used in the groundwater flow model to provide a conservative estimate of groundwater discharge rates and travel times to surface water components based on advective flow processes. The effects of other physical flow processes, such as dispersion and diffusion, and chemical processes, such as adsorption and precipitation or dissolution, was not considered. These other processes will reduce parameter concentrations and arrival times.
- The MRSA will take years to reach a steady-state saturation condition where the volume of water infiltrating into the MRSA from precipitation will result in an equal amount of seepage or recharge out of the base of the MRSA. This is referred to as the wetting time, where infiltrating precipitation is retained within the MRSA as the moisture content and saturation increases. This wetting time was not accounted for in the groundwater flow modelling and conservatively was assumed to be steady-state saturated for each model scenario. This assumption results in higher recharge rates and loading to the groundwater table.

Using the conservative discharge rates from the groundwater flow model, the loading to the natural environment is estimated by multiplying the discharge rate by the source water quality from the water quality model. The prediction of concentrations and mass loading did not consider physical flow processes, such as dispersion and diffusion, and chemical processes, such as adsorption, precipitation, and dissolution along the groundwater flow path of the travel time to reach the ultimate receptor. These processes will result in reductions in groundwater concentrations along the groundwater flow path, and therefore represents a conservative approach to estimating loading to the natural environment. Furthermore, the loading assessment did not consider the effect of timing for infrastructure development (i.e., gradual development of a MRSA over the life of mine) or the groundwater travel time in calculating the mass loading to the environment. This results in a conservative prediction of the mass loading in early phases of the Project (i.e., operation) and provides a better representation of long-term water quality through closure, although still a conservative prediction.

Surface Water Quantity

The prediction confidence with respect to surface water quantity is high as the effects are common to mining operations and are well understood. Effects on surface water quantity are assessed based on runoff characterization, changes in effective contributing watershed areas, changes in groundwater discharges and Project effluent discharges, and are founded upon extensive empirical and deterministic modelling with supporting field monitoring. The effects were quantified through the use of regional regression relationships developed between watershed areas and flows based on long-term flow records of selected Water Survey of Canada (WSC) stations, hydrogeology modelling, as well as site-wide water balance modelling. Quantified effects were estimated with the following assumption for conservativity:

- The worst-case scenario for each phase of the Project was used to predict the largest expected changes compared to baseline conditions

Potential effects on water quantity are addressed through standard and site-specific mitigation measures as discussed in Section 6.2.3.6.3 of this report. The models used for quantifying the effects on surface water quantity are considered reliable.

Surface Water Quality

The prediction confidence with respect to surface water quality is high as the mobilization of sediment can be readily mitigated making the effects prediction relative to this effect pathway easily understood.

Potential effects to water quality as the result of project discharges to local receiving environments were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based are conservative. For example:

- The geochemical source terms on which the predictions of concentrations and mass loadings from site aspects (MRSA, PSMF) are conservative in nature.
- Baseline water quality is defined by the 75th percentile concentrations of individual constituents. Such an assumption is conservative as it constrains the assimilative capacity associated with the receiving environment. By definition, the assimilative capacity of a receiving environment is equal to the incremental difference between the existing baseline condition and the assessment benchmark (i.e., water quality criterion) on which the evaluation is based. Use of the 75th percentile concentration, rather than a measure of central tendency (i.e., 50th percentile, geomean), means that the incremental change in a given constituent concentration that can be assimilated by the receiving environment whereby use of the receiving environment is protected is relatively small in magnitude
- Water quality predictions did not consider physical or chemical processes that may attenuate concentrations in the receiving environment. An example of such a process would be partitioning of constituents from the water column to Hare Lake sediments. No attempt has been made to

adjust water quality predictions to account for this portioning, despite using this relationship to consider the potential effects the discharge on sediment quality.

Due to the conservative nature of the assumptions on which the numerical assumptions are based, a high degree of confidence can be assumed.

Sediment Quality

The mobilization of sediments to local watercourses and water bodies and the resulting effect on sediment quality can be readily mitigated and therefore the effects prediction relative to this effect pathway has a high degree of confidence.

The potential effect on sediment quality in Hare Lake as the result of the discharge of effluent from the WMP were assessed by way of numerical modeling. These predictions are generally considered conservative in nature because the assumptions on which they are based, including those associated with the prediction of effluent quality, are conservative.

Due to the conservative nature of the assumptions on which the numerical assumptions are based, a high degree of confidence can be assumed.

6.2.3.8 Summary of Project Residual Effects

A summary of water quantity and quality (including sediment quality) residual environmental effects that are likely to occur as a result of the Project and their significance is provided in Table 6.2.3-13.

Table 6.2.3-13: Project Residual Effects on Water Quality and Quantity Environment

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Ecological/ Societal Value	Significance Determination
Change in groundwater quantity related to construction	C	A	L	L	N/A	L	L	N	N/A	N/S
Change in groundwater quantity related to open pits	O D	A A	H L	M M	N/A N/A	M H	H H	M H	L	N/S N/S
Change in groundwater quantity related to PSMF	O D	P P	L L	M M	N/A N/A	H H	H H	H H	L	N/S N/S

Table 6.2.3-13: Project Residual Effects on Water Quality and Quantity Environment

Residual Effect	Residual Effects Characterization									
	Project Phase	Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Ecological/ Societal Value	Significance Determination
Change in groundwater quality	O, D	A	H	LSA	N/A	H	H	H	H	N/S
Change in surface water quantity	C, O, D	A	H	M	MS	H	H	H	H	N/S
Change in surface water quality	C, O, D	A	L	M	N/A	M	H	H	H	N/S
Change in sediment quality	C, O, D	A	N to L	M	N/A	M	H	H	M	N/S

KEY

See Section 2.5 of EIS Addendum (Vol 1) and Table 6.2.3-2 for detailed definitions

Project Phase:
C: Site Preparation / Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Medium
H: High

N/A: Not applicable

Geographic Extent:
N: Negligible
L: Low
M: Medium
H: High

Timing:
NS: No sensitivity
MS: Medium sensitivity
HS: High sensitivity

Duration:
N: Negligible
L: Low
M: Medium
H: High

Significance Determination
S: Significant
NS: Not Significant

Frequency:
N: Negligible
L: Low
M: Medium
H: High

Reversibility:
N: Negligible
L: Low
M: Medium
H: High

Ecological / Societal Value:
N: Negligible
L: Low
M: Medium
H: High

Note: Timing was not included in the original EIS.

6.2.3.9 References

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