APPENDIX JJ

WATER REPORT

NOTE TO READER
APPENDIX JJ

In April 2015, Treasury Metals submitted an Environmental Impact Statement (EIS) for the proposed Goliath Gold Project (the Project) to the Canadian Environmental Assessment Agency (the Agency) for consideration under the Canadian Environmental Assessment Act (CEAA), 2012. The Agency reviewed the submission and informed Treasury Metals that the requirements of the EIS Guidelines for the Project were met and that the Agency would begin its technical review of the submission. In June 2015, the Agency issued a series of information requests to Treasury Metals regarding the EIS and supporting appendices (referred to herein as the Round 1 information requests). The Round 1 information requests included questions from the Agency, other federal and provincial reviewers, and members of Indigenous communities, as well as interested stakeholders. As part of the Round 1 information request process, the Agency requested that Treasury Metals consolidate the responses to the information requests into a revised EIS for the Project.

Appendix JJ to the revised EIS (Water Report) provides a revised set of water estimates that reflect the refinements to the Project description and water balance since the filing of the original EIS. The document also incorporates information presented in the answers to the Round 1 information requests. While the focus of Appendix JJ (Water Report) is the changes in surface water quantity (hydrology) and surface water quality, Appendix JJ (Water Report) also includes relevant information necessary to understand the refined water estimates. The hydrogeological estimates provided in Appendix M to the revised EIS remain valid and unchanged from the original EIS. The hydrogeological information that affect surface water hydrology and surface water quality estimates are presented in Appendix JJ (Water Report) for reference purposes. Although no new geochemical testing has been initiated since the submission of the original EIS, geochemical data presented in the original EIS, along with additional samples from long-standing tests, were re-evaluated and geochemical water quality estimates were made, which serve as input parameters to understanding surface water quality.

Appendix JJ (Water Report) presents the updated predictions for surface water quantity (hydrology), which replaces the information presented in Appendix O to the original EIS. Appendix JJ (Water Report) also presents the updated geochemical modelling and resulting estimated of surface water quality, which replaces the information presents in Appendix L to the original EIS. The information presented in Appendix JJ (Water report) was used primarily in the assessment of effects of the Project on surface quality and quantity, presented in Sections 6.8 and 6.9 of the revised EIS, respectively.

As part of the process to revise the EIS, Treasury Metals has undertaken a review of the status for the various appendices. The status of each appendix to the revised EIS has been classified as one of the following:

- **Unchanged**: The appendix remains unchanged from the original EIS, and has been re-issued as part revised EIS.

- **Minor Changes:** The appendix remains relatively unchanged from the original EIS, and has been re-issued with relevant clarification.
- **Major Revisions**: The appendix has been substantially changed from the original EIS. A re-written appendix has been issued as part of the revised EIS.
- **Superseded:** The appendix is no longer required to support the EIS. The information in the original appendix has been replaced by information provided in a new appendix prepared to support the revised EIS.
- **New**: This is a new appendix prepared to support the revised EIS.

The following table provides a listing of the appendices to the revised EIS, along with a listing of the status of each appendix and their description.

List of Appendices to the Revised EIS		
Appendix	Status	Description
Appendix A	Major Revisions	Table of Concordance
Appendix B	Unchanged	Optimization Study
Appendix C	Unchanged	Mining Study
Appendix D	Major Revisions	Tailings Storage Facility
Appendix E	Minor Changes	Traffic Study
Appendix F	Major Revisions	Water Management Plan
Appendix G	Superseded	Environmental Baseline
Appendix H	Minor Changes	Acoustic Environment Study
Appendix I	Unchanged	Light Environment Study
Appendix J	Minor Changes	Air Quality Study
Appendix K	Minor Changes	Geochemistry
Appendix L	Superseded	Geochemical Modelling
Appendix M	Minor Changes	Hydrogeology
Appendix N	Unchanged	Surface Hydrology
Appendix O	Superseded	Hydrologic Modeling
Appendix P	Unchanged	Aquatics DST
Appendix Q	Major Revisions	Fisheries and Habitat
Appendix R	Major Revisions	Terrestrial
Appendix S	Major Revisions	Wetlands
Appendix T	Unchanged	Socio-Economic
Appendix U	Minor Changes	Heritage Resources
Appendix V	Major Revisions	Public Engagement
Appendix W	Unchanged	Screening Level Risk Assessment
Appendix X	Major Revisions	Alternatives Assessment Matrix
Appendix Y	Unchanged	EIS Guidelines
Appendix Z	Unchanged	TML Corporate Policies

List of Appendices to the Revised EIS		
Appendix	Status	Description
Appendix AA	Major Revisions	List of Mineral Claims
Appendix BB	Unchanged	Preliminary Economic Assessment
Appendix CC	Unchanged	Mining, Dynamic And Dependable For Ontario's Future
Appendix DD	Major Revisions	Indigenous Engagement Report
Appendix EE	Unchanged	Country Foods Assessment
Appendix FF	Unchanged	Photo Record Of The Goliath Gold Project
Appendix GG	Minor Changes	TSF Failure Modelling
Appendix HH	Unchanged	Failure Modes And Effects Analysis
Appendix II	Major Revisions	Draft Fisheries Compensation Strategy and Plans
Appendix JJ	New	Water Report
Appendix KK	New	Conceptual Closure Plan
Appendix LL	New	Impact Footprints and Effects

TREASURY METALS INCORPORATED
GOLIATH GOLD PROJECT

WATER REPORT

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NOTICE TO READERS

In April 2015, Treasury Metals submitted an Environmental Impact Statement (EIS) for the proposed Goliath Gold Project (the Project) to the Canadian Environmental Assessment Agency (the Agency) for consideration under the Canadian Environmental Assessment Act (CEAA), 2012. The Agency reviewed the submission and informed Treasury Metals that the requirements of the EIS Guidelines for the Project were met and that the Agency would begin its technical review of the submission. In June 2015, the Agency issued a series of information requests to Treasury Metals regarding the original EIS and supporting appendices (referred to herein as the Round 1 information requests). The Round 1 information requests included questions from the Agency, other federal and provincial reviewers, Indigenous communities, as well as interested stakeholders. Since the submission of the original EIS, Treasury Metals has advanced the engineering for the Project, as well as prepared complete and comprehensive responses to the Round 1 information requests. As a result, there are a number of changes and refinements to the Project that will change the water predictions or conclusions from those presented in the original EIS.

In order to effectively describe the changes in the water predictions and reflect the changes resulting from the advancement of the Project engineering, Treasury Metals has prepared this stand-alone Water Report. The Water Report is also considered an effective means to support the responses to the Round 1 information requests and the revisions to the EIS prepared as part of the responses to the Round 1 information requests. The Water Report, presented herein, is a technical document that describes how changes and refinements to the Project since the submission of the original EIS will alter the water results, specifically the estimates for surface water hydrology (i.e., surface water quantities) and surface water quality. To support these estimates, relevant information regarding the refined operational water balance for the Project and the hydrogeological estimates provided in Appendix M to the EIS have been included. Additionally, information is provided regarding the re-analysis of the geochemical data presented in the original EIS. This re-evaluation was undertaken as part of the work to respond to the Round 1 information requests. The re-evaluation of the geochemistry is important as it is a key input for the revised surface water quality estimates. The Water Report includes information about the prediction methods and mitigation built into the Project design that were considered as part of the predictions. The Project design and built in mitigation are outlined in Section 3 of the revised EIS. However, the Water Report does not include information about the assessment of significance related to the changes in surface water quantity of quality, additional mitigation, management plans or follow-up monitoring plans. This information is presented in a revised version of the EIS, specifically in the following sections:

- **Groundwater quality (hydrogeology)**:
    - description of Project effects, Section 6.10
    - determination of significance Section 8.10

- **Groundwater quantity (hydrogeology)**:
  - description of Project effects, Section 6.11
  - determination of significance Section 8.11
- **Geochemistry**:
  - description of Project effects, Section 6.3
  - determination of significance Section 8.3
- **Surface Water Quality:**
  - description of Project effects, Section 6.8
  - determination of significance Section 8.8
- **Surface Water Quantity (hydrology):**
  - description of Project effects, Section 6.9
  - determination of significance Section 8.9

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1.0 INTRODUCTION

1.1 Purpose and Objective

Since the submission of the EIS, Treasury Metals has been advancing the engineering for the Project and has refined a number of aspects of the Project presented in the EIS. These refinements are outlined in the Project Update Report, a stand-alone document prepared by Treasury Metals to accompany the Round 1 responses. The Project Update Report provides a full description of the refined Project, as well as providing a description of the changes and refinements from the Project described in Section 3 of the EIS.

One aspect of the Project that has been refined is the water balance. This was done to accommodate physical changes to the Project (e.g., changes to the footprint of the Project), changes in the handling of runoff for the Project (an engineered perimeter ditch will be constructed to collect all of the runoff from the operations area), and changes to reduce the potential fresh water takings from adjacent watercourses. These changes to the water balance will result in changes to the estimated water effects described in the EIS, most notably the surface water hydrology (surface water quantity) and surface water quality.

This report, the Water Report, has been prepared by Treasury Metals to provide a complete overview of these changes to the water estimates as a result of the refinements to the Project and the water balance, as well as incorporating information presented in the answers to the Round 1 information requests. While the focus of the Water Report is the changes in surface water hydrology and surface water quality, the Water Report also includes relevant information necessary to understand the refined water estimates. The hydrogeological estimates provided in Appendix M to the EIS remain valid and unchanged. The hydrogeological information that affect surface water hydrology and surface water quality estimates are presented in this report for reference purposes. Although no new geochemical testing has been initiated since the submission of the EIS, geochemical data presented in the EIS, along with additional samples from long-standing tests, were re-evaluated and geochemical water quality estimates were made, which serve as input parameters to understanding surface water quality. The geochemical section presented in this report also supports the responses to the Round 1 information requests.

The Water Report presents updated estimates for surface water hydrology and surface water quality, as well as geochemical results that were re-evaluated. This report is intended to act as a stand-alone document but also intended as a supporting document for the responses to the Round 1 information requests as well as supporting the revised evaluation of the potential effects of the Project, which is presented in the Impact Review Report. The Impact Review Report is a stand-alone document prepared by Treasury Metals to accompany the responses to the Round 1 information requests, the Impact Review Report was prepared to address questions raised regarding the organization of the effects assessment presented in the EIS, as well as addressing issues raised through responding to the Round 1 questions. Simply stated, the estimated changes (i.e., quantitative results) in surface water hydrology and surface water quality are presented in the Water Report, while the impacts resulting from those changes (i.e., qualitative narrative) are located in the Impact Review Report.

1.2 Report Organization

The Water Report is organized into the following six sections, which are described below:

1. Introduction
2. Water Balance
3. Groundwater
4. Surface Water Hydrology
5. Geochemistry
6. Surface Water Quality

The Water Report presents information used in the refinement of surface water hydrology and surface water quality estimates. Each section of this report focuses on information that was relevant and served as input parameters for determining how the refined estimates were made. To illustrate this, Figure 1-1 provides a diagram showing the linkages between the various sections of the Water Report and highlights the specific information that is passed between sections.

Within each section of the Water Report, the information has been organized with the text provided first, followed by the relevant tables referenced in the section (if any), and then followed by the relevant figures referenced in the section (if any).

1.2.1 Introduction

The Introduction (Section 1) provides an overview of the Water Report's organization and relevance. This section also provides the structure of the report and how information is shared between the various disciplines.

1.2.2 Water Balance

The conceptual water balance for the Project has been refined since the submission of the EIS to reflect the refinements in the Project design, and has been included as an appendix to the Project Update Report. The emphasis of Section 2 of the Water Report is not to reproduce the information in the conceptual water balance, rather it presents the information relied on from the conceptual water balance in estimating the effects of the Project on surface water hydrology and surface water quality. The primary information used (Figure 1-1) are as follows:

- Estimated volumes of effluent discharged to Blackwater Creek during operations. This information is used to estimate changes in both surface water hydrology and surface water quality.

- Estimated withdrawals of fresh water from irrigation ponds on Thunder Lake Tributary 2 and Thunder Lake Tributary 3. This information is used to estimate the changes in surface water hydrology.

1.2.3 Groundwater

As part of the work done to support the original EIS, a detailed hydrogeological study was completed and included as Appendix M to the EIS. The information presented in Appendix M to the EIS remains valid, and Appendix M remains unchanged since the submission of the EIS. Section 3 of the Water Report provides a summary of the key hydrogeological information from Appendix M to the EIS that is relied on when providing the refined estimates of the effects of the Project on surface water quantity and surface water quality, as shown in Figure 1-1. This key information includes the following:

- Estimates of the groundwater inflow to the open pit and underground mine during operations. This information helps define the amount of dewatering required, as well as the volumes of mine water to be managed during operations.

- Estimates of the groundwater inflow to the open pit once the operations cease and the open pit is allowed to start filling with water. This information will help determine how long it will take for the open pit to fill with water, as well as how long the waste rock and mine faces in the open pit will be exposed to environmental conditions.

- Estimates of groundwater inflow to the open pit once it is fully filled with water. This information will be used in estimating the quality of water in the pit lake, as well as the volume of water from the flooded pit lake that will be released through the spillway into Blackwater Creek.

- The estimated quantities of seepage from the tailings storage facility (TSF) and waste rock storage area (WRSA) to the open pit as it is filling with water. This information is used in determining the quality of the water in the pit lake.

- The estimated quantities of seepage from the TSF and WRSA to the open pit once it is fully flooded with water. This information is used in determining the quality of the water in the pit lake.

- The estimated quantities of seepage from the TSF and WRSA to the receiving surface water courses. This information is used as an input to the model used to estimate surface water quality in the receiving environment.

As with the other subsequent sections of the Water Report, the above hydrogeological information has been used for two alternative approaches being considered for the closure strategy for the TSF, both of which are described in Section 3.14.4 of the Project Update Report. The first strategy is the use of a low permeability dry cover. At closure, the water in the TSF will be withdrawn, treated and used to help fill the open pit. The tailings will then be covered with a granular cover to physically isolate them. Finally, a low permeability dry cover will then be applied to isolate the tailings from oxygen and water to preclude acidification. With the wet cover option as the second strategy, the water in the TSF at closure will be withdrawn, treated and used to help fill the open pit. The tailings will be physically isolated by applying a layer of granular material. The tailings will then be isolated from oxygen by adding a cover of non-process water.

1.2.4 Surface Water Hydrology

The surface water hydrology for the Project site has been refined since the submission of the EIS as Treasury Metals has continued to advance their engineering for the Project. This refined hydrology data, which is presented in Section 4 of this report, modifies some of the water related predictions presented in the EIS including changes to predicted water quantities in the surface water receiving environment. The information presented in Section 4 of this report includes the following:

- Establishment of surface water flows for existing conditions, operations and post-closure phases for various sub-watershed catchment areas in the receiving environment. These surface water flows were used as modelling inputs for determining the surface water quality in the receiving environment (Figure 1-1).

- The determination of runoff volumes to be directed to the open pit during the post-closure phase to determine the duration for the open pit to fill with water. This value was used as a modelling input to assess the pit lake water quality while the open pit is filling (Figure 1-1).

- The maximum allowable fresh water takings from Thunder Lake Tributary 2 and Thunder Lake Tributary 3 during the operations phase.

The revised hydrological information was used for the two closure strategies for the TSF, as described above in Section 1.2.3.

1.2.5 Geochemistry

In preparing responses to the Round 1 information requests, all of the geochemical data presented in Appendix K of the EIS was reviewed, and in some cases re-evaluated. The purpose of this work was to develop defensible geochemical estimates of seepage from the TSF and WRSA, as well as the quality of the water in the open pit once flooding occurs. Additional geochemical sampling of existing, long-standing field barrel test was incorporated, along with data from Appendix K of the EIS. In determining the geochemical properties of seepage from the TSF, consideration was given to closure scenarios where a dry cover is used, as well as using a wet cover over the TSF.

Section 5 of this report includes a summary and re-evaluation of geochemistry from Appendix K of the EIS which, in turn, are key input parameters for estimating surface water quality in the receiving environment (Figure 1-1). A summary of key information that Section 5 provides includes the following:

- Estimate of the post flooding pit water quality. This information provides pit water quality at the point the open pit is flooded; assuming that Treasury Metals has not implemented any remedial mitigation measures during the period when the pit is filling.

- Estimate of the long-term pit water quality. This information provides pit water quality for the long-term post-closure phase. This information will be used as an input to estimate the surface water quality in the receiving environment during the post-closure phase as pit water, during the post-closure phase, will be discharged to the receiving environment.

- Estimate of the long-term seepage water quality of the TSF. This information will be used as an input to estimate the surface water quality in the receiving environment during the post-closure phase as a portion of TSF seepage, during the post-closure phase, will be discharged to the receiving environment.

- Estimate of the long-term seepage water quality of the WRSA. This information will be used as an input to estimate the surface water quality in the receiving environment during the post-closure phase as a portion of WRSA seepage, during the post-closure phase, will be discharged to the receiving environment.

1.2.6 Surface Water Quality

As part of the work to prepare responses to the Round 1 information requests, a surface water quality model was developed in order to estimate the concentrations of key parameters for existing conditions, as well as during the operations and post-closure phases of the Project. There will be no runoff from the operations area during the site preparation and construction phase once the perimeter ditch is completed. There will be no discharges to surface water during the closure phase, therefore the quality of surface water during these phases will be the same as the existing conditions. Surface water quality was determined at nine locations in total in the receiving environment. The surface water quality model relied on inputs from all four water disciplines (e.g., water balance, groundwater, surface water hydrology, and geochemistry) previously described above in order to estimate the surface water quality in the receiving environment. Section 6 of the Water Report provides a description of the model, information from the previous sections of the Water Report that were used as input parameters and surface water quality results. Key input information for the determination of surface water quality, as shown in Figure 1-1, includes the following:

- The treated effluent discharge volume discharging to Blackwater Creek during the operations phase (from Section 2).

- The estimated quantities of seepage from the TSF and WRSA ultimately reporting to the receiving environment during the post-closure phase (from Section 3).

- The surface water flows that were used in a mass-balance equation for determining water quality for existing, operations and post-closure phases of the Project (from Section 4).

- The estimated seepage qualities from the TSF and WRSA and long-term pit lake quality reaching the various watercourses during the post-closure phase (from Section 5).

This information was considered when modelling the surface water quality for the various locations in the receiving waterbodies.

Similar to the hydrogeological section (Section 3) of the Water Report, the surface water quality in the receiving environment was determined for the two closure options being considered for the TSF (i.e., a dry cover and a wet cover option). The results for both scenarios during the post-closure phase are presented in Section 6.

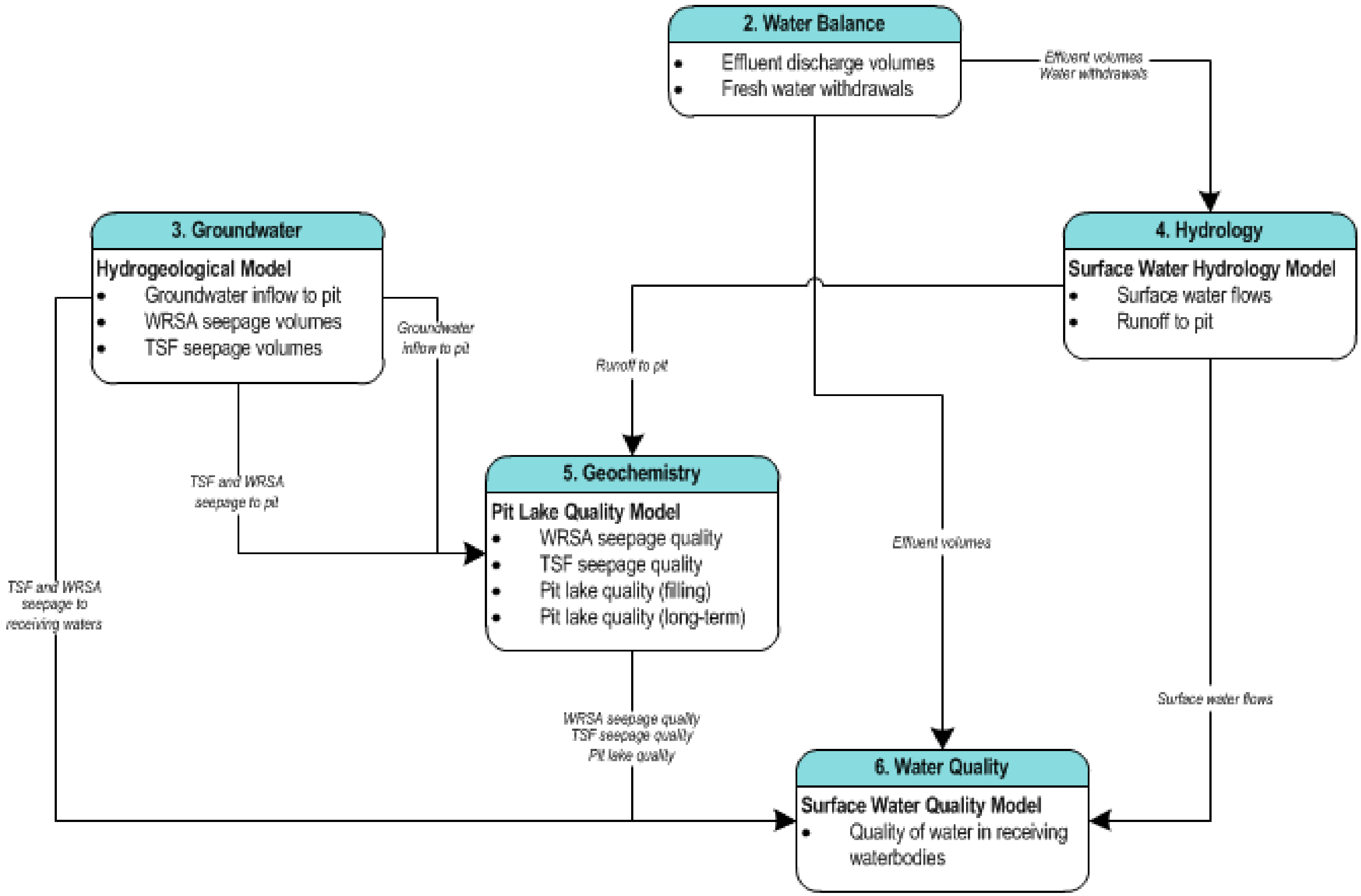


Figure 1-1: Linkage Diagram for Water Disciplines

2.0 WATER BALANCE

Since the submission of the EIS, Treasury Metals has been advancing the engineering and has refined the water management concept for the Project. A key element of the refined concept for managing water at the mine is the containment of all mine contact water by implementing a perimeter surface runoff and seepage collection ditch/berm system around the operations area for the Project. The system will be constructed at the outset of the site preparation and construction phase, and will help protect against effects on the environment, as well as providing a source of water for use in the operations. The refinements since the EIS was submitted have been outlined in the Project Update Report, a stand-alone document prepared by Treasury Metals to accompany the Round 1 responses, with a conceptual water balance for the operations phase provided as an appendix. The overall concept for managing water at the Project varies by phase in the following manner:

- **Site preparation and construction phase**: The perimeter runoff and seepage collection system around the operations area will be developed as part of the site preparation, and will collect the runoff from the site for use in the start-up of the tailings storage facility (TSF) and the processing plant. A series of three runoff collection ponds will be constructed to manage the runoff from the site. During this phase, dewatering of the overburden will begin so the material can be stripped in preparation for mining operations. A minewater pond will be constructed at the toe of the TSF to help manage this water. Construction will also start on the TSF, and any excess water will be directed to the newly constructed facility. During the site preparation and construction phase there will be no surface water discharges once the water management systems are in place.

- **Operations phase**: During operations, water management will occur as described in the conceptual water balance appended to the Project Update Report. All of the runoff from the operations area will be collected and used in the process plant. The open pit and underground mine will need to be dewatered to provide a safe working environment. This water will be used to supplement the processing requirements, and will be managed onsite to balance the water available to meet the requirements during the year. Water will be used to process the ore and recover the resources present. At the end of the process, the tailings will be treated to destroy any cyanide present before the tailings and water are discharged to the TSF. A steady supply of water for the process plant is required as a portion of the water sent to the TSF will remain bound in the tailings and will no longer be available for use. Excess water at the site will be treated and discharged to the environment through an engineered release point on Blackwater Creek. All of the effluent will be treated to meet the Provincial Water Quality Objectives (PWQO) prior to discharge to the environment. If required, fresh water to support the Project will be taken from the irrigation ponds at the former MNRF tree nursery. These ponds are located on Thunder Lake Tributary 2 and Thunder Lake Tributary 3. The amount of water withdrawn from these ponds will vary based on the season and weather conditions, but will not exceed 5% of the flow into either of the irrigation ponds.

- **Closure phase**: During the closure phase, the facility will be decommissioned and the open pit and underground mine will be allowed to start filling with water. The water within the TSF will be withdrawn, treated and used to help fill the pit. The tailings will physically isolated with a granular layer and then isolated from oxygen with either a low permeability dry cover or a wet cover of non-process water. Groundwater will continue inflow to the open pit after closure. There will also be relatively small amounts of seepage from the TSF and the waste rock storage area (WRSA) that report to the open pit. All runoff from the site will be also directed to the open pit. During the closure phase, there will be no discharges of surface water to the surrounding watercourses.

- **Post-closure phase**: Water management during the first few years of the post-closure phase will be similar to the closure phase conditions. All of the runoff from the site will continue to be directed to the open pit and there will be no discharges of surface water until the pit is fully flooded. Once this occurs, water from the open pit will be released into Blackwater Creek Tributary 1 through an engineered spillway. Groundwater inflow will continue to the open pit in the post-closure phase.

The conceptual water balance for the operation phase (appended to the Project Update Report) provides a detailed estimate of the water needs and requirements. The water balance considers the refinements to the Project, and considers three scenarios to cover the range of meteorological conditions likely over the relatively short 15-year mine life (including site preparation and construction, operations and closure). These scenarios correspond to the average yearly precipitation, the 1:20 year dry (5th percentile) annual precipitation and 1:20 year wet (95th percentile) annual precipitation. These data were selected to cover the range of conditions likely expected at the site over the operating life of the Project. The specific parameters used included monthly rainfall, snowfall, and lake evaporation rates. These data are described more fully in the surface water hydrology discussion (Section 4) of this report. Although climate has been identified as likely to change in the future, the relatively short operating life of the Project means these likely changes would be affecting the post-closure conditions only. The future climate for the region (McDermid et al, 2015) has been described as one with warming annual, summer and winter temperatures, with increasing annual and winter precipitation.

The conceptual water balance for the operations phase of the Project is presented in Tables 2-1a, 2-1b, and 2-1c, for the average year, dry year, and wet year scenarios, respectively. A flow diagram for the conceptual water balance is provided in Figure 2-1. Overall, the process plant will require a total water volume of 3,044 m^3/day, on average. This total volume is comprised of 2,226 m^3/day of reclaimed water from the TSF and from the minewater pond, and 818 m^3/day of raw/fresh water from the surface runoff collection ponds. In dry years or periods of low water amounts, the water in the surface runoff collections ponds will be supplemented with water withdrawn from the irrigation ponds or water from the treatment plant.

2.1 References

McDermid, J., S. Fera and A. Hogg, 2015. Climate Change Projections for Ontario: An Updated Synthesis for Policymakers and Planners. Ontario Ministry of Natural Resources and Forestry. CCRR-44.

Table 2-1a: Conceptual Water Balance for Operations (average year)

Water Transfer	Average Flow (m³/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TAILINGS STORAGE FACILITY												
Water Reclaim to Plant (1)	1,592	1,647	1,960	2,226	1,163	1,485	989	1,098	2,174	2,172	2,226	1,615
Water Transfer to Treatment (2)	0	0	0	1,180	0	0	0	0	0	0	147	0
MINE DEWATERING POND												
Water Transfer to TSF (3)	0	0	0	0	0	0	0	0	0	0	0	0
Water Reclaim to Plant (4)	634	579	266	0	1,063	741	1,237	1,128	52	54	0	611
Water Transfer to Treatment (5)	715	799	1,276	2,376	924	1,558	918	871	2,079	1,861	1,758	749
SURFACE RUNOFF COLLECTION PONDS												
Water Reclaim to Plant (6)	818	818	818	818	818	818	818	818	818	818	818	818
Fresh Water from Tributaries (7)	158	119	138	11	0	0	0	0	0	0	0	274
Water Transfer to Treatment (8)	0	0	0	0	0	0	416	407	557	263	58	0
PROCESS PLANT												
Total Water to Process Plant (9)	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044
Water in Tailings to TSF (10)	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913
TREATMENT PLANT												
Total Transfer to Treatment (11)	715	799	1,276	3,556	924	1,558	1,335	1,277	2,637	2,124	1,963	749
Treated Water to Collection Ponds (12)	0	0	0	0	0	0	0	0	0	0	0	0
Treated Water to Environment (13)	715	799	1,276	3,556	924	1,558	1,335	1,277	2,637	2,124	1,963	749

Note: The values in parentheses correspond to the flow diagram in Figure 2-1

Table 2-1b: Conceptual Water Balance for Operations (dry year)

Water Transfer	Average Flow (m^3/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TAILINGS STORAGE FACILITY												
Water Reclaim to Plant (1)	1,575	1,613	1,830	2,226	115	144	0	7	1,336	1,625	2,116	1,591
Water Transfer to Treatment (2)	0	0	0	504	0	0	0	0	0	0	0	0
MINE DEWATERING POND												
Water Transfer to TSF (3)	0	0	0	0	0	0	357	0	0	0	0	0
Water Reclaim to Plant (4)	651	613	396	0	2,111	2,082	2,226	2,219	890	601	110	635
Water Transfer to Treatment (5)	689	747	1,078	2,043	0	0	0	0	0	264	1,514	713
SURFACE RUNOFF COLLECTION PONDS												
Water Reclaim to Plant (6)	818	818	818	818	818	818	818	818	818	818	818	818
Fresh Water from Tributaries (7)	45	33	40	337	382	204	189	74	122	147	118	78
Water Transfer to Treatment (8)	0	0	0	0	0	0	0	0	0	0	0	0
PROCESS PLANT												
Total Water to Process Plant (9)	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044
Water in Tailings to TSF (10)	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913
TREATMENT PLANT												
Total Transfer to Treatment (11)	689	747	1,078	2,548	0	0	0	0	0	264	1,514	713
Treated Water to Collection Ponds (12)	483	489	416	0	0	0	0	0	0	264	595	642
Treated Water to Environment (13)	206	258	662	2,548	0	0	0	0	0	0	918	71

Note: The values in parentheses correspond to the flow diagram in Figure 2-1

Table 2-1c: Conceptual Water Balance for Operations (wet year)

Water Transfer	Average Flow (m³/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TAILINGS STORAGE FACILITY												
Water Reclaim to Plant (1)	1,609	1,681	2,090	2,226	2,055	2,226	2,130	2,023	2,226	2,226	2,226	1,638
Water Transfer to Treatment (2)	0	0	0	1,842	0	417	0	0	700	447	403	0
MINE DEWATERING POND												
Water Transfer to TSF (3)	0	0	0	0	0	0	0	0	0	0	0	0
Water Reclaim to Plant (4)	617	545	136	0	171	0	96	203	0	0	0	588
Water Transfer to Treatment (5)	740	850	1,474	2,708	2,103	2,696	2,424	2,091	2,426	2,123	1,893	785
SURFACE RUNOFF COLLECTION PONDS												
Water Reclaim to Plant (6)	818	818	818	818	818	818	818	818	818	818	818	818
Fresh Water from Tributaries (7)	0	0	0	0	0	0	0	0	0	0	0	0
Water Transfer to Treatment (8)	0	0	0	0	842	1,812	1,492	1,122	1,325	792	424	0
PROCESS PLANT												
Total Water to Process Plant (9)	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044	3,044
Water in Tailings to TSF (10)	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913	2,913
TREATMENT PLANT												
Total Transfer to Treatment (11)	740	850	1,474	4,549	2,945	4,925	3,915	3,213	4,451	3,362	2,720	785
Treated Water to Collection Ponds (12)	0	0	0	0	0	0	0	0	0	0	0	0
Treated Water to Environment (13)	740	850	1,474	4,549	2,945	4,925	3,915	3,213	4,451	3,362	2,720	785

Note: The values in parentheses correspond to the flow diagram in Figure 2-1

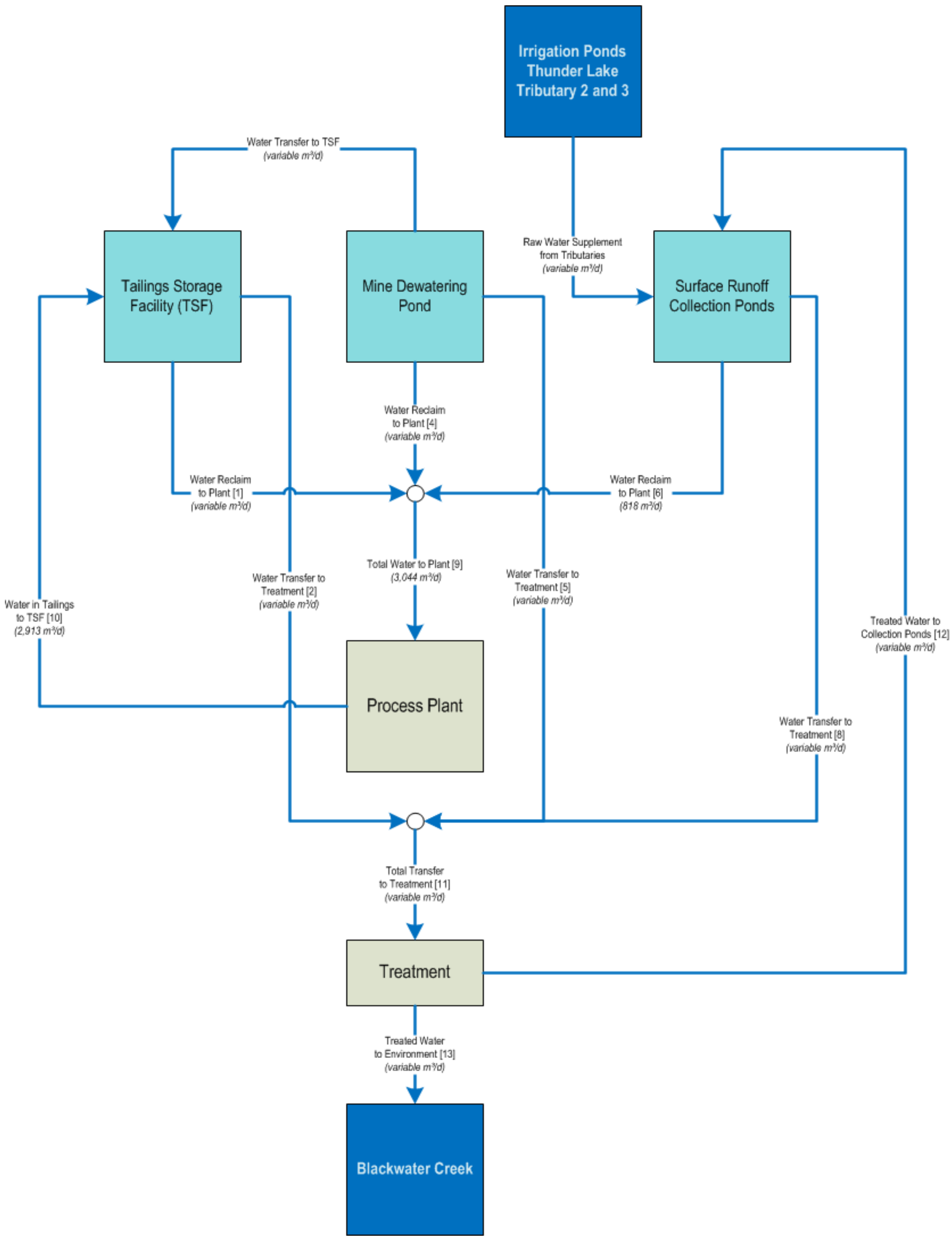


Figure 2-1: Conceptual Water Balance Flow Diagram

3.0 GROUNDWATER (HYDROGEOLOGY)

3.1 Summary of Conceptual Understanding of Groundwater Flow

The hydrogeology of the proposed Project site has been based on the overburden and rock characteristics and the data obtained from a hydrogeological investigation undertaken primarily during the period 2012 to 2013 (Appendix M of the EIS). Overall, it appears that groundwater levels are relatively close to surface and approximately follow topography. Groundwater flow from the Project site follows the surface drainage with flow both to the west towards Thunder Lake and to the south towards Wabigoon Lake.

The information further suggests that the groundwater regime has limited groundwater flow that groundwater provides minimal baseflow to creeks in the immediate vicinity of the Project site, and for much of the Project area. The creeks in the area of the proposed Project are runoff dominated. Groundwater baseflow represents a small proportion of the total flow in the surface watercourses near the Project. The following five hydrostratigraphic units have been identified that are key to explaining the groundwater – surface water interaction in the vicinity of the Project:

- Clay: Fine-grained glaciolacustrine deposits of dominantly clay composition (clay, silty clay, layered clay and silt) are located around the Project site and dominate the southern part of the Project area. This unit is an aquitard providing little or no flow to creeks rising on it. The effectiveness of this aquitard is expected increase towards the south-west where the Wabigoon basin deepens.

- Basal Sand: This is a relatively thin discontinuous sand layer at the base of the clay that is on average 3-4 m thick, when present. This is a minor aquifer that has limited groundwater flow with a hydraulic conductivity around 1×10^{-6} m/s.

- Bedrock knolls: These represent areas where the bedrock is exposed or covered with a very thin sand layer.

- Sand-Clay/Silt-Sand: These are units with generally silty sand, overlying a largely continuous clay/silt, overlying the basal sand. These units occur in the north-western part of the Blackwater Creek Watershed (top of Blackwater Creek Tributary 2). The upper sand provides some baseflow to Blackwater Creek and is expected to have a similar hydraulic conductivity as the basal sand.

- Sand and Gravel: These coarser glacial deposits are located mainly on the northern to north-eastern edge of the Project. These are the only reasonable aquifer present within the vicinity of the Project, and are providing baseflow to Thunder Lake Tributary 2 and Thunder Lake Tributary 3.

Most of the groundwater flow that occurs around the Project site is expected to follow the topography with greatest flows along the contact between the upper weathered and fractured bedrock and the basal sand. Rates of groundwater flow are expected to be much lower in the deeper bedrock.

3.2 Prediction Method for Groundwater Flow

A numerical three-dimensional steady-state groundwater flow model was developed, as described in Appendix M to the EIS. The model was used to estimate:

- Groundwater inflow rates into the open pit and underground mine workings;
- Zone of influence (ZOI) and drawdown created by the mine dewatering;
- Reduction in groundwater discharge to local creeks; and
- Seepage rates to groundwater from the tailings storage facility (TSF) and waster rock storage area (WRSA), as well as their potential groundwater pathways.

Further details on the development of the numerical groundwater flow model are provided in Appendix M of the EIS.

3.3 Predictions of Pit Inflow Rates

During operations, when mine dewatering is actively used to keep the open pit and underground wine working free of water, groundwater will be flowing into the mine workings. This water will be collected and used as part of the water balance appended to the Project Update Report, and described in Section 2.

Once the operations cease, dewatering activities will end and the open pit and underground mine workings will be allowed to fill with water. The groundwater modelling indicates a groundwater inflow rate of 700 m^3/day while the pit is filling with water. Once the open pit is completely flooded, the modelling indicates that there will continue to be an inflow of groundwater to the open pit, at an estimated rate of 100 m^3/day.

3.4 Predictions of Reduction of Groundwater Discharge to Local Streams

During operations the groundwater discharge to local streams falling within the ZOI may be reduced. At runoff dominated streams that reside on clay, such as Little Creek and Hoffstrom's Bay Tributary, reduction in groundwater discharge is not expected to be notable.

Some reduction in groundwater discharge is expected for streams with watershed areas that do not predominantly reside on clay. The base case model prediction shows that due to the Goliath mine dewatering, annual average groundwater discharge into the Thunder Lake Tributary #2 and #3 (entire watershed from Thunder Lake) can be potentially reduced by about 150 m^3/d. The same predictive simulation shows that the annual average discharges to the Blackwater Creek will be potentially reduced by approximately 700 m^3/d. However, as Blackwater Creek has intermittent flows, during dry conditions it may be expected that the reduction in groundwater discharge will be several hundred m^3/d lower and approach zero under very dry conditions when there is minimal or no flow in Blackwater Creek. Under wetter than average conditions the reduction in groundwater discharge to Blackwater creek may be expected to be several hundred m^3/d higher than the prediction for average conditions.

3.5 Predictions of Seepage at Post-Closure

During the operations phase of the Project, active dewatering of the open pit and underground mine will result in a localized ZOI where the groundwater table will be drawn down. Within this drawdown zone, groundwater flow and seepage from the TSF and WRSA will be directed towards the open pit where it will be collected and managed as part of the site water balance. Therefore, no seepage from either the TSF or WRSA will leave the Project while the drawdown zone remains. Following closure of the Project, dewatering activities will cease and the water table will be allowed to return to conditions similar to those prior to the development of the Project. Once this happens, a portion of seepage from the TSF and WRSA that escapes the perimeter ditch seepage collection system will leave the Project site. The open pit would be expected to capture all of the seepage when it is fully dewatered (at the start of closure), with the amount of seepage captured by the open pit decreasing as a function of the water level recovery within the open pit. The quantities of seepage from the WRSA and TSF are listed in Table 3-1, and are described below.

3.5.1 Seepage from the Capped WRSA

An the end of mining operations, the WRSA will be reclaimed, and capped with a low permeability dry cover to isolate the materials from water and oxygen, thus limiting the potential for acid generation. Groundwater modelling indicates that a total seepage volume of 30 m^3/day from the WRSA is estimated (Figure 25 of Appendix M of the EIS), with 10 m^3/day of this seepage reporting to Thunder Lake, and the remaining 20 m^3/day of seepage reporting to the open pit (ultimately report to Blackwater Creek in the post-closure phase once the pit is fully flooded).

The volumes of seepage estimated from WRSA were used as input parameters into estimating the long-term quality of water in the open pit (Section 5), as well as for estimating the post-closure surface water quality in the receiving environment (Section 6).

3.5.2 Seepage from the Capped TSF (Dry Cover)

During the closure phase of the Project, the water present in the TSF will be withdrawn, treated, and used to help fill the open pit. A granular cover will then be placed over the TSF to physically isolate the tailings. Finally, the tailings will be isolated to prevent acidification. One option for chemically isolating the tailings in with the placement of a low-permeability dry cover. This is referred to as the "capped TSF" in Appendix M to the EIS. The groundwater modelling indicates that a total seepage volume of 50 m^3/day (Figure 24 of Appendix M of the EIS) will bypass the perimeter ditches and seepage collection system of the capped TSF (i.e., dry cover) during the post-closure phase. It is estimated that 10 m^3/day of the seepage will report to Hoffstrom's Bay Tributary, 10 m^3/day will report to the open pit, and 30 m^3/day will report to Blackwater Creek. Thunder Lake Tributary 3 and Thunder Lake (i.e., at Hoffstrom's Bay) were estimated to each receive much less than 10 m^3/day of seepage.

The volumes of seepage estimated from the TSF were used as input parameters into estimating the long-term quality of water in the open pit (Section 5), as well as for estimating the post-closure surface water quality in the receiving environment (Section 6).

3.5.3 Seepage from the Uncapped TSF (Wet Cover)

Once the operations cease at the Project, closure activities will begin. During the closure phase of the Project, the water present in the TSF will be withdrawn, treated, and used to help fill the open pit. A granular cover will then be placed over the TSF to physically isolate the tailings. Finally, the tailings will be isolated from oxygen to prevent acidification. One option for isolating the tailings from oxygen is to cover the TSF with a water cover, using non-process water. This "wet cover" option is referred to as the "uncapped TSF" in Appendix M to the EIS. The groundwater modelling indicates that approximately 90 m^3/day of seepage from the TSF with a wet cover will bypass collection ditches and report to various waterbodies during the post-closure phase (Figure 22 of Appendix M of the EIS). It is estimated that 10 m^3/day of seepage will report to Thunder Lake, 20 m^3/day of seepage will report to Thunder Lake Tributary 3, 10 m^3/day of seepage will report to Hoffstrom's Bay Tributary, and 50 m^3/day of seepage will report to Blackwater Creek.

Leakage from an uncapped (wet cover) TSF would be greatly reduced by the installation of an HDPE liner. For the 60 hectare TSF area, typical leakage with an HDPE basal liner installed is considered to be less than 5 m^3/d, as indicated in Appendix M.

The volumes of seepage estimated from TSF were used as input parameters into estimating the long-term quality of water in the open pit (Section 5), as well as for estimating the post-closure surface water quality in the receiving environment (Section 6).

Table 3-1: Seepage Quantities during Post-Closure

Waterbody Receiver	Volume of Discharge (m^3/day)		
	Capped WRSA (1)	Capped TSF (2) (dry cover)	Uncapped TSF (3) (wet cover)
Thunder Lake (at Hoffstrom's Bay)	10	much less than 10	10
Thunder Lake Tributary 3	—	much less than 10	20
Hoffstrom's Bay Tributary	—	10	10
Blackwater Creek	—	30	50
Open Pit	20	10	—
Total Seepage	**30**	**50**	**90**

Notes:
(1) Seepage quantity for capped WRSA from Figure 25 of Appendix M of the EIS.
(2) Seepage quantities for dry cover TSF from Figure 24 of Appendix M of the EIS.
(3) Seepage quantities for wet cover TSF from Figure 22 of Appendix M of the EIS.

4.0 SURFACE WATER QUANTITY (HYDROLOGY)

4.1 Study Area and Likely Effects

The Project is located east of Thunder Lake and north-east of Wabigoon Lake. The study area for the Project comprises watersheds which drain to either Thunder Lake or Wabigoon Lake. Thunder Lake ultimately discharges to Wabigoon Lake via Thunder Creek. On a local scale, the sub-watersheds surrounding the Project Site include Thunder Lake Tributaries 2 and 3, Hoffstrom's Bay Tributary, and Little Creek in the Thunder Lake watershed, and Blackwater Creek in the Wabigoon Lake watershed. These sub-watershed boundaries are illustrated in Figure 4-1.

Potential effects of the Project on surface water hydrology are anticipated to primarily affect the Thunder Lake and Wabigoon Lake watersheds. The water management activities during the life of the mine likely to affect surface water hydrology are described below:

- During the site preparations and construction phase, a perimeter ditch and seepage collection system will be established to collect all of the runoff from the operations area. The footprint of this ditch will overlay small portions of the Hoffstrom's Bay and Little Creek sub-watersheds, diverting runoff towards the Blackwater Creek sub-watershed.

- The majority of the Project footprint will be located within the Blackwater Creek watershed. Blackwater Creek Tributaries 1 and 2 will be partially overprinted by the open pit and tailings storage facility (TSF), respectively.

- During operations, the open pit and underground mine will be dewatered to provide a safe working environment. This water will be combined with the runoff from the operations area for use in the process. Effluent from the processing plant will be treated and discharged to the TSF where the solids will be allowed to settle. A portion of the water from the TSF will be recovered for use in the process.

- The Zone of Influence created by Mine dewatering during operations will result in reduced groundwater discharges to Thunder Lake Tributaries 2 and 3, as well as Blackwater Creek.

- There will be no runoff released during the site preparation and construction phase after drainage ditch construction as all collected water will be retained to help establish the TSF and provide a supply of water for use in the processing plant. During operations, excess water not required in the processing will be treated and discharged into Blackwater Creek just upstream of location BW1 (Figure 4-2). At closure, runoff from the operations area will be directed to the open pit. There will be no discharges from the Project until the open pit fills with water. Once the open pit is fully flooded, during post-closure, the water from the site will be allowed to passively discharge to Blackwater Creek (Figure 4-3).

- During operations, fresh water will be supplied to the processing plant from two existing dug ponds along Thunder Lake Tributary 3, referred to as the tree nursery ponds (bordering Nursey Road), as well as a pond on Thunder Lake Tributary 2. Thunder Lake Tributary 3 flows into Thunder Lake Tributary 2 prior to feeding Thunder Lake.

4.2 Review of Existing Data

4.2.1 Climate Data

Annual precipitation values were determined for average, wet, and dry years based on available annual precipitation data from three Environment Canada Climate Stations covering a time period from 1970 to 2015 (2010 excluded due to missing data). The three stations were Dryden A (ID: 6032119), Dryden A (AUT) (ID: 6032120), and Dryden Regional (ID: 6032125). These stations are located 13 km north east from the Project site. Dryden A is 13 km NW of site. Dryden A was used for annual precipitation data from 1970 to 2004; Dryden A (AUT) was used for 2005 to 2009; and Dryden Regional was used for 2011 to 2015. The annual average precipitation from these stations over this time period was 671.4 mm with a standard deviation of 125.4 mm. The annual average precipitation value compared well with the 1981 to 2010 Climate Normals for the Dryden A station (719.7 mm). A normal probability distribution was fit to the annual precipitation data to generate 1:20 year return period dry and wet annual precipitation estimates of 465.1 mm and 877.7 mm, respectively. Monthly rain and snowfall data was determined by matching the monthly distribution of rainfall and snowfall to total annual precipitation for the 1981 to 2010 Dryden A Climate Normals. The monthly precipitation estimates are provided in Table 4-1.

Lake evaporation data from the Rawson Lake monitoring station (6036904) was used to estimate annual and monthly lake evaporation for the project. The Rawson Lake monitoring station is located approximately 80 km west of the site and collected lake evaporation data between 1969 and 1999. Mean annual lake evaporation at Rawson Lake is approximately 549 mm, which compares well with the previous estimate of 536 mm (Tetra-Tech, 2014), and the Hydrological Atlas of Canada (1978) which indicates a range of lake evaporation values between 500 to 600 mm. Observed annual lake evaporation data followed a normal distribution with a standard deviation of 93 mm. The 1:20 year return period extreme annual lake evaporation values were calculated using the normal probability distribution, and were determined to be 701 and 396 mm, respectively. The 1:20 year extreme annual lake evaporation value of 701 mm has been assumed to occur during the 1:20 dry precipitation year. Though a dry precipitation year does not necessarily indicate that lake evaporation will be high in that year, it has been assumed for this analysis to provide a conservative estimate for the dry year analysis. The low annual lake evaporation has been similarly applied for the wet year analysis. The monthly lake evaporation values for dry, average, and wet years are provided in Table 4-2.

4.2.2 Hydrological Data

Previous baseline hydrology work has been completed for the Project as part of the 2015 Environmental Impact Statement (EIS). In 2012, Klohn Crippen Berger (KCB) completed an Environmental Baseline Study (Appendix G of the EIS) which included discrete flow measurements within the sub-watersheds of interest. In 2014, DST Consulting Engineers Inc. completed a Hydrology Baseline Study (Appendix N of the EIS), which focused on collection of continuous water level and flow data for sub-watersheds within the Project and study area. In 2014, Tetra-Tech WEI Inc. completed a Hydrologic Modelling Study (Appendix O of the EIS), which focused on likely hydrological impacts from mine development, operation, and closure.

A summary of discrete flow measurements from 2011 is provided in Appendix G of the EIS (Table 3-3). Discrete flow measurements were completed approximately once per month during 2011. The total precipitation at the Dryden Regional climate station was 369 mm in 2011, indicating that 2011 was an exceptionally dry year (less than a 1:20 year dry condition) regionally across northwest Ontario. At Blackwater and Little Creeks, flowing conditions were only recorded during the freshet in 2011; otherwise these two creeks had no flow or not enough flow to allow accurate measurement. This observation provides a clear indication that there are no significant contributions from groundwater to the surface water flows within the watersheds of these two creeks. If groundwater were a significant contributor, some baseflow in these creeks could be expected even during very dry conditions (hydrogeological study [Amec, 2014], provided as Appendix M to the EIS).

Manual stream measurements were completed at the hydrometric stations by DST during the summer and fall of 2012, as well as during the spring, summer and fall of 2013. Details of these flow measurements can be found in Appendix N of the EIS (Tables A-1 to A-7). Manual flow measurements were used to generate stage-discharge curves, provided as Figures 3-1 to 3-7 of Appendix N to the EIS. The squared correlation values (R^2) provided in Table 4-3 of Appendix N of the EIS indicate a range in the degree of correlation between the formulas generated and the manual measurements. Some of the R^2 values are extremely low, such as for HS4, which had an R^2 of 0.375. The relatively low correlation values for some stations are indicative of the challenges associated with accurately measuring continuous streamflow in small, low gradient runoff-dominated systems which experience frequent beaver impoundment.

A summary of hydrometric monitoring station data for 2012 and 2013, calculated using the stage-discharge curves and water level readings at each of the stations, is provided in Table 4-4 in Appendix N of the EIS. Generally, most of the gauging stations showed higher flows in the spring, and lower flows in the summer period. Minimum flow periods generally occurred in the summer and winter periods. Total precipitation in 2012 and 2013 was 598 mm, and 518 mm, respectively, indicating that flows recorded during 2012 and 2013 may be typical of more average conditions than those recorded in 2011 (Appendix M).

The minimum daily flows provide a quantitative indication of groundwater discharge and by inference also groundwater recharge. The gauging stations within watershed areas dominated by clay and bedrock knolls (JCTa, HS3 [Blackwater Creek], HS5 [Hoffstrom's Bay Tributary] and HS6 [Little Creek]) have groundwater recharge values in the range of 0 to 10 mm/year. Gauging stations with watershed areas dominated by sand at surface (HS4 and HS7 Thunder Lake Tributaries) have values in the range 50 to 100 mm/year (Appendix M).

Given the challenges associated with accurately measuring streamflow in small, low gradient systems and the limited period of monitoring (less than one full year), the baseline flow data should be used with caution. The baseline data is likely useful in characterizing when the creeks were flowing or when they were dry, but not for determining accurate flow rates or the development of long term runoff coefficients or flow statistics. It is unlikely that any useful data could be obtained through additional flow measurements, due to the above noted challenges.

Therefore, long term flow statistics for the Project site area have been developed based on regional runoff estimates instead. This approach estimates flow in the tributaries within the site area by directly prorating data developed from a representative Water Survey Canada (WSC) station. The approach is described in further detail in Section 4.3 of this Water report, with the results provided in Section 4.4.

4.3 Prediction Methods

A hydrologic modelling study was previously completed by Tetra-Tech WEI Inc., and included as Appendix O to the EIS. The previous hydrologic modelling study focused on the development and calibration of a hydrologic model based on the limited surface water data collected to date (as outlined in Section 4.2 of this report). Based on the feedback and questions provided in the Round 1 information requests, reviewers had several concerns regarding the validity of the model based on limited surface water data and model calibration. Since the development of the previous hydrologic modelling study, several Project features have been refined. As a result, the water balance for the Project has also changed. A revised conceptual water balance for the Project has been prepared and is provided as an appendix to the Project Update Report. A summary of the revised water balance is provided in Section 2 of this report. In light of the changes to the Project and water balance since the submission of the EIS, and considering the feedback as part of the Round 1 information requests, it was decided to develop a surface water hydrologic model based on long-term flow statistics from a representative, regional Water Survey of Canada (WSC) station, instead of revising the previous hydrologic modelling presented in Appendix O of the EIS. Utilizing flow data from a representative, regional WSC station is considered more accurate than a hydrologic model calibrated on limited monitoring data.

The updated surface water hydrologic model includes estimates of monthly flows in Thunder Lake Tributaries 2 and 3, Little Creek, Hoffstrom's Bay Tributary, and Blackwater Creek during mine development, operation, and post-closure. Changes to average monthly flows as a result of the various Project phases will be estimated for average, wet and dry years in comparison to the existing conditions.

4.3.1 Establishing Existing Conditions

The long term flow statistics for existing conditions have been developed based on regional runoff estimates. This approach estimates flow in the tributaries within the site area by directly prorating the data developed from a representative Water Survey Canada (WSC) station.

Three WSC stations in relative close proximity to the site were considered. Wabigoon River at Dryden (05QD016) was considered since it is located on the same watershed as the Project Site, and would therefore have similar hydrologic characteristics (albeit at a much larger watershed size). North Current River (02AB015) was selected since it is a much smaller watershed compared the Wabigoon River at Dryden. These two stations were also considered in the 2012 Baseline Hydrology Report (Appendix G). Lake 240 Outlet near Kenora (05PD015) was selected since it has a watershed area similar to those on the Project site (approximately 10 km^2), and is relatively close to the project site (only 83 km away). Wabigoon River at Dryden (05QD016) is a regulated station, however the other two station are non-regulated (natural). General information for these stations is summarized in Table 4-5.

Monthly runoff values and annual runoff coefficients are provided in Table 4-6 for all three stations. The estimated annual runoff coefficients at Wabigoon River and Lake 240 Outlet near Kenora are very similar at 0.29 and 0.33, respectively. The estimated annual runoff coefficient at North Current River is much higher at 0.55. According to the Hydrologic Atlas of Canada, the project site produces a runoff between 200 and 300 mm per year (likely somewhere around 225 mm). Assuming a runoff of 225 mm per year, and an annual precipitation of 671.4 mm, an annual runoff coefficient of 0.34 is obtained for the Hydrologic Atlas of Canada estimate. The consensus for an annual runoff coefficient is therefore between 0.3 and 0.4.

Annual runoff coefficients derived from Project site hydrometric stations are provided in Table 4-7 for comparison. It should be noted that the 2012 runoff coefficients vary in terms of the length of the monitoring period. For example, HS4, HS6, and HS7 were only monitored from July to December of 2012. The 2013 monitoring data was also only collected between May and November, which will tend to artificially inflate runoff coefficients since this is typically the wetter period of the year.

In reviewing the quality of the monitoring data (Table 4-3), the flow data from HS7 (Thunder Lake Tributary 2) and TL1A and JCTA (Blackwater Creek) are likely the most reliable applicable data for comparison. The mean runoff coefficient for HS7 (Thunder Lake Tributary 2) was approximately 0.43 and mean runoff coefficients for TL1A and JCTA (Blackwater Creek) were 0.35 and 0.62, respectively (note that flow data for JCTA was only collected for 2013, which had much higher runoff coefficients). Based on the limited monitoring data collected, the annual runoff coefficients for Wabigoon River and Lake 240 Outlet near Kenora appear most comparable to those calculated for the Project site watersheds (Table 4-7). The annual runoff coefficient for the North Current River is generally higher than observed site monitoring data, and would therefore not be representative of site conditions.

Comparing the watershed sizes of the Wabigoon River and Lake 240 Outlet near Kenora, the smaller watershed size of Lake 240 Outlet near Kenora is likely more representative of Project site sub-watersheds. All other aspects being equal, smaller watersheds generally produce higher runoff in the spring, and lower runoff in the winter and late summer compared with larger watersheds.

Based on the above, WSC Station Lake 240 Outlet near Kenora (05PD015) is considered to be the most applicable regional station to Project site sub-watershed conditions. Additionally, a comparison of the land cover types within the Goliath Project Site and Lake 240 Outlet near Kenora (Table 4-8) indicates that the selected WSC station is relatively similar in land use to the Project Site sub-watersheds.

The WSC flow data for Lake 240 Outlet near Kenora is provided in Table 4-9, along with average annual runoff and annualized 1:20 year wet and dry condition runoff values, representative of annual extreme annual flows. It is stressed that the 1:20 year wet and dry monthly values shown in Table 4-9 are annualized monthly values, and not 1:20 year wet and dry values calculated from individual monthly data.

Reviewing Table 4-9, it is evident that although the 1:20 year wet and dry flows for the WSC station show a flow value in each month, a watershed of this size can experience extended dry periods. Extreme dry years such as 1988, 1989 and 1990 had extended dry periods with no flow between January and March, and September and December. The Project sub-watersheds are of a similar size and would therefore likely experience similar extended periods of dry conditions (similar to those observed for Blackwater Creek in 2011).

Existing sub-watershed delineations are provided in Figure 4-1, and existing sub-watershed areas are provided in Table 4-10. The existing watershed delineation was completed using the Ontario Flow Assessment Tool (MNRF, 2015).

4.3.2 Operations Phase Conditions

During the operations phase of the project, the footprint of the mine site will overlap onto several of the existing sub-watersheds (Hoffstrom's Bay, Little Creek and Blackwater Creek) as shown in Figure 4-2. The mine site footprint shown in Figure 4-2 is based on the layout provided by WSP. Sub-watershed areas during operations, are provided in Table 4-11. Runoff from the un-affected portion of the sub-watersheds is calculated using the same methodology as that used for the existing conditions.

During operations, water takings from Thunder Lake Tributary 2 and 3 will be required for mine process water. Water taking rates have been estimated in the conceptual water balance provided in Table 4-12. The conceptual water balance for the Project is provided as an appendix to the Project Update Report, and summarized in Section 2 of this report. The maximum flow taking at any given time has been limited to 5% of the available flow. No water taking is anticipated during a wet year, and only during some months in an average year.

Reduction of groundwater discharge to Thunder Lake Tributaries 2 and 3, as well as Blackwater Creek are anticipated during operations as a result of the Mine's Zone of Influence. As described in Section 3.4, the reduction in annual average groundwater discharge to the Thunder Lake Tributaries 2 and 3 was estimated to be approximately 150 m^3/d. The reduction in annual average discharge to Blackwater Creek was estimated at approximately 700 m^3/d. To reflect the variation in the reduction to groundwater discharge caused by climatic and streamflow conditions, these average annual values were prorated based on the annual runoff statistics to determine the reduction in groundwater discharge for the 1:20 Dry and 1:20 Wet years. An exception was made for the 1:20 Wet year in Blackwater Creek, as the prorated annual reduction was outside of the groundwater model's estimated range (as defined in Section 3.4). Annual reductions were then prorated to estimate monthly reductions based on the monthly runoff distribution. Finally, these reductions were then prorated to the various assessment points based on drainage areas within the Zone of Influence. As noted in Section 3.4, there is not expected to be any notable reduction in groundwater discharge in Little Creek or Hoffstrom's Bay Tributary.

During operations all runoff from the mine footprint area will be collected, managed, treated, and discharged to Blackwater Creek. The TSF will be constructed with a synthetic liner at the base, minimizing seepage through the bottom. Any seepage not captured by perimeter collection ditches will be captured within the drawdown cone generated by active mine dewatering, and will ultimately report to the open pit. Discharge to Blackwater Creek has been estimated in the conceptual water balance, which utilizes monthly runoff coefficients to generate average monthly flows. Anticipated discharge rates of treated effluent to Blackwater Creek are provided in Table 4-13. During average and wet years, effluent will be discharged to Blackwater Creek throughout the entire year; however, during a dry year there will be no excess water between May and October to discharge as effluent. The effluent discharge to Blackwater Creek is combined with the runoff from the un-affected portion of the watershed to determine expected total monthly Blackwater Creek flows.

4.3.3 Post-Closure Phase Conditions

At closure, the tailings storage facility (TSF) and waste rock storage area (WRSA) will be capped with a low permeability cover to reduce infiltration. This will also have the effect of maximizing the runoff from these areas. The TSF will also be lined at the base with a synthetic liner to minimize seepage into the groundwater. All runoff and seepage from the TSF and WRSA, as well as from the rest of the operations area, will be directed towards the open pit. Seepage from the base of the TSF is expected to be relatively small. Once the open pit has been filled (this will start during the closure period and should be completed several years after closure activities cease), excess water from the pit will be passively released to Blackwater Creek. All runoff from the former mine site area will be directed towards the open pit, such that no runoff will be directed towards Little Creek and Hoffstrom's Bay. There will be no water taking from Thunder Lake Tributaries 2 and 3 during the post-closure phase. The post-closure watershed map and expected associated land uses are provided in Figure 4-3. Post-closure sub-watershed areas are provided in Table 4-14.

As a result of the change in land use within the mine site footprint, runoff from these areas will be calculated using an annual runoff coefficient, as opposed to the prorated runoff from WSC station (05PD015). Post-closure runoff coefficients for the land uses at post-closure are provided in Table 4-15. The natural runoff coefficients have been calculated based on observed runoff data from the WSC station (05PD015). Other applicable post-closure runoff coefficients were estimated based on engineering judgment.

Monthly precipitation data and lake evaporation data were based on the existing data sources (Tables 4-1 and 4-2). Monthly precipitation data was redistributed to match the distribution of flows to the annual total at the WSC station (05PD015) flow gauge. This redistribution of precipitation produces potential runoff that accounts for the effects of the spring freshet.

Groundwater will inflow to the open pit as it is filling, and is estimated to continue once the pit has been fully flooded. This groundwater inflow has been conservatively estimated at 100 m^3/day (Section 3.3), and will combine with the runoff from the site being passively released to Blackwater Creek from the pit lake. At post-closure conditions, it is assumed that the Zone of Influence created by the dewatered Mine has diminished and all groundwater conditions have returned to their steady-state pre-development conditions.

4.4 Surface Water Hydrology Results

4.4.1 Existing Conditions Results

Runoff conditions determined from Lake 240 Outlet near Kenora (05PD015) were used as a basis to determine long term flow statistics for site area tributaries by prorating Lake 240 Outlet near Kenora values to effective site area sub-watershed catchments. The existing condition flows calculated for site sub-watersheds are provided in Table 4-16.

4.4.2 Operations Phase Results

Flows in the site sub-watersheds have been calculated for average, dry, and wet conditions during the operations phase. The operations flows are compared to the existing conditions to quantify expected changes in flows. The resulting flows for the operations phase are provided in Table 4-17.

A decrease in flow is predicted in Thunder Lake Tributary 2 (TL1) as result of direct water takings. During the 1:20 dry year, it is expected that water taking will occur every month at a rate of 5% of the flow in the stream. On an average annual basis, there will be a predicted decrease of 5% during the 1:20 dry year. During average year conditions, a decrease of 0.6% is predicted.

Flow reduction is slightly greater in Thunder Lake Tributary 3 (TL2) as well as further downstream on Thunder Lake Tributary 2 (TL3) due to a reduction of groundwater discharge in local streams caused by the dewatered Mine’s Zone of Influence. A maximum average annual decrease of 5.2%

and 5.6% are estimated in TL2 and TL3, respectively during a 1:20 dry year. During an average year, the average annual decrease in TL2 and TL3 is 0.8% and 1.7%, respectively and 0.2% and 1.2% in a 1:20 wet year.

A decrease in annual flow is also predicted for the Hoffstrom's Bay Tributary and Little Creek due to the loss in drainage area. Small portions of these watersheds are overprinted by proposed mine site facilities which will collect and treat all site runoff. Average annual flows are predicted to decrease 7.8% and 8.7% in Hoffstrom's Bay Tributary and Little Creek, respectively, for all flow conditions.

In Blackwater Creek (BW1), a decrease in annual flow of 6.7%, 3.9% and 1.7% is predicted for dry, average and wet conditions, respectively. These results reflect proposed treated effluent discharge to this system as well as the reduction of groundwater discharge in local streams caused by the dewatered Mine's Zone of Influence. Flow reduction is slightly greater downstream in Blackwater Creek (BW2) as a result of the proportion of its catchment within the Zone of Influence. The decrease in annual flow at BW2 is estimated at 7.3%, 5.5% and 3.4% for dry, average and wet conditions, respectively. Table 4-18 provides additional details on the calculations used to determine flows for Blackwater Creek (BW1) during operations.

4.4.3 Post-Closure Phase Results

Expected flows in site sub-watersheds have been calculated for the average, dry, and wet conditions during the post-closure phase, and are provided in Table 4-19.

No change in flows is predicted for any of the Thunder Lake tributaries as direct flow takings will not occur during post-closure conditions, and groundwater conditions have returned to their pre-development state.

Similar to operations, a decrease in annual flow is predicted for the Hoffstrom's Bay Tributary and Little Creek due to the loss in drainage area. During post-closure, all of the mine site runoff will be directed towards the open pit. Average annual flows in Hoffstrom's Bay Tributary and Little Creek are predicted to be reduced by 7.2% and 7.5%, respectively, for all flow conditions.

In Blackwater Creek (BW1), increases in annual flows are predicted for all flow conditions as a result of higher runoff from the rehabilitated mine site (e.g., semi-impervious membrane with vegetated cover). A maximum increase in annual flow of 24.3% is predicted for the dry year; however, the resulting flows will still be considerably lower than under average conditions. Flow effects are reduced further downstream on Blackwater Creek (BW2), as a result of the addition of un-affected drainage area. A maximum increase in annual flow of 15.3% for BW2 is estimated for the dry year. Table 4-20 provides additional calculations used to determine the flows for Blackwater Creek (BW1) during the post-closure phase. Flows from the rehabilitated mine site will be directed to the open pit lake, and passively discharged back into Blackwater Creek. The pit lake is predicted to discharge continuously except during the summer months of a dry year.

4.4.4 Other Considerations

Site Preparation and Construction Phase

A perimeter ditch will be constructed at the start of the site preparation and construction phase to collect all site runoff from the operations area. There will be no releases from the operations area during the site preparation and construction phase as all collected water will be retained to help establish the initial TSF inventory to provide water once processing starts. There will be diminished flows in Blackwater Creek for this period of time, with the effects expected to be similar to those as the pit is filling with water following the end of mining activities.

Closure Phase

At the start of closure, the water present in the TSF will be withdrawn, treated, and used to help fill the open pit. All runoff from the site will be directed towards the open pit to accelerate the rate of filling. It is estimated that it will take between 5 to 9 years to fill the open pit, with an expected time to fill the pit of 6.7 years. Once the open pit is fully flooded, there will be a passive overflow to Blackwater Creek (Post-Closure Phase). Until that time there will be diminished flows in the Blackwater Creek system as the open pit fills. Based on the drainage area directed towards the open pit at closure (Table 4-14), a reduction in drainage area of 20.8% is estimated at BW1 and 13.1% at BW2. Reduction in groundwater discharge in the surrounding streams caused by the Mine's Zone of Influence will decrease as the Open Pit fills and groundwater conditions return to their pre-development state.

4.4.5 Post-Closure Wet Cover Alternative

One of the methods considered to mitigate possible effects associated with acidification of the tailings within the TSF is the use of a wet cover. This wet cover will fully isolate the tailings from oxygen and will prevent acidification. Excess water within the TSF would be allowed to passively overflow through the spillway and would be directed to the open pit. The post-closure watershed map, and expected associated land uses for the TSF wet cover alternative are provided in Figure 4-4. The wet cover post-closure land use areas are provided in Table 4-21. Expected flows in site sub-watersheds have been calculated for the average, dry, and wet conditions during the post-closure phase (wet cover alternative), and are provided in Table 4-22. Results are similar to the dry cover analysis, however, flow effects at Blackwater Creek are somewhat reduced due to additional evaporation associated with the wet cover.

4.4.6 References

AMEC Environment & Infrastructure, 2014. Hydrogeological Pre-Feasibility / EA Support Study Goliath Project. TB124004. Appendix M of the Environmental Impact Statement.

Hydrologic Atlas of Canada, 1978.

Ministry of Natural Resources and Forestry. 2015. Ontario Flow Assessment Tool (OFAT III).

Table 4-1: Annual Precipitation

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Percent
Dryden A (6032119) 1981 - 2010 Climate Normals														
Precipitation (mm) (1,4)	26.5	20.0	29.9	39.6	73.4	115.2	103.1	83.7	88.9	63.6	46.7	29.1	719.7	100.0%
Rain (mm) (1)	0.2	2.1	6.7	24.7	69.2	115.2	103.1	83.5	87.7	49.2	13.0	1.2	555.8	77.2%
Snow (mm equivalent) (2)	26.3	17.9	23.2	14.9	4.2	0.0	0.0	0.2	1.2	14.4	33.7	27.9	163.9	22.8%
Monthly Distribution of Rain, Snow, and Precipitation as Percentage of Total Annual Precipitation														
Precipitation (%)	3.7	2.8	4.2	5.5	10.2	16.0	14.3	11.6	12.4	8.8	6.5	4.0	100.0	—
Rain (%)	0.0	0.3	0.9	3.4	9.6	16.0	14.3	11.6	12.2	6.8	1.8	0.2	77.2	—
Snow (%, mm equivalent)	3.7	2.5	3.2	2.1	0.6	0.0	0.0	0.0	0.2	2.0	4.7	3.9	22.8	—
Monthly Rain, Snow, and Precipitation for the Project – Average Year														
Precipitation (mm) (3,4)	24.7	18.7	27.9	36.9	68.5	107.5	96.2	78.1	82.9	59.3	43.6	27.1	671.4	100.0%
Rain (mm)	0.2	2.0	6.3	23.0	64.6	107.5	96.2	77.9	81.8	45.9	12.1	1.1	518.5	77.2%
Snow (mm equivalent)	24.5	16.7	21.6	13.9	3.9	0.0	0.0	0.2	1.1	13.4	31.4	26.0	152.9	22.8%
Monthly Rain, Snow, and Precipitation for the Project – Dry Year														
Precipitation (mm) (3)	17.1	12.9	19.3	25.6	47.4	74.4	66.6	54.1	57.4	41.1	30.2	18.8	465.1	100.0%
Rain (mm)	0.1	1.4	4.3	16.0	44.7	74.4	66.6	54.0	56.7	31.8	8.4	0.8	359.2	77.2%
Snow (mm equivalent)	17.0	11.6	15.0	9.6	2.7	0.0	0.0	0.1	0.8	9.3	21.8	18.0	105.9	22.8%
Monthly Rain, Snow, and Precipitation for the Project – Wet Year														
Precipitation (mm) (3)	32.3	24.4	36.5	48.3	89.5	140.5	125.7	102.1	108.4	77.6	57.0	35.5	877.7	100.0%
Rain (mm)	0.2	2.6	8.2	30.1	84.4	140.5	125.7	101.8	107.0	60.0	15.9	1.5	677.8	77.2%
Snow (mm equivalent)	32.1	21.8	28.3	18.2	5.1	0.0	0.0	0.2	1.5	17.6	41.1	34.0	199.9	22.8%

Notes:

(1) Environment Canada Climate Normals 1981 to 2010 for Dryden A (6032119) were obtained from Environment Canada's website: <http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=dryden&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=3953&dispBack=0>; accessed on December 6, 2016.

(2) Snow values are calculated as precipitation minus rainfall and are reported as mm of water equivalent. Values here do not directly match 1981 to 2010 climate normals for the Dryden A (6032119) station, which are reported as cm as snow, due to variation in snowfall density leading to some minor deviations from reported climate normals.

(3) Total annual precipitation values for average and 20 year wet and dry scenarios were determined from annual totals from three Environment Canada climate stations covering a period of 1970 - 2015. The stations were: Dryden A (6032119) from 1970 - 2004; Dryden A (AUT) (6032120) from 2005 - 2009; and Dryden Regional (6032125) from 2011 to 2015. Data for 2010 was excluded from the analysis as it was incomplete, missing values for October through December. A normally distributed random variable with a mean of 671.4 mm and a standard deviation of 125.4 mm was fit to the annual precipitation totals. The 20 year dry and wet scenarios are represented by the 5th and 95th percentiles, respectively, of the normally distributed random variable.

(4) It is noted that the 1981 to 2010 climate normals for Dryden A have a total annual precipitation of 719.7 mm, while the average annual precipitation for the 1970 to 2015 is only 671.4 mm (Note 3). This difference may be partially explained by the inclusion of 2011 to 2015 years, all of which had total annual precipitation below 600 mm, and which had an average annual precipitation of 497.5 mm. If only the years 1981 - 2010 are considered in the set of annual precipitation data generated in Note 3, then the annual average precipitation is 698.8 mm, which is still less than the 1981 to 2010 climate normals for Dryden A, but is a deviation of only 2.9%. This remaining difference is likely due to the merging of different data sets; however, this was necessary to do since access to the Dryden A precipitation data was not available from the Environment Canada website beyond the year 2004

Table 4-2: Lake Evaporation

Month (1)	Monthly Lake Evaporation (mm)		
	Average (1)	Dry (3)	Wet (3)
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	0.0
April	8.7	11.2	6.3
May	100.4	128.3	72.5
June	117.1	149.7	84.6
July	130.7	167.0	94.4
August	105.8	135.2	76.4
September	55.5	70.9	40.1
October	30.4	38.9	22.0
November	0.0	0.0	0.0
December	0.0	0.0	0.0
Total	**548.6**	**701.0**	**396.2**

Notes:

(1) The distribution of monthly lake evaporation is based on the monthly distribution of the observed data (average condition).

(2) Monthly average lake evaporation was calculated from daily lake evaporation data 1969 to 1999 for Rawson Lake (6036904), obtained from Environment Canada. Missing days were ignored from the monthly average.

(3) Total lake evaporation for average and 1:20 year wet and dry scenarios were determined using a normally distributed random variable with a mean of 548.6 mm and a standard deviation of 92.6 mm was fit to the annual evaporation totals.

Table 4-3: Stage-Discharge Curve Correlation Values (DST, 2014)

Hydrometric Monitoring Station	Sub-watershed	Correlation Coefficient (R^2)
TL1A	Blackwater Creek	0.6107
JCTA	Blackwater Creek	0.7102
TL3	Blackwater Creek	0.6143
HS4	Thunder Lake Tributary 3	0.375
HS5	Hoffstrom's Bay Tributary	0.79
HS6	Little Creek	0.6413
HS7	Thunder Lake Tributary 2	0.875

Table 4-4: Summary of Hydrometric Monitoring Stations (DST, 2014)

Sub-watershed	Hydrometric Monitoring Station	Drainage Area (ha)	Date Installed	Monitoring Period	Average Daily Discharge Statistics (L/s)					
					2012			2013		
					Min	Max	Mean	Min	Max	Mean
Wabigoon Lake Watershed										
Blackwater Creek	TL1A	671	Dec 16, 2011	Dec 16, 2011 to Nov 6, 2012 and May 8, 2013 to Nov 7, 2013	0.1 May 18	173.3 Mar 12	27.0	9.6 Jul 4	356.3 May 8	53.0
	JCTA	835.2 (1)	May 15, 2013	May 15, 2013 to Nov 7, 2013	—	—	—	16.1 Oct 20	930.9 May 21	85.1
	TL3	1112.3 (2)	Dec 16, 2011	Dec 16, 2011 to Jan 19, 2013, and May 8, 2013 to Nov 7, 2013	2.7 Dec 26	81.4 Mar 18	7.2	19.9 May 18	100.6 Sep 1	66.2
Thunder Lake Watershed										
Thunder Lake Tributary 2	HS7	961.8	Jul 24, 2012	Jul 24, 2012 to Dec 10, 2012, and May 7, 2013 to Nov 7, 2013	19.7 Sep 1	127.7 Oct 10	53.0	15.2 Aug 20	791.6 May 21	91.0
Thunder Lake Tributary 3	HS4	1039.2	Jul 24, 2012	Jul 24, 2012 to Dec 10, 2012, and Jun 7, 2013 to Nov 7, 2013	13.1 Jul 28	77.2 Oct 25	26.8	26.5 Jul 5	569.2 Sep 20	111.6
Hoffstrom's Bay	HS5	223.5	Aug 22, 2012	Aug 22, 2012 to May 7, 2013, and Aug 22, 2013 to Nov 7, 2013	0.4 Dec 31	6.2 Oct 24	1.9	0.003 Jul 20	46.6 Apr 28	1.9
Little Creek	HS6	103.2	Jul 24, 2012	Jul 24, 2012 to Dec 10, 2012, and May 7, 2013 to Nov 7, 2013	9.2 Jul 24	12.5 Oct 24	10.6	0.1 May 13	22.0 May 7	3.6

Notes:
(1) Inclusive of TL1A. Without TL1A = 164.2 ha
(2) Inclusive of TL1A and JCTA. Without TL1A and JCTA = 277.1 ha

Table 4-5: Summary of WSC Stations Considered

Station Number	Station Name	Period of Record	Years	Distance and Direction from Site (km)	Drainage Area (km^2)	Regulation Type
05QD016	Wabigoon at Dryden	1970 - 2014	44	24 NW	2337.27	Regulated
02AB014	North Current River near Thunder Bay	1972 - 2015	43	282 SE	104.7	Natural
05PD015	Lake 240 Outlet near Kenora	1969-1995	26	83 W	7.25	Natural

Table 4-6: Monthly Runoff (mm) for WSC Stations Considered

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Runoff	Annual Runoff Coefficient
Wabigoon at Dryden	12.1	11.4	12.2	16.9	34.0	31.1	22.1	15.3	14.3	12.9	12.5	10.6	205	0.29
North Current River near Thunder Bay	8.6	5.9	9.8	97.8	90.2	35.8	17.9	9.4	22.6	30.8	34.0	17.2	380	0.55
Lake 240 Outlet near Kenora	6.0	4.4	5.2	44.7	50.6	27.0	25.0	9.8	16.2	19.5	15.6	10.4	234	0.33

Table 4-7: Annual Runoff Coefficients of Project Site Hydrometric Stations (TetraTech, 2014)

Station	Sub-Watershed	2012 Runoff Coefficient	2013 Runoff Coefficient	Mean Runoff Coefficient
TL1A	Blackwater Creek	0.21	0.48	0.35
JCTA	Blackwater Creek	-	0.62	0.62
TL3	Blackwater Creek	0.08	0.36	0.22
HS7	Thunder Lake Tributary 2	0.29	0.58	0.43
HS4	Thunder Lake Tributary 3	0.15	0.65	0.39
HS5	Hoffstrom's Bay Tributary	0.04	0.05	0.05

Note: Runoff coefficients from local hydrometric stations were obtained from *Goliath Gold Project Hydrologic Modelling Study* (Tetra Tech, 2014). A runoff coefficient for HS6 was not provided.

Table 4-8: Watershed Land Use Comparison (Goliath Project Site and Lake 240 Outlet near Kenora)

Land Cover Type	Goliath Project Site (1)	Lake 240 (2)
Forested / Treed	52%	77%
Wetland Areas / Open Water	19%	17%
Rock	0%	2%
Sand	0% (3)	0.0%
Not Applicable Areas	8% (4)	5%
Unknown Areas	21% (5)	0%

Notes:

(1) (Tetra Tech, 2014)

(2) Ontario Flow Assessment Tool (OFAT)

(3) Data from a different dataset than surficial geology

(4) Includes developed areas, highways, water bodies, etc.

(5) Unknown Areas represent areas that did not have land cover data.

Table 4-9: Lake 240 Outlet near Kenora (7.25 km^2) – Monthly Mean Discharge (05PD015)

Year	Jan (m³/s)	Feb (m³/s)	Mar (m³/s)	Apr (m³/s)	May (m³/s)	Jun (m³/s)	Jul (m³/s)	Aug (m³/s)	Sep (m³/s)	Oct (m³/s)	Nov (m³/s)	Dec (m³/s)	Mean (m³/s)	Annual Runoff (mm)
1969					0.15	0.119	0.072	0.17	0.069	0.136	0.043	0.029	0.099	428.5
1970	0.019	0.015	0.022	0.074	0.355	0.135	0.04	0.002	0.1	0.101	0.129	0.051	0.087	378.1
1971	0.024	0.015	0.014	0.16	0.125	0.098	0.124	0.033	0.036	0.168	0.136	0.052	0.082	357.0
1972	0.028	0.019	0.018	0.061	0.166	0.034	0.085	0.098	0.081	0.062	0.051	0.032	0.061	266.4
1973	0.021	0.01	0.014	0.1	0.107	0.059	0.081	0.103	0.123	0.154	0.062	0.041	0.073	317.2
1975	0.033	0.028	0.02	0.161	0.219	0.137	0.095	0.009	0.031	0.043	0.044	0.034	0.071	309.6
1976	0.024	0.022	0.022	0.243	0.104	0.032	0.035	0.001	0	0	0	0	0.040	175.1
1977	0	0	0.015	0.07	0.129	0.207	0.079	0.018	0.065	0.048	0.076	0.071	0.065	282.0
1978	0.034	0.018	0.012	0.205	0.288	0.16	0.046	0.039	0.039	0.03	0.016	0.022	0.076	329.5
1979	0.019	0.019	0.026	0.196	0.25	0.092	0.015	0	0	0	0.005	0.02	0.054	232.7
1980	0.023	0.018	0.014	0.098	0.07	0.007	0.008	0.056	0.064	0.061	0.058	0.032	0.042	184.5
1981	0.017	0.013	0.009	0.06	0.031	0.062	0.167	0.03	0.055	0.168	0.08	0.05	0.062	269.0
1982	0.032	0.022	0.02	0.24	0.179	0.098	0.163	0.032	0.009	0.2	0.069	0.043	0.092	401.3
1983	0.029	0.02	0.024	0.153	0.122	0.084	0.045	0.003	0	0	0	0	0.040	174.0
1984	0	0	0	0.144	0.078	0.064	0.024	0.001	0	0.013	0.066	0.06	0.038	163.1
1986	0.021	0.016	0.017	0.235	0.253	0.019	0.005	0	0	0	0.001	0.009	0.048	208.8
1987	0.006	0.005	0.033	0.135	0.041	0.054	0.007	0.001	0	0	0	0	0.024	102.2
1988	0	0	0	0.053	0.046	0.016	0.064	0.01	0	0	0	0	0.016	68.5
1989	0	0	0	0.136	0.152	0.094	0.055	0.009	0	0	0	0	0.037	161.7
1990	0	0	0	0.002	0.015	0.083	0.069	0.004	0	0	0	0	0.014	62.7
1991	0	0	0	0.017	0.13	0.039	0.025	0.002	0.025	0.09	0.107	0.073	0.042	184.1
1992	0.025	0.026	0.027	0.169	0.258	0.065	0.2	0.055	0.185	0.041	0.013	0.012	0.090	390.0
1993	0.002	0.002	0.008	0.069	0.068	0.049	0.104	0.104	0.062	0.022	0.014	0.002	0.042	183.4
1994	0	0	0	0.056	0.034	0.029	0.069	0.025	0.175	0.067	0.083	0.07	0.051	220.4
1995	0.031	0.02	0.025	0.064	0.067	0.035	0.02	0.004	0	0	0.002	0	0.022	97.1
Mean	0.016	0.012	0.014	0.121	0.137	0.073	0.068	0.027	0.044	0.053	0.042	0.028	**0.053**	229.9
Mean Runoff (mm)	5.973	4.433	5.234	44.655	50.597	26.969	25.014	9.836	16.163	19.518	15.578	10.375	—	—
1:20 Dry Year (1)	0.005	0.003	0.004	0.034	0.038	0.020	0.019	0.007	0.012	0.015	0.012	0.008	**0.015**	**64.5**
1:20 Wet Year (2)	0.028	0.021	0.024	0.208	0.235	0.126	0.116	0.046	0.075	0.091	0.073	0.048	**0.091**	**395.4**

Notes:

(1) Calculated as mean monthly flow x (0.015/0.053) (i.e., the monthly values are annualized)

(2) Calculated as mean monthly flow x (0.091/0.053) (i.e., the monthly values are annualized)

Table 4-10: Existing Conditions Drainage Areas

Sub-watershed	Location ID	Existing Conditions Drainage Area (km^2)
Thunder Lake Tributary 2	TL1	8.68
Thunder Lake Tributary 3	TL2	8.00
Thunder Lake Tributary 2	TL3	19.14
Hoffstrom's Bay Tributary	HB1	2.96
Little Creek	LC1	1.32
Blackwater Creek	BW1	11.64
Blackwater Creek	BW2	18.45
Thunder Creek	TC1	65.07
Wabigoon Lake	WR1	2,265.00

Table 4-11: Operations Phase Drainage Areas

Sub-Watershed	Location ID	Existing Conditions Drainage Area (km^2)	Mine Footprint within Existing Watersheds during Operations (km^2)	Un-affected Drainage Area (km^2)
Thunder Lake Tributary 2	TL1	8.68	0.00	8.68
Thunder Lake Tributary 3	TL2	8.00	0.00	8.00
Thunder Lake Tributary 2	TL3	19.14	0.00	19.14
Hoffstrom's Bay Tributary	HB1	2.96	0.23	2.73
Little Creek	LC1	1.32	0.12	1.20
Blackwater Creek	BW1	11.64	2.40	9.24
Blackwater Creek	BW2	18.45	2.40	16.05
Thunder Creek	TC1	65.07	0.34	64.72
Wabigoon Lake	WR1	2,265.00	2.74	2,262.26

Table 4-12: Expected Operations Water Taking from Local Tributaries

Month	Water Taking Rate (m^3/day)			Water Taking Rate (m^3/s)		
	Average	Dry	Wet	Average	Dry	Wet
From Thunder Lake Tributary 2 (TL1)						
January	82	23	0	0.001	0.000	0.000
February	62	17	0	0.001	0.000	0.000
March	72	21	0	0.001	0.000	0.000
April	6	175	0	0.000	0.002	0.000
May	0	199	0	0.000	0.002	0.000
June	0	106	0	0.000	0.001	0.000
July	0	98	0	0.000	0.001	0.000
August	0	39	0	0.000	0.000	0.000
September	0	63	0	0.000	0.001	0.000
October	0	76	0	0.000	0.001	0.000
November	0	61	0	0.000	0.001	0.000
December	143	41	0	0.002	0.000	0.000
Average	30	77	0	0.000	0.001	0.000
From Thunder Lake Tributary 3 (TL2)						
January	76	22	0	0.001	0.000	0.000
February	57	16	0	0.001	0.000	0.000
March	66	19	0	0.001	0.000	0.000
April	5	162	0	0.000	0.002	0.000
May	0	183	0	0.000	0.002	0.000
June	0	98	0	0.000	0.001	0.000
July	0	91	0	0.000	0.001	0.000
August	0	35	0	0.000	0.000	0.000
September	0	59	0	0.000	0.001	0.000
October	0	71	0	0.000	0.001	0.000
November	0	57	0	0.000	0.001	0.000
December	131	37	0	0.002	0.000	0.000
Average	28	71	0	0.000	0.001	0.000
Total Water Takings						
January	158	45	0	0.002	0.001	0.000
February	119	33	0	0.001	0.000	0.000
March	138	40	0	0.002	0.000	0.000
April	11	337	0	0.000	0.004	0.000
May	0	382	0	0.000	0.004	0.000
June	0	204	0	0.000	0.002	0.000
July	0	189	0	0.000	0.002	0.000
August	0	74	0	0.000	0.001	0.000
September	0	122	0	0.000	0.001	0.000
October	0	147	0	0.000	0.002	0.000
November	0	118	0	0.000	0.001	0.000
December	274	78	0	0.003	0.001	0.000
Average	58	148	0	0.001	0.002	0.000

Source: Conceptual Water Balance, appended to Project Update Report.

Table 4-13: Operations Mine Discharge Rate

Month	Treated Effluent Discharge (m^3/day)			Treated Effluent Discharge (m^3/s)		
	Average	Dry	Wet	Average	Dry	Wet
January	715	206	740	0.008	0.002	0.009
February	799	258	850	0.009	0.003	0.010
March	1,276	662	1,474	0.015	0.008	0.017
April	3,556	2,548	4,549	0.041	0.029	0.053
May	924	0	2,945	0.011	0.000	0.034
June	1,558	0	4,925	0.018	0.000	0.057
July	1,335	0	3,915	0.015	0.000	0.045
August	1,277	0	3,213	0.015	0.000	0.037
September	2,637	0	4,451	0.031	0.000	0.052
October	2,124	0	3,362	0.025	0.000	0.039
November	1,963	918	2,720	0.023	0.011	0.031
December	749	71	785	0.009	0.001	0.009
Average	**1,573**	**384**	**2,829**	**0.018**	**0.004**	**0.033**

Source: Conceptual Water Balance, appended to Project Update Report.

Table 4-14a: Post-Closure Drainage Area by Sub-watershed

Sub-Watershed	Location ID	Existing Conditions Drainage Area (km^2)	Mine Footprint Within Existing Watersheds Post-closure (km^2)	Un-affected Drainage Area (km^2)
Thunder Lake Tributary 2	TL1	8.68	0.00	8.68
Thunder Lake Tributary 3	TL2	8.00	0.00	8.00
Thunder Lake Tributary 2	TL3	19.14	0.00	19.14
Hoffstrom's Bay Tributary	HB1	2.96	0.21	2.75
Little Creek	LC1	1.32	0.10	1.22
Blackwater Creek	BW1	11.64	2.42	9.22
Blackwater Creek	BW2	18.45	2.42	16.04
Thunder Creek	TC1	65.07	0.31	64.75
Wabigoon Lake	WR1	2,265.00	2.73	2,262.27

Table 4-14b Post-Closure Drainage Area by Land Use

Land Use	Area (km^2)	% of Total
Area Restored to Natural State	0.46	17%
Semi-Impervious Membrane with Vegetated Cover	1.32	48%
Open Water	0.32	12%
Restored Operations Area	0.63	23%
Total	2.73	100%

Table 4-15: Post-Closure Runoff Coefficients

Flow Condition	Runoff Coefficient				
	Natural	Area Restored to Natural State	Semi-Impervious Membrane with Vegetated Cover	Open Water	Restored Operations Area
Dry	0.24	0.28	0.35	1.00	0.32
Average	0.34	0.40	0.50	1.00	0.45
Wet	0.46	0.54	0.68	1.00	0.61

Table 4-16: Existing Flow Conditions

Creek / Condition	Watershed Area (km^2)	Calculated Flow (m^3/s)													Mean Annual Runoff (mm)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
TL1															
Average (1)		0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	229.9
1:20 Dry Year (2, 3)	8.679	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	64.5
1:20 Wet Year (2, 4)		0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	395.4
TL2															
Average (1)		0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	229.9
1:20 Dry Year (2, 3)	7.999	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	64.5
1:20 Wet Year (2, 4)		0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.100	395.4
TL3															
Average (1)		0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	229.9
1:20 Dry Year (2, 3)	19.142	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	64.5
1:20 Wet Year (2, 4)		0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.240	395.4
HB1															
Average (1)		0.007	0.005	0.006	0.049	0.056	0.030	0.028	0.011	0.018	0.022	0.017	0.011	0.022	229.9
1:20 Dry Year (2, 3)	2.959	0.002	0.001	0.002	0.014	0.016	0.008	0.008	0.003	0.005	0.006	0.005	0.003	0.006	64.5
1:20 Wet Year (2, 4)		0.011	0.008	0.010	0.085	0.096	0.051	0.048	0.019	0.031	0.037	0.030	0.020	0.037	395.4
LC1															
Average (1)		0.003	0.002	0.003	0.022	0.025	0.013	0.012	0.005	0.008	0.010	0.008	0.005	0.010	229.9
1:20 Dry Year (2, 3)	1.316	0.001	0.001	0.001	0.006	0.007	0.004	0.003	0.001	0.002	0.003	0.002	0.001	0.003	64.5
1:20 Wet Year (2, 4)		0.005	0.004	0.004	0.038	0.043	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	395.4
BW1															
Average (1)		0.026	0.019	0.023	0.194	0.220	0.117	0.109	0.043	0.070	0.085	0.068	0.045	0.085	229.9
1:20 Dry Year (2, 3)	11.637	0.007	0.005	0.006	0.054	0.062	0.033	0.030	0.012	0.020	0.024	0.019	0.013	0.024	64.5
1:20 Wet Year (2, 4)		0.045	0.033	0.039	0.334	0.378	0.201	0.187	0.073	0.121	0.146	0.116	0.078	0.146	395.4
BW2															
Average (1)		0.041	0.031	0.036	0.308	0.349	0.186	0.172	0.068	0.111	0.134	0.107	0.071	0.135	229.9
1:20 Dry Year (2, 3)	18.454	0.012	0.009	0.010	0.086	0.098	0.052	0.048	0.019	0.031	0.038	0.030	0.020	0.038	64.5
1:20 Wet Year (2, 4)		0.071	0.053	0.062	0.529	0.599	0.319	0.296	0.117	0.191	0.231	0.185	0.123	0.231	395.4

Notes:

(1) Flows are prorated from Lake 240 Outlet near Kenora (WSC Station 05PD015)

(2) Prorated annualized flows for monthly 1:20 wet and dry are different from monthly 1:20 wet and dry flows; Monthly 1:20 year wet and dry flows would be more extreme

(3) 1:20 dry year annualized values prorated by a factor of (0.015/0.053) derived from Lake 240 Outlet near Kenora (WSC Station 05PD015) flow statistics

(4) 1:20 wet year annualized values prorated by a factor of (0.091/0.053) derived from Lake 240 Outlet near Kenora (WSC Station 05PD015) flow statistics

Table 4-17a: Surface Water Hydrology Results for Operations, Average Year Conditions

Sub-watershed ID	Scenario	Calculated Flows (m^3/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	—	—
	Operations	0.018	0.014	0.016	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.032	0.063	0.000	-0.6
TL2	Existing	0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	—	—
	Operations	0.017	0.013	0.015	0.133	0.151	0.080	0.075	0.029	0.048	0.058	0.046	0.029	0.058	0.000	-0.8
TL3	Existing	0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	—	—
	Operations	0.040	0.030	0.035	0.315	0.357	0.190	0.177	0.069	0.114	0.138	0.110	0.070	0.138	-0.002	-1.7
HB1	Existing	0.007	0.005	0.006	0.049	0.056	0.030	0.028	0.011	0.018	0.022	0.017	0.011	0.022	—	—
	Operations	0.006	0.005	0.005	0.046	0.052	0.027	0.025	0.010	0.016	0.020	0.016	0.011	0.020	-0.002	-7.8
LC1	Existing	0.003	0.002	0.003	0.022	0.025	0.013	0.012	0.005	0.008	0.010	0.008	0.005	0.010	—	—
	Operations	0.003	0.002	0.002	0.020	0.023	0.012	0.011	0.004	0.007	0.009	0.007	0.005	0.009	-0.001	-8.7
BW1	Existing	0.026	0.019	0.023	0.194	0.220	0.117	0.109	0.043	0.070	0.085	0.068	0.045	0.085	—	—
	Operations	0.028	0.024	0.032	0.186	0.175	0.106	0.097	0.047	0.083	0.088	0.073	0.042	0.082	-0.003	-3.9
BW2	Existing	0.041	0.031	0.036	0.308	0.349	0.186	0.172	0.068	0.111	0.134	0.107	0.071	0.135	—	—
	Operations	0.042	0.034	0.044	0.290	0.293	0.168	0.155	0.070	0.121	0.133	0.110	0.067	0.127	-0.007	-5.5

Table 4-17b: Surface Water Hydrology Results for Operations, Dry Year Conditions

Sub-watershed ID	Scenario	Calculated Flows (m³/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	—	—
	Operations	0.005	0.004	0.005	0.039	0.044	0.023	0.022	0.008	0.014	0.017	0.013	0.009	0.017	-0.001	-5.0
TL2	Existing	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	—	—
	Operations	0.005	0.004	0.004	0.035	0.040	0.021	0.020	0.008	0.013	0.016	0.012	0.008	0.016	-0.001	-5.2
TL3	Existing	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	—	—
	Operations	0.011	0.008	0.010	0.085	0.096	0.051	0.047	0.019	0.031	0.037	0.029	0.020	0.037	-0.002	-5.6
HB1	Existing	0.002	0.001	0.002	0.014	0.016	0.008	0.008	0.003	0.005	0.006	0.005	0.003	0.006	—	—
	Operations	0.002	0.001	0.001	0.013	0.014	0.008	0.007	0.003	0.005	0.006	0.004	0.003	0.006	0.000	-7.8
LC1	Existing	0.001	0.001	0.001	0.006	0.007	0.004	0.003	0.001	0.002	0.003	0.002	0.001	0.003	—	—
	Operations	0.001	0.001	0.001	0.006	0.006	0.003	0.003	0.001	0.002	0.002	0.002	0.001	0.002	0.000	-8.7
BW1	Existing	0.007	0.005	0.006	0.054	0.062	0.033	0.030	0.012	0.020	0.024	0.019	0.013	0.024	—	—
	Operations	0.008	0.007	0.012	0.070	0.046	0.025	0.023	0.009	0.015	0.018	0.025	0.010	0.022	-0.002	-6.7
BW2	Existing	0.012	0.009	0.010	0.086	0.098	0.052	0.048	0.019	0.031	0.038	0.030	0.020	0.038	—	—
	Operations	0.012	0.010	0.016	0.099	0.079	0.042	0.039	0.015	0.025	0.031	0.035	0.017	0.035	-0.003	-7.3

Table 4-17c: Surface Water Hydrology Results for Operations, Wet Year Conditions

Sub-watershed ID	Scenario	Calculated Flows (m^3/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	—	—
	Operations	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	0.000	0.0
TL2	Existing	0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.101	—	—
	Operations	0.031	0.023	0.027	0.229	0.259	0.138	0.128	0.050	0.083	0.100	0.080	0.053	0.100	0.000	-0.2
TL3	Existing	0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.241	—	—
	Operations	0.072	0.054	0.064	0.542	0.614	0.327	0.304	0.119	0.196	0.237	0.189	0.126	0.238	-0.003	-1.2
HB1	Existing	0.011	0.008	0.010	0.085	0.096	0.051	0.048	0.019	0.031	0.037	0.030	0.020	0.037	—	—
	Operations	0.010	0.008	0.009	0.078	0.089	0.047	0.044	0.017	0.028	0.034	0.027	0.018	0.034	-0.003	-7.8
LC1	Existing	0.005	0.004	0.004	0.038	0.043	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.017	—	—
	Operations	0.005	0.003	0.004	0.034	0.039	0.021	0.019	0.008	0.012	0.015	0.012	0.008	0.015	-0.001	-8.7
BW1	Existing	0.045	0.033	0.039	0.334	0.378	0.201	0.187	0.073	0.121	0.146	0.116	0.078	0.146	—	—
	Operations	0.042	0.035	0.047	0.306	0.321	0.210	0.187	0.093	0.143	0.150	0.120	0.068	0.144	-0.003	-1.7
BW2	Existing	0.071	0.053	0.062	0.529	0.599	0.319	0.296	0.117	0.191	0.231	0.185	0.123	0.232	—	—
	Operations	0.067	0.053	0.068	0.489	0.529	0.321	0.290	0.133	0.209	0.230	0.184	0.110	0.224	-0.008	-3.4

Table 4-18a: Calculated Flows in Blackwater Creek at BW1 during Operations, Average Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Operations, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Treated Discharge from Project to Blackwater Creek (m^3/s)	Reduction of Baseflow due to Open Pit ZOI in BW1 (m^3/s)	Net Flows during Operations (m^3/s)	Change in Net Flows at BW1 (%)
January	0.026	0.021	0.008	0.001	0.028	+6.6%
February	0.019	0.015	0.009	0.001	0.024	+22.7%
March	0.023	0.018	0.015	0.001	0.032	+39.6%
April	0.194	0.154	0.041	0.009	0.186	-4.1%
May	0.220	0.175	0.011	0.010	0.175	-20.4%
June	0.117	0.093	0.018	0.005	0.106	-9.9%
July	0.109	0.086	0.015	0.005	0.097	-11.1%
August	0.043	0.034	0.015	0.002	0.047	+9.3%
September	0.070	0.056	0.031	0.003	0.083	+18.2%
October	0.085	0.067	0.025	0.004	0.088	+3.7%
November	0.068	0.054	0.023	0.003	0.073	+8.3%
December	0.045	0.036	0.009	0.002	0.042	-6.1%
Annual	**0.085**	**0.068**	**0.018**	**0.004**	**0.082**	**-3.90%**

Table 4-18b: Calculated Flows in Blackwater Creek at BW1 during Operations, Dry Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Operations, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Treated Discharge from Project to Blackwater Creek (m^3/s)	Reduction of Flow due to dewatered Mine's ZOI in BW1 (m^3/s)	Net Flows during Operations (m^3/s)	Change in Net Flows at BW1 (%)
January	0.007	0.006	0.002	0.000	0.008	+7.4%
February	0.005	0.004	0.003	0.000	0.007	+30.0%
March	0.006	0.005	0.008	0.000	0.012	+94.8%
April	0.054	0.043	0.029	0.003	0.070	+28.9%
May	0.062	0.049	0.000	0.003	0.046	-25.3%
June	0.033	0.026	0.000	0.002	0.025	-25.3%
July	0.030	0.024	0.000	0.001	0.023	-25.3%
August	0.012	0.010	0.000	0.001	0.009	-25.3%
September	0.020	0.016	0.000	0.001	0.015	-25.3%
October	0.024	0.019	0.000	0.001	0.018	-25.3%
November	0.019	0.015	0.011	0.001	0.025	+30.7%
December	0.013	0.010	0.001	0.001	0.010	-18.8%
Annual	**0.024**	**0.019**	**0.004**	**0.001**	**0.022**	**-6.7%**

Table 4-18c: Calculated Flows in Blackwater Creek at BW1 during Operations, Wet Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Operations, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Treated Discharge from Project to Blackwater Creek (m^3/s)	Reduction of Flow due to dewatered Mine's ZOI in BW1 (m^3/s)	Net Flows during Operations (m^3/s)	Change in Net Flows at BW1 (%)
January	0.045	0.035	0.009	0.002	0.042	-4.9%
February	0.033	0.026	0.010	0.001	0.035	+5.6%
March	0.039	0.031	0.017	0.001	0.047	+19.5%
April	0.334	0.265	0.053	0.012	0.306	-8.3%
May	0.378	0.300	0.034	0.013	0.321	-15.1%
June	0.201	0.160	0.057	0.007	0.210	+4.2%
July	0.187	0.148	0.045	0.007	0.187	+0.1%
August	0.073	0.058	0.037	0.003	0.093	+26.5%
September	0.121	0.096	0.052	0.004	0.143	+18.5%
October	0.146	0.116	0.039	0.005	0.150	+2.6%
November	0.116	0.092	0.031	0.004	0.120	+2.9%
December	0.078	0.062	0.009	0.003	0.068	-12.4%
Annual	**0.146**	**0.116**	**0.033**	**0.005**	**0.144**	**-1.7%**

Table 4-19a: Surface Water Hydrology Results for Post-Closure, Average Year Conditions (dry cover TSF)

Sub-watershed ID	Scenario	Calculated Flows (m^3/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	—	—
	Post-closure	0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	0.000	0.0
TL2	Existing	0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	—	—
	Post-closure	0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	0.000	0.0
TL3	Existing	0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	—	—
	Post-closure	0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	0.000	0.0
HB1	Existing	0.007	0.005	0.006	0.049	0.056	0.030	0.028	0.011	0.018	0.022	0.017	0.011	0.022	—	—
	Post-closure	0.006	0.005	0.005	0.046	0.052	0.028	0.026	0.010	0.017	0.020	0.016	0.011	0.020	-0.002	-7.2
LC1	Existing	0.003	0.002	0.003	0.022	0.025	0.013	0.012	0.005	0.008	0.010	0.008	0.005	0.010	—	—
	Post-closure	0.003	0.002	0.002	0.020	0.023	0.012	0.011	0.004	0.007	0.009	0.007	0.005	0.009	-0.001	-7.5
BW1	Existing	0.026	0.019	0.023	0.194	0.220	0.117	0.109	0.043	0.070	0.085	0.068	0.045	0.085	—	—
	Post-closure	0.031	0.024	0.028	0.224	0.243	0.122	0.111	0.038	0.076	0.096	0.080	0.053	0.094	0.009	+10.6
BW2	Existing	0.041	0.031	0.036	0.308	0.349	0.186	0.172	0.068	0.111	0.134	0.107	0.071	0.135	—	—
	Post-closure	0.047	0.035	0.041	0.338	0.372	0.191	0.175	0.063	0.117	0.145	0.119	0.080	0.144	0.009	+6.7

Table 4-19b: Surface Water Hydrology Results for Post-Closure, Dry Year Conditions (dry cover TSF)

Sub-watershed ID	Scenario	Calculated Flows (m³/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	—	—
	Post-closure	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	0.000	0.0
TL2	Existing	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	—	—
	Post-closure	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	0.000	0.0
TL3	Existing	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	—	—
	Post-closure	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	0.000	0.0
HB1	Existing	0.002	0.001	0.002	0.014	0.016	0.008	0.008	0.003	0.005	0.006	0.005	0.003	0.006	—	—
	Post-closure	0.002	0.001	0.002	0.013	0.015	0.008	0.007	0.003	0.005	0.006	0.004	0.003	0.006	0.000	-7.2
LC1	Existing	0.001	0.001	0.001	0.006	0.007	0.004	0.003	0.001	0.002	0.003	0.002	0.001	0.003	—	—
	Post-closure	0.001	0.001	0.001	0.006	0.006	0.003	0.003	0.001	0.002	0.002	0.002	0.001	0.002	0.000	-7.5
BW1	Existing	0.007	0.005	0.006	0.054	0.062	0.033	0.030	0.012	0.020	0.024	0.019	0.013	0.024	—	—
	Post-closure	0.012	0.009	0.011	0.080	0.077	0.032	0.027	0.010	0.016	0.032	0.029	0.020	0.030	0.006	+24.3
BW2	Existing	0.012	0.009	0.010	0.086	0.098	0.052	0.048	0.019	0.031	0.038	0.030	0.020	0.038	—	—
	Post-closure	0.016	0.013	0.015	0.112	0.114	0.051	0.045	0.017	0.027	0.046	0.041	0.028	0.044	0.006	+15.3

Table 4-19c: Surface Water Hydrology Results for Post-Closure, Wet Year Conditions (dry cover TSF)

Sub-watershed ID	Scenario	Calculated Flows (m^3/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	—	—
	Post-closure	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	0.000	0.0
TL2	Existing	0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.101	—	—
	Post-closure	0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.101	0.000	0.0
TL3	Existing	0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.241	—	—
	Post-closure	0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.241	0.000	0.0
HB1	Existing	0.011	0.008	0.010	0.085	0.096	0.051	0.048	0.019	0.031	0.037	0.030	0.020	0.037	—	—
	Post-closure	0.011	0.008	0.009	0.079	0.089	0.048	0.044	0.017	0.028	0.034	0.027	0.018	0.035	-0.003	-7.2
LC1	Existing	0.005	0.004	0.004	0.038	0.043	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.017	—	—
	Post-closure	0.005	0.003	0.004	0.035	0.040	0.021	0.020	0.008	0.013	0.015	0.012	0.008	0.015	-0.001	-7.5
BW1	Existing	0.045	0.033	0.039	0.334	0.378	0.201	0.187	0.073	0.121	0.146	0.116	0.078	0.146	—	—
	Post-closure	0.052	0.039	0.046	0.382	0.425	0.222	0.204	0.076	0.135	0.166	0.135	0.090	0.165	0.018	+12.6
BW2	Existing	0.071	0.053	0.062	0.529	0.599	0.319	0.296	0.117	0.191	0.231	0.185	0.123	0.232	—	—
	Post-closure	0.079	0.059	0.069	0.578	0.647	0.340	0.313	0.119	0.205	0.251	0.203	0.135	0.250	0.018	+8.0

Table 4-20a: Calculated Flows in Blackwater Creek at BW1 during Post-Closure, Average Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Post-closure, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Discharge from Pit Lake to Blackwater Creek (m^3/s)	Net Flows during Post-closure (m^3/s)	Change in Net Flows at BW1 (%)
January	0.026	0.021	0.011	0.031	+20.8%
February	0.019	0.015	0.008	0.024	+22.7%
March	0.023	0.018	0.010	0.028	+21.6%
April	0.194	0.154	0.070	0.224	+15.6%
May	0.220	0.174	0.069	0.243	+10.6%
June	0.117	0.093	0.029	0.122	+4.4%
July	0.109	0.086	0.025	0.111	+2.5%
August	0.043	0.034	0.004	0.038	-10.6%
September	0.070	0.056	0.020	0.076	+7.8%
October	0.085	0.067	0.028	0.096	+12.8%
November	0.068	0.054	0.026	0.080	+17.5%
December	0.045	0.036	0.018	0.053	+18.5%
Annual	**0.085**	**0.067**	**0.027**	**0.094**	**+10.6%**

Table 4-20b: Calculated Flows in Blackwater Creek at BW1 during Post-Closure, Dry Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Post-closure, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Discharge from Pit Lake to Blackwater Creek (m^3/s)	Net Flows during Post-closure (m^3/s)	Change in Net Flows at BW1 (%)
January	0.007	0.006	0.006	0.012	+67.2%
February	0.005	0.004	0.005	0.009	+74.0%
March	0.006	0.005	0.006	0.011	+70.0%
April	0.054	0.043	0.037	0.080	+47.9%
May	0.062	0.049	0.029	0.077	+25.5%
June	0.033	0.026	0.006	0.032	-3.6%
July	0.030	0.024	0.003	0.027	-12.3%
August	0.012	0.010	0.000	0.010	-20.8%
September	0.020	0.016	0.000	0.016	-21.2%
October	0.024	0.019	0.013	0.032	+34.4%
November	0.019	0.015	0.014	0.029	+55.2%
December	0.013	0.010	0.010	0.020	+59.0%
Annual	**0.024**	**0.019**	**0.011**	**0.030**	**+24.3%**

Table 4-20c: Calculated Flows in Blackwater Creek at BW1 during Post-Closure, Wet Year

Month	Existing Conditions, Calculated Flows (m^3/s) (watershed 11.64 km^2)	Post-closure, Calculated Flows (m^3/s) (watershed 9.24 km^2)	Discharge from Pit Lake to Blackwater Creek (m^3/s)	Net Flows during Post-closure (m^3/s)	Change in Net Flows at BW1 (%)
January	0.045	0.035	0.017	0.052	+17.6%
February	0.033	0.026	0.013	0.039	+18.7%
March	0.039	0.031	0.015	0.046	+18.0%
April	0.334	0.264	0.118	0.382	+14.6%
May	0.378	0.300	0.126	0.425	+12.5%
June	0.201	0.160	0.062	0.222	+10.0%
July	0.187	0.148	0.056	0.204	+9.2%
August	0.073	0.058	0.018	0.076	+4.0%
September	0.121	0.096	0.039	0.135	+11.5%
October	0.146	0.116	0.050	0.166	+13.6%
November	0.116	0.092	0.042	0.135	+15.6%
December	0.078	0.061	0.029	0.090	+16.2%
Annual	**0.146**	**0.116**	**0.049**	**0.165**	**+12.6%**

Table 4-21: Wet Cover Land Uses

Land Use	Area (km^2)	% of Total
Area Restored to Natural State	0.46	17%
Semi-Impervious Membrane with Vegetated Cover	0.70	26%
Open Water	0.94	34%
Restored Operations Area	0.63	23%
Total	**2.73**	**100%**

Table 4-22a: Surface Water Hydrology Results for Post-Closure, Average Year Conditions (wet cover TSF)

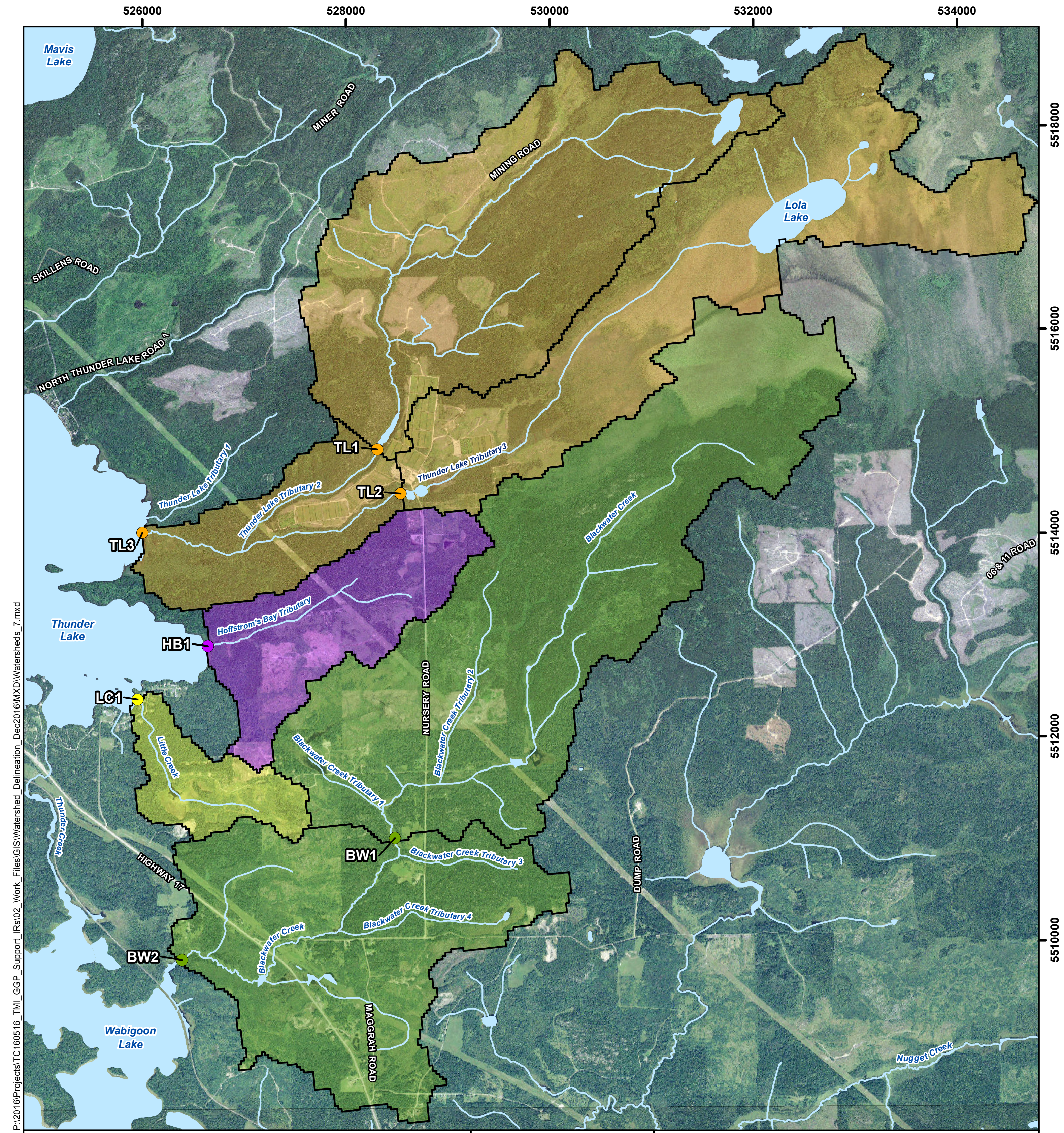
Sub-watershed ID	Scenario	Calculated Flows (m³/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	—	—
	Post-closure	0.019	0.014	0.017	0.145	0.164	0.087	0.081	0.032	0.052	0.063	0.050	0.034	0.063	0.000	0.0
TL2	Existing	0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	—	—
	Post-closure	0.018	0.013	0.016	0.133	0.151	0.081	0.075	0.029	0.048	0.058	0.047	0.031	0.058	0.000	0.0
TL3	Existing	0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	—	—
	Post-closure	0.043	0.032	0.037	0.319	0.362	0.193	0.179	0.070	0.116	0.139	0.111	0.074	0.140	0.000	0.0
HB1	Existing	0.007	0.005	0.006	0.049	0.056	0.030	0.028	0.011	0.018	0.022	0.017	0.011	0.022	—	—
	Post-closure	0.006	0.005	0.005	0.046	0.052	0.028	0.026	0.010	0.017	0.020	0.016	0.011	0.020	-0.002	-7.2
LC1	Existing	0.003	0.002	0.003	0.022	0.025	0.013	0.012	0.005	0.008	0.010	0.008	0.005	0.010	—	—
	Post-closure	0.003	0.002	0.002	0.020	0.023	0.012	0.011	0.004	0.007	0.009	0.007	0.005	0.009	-0.001	-7.5
BW1	Existing	0.026	0.019	0.023	0.194	0.220	0.117	0.109	0.043	0.070	0.085	0.068	0.045	0.085	—	—
	Post-closure	0.029	0.022	0.026	0.228	0.237	0.113	0.103	0.035	0.070	0.089	0.074	0.050	0.090	0.005	+5.7
BW2	Existing	0.041	0.031	0.036	0.308	0.349	0.186	0.172	0.068	0.111	0.134	0.107	0.071	0.135	—	—
	Post-closure	0.045	0.033	0.039	0.341	0.366	0.182	0.167	0.060	0.111	0.139	0.114	0.076	0.140	0.005	+3.6

Table 4-22b: Surface Water Hydrology Results for Post-Closure, Dry Year Conditions (wet cover TSF)

Sub-watershed ID	Scenario	Calculated Flows (m^3/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	—	—
	Post-closure	0.005	0.004	0.005	0.041	0.046	0.025	0.023	0.009	0.015	0.018	0.014	0.009	0.018	0.000	0.0
TL2	Existing	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	—	—
	Post-closure	0.005	0.004	0.004	0.037	0.042	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.016	0.000	0.0
TL3	Existing	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	—	—
	Post-closure	0.012	0.009	0.010	0.090	0.101	0.054	0.050	0.020	0.032	0.039	0.031	0.021	0.039	0.000	0.0
HB1	Existing	0.002	0.001	0.002	0.014	0.016	0.008	0.008	0.003	0.005	0.006	0.005	0.003	0.006	—	—
	Post-closure	0.002	0.001	0.002	0.013	0.015	0.008	0.007	0.003	0.005	0.006	0.004	0.003	0.006	0.000	-7.2
LC1	Existing	0.001	0.001	0.001	0.006	0.007	0.004	0.003	0.001	0.002	0.003	0.002	0.001	0.003	—	—
	Post-closure	0.001	0.001	0.001	0.006	0.006	0.003	0.003	0.001	0.002	0.002	0.002	0.001	0.002	0.000	-7.5
BW1	Existing	0.007	0.005	0.006	0.054	0.062	0.033	0.030	0.012	0.020	0.024	0.019	0.013	0.024	—	—
	Post-closure	0.014	0.011	0.012	0.091	0.069	0.027	0.024	0.010	0.016	0.023	0.027	0.018	0.029	0.005	+19.6
BW2	Existing	0.012	0.009	0.010	0.086	0.098	0.052	0.048	0.019	0.031	0.038	0.030	0.020	0.038	—	—
	Post-closure	0.018	0.014	0.016	0.123	0.105	0.047	0.042	0.017	0.027	0.037	0.038	0.026	0.043	0.005	+12.4

Table 4-22c: Surface Water Hydrology Results for Post-Closure, Wet Year Conditions (wet cover TSF)

Sub-watershed ID	Scenario	Calculated Flows (m³/s)														ΔQ (%)
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	ΔQ	
TL1	Existing	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	—	—
	Post-closure	0.033	0.025	0.029	0.249	0.282	0.150	0.139	0.055	0.090	0.109	0.087	0.058	0.109	0.000	0.0
TL2	Existing	0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.101	—	—
	Post-closure	0.031	0.023	0.027	0.229	0.260	0.138	0.128	0.051	0.083	0.100	0.080	0.053	0.101	0.000	0.0
TL3	Existing	0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.241	—	—
	Post-closure	0.073	0.054	0.064	0.549	0.622	0.331	0.307	0.121	0.199	0.240	0.191	0.127	0.241	0.000	0.0
HB1	Existing	0.011	0.008	0.010	0.085	0.096	0.051	0.048	0.019	0.031	0.037	0.030	0.020	0.037	—	—
	Post-closure	0.011	0.008	0.009	0.079	0.089	0.048	0.044	0.017	0.028	0.034	0.027	0.018	0.035	-0.003	-7.2
LC1	Existing	0.005	0.004	0.004	0.038	0.043	0.023	0.021	0.008	0.014	0.016	0.013	0.009	0.017	—	—
	Post-closure	0.005	0.003	0.004	0.035	0.040	0.021	0.020	0.008	0.013	0.015	0.012	0.008	0.015	-0.001	-7.5
BW1	Existing	0.045	0.033	0.039	0.334	0.378	0.201	0.187	0.073	0.121	0.146	0.116	0.078	0.146	—	—
	Post-closure	0.054	0.041	0.048	0.393	0.423	0.209	0.189	0.071	0.125	0.162	0.139	0.093	0.163	0.016	+11.1
BW2	Existing	0.071	0.053	0.062	0.529	0.599	0.319	0.296	0.117	0.191	0.231	0.185	0.123	0.232	—	—
	Post-closure	0.080	0.060	0.070	0.589	0.644	0.327	0.299	0.114	0.196	0.247	0.207	0.138	0.248	0.016	+7.0



LEGEND

Sub-Watershed Outlet Locations

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2

Sub-Watershed

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Agriculture Information Atlas, OMAFRA.

Datum: NAD83
Projection: UTM Zone 15N

0 0.25 0.5 1 1.5 2 2.5 3 Kilometres

amec foster wheeler

GOLIATH GOLD PROJECT

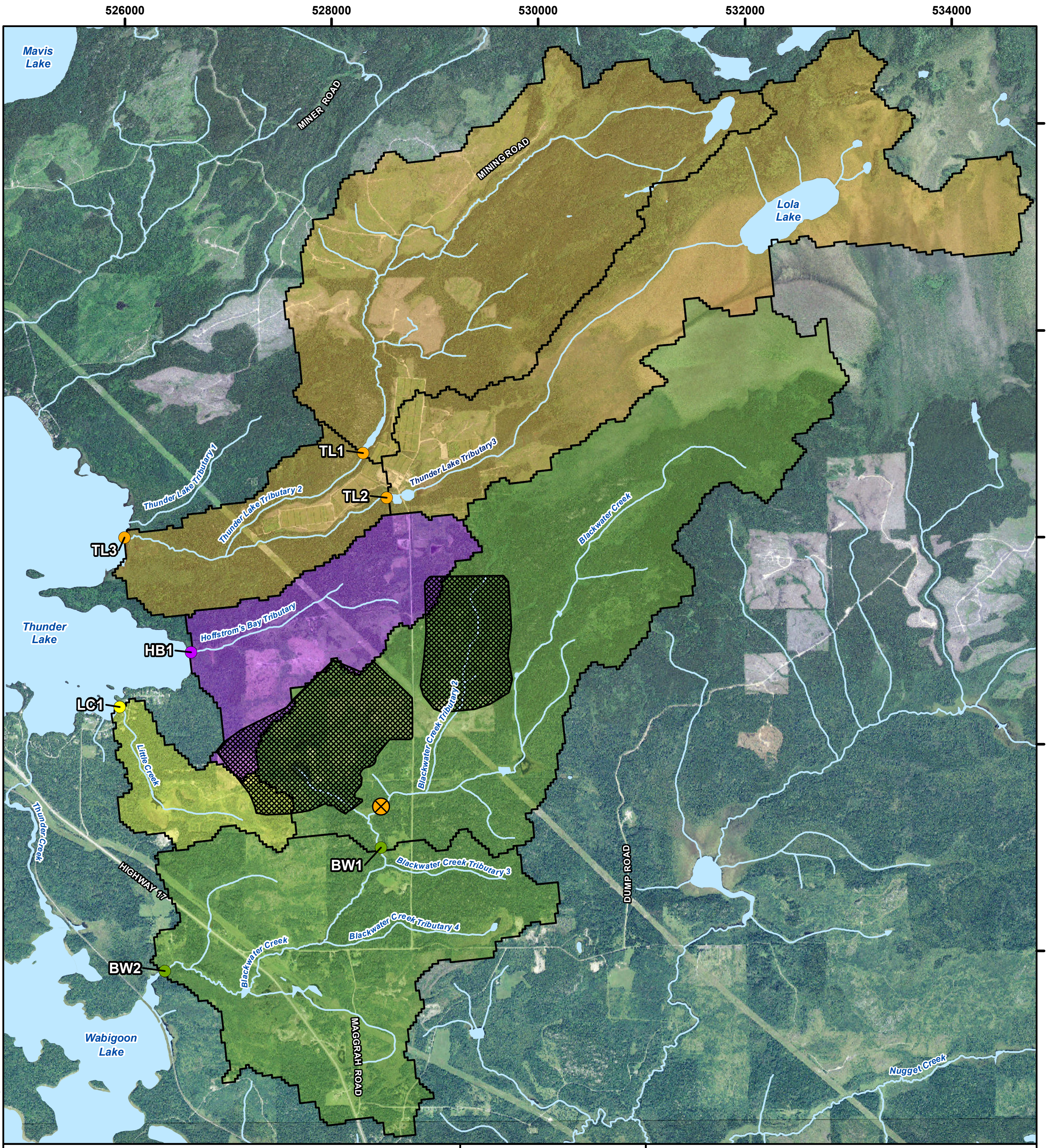
Existing Sub-Watersheds

PROJECT N°: TC160516

FIGURE: 4-1

SCALE: 1:50,000

DATE: March 2017



P:\2016\Projects\TC160516_TMI_GGP_Support_IRs\02_Work_Files\GIS\Watershed_Delineation_Dec2016\MXD\Operational_Watersheds_7.mxd

LEGEND

Operations Area — Effluent Discharge Location

Sub-Watershed Outlet Locations
- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2

Sub-Watershed
- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

0 0.25 0.5 1 1.5 2 2.5 3 Kilometres

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Agriculture Information Atlas, OMAFRA.

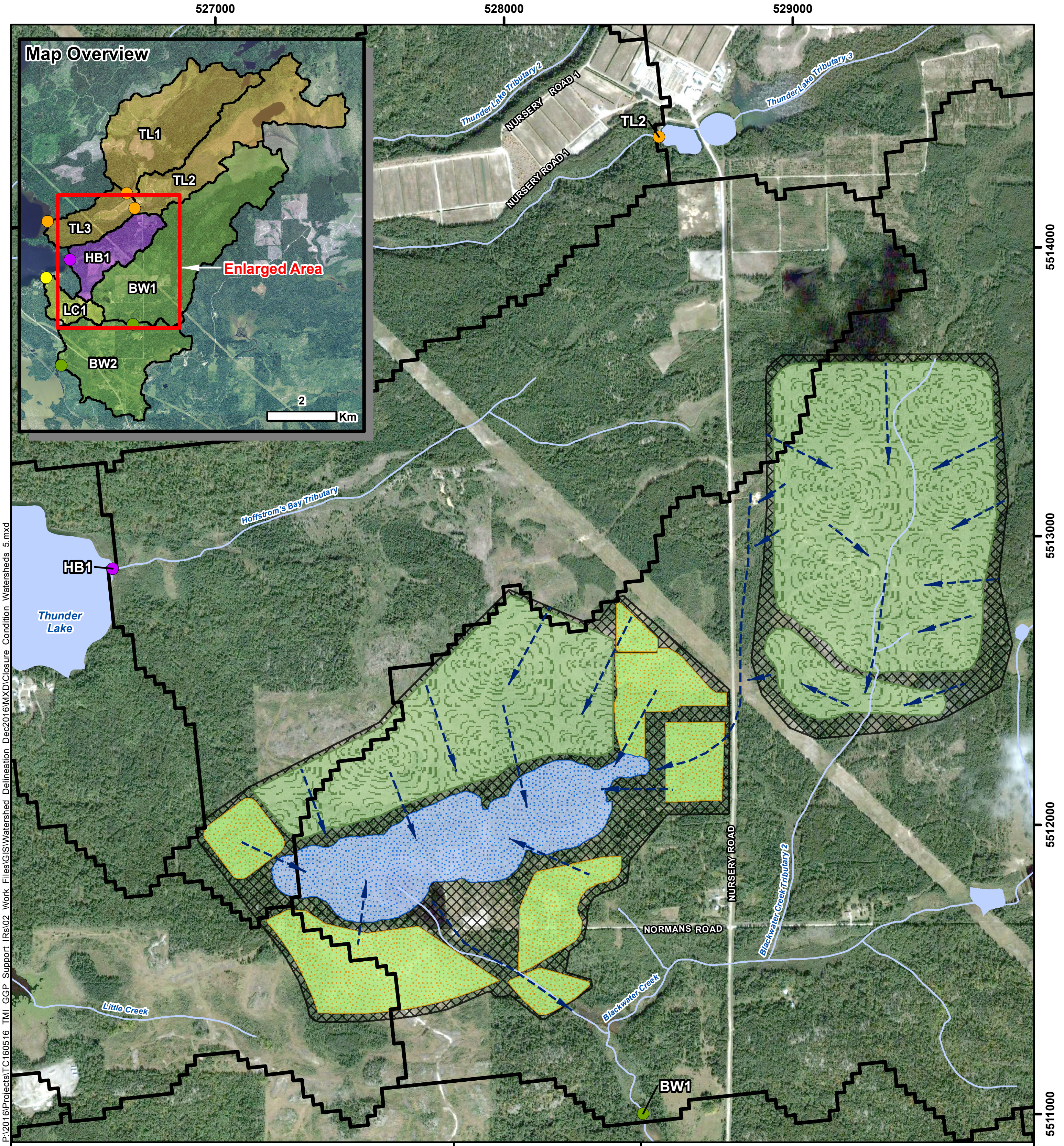
Datum: NAD83
Projection: UTM Zone 15N

amec foster wheeler

GOLIATH GOLD PROJECT

Operational Sub-Watersheds

PROJECT Nº: TC160516	**FIGURE: 4-2**
SCALE: 1:50,000	DATE: April 2017



LEGEND

Post Closure Land Use
- Flooded Open Pit
- Restored Operations Area
- Return to Prior State
- Semi-impervious Membrane

- Post Closure Flow Direction
- Sub-Watershed Boundary

Sub-Watershed Outlet Locations
- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2

Sub-Watershed
- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Google Earth Pro, 2006

Datum: NAD83
Projection: UTM Zone 15N

0 0.25 0.5 1 1.5 Kilometres

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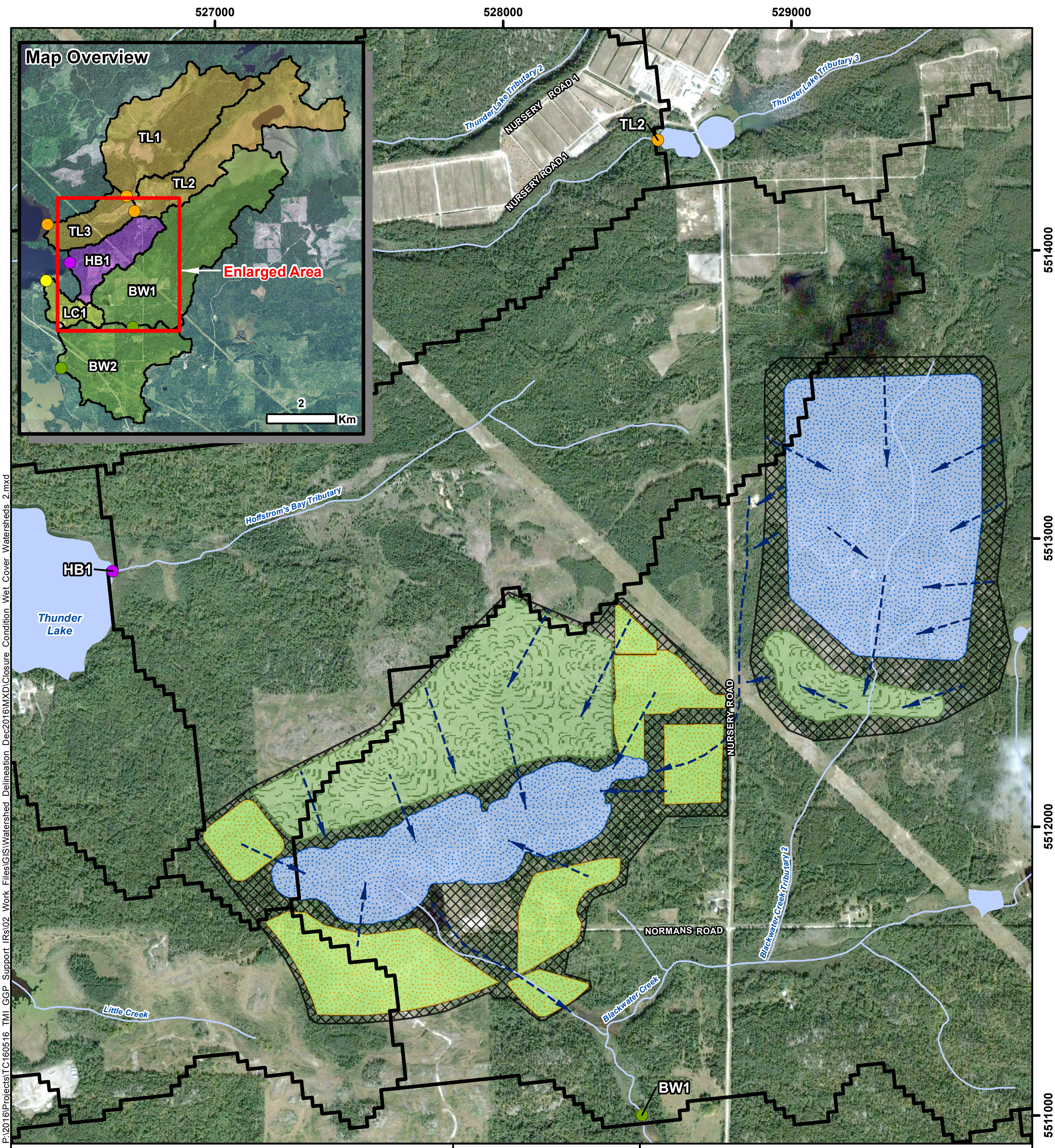
GOLIATH GOLD PROJECT

Post Closure Land Use Dry TSF Cover

PROJECT N^o^: TC160516 | FIGURE: 4-3
SCALE: 1:18,000 | DATE: March 2017



LEGEND

Post Closure Land Use

- Flooded Open Pit/Wet TSF Cover
- Restored Operations Area
- Return to Prior State
- Semi-impervious Membrane
- Post Closure Flow Direction
- Sub-Watershed Boundary

Sub-Watershed Outlet Locations

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2

Sub-Watershed

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Google Earth Pro, 2006

Datum: NAD83
Projection: UTM Zone 15N

0 0.25 0.5 1 1.5 Kilometres

N W E S

amec foster wheeler

GOLIATH GOLD PROJECT

Post Closure Land Use Wet TSF Cover

PROJECT N^{o}: TC160516	FIGURE: 4-4
SCALE: 1:18,000	DATE: March 2017

5.0 GEOCHEMISTRY

During operations, all water from active mining areas will be intercepted, collected and treated as necessary. However, assessment of water quality in the post-closure period is required to guide management and mitigation decisions to support long-term closure without a requirement for ongoing water treatment.

The mine rock and tailings for the Project have largely been identified as being potentially acid generating (PAG) based on previous static and kinetic testing. However, the risk of metal leaching and acid rock drainage (ML/ARD) was expected to be largely minimized by a time lag to acidic conditions measured in tens of years (Appendix K of the EIS). This suggested development of ML/ARD would not occur within the operational time frame of the mine (about 15 years including site preparation and construction, operations, and closure), and that closure measures would prevent such impacts during the post-closure period.

In support of this updated assessment of water quality for the Project, an updated water quality model for the post-closure and abandonment phase was required. The available geochemistry for the Project has been reviewed and in some cases re-evaluated to support the updated surface water quality model.

The following sections provide an overview of site geology and geochemistry, and provide preliminary long-term water quality estimates for projected water quality in the open pit, and the quality of the seepage from the WRSA and TSF. The water quality estimates derived herein, utilize updated site water balance and mine plan information in addition to considering the onset of ML/ARD during the operational phase of the mine.

5.1 Geology

The surficial, local and deposit geology are summarized in the following sections as adapted from the EIS (Sections 5.4 and 5.6) and the associated EIS Appendices (Section 1.4 of Appendix K and Section 3.1 of Appendix M) and the updated resource estimate (P & E Mining Consultants, 2015). The reader is referred to the above referenced information for further detail and primary sources of information.

5.1.1 Physiography and Surficial Geology

The Project area is located in the Ontario Canadian Shield in the Lake Wabigoon Ecoregion that is typified by extensive wetlands and boreal forests. Archean bedrock is overlain by a discontinuous mantle of glacial origin Quaternary surficial deposits. The area exhibits maximum relief in the order of 30 to 40 m.

There are three main terrain types that dominate the landscape including:

- Rolling glaciolacustrine plains composed of varved clay and bedrock knobs;
- Rolling rocky uplands of bedrock which may be bare or thinly covered with patches of till and/or varved clay; and
- Complex, moraine-like features commonly capped with beach sand and gravel.

Alluvial terrain represents a fourth, more localized, terrain type comprised of mainly organic materials and accounts for the abundance of peat and swampy areas in the low-lying poorly drained areas.

Much of the immediate Project infrastructure area including the WRSA and open pit are predominantly located on a fine grained glaciolacustrine plain or thin till veneer to bare bedrock outcrop. The TSF, located at generally higher elevations above 395 masl, is also located on the glaciolacustrine plain. However, shallow surficial materials are more typically sand and silty sand at these elevations, probably reflecting a more near-shore lake environment.

Overburden tends to be generally thin near the WRSA and TSF at generally < 5 m, and 5 to 10 m, respectively. Overburden is generally thicker at 15 to 25 m or more in the vicinity of the open pit and an area extending further to the south in an apparent irregular bedrock trough. A relatively thin basal sand unit (on average 3 to 4 m thick) may occur beneath the fine silt and clay and in contact with the bedrock below.

5.1.2 Regional and Local Bedrock Geology

The Project is located in the Eagle-Wabigoon-Manitou greenstone belt situated in the Wabigoon Subprovince of the Archean Age Superior Province. This belt is situated in a 150 km wide volcano-plutonic domain with an exposed strike extent of 700 km and extends an unknown distance beneath Palaeozoic strata at either end. South of the Property, and just north of the Village of Wabigoon, is the Wabigoon Fault which is a major regional fault structure. It separates a northern domain, characterized by generally southward-facing alternating panels of metavolcanic and metasedimentary rocks, from a southern domain of generally northward-facing metavolcanic rocks.

Rocks in the vicinity of the site have been grouped into two assemblages:

- The Thunder Lake Assemblage: A volcanogenic-sedimentary complex of felsic metavolcanic rocks and clastic metasedimentary rocks that underlies much of the Project area; and
- The Thunder River Mafic metavolcanic rocks: Generally massive or locally pillowed flows and amphibolite and mafic dykes that underlie the southern region of the Project area.

All of the rocks have been subjected to folding and moderate to intense shearing with local hydrothermal alteration, quartz veining, and sulphide mineralization. Schistosity is commonly developed within both the metasedimentary rocks and volcanic rocks, exhibiting a similar orientation to compositional layering in the metasedimentary rocks with a strike of around 090° and dips from 70° to 80° south-southeast.

The primary components of the Thunder Lake Assemblage are described as follows:

- Biotite muscovite schist: Dark grey to grey, fine to medium grained mica schist. Usually it consists of intercalated leucocratic and melanocratic bands. This unit contains a high number of grey to milky white quartz veins. Most of the veins are 1 to 15 cm wide, parallel or crosscutting the foliation. Some veins are associated with highly chloritized and silicified intervals with tourmaline and sulphides.

- Muscovite sericite schist: Light grey to beige grey, fine to medium grained quartz- sericite schist. It is variably siliceous, commonly contains interbedded, dark grey biotite-muscovite bands and grey to milky white quartz veins. It is characterized by the presence of moderate to strong pervasive sericite alteration and gold and silver bearing disseminated sulphides.

- Iron formation: Dark greenish grey calc-silicate metamorphic rocks, which include coarse to medium grained gneiss, biotite schist, 10 to 15 cm wide distinctive layers enriched with garnet, chlorite and narrow ink blue magnetite bands. The rock unit is magnetic and contains disseminated pyrite.

- Metasediment: Grey to dark grey-green medium grained massive unit, which consists of biotite, feldspar, quartz, muscovite with a weak patchy potassium and sericite alteration and rare hematite (rusty brown) alteration. Foliation is poorly developed but more prominent in contact and altered areas. Quartz veins, parallel or crosscutting the foliation are very common. This unit can be distinguished by presence of numerous “quartz eyes” or quartz porphyroblast. This unit may contain 1 to 5% bleb-finely disseminated pyrite and chalcopyrite.

- Biotite schist (BS): Dark grey to black, fine to medium grained, slightly to well-foliated schist. Locally contains disseminated pyrite in the foliation planes and fractures.

- Chloritic-Biotite schist: Dark grey to greenish grey medium grained, slightly to well-foliated schist. Locally it contains disseminated pyrite along foliation planes and fractures.

5.1.3 Deposit Area Geology

The altered schists in the deposit have been grouped into two distinct geological units based on the relative modal abundance of biotite rich versus sericite rich layers, quartz (silicification) and sulphide mineral content. In general, the most altered and light coloured schists containing greater than 60% quartz-sericite felsic bands, are silicified and often contain base metal mineralization, have been mapped as MSS. Darker schist units containing less than 60% white mica have been mapped as biotite muscovite schist BMS. It should be noted that contacts are almost always gradational. Gold is usually associated with the MSS units in association with sphalerite and galena or occurs in smaller MSS bands hosted within the BMS units.

For the purpose of the exploration and development, the following four groupings are consistently recognized from south to north at the Goliath Gold Deposit:

- A Hanging Wall Unit of metasedimentary rocks (MSED), which share a sharp contact or may gradually grade to a biotite-quartz-feldspar-sericite schist (BMS) that have been intruded by quartz ± feldspar-porphyry intrusive rocks which may appear periodically along the strike length of the deposit.

- A Transitional Unit of biotite-quartz-feldspar-sericite schist (BMS), occasionally intruded by porphyry rocks.

- A Central Unit that consists of:

  - A package of biotite-quartz-feldspar-sericite schist (BMS), occasionally intruded by porphyry rocks, interlayered with up to four hanging wall alteration zones (HW1 to HW4) consisting of quartz-feldspar-sericite schist (MSS) that can have significant gold mineralization and are often silicified.

  - A core section of rocks, approximately 100 to 150 m true thickness, that hosts the most significant gold concentrations in the deposit (the Main and C Zones) and consist of intensely deformed and variably altered felsic, fine to medium grained, quartz-feldspar-sericite schist (MSS) and biotite-quartz-feldspar-sericite schist (BMS) with minor metasedimentary rocks (MSED).

  - A package of rocks similar to the upper most central unit that hosts the D and E Zones in silicified MSS rocks surrounded by BMS.

- A Footwall Unit of predominantly metasedimentary rocks (MSED, BMS and weak iron formation) with some porphyritic intrusive bodies and minor felsic gneiss and schist rocks.

5.1.4 Mineralization

The gold mineralization is located primarily in the central unit, and is concentrated in a pyritic (phyllic) alteration zone, consisting of the muscovite sericite schist, quartz-eye gneiss and quartz-feldspar gneiss. This area of mineralization appears to extend to a maximum drill-tested depth of 805 m below grade, over a strike length of approximately 2,300 m, with the possibility of this strike length extending to greater than 5,000 m.

The mineralised zones are tabular composite units defined on the basis of anomalous to strongly elevated gold concentrations, increased sulphide content and distinctive altered rock units. These tabular units are concordant to the local stratigraphic units. Sulphide mineralisation and local visible gold occurs mainly within the leucocratic bands but occasionally it is localized in the melanocratic bands enriched with biotite and chlorite. Usually, mineralised intervals are narrow (up to 0.5 m) zones enriched with 3 to 5% visible sulphides and locally up to 15%. Sulphides include pyrite (FeS_2), sphalerite (ZnS), galena (PbS), chalcopyrite ($CuFeS_2$) ± arsenopyrite (FeAsS), ± dark grey needles of stibnite (Sb_2S_3). The narrow mineralised intervals occur within wider quartz-sericite or biotite-feldspar sections with fine-grained disseminated pyrite located in the foliation planes.

In general, the highest gold and silver values occur in association with very strong pervasive quartz-sericite alteration. An increase in gold and silver correlates with an increase in pyrite and more specifically an increase in sphalerite content. The modal abundance of sphalerite usually exceeds that of galena and pyrite. Although the presence of elevated sphalerite and galena have been used as an indicator of the potential presence of gold with the deposit, there are some instances when gold is not present even through the lead and zinc sulphides are clearly visible in drill core. In addition, an increase in chalcopyrite and galena content has a lower correlation to an increase in gold values.

Two distinct types of pyrite are recognized: disseminated fine grained cubic euhedral crystals occurring in the foliation planes; and disseminated subhedral to irregular grains and stringers, with inclusions of galena, occurring in quartz veins and along the margins of the veins. The second type is commonly associated with other base metal sulphides.

Pyrite can occur as fine grained disseminations in the foliation planes, disseminations in the matrix, blebs, stringers and or veinlets. The base metals sulphides can be concentrated in blebs and stringers of sphalerite, cubic fine-grained galena and on occasion as chalcopyrite. Most of the sulphides are located mainly in blebs or stringers parallel to the foliation planes. Usually blebs, stringers and veinlets of pyrite are associated with the stringers of sphalerite, cubic fine-grained galena, chalcopyrite and pyrrhotite ($Fe_{1-x}S$). Very often they in-fill small fractures in the host rock or occur along margins of quartz veins.

5.2 ML/ARD Assessment

An ML/ARD assessment of mine materials is documented in Appendix K of the EIS. The available data, and its interpretation was reviewed as part the Round 1 information request process, which included consideration of updated field cell data. This evaluation was completed to support an updated water quality model for the Project (Section 5.3).

Previous characterization work included assessment of waste rock and a single composite tailings sample. Work included both static testing programs (acid base accounting, elemental content analysis and short-term metal leaching assessment) and kinetic testing programs (laboratory humidity cells and field cells constructed with project waste rock drill core). A summary of ML/ARD testing completed for the Project is provided in Table 5-1.

The previous ML/ARD assessment included characterization of four rock types including: biotite muscovite schist (BMS), biotite schist (BS), muscovite sericite schist (MSS) and meta-sediment (MSED). As described in Section 5.4.3.3 of the EIS and Section 5.1.3 above, the BMS and BS rock types have since been grouped together based on geological similarity and to facilitate deposit-wide mapping.

The previous static geochemical characterization work for waste rock and a single simulated tailings sample included the following analyses:

- Acid base accounting (ABA) including paste pH, total sulphur, sulphate-sulphur, sulphide-sulphur, modified Sobek NP (NP), total carbon, total organic carbon, and total carbonate analyses with calculation of carbonate NP (Carb NP), acid generating potential (AP), net neutralization potential (NNP), and Sobek NPR and carbonate NPR (Carb NPR).

- Determination of elemental/metal content by aqua-regia leach and inductively coupled plasma mass spectrometry (ICP-MS) analyses.

- Assessment of short-term leachable metal content by shake flask extraction (SFE) using a mass ratio of 3:1 deionized water and sample (MEND 2009), and a modified SFE procedure using the same fluid to sample ratio, but with 0.1M HCl solution.

Kinetic testing included three humidity cell tests of composite samples with different sulphur content ranges for each of the BSS, MSS, and BS rock types. For the MSED material, two tests were initiated on composite samples representing lower and higher sulphur material. Two duplicate HCTs were setup using the prepared composite simulated tailings sample. One barrel style field cell was set-up for each of the four rock types and sampled approximately monthly until July 2014 in support of the EIS. Cells were sampled again in November 2016 in support of the present update.

The following sections summarize the current re-evaluation of geochemical data from Appendix K of the EIS. The re-evaluation includes a summary of the previous findings and any additional evaluation completed in support of the current work (as applicable).

5.2.1 Acid Base Accounting Results

The total sulphur content of Project mine rock samples ranged from 0.06 to 9.5% S predominantly as sulphide (Figure 5-1). Some samples, particularly below 1.3% S, contain a notable fraction of sulphur as sulphate. Overall, sulphate concentrations ranged from 0.01 to 1.0%. In general, the total-sulphur content of the four rock types was similar. It was assessed that total sulphur may be suitable for estimating sulphide sulphur content of the BMS, BS, MSS, or MSED mine rock materials for management purposes (Appendix K of the EIS). Paste pH for the samples were primarily neutral to alkaline and ranged from pH 6.15 to 10.15.

Neutralization potentials for the mine rock were assessed to be low. Modified Sobek NP ranged from 2.1 to 20.8 kg $CaCO_3$/t. Carb NP values were lower and assessed to represent less than one-half of the modified Sobek NP values (Figure 5-2). A comparison of carbonate carbon and total carbon (Figure 5-3) indicates that non-carbonate carbon may be present in some samples, but only in small amounts (generally <0.05%). For this update, Carb NP was determined from carbonate carbon where data was available, and total carbon less 0.05% to a minimum of 0.01% (carbon analysis detection limit) where carbon speciation analysis was not available.

A high proportion of the samples analysed for the Project have NPR <2 (Figure 5-4) and most samples have a Carb NPR <2 (Figure 5-5). This confirms the previous assessment that most mine rock is expected to be PAG, based on the sampling and analysis completed.

Approximately 88% of samples had an NPR <2 and would be considered to be PAG or have an uncertain acid generating potential. Approximately 96% of samples had a Carb NPR <1 and would be considered PAG on this basis. The previous assessment had indicated approximately 93% of waste rock should be considered PAG for management purposes.

The composite tailings sample analysed was also PAG with low neutralization potential. The sample had 1.5% total sulphur and 0.3% sulphate. The NP and Carb NP were 5.1 and 0.3 kg $CaCO_3$/t respectively. NPR and Carb NPR were 0.13 and 0.01 respectively.

5.2.2 Elemental Content Results

Waste rock samples were analysed for total element content by aqua-regia leach and compared to average crustal abundance (Price, 1997). Results were considered enriched if they exceeded a 10 times crustal threshold. It should be noted that elevated metal content in samples generally has a poor relationship to potential for metal leaching, but rather the comparison is used as a screening tool to aid in identifying elements of potential interest.

Screening analysis of elemental content identified the following (see also Table 5-2):

- Antimony concentrations were enriched in 11 of 161 samples and average values exceeded the screening value for the MSED and MSS rock types.

- Arsenic concentrations were enriched in 50 of 161 samples and the screening value was exceeded by the average concentration for the MSS rock type.

- Bismuth concentrations were enriched in 55 of 161 samples and the screening value was exceeded by the average concentrations for all four rock types.

- Cadmium concentrations were enriched in 12 of 161 samples; however, the average values calculated for each rock type did not exceed the screening value.

- Cobalt concentrations were enriched in 6 of 161 samples, which occurred amongst the BMS and MSS samples.

- Lead concentrations were enriched in 16 of 161 samples and the screening value was exceeded for the average calculated values for the MSS samples.

- Molybdenum concentrations were enriched in 1 of 166 samples, which was a MSS sample.

- Selenium concentrations were enriched above detection limits and the screening value in 28 of 161 samples (the majority of samples for all rock types were measured below method detection limits that were above the 10 times screening value).

- Silver concentrations were enriched in 27 of 161 samples and the screening value was only exceeded for the average value of the MSS rock type.

- Zinc concentrations were enriched in 9 of 161 samples, which only occurred for samples amongst the BMS and MSS rock types.

Limited data was available for mercury, which was enriched in 2 of 49 waste rock samples tested. Both of these samples were from MSS rock type that were notably elevated in Pb and Zn. Limited data on Hg has been identified as a gap for the Project, and further analysis has been recommended to be collected as the Project advances through the engineering process.

The single composite tailings sample was enriched in antimony, arsenic, bismuth, cadmium, lead, silver and zinc, when compared to the 10 times crustal screening criteria.

5.2.3 Shake Flask Extraction Results

For screening purposes, deionized water SFE leachable metals data were compared to Provincial Water Quality Objectives (PWQO) for the protection of aquatic life. PWQO values for screening comparison included current (in place) guidelines and interim guidelines for parameters without current values. This comparison is for reference purposes only, as it does not provide a direct assessment of water quality, and holds no regulatory significance.

Screening analysis for the deionized SFE results indicated the following:

- Results generally indicate low metal leaching results in neutral to weakly alkaline pH leachates.

- Four of the 28 samples had pH below the lower limit specified by PWQO; however, all were older samples (2008 and 2009 drill core) at the time of the original EIS assessment. It is possible these sample materials were responding to weathering that occurred during sample storage, but this has not yet been assessed for this Project.

- The highest concentrations of metals including cadmium, cobalt, iron, lead, nickel and zinc were observed in the three lowest pH samples (pH less than 6). For these samples at least two of three results for each of the identified metals exceeded PWQO values with the exception of copper where only one of the three samples exceeded the PWQO value.

- One of the 25 pH neutral to alkaline pH samples had a cobalt concentration in excess of the PWQO value.

- One of the 28 samples exceeded the PWQO value for silver.

Most of the samples exhibited aluminum concentrations above the interim PWQO value; however, this may be an artefact of the test due to mobilization of colloids that is not expected to occur under site drainage conditions. Six of the 28 deionized water SFE results had an alkaline pH greater than the PWQO upper limit of 8.5; however, this may be due to the nature of the test and elevated pH from Project waste rock under site drainage conditions is not expected. All results for phosphorous were below detection limit; however, the reported detection limit of 0.2 mg/L was above the specified minimum interim PWQO value of 0.01 mg/L.

A deionized water SFE leach was also completed for the composite tailings material in triplicate. Average of the three analyses exceed the current PWQO for cadmium, cobalt, lead and zinc. As for waste rock, phosphorous was below detection limit, but this value was higher than the specified minimum interim PWQO value.

5.2.4 Kinetic Results

All 11 waste rock humidity cells (Appendix K of the EIS) were operated for a minimum of 63 weeks with the highest sulphur humidity cell for each rock type continued to 83 weeks. Cells reached generally stable pH in the range of 6.5 to 7 between 20 and 44 weeks after which time some decline to distinct declines in pH were observed in most cells. Cells that continued operating to 83 weeks exhibited final pH in the range of pH 4.5 for the MSS-C, BMS-C and BS-C cells and a final pH of 5.4 for the MSED-B cell.

Sulphate and metal rates were generally stable after 20 weeks, but showed evidence of increasing oxidation and metal release generally consistent with the observed declines in pH especially after 60 weeks of operation in the continuing cells.

Static testing completed on all waste rock humidity cells identified the materials in most cells with NPR <1 and Carb NPR < 1 and are considered to represent PAG rock. One BS cell (BS-A) had a carbonate NPR of 2.2 and an NPR of 1.8 while one BMS cell had an NPR of 1.3 and Carb NPR of 0.1.

A revised assessment of the time to ML/ARD for the Project was completed using the available kinetic data. Carbonate and sulphide depletion times were estimated for the cells based on projected AP and Carb NP content and measured sulphur and molar calcium + magnesium release in the cells respectively. Carbonate depletion times for all cells except BS-A were projected to be shorter than sulphide depletion which indicated the materials to be PAG. The projected time to carbonate depletion for the PAG cells based on pre-acidic release rates ranged from 2 to 13 years. Cell BS-A was projected to be NPAG based on an estimated 45 year carbonate depletion time and a 41 year sulphur depletion time. Generally the humidity cells showed trends towards lower pH values that were shorter in duration than their predicted NP depletion times. The MSS-C and BS-C cells had projected depletion times of 2 to 3 years respectively whereas the trend to low pH occurred at a little over one year. The BMS-C and MSED-B cells had projected carbonate depletion times of 4 and 6 years respectively in comparison to the trend toward low pH of a little over one year. Longer operating times of the humidity cells may have provided a more refined understanding of projected depletion times for Project waste rock.

Waste rock field cells were set up for each of the four mine rock types in September 2012 and sampled seven times over 96 months until July 2014 after which time they remained in operation but went unsampled for a period of time. An additional round of sampling was completed at week 218 in November 2016 as part of this update analysis. Field cell results including the additional week 218 data are provided in Appendix A. The BS field cells exhibited declining and acidic pH (pH less than 6) at 83 weeks and had a minimum recorded pH of 3.8 at 218 weeks. The BMS and MSS cells exhibited generally neutral pH during initial testing, but recorded acidic pH of 4.3 and 5.4 respectively for the most recent measurement (218 weeks). The MSED field cell remained pH neutral with low metal content leachate over the duration of testing.

For tailings, duplicate humidity cells (1 and 2) were operated using the composite tailings material for a minimum of 59 weeks. One of the two duplicate cells was continued to 78 weeks. As identified previously the tailings had both NPR <1 and Carb NPR <1 and were considered PAG.

The pH for both cells exhibited an initial decline from pH 8 reaching a short plateau above pH 6 from about week 25 to week 40 for both cells. After week 40, pH continued to steadily decline to the end of testing (week 78 for tailings cell 1). The minimum recorded pH in this cell was 3.6. Sulphate and metal release exhibited increasing rates generally consistent with the observed declines in pH. Notably elevated release of cadmium, lead and zinc were observed in the tailings cells after week 40. Cells were shut-down at week 78 so it is not possible to determine if these high release rates represented initially high transient rates during initial stages of acidic leaching or if they would represent elevated long term rates. Longer operation of the cells would have been required to provide expected steady long-term acidic leaching rates for Project tailings.

5.3 Open Pit Water Quality Estimates

Mass balance water quality models were developed for the open pit at the end of flooding and under projected long-term steady state conditions in the post-closure period. The models described herein utilize a site water balance combined with estimated mass loading rates from the various loading sources at the site to estimate water quality in the open pit. The model is based on various defined mine plan constraints, site specific baseline monitoring results, laboratory data and assumptions/estimates where site-specific data was not available.

5.3.1 Basis of Models

The basis of the post flooding and long-term post-closure pit water quality models was the annual average post-closure site water balance that integrates both surface hydrologic and hydrogeological flows for the preferred option of a dry cover TSF (Section 4.3.3). A preliminary pit flooding model was incorporated into the end of mine flooding model using the annual water balance, the final pit configuration and the in-pit waste rock dump volume.

The principal quantities used in developing the water quality models for the waste rock, the final combined open pits and the TSF (as well as the sources of this information) are provided in Table 5-5.

Estimated loadings for each modelled constituent were determined on an annual basis. The post flooding pit water quality model applied the sum of the annual loads for each constituent while the pit floods to the final flooded volume of the open pit to determine each constituent concentration in an assumed completely mixed pit. The long-term pit water quality model applied the post flooding estimated annual load to the annual net pit in-flow to represent a steady-state average long-term water quality.

5.3.1.1 Open Pit Flooding Time

A flooded open pit is expected to limit sulphide oxidation on inundated pit walls and in-pit waste rock, therefore the time to flood the open pit was a key consideration in developing the water quality estimates. The water quality model therefore incorporated a simplified pit flooding scenario into the model design. The basis and assumptions for the pit flooding model included the following:

- A total pit volume to elevation 388 masl (spillway elevation) of 11.9 Mm^3 (Table 5-5);
- Final in-pit waste rock volume of 12.5 Mt (Table 5-5) with an assumed porosity of 19%;
- A constant groundwater inflow of 700 m^3/day (Section 3.3);

- Surface catchment inflows assuming post-closure TSF dry cover hydrology that was adjusted in years 1 and 2 after end of mining for the uncovered WRSA and assumptions regarding run-off within the in-pit catchment (see below);

- A one time transfer of 970,000 m^3 tailings supernatant in year one of the closure process; and

- Direction of all TSF run-off to the open pit in the closure and post-closure period.

The estimated pit flooding time for the above assumptions is 6.7 years after completion of mining.

5.3.1.2 End of Flooding (Transitional) Open Pit Water Quality Model

The operational time line of open pit and underground mining development and waste rock placement (WRSA and in-pit) is provided in Figure 2.3.1 of the Draft Project Update Report (Treasury Metals Inc., 2017). Open pit mining is projected to give way to primarily underground mining after year three of operations. During operations, all drainage from the WRSA will ultimately report to the open pit which will be dewatered and directed for water treatment prior to discharge. Flooding of the open pits may not be possible until completion of underground mining. It has been assumed that both the WRSA and in-pit waste rock storage will remain in operation and exposed to weathering for the duration of mining operations (11 years).

The following principal assumptions during the closure period (and including the extended period into post-closure required for pit flooding of 6.7 years) formed the basis of the post flooding pit water quality model:

- Underground mine workings are not connected to the open pit.

- The WRSA is initially uncovered with an engineered semi-impervious membrane constructed and placed two years after the end of all open pit and underground mining operations.

- The TSF will be drained at the end of mining and an engineered semi-impervious membrane cover effectively placed over the tailings immediately after the end of mining.

- The low-grade ore stockpile will be consumed and any remaining PAG residue will be stripped from the former stockpile area and placed within the bottom of Pit 3 and under water cover within the first year after end of mining with essentially no effect on the water quality and pit flooding estimate.

- At the end of mining, the overburden stockpile will be reclaimed as cover material in various closure works and any remaining material contoured and revegetated.

5.3.1.3 Long-term Open Pit Water Quality Model

The long-term pit water quality model assumes the following post-closure conditions including:

- Flooded open pit with no legacy load inputs (no loads from in-pit waste rock or pit walls under water cover);
- Covered WRSA;
- Base of TSF is HDPE lined and top has low permeability cover ; and
- All other steady-state surface and groundwater flows based on post-closure water balance.

5.3.2 Mass Loading Source Terms

Mass loading source terms were developed from site specific data or analogue site data as follows:

- Loadings from waste rock and open pit walls were derived based on surface area and scaled from laboratory humidity cell or field cell data.
- Due to a lack of site specific data, loadings from possible future acidic drainage from waste rock was estimated on an adjusted surface area basis from an unnamed analogue site with site specific adjustment of minor and trace metals based on acidic data from operating Project field cells.
- Loadings from tailings in the TSF were derived from estimated supernatant tailings water quality and laboratory tailings humidity cell data.
- Loadings from run-off on natural ground and the engineered WRSA and TSF covers were derived based on baseline surface water quality in natural drainage near the future mining development.
- Loadings from groundwater were derived from baseline groundwater quality data near the future open pit.

To allow for uncertainty related to PAG and NPAG drainage from mine rock (open pit walls and waste rock) the NPAG and PAG rock source terms each included (from the respective data sets):

- A lower bound value determined from median (50^{th} percentile) concentration data, and
- An upper bound value determined from 75^{th} percentile data.

The specific basis and description of the mass loading source terms for the water quality estimates are described in Table 5-6. The source terms applied for the end of pit flooding model are provided in Table 5-7. The source terms applied for the post-closure water quality model are provided in Table 5-8.

5.3.3 Assumptions and Uncertainties

In addition to the definitions and constraints specified above, other key assumptions and uncertainties in the water quality estimates specifically include the following:

Mine Schedule

- It is conservatively assumed that all open pits are complete and all surface waste rock is placed in WRSA and in-pit by the end of year 2 of operations. This maximizes the amount of time the exposed mine faces and waste rock will be exposed.
- Pit flooding begins once mining ceases (year 12).
- Transfer of excess TSF supernatant water occurs in year 12.
- The model assumes the TSF cover is effectively placed immediately after the end of mining (year 12).
- Covering of WRSA occurs at year 14 (the end of year 2 in the closure period).
- The in-pit mine rock and pit walls are progressively covered by the flooding open pit in the closure and post-closure period.

Mine Rock

- The proportions by rock type assumed for all open pit walls and stored waste rock was 70% BMS (BMS and BS rock types combined), 15% MSS and 15% MSED (Table 5.4.2 of the EIS), since detailed production schedules by rock type are not yet available.
- The proportion of PAG rock at all open pit walls and stored waste rock was 93% (Appendix K of the EIS).
- A surface area of 50 m^2/t was assumed for the in-pit and WRSA mine rock.
- For unflooded mine rock including in-pit rock and the WRSA, a flushing factor of 40% of surfaces was applied with no accumulation of load on unflushed surfaces.
- For flooded mine rock 100% of the rock surface was assumed to be flushed.

- During operations, all flushed load was assumed to be removed from the open pit by ongoing dewatering and treatment activities.

- No allowance for flushing of accumulated load during operations was included in the model on the basis that the largest fraction of this load would be released to in-pit porewater and the net transfer rate of this pore water to pit water was expected to be relatively slow.

- Below 360 masl, Pits 1 and 2 are separate from Pit 3. Pit 3, which has no waste rock, has a relatively large volume of 1.95 Mm^3 below 360 masl. Therefore, the model was adjusted to initially fill the volume below 360 masl (2.3 years) for all three pits and then fill the remainder of the pits.

- For each square metre of exposed pit wall, a fracture factor of 50 m^2/m^2 was assumed.

- The time to acid on-set for waste rock and pit walls in the model was conservatively assumed to be only two years.

- The load released from the covered WRSA was conservatively assumed to be reduced only in direct proportion to the reduction in seepage rate with no further reduction due to restricted oxygen and water ingress by the cover.

- No legacy load from in-pit waste rock and pit walls was included in the long-term water quality estimate.

- Upon pit flooding to 388 masl, it was assumed all waste rock and pit walls are water covered with no further load release to the flooded open pit.

Tailings

- Operations and closure activities were successful at preventing acidic drainage within the covered tailings during the period of pit filling.

- Consideration of possible reject water from the reverse osmosis placed in the TSF during operations or in post-closure were specifically excluded from the current estimate based on insufficient information.

- Limited acidic loads were assumed to develop within the covered and lined tailings in the long-term from an average 2.5 cm thick active layer (thicker in the core and thinner at the periphery) within covered and lined, but unsaturated tailings. This load reported to the limited seepage defined for the liner and the balance of load was assumed to be directed to the open pit.

- The engineered tailings cover was assumed to be 90% efficient at limiting load release from the active tailings volume.

- High estimated lead loads from acidic leaching within the TSF in the long-term post-closure scenario were assumed to be solubility limited (see also Section 5.4) by precipitation of anglesite ($PbSO_4$).

- Aside from lead, no further equilibration/reductions were included in current estimates as may occur due to changing geochemical conditions along the flow-path down-stream of TSF seepage.

Surface Water

- Direct precipitation onto the filling open pit water surface was assumed to be proportional to the flooded pit volume/total pit volume with the remainder of the in-pit catchment assumed to be uncovered waste rock.

- Complete mixing of water in the flooding open pit was assumed to occur.

Groundwater

- During the period of pit flooding, all seepage from the WRSA and TSF was assumed to be captured by the filling open pit.

- In the long-term post-closure model:

    - 67% of the WRSA seepage (20 m^3/day) was captured by the open pit (Appendix M of the EIS);

    - 20% of the TSF seepage (10 m^3/day) was captured by the open pit (Appendix M of the EIS); and

    - The remainder of seepage was released off-site, and would eventually intercept with surface receiving waters (Section 6).

- Net groundwater inflow rates to the open pit were assumed to be:

    - 700 m^3/day during pit filling (Appendix M of the EIS), and

    - 100 m^3/day for the fully flooded open pit (Section 3).

5.3.4 End of Flooding (Transitional) Pit Water Quality Estimate

Based on the assumptions described, and without mitigation, it is currently projected that ML/ARD rich waters could develop in the open pit during flooding in the initial post-closure period (Table 5-9). Inspection of the model identifies that the in-pit waste rock is the dominant load source (approximately 53 to 62% of load) for sulphate and elevated metals (aluminum, cadmium, cobalt, iron, lead, nickel and zinc) to the open pit. The initially uncovered waste rock storage area contributes the bulk of the remaining load (21 to 24%) for sulphate and the above metals. It is noted that because of the relatively low levels, the estimated concentrations of antimony, beryllium, boron, chromium, molybdenum, silver and vanadium are primarily influenced by laboratory detection limit values in the source terms.

All results are conservative in that they assume complete mixing within the open pit without geochemical equilibration. It is possible that the deepest east open pit may undergo thermal and chemical stratification of the water column that could tend to isolate the high sulphate and high metal loads to the bottom of the pit or that such conditions could be exploited as one option for mitigation. Such processes could substantially improve water quality discharging from the open pit; however, additional work is required to confirm that such processes would be active and stable in the long-term.

5.3.5 Long-term Post-Closure Pit Water Quality Estimate

The long-term post-closure water quality model results (Table 5-9) was projected to have slightly elevated sulphate (60 mg/L) and metals (e.g., cadmium, cobalt, copper, iron, lead, nickel and zinc). We note that this model assumes that the ML/ARD impacts that may occur during flooding have been mitigated.

All results were conservative estimates in that they assume complete mixing of load within the open pit volume with no allowance for reactions that may occur within the flooded open pit. As described above, the initial results for elevated lead seepage from the covered TSF were equilibrated for solubility control by anglesite precipitation, which would be expected to occur. All other results are presented without geochemical equilibration. For this estimate the predominant source of load (79 to 89%) for sulphate, aluminum, cobalt, iron, and nickel is from possible acidic seepage from the covered WRSA. The dominant source of load for cadmium, copper, lead, and zinc (87 to 97%) is from an assumed acidic load within the covered and lined TSF that may need to be intercepted and managed.

It has been identified that the acidic tailings source term for TSF seepage used in this estimate may be very high, especially for cadmium, lead and zinc. The single humidity cell that was the origin of this data was terminated during the initial on-set of acidic conditions and the elements in question may have been measured as a short-term transient condition in the test. The test was stopped at this point in analysis and therefore confirmation of a transient response cannot be ascertained without additional testing. It is also noted that estimated antimony, arsenic, boron, chromium, molybdenum, silver and vanadium concentrations are primarily influenced by laboratory detection limit values in source terms.

5.4 Long-term Seepage Water Quality Estimates from the WRSA and TSF

Estimates of the long-term TSF and WRSA seepage water quality under post-closure conditions were also determined since a portion of the seepage may not be captured by the open pit after flooding is complete.

Model results indicate that seepage from the WRSA is expected to be acidic with elevated sulphate and metals (Table 5-10), although the net loads released due to the presence of the cover are relatively modest due to low seepage rates. It is noted that estimated boron, chromium, molybdenum, silver and vanadium concentrations are primarily influenced by laboratory detection limit values in source terms.

Acidic and metal-rich waters have also been projected for the limited long-term seepage (through the HDPE liner) from the TSF (Table 5-10). However, as identified in the previous section the elevated loads for cadmium, copper, lead and particularly zinc in this estimated seepage quality may be driven by a particularly aggressive laboratory humidity cell source term that is based on insufficient data. It is noted that estimated antimony, chromium, molybdenum, silver and vanadium concentrations are primarily influenced by laboratory detection limit values in source terms.

5.4.1 Modifications to Model Source Terms and Assumptions for TSF Wet Cover Option

An updated water quality estimate was prepared assuming placement of an engineered wet cover that was effective at eliminating acid rock drainage concerns for the TSF runoff and seepage under long-term post-closure conditions. The mass loading source term assumptions for this water quality estimate are largely the same as for the previous post-closure water quality model with the exception that TSF run-off was assumed to have no net effect on water quality and the small amount of seepage through the liner was non-acidic tailings porewater. The long-term TSF runoff was assumed to approach surface water quality conditions and the TSF seepage was assumed to be similar to tailings supernatant water. (Table 5-11).

5.4.2 Water Quality Estimates Including TSF Wet Cover Option

The long-term post-closure open pit water quality model results assuming a TSF wet cover option (and assuming potential degradation of the initial post flooding pit water quality is prevented or mitigated) was projected to have slightly elevated sulphate (60 mg/L), but generally low metal concentrations (Table 5-12).

Overall pit water quality is projected to be similar to that of the TSF dry cover option for some parameters (e.g., sulphate, aluminum, antimony, arsenic, beryllium, chromium, cobalt, iron, molybdenum, nickel, selenium, thallium, uranium, and vanadium), but much lower for other elements (cadmium, copper, lead and zinc) upon elimination of acidic drainage from the TSF.

Mercury was also able to be estimated for this scenario, since source term data was available. The estimated mercury concentrations are low and largely based on detection limit values in the available source term data.

All pit water quality results are conservative estimates in that they assume complete mixing of load within only the annual estimated open pit discharge volume with no allowance for reactions and equilibration within the flooded open pit. For this estimate the predominant source of load (76 to 100%) for sulphate, aluminum, arsenic, cadmium, cobalt, copper, iron, lead, nickel and zinc is from possible acidic seepage from the covered WRSA. It is noted that in addition to mercury, estimated antimony, arsenic, boron, chromium, molybdenum, silver and vanadium concentrations are primarily influenced by laboratory detection limit values in source terms.

Water quality estimates for WRSA seepage are the same for this scenario as for the TSF dry cover scenario since there is no relationship between TSF management and the future WRSA. The TSF seepage water quality is assumed to approach simulated tailings porewater concentrations due to assumed limited mixing with meteoric water and very slowly drainage through the HDPE liner.

It should be noted that careful management of tailings in the TSF during operations and at closure would be required to prevent possible localized ARD from features such as exposed tailings beaches and to achieve the management assumptions made for water quality estimates prepared for this scenario.

5.5 Recommendations for Additional Work

A number of recommendations have been identified, based on the updated analysis of available geochemical data including development of water quality estimates provided herein. These recommendations form part of the monitoring recommended in the Impact Review Report (Section 4.2.3).

5.6 References

P & E Mining Consultants, 2015. Technical Report and Updated Resource Estimate for the Goliath Gold Project, Kenora Mining Division, Northwestern Ontario.

Price, W.A. 1997, DRAFT Guidelines and Recommended Method for Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia.

Table 5-1: Summary of ML/ARD Testing Completed

Material Description	Static Testing Samples				Kinetic Testing Samples**	
	Acid Base Accounting*	Elemental Analysis*	Shake Flask Extraction		Humidity Cell Tests	Field Cell Tests***
			Deionized Water	0.1M HCl Acid		
Waste Rock						
Biotite Muscovite Schist (BMS)	67	67	13	5	3	1
Biotite Schist (BS)	20	20	4	2	3	1
Muscovite Sericite Schist (MSS)	59	59	8	3	3	1
Meta-sediment (MSED)	15	15	3	1	2	1
Total	161	161	28	11	11	4
Tailings						
Composite	1	1	in triplicate	in duplicate	1	0

Notes:

* Includes EcoMetrix and KCB Testing Programs (aqua-regia extraction)

** ABA and Metals Analyses conducted on composite samples of humidity and field cell content prior to setup of kinetic testing

*** Field Cells consist of 78 - 90 kg of 50 - 100 cm long full and ½ cut drill core segments in a plastic barrel

Table 5-2: Summary of Waste Rock Elemental Content Results

Parameter	Unit	Average Crustal*	10x Average Crustal	Total Number of Samples	Number of Exceedances	% Exceedances	BMS				BS				MSS				MSED			
							Median	Mean	Min	Max	Median	Mean	Min	Max	Median	Mean	Min	Max	Median	Mean	Min	Max
Antimony	mg/kg	0.20	2.0	161	11	6.8	2.0	1.9	0.025	17	2.0	1.6	0.025	2.0	2.0	5.0	0.025	155	2.0	2.8	0.070	22
Arsenic	mg/kg	1.8	18	161	50	31	5.4	11	0.50	78	9.5	15	1.4	77	17	24	0.50	150	6.0	17	0.80	101
Bismuth	mg/kg	0.0085	0.090	161	55	34	0.090	0.13	0.020	1.1	0.20	0.20	0.080	0.34	0.090	0.12	0.020	1.1	0.090	0.18	0.020	0.54
Cadmium	mg/kg	0.15	1.5	161	12	7.5	0.11	0.82	0.020	28	0.090	0.24	0.040	2.5	0.10	0.95	0.010	19	0.11	0.18	0.020	0.60
Cobalt	mg/kg	25	250	161	6	3.7	170	134	3.5	380	160	114	6.6	210	13	93	2.4	290	10	33	4.2	190
Copper	mg/kg	60	600	161	1.0	0.6	14	21	0.50	83	36	38	11	75	16	39	0.25	813	16	27	1.7	72
Lead	mg/kg	14	140	161	16	9.9	17	76	1.1	2,900	21	47	3.8	500	21	163	1.3	2,120	8.9	29	1.0	99
Mercury	mg/kg	0.085	0.85	49	2	4.1	0.010	0.016	0.010	0.080	0.010	0.010	0.010	0.010	0.010	0.26	0.010	3.7	0.010	0.015	0.010	0.040
Molybdenum	mg/kg	1.2	12	161	1	0.6	0.24	0.62	0.10	8.7	0.90	0.92	0.10	2.1	0.30	0.76	0.10	16	0.50	0.81	0.16	1.8
Selenium	mg/kg	0.050	0.50	161	28**	17	0.70	0.80	0.70	1.5	0.70	0.76	0.70	1.0	0.80	0.88	0.70	2.0	0.90	0.86	0.70	1.0
Silver	mg/kg	0.075	0.75	161	27	17	0.25	0.61	0.010	16	0.12	0.20	0.010	0.72	0.29	1.5	0.010	29	0.37	0.67	0.010	3.6
Zinc	mg/kg	70	700	161	9.0	5.6	78	337	25	12,000	79	93	61	330	67	365	5.0	6,480	74	97	40	286

Notes:

* Price, 1997

** Detection limit greater than the screening value (10x Crustal Abundance) for all samples. The number of exceedances only include those above detection limit and screening value

Table 5-3: Summary of Deionized Water SFE Waste Rock Results

Parameter	Unit	PWQO	TL 08-16	TL 09-81	TL 11-165	TL 11- 204A	TL 09-83	TL 11-165	TL 08-36	TL 08-14	TL08-30	TL 09-76
Depth	—	—	67.5-68	16.5-17	110-110.5	204-204.5	73-73.5	108.5-109	84-84.5	100.5-101	61.5-62	20-20.5
Lithology	—	—	BMS	BMS	BMS	BMS	BMS	BMS	BMS	BMS	BMS	BMS
Solid Added	g	—	252	254	251	254	256	254	255	253	250	251
Water Added	mL	—	752	755	753	784	750	749	752	750	775	748
pH	pH units	6.5-8.5	8.1	7.4	7.6	7.2	8.5	7.3	**6.4**	8.0	8.2	7.9
Conductivity	µS/cm	—	85	33	24	26	51	17	40	42	31	50
Aluminum	mg/L	0.015-0.075[1,2]	**0.44**	**0.81**	**0.67**	**0.79**	**0.84**	**0.12**	0.012	**0.14**	**0.077**	**0.049**
Antimony	mg/L	0.02[1]	0.0025	0.00095	0.0010	0.00090	0.0073	0.00034	< 0.00010	0.00054	0.00034	0.00083
Arsenic	mg/L	0.1	0.0046	0.0021	0.0033	0.0026	0.0054	0.00091	0.00042	0.0019	0.0017	0.00061
Barium	mg/L	—	0.0023	0.0018	0.0030	0.0033	0.00064	0.00050	0.0013	0.00058	0.00024	0.00067
Beryllium	mg/L	0.011-1.1[3]	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Bismuth	mg/L	—	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050
Boron	mg/L	0.2[1]	0.013	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Cadmium	mg/L	0.0002	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000018	< 0.000010	< 0.000010	< 0.000010
Calcium	mg/L	—	11	2.2	1.1	1.3	5.9	1.6	2.5	3.8	1.3	2.3
Chromium	mg/L	0.001	< 0.00010	< 0.00010	0.00014	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00011	< 0.00010	< 0.00010
Cobalt	mg/L	0.0009	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00056	< 0.00010	< 0.00010	0.00038
Copper	mg/L	0.005	0.00069	0.00036	0.00030	0.00026	0.00032	< 0.00020	0.0038	0.0023	0.00057	0.00055
Iron	mg/L	0.3	0.015	0.024	0.048	0.035	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Lead	mg/L	0.005-0.025[4]	0.00061	0.0012	0.00052	0.00015	0.0029	0.000054	0.00022	0.00073	0.00016	0.00016
Lithium	mg/L	—	0.0028	0.0013	0.0011	0.0015	0.0017	< 0.00050	0.00075	< 0.00050	< 0.00050	< 0.00050
Magnesium	mg/L	—	1.7	0.32	0.24	0.20	0.63	0.17	0.66	0.68	0.21	0.21
Manganese	mg/L	—	0.010	0.0031	0.0062	0.0044	0.0023	0.0038	0.017	0.0075	0.0019	0.010
Molybdenum	mg/L	0.04[1]	0.0017	0.00012	0.00018	0.00039	0.00039	0.00015	0.000084	0.00046	0.000061	0.00016
Nickel	mg/L	0.025	< 0.00050	< 0.00050	0.00082	< 0.00050	< 0.00050	< 0.00050	0.0027	< 0.00050	< 0.00050	0.0020
Phosphorus	mg/L	0.01-0.03[1,5]	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**
Potassium	mg/L	—	5.0	2.9	3.6	2.9	4.5	0.96	0.83	5.2	0.55	1.3
Selenium	mg/L	0.1	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Silicon	mg/L	—	2.0	2.2	2.0	1.6	1.9	0.28	0.19	0.46	0.29	0.21
Silver	mg/L	0.0001	< 0.000010	< 0.000010	0.000017	< 0.000010	< 0.000010	0.000016	< 0.000010	**0.0016**	< 0.000010	< 0.000010
Sodium	mg/L	—	1.2	2.5	1.3	1.7	1.4	0.47	1.2	1.3	1.4	0.54
Strontium	mg/L	—	0.031	0.0041	0.0018	0.0034	0.010	0.0065	0.024	0.018	0.0040	0.0045
Sulfur	mg/L	—	11	2.8	2.2	1.9	5.5	0.92	3.6	0.99	0.59	1.1
Thallium	mg/L	0.0003[1]	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000015
Tin	mg/L	—	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Titanium	mg/L	—	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Uranium	mg/L	0.005[1]	0.000043	0.000052	0.000040	0.000047	0.000020	0.000078	0.000095	0.00037	0.00017	0.00040
Vanadium	mg/L	0.006[1]	< 0.0010	< 0.0010	< 0.0010	0.0014	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Zinc	mg/L	0.03	0.0059	< 0.0010	< 0.0010	0.0011	0.0023	< 0.0010	0.0072	< 0.0010	< 0.0010	0.0075

Notes:

1 Interim PWQO Value
2 Dependant on pH
3 Dependant on hardness
4 Dependant on alkalinity
5 Varies with receiver type

Bold faced entries represent those values that surpass PWQO concentration or were outside PWQO specified pH range

Table 5-3: Summary of Deionized Water SFE Waste Rock Results (Cont'd)

Parameter	Unit	PWQO	TL 08-08	TL 08-08 Dup	TL 08-07	TL 11-132	TL 11-132 Dup	TL 11-127	TL 08-36A	TL 08-36A	TL 08-09	TL 11-150
Depth	—	—	84.5-85	84.5-85	20.5-21	21.5-22	21.5-22	41-41.5	75-75.5	74.5-75	116-117	21.5-22
Lithology	—	—	BMS	BMS	BMS	BMS	BMS	BS	BS	BS	BS	MSS
Solid Added	g	—	252	—	250	256	—	250	250	256	252	250
Water Added	mL	—	744	—	748	752	—	756	767	769	736	752
pH	pH units	6.5-8.5	7.2	—	7.9	**9.5**	—	**8.8**	7.2	8.3	**9.0**	7.0
Conductivity	µS/cm	—	52	—	34	31	—	69	28	27	57	31
Aluminum	mg/L	0.015-0.075[1,2]	**0.016**	**0.016**	**0.061**	**0.10**	**0.10**	**0.73**	**0.78**	**0.055**	**0.13**	**0.34**
Antimony	mg/L	0.02[1]	0.00017	0.00018	0.0015	0.00054	0.00053	0.00022	0.00015	0.00012	0.0047	0.00046
Arsenic	mg/L	0.1	0.00053	0.00062	0.00077	0.0014	0.0014	0.0044	0.00061	0.00056	0.0065	0.00060
Barium	mg/L	—	0.00085	0.00078	0.00053	0.00077	0.00078	0.0030	0.0094	0.0080	0.00051	0.00076
Beryllium	mg/L	0.011-1.1[3]	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Bismuth	mg/L	—	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050
Boron	mg/L	0.2[1]	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Cadmium	mg/L	0.0002	0.000013	0.000014	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010
Calcium	mg/L	—	1.8	1.8	1.6	2.5	2.5	6.4	1.6	2.5	5.2	0.13
Chromium	mg/L	0.001	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00018	0.00017	< 0.00010	< 0.00010	0.00022
Cobalt	mg/L	0.0009	**0.0032**	**0.0031**	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00016	< 0.00010	< 0.00010	< 0.00010
Copper	mg/L	0.005	0.00066	0.00068	0.0011	0.00046	0.00047	0.00026	0.00071	0.00068	0.00090	0.00031
Iron	mg/L	0.3	0.12	0.12	0.018	0.011	0.011	0.035	0.23	0.037	0.013	< 0.010
Lead	mg/L	0.005-0.025[4]	0.0016	0.0015	0.0015	0.0011	0.00099	0.000092	0.0021	0.00098	0.00057	0.00018
Lithium	mg/L	—	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	0.0012	0.00097	< 0.00050	< 0.00050	< 0.00050
Magnesium	mg/L	—	0.27	0.27	0.27	0.26	0.25	0.90	0.56	0.29	0.43	0.038
Manganese	mg/L	—	0.039	0.041	0.0079	0.011	0.011	0.0013	0.021	0.012	0.0035	0.00043
Molybdenum	mg/L	0.04[1]	< 0.000050	< 0.000050	0.00011	< 0.000050	< 0.000050	0.000093	0.000085	0.000075	0.00037	0.000083
Nickel	mg/L	0.025	0.019	0.019	< 0.00050	< 0.00050	< 0.00050	0.00090	0.0012	0.0013	0.0024	< 0.00050
Phosphorus	mg/L	0.01-0.03[1,5]	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**
Potassium	mg/L	—	0.73	0.67	1.1	1.2	1.1	6.0	2.7	0.88	1.6	2.8
Selenium	mg/L	0.1	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00046	0.00027	< 0.00010	< 0.00010	< 0.00010
Silicon	mg/L	—	0.11	0.11	0.24	0.32	0.32	2.0	1.9	0.19	0.53	1.3
Silver	mg/L	0.0001	0.000024	0.000018	0.000011	0.000057	0.000043	0.000012	0.000010	< 0.000010	0.000020	< 0.000010
Sodium	mg/L	—	0.62	0.61	0.56	0.46	0.45	1.7	1.5	1.0	2.6	1.4
Strontium	mg/L	—	0.0078	0.0077	0.0058	0.0062	0.0062	0.013	0.0082	0.012	0.0093	0.00030
Sulfur	mg/L	—	1.9	1.9	0.83	0.93	0.93	8.3	2.0	1.3	3.1	0.85
Thallium	mg/L	0.0003[1]	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000011	< 0.000010	< 0.000010	< 0.000010
Tin	mg/L	—	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Titanium	mg/L	—	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.020	< 0.010	< 0.010	< 0.010
Uranium	mg/L	0.005[1]	0.00023	0.00023	0.00020	0.000071	0.000070	0.00011	0.000039	0.000055	0.00097	< 0.000010
Vanadium	mg/L	0.006[1]	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0021	< 0.0010	< 0.0010	< 0.0010	0.0024
Zinc	mg/L	0.03	0.0076	0.0074	< 0.0010	< 0.0010	< 0.0010	0.0063	0.0039	< 0.0010	0.0011	< 0.0010

Notes:
1 Interim PWQO Value
2 Dependant on pH
3 Dependant on hardness
4 Dependant on alkalinity
5 Varies with receiver type

Bold faced entries represent those values that surpass PWQO concentration or were outside PWQO specified pH range

Table 5-3: Summary of Deionized Water SFE Waste Rock Results (Cont'd)

Parameter	Unit	PWQO	TL 11-150	TL 08-08	TL 09-08	TL 08-02	TL 11-204A	TL 09-83	TL 09-86	TL 09-86 DUP	TL 09-75	TL 09-86	TL 08-43
Depth	—	—	21.5-22	149-149.5	36-36.5	61.5-62	216-216.5	22.4-23	27.5-28	27.5-28	32-32.5	81-81.5	59-59.5
Lithology	—	—	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSS	MSED	MSED	MSED
Solid Added	g	—	258	250	251	251	251	253	250	—	250	255	249
Water Added	mL	—	748	753	758	755	750	751	751	—	755	764	762
pH	pH units	6.5-8.5	7.5	6.9	**9.0**	**4.4**	8.4	**9.5**	**9.2**	—	7.6	**4.9**	**5.8**
Conductivity	µS/cm	—	31	31	68	87	25	31	35	—	31	178	239
Aluminum	mg/L	0.015-0.075[1,2]	**0.88**	**0.036**	**1.1**	**0.49**	**0.087**	**0.13**	**0.097**	**0.093**	**1.1**	**0.095**	**0.24**
Antimony	mg/L	0.02[1]	0.00032	0.00093	0.011	0.0020	0.0050	0.0014	0.0021	0.0021	0.00094	0.00030	0.00069
Arsenic	mg/L	0.1	0.0013	0.0012	0.015	0.0044	0.016	0.00087	0.0064	0.0065	0.0071	0.00060	0.00054
Barium	mg/L	—	0.0028	0.00079	0.00096	0.028	0.00024	0.00032	0.00051	0.00047	0.0021	0.013	0.016
Beryllium	mg/L	0.011-1.1[3]	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00072
Bismuth	mg/L	—	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050	< 0.00050
Boron	mg/L	0.2[1]	< 0.010	< 0.010	0.010	0.011	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.011	0.012
Cadmium	mg/L	0.0002	< 0.000010	< 0.000010	< 0.000010	**0.00083**	0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	**0.00033**	0.000064
Calcium	mg/L	—	2.6	2.0	7.3	4.5	1.2	2.4	3.0	2.9	2.2	17	20
Chromium	mg/L	0.001	0.00027	< 0.00010	< 0.00010	0.00022	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00034
Cobalt	mg/L	0.0009	0.00012	0.00018	< 0.00010	**0.0035**	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	**0.017**	**0.0044**
Copper	mg/L	0.005	0.00050	0.00057	0.00068	0.00041	0.00042	0.0011	0.0017	0.0017	0.00057	0.00097	**0.023**
Iron	mg/L	0.3	0.045	0.015	0.014	**1.7**	< 0.010	< 0.010	< 0.010	< 0.010	0.030	0.034	**0.49**
Lead	mg/L	0.005-0.025[4]	0.00040	0.00025	0.0011	**0.0083**	0.00010	0.000097	0.00021	0.00042	0.00021	0.0041	**0.014**
Lithium	mg/L	—	0.0010	< 0.00050	0.00059	0.0025	< 0.00050	< 0.00050	< 0.00050	< 0.00050	0.0017	0.0033	0.0035
Magnesium	mg/L	—	0.28	0.19	0.48	2.1	0.17	0.28	0.25	0.24	0.22	4.6	5.8
Manganese	mg/L	—	0.0023	0.0098	0.0037	0.13	0.0038	0.0057	0.013	0.014	0.0028	0.48	0.42
Molybdenum	mg/L	0.04[1]	0.00011	0.00018	0.00013	< 0.000050	0.00027	0.000074	0.00020	0.00020	0.0048	< 0.000050	0.000065
Nickel	mg/L	0.025	< 0.00050	0.0033	< 0.00050	0.015	0.00083	< 0.00050	0.0014	0.0018	0.0012	**0.26**	**0.41**
Phosphorus	mg/L	0.01-0.03[1,5]	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**	**< 0.30**
Potassium	mg/L	—	2.4	1.3	4.7	6.2	0.59	0.96	0.63	0.61	4.3	10	3.0
Selenium	mg/L	0.1	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00037	0.00011
Silicon	mg/L	—	2.1	0.24	2.1	1.6	0.20	0.33	0.34	0.33	2.6	2.8	0.48
Silver	mg/L	0.0001	< 0.000010	0.000015	0.000018	0.000025	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000075	< 0.000010	0.000063
Sodium	mg/L	—	2.1	1.4	1.1	2.2	0.49	0.35	0.60	0.59	1.6	1.7	2.1
Strontium	mg/L	—	0.0045	0.0062	0.0050	0.052	0.0070	0.0084	0.0057	0.0059	0.0018	0.064	0.12
Sulfur	mg/L	—	1.3	1.7	14	13	< 0.50	< 0.50	< 0.50	< 0.50	1.3	28	27
Thallium	mg/L	0.0003[1]	< 0.000010	< 0.000010	< 0.000010	0.000060	< 0.000010	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000042	**0.00069**
Tin	mg/L	—	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Titanium	mg/L	—	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Uranium	mg/L	0.005[1]	0.00011	0.00049	0.00013	0.0014	0.00020	0.000049	0.000063	0.000079	0.00019	0.00035	0.0026
Vanadium	mg/L	0.006[1]	0.0016	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.0016	< 0.0010	< 0.0010
Zinc	mg/L	0.03	0.0033	0.0014	0.0013	**0.49**	< 0.0010	0.0036	0.0014	0.0011	< 0.0010	**0.052**	**0.074**

Notes:

1 Interim PWQO Value
2 Dependant on pH
3 Dependant on hardness
4 Dependant on alkalinity
5 Varies with receiver type

Bold faced entries represent those values that surpass PWQO concentration or were outside PWQO specified pH range

Table 5-4: Summary of SFE Results for Tailings Composite Sample

Parameter	Units	PWQO	Average n=3
pH	pH units	6.5-8.5	7.2
Conductivity	µS/cm	—	287
Sulphate	mg/L	—	113
Aluminum	mg/L	0.015-0.075 (1, 2)	0.0091
Antimony	mg/L	0.02 (1)	0.0068
Arsenic	mg/L	0.1	0.00023
Barium	mg/L	—	0.0070
Beryllium	mg/L	0.011-1.1 (3)	< 0.00010
Bismuth	mg/L	—	< 0.00050
Boron	mg/L	0.2 (1)	< 0.010
Cadmium	mg/L	0.0002	**0.0016**
Calcium	mg/L	—	43
Chromium	mg/L	0.001	0.00013
Cobalt	mg/L	0.0009	**0.0017**
Copper	mg/L	0.005	0.00050
Iron	mg/L	0.3	< 0.010
Lead	mg/L	0.005–0.025 (4)	**0.019**
Lithium	mg/L	—	0.0019
Magnesium	mg/L	—	1.4
Manganese	mg/L	—	0.27
Molybdenum	mg/L	0.04 (1)	0.00073
Nickel	mg/L	0.025	0.00088
Phosphorus	mg/L	0.01-0.03 (1, 5)	**< 0.30**
Potassium	mg/L	—	5.22
Selenium	mg/L	0.1	0.00030
Silicon	mg/L	—	1.1
Silver	mg/L	0.0001	< 0.000010
Sodium	mg/L	—	4.4
Strontium	mg/L	—	0.082
Sulphur	mg/L	—	38
Thallium	mg/L	0.0003 (1)	0.000089
Tin	mg/L	—	< 0.00010
Titanium	mg/L	—	< 0.010
Uranium	mg/L	0.005 (1)	0.00016
Vanadium	mg/L	0.006 (1)	< 0.0010
Zinc	mg/L	0.03	**0.13**

Notes:
1 Interim PWQO Value
2 Dependant on pH
3 Dependant on hardness
4 Dependant on alkalinity
5 Varies with receiver type
Bold faced entries indicate value exceeded PWQO concentration or was outside PWQO specified pH range

Table 5-5: Principal Quantities Used as Basis of Water Quality Models

Parameter	Quantity
Tonnage of waste rock in the WRSA (1)	12.9 Mt
Tonnage of waste rock in the integrated open pit (2)	12.5 Mt
Volume of in-place waste rock in the WRSA (3)	4.6 Mm^3
Integrated open pit volume	11.9 Mm^3
Available volume in the integrated open pit (4)	7.3 Mm^3
Open pit wall surface area (5)	0.4 Mm^2
Area of TSF (6)	851,200 m^2
Tonnage of active tailings in TSF (7)	93,632 t

Sources:
(1) Information Request TMI_39—MW(1)-01
(2) Plan view of Goliath Ultimate Pit with In-Pit Waste Rock Dumps (P&E Mining Consultants, 31 Jan 2017)
(3) Assuming in-place density of 2.7 tonnes/m^3
(4) Total pit volume excluding volume of in-place waste rock
(5) Measured from AutoCAD Drawing entitled "Goliath End of Phase3 Pit design.dwg" (Provided by Treasury)
(6) Measured from GIS shape files from figure entitled "ENVE_2017_Closure Flow.pdf" (Provided by Treasury)
(7) Based on an in-situ dry density of 1.1 t/m3 (Appendix D of the EIS), and a 0.1 m thick unsaturated active layer of oxidizing tailings

Table 5-6: Mass Loading Source Terms for Water Quality Models

Source of Loading	Description	Source Reference	Applicable Model	
			End of Pit Flooding	Post-closure
Background / natural runoff	Representative surface water quality	Mean of values from *EIS Appendix P - Table 3.38. Concentrations of dissolved metals for TL2A*	Yes	Yes
Tailings supernatant water (transfer to pit at closure)	Predicted tailings supernatant water	Section 3 of *EIS - Table 3.8.3 Discharge Qualities*	Yes	No
Groundwater seepage	Representative groundwater quality	Mean of values from BH1A, BH2A, BH4A, BH8A in *EIS Appendix M - Table E2 Summary of Dissolved Metals in Groundwater*	Yes	Yes
TSF seepage - end of pit flooding	Predicted tailings supernatant water	Section 3 of *EIS - Table 3.8.3 Discharge Qualities*	Yes	No
TSF seepage – post-closure	Acidic tailings seepage	Last week of data from Tailings HCs from *EIS Appendix K - Table G1 Tailings HCT results*	No	Yes
Runoff from TSF dry cover	Representative surface water quality	Mean of values from *EIS Appendix P - Table 3.38. Concentrations of dissolved metals for TL2A*	Yes	Yes
NPAG waste rock - lower bound	Mine rock non-acidic humidity cell drainage - midrange	Median of weeks 20 to 63 of the Mine Rock Humidity Cells - *EIS Appendix K -Tables F1 to F11*	Yes	Yes
NPAG waste rock - upper bound	Mine rock non-acidic humidity cell drainage - upper range	75th Percentile of weeks 20 to 63 of the Mine Rock Humidity Cells - *EIS Appendix K -Tables F1 to F11*	Yes	Yes
Acid PAG waste rock - lower bound	Simulated acidic PAG rock loadings – midrange	Median values - Simulated Acid PAG loadings based on analogue site with site specific adjustment of minor and trace elements from acidic field cell data (see text).	Yes	Yes
Acid PAG waste rock - upper bound	Simulated acidic PAG rock loadings - upper range	75th percentile values - Simulated Acid PAG loadings based on analogue site with site specific adjustment of minor and trace elements from acidic field cell data (see text).	Yes	Yes

Table 5-7: Mass Loading Source Terms for End of Pit Flooding Water Quality Model

Source of Loading	Background / Natural Runoff	Tailings Supernatant Water (Transfer to Pit at Closure)	Groundwater Seepage	TSF Seepage	Runoff from TSF Dry Cover	NPAG Waste Rock - Lower Bound	NPAG Waste Rock - Upper Bound	Acid PAG Waste Rock - Lower Bound	Acid PAG Waste Rock - Upper Bound
Description (Table 5-6)	**Representative Surface Water Quality (mg/L)**	**Predicted Tailings Supernatant Water (mg/L)**	**Representative Groundwater Quality (mg/L)**	**Predicted Tailings Supernatant Water (mg/L)**	**Representative Surface Water Quality (mg/L)**	**Mine Rock Non-acidic Humidity Cell Drainage - midrange (mg/m2/wk)**	**Mine Rock Non-acidic Humidity Cell Drainage - upper range (mg/m2/wk)**	**Simulated Acidic PAG Rock Loadings - midrange (mg/m2/wk)**	**Simulated Acidic PAG Rock Loadings - upper range (mg/m2/wk)**
Sulphate	1.8	69	*31*	69	1.8	*1.6*	*2.1*	155	214
Aluminum	0.069	0.20	*0.015*	0.20	0.069	*0.0027*	*0.0060*	2.2	3.9
Antimony	*0.0012*	0.0020	*0.00074*	0.0020	*0.0012*	*9.0E-05*	*0.00032*	*2.7E-05*	*0.00030*
Arsenic	*0.0011*	0.018	*0.0025*	0.018	*0.0011*	*0.00011*	*0.00022*	*0.00096*	*0.011*
Beryllium	*0.0010*	0.00050	*0.0020*	0.00050	*0.0010*	*6.1E-05*	*6.2E-05*	0.00013	0.0014
Boron	*0.050*	0.020	*0.12*	0.020	*0.050*	*0.0063*	*0.0063*	*0.0030*	*0.033*
Cadmium	*2.7E-05*	0.0020	*4.4E-05*	0.0020	*2.7E-05*	*9.2E-06*	*1.8E-05*	0.00019	0.0020
Chromium	0.00096	0.00010	*0.0020*	0.00010	0.00096	*6.3E-05*	*6.6E-05*	*5.3E-05*	*0.00058*
Cobalt	*0.00050*	0.0040	*0.0016*	0.0040	*0.00050*	*9.7E-05*	*0.00043*	0.019	0.21
Copper	*0.0013*	0.018	*0.0056*	0.018	*0.0013*	*0.00027*	*0.00028*	0.0069	0.075
Iron	0.38	0.36	*0.27*	0.36	0.38	*0.0064*	*0.0081*	6.7	23
Lead	*0.0010*	0.082	*0.0020*	0.082	*0.0010*	*0.00016*	*0.00025*	0.0053	0.059
Molybdenum	*0.0010*	0.0010	*0.0023*	0.0010	*0.0010*	*3.1E-05*	*3.2E-05*	*1.4E-05*	*0.00015*
Nickel	*0.0020*	0.021	*0.0054*	0.021	*0.0020*	*0.00077*	*0.0018*	0.15	1.6
Selenium	*0.00091*	0.00050	*0.0024*	0.00050	*0.00091*	*6.1E-05*	*6.2E-05*	6.9E-05	0.00075
Silver	*0.00010*	5.0E-05	*0.00020*	5.0E-05	*0.00010*	*1.8E-05*	*3.1E-05*	*2.7E-06*	*3.0E-05*
Thallium	*0.00030*	0.03*	*0.00060*	0.03*	*0.00030*	*6.2E-06*	*6.6E-06*	1.5E-05	0.00016
Uranium	*0.0050*	0.0050	*0.0080*	0.0050	*0.0050*	7.4E-05	9.2E-05	0.0029	0.031
Vanadium	*0.0010*	0.0040	*0.0020*	0.0040	*0.0010*	*0.00061*	*0.00062*	*0.00014*	*0.0015*
Zinc	*0.0041*	0.040	*0.0072*	0.040	*0.0041*	*0.0017*	*0.0050*	0.086	0.95

Notes:

Chloride, mercury and phosphorus were not available for all source terms used in modelling and were therefore not included.

* Note - incorrect predicted value originally reported in source

Source terms for italicized and underlined values are based on some values reported as less than the detection limit

Table 5-8: Mass Loading Source Terms for Post-Closure Water Quality Model

Source of Loading	Background / Natural Runoff	Groundwater Seepage	TSF Seepage	Runoff from TSF Dry Cover	NPAG Waste Rock - Lower Bound	NPAG Waste Rock - Upper Bound	Acid PAG Waste Rock - Lower Bound	Acid PAG Waste Rock - Upper Bound
Description (see Table 5-6)	**Surface Water Quality (mg/L)**	**Groundwater Quality (mg/L)**	**Acid Tailings Seepage (mg/kg/wk)**	**Surface Water Quality (mg/L)**	**Mine Rock Non-acidic Humidity Cell Drainage - Midrange (mg/m²/wk)**	**Mine Rock Non-acidic Humidity Cell Drainage - Upper range (mg/m²/wk)**	**Simulated Acidic PAG Rock Loadings - Midrange (mg/m²/wk)**	**Simulated Acidic PAG Rock Loadings - Upper Range (mg/m²/wk)**
Sulphate	1.8	*31*	30	1.8	*1.6*	*2.1*	155	214
Aluminum	0.069	*0.015*	0.77	0.069	*0.0027*	*0.0060*	2.2	3.9
Antimony	*0.0012*	*0.00074*	0.00036	*0.0012*	*9.0E-05*	*0.00032*	*2.7E-05*	*0.00030*
Arsenic	*0.0011*	*0.0025*	0.0024	*0.0011*	*0.00011*	*0.00022*	*0.00096*	*0.011*
Beryllium	*0.0010*	*0.0020*	0.00018	*0.0010*	*6.1E-05*	*6.2E-05*	0.00013	0.0014
Boron	*0.050*	*0.12*	*0.0088*	*0.050*	*0.0063*	*0.0063*	*0.0030*	*0.033*
Cadmium	*2.7E-05*	*4.4E-05*	0.015	*2.7E-05*	*9.2E-06*	*1.8E-05*	0.00019	0.0020
Chromium	0.00096	*0.0020*	*8.8E-05*	0.00096	*6.3E-05*	*6.6E-05*	*5.3E-05*	*0.00058*
Cobalt	*0.00050*	*0.0016*	0.0075	*0.00050*	*9.7E-05*	*0.00043*	0.019	0.21
Copper	*0.0013*	*0.0056*	0.17	*0.0013*	*0.00027*	*0.00028*	0.0069	0.075
Iron	0.38	*0.27*	1.0	0.38	*0.0064*	*0.0081*	6.7	23
Lead	*0.0010*	*0.0020*	6.5	*0.0010*	*0.00016*	*0.00025*	0.0053	0.059
Molybdenum	*0.0010*	*0.0023*	*4.4E-05*	*0.0010*	*3.1E-05*	*3.2E-05*	*1.4E-05*	*0.00015*
Nickel	*0.0020*	*0.0054*	0.024	*0.0020*	*0.00077*	*0.0018*	0.15	1.6
Selenium	*0.00091*	*0.0024*	0.00061	*0.00091*	*6.1E-05*	*6.2E-05*	6.9E-05	0.00075
Silver	*0.00010*	*0.00020*	*8.8E-06*	*0.00010*	*1.8E-05*	*3.1E-05*	*2.7E-06*	*3.0E-05*
Thallium	*0.00030*	*0.00060*	0.00012	*0.00030*	*6.2E-06*	*6.6E-06*	1.5E-05	0.00016
Uranium	*0.0050*	*0.0080*	0.0031	*0.0050*	7.4E-05	9.2E-05	0.0029	0.031
Vanadium	*0.0010*	*0.0020*	*0.00088*	*0.0010*	*0.00061*	*0.00062*	*0.00014*	*0.0015*
Zinc	*0.0041*	*0.0072*	7.6	*0.0041*	*0.0017*	*0.0050*	0.086	0.95

Notes:

Chloride, mercury and phosphorus were not available for all source terms used in modelling and were therefore not included.

Source terms for *italicized and underlined values* are based on some values reported as less than the detection limit

Table 5-9: Estimated Open Pit Water Quality

Parameter	End of Pit Flooding		Long Term Post-Closure	
	Lower Bound (mg/L)	Upper Bound (mg/L)	Lower Bound (mg/L)	Upper Bound (mg/L)
Sulphate	490	673	53	71
Aluminum	6.7	12	0.81	1.3
Antimony	0.00085	0.0017	0.0012	0.0013
Arsenic	0.0043	0.034	0.0017	0.0045
Beryllium	0.0013	0.0052	0.0010	0.0014
Boron	0.058	0.15	0.052	0.061
Cadmium	0.00063	0.0064	0.0022	0.0028
Chromium	0.0010	0.0027	0.0010	0.0011
Cobalt	0.060	0.65	0.0073	0.064
Copper	0.023	0.24	0.027	0.047
Iron	21	72	2.5	7.4
Lead	0.019	0.18	0.021	0.037
Molybdenum	0.00099	0.0014	0.0010	0.0010
Nickel	0.46	5.0	0.049	0.48
Selenium	0.0011	0.0032	0.0010	0.0012
Silver	0.000098	0.00018	0.00010	0.00011
Thallium	0.00073	0.0012	0.00031	0.00036
Uranium	0.013	0.10	0.0060	0.015
Vanadium	0.0015	0.0058	0.0011	0.0016
Zinc	0.27	2.9	1.1	1.3

Note: Concentrations for chloride, mercury and phosphorus not included due to incomplete source term data

Table 5-10: Estimated WRSA and TSF Seepage Concentrations for Long Term Post-Closure

Parameter	TSF Seepage Dry Cover (mg/L)	TSF Seepage Wet Cover (mg/L)	WRSA Runoff/Seepage - Lower Bound (mg/L)	WRSA Runoff/Seepage - Upper Bound (mg/L)
Sulphate	203	68.6700	6,121	8,442
Aluminum	5.1	0.1990	85	155
Antimony	0.0024	0.0020	0.0011	0.012
Arsenic	0.016	0.0180	0.038	0.42
Beryllium	0.0012	0.0005	0.0049	0.054
Boron	0.059	0.0200	0.12	1.3
Cadmium	0.10	0.0020	0.0074	0.081
Chromium	0.00059	0.0001	0.0021	0.023
Cobalt	0.050	0.0040	0.76	8.3
Copper	1.1	0.0180	0.27	3.0
Iron	6.9	0.3580	266	909
Lead	0.87	0.0820	0.21	2.3
Molybdenum	0.00029	0.0010	0.00053	0.0059
Nickel	0.16	0.0210	5.8	63
Selenium	0.0041	0.0005	0.0027	0.030
Silver	0.000059	0.0001	0.00011	0.0012
Thallium	0.00084	0.0300	0.00058	0.0064
Uranium	0.021	0.0050	0.11	1.2
Vanadium	0.0059	0.0040	0.0055	0.061
Zinc	51	0.0400	3.4	37

Notes:

Concentrations for chloride, mercury and phosphorus are not included due to incomplete source term data

Un-equilibrated results.

Table 5-11: Revised Source Terms for TSF Wet Cover Option

Source of Loading	Background / Natural Runoff	Groundwater Seepage	TSF Seepage	Runoff from TSF	NPAG Waste Rock - Lower Bound	NPAG Waste Rock - Upper Bound	Acid PAG Waste Rock - Lower Bound	Acid PAG Waste Rock - Upper Bound
Description (see Table 5-6)	**Representative Surface Water Quality (mg/L)**	**Representative Groundwater Quality (mg/L)**	**Predicted Tailings Supernatant Water (mg/L)**	**Representative Surface Water Quality (mg/L)**	**Mine Rock Non-acidic Humidity Cell Drainage ($mg/m^2/wk$)**	**Mine Rock Non-acidic Humidity Cell Drainage ($mg/m^2/wk$)**	**Simulated Acidic PAG Rock Loadings ($mg/m^2/wk$)**	**Simulated Acidic PAG Rock Loadings ($mg/m^2/wk$)**
Sulphate	1.8	*31*	69	1.8	*1.6*	*2.1*	155	214
Aluminum	0.069	*0.015*	0.20	0.069	*0.0027*	*0.0060*	2.2	3.9
Antimony	*0.0012*	*0.00074*	0.0020	*0.0012*	*9.0E-05*	*0.00032*	*2.7E-05*	*0.00030*
Arsenic	*0.0011*	*0.0025*	0.018	*0.0011*	*0.00011*	*0.00022*	*0.00096*	*0.011*
Beryllium	*0.0010*	*0.0020*	0.00050	*0.0010*	*6.1E-05*	*6.2E-05*	0.00013	0.0014
Boron	*0.050*	*0.12*	0.020	*0.050*	*0.0063*	*0.0063*	*0.0030*	*0.033*
Cadmium	*2.7E-05*	*4.4E-05*	0.0020	*2.7E-05*	*9.2E-06*	*1.8E-05*	0.00019	0.0020
Chromium	0.00096	*0.0020*	0.00010	0.00096	*6.3E-05*	*6.6E-05*	*5.3E-05*	*0.00058*
Cobalt	*0.00050*	*0.0016*	0.0040	*0.00050*	*9.7E-05*	*0.00043*	0.019	0.21
Copper	*0.0013*	*0.0056*	0.018	*0.0013*	*0.00027*	*0.00028*	0.0069	0.075
Iron	0.38	*0.27*	0.36	0.38	*0.0064*	*0.0081*	6.7	23
Lead	*0.0010*	*0.0020*	0.082	*0.0010*	*0.00016*	*0.00025*	0.0053	0.059
Molybdenum	*2.3E-05*	*4.0E-05*	0.0010	*2.3E-05*	*1.4E-6 (1)*	*1.5E-5 (1)*	*1.4E-06*	*1.5E-05*
Nickel	*0.0010*	*0.0023*	0.021	*0.0010*	*3.1E-05*	*3.2E-05*	*1.4E-05*	*0.00015*
Selenium	*0.0020*	*0.0054*	0.00050	*0.0020*	*0.00077*	*0.0018*	0.15	1.6
Silver	*0.00091*	*0.0024*	5.0E-05	*0.00091*	*6.1E-05*	*6.2E-05*	6.9E-05	0.00075
Thallium	*0.00010*	*0.00020*	0.03*	*0.00010*	*1.8E-05*	*3.1E-05*	*2.7E-06*	*3.0E-05*
Uranium	*0.00030*	*0.00060*	0.0050	*0.00030*	*6.2E-06*	*6.6E-06*	1.5E-05	0.00016
Vanadium	*0.0050*	*0.0080*	0.0040	*0.0050*	7.4E-05	9.2E-05	0.0029	0.031
Zinc	*0.0010*	*0.0020*	0.040	*0.0010*	*0.00061*	*0.00062*	*0.00014*	*0.0015*

Notes:

Chloride, mercury and phosphorus were not available for all source terms used in modelling and were not included

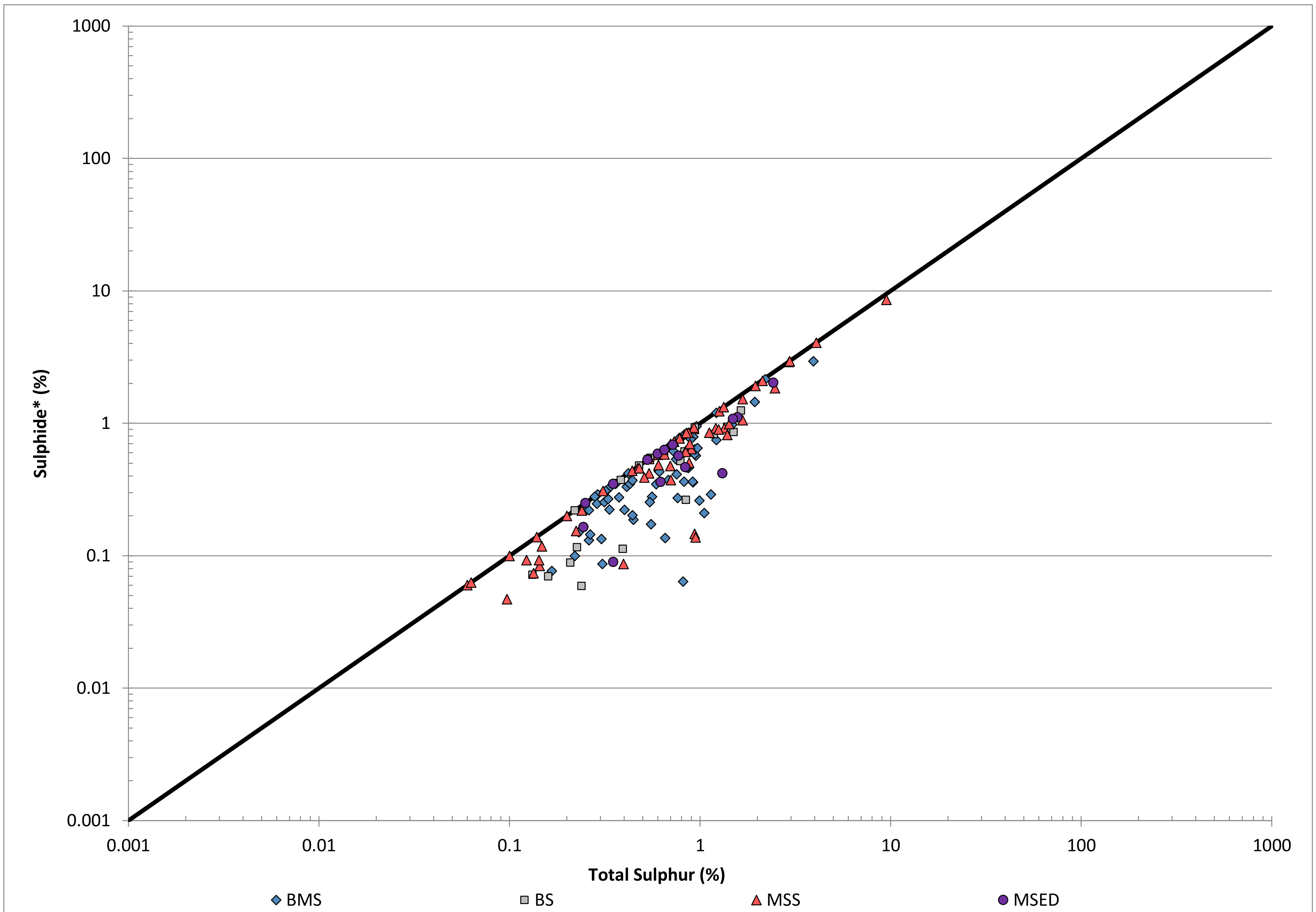
Greyed source terms indicate no change from TSF Dry Cover Model (Table 5-8)

Source terms for *italicized and underlined values* are based on some values reported as less than the detection limit

Table 5-12: Estimated Long-term Post-Closure Water Quality with TSF Wet Cover Option

Parameter	Open Pit - Lower Bound (mg/L)	Open Pit - Upper Bound (mg/L)	TSF Seepage (mg/L)	WRSA Runoff/Seepage - Lower Bound (mg/L)	WRSA Runoff/Seepage - Upper Bound (mg/L)
Sulphate	59	81	69	6,121	8,442
Aluminum	0.84	1.5	0.2	85	155
Antimony	0.0011	0.0012	0.002	0.0011	0.012
Arsenic	0.0014	0.0049	0.018	0.038	0.42
Beryllium	0.0010	0.0015	0.0005	0.0049	0.054
Boron	0.051	0.062	0.02	0.12	1.3
Cadmium	9.5-05	0.00077	0.002	0.0074	0.081
Chromium	0.00097	0.0012	0.0001	0.0021	0.023
Cobalt	0.0074	0.076	0.004	0.76	8.3
Copper	0.0039	0.029	0.018	0.27	3.0
Iron	2.8	8.7	0.36	266	909
Lead	0.0030	0.022	0.082	0.21	2.3
Mercury	2.4E-05	2.9E-05	0.0018	5.3E-05	0.00059
Molybdenum	0.0010	0.0011	0.001	0.00053	0.0059
Nickel	0.055	0.58	0.021	5.8	63
Selenium	0.00095	0.0012	0.0005	0.0027	0.030
Silver	9.9E-05	0.00011	5.00E-05	0.00011	0.0012
Thallium	0.00033	0.00038	0.03*	0.00058	0.0064
Uranium	0.0059	0.016	0.005	0.11	1.2
Vanadium	0.0010	0.0015	0.004	0.0055	0.061
Zinc	0.035	0.35	0.04	3.4	37

Note: Concentrations for chloride and phosphorus not included due to incomplete source term data

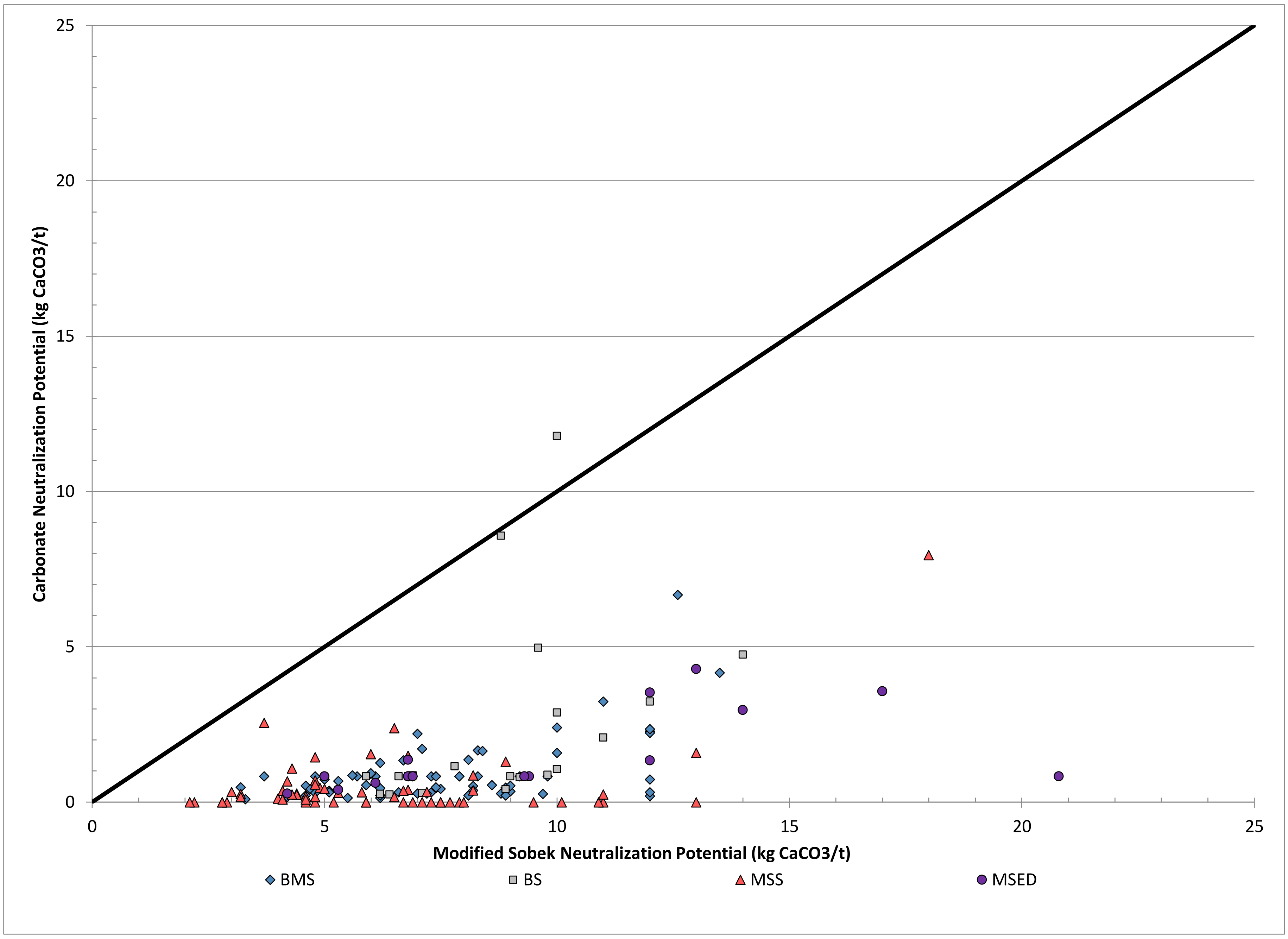


* Sulphide sulphur by difference (total sulphur - sulphate)

GOLIATH GOLD PROJECT

Waste Rock Total Sulphur vs. Sulphide

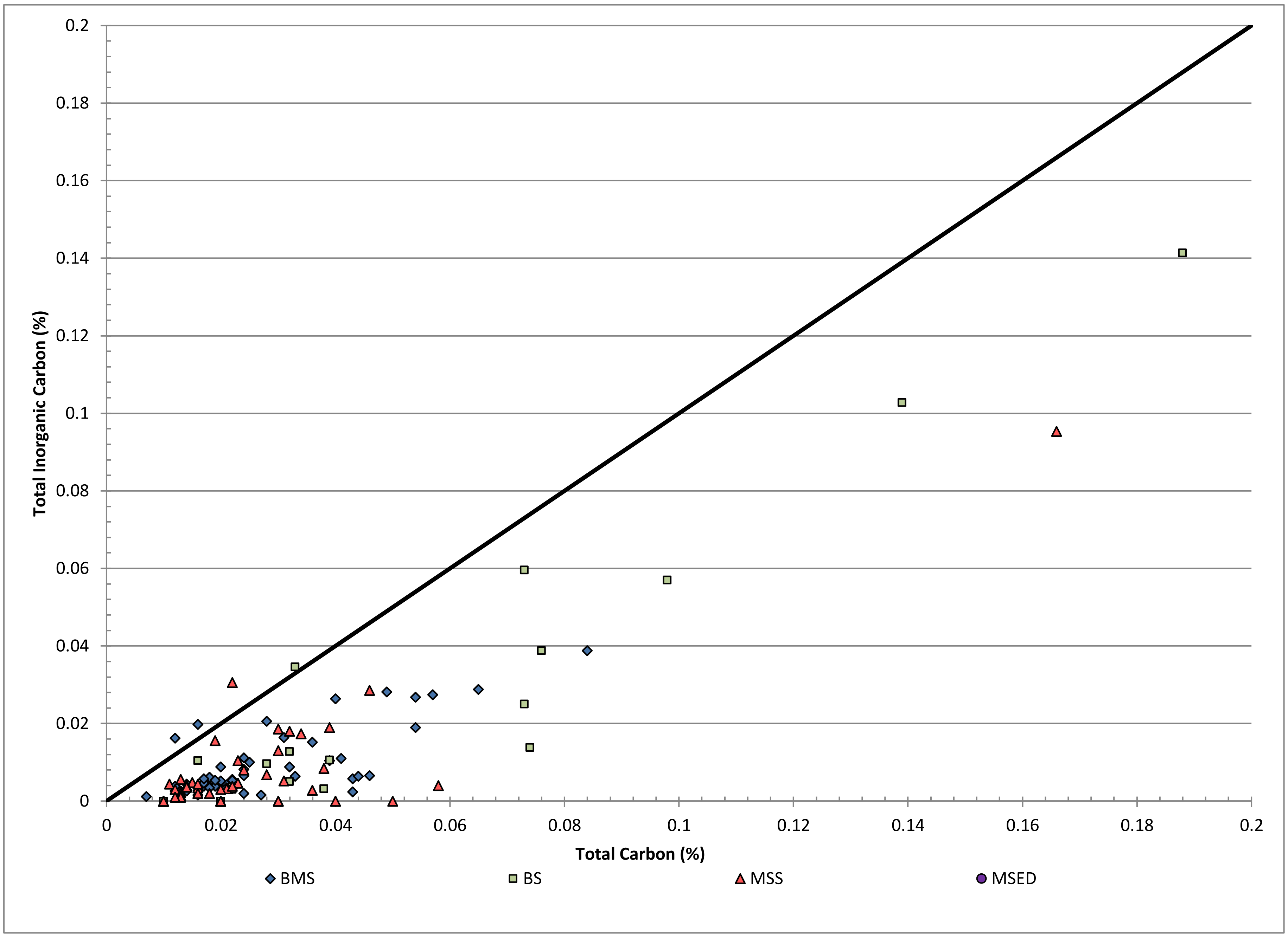
Drawn by: MLT	Checked by: SW	Date: April 2017
Project: TC160516		FIGURE 5-1



GOLIATH GOLD PROJECT

Waste Rock Modified Sobek Neutralization Potential vs. Carbonate Neutralization Potential

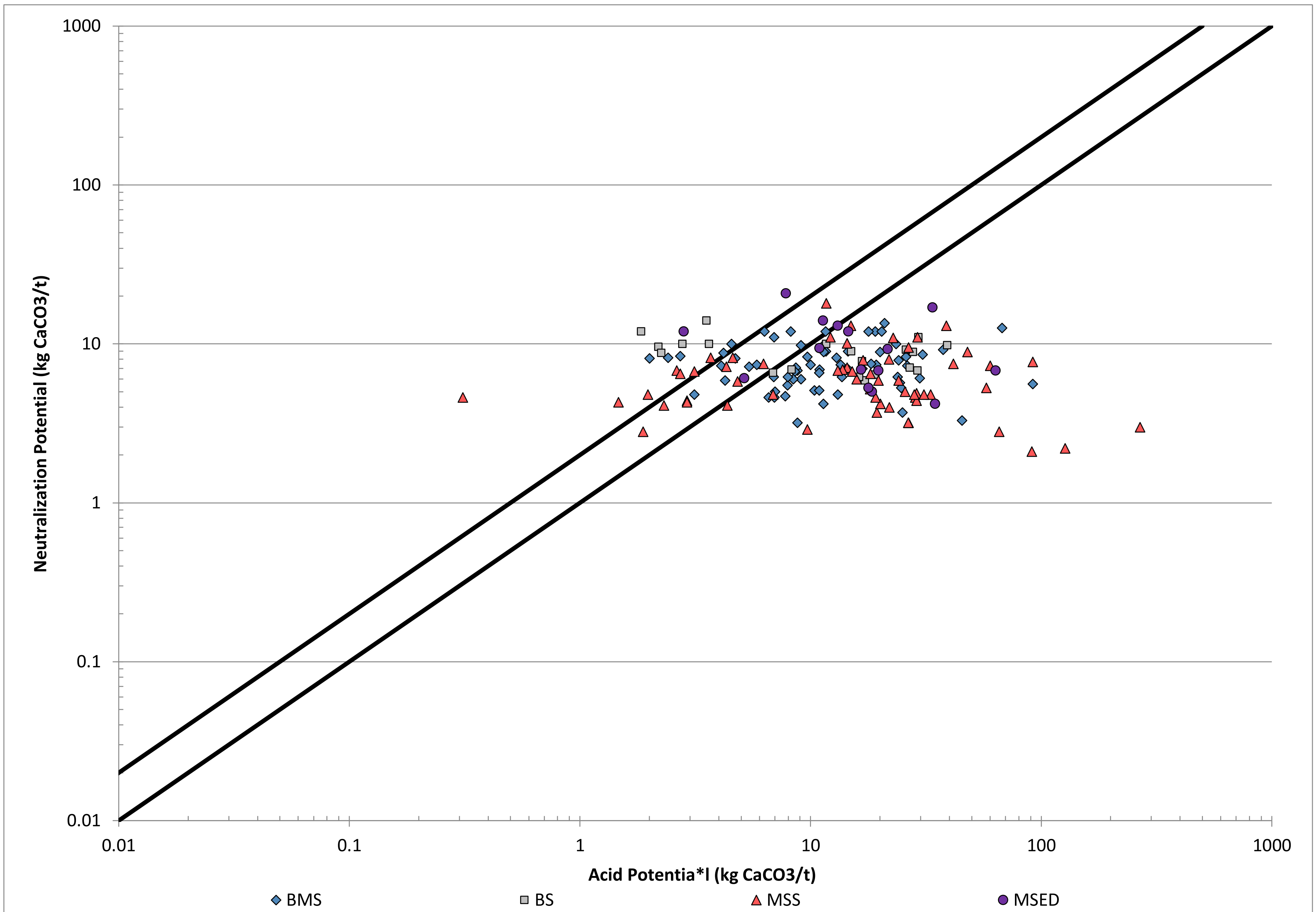
Drawn by: CS	Checked by: SW	Date: April 2017
Project: TC160516		FIGURE 5-2



GOLIATH GOLD PROJECT

Waste Rock Total Carbon vs. Total Inorganic Carbon Potential

Drawn by: CS	Checked by: SW	Date: April 2017
Project: TC160516		FIGURE 5-3

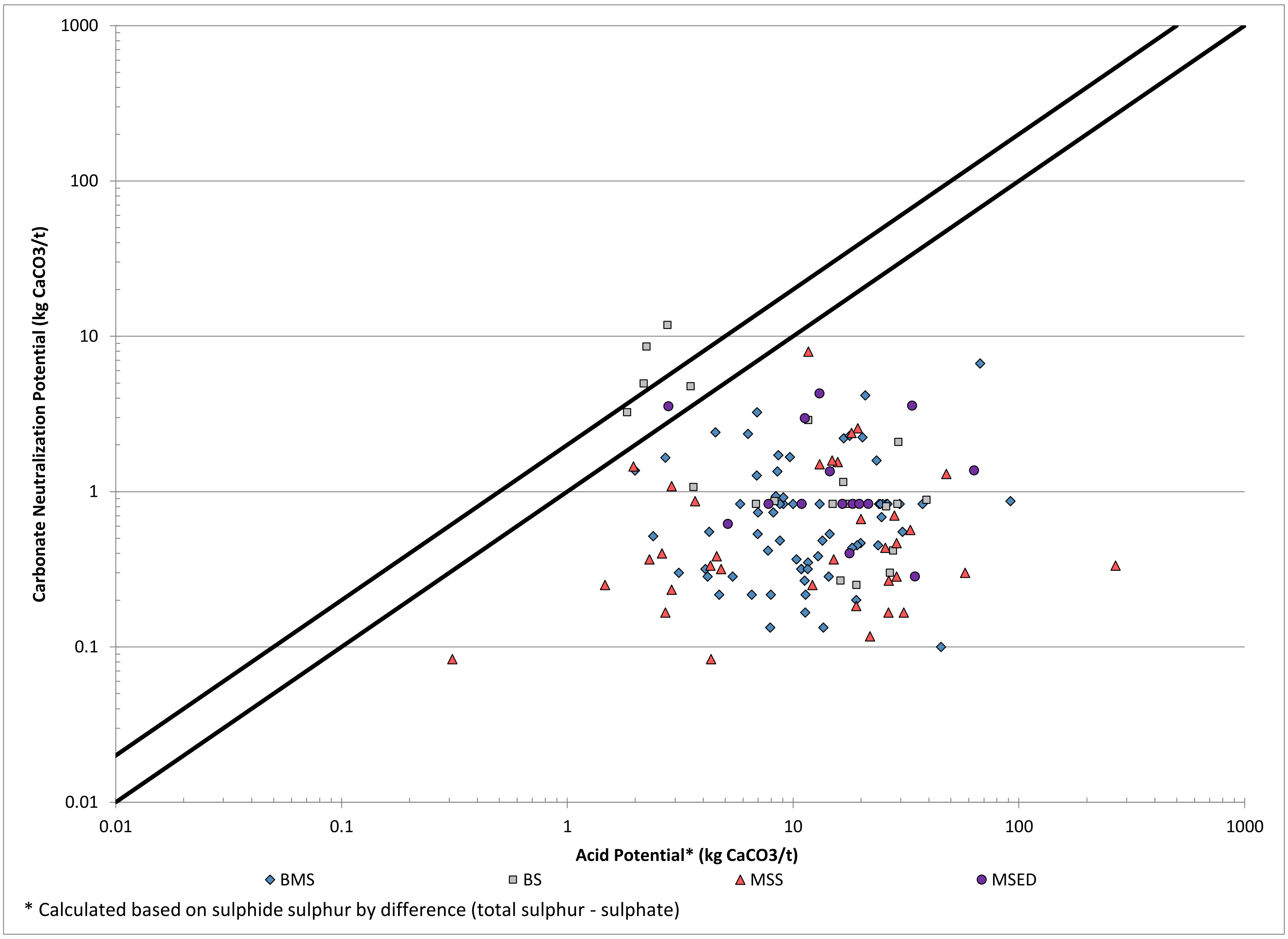


* Calculated based on sulphide sulphur by difference (total sulphur - sulphate)

GOLIATH GOLD PROJECT

Waste Rock Acid Potential vs. Neutralization Potential

Drawn by: MLT	Checked by: SW	Date: April 2017
Project: TC160516		FIGURE 5-4



GOLIATH GOLD PROJECT

Waste Rock Acid Potential vs. Carbonate Neutralization Potential

Drawn by: MLT	Checked by: SW	Date: April 2017
Project: TC160516		FIGURE 5-5

6.0 SURFACE WATER QUALITY

Since the filing of the EIS, Treasury Metals has continued to advance their engineering work for this Project. This work includes an update to the conceptual water balance for the Project that was included as an appendix to the Project Update Report, and has been summarized in Section 2 of this report. The hydrogeological modelling completed to support the EIS was included as Appendix M to the EIS, and remains valid for the Project. Relevant information from Appendix M that is relied on for modelling surface water quality has been summarized in Section 3 of this report. Refinements to the conceptual water balance for the Project have in turn resulted in updated surface water hydrology (Section 4) that surface water quality estimates relied on. Finally, the analysis of geochemistry for the Project has been re-evaluated in order to respond to the Round 1 information requests. This re-analysis has resulted in refined estimates of seepage qualities from both the tailings storage facility (TSF) and waste rock storage area (WRSA), as well as refined estimates for the water quality in the pit lake. These refined geochemical estimates (Section 5) were used as modelling inputs to estimate surface water quality. A summary of the input parameters, methodology and surface water quality results in the receiving waterbodies are provided in the subsections below.

6.1 Surface Water Systems

6.1.1 Overview

The Project is located east of Thunder Lake and north-east of Wabigoon Lake, and sits within sub-watersheds that drain to either Thunder Lake or Wabigoon Lake. Thunder Lake ultimately discharges to Wabigoon Lake via Thunder Creek. The sub-watersheds surrounding the Project Site include Thunder Lake Tributaries 2 and 3, Hoffstrom's Bay Tributary, and Little Creek in the Thunder Lake watershed, and Blackwater Creek in the Wabigoon Lake watershed. A perimeter runoff and seepage collection system will be constructed around the operations area at the start of the site preparation and construction phase to collect runoff and seepage. As a result, runoff from portions of the Hoffstrom's Bay Tributary and Little Creek catchments will no longer drain to Thunder Lake, but will be collected, used in the process, and ultimately treated and discharged to Blackwater Creek. During operations, fresh water required in the process will be withdrawn from the pre-existing ponds located on Thunder Lake Tributary 2 and Thunder Lake Tributary 3. Both of these tributaries are located within the Thunder Lake Tributary 2 catchment area that eventually drains to Thunder Lake.

Figure 6-1 illustrates the relative location of the operations area, from which all site runoff will be collected, and the four catchment areas and various watercourses in the vicinity of the Project. The figure also illustrates the location of the proposed single discharge point on Blackwater Creek, as well as the location of the irrigation ponds at the former MNRF tree nursery to be used for withdrawal of fresh water.

6.1.2 Water Management Strategy

Water management strategies will evolve as the Project Site is developed from site preparation and construction to operations and eventually post-closure, as summarized in the following subsections.

6.1.2.1 Site Preparation and Construction Phase

During the site preparation and construction phase, a perimeter runoff and seepage collection ditch will be constructed around what is referred to as the operations area. This system will capture all of the runoff from the developed site area, which will be retained to the extent practical to help establish the tailings storage facility (TSF) to provide water for use in the processing plant. There will be no discharges from the Project site area to surface waters during the site preparation and construction phase to the extent practical. Discharge to Blackwater Creek would only be undertaken in response to large rainfall and/or snowmelt events, and would be in accordance with federal and provincial regulatory requirements.

6.1.2.2 Operations Phase

During operations, all site runoff will continue to be collected from within the operations area for use in the processing plant. Dewatering activity will increase as the open pit and underground mine workings are developed to provide dry working conditions and a safe working environment. As detailed in Appendix M to the EIS, these dewatering activities will lower the groundwater table around the perimeter of the open pit and mine workings, creating what is referred to as a drawdown zone. Within this drawdown zone, groundwater will migrate towards the open pit. During operations, seepage from on-site structures, such as the TSF, WRSA and low grade ore (LGO) stockpile will be captured largely by the perimeter collection ditches around each structure. The seepage that escapes the seepage collection systems will be captured within the drawdown zone caused by dewatering and will ultimately report to the open pit.

Runoff from the site and the water collected by the dewatering of the open pit and underground mine will be used in the processing plant, as described in the conceptual water balance provided as an appendix to the Project Update Report, and summarized in Section 2 of this report. Any excess water collected during operations will be treated and discharged to Blackwater Creek at a single point location (Figure 6-1). Treated effluent (i.e., all excess collected site runoff, dewatering water, and water from the TSF) will be treated to concentrations that meet Provincial Water Quality Objectives (PWQO) or Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life, prior to discharge to Blackwater Creek. In the case of mercury, effluent will be treated to meet the background concentrations in Blackwater Creek, at a minimum. It is anticipated that there could be some level of treated effluent discharged throughout the year, as described in Section 2.

6.1.2.3 Closure Phase

Following the end of mining activities, Treasury Metals will decommission the site and implement the closure plan. All of the free water present in the TSF will be withdrawn, treated and used to fill the open pit, together with general site runoff. The TSF will then be covered to reduce oxidation of the tailings. The two cover options being considered are a low permeability dry cover, or a wet cover with non-process water. The mine dewatering activities would be stopped and groundwater would be allowed to inflow to the pit, speeding the filling process. As the pit is filling, there will continue to be a drawdown zone that will continue to capture any of the seepage from the TSF and WRSA that escapes the seepage collection systems. This seepage will continue to report to the open pit. There will be no releases to surface water during the active closure phase.

6.1.2.4 Post-closure Phase

Upon cessation of the mining activities, dewatering will cease and the open pit and underground workings will be allowed to flood, and the groundwater table will return to near pre-development conditions. Even when the open pit is fully flooded, the hydrogeologic modelling suggests that the groundwater will still tend to flow toward the open pit, and similarly for a portion of the seepage from the TSF and WRSA. Once the groundwater levels recover to near pre-development conditions, modelling suggests a portion of seepage from the TSF and WRSA will also report to surrounding waterbodies. Specifically, seepage from the capped WRSA will report to Thunder Lake (Section 3). Seepage from the TSF (with a dry cover) will report to Blackwater Creek, Hoffstrom's Bay Tributary and Thunder Lake Tributary 3 (Section 3). With a wet cover over the TSF, seepage will report to Blackwater Creek, Hoffstrom's Bay Tributary, Thunder Lake Tributary 3, and Thunder Lake. Runoff and groundwater inflow to the pit lake will be allowed to passively discharge from a spillway into the former channel of Blackwater Creek Tributary 1, which drains into Blackwater Creek.

6.2 Surface Water Quality Model

Surface water quality was evaluated at nine locations in the surrounding receiving waterbodies. These locations, commonly referred to as "nodes" in the model, are listed below (in order of upstream to downstream location) along with a brief description for each node:

- Thunder Lake Tributary 2 (TL1); downstream of the irrigation pond at the former MNRF tree nursery;
- Thunder Lake Tributary 3 (TL2); downstream of the irrigation ponds at the former MNRF tree nursery;
- Thunder Lake Tributary 2 (TL3); at Thunder Lake;
- Hoffstrom's Bay Tributary (HB1); at Thunder Lake;

- Little Creek (LC1); at Thunder Lake;
- Blackwater Creek (BW1); downstream of the proposed Project site and treated effluent discharge location;
- Blackwater Creek (BW2); discharge to Wabigoon Lake;
- Thunder Lake (TL); and
- Wabigoon Lake (WL).

The location of all the nodes for which receiver surface water quality has been evaluated for is shown on Figure 6-1, and listed in Table 6-1 for reference. The selection of these nodes includes two that are in the vicinity of the Project site area and within the Wabigoon Lake watershed area (i.e., BW1 and BW2). The node BW1 is immediately downstream of the proposed treated effluent discharge location (Figure 6-1). Five nodes are within the Thunder Lake watershed area (i.e., HB1, TL1, TL2, TL3 and LC1) and one node is in each of the lakes (i.e., TL in Thunder Lake and WL in Wabigoon Lake).

Surface water quality for each node was evaluated and based on annual average flow data, as there was insufficient data to support monthly variability. Surface water quality was also modeled for an average year, dry year and wet year. A fulsome description for the establishment of the average, wet and dry precipitation scenarios is provided in Section 4 of this report.

The model was used to establish the surface water quality for existing conditions (pre-development), as well as the operations and post-closure phases of the Project. As noted previously, there will be minimal discharges to surface water during the site preparation and construction phase, or the closure phase, as site waters will be directed to the TSF or the open pit, respectively, during these phases.

A general mass balance equation, as shown below, was rearranged and used to determine the final concentration (C_{out}) of each node for the three Project phases, as follows:

$$F_{\mathrm{wc}}\mathrm{C}_{\mathrm{wc}} + F_{\mathrm{in}}\mathrm{C}_{\mathrm{in}} = F_{out}C_{out}$$

where:

F_{wc} = flow rate of watercourse, m^3/s

C_{wc} = concentration of watercourse, mg/L

F_{in} = flow rate of input parameter, m^3/s

C_{in} = concentration of input parameter, mg/L

F_{out} = flow rate at node, m^3/s

C_{out} = concentration at node, mg/L

6.2.1 Surface Water Quality Model Inputs

6.2.1.1 Existing Conditions, Operations Phase, Post-closure Phase

Background surface water quality was determined for each watercourse or waterbody potentially affected by the Project. Background water quality was based on background data collected in 2012 and 2013 (Appendix P of the EIS). For example, the determination of background water quality in Blackwater Creek was comprised of five water quality sampling stations within the Blackwater Creek catchment area. Background water quality for each watercourse was determined by calculating the 50th percentile concentrations for each key parameter. For Blackwater Creek, this included taking the 50th percentile for all data of the following five stations: SW-TL1A, SW-TL2, SW-TL3, SW-JCTa, and SW-11. The location for these five stations is shown on Figure 6-2. This figure also includes a table listing each watercourse and corresponding sampling stations from Appendix P that were used for establishing background water quality. The background water quality at nodes BW1 and BW2, both located in Blackwater Creek, would be equal to and based on all background water quality presented in Appendix P of the EIS for Blackwater Creek. Table 6-2 provides a listing of the background surface water quality, summarized by waterbody, which served as input data for determining surface water quality in the receiving environment for the existing conditions, as well as the operations phase and post-closure phase of the Project.

6.2.1.2 Operations Phase

During operations, there will be a single point of discharge from the Project to Blackwater Creek (Figure 6-1). All site runoff from within the operations area will be collected and directed to the water management system, where it will be available for use in the processing plant. Excess water, not required in eh process, will be treated and discharged as effluent to Blackwater Creek. Treated effluent quality will meet PWQO, CWQG when there are no PWQO criteria, or background concentrations for the case of mercury, during the operations phase of the Project life. Refer to Table 6-3 for the proposed treated effluent discharge water quality.

As previously described, surface water quality was modeled for each phase under three different hydrologic scenarios: average year, wet year, and dry year. The volume of treated effluent discharged for each hydrologic scenario, on an annual basis, is provided in Table 6-4 and serves as input parameters for the surface water quality model during the operations phase. There will be no discharges to the surface water in any of the tributaries to Thunder Lake, however, fresh water will be withdrawn periodically from the irrigation ponds at the former MNRF tree nursery. These ponds are located on Thunder Lake Tributary 2 and Thunder Lake Tributary 3. As described previously, any seepage from the TSF and WRSA that escapes the seepage collection systems will be captured by the drawdown zone created by the dewatering of the open pit and underground mine, and will report to the open pit.

6.2.1.3 Post-closure Phase

Upon closure of the mine site, the site will be sloped and/or ditched to direct all of the runoff towards the open pit to aid in the filling. Dewatering of the open pit will be discontinued and the pit allowed to flood. Once the pit lake is fully flooded, the excess water will be passively discharged via a spillway into the former channel of Blackwater Creek Tributary 1, which drains into Blackwater Creek. The rate at which the pit lake will discharge to the receiving environment is provided in Table 6-4. The table includes estimates of discharges on an annual basis for an average, wet and dry year. The quality of the water in the pit lake at post-closure is described in Section 5 of this report. The pit lake quality, without consideration of treatment, is provided in Table 5-9, however, Treasury Metals will monitor the pit lake as it is filling to determine whether treatment will be required in order that the pit lake discharge meets PWQO. It is expected that the quality of pit lake water discharged to the environment will be consistent with the data presented in Section 5, or the PWQO, whichever is lower.

Once the pit lake is fully flooded, groundwater levels will have returned to near pre-development conditions. Groundwater modelling (described in Section 3) indicates that seepage from the TSF and WRSA at post-closure will report to various waterbodies around the Project, at different seepage rates as described in Section 3.4. Table 6-5 lists the respective seepage rates from the TSF and WRSA.

6.2.2 Methodology for Existing Conditions

Existing water quality data was used to established representative water quality for each node (node locations shown on Figure 6-1), with background surface water quality (described above in Section 6.2.1) as the key input parameter to the model, along with flow rate information as per Table 4-16. A schematic diagram representing input parameters for each node (i.e., natural runoff, tributary flow and groundwater) is shown in Figure 6-3.

6.2.3 Methodology for Operations Phase

Modelling of the surface water quality for each of the nine nodes shown on Figure 6-1 was based on the following assumptions for the operations phase:

- Seepage not captured by perimeter collection ditches will be captured within the drawdown zone caused by active mine dewatering, and will ultimately report to the open pit.

- Site runoff will be collected from within the Project site boundary area and treated prior to being discharged to Blackwater Creek. The effluent discharge point is located immediately upstream of node BW1 (Figure 6-1).

- The water quality of natural runoff from those areas outside of the operations area is assumed to be equivalent to background water quality that was described above.

The method for determining the surface water quality at the nine nodes is summarized in the text that follows and organized by the four watershed areas and two lakes as shown on Figure 6-2.

6.2.3.1 Thunder Lake Tributary 2 and Tributary 3 Catchment

The surface water quality at node TL1, for Thunder Lake Tributary 2, was based on the following input parameters: upstream Thunder Lake Tributary 2 and Tributary 3 and natural runoff. The 'upstream' and 'natural runoff' input parameters for concentration were determined by taking the 50^{th} percentile concentration of all background samples collected in Thunder Lake Tributaries 2 and 3 (SW-7, SW-8 and SW-10 from Figure 6-2). The input flow rates for TL1 were taken from Table 4-17. Using a mass-balance equation described above in Section 6.2, the surface water quality concentration at node TL1 was determined. The water quality for node TL2 was determined in the same manner as described above for node TL1, however, input variables (i.e., flow rate and concentration) specific for node TL2 were used. The surface water quality and flow rates previously calculated for nodes TL1 and TL2 serve as inputs to determine the surface water quality at node TL3; representative of the 'upstream' input parameter. The second input parameter, natural runoff, was calculated by subtracting the sum of the flow rates associated at nodes TL1 and TL2 from the flow rate associated with node TL3 (Table 4-17). The water quality concentration associated with the natural runoff component was assumed to be the same as background water quality concentration determined for Thunder Lake Tributary 2 (based on data collected from SW-7 and SW-10 shown on Figure 6-2). Refer to Figure 6-4 which shows the Thunder Lake Tributary 2 catchment area and summarizes the input and output variables and relationship between nodes TL1, TL2 and TL3. The determination of surface water quality at nodes TL1 and TL2 also took into account a fresh water withdrawal from Thunder Lake Tributaries 2 and 3 that occurs during the operations phase.

6.2.3.2 Hoffstrom's Bay Tributary Catchment

The water quality in Hoffstrom's Bay Tributary, at node HB1, was calculated using the same method as described above for nodes TL1 and TL2, but with flow and water quality data specific to HB1. Hoffstrom's Bay Tributary natural runoff and upstream input parameters (Figure 6-4) were the same in terms of water quality, and were based on station SW-9 background water quality data (Figure 6-2).

6.2.3.3 Little Creek Catchment

The water quality for node LC1 in Little Creek was determined in the same manner as described for the nodes above (i.e., for TL1, TL2 and HB1), however, input variables specific for node LC1 were used. Flow data from Table 4-17 and 50^{th} percentile background water quality data for Little Creek (station SW-2 shown on Figure 6-2) were used as input parameters for calculating receiving water quality at node TL2. A schematic diagram depicting the input variables used to calculate the receiving water quality at node LC1 is shown on Figure 6-4.

6.2.3.4 Blackwater Creek Catchment

The determination of surface water quality at node BW1 was based on the following input parameters: upstream Blackwater Creek, natural runoff and treated effluent discharge. Surface water quality at node BW2 was based on the following inputs: natural runoff and tributary flow and water quality, and flow and water quality previously calculated for node BW1. Therefore, the outputs determined at node BW1 served as inputs for determining surface water quality at node BW2. Figure 6-4 illustrates this relationship between the two nodes BW1 and BW2 in the Blackwater Creek catchment. Water quality of the natural runoff and tributary flow was assumed to be equivalent to background concentrations determined for Blackwater Creek that included the data collected for stations SW-TL1A, SW-TL2, SW-TL3, SW-JCTa and SW-11 (Figure 6-2).

6.2.3.5 Thunder Lake

Water quality in Thunder Lake for node TL, was determined based on the following input parameters and assumptions made for input water quality:

- Previously calculated flow rates and concentrations for nodes TL3, HB1 and LC1, which are upstream of TL, served as input parameters.

- It was assumed that groundwater quality directed to Thunder Lake was equal to background water quality in Thunder Lake (based on 50th percentile data collected at stations SW-5 and SW-6, as shown on Figure 6-2).

- Natural runoff and tributary flow water quality to Thunder Lake was assumed to be equal to Thunder Lake Tributary 2 and Tributary 3 background water quality (based on 50th percentile data collected at stations SW-7, SW-8 and SW-10, as shown on Figure 6-2).

Wabigoon Lake

Water quality for node WL, in Wabigoon Lake, was based on two input parameters, with the following assumptions:

- Previously calculated flow rates and concentrations for nodes TL and BW2 served as upstream input parameters.

- It was assumed that natural runoff and tributary flow water quality to Wabigoon Lake is the same as the background water quality and to the same as the 50th percentile data collected at stations SW-4 as per Figure 6-2).

6.2.4 Methodology for Post-Closure Phase

6.2.4.1 Thunder Lake Tributary 2 and Tributary 3 Catchment

Surface water quality for nodes TL1, TL2 and TL3 for the post-closure phase was determined using a similar method described above for the operations phase but with flow data specific to post-closure (Table 4-19), and with the following key changes listed below:

- There is no fresh water withdrawal from Thunder Lake Tributaries 2 and 3; and
- There is seepage from the covered TSF to Thunder Lake Tributary 3 at node TL2.

Figure 6-5 provides the input and output variables summarized above for nodes TL1, TL2 and TL3.

6.2.4.2 Hoffstrom's Bay Tributary Catchment

Surface water quality in Hoffstrom's Bay Tributary for node HB1 was determined using a similar method described above for HB1 for operations, however, a seepage component from the TSF was included for this phase and not relevant for operations. Refer to Figure 6-5 for a schematic diagram, which depicts all of the input parameters used to determine surface water quality for HB1.

6.2.4.3 Little Creek Catchment

The water quality for node LC1 in Little Creek was determined in the same manner as TL1 and TL2 described above, however, input variables specific for node LC1 were used. Flow data from Table 4-19 of this report and 50th percentile background water quality data for Little Creek (station SW-2 shown on Figure 6-2) was assumed to represent natural runoff water quality, which is shown as an input parameter on Figure 6-5.

6.2.4.4 Blackwater Creek Catchment

Surface water quality was determined at nodes BW1 and BW2 for the post-closure phase. The method used to determine water quality during post-closure was based on a similar method described above for the same water catchment during operations, with the following key changes:

- Treated effluent (collection of site runoff from the Project site area) is no longer being discharged to Blackwater Creek (BW1) during the post-closure phase;

- Pit lake discharge occurs via a spillway and ditch into Blackwater Creek during post-closure (BW1);

- Seepage component from the TSF to Blackwater Creek (BW1); and

- Seepage component from the TSF to Blackwater Creek (BW2).

These key changes are summarized in Figure 6-5 for the Blackwater Creek Catchment. Pit lake discharge and TSF seepage volumes to the receiving environment are provided in Table 6-5.

6.2.4.5 Thunder Lake

Surface water quality at TL in Thunder Lake was determined in a similar method described above for the same node during the operations phase. However, the following key change to the post-closure phase model was made: inclusion of a seepage component from the WRSA to Thunder Lake during the post-closure phase.

6.2.4.6 Wabigoon Lake

Surface water quality for node WL in Wabigoon Lake for post-closure was determined using the same method described above for the operations phase (as the input parameters are the same for both the operations and post-closure phases). However, flow data specific to post-closure (Table 4-19) instead of flow data corresponding to operations (Table 4-17) was used. Figure 6-5 provides the input and output variables for the post-closure phase for the node WL.

6.3 Surface Water Quality Results

Surface water quality results for each of the nine nodes for the various phases (i.e., existing conditions, operations and post-closure phases) are shown in Table 6-6 through 6-14 for each node in the following order: TL1, TL2, TL3, HB1, LC1, BW1, BW2, TL and WL. Post-closure surface water quality results are presented for a TSF dry cover and TSF wet cover (for both post-closure scenarios, the WRSA is capped).

Table 6-1: Receiver Water Quality Nodes for Modelling

Node	Waterbody Receiver
TL1	Thunder Lake Tributary 2
TL2	Thunder Lake Tributary 3
TL3	Thunder Lake Tributary 2
HB1	Hoffstrom's Bay Tributary
LC1	Little Creek
BW1	Blackwater Creek
BW2	Blackwater Creek
TL	Thunder Lake
WL	Wabigoon Lake

Table 6-2: Background Surface Water Quality Inputs

Parameter	Thunder Lake Tributary 2 and 3 (mg/L)	Hoffstrom's Bay Tributary (mg/L)	Little Creek (mg/L)	Blackwater Creek (mg/L)	Thunder Lake (mg/L)	Wabigoon Lake (mg/L)
Aluminum	0.077	0.078	0.555	0.251	0.016	0.692
Antimony	0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	0.3	0.4	1.2	0.9	4.2	3.2
Chromium	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	0.001	0.001	0.001	0.001	0.001	0.001
Copper	0.001	0.001	0.002	0.001	0.001	0.002
Cyanide	0.002	0.002	0.002	0.002	0.002	0.002
Iron	0.862	0.365	1.010	1.450	0.036	0.459
Lead	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	0.002	0.002	0.002	0.002	0.002	0.002
Nitrate	0.090	0.101	0.039	0.030	0.030	0.030
Phosphorus	0.011	0.011	0.047	0.027	0.008	0.024
Selenium	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.002	0.001	0.001	0.001
Zinc	0.003	0.003	0.005	0.004	0.003	0.003

Note: Background surface water quality based on 50^{th} percentile data

Table 6-3: Treated Effluent Discharge Water Quality – Operations Phase

Parameter	Effluent Concentration (mg/L)
Aluminum (filtered)	0.075
Antimony	0.020
Arsenic	0.10
Beryllium	0.011
Boron	0.20
Cadmium	0.0002
Chloride	120
Chromium	0.0089 (1)
Cobalt	0.0009 (1)
Copper	0.005
Cyanide	0.005
Iron	0.30
Lead	0.005
Mercury	0.00002
Molybdenum	0.040 (1)
Nickel	0.025
Nitrate	13
Phosphorus	0.030
Selenium	0.10
Silver	0.0001
Thallium	0.0003
Uranium	0.005
Vanadium	0.006 (1)
Zinc	0.030

Source: Table 9.0.1 of the EIS

Note:

1) Chromium, cobalt, molybdenum and vanadium have been updated from Table 9.0.1 of the EIS to reflect current PWQO criteria (or interim PWQO when there is no firm PWQO criteria).

2) All metal concentrations are for total metals, unless otherwise indicated.

Table 6-4: Surface Water Discharge Volumes to Receiving Waters

Node	Source	Climate Conditions	Waterbody Receiver	Volume of Discharge (m^3/s)		Reference
				Operations Phase	Post-closure Phase	
BW1	Effluent from Project site	dry year	Blackwater Creek	0.004	0	Table 4-13
BW1		average year	Blackwater Creek	0.018	0	
BW1		wet year	Blackwater Creek	0.033	0	
BW1	Passive discharge from pit lake (TSF dry cover)	dry year	Blackwater Creek	0	0.011	Table 4-20
BW1		average year	Blackwater Creek	0	0.027	
BW1		wet year	Blackwater Creek	0	0.049	
BW1	Passive discharge from pit lake (TSF wet cover)	dry year	Blackwater Creek	0	0.010	
BW1		average year	Blackwater Creek	0	0.023	
BW1		wet year	Blackwater Creek	0	0.047	

Note: During operations, effluent will be treated and discharged to Blackwater Creek from a single point discharge location upstream of node BW1.

Table 6-5: Seepage Discharge Volumes to Receiving Waters

Node	Source	Waterbody Receiver	Volume of Seepage (m^3/d)		Reference
			Operations Phase	Post-closure Phase	
TL	WRSA (capped)	Thunder Lake	0	10	Figure 25 of Appendix M of EIS
TL	TSF (dry cover)	Thunder Lake	0	0.1	
TL2	TSF (dry cover)	Thunder Lake Tributary 3	0	0.1	Figure 24 of Appendix M of EIS
HB1	TSF (dry cover)	Hoffstrom's Bay Tributary	0	0.1	Figure 24 of Appendix M of EIS
BW1	TSF (dry cover)	Blackwater Creek	0	0.7	Figure 24 of Appendix M of EIS
BW2	TSF (dry cover)	Blackwater Creek	0	0.1	Figure 24 of Appendix M of EIS
TL	TSF (wet cover)	Thunder Lake	0	0.1	Figure 22 of Appendix M of EIS
TL2	TSF (wet cover)	Thunder Lake Tributary 3	0	0.1	Figure 22 of Appendix M of EIS
HB1	TSF (wet cover)	Hoffstrom's Bay Tributary	0	0.1	Figure 22 of Appendix M of EIS
BW1	TSF (wet cover)	Blackwater Creek	0	0.7	Figure 22 of Appendix M of EIS
BW2	TSF (wet cover)	Blackwater Creek	0	0.1	

Notes:

(1) During operations, seepage from the WRSA and TSF not captured by perimeter collection ditches will be captured within the drawdown cone caused by active dewatering, and will ultimately report to the open pit.

(2) During operations, there will be no discharge from the pit lake to the surrounding environment.

Table 6-6: Receiving Water Quality Results for TL1

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cyanide	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Iron	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Nickel	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Nitrate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phosphorus	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030

Table 6-7: Receiving Water Quality Results for TL2

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.077	0.077	0.077	0.077	0.077	0.077	0.078	0.077	0.077	0.077	0.077	0.077
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.0010	0.0010	0.0010	0.001	0.001	0.001	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	0.3	0.3	0.3	0.3	0.3	0.3	—	—	—	0.3	0.3	0.3
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cyanide	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.002	0.002	0.002
Iron	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.861	0.861	0.861
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Nickel	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Nitrate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phosphorus	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0066	0.0040	0.0036	0.0030	0.0030	0.0030

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-8: Receiving Water Quality Results for TL3

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0010	0.0010	0.0010
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	0.3	0.3	0.3	0.3	0.3	0.3	—	—	—	0.3	0.3	0.3
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001
Copper	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.001	0.001	0.001
Cyanide	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Iron	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.861	0.861	0.861
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Nitrate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phosphorus	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0045	0.0034	0.0032	0.0030	0.0030	0.0030

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-9: Receiving Water Quality Results for HB1

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.078	0.078	0.078	0.078	0.078	0.078	0.079	0.078	0.078	0.078	0.078	0.078
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00004	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	0.4	0.4	0.4	0.4	0.4	0.4	—	—	—	0.4	0.4	0.4
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001
Copper	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0012	0.0011	0.0010	0.001	0.001	0.001
Cyanide	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.002	0.002	0.002
Iron	0.365	0.365	0.365	0.365	0.365	0.365	0.366	0.365	0.365	0.365	0.365	0.365
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Nickel	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Nitrate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phosphorus	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Zinc	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0134	0.0059	0.0047	0.0030	0.0030	0.0030

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-10: Receiving Water Quality Results for LC1

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	1	1	1	1	1	1	1	1	1	1	1	1
Chromium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.001	0.001	0.001
Copper	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Cyanide	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Iron	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.010
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Molybdenum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Nitrate	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Phosphorus	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Zinc	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Table 6-11: Receiving Water Quality Results for BW1

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.251	0.251	0.251	0.219	0.212	0.211	0.187	0.201	0.199	0.189	0.206	0.200
Antimony	0.00060	0.00060	0.00060	0.0041	0.0049	0.0051	0.00081	0.00077	0.00077	0.00079	0.00074	0.00075
Arsenic	0.0010	0.0010	0.0010	0.019	0.023	0.024	0.0013	0.0012	0.0012	0.0012	0.0011	0.0011
Beryllium	0.001	0.001	0.001	0.003	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.077	0.083	0.084	0.051	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00005	0.0001	0.0001	0.0001	0.0001	0.0001	0.00005	0.00004	0.00004
Chloride	1	1	1	22	27	28	—	—	—	43	31	35
Chromium	0.0010	0.0010	0.0010	0.002	0.003	0.003	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
Copper	0.0012	0.0012	0.0012	0.0018	0.0020	0.0020	0.003	0.002	0.002	0.002	0.002	0.002
Cyanide	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Iron	1.450	1.450	1.450	1.244	1.197	1.186	1.025	1.120	1.108	1.047	1.156	1.117
Lead	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00002	0.00001	0.00001
Molybdenum	0.0010	0.0010	0.0010	0.0080	0.0096	0.0100	0.0010	0.0010	0.0010	0.001	0.001	0.001
Nickel	0.0020	0.0020	0.0020	0.0061	0.0071	0.0073	0.01	0.01	0.01	0.010	0.008	0.009
Nitrate	0.03	0.03	0.03	2.4	2.9	3.0	4.8	3.8	3.9	4.6	3.3	3.8
Phosphorus	0.027	0.027	0.027	0.027	0.027	0.027	0.028	0.028	0.028	0.028	0.027	0.028
Selenium	0.001	0.001	0.001	0.019	0.023	0.024	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.0012	0.0012	0.0012	0.0021	0.0023	0.0023	0.0012	0.0012	0.0012	0.001	0.001	0.001
Zinc	0.004	0.004	0.004	0.009	0.010	0.010	0.028	0.016	0.014	0.013	0.011	0.012

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-12: Receiving Water Quality Results for BW2

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.251	0.251	0.251	0.231	0.226	0.225	0.208	0.218	0.217	0.210	0.222	0.218
Antimony	0.00060	0.00060	0.00060	0.0028	0.0033	0.0035	0.00075	0.00071	0.00071	0.00073	0.00069	0.00070
Arsenic	0.0010	0.0010	0.0010	0.012	0.015	0.016	0.0012	0.0011	0.0011	0.0011	0.0011	0.0011
Beryllium	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.067	0.071	0.072	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00004	0.00004	0.00004	0.0001	0.0001	0.0001	0.00004	0.00003	0.00003
Chloride	1	1	1	14	18	18	—	—	—	29	20	23
Chromium	0.0010	0.0010	0.0010	0.002	0.002	0.002	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.001	0.001	0.001	0.0007	0.0006	0.0006
Copper	0.0012	0.0012	0.0012	0.0016	0.0017	0.0017	0.002	0.002	0.002	0.002	0.002	0.002
Cyanide	0.0020	0.0020	0.0020	0.0023	0.0024	0.0024	0.0028	0.0026	0.0026	0.003	0.002	0.003
Iron	1.450	1.450	1.450	1.319	1.288	1.281	1.161	1.235	1.225	1.179	1.261	1.232
Lead	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.0010	0.0010	0.0010	0.0054	0.0065	0.0067	0.0010	0.0010	0.0010	0.001	0.001	0.001
Nickel	0.0020	0.0020	0.0020	0.0046	0.0052	0.0054	0.008	0.006	0.007	0.007	0.006	0.006
Nitrate	0.03	0.03	0.03	1.5	1.9	1.9	3.3	2.5	2.6	3.1	2.2	2.5
Phosphorus	0.027	0.027	0.027	0.027	0.027	0.027	0.028	0.027	0.027	0.027	0.027	0.027
Selenium	0.001	0.001	0.001	0.012	0.015	0.016	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.004	0.004	0.004	0.007	0.008	0.008	0.02	0.01	0.01	0.010	0.009	0.009

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-13: Receiving Water Quality Results for TL

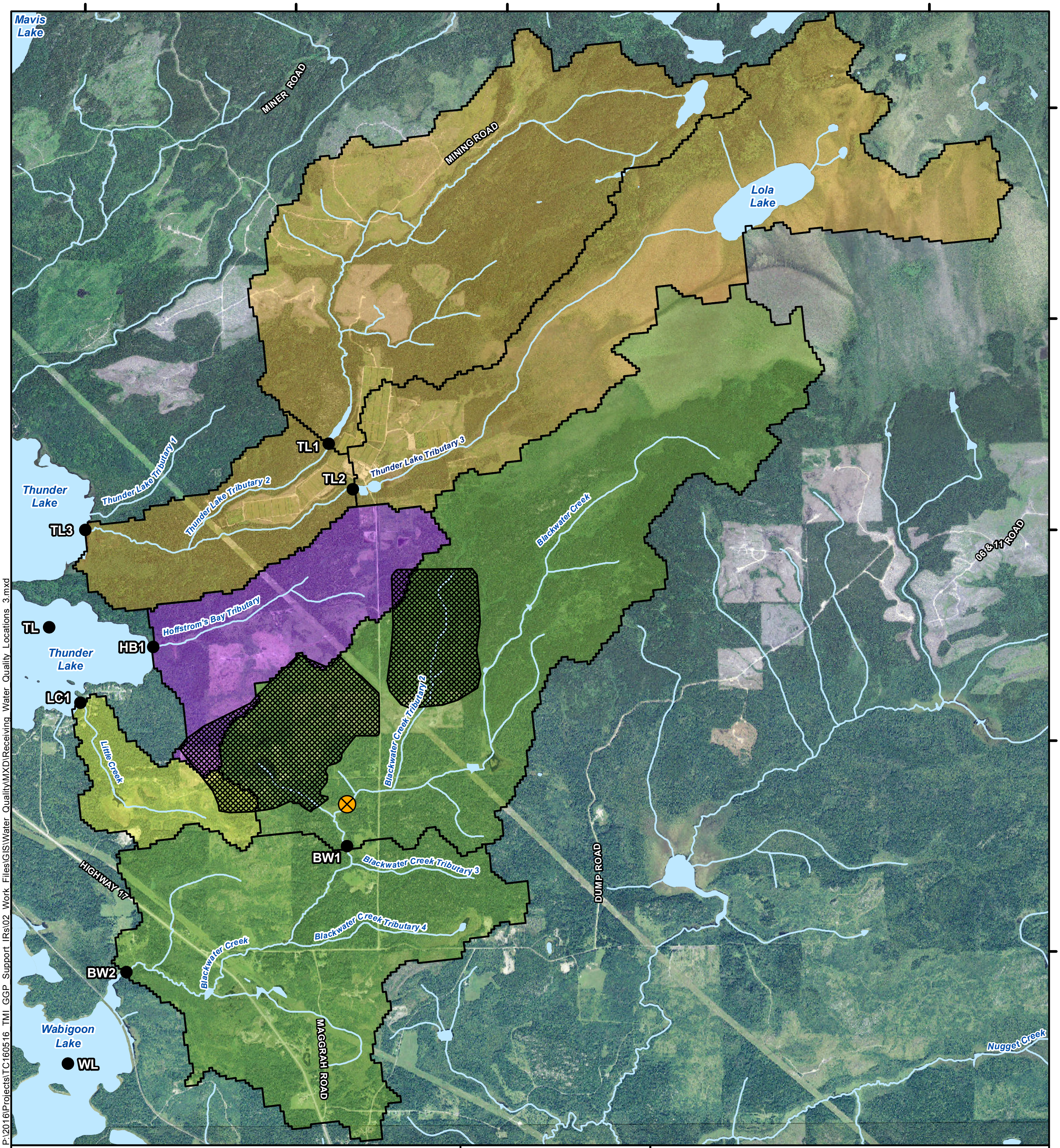
Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.025	0.026	0.027	0.025	0.026	0.027	0.028	0.029	0.029	0.028	0.029	0.029
Antimony	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.0010	0.0010	0.0010	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	4	4	4	4	4	4	—	—	—	—	—	—
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.001	0.001	0.001	0.0005	0.0005	0.0005
Copper	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cyanide	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Iron	0.152	0.150	0.148	0.151	0.149	0.147	0.160	0.158	0.156	0.160	0.158	0.156
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Nitrate	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Phosphorus	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.

Table 6-14: Receiving Water Quality Results for WL

Parameter (total metals)	Existing Concentrations (mg/L)			Operations Concentrations (mg/L)			Post-closure Concentrations TSF Dry Cover (mg/L)			Post-closure Concentrations TSF Wet Cover (mg/L)		
	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year	Dry Year	Avg. Year	Wet Year
Aluminum	0.671	0.669	0.666	0.671	0.669	0.666	0.671	0.668	0.665	0.671	0.668	0.665
Antimony	0.00060	0.00060	0.00060	0.00060	0.00062	0.00064	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060
Arsenic	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Beryllium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Boron	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Cadmium	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Chloride	3.24	3.23	3.21	3.27	3.36	3.45	—	—	—	—	—	—
Chromium	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.001	0.001	0.001
Cobalt	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Cyanide	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Iron	0.452	0.457	0.463	0.451	0.456	0.460	0.452	0.456	0.461	0.452	0.456	0.461
Lead	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mercury	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	—	—	—	0.00001	0.00001	0.00001
Molybdenum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Nitrate	0.03	0.03	0.03	0.03	0.04	0.1	0.04	0.05	0.07	0.04	0.05	0.07
Phosphorus	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.0232	0.0232	0.0232
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Thallium	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Uranium	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Vanadium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zinc	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

Note: "—" indicates that surface water quality was not modelled due to insufficient source data.



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LEGEND

- Surface Water Quality Node
- Operations Area
- Effluent Discharge Location

Watershed

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

0 0.25 0.5 1 1.5 2 2.5 3 Kilometres

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Agriculture Information Atlas, OMAFRA.

Datum: NAD83
Projection: UTM Zone 15N

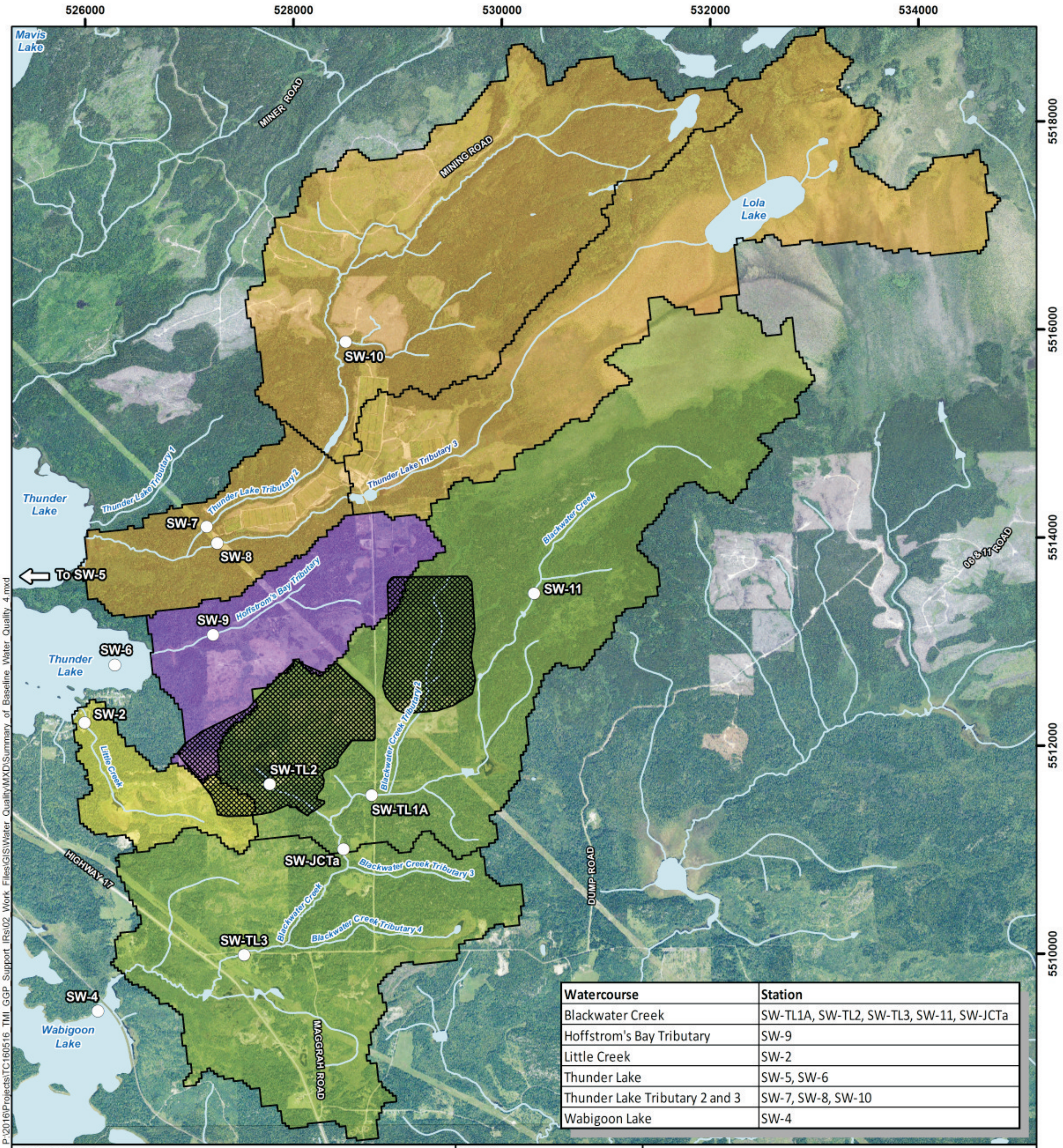
N E S W

amec foster wheeler

GOLIATH GOLD PROJECT

Surface Water Quality Locations

PROJECT Nº: TC160516	**FIGURE: 6-1**
SCALE: 1:50,000	DATE: April 2017



Watercourse	Station
Blackwater Creek	SW-TL1A, SW-TL2, SW-TL3, SW-11, SW-JCTa
Hoffstrom's Bay Tributary	SW-9
Little Creek	SW-2
Thunder Lake	SW-5, SW-6
Thunder Lake Tributary 2 and 3	SW-7, SW-8, SW-10
Wabigoon Lake	SW-4

LEGEND

- Baseline Surface Water Quality Sampling Locations
- Operations Area

Watershed

- Blackwater Creek
- Hoffstrom's Bay Tributary
- Little Creek
- Thunder Lake Tributary 2 and 3

0 0.25 0.5 1 1.5 2 2.5 3 Kilometres

NOTES:
- Topographic data extracted from Land Information Ontario, MNRF.
- Imagery extracted from Agriculture Information Atlas, OMAFRA.
- Baseline locations from Appendix P of the EIS.

Datum: NAD83
Projection: UTM Zone 15N

amec foster wheeler

GOLIATH GOLD PROJECT

Summary of Background Water Quality

PROJECT N°: TC160516

FIGURE: 6-2

SCALE: 1:50,000

DATE: April 2017

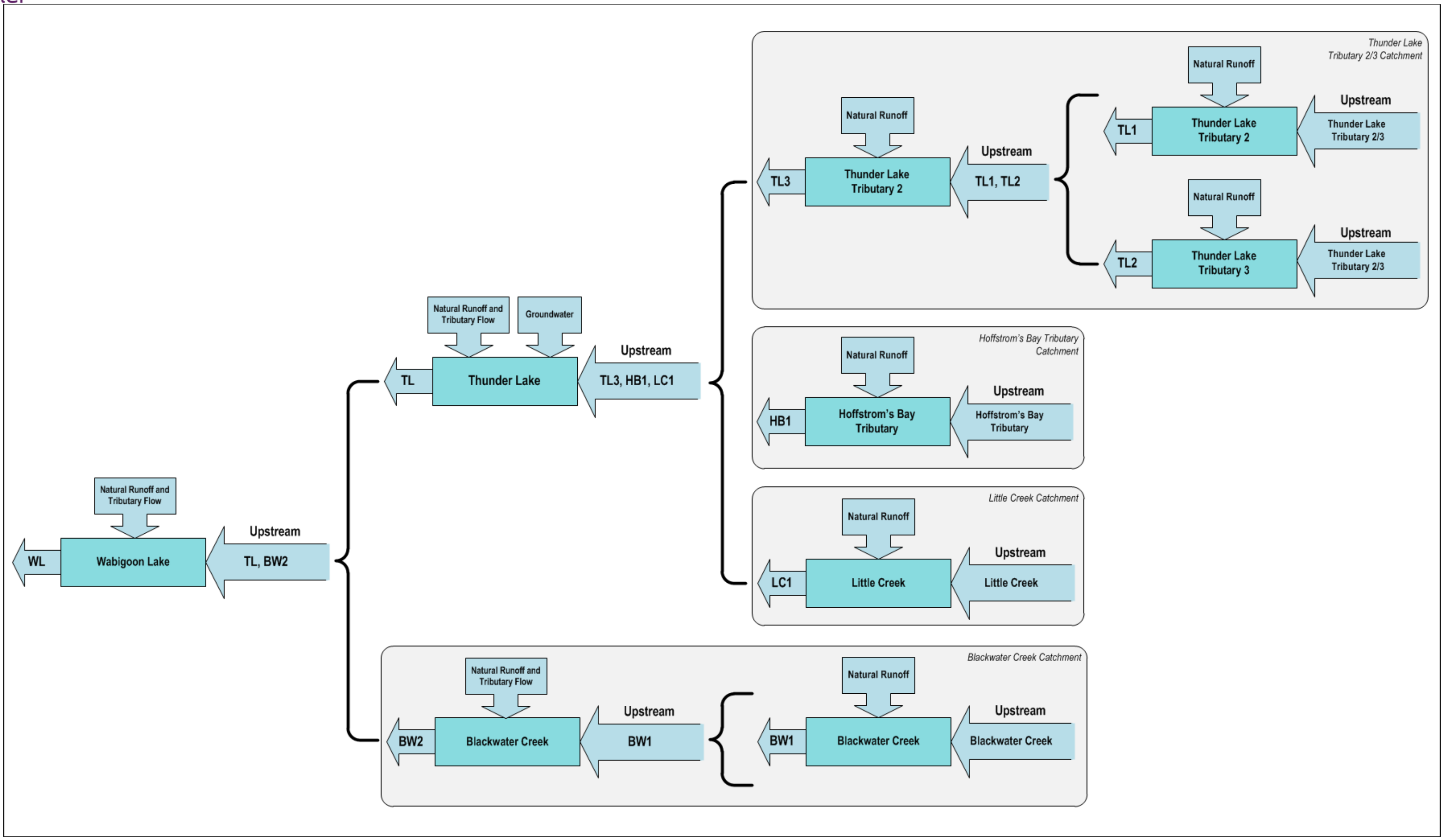


Figure 6-3: Surface Water Quality Model Existing Conditions

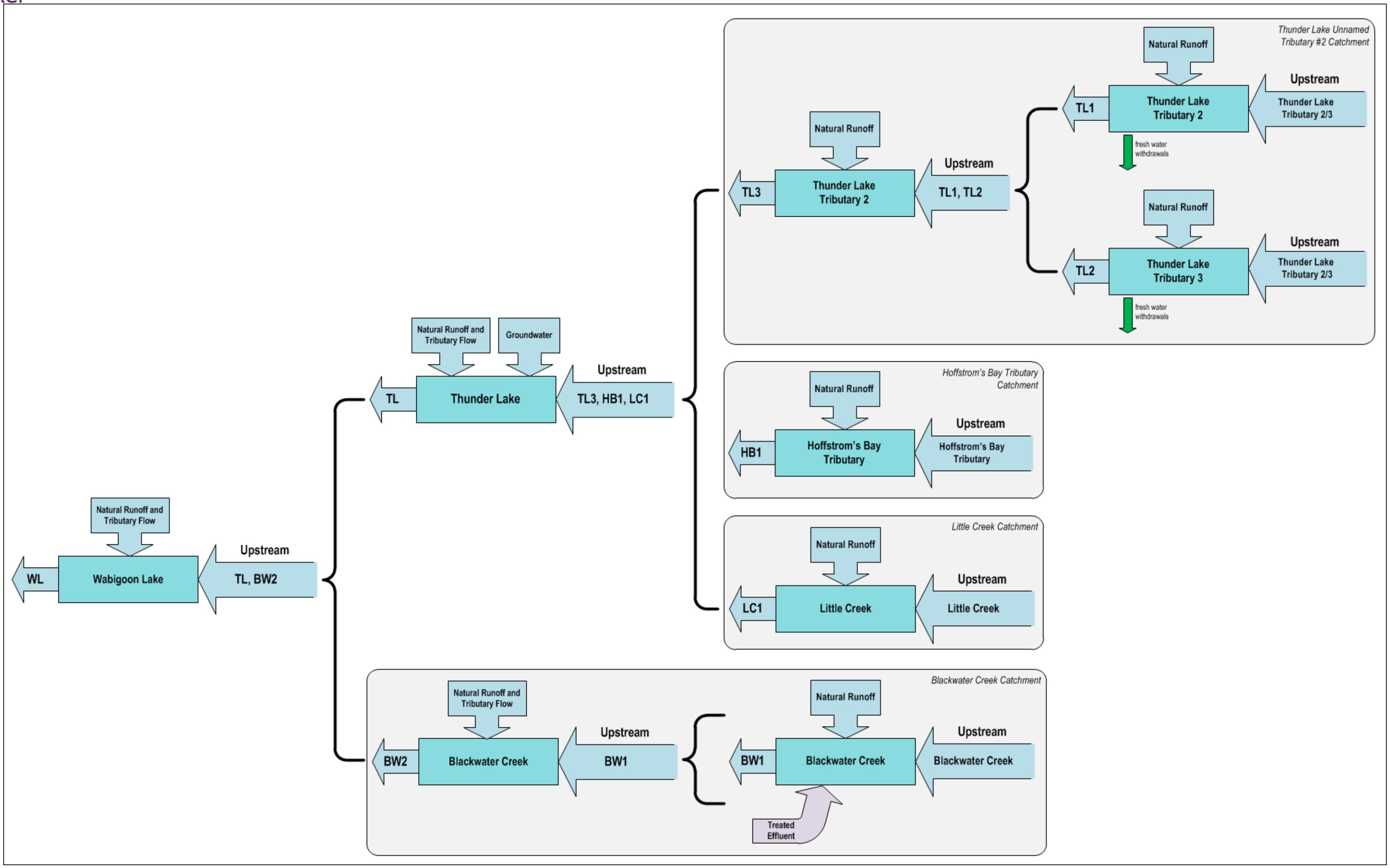


Figure 6-4: Surface Water Quality Model Operations Phase

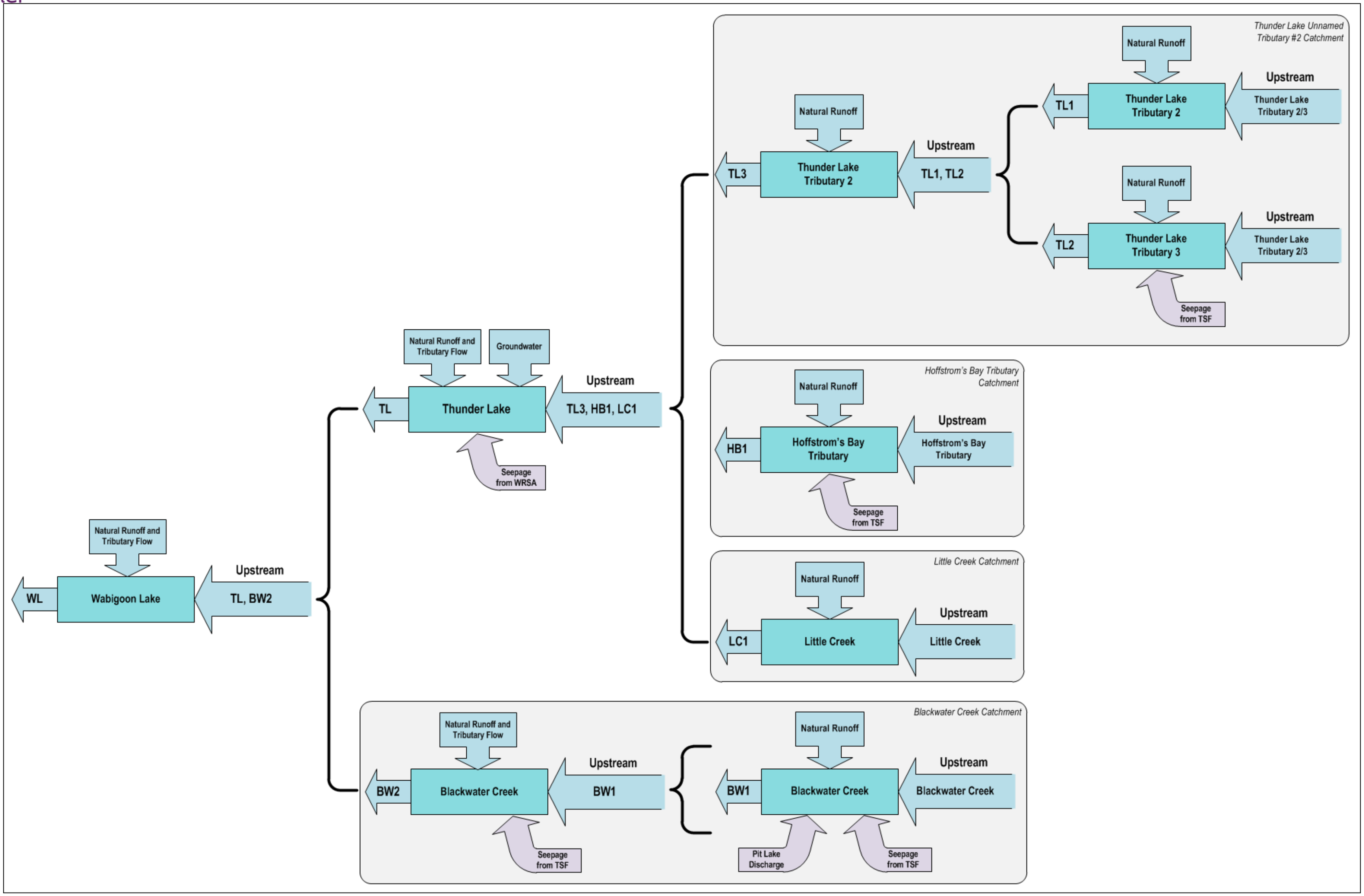


Figure 6-5: Surface Water Quality Model Post-Closure Phase

APPENDIX A

FIELD BARREL RESULTS

Table A-1: Field Barrel General Chemistry Results
Table A-2: Field Barrel Dissolved Metals Concentrations

Table A1 - Field Barrel General Chemistry Results

Sample ID	Date Sampled	Week	Volume Collected	Temp	Lab pH	Conductivity (EC)	Acidity (as CaCO3)	Alkalinity (as CaCO3)	Ammonia, Total (as N)	Chloride (Cl)	Nitrate (as N)	Nitrite (as N)	Phosphorus (P)	Sulfate
			(mL)	(°C)	pH Units	(µS/cm)	(mg L-1)	(mg L-1)	(mg L-1)	(mg L-1)	(mg L-1)	(mg L-1)	(mg L-1)	(mg L-1)
BMS	12-Nov-12	8	11210	19	6.92	120	2.8	15	0.31	5.29	0.95	< 0.02	0.024	27
	11-Jan-13	17	5675	6	6.94	117	13	11	0.37	4.07	1.05	< 0.02	0.071	31
	27-Mar-13	27	3650	11	6.94	121	7.8	9.6		3.46	0.79	< 0.02		36
	27-May-13	36	11725	30	7.18	78	4.8	13	0.36	1.47	0.39	< 0.02	0.040	20
	18-Jun-13	39	9470	22	7.12	69	2.2	11	0.89	0.81	0.26	< 0.02	0.035	17
	30-Jul-13	47	15950	22	6.29	94	< 5	10	0.64	0.94	0.29	0.36	0.060	23
	11-Apr-14	83	16560	14	6.53	214		< 10						74
	17-Jul-14	96	12950	28	6.3	65		< 2						21
	16-Nov-16	218	n.a.	n.a.	4.29	162	12	< 2	0.46	0.17	0.26	< 0.01	0.011	62
BS	12-Nov-12	8	11220	20	6.68	160	3.4	9.2	0.59	6.16	1.2	< 0.02	0.0096	46
	11-Jan-13	17	5955	5	6.7	134	11	6.9	0.46	3.85	1.09	< 0.02	0.032	42
	27-Mar-13	27	2605	10	6.42	200	14	5.6		4.8	1	< 0.02		73
	27-May-13	36	12490	28	6.96	97	3.8	9.8	0.98	1.72	0.43	< 0.02	0.051	30
	18-Jun-13	39	9185	22	7.02	79	2	8.7	0.97	0.90	0.28	< 0.02	0.019	22
	30-Jul-13	47	15750	23	6.32	105	< 5	6	0.94	0.80	0.27	< 0.05	0.040	33
	11-Apr-14	83	16700	11	5.78	261		< 10						90
	17-Jul-14	96	12610	29	4.53	112		< 2						35
	16-Nov-16	218	n.a.	n.a.	3.76	256	28	< 2	0.53	0.17	0.22	< 0.01	0.0054	85
MSS	12-Nov-12	8	11175	2	6.96	131	2.8	16	0.38	5.9	0.76	< 0.02	0.016	30
	11-Jan-13	17	5480	5	6.86	88	11	8.9	0.41	2.39	0.77	< 0.02	0.11	23
	27-Mar-13	27	15425	28	7.01	78	6.6	12	0.48	3.36	0.34	< 0.02	0.037	18
	27-May-13	36	9555	22	7.12	53	2	9.4	0.55	0.53	0.22	< 0.02	0.046	12
	18-Jun-13	39	15900	22	6.86	86	< 5	17	1.67	0.52	0.23	0.18	0.19	18
	30-Jul-13	47	16750	12	6.65	130		< 10						43
	11-Apr-14	83	13110	27	6.59	74		< 2						25
	16-Nov-16	219	n.a.	n.a.	5.41	118	6.4	< 2	0.41	0.16	0.22	< 0.01	0.0062	46
MSED	12-Nov-12	8	11340	18	7.1	136	2.6	19	0.23	4.73	0.87	< 0.02	0.020	32
	11-Jan-13	17	5781	4	7.05	144	6	17	0.28	3.92	0.94	< 0.02	0.037	41
	27-Mar-13	27	4235	10	7.09	123	10	13		2.93	0.59	< 0.02		34
	27-May-13	36	11675	30	7.36	99	5	20	0.90	1.56	0.36	< 0.02	0.090	22
	18-Jun-13	39	9395	21	7.45	77	2	16	0.71	1.16	0.24	< 0.02	0.042	14
	30-Jul-13	47	16020	22	6.23	88	< 5	7	0.23	4.27	0.33	< 0.05	0.15	17
	11-Apr-14	83	16700	15	6.99	236		18						81
	17-Jul-14	96	12750	26	9.49	94		7.8						21
	16-Nov-16	218	n.a.	n.a.	8.49	132	< 2	5.1	< 0.02	0.13	0.61	0.043	0.013	51
FIELD BLANK	27-Mar-13	27			5.52	< 3	< 2	< 5		< 0.1	< 0.03	< 0.02		< 0.3
	27-May-13	36			5.49	< 3	< 2	< 5	< 0.02	< 0.1	< 0.03	< 0.02	< 0.005	< 0.3
	30-Jul-13	45			5.34	2	< 5	5	< 0.02	< 0.1	< 0.05	< 0.05	< 0.02	< 0.1
TRAVEL BLANK	27-Mar-13	27			5.5	< 3	< 2	< 5		< 0.1	< 0.03	< 0.02		< 0.3
	27-May-13	36			5.41	< 3	< 2	< 5	< 0.02	< 0.1	< 0.03	< 0.02	< 0.005	< 0.3
	30-Jul-13	45			4.76	2	< 5	5	< 0.02	< 0.1	< 0.05	< 0.05	< 0.02	< 0.1

Notes:

New data since EIS

n.a. = data not available

Table A-2: Field Barrel Dissolved Metals Concentrations (mg/L)

Sample ID	Date Sampled	Week	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Cesium	Chromium	Cobalt
BMS	12-Nov-12	8	0.0058	0.0030	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	6.1E-05	13		< 0.001	0.0040
	11-Jan-13	17	0.53	0.0025	0.0026	< 0.01	< 0.001	< 0.001	< 0.05	9.4E-05	13		< 0.001	0.0080
	27-Mar-13	27	< 0.005	0.0014	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	5.5E-05	12		< 0.001	0.0064
	27-May-13	36	< 0.05	< 0.006	< 0.01	< 0.1	< 0.01	< 0.01	< 0.5	< 0.00017	7.9		< 0.01	< 0.005
	18-Jun-13	39	0.015	0.0017	0.0015	< 0.01	< 0.001	< 0.001	< 0.05	3.1E-05	8.0		< 0.001	< 0.0005
	30-Jul-13	47	0.014	< 0.003	< 0.003	0.0020	< 0.002	< 0.001	0.010	< 0.0001	7.9		< 0.003	0.00060
	11-Apr-14	83	0.0070	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00026	24		< 0.001	0.024
	17-Jul-14	96	0.018	0.0026	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00037	6.8		< 0.001	0.0015
	16-Nov-16	218	0.93	< 0.0001	0.0023	0.0042	0.00043	< 0.00005	< 0.01	0.00083	13	0.00023	< 0.0001	0.026
BS	12-Nov-12	8	0.012	0.0017	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00019	16		< 0.001	0.055
	11-Jan-13	17	0.016	0.0015	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00010	14		< 0.001	0.050
	27-Mar-13	27	0.021	0.0011	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00016	22		< 0.001	0.079
	27-May-13	36	0.0096	0.0012	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00011	9.2		< 0.001	0.036
	18-Jun-13	39	0.014	0.0010	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	7.0E-05	8.1		< 0.001	0.029
	30-Jul-13	47	0.021	< 0.003	< 0.003	0.0040	< 0.002	< 0.001	0.010	< 0.0001	8.0		< 0.003	0.045
	11-Apr-14	83	0.077	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00020	34		< 0.001	0.11
	17-Jul-14	96	0.17	< 0.0006	0.0010	< 0.01	< 0.001	< 0.001	< 0.05	0.00018	7.8		< 0.001	0.059
	16-Nov-16	218	1.9	< 0.0001	0.0054	0.011	0.00051	< 0.00005	0.013	0.00049	13	0.00029	0.00033	0.13
MSS	12-Nov-12	8	0.016	0.014	0.0039	< 0.01	< 0.001	< 0.001	< 0.05	0.00041	14		< 0.001	0.0037
	11-Jan-13	17	0.015	0.0078	0.0024	< 0.01	< 0.001	< 0.001	< 0.05	0.00023	9.2		< 0.001	0.0029
	27-Mar-13	27	0.0084	0.0073	0.0019	< 0.01	< 0.001	< 0.001	< 0.05	0.00020	7.5		< 0.001	0.0017
	27-May-13	36	0.012	0.0067	0.0025	< 0.01	< 0.001	< 0.001	< 0.05	0.00014	6.0		< 0.001	0.00082
	18-Jun-13	39	0.018	0.0050	0.0040	0.0030	< 0.002	< 0.001	0.010	0.00020	6.1		< 0.003	< 0.0005
	30-Jul-13	47	0.0072	0.00355	0.0012	< 0.01	< 0.001	< 0.001	< 0.05	0.00059	15		< 0.001	0.0045
	11-Apr-14	83	0.057	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	3.3E-05	7.3		< 0.001	0.00098
	16-Nov-16	219	0.57	0.00014	0.0031	0.0074	0.00038	< 0.00005	< 0.01	0.0036	11	0.00015	< 0.0001	0.017
MSED	12-Nov-12	8	< 0.005	0.0011	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	4.9E-05	14		< 0.001	0.0037
	11-Jan-13	17	< 0.005	0.00089	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	4.6E-05	16		< 0.001	0.0039
	27-Mar-13	27	< 0.005	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	4.0E-05	12		< 0.001	0.0034
	27-May-13	36	0.0081	0.0011	0.0012	< 0.01	< 0.001	< 0.001	< 0.05	2.8E-05	10		< 0.001	< 0.0005
	18-Jun-13	39	0.016	0.0012	0.0013	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	8.7		< 0.001	< 0.0005
	30-Jul-13	47	0.021	< 0.003	< 0.003	< 0.002	< 0.002	< 0.001	0.010	< 0.0001	7.9		< 0.003	< 0.0005
	11-Apr-14	83	< 0.005	0.00085	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	0.00019	27		< 0.001	0.0026
	17-Jul-14	96	0.0084	0.00076	0.0013	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	8.5		0.002	< 0.0005
	16-Nov-16	218	0.0069	0.00035	0.00037	0.00435	< 0.0001	< 0.00005	< 0.01	1.0E-05	16	3.7E-05	< 0.0001	0.00037
FIELD BLANK	27-Mar-13	27	< 0.005	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	< 0.2		< 0.001	< 0.0005
	27-May-13	36	< 0.005	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	< 0.2		< 0.001	< 0.0005
	30-Jul-13	45	0.010	< 0.003	< 0.003	< 0.002	< 0.002	< 0.001	< 0.01	< 0.0001	0.10		< 0.003	< 0.0005
TRAVEL BLANK	27-Mar-13	27	< 0.005	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	< 0.2		< 0.001	< 0.0005
	27-May-13	36	< 0.005	< 0.0006	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05	< 0.000017	< 0.2		< 0.001	< 0.0005
	30-Jul-13	45	< 0.004	< 0.003	< 0.003	< 0.002	< 0.002	< 0.001	< 0.01	< 0.0001	0.050		< 0.003	< 0.0005

Notes:

New data since EIS

Table A-2: Field Barrel Dissolved Metals Concentrations (mg/L) cont.

Sample ID	Date Sampled	Copper	Iron	Lead	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Rubidium	Selenium	Silicon
BMS	12-Nov-12	0.0063	< 0.02	< 0.001	< 0.05	2.3	0.074	< 0.00001	< 0.001	0.041		2.2		< 0.001	
	11-Jan-13	0.017	0.59	0.019	< 0.05	2.6	0.15	< 0.00001	0.001	0.048		2.4		< 0.001	
	27-Mar-13	0.0081	< 0.02	< 0.001	< 0.05	1.9	0.11	< 0.00001	< 0.001	0.044		2.3		< 0.001	
	27-May-13	< 0.01	< 0.2	< 0.01	< 0.5	1.4	< 0.01	1.2E-05	< 0.01	< 0.02		< 5		< 0.01	
	18-Jun-13	0.0032	0.11	0.0010	< 0.05	1.4	0.016	< 0.00001	< 0.001	0.017		1.4		< 0.001	
	30-Jul-13	0.0040	< 0.01	< 0.001	< 0.005	1.5	0.022	< 0.0001	< 0.002	0.013		1.5		< 0.004	
	11-Apr-14	0.0043	< 0.02	< 0.001	< 0.05	3.4	0.38		< 0.001	0.14		2.0		< 0.001	
	17-Jul-14	0.0027	0.084	0.0030	< 0.05	0.89	0.057		< 0.001	0.015		0.94		< 0.001	
	16-Nov-16	0.028	0.047	0.028	0.0015	3.9	0.52	< 0.000005	< 0.00005	0.19	< 0.05	0.84	0.0019	0.00017	1.2
BS	12-Nov-12	0.013	< 0.02	< 0.001	< 0.05	2.3	0.20	< 0.00001	0.019	0.35		2.5		< 0.001	
	11-Jan-13	0.015	0.047	< 0.001	< 0.05	2.0	0.19	< 0.00001	0.0067	0.33		2.1		< 0.001	
	27-Mar-13	0.015	0.061	< 0.001	< 0.05	2.2	0.27	< 0.00001	0.0027	0.44		3.2		< 0.001	
	27-May-13	0.0073	< 0.02	< 0.001	< 0.05	1.4	0.12	< 0.00001	0.0059	0.22		1.5		< 0.001	
	18-Jun-13	0.0056	0.038	< 0.001	< 0.05	1.2	0.090	< 0.00001	0.0043	0.17		1.3		< 0.001	
	30-Jul-13	0.0050	0.050	< 0.001	< 0.005	1.5	0.13	< 0.0001	< 0.002	0.22		1.4		< 0.004	
	11-Apr-14	0.0080	0.30	< 0.001	< 0.05	2.9	0.37		< 0.001	0.58		1.6		0.0017	
	17-Jul-14	0.011	0.79	0.0019	< 0.05	1.5	0.16		< 0.001	0.32		0.94		< 0.001	
	16-Nov-16	0.022	0.26	0.0082	0.0045	4.6	0.56	< 0.000005	< 0.00005	1.0	< 0.05	0.70	0.0030	0.00036	1.9
MSS	12-Nov-12	0.023	0.023	0.011	< 0.05	1.9	0.10	< 0.00001	0.0015	0.037		2.9		< 0.001	
	11-Jan-13	0.022	< 0.02	0.0073	< 0.05	1.4	0.078	< 0.00001	0.0011	0.031		2.2		< 0.001	
	27-Mar-13	0.0095	< 0.02	0.0034	< 0.05	0.89	0.053	< 0.00001	0.0011	0.016		2.0		< 0.001	
	27-May-13	0.0066	0.046	0.0059	< 0.05	0.72	0.031	< 0.00001	< 0.001	0.011		1.4		< 0.001	
	18-Jun-13	0.0070	0.020	0.0040	< 0.005	0.86	0.012	< 0.0001	< 0.002	0.0090		1.7		< 0.004	
	30-Jul-13	0.0056	< 0.02	0.0021	< 0.05	1.5	0.14		< 0.001	0.039		1.6		< 0.001	
	11-Apr-14	0.0022	0.17	< 0.001	< 0.05	1.5	0.032		< 0.001	0.0084		1.1		< 0.001	
	16-Nov-16	0.043	0.070	0.20	< 0.001	1.7	0.28	< 0.000005	< 0.00005	0.11	< 0.05	0.77	0.0015	0.00019	0.84
MSED	12-Nov-12	0.013	< 0.02	< 0.001	< 0.05	2.9	0.088	< 0.00001	0.0015	0.047		2.2		< 0.001	
	11-Jan-13	0.011	< 0.02	< 0.001	< 0.05	3.6	0.13	< 0.00001	0.0016	0.042		2.5		< 0.001	
	27-Mar-13	0.010	< 0.02	< 0.001	< 0.05	2.5	0.11	< 0.00001	0.0011	0.034		2.7		< 0.001	
	27-May-13	0.015	< 0.02	< 0.001	< 0.05	2.1	0.0014	1.1E-05	0.0016	0.017		2.1		< 0.001	
	18-Jun-13	0.010	< 0.02	< 0.001	< 0.05	1.7	< 0.001	< 0.00001	0.0011	0.0076		1.9		< 0.001	
	30-Jul-13	0.016	< 0.01	< 0.001	< 0.005	1.5	0.024	< 0.0001	< 0.002	0.012		2.4		< 0.004	
	11-Apr-14	0.0055	< 0.02	< 0.001	< 0.05	5.6	0.18		0.0011	0.047		3.0		0.0011	
	17-Jul-14	0.0059	< 0.02	< 0.001	< 0.05	1.5	0.0053		< 0.001	0.0047		2.6		< 0.001	
	16-Nov-16	0.0017	< 0.01	6.9E-05	0.0011	3.4	0.0035	< 0.000005	0.00013	0.0056	< 0.05	1.8	0.0026	0.00022	0.93
FIELD BLANK	27-Mar-13	< 0.001	< 0.02	< 0.001	< 0.05	< 0.02	< 0.001	< 0.00001	< 0.001	< 0.002		< 0.5		< 0.001	
	27-May-13	< 0.001	< 0.02	< 0.001	< 0.05	< 0.02	< 0.001	< 0.00001	< 0.001	< 0.002		< 0.5		< 0.001	
	30-Jul-13	< 0.002	< 0.01	< 0.001	< 0.005	< 0.05	< 0.002	< 0.0001	< 0.002	< 0.003		< 0.05		< 0.004	
TRAVEL BLANK	27-Mar-13	< 0.001	< 0.02	< 0.001	< 0.05	< 0.02	< 0.001	< 0.00001	< 0.001	< 0.002		< 0.5		< 0.001	
	27-May-13	< 0.001	< 0.02	< 0.001	< 0.05	< 0.02	< 0.001	< 0.00001	< 0.001	< 0.002		< 0.5		< 0.001	
	30-Jul-13	< 0.002	< 0.01	< 0.001	< 0.005	< 0.05	< 0.002	< 0.0001	< 0.002	< 0.003		< 0.05		< 0.004	

Notes:

New data since EIS

Table A-2: Field Barrel Dissolved Metals Concentrations (mg/L) cont.

Sample ID	Date Sampled	Silver	Sodium	Strontium	Sulfur	Tellurium	Thallium	Thorium	Tin	Titanium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
BMS	12-Nov-12	< 0.0001	3.2	0.058		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.029	0.0019
	11-Jan-13	< 0.0001	3.6	0.058		< 0.001	< 0.0003		< 0.001	0.012	< 0.01	< 0.005	< 0.001	0.069	0.0022
	27-Mar-13	< 0.0001	2.8	0.057		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.040	0.0010
	27-May-13	< 0.001	1.6	0.031		< 0.01	< 0.003		< 0.01	< 0.02	< 0.1	< 0.05	< 0.01	< 0.03	< 0.01
	18-Jun-13	< 0.0001	1.2	0.029		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.013	< 0.001
	30-Jul-13	< 0.0001	1.2	0.031		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.014	
	11-Apr-14	< 0.0001	2.1	0.12		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.11	< 0.001
	17-Jul-14	< 0.0001	0.43	0.027		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.12	< 0.001
	16-Nov-16	< 0.00001	0.74	0.053	20	< 0.0002	2.7E-05	< 0.0001	< 0.0001	< 0.0003	0.00011	0.0033	< 0.0005	0.41	< 0.0003
BS	12-Nov-12	< 0.0001	6.0	0.067		< 0.001	< 0.0003		< 0.001	< 0.002	0.01	< 0.005	< 0.001	0.048	0.0015
	11-Jan-13	< 0.0001	5.7	0.055		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.035	0.0013
	27-Mar-13	0.00012	5.4	0.11		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.062	< 0.001
	27-May-13	< 0.0001	2.7	0.036		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.020	< 0.001
	18-Jun-13	< 0.0001	1.8	0.026		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.018	< 0.001
	30-Jul-13	< 0.0001	1.8	0.030		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.026	
	11-Apr-14	< 0.0001	3.6	0.14		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.087	< 0.001
	17-Jul-14	< 0.0001	1.2	0.030		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.070	< 0.001
	16-Nov-16	< 0.00001	1.3	0.051	24	< 0.0002	9.3E-05	< 0.0001	< 0.0001	< 0.0003	< 0.0001	0.021	0.00054	0.19	< 0.0003
MSS	12-Nov-12	< 0.0001	3.6	0.067		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.21	0.0056
	11-Jan-13	< 0.0001	2.5	0.045		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.14	0.0032
	27-Mar-13	< 0.0001	1.5	0.032		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.075	0.0013
	27-May-13	< 0.0001	0.87	0.023		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.061	< 0.001
	18-Jun-13	< 0.0001	0.80	0.026		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.079	
	30-Jul-13	< 0.0001	1.0	0.076		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.26	< 0.001
	11-Apr-14	< 0.0001	0.75	0.029		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.015	< 0.001
	16-Nov-16	< 0.00001	0.48	0.039	14	< 0.0002	5.0E-05	< 0.0001	< 0.0001	< 0.0003	0.00024	0.0022	< 0.0005	1.4	< 0.0003
MSED	12-Nov-12	< 0.0001	3.0	0.088		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.066	0.0018
	11-Jan-13	< 0.0001	3.7	0.11		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.020	0.0018
	27-Mar-13	< 0.0001	2.8	0.077		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.022	< 0.001
	27-May-13	< 0.0001	2.0	0.062		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.0067	< 0.001
	18-Jun-13	< 0.0001	1.4	0.049		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.0056	< 0.001
	30-Jul-13	< 0.0001	1.3	0.045		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.011	
	11-Apr-14	< 0.0001	2.8	0.19		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.019	< 0.001
	17-Jul-14	< 0.0001	1.1	0.048		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	0.0046	< 0.001
	16-Nov-16	< 0.00001	0.66	0.085	16	< 0.0002	3.2E-05	< 0.0001	< 0.0001	< 0.0003	0.00013	9.4E-05	< 0.0005	0.0032	< 0.0003
FIELD BLANK	27-Mar-13	< 0.0001	< 0.1	< 0.001		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	< 0.003	< 0.001
	27-May-13	< 0.0001	< 0.1	< 0.001		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	< 0.003	< 0.001
	30-Jul-13	< 0.0001	0.24	< 0.005		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.005	
TRAVEL BLANK	27-Mar-13	< 0.0001	< 0.1	< 0.001		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	< 0.003	< 0.001
	27-May-13	< 0.0001	< 0.1	< 0.001		< 0.001	< 0.0003		< 0.001	< 0.002	< 0.01	< 0.005	< 0.001	< 0.003	< 0.001
	30-Jul-13	< 0.0001	< 0.05	< 0.005		< 0.05	< 0.0003		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.005	

Notes:

New data since EIS

APPENDIX JJ

Attachment JJ-1- Amec Foster Wheeler Technical Memorandum

Memo

Date:	March 27, 2018
To:	Mark Wheeler (Treasury Metals)
From:	Mei Ling Tamkei (Amec Foster Wheeler)
Reviewed:	Mark Sullivan (Amec Foster Wheeler)
CC:	Martin Rawlings, Braeden Connor and Mackenzie Denyes (Amec Foster Wheeler)
Ref:	TC160516
Re:	**Treasury Metals Goliath Gold Project – Water Cover Analysis on the Tailings Storage Facility at Closure**

1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) was asked by Treasury Metals Incorporated (Treasury Metals) to complete a water cover analysis of the Tailings Storage Facility (TSF) at closure to help answer an information request submitted regarding the EIS. The purpose of this analysis is to confirm that the elevation of the closure overflow spillway is adequate to maintain a water cover over the deposited tailings during long-term closure, including during extreme dry conditions.

2.0 BACKGROUND

At closure the TSF will be drained of its supernatant water in order to facilitate the filling of the Open Pit. The tailings will then be covered with a granular material to physically isolate the tailings and prevent re-suspension. A cover of non-process will then be applied to prevent oxidation of the tailings.

The water surface elevation in the TSF will be maintained by the overflow spillway, designed with an invert elevation of 418.5 m (WSP, 2014). Water discharged from the TSF will be directed to the Open Pit which will ultimately discharge to Blackwater Creek once the Open Pit has been filled (approximately 7 years after closure).

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3.0 DESIGN CRITERIA

In order to prevent oxidation of the tailings, and the resultant acid rock drainage (ARD), the tailings must remain saturated at all times, covered with a water layer, even during extreme dry conditions. In order to maintain a water cover in the TSF during extreme dry conditions, there must be a surplus of water during average annual climatic conditions. To test the performance under extreme dry conditions, a 1:100 dry year will be used to evaluate the adequacy of the proposed post-closure water cover.

4.0 INPUTS

The annual precipitation for a 1:100 dry year is estimated at 379.6 mm (compared to 671.4 mm in an average year). The annual precipitation was re-distributed as runoff according to the monthly distribution of flows in a representative Water Survey of Canada gauged river (05PD015 - Lake 240 Near Kenora), similar to the Water Report (Amec Foster Wheeler, 2018: included as Appendix JJ to the revised EIS). The resulting monthly potential runoff is provided in Table 4-1. The lake evaporation rates calculated from daily data for Rawson Lake (6036904, 1969-1999), obtained from Environment Canada are also provided. These climatic conditions were estimated in a consistent manner as those used in the Water Report (Appendix JJ to the revised EIS).

Table 4-1: Monthly Potential Runoff and Lake Evaporation

Month	Potential Runoff (mm)		Lake Evaporation (mm)	
	1:100 Dry	Average	1:100 Dry	Average
January	9.8	17.4	0.0	0.0
February	6.6	11.7	0.0	0.0
March	8.6	15.2	0.0	0.0
April	71.1	125.8	12.2	8.7
May	83.3	147.3	139.8	100.4
June	43.0	76.0	163.1	117.1
July	41.2	72.8	182.0	130.7
August	16.2	28.6	147.3	105.8
September	25.7	45.5	77.3	55.5
October	32.1	56.8	42.4	30.4
November	24.8	43.9	0.0	0.0
December	17.1	30.2	0.0	0.0
Annual	**379.6**	**671.4**	**764.1**	**548.6**

The 1:100 dry year precipitation and 1:100 dry lake evaporation have been assumed to occur in the same year, which is an extremely conservative assumption. In reality this would be a much more extreme condition than a 1:100 dry year.

The TSF catchment area is defined by the dam crest (i.e., only direct precipitation contributes runoff). Table 4-2 summarizes the land uses within this catchment, as well as the areas and assumed runoff coefficients. The runoff coefficients for the average year are consistent with those used in the Water Report. The runoff coefficients for the 1:100 dry year are the same as those used for the 1:20 dry year in the Water Report (Appendix JJ to the revised EIS).

Table 4-2: TSF Land Use and Runoff Coefficients

Parameter	Land Use		
	Open Water	**Restored Operations Area**	**TOTAL**
ROC – Average Year	1.0	0.45	—
ROC – Dry Year	1.0	0.32	—
TSF Catchment Area (m^2)	618,569	11,431	**630,000**

Seepage through the base of the TSF was estimated to be 2.4 m^3/d, assuming that the basin has been lined with a synthetic liner. Inputs (runoff) and losses (evaporation and seepage) were calculated to determine the net inflow / outflow to the TSF every month of the year. A monthly timestep is considered appropriate for determining the suitability of water cover (note a daily model could potentially show slightly more variation in net inflow / outflow, which a monthly model cannot).

The stage-storage relationship for the TSF at closure was developed by WSP and is provided in Figure 4- 1. The stage-storage relationship was used to calculate the monthly change in water level associated with the net inflow / outflow to the TSF. This analysis assumed there was no storage available for water below the maximum elevation of the tailings (416.4 m). There is approximately 1.59 Mm^3 of storage available between the top of the tailings and the overflow spillway invert of 418.5 m.

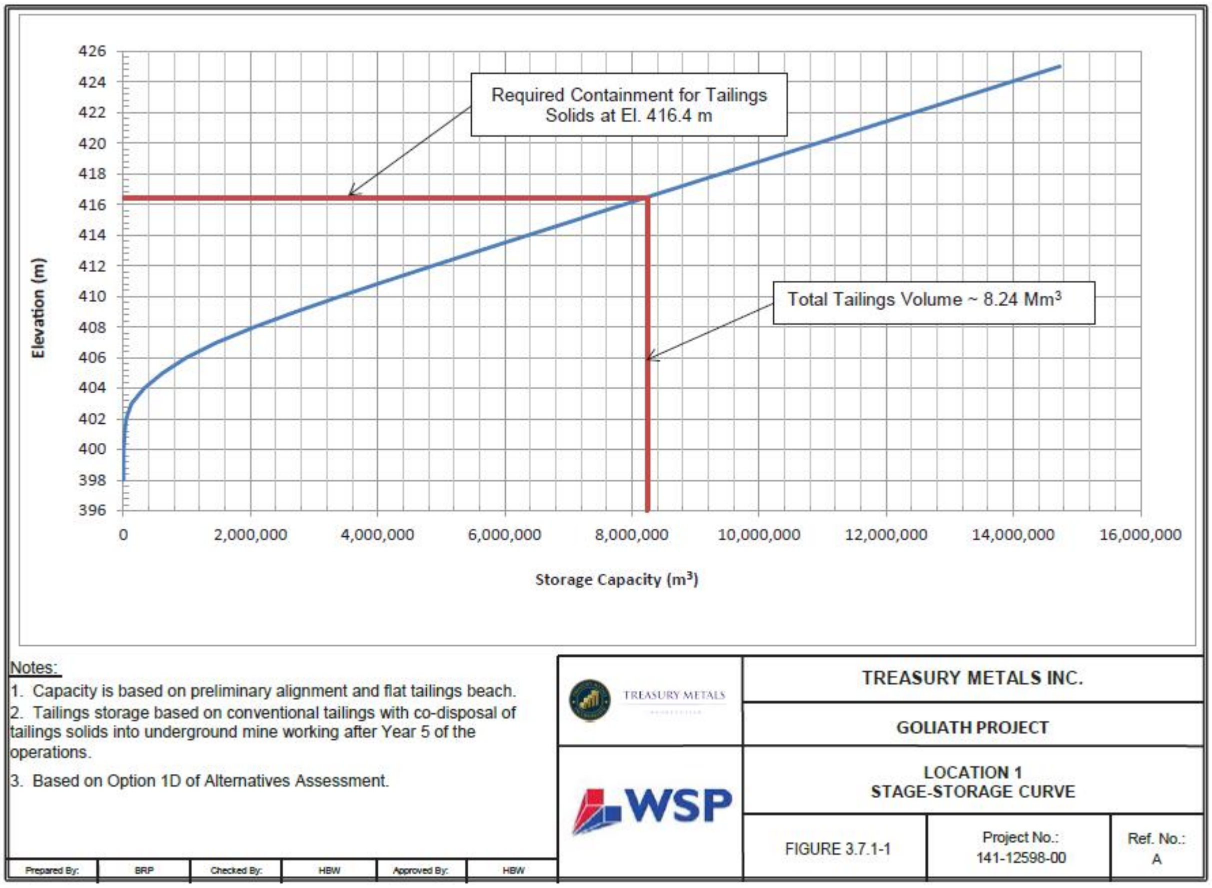

Figure 4-1: TSF Stage-Storage Curve (WSP, 2014)

5.0 RESULTS

A summary of the average year and 1:100 dry year water balances are provided in Tables 5-1 and 5-2, respectively. For average year conditions, there is an annual surplus of approximately 78,500 m^3 of water in the TSF as the annual precipitation exceeds evaporation and seepage losses. This indicates that for long-term closure, the water cover will be sustainable. The initial water level in January for the average condition was solved iteratively until the starting water level matched the end of year water level. This corresponds to an elevation of 418.4 m (just below the overflow spillway invert of 418.5 m). Once the higher runoff occurs in the spring, the water level in the TSF would rise and discharge excess runoff through the spillway. In the summer months the increased evaporation would cause the level to fall below the spillway.

For the 1:100 dry year condition, the starting water level was assumed to be the same as the average year starting water level (418.4 m). The analysis indicates that in a 1:100 dry year, the TSF water level will drop to a minimum elevation of 418.1 m. As this elevation is 1.7 m above the highest elevation of tailings, this indicates that the spillway elevation of 418.5 m is sufficient to maintain a water cover in extreme dry conditions. The resulting water levels for the average and 1:100 dry year are presented in Figure 4-1.

It is noted that during a 1:100 dry year, the water surface elevation is drawn down approximately 0.35 m from the initial water level in January (this corresponds to a drawdown of 265,000 m^3). It is therefore recommended that after the TSF supernatant water is removed, treated and used to help fill the Open Pit, a minimum of 300,000 m^3 of non-process should be deposited into the TSF in order to ensure that a water cover is maintained, even if a 1:100 dry year occurred immediately after closure. Note the 300,000 m^3 of non-process water would need to be added to any water required to saturate the granular layer which isolates the tailings. According to the conceptual mine site water balance (WSP, 2017: Appendix F to the revised EIS), there is approximately 320,000 m^3 of storage capacity in Collection Ponds 1-3, and the Mine Dewatering Pond. As the Project nears the end of operations, excess water could be managed within these ponds rather than being discharged, such that there would be an adequate supply of non-process water at the end of operations to provide the required water cover over the TSF. As previously noted, there is approximately 1.59 Mm^3 of storage available between the top of the tailings and the overflow spillway invert of 418.5 m.

6.0 REFERENCES

Amec Foster Wheeler, 2018. Water Report, Treasury Metals Incorporated, Goliath Gold Project. Amec Foster Wheeler, March 2018. Included as Appendix JJ to the revised EIS.

WSP, 2014. Tailings Storage Facility Alternatives Assessment, Goliath Project, Treasury Metals Incorporated. WSP, July 2014. Included as Appendix D-1 to the revised EIS.

WSP, 2017. Goliath Site – Conceptual Mine Site Water Balance. WSP, February 24, 2017. Included as Appendix F to the revised EIS.

Table 5 1: TSF Water Balance for the Average Year

Month	Beginning of Month WSEL (m)	Inflows (m^3)			Outflows (m^3)			Net Inflows-Outflows (m^3)	Discharge volume (m^3)	End of Month Volume after discharge (m^3)
		Open Water Runoff	Restored Operations Area Runoff	Total Inflows	Pond Evap	Seepage	Total Outflows			
Jan	418.43	10,757	89	10,847	0	74	74	10,772	0	1,550,762
Feb	418.45	7,212	60	7,272	0	67	67	7,205	0	1,557,967
Mar	418.46	9,426	78	9,505	0	74	74	9,430	0	1,567,397
Apr	418.47	77,835	647	78,482	5,407	72	5,479	73,003	48,819	1,591,580
May	418.50	91,131	758	91,889	62,101	74	62,176	29,714	29,714	1,591,580
Jun	418.50	47,007	391	47,398	72,446	72	72,518	-25,120	0	1,566,460
Jul	418.47	45,053	375	45,427	80,823	74	80,897	-35,470	0	1,530,990
Aug	418.42	17,716	147	17,863	65,430	74	65,504	-47,641	0	1,483,349
Sep	418.36	28,172	234	28,406	34,310	72	34,382	-5,976	0	1,477,373
Oct	418.35	35,155	292	35,447	18,830	74	18,905	16,543	0	1,493,916
Nov	418.37	27,152	226	27,378	0	72	72	27,306	0	1,521,222
Dec	418.41	18,686	155	18,842	0	74	74	18,767	0	1,539,990
Total		**415,303**	**3,454**	**418,757**	**339,348**	**876**	**340,224**	**78,533**	**78,533**	

Table 5-2: TSF Water Balance for the 1:100 Dry Year

Month	Beginning of Month WSEL (m)	Inflows (m^3)			Outflows (m^3)			Net Inflows-Outflows (m^3)	Discharge volume (m^3)	End of Month Volume after discharge (m^3)
		Open Water Runoff	Restored Operations Area Runoff	Total Inflows	Pond Evap	Seepage	Total Outflows			
Jan	418.43	6,082	36	6,118	0	74	74	6,043	0	1,546,033
Feb	418.44	4,077	24	4,101	0	67	67	4,034	0	1,550,067
Mar	418.45	5,329	32	5,361	0	74	74	5,286	0	1,555,353
Apr	418.45	44,004	260	44,264	7,532	72	7,604	36,660	433	1,591,580
May	418.50	51,521	305	51,826	86,499	74	86,574	-34,748	0	1,556,832
Jun	418.45	26,575	157	26,732	100,909	72	100,981	-74,248	0	1,482,584
Jul	418.36	25,471	151	25,621	112,577	74	112,651	-87,030	0	1,395,554
Aug	418.24	10,016	59	10,075	91,136	74	91,210	-81,135	0	1,314,418
Sep	418.13	15,927	94	16,021	47,790	72	47,862	-31,840	0	1,282,578
Oct	418.09	19,875	118	19,992	26,228	74	26,303	-6,310	0	1,276,268
Nov	418.08	15,351	91	15,441	0	72	72	15,369	0	1,291,637
Dec	418.10	10,564	62	10,627	0	74	74	10,552	0	1,302,189
Total	**-**	**234,792**	**1,388**	**236,180**	**472,671**	**876**	**473,547**	**-237,367**	**433**	-

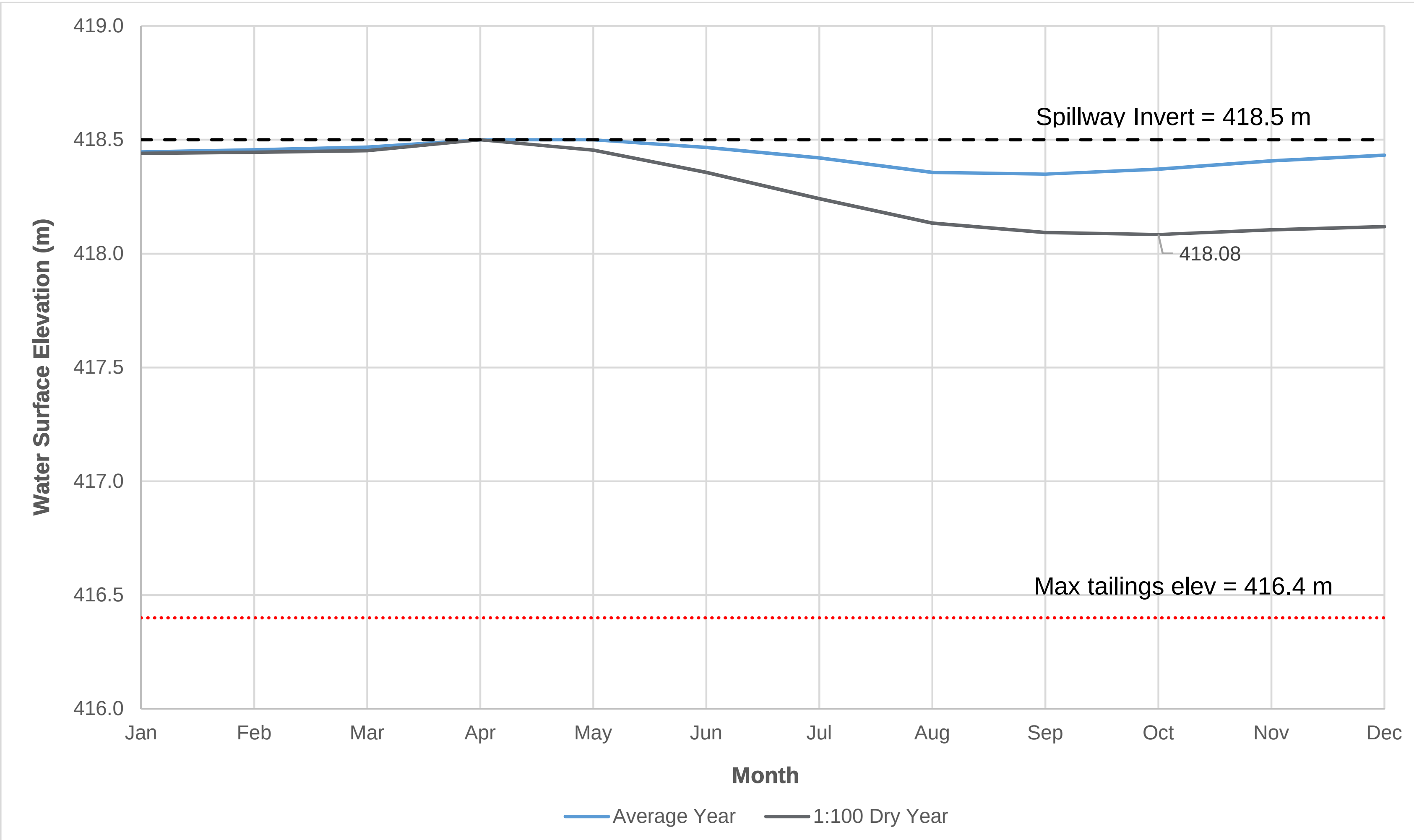

Figure 5-1: TSF Water Surface Elevation During Average and 1:100 Dry Year