APPENDIX W

SCREENING LEVEL RISK ASSESSMENT

NOTE TO READER
APPENDIX W

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 W to the revised EIS (Screening Level Risk Assessment) presents a conservative assessment of the potential human and ecological risks associated with the Project. The information presented in this appendix was considered in the assessment of effects of the Project on human health (Section 6.19 of the revised EIS). In response to a number of Round 1 information requests regarding the risk assessment, the risk assessment was reviewed and additional discussion was added to Section 6.19 of the revised EIS. Although the Detailed Quantitative Risk Assessment Model used in the screening level risk assessment is no longer recommend for use by Health Canada, the receptors, exposure pathways, potential risks estimates, and overall conclusions remain valid. No changes have been made to this appendix from the original EIS issued in April 2015.

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
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

List of Appendices to the Revised EIS		
Appendix	Status	Description
Appendix JJ	New	Water Report
Appendix KK	New	Conceptual Closure Plan
Appendix LL	New	Impact Footprints and Effects

TETRA TECH

SCREENING LEVEL RISK ASSESSMENT FOR THE GOLIATH MINE SITE

PRESENTED TO

Treasury Metals Inc.

FEBRUARY 2015
ISSUED FOR USE
FILE: ENVMIN03018-01.003

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EXECUTIVE SUMMARY

Treasury Metals Inc. (TML) retained Tetra Tech Inc. (Tetra Tech) to conduct a screening level risk assessment (SLRA) for the proposed Goliath Mine Project (hereinafter referred to as the Project). The Project is located approximately 4 km northwest of the Village of Wabigoon, 20 km east of the City of Dryden, Ontario Canada, and within the Kenora Mining District of the Ministry of Northern Development and Mines (MNDM). The SLRA is a component of the Goliath Gold Project Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS). The objective of this SLRA is to incorporate information collected in the baseline reports and the EIS to complete a preliminary assessment of human and ecological health risks due to exposure from mine-based effluent, waste rock, and tailings that will be generated during the Operational and Post-Closure Phase of the Project. The information incorporated in the SLRA was provided to the RA team and was current as of October 7, 2014.

Human Health SLRA

A human health SLRA was completed to determine if contamination generated by the Project will result in levels of risk exceeding regulatory benchmarks for humans exposed to contamination sources.

The SLRA included evaluation of exposure pathways for direct soil contact (soil ingestion, soil dermal contact, and dust inhalation), and direct surface water contact (dermal contact and drinking water) as well as a Country Foods Assessment for the ingestion of game, plants, and fish. Soil was defined as either baseline soils, waste rock or tailings. Two groups of humans were identified for the Project that would potentially be exposed to mine-based Contaminants of Concern (COCs): permanent residents (this includes construction or mine workers that are residents), and recreational users. Permanent residents included residents of the Village of Wabigoon and the City of Dryden and surrounding area, and First Nation residents. Using these two human groups two exposure scenarios were quantitatively assessed for the complete pathways with COCs identified: residents exposed to mine-related COCs in dust, and recreational users exposed to mine-related COCs from dust. Operational discharge of secondarily treated water and passive discharge (post-closure) of pit water to Blackwater Creek (BWC) was not quantitatively assessed in this SLRA because there were no COCs selected for these exposure media. Country Foods Assessment focuses on First Nation residents as the related exposure parameters were expected to be representative of all those who harvest country foods in the area, and was conducted for both the Operational and Post-closure phases.

Operational and Post-closure Phases of the Project were assessed as they pose different COCs, exposure amounts and routes of exposure. The results of the SLRA represent risk estimates inclusive of all complete exposure pathways (e.g., dust inhalation) as appropriate for the COC. The direct contact soil exposure pathways were considered incomplete for all humans because access to the Project site will be restricted for residents and recreational users, and workers will use personal protective equipment (PPE).

The human health SLRA identified and quantitatively assessed two COCs in waste rock and tailings for the Operational Phase – mercury and lead. These two COCs were retained because they were above baseline soil concentrations in waste rock and tailings, may bioaccumulate, and mercury is of historical interest in the region. There were no COCs selected for the Post-Closure Phase as waste rock and tailings will be encapsulated or maintained under water, and concentrations of metals in passive effluent discharge from the Pit Lake were below background and/or below human health screening levels. Nonetheless, exposure to lead and mercury through country foods was evaluated in the Post-Closure Phase to provide a conservative and complete estimate of risk.

Risk estimates called hazard quotients (HQs) were calculated for humans for the Operational Phase using default Health Canada (2012) exposure factors. Hazard quotients were calculated as the ratio of the estimated exposure to the Toxicity Reference Value (TRV). Non-carcinogenic risk characterization in the assessment was completed for both COCs. When a HQ is below the threshold risk level (0.2), a substance is considered to pose a negligible risk to human health.

The results of the human health component of this SLRA indicated that risk estimates did not exceed the acceptable threshold for both mercury and lead during the Operational or Post-Closure Phases of the mine.

The overall level of confidence associated with the calculated risk estimates is moderate for lead and moderate for mercury. This level of confidence could be increased through the collection of site-specific resident, First Nation, and worker site-use that in turn would allow for the refinement of exposure parameters to generate the current risk estimates.

Ecological SLRA

An ecological SLRA was completed to determine if contamination at the Project site may result in levels of risk exceeding regulatory benchmarks for wildlife that may use the mine property (defined as the Project site) or watercourses receiving effluent from the Project site for habitat and/or foraging.

Mine-related COCs were identified and the COCs assessed in the SLRA were those exceeding the human health guidelines. The human health SLRA identified and assessed two COCs in dust generated from the Project site — mercury and lead. Although plants, fish, and animals are identified during the initial phases of the SLRA, only animals being hunted and trapped by residents of the Village of Wabigoon and City of Dryden, First Nation Residents, and Recreational Users underwent exposure and risk calculations in the SLRA. The four key receptors assessed in the wildlife assessment were the Snowshoe Hare, White-tailed Deer, Moose and Ruffed Grouse. They were selected because of their commercial or recreational value to residents of the Village of Wabigoon and the City of Dryden.

Exposure pathways evaluated in the SLRA for wildlife included direct soil/tailings contact, ingestion of soil/tailings (while foraging), ingestion of surface water, and the ingestion of food (i.e., plants, soil invertebrates). Hazard quotients (HQ) were calculated for the selected wildlife receptors based on the ratio of the estimated exposure to the toxicity reference value (TRV) to evaluate potential risk from exposure to mine-related COCs.

Based on the calculated HQs, estimated risks for wildlife were below risk thresholds (1.0) for Hare, Deer and Moose exposed to mercury and lead for the Operational Phase. For Grouse, the HQ for mercury was below risk thresholds for the Operational Phase. However, the HQ for lead was just above the risk threshold (HQ = 1.2) for Grouse exposed to lead from the ingestion of tailings and food (plants and soil invertebrates) from the tailings during the Operational Phase. The HQ falls below the risk threshold when the assumption is made that Grouse obtain one third rather than one half of their food from plants and soil invertebrates living on the tailings. These HQ were derived using a very small set of COC concentrations in tailings, and modelled surface water concentrations.

Forage fish are present within Blackwater Creek and habitat quality for fish within this system is moderate. Therefore fish would likely be exposed to the mine-related COCs proposed to be discharged in effluent. Under Post-Closure conditions the Pit Lake may also support small fish and other aquatic organisms. Depending upon the habitat quality wildlife may use the waters in Blackwater Creek and Pit Lake as drinking water, and feed on aquatic plants/animals within these waters. There are no significant exceedances of aquatic life criteria based on Operational and Post-Closure conditions used in this SLRA (wildlife with aquatic based diets were not assessed in the SLRA).

Overall SLRA Recommendations

Further refinement of exposure parameters, site use, pit water transport in groundwater and effluent migration/dilution during the Closure and Post-Closure Phase is recommended through the execution of a plume and dilution model study. A water plume study combined with an effluent discharge rate could provide a more accurate prediction of all concentrations in surface water and groundwater over time. It should also be noted that the lack of COCs in surface water during the Operational Phase relies on the secondary treatment of water as is currently planned, with achievement of the Provincial Water Quality Objectives (PWQO) and background concentrations used to select COCs in this SLRA. Any variations in the secondary treatment plan that increase effluent concentrations will change the results of this SLRA.

Wildlife with aquatic based diets that inhabit wetlands and creeks such as Blackwater Creek were not identified and assessed in the SLRA. The scope of the SLRA includes identification of potential risk due to exposure from mine-related COCs for aquatic plants and invertebrates (wildlife with aquatic-based diets were not evaluated). The habitat quality for areas surrounding the Project site is moderate, and the habitat contains numerous creeks and tributaries draining into Blackwater Creek which will receive effluent discharge into their waters based on the current Project plan. These receptors are relevant and could use portions of the Project site as habitat and for foraging.

The Post-Closure Phase analysis relied upon modelled concentrations in Pit Water that will passively discharge into Blackwater Creek. Leaching to groundwater is predicted to be limited and insignificant. To the extent that concentrations of COCs in effluent or transport in groundwater may increase during the Post-Closure Phase compared to the modeled estimates, these risks and discharges will need to be addressed by TML as the Post-Closure plans are reviewed and finalized during the Operational Phase. It is recommended that COC releases are monitored to maintain a health-protective level for fish and wildlife with aquatic based diets and humans drinking water within Blackwater Creek and Wabigoon Lake.

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ACRONYMS & ABBREVIATIONS

ARD	Acid Rock Drainage
BAF	Bioaccumulation Factor
CCME	Canadian Council of Ministers of the Environment
COC(s)	Contaminant(s) of Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSM	Conceptual Site Model
CSQG	Canadian Soil Quality Guideline
DAF	Dose Adjustment Factor
DQRA	Detailed Quantitative Risk Assessment
EA	Environmental Assessment
Eco SSL	Ecological Soil Screening Level
EIS	Environmental Impact Statement
EPC	Exposure Point Concentration
FCSAP	Federal Contaminated Sites Action Plan
FIR	Food Ingestion Rate
CDWQG	Canadian Drinking Water Quality Guidelines
ha	Hectare
HC	Health Canada
HQ	Hazard Quotient
HTC	Humidity Cell Tests
IARC	International Agency for Research on Cancer
KCB	Klohn Crippen Berger
LOAEL	Lowest Observable Adverse Effect Level
MMER	Metal Mine Effluent Regulations
MNDM	Ministry of Northern Development and Mines
NOAEL	No Observable Adverse Effect Level
NPAG	Non-Potentially Acid Generating
OMNR	Ontario Ministry of Natural Resources
PAG	Potentially Acid Generating
PD	Project Description
SARA	Species at Risk Ace
SARO	Ontario Species at Risk
PQRA	Preliminary Quantitative Risk Assessment
SLRA	Screening Level Risk Assessment
SIR	Soil Ingestion Rate
TC	Tolerable Concentration
TDI	Tolerable Daily Intake
Tetra Tech	Tetra Tech Inc.
TKS	Traditional Knowledge Survey
TML	Treasury Metals Inc.
TRV	Toxicity Reference Value
TSF	Tailings Storage Facility
USEPA	United States Environmental Protection Agency

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of TML and their agents. Tetra Tech Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than TML, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech's Services Agreement. Tetra Tech's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

1.1 Project Overview

Treasury Metals Inc. (TML) retained Tetra Tech Inc. (Tetra Tech), to conduct a screening level risk assessment (SLRA) for the proposed Goliath Gold Project (hereinafter referred to as the Project) located approximately 20 km east of the City of Dryden, Ontario. The SLRA is a component of the Goliath Gold Project Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS). The potential effects of the construction phase on human and environmental health are expected to be lower than any effects from the Operation and Post-Closure Phases. Because the inherent nature of a SLRA is to be conservative, the SLRA assessed possible worst-case scenarios and therefore the construction phase was not included in the assessment. The information used in the SLRA was current as of October 7, 2014.

1.2 Project Objectives

The objective of this SLRA is to present the predicted risks to human health and ecological receptors that are associated with potential exposures to mine–related contaminants in the areas of the Project downstream of the Mine Site during the Operational and Post-Closure Phases of the project. The purpose of this SLRA was to determine whether there could be risks to human health from drinking water receiving mine-related effluent and from exposure to mine-related contaminants of concern (COCs) in air generated during the Operation and Post-Closure Phases of the mine. In addition, calculations were completed to evaluate whether wildlife (Hare, Deer, Moose, and Grouse) exposed to mine-related sources and effluent could be at risk. This SLRA includes a Country Foods Assessment.

The approach in this SLRA is to use a conservative approach, based on the fact that very limited site-specific information was available. Using this approach, there is high certainty that risks have not been underestimated. The results of the SLRA will be used to identify if there are potential health and environmental risks associated with the Project.

2.0 SITE SETTING

2.1 Site Description

The Project is located approximately 4 km northwest of the Village of Wabigoon and 20 km east of the City of Dryden, Ontario Canada (Figure 1). The Project is located within the Kenora Mining District of the Ministry of Northern Development and Mines (MNDM).

The Project is located on a property with the total area of 4,976 ha. The Project footprint will cover approximately 188 ha during the maximum extent of operations, with 133 ha or 71 percent of the footprint on TML private lands. Figure 1 and Figure 2 show the layout during the Operational Phase and Post-closure Phase, respectively.

The Project site is located in a low density rural area within the Hartman and Zealand Townships. There is some limited local agriculture focused on cattle, as well as logging activities in the area. Immediately adjacent areas are mainly second growth poplar-dominated forests and wetlands. Access to the site is by Trans-Canada Highway 17 located 2 km south of the site and via existing gravel roads (Tree Nursery Road and Anderson Road) which originates at Highway 17, west of the Village of Wabigoon.

2.2 Project Description

The total lifespan of the Project is approximately 17 years beginning with site preparation and ending with the completion of the closure activities. Some of the phases and activities will overlap.

The estimated duration of each key Project phase is as follows:

- Site Preparation Phase: 1 year;
- Construction Phase: 2 years;
- Operational Phase: 12 years;
- Closure Phase: 2 years; and
- Post-Closure Phase.

The two phases assessed in this SLRA are the Operational and Post-Closure Phases. The Operational Phase will start as soon as ore production is initiated. Initial mining will be by open pit methods with underground development activities starting immediately thereafter. Ore will begin to be produced immediately by processing incoming material from the open pit. The process plant will operate at approximately 2,700 tonnes per day to process a total of approximately 5,500,000 tonnes of open pit ore and 3,500,000 tonnes of underground ore over the 12 year Operational Phase of the mine. As the Operational Phase continues, the open pit will become progressively deeper. Approximately one half of the waste rock will be used to backfill the mined-out areas of the pit. The TSF capacity will be increased as required through dam raises.

During the Closure Phase the objective will be to reclaim the Project site area to a naturalized and productive biological state when mining ceases. The terms naturalized and productive are interpreted to mean a reclaimed site without infrastructure, which while different from the existing environment, is capable of supporting plant, wildlife and fish communities, and other land uses.

TML expects the active Closure Phase at the Goliath Project will take approximately two years after operations cease. Until such time that the final pit is fully flooded, TML will hold the site in care maintenance. Environmental monitoring and potentially effluent quality management will occur during this passive period of reclamation. Once the pit is flooded, an additional period of active reclamation may occur to remove remaining project infrastructure that was retained to facilitate the maintenance, monitoring, and final closure activities.

2.3 The Key Features of the Proposed Mine Site

The information contained within this section was obtained from the TML project description (PD) located within Section 3 of the Environmental Impact Statement (EIS). The mine layout places most required mine related facilities in close proximity to the proposed open pit and to the extent possible, on private lands owned by TML as identified in Figure 3.0.1 of the PD. The Project footprint will cover approximately 188 ha during the maximum extent of operations, with 133 ha or 71 percent of the footprint on TML private lands.

Waste Rock

Approximately 25 million tonnes of waste rock and 4-6 million tonnes of overburden will be produced during the life of the mine. The waste rock stockpile will have a footprint of 37 hectares, a height of 30 m above grade, and side slopes with a final overall grade of 3 horizontal width to 1 vertical height (3H:1V). The waste rock stockpile will be wholly within property owned by TML. Waste rock will be placed in open pits that will be developed and mined in series from west to east. As a result, approximately 40 percent of the total open pit waste rock will be used to backfill the pits and minimize the volume and footprint of the waste rock stockpile north of the pit.

During production, waste rock will be classified and separated according to acid generation potential. Where possible, potentially acid generating (PAG) rock will be placed within the completed Pit Lake to provide a long term water cover in order to mitigate potential acid generation as described in Section 11 of the EIS.

Ditching and seepage collection will be created around the edges of the stockpile to collect and direct surface water runoff and seepage. This water will be directed to the mine water management system for further treatment, testing and release. The system will be designed to handle the average annual precipitation and will also include provisions for functionality under all climatic conditions as described in Section 3 of the EIS. The mine water management system may include directing run-off water into the completed Pit Lake after closure and to facilitate pit flooding.

Progressive rehabilitation of mine rock and overburden piles will be undertaken where practical once the maximum height of each stockpile has been reached and as each lift is completed, to minimize the amount of reclamation required upon closure. All stockpiles will be re-shaped, scarified, and stabilized as necessary during the Operational Phase of the project.

At closure waste rock piles will be covered with an impermeable barrier or with 1 m of soil and then re-vegetated. In the area containing only non-potentially acid generating rock (NPAG) rock, acid rock drainage (ARD) is not of concern and TML proposes to place a re-vegetated layer of overburden. For the area above surface containing PAG rock, TML proposes to use a multi layered cover for reclamation purposes. This main purpose of this cover would be to control long term ARD by achieving encapsulation and limiting oxygen to the PAG rock.

Tailings Storage Facility

The objective of the Tailings Storage Facility (TSF) for the Goliath Project is to ensure protection of the environment during operations and in the long-term (after closure) and to achieve effective reclamation at mine closure. The design of the TSF will take into account the following requirements:

- Permanent, secure and total confinement of all solid waste materials within an engineered facility.
- During the Operational Phase of the mine, maintain a water cover over the tailings beach to minimize potential acid generation of the tailings solids as initial studies have indicated that mine waste can be considered as PAG. Excess water directed to the facility will be retained and directed to the plant site as reclaim for use in the operations and any surplus to treatment at a water treatment plant.

Inputs to the TSF include cyanide-treated tailings slurry from the mill, excess mine dewater, precipitation, and run-off from any tailings beach areas. The water quality of the TSF is equivalent to the water quality of the site effluent.

The combined tails slurry will be pumped (at the density it is received) to the tailings pond. Tailings deposition into the facility will result in development of a tailings beach that will rise over the Operational life and dictate the required embankment heights at each stage to provide containment.

Both the on land waste rock and the TSF will be encapsulated at closure with a pioneer layer to fill voids, a water shedding layer of clay to minimize penetration of water, and a soil layer to support vegetation. The encapsulation will tie into the surrounding clay soils to minimize runoff and shallow groundwater penetration.

Mine Pit Lake

During the Operational Phase of the Mine, water will be released to the Pit or to Blackwater Creek after treatment in the reverse osmosis (RO) plant. The drawdown from the Operational Phase of the mine will cause a 1 m drawdown contour (AMEC 2014a). Within the drawdown cone flow of groundwater will be towards the mine during the Operational Phase (AMEC 2014a,b). The quality of the water from the dewatering activities in the underground stopes used to fill the Pit is assumed to be the same as Pit run-off water.

During the Closure Phase waste rock will be added to the Pit and submerged with water (Tetra Tech EBA, 2014). The Pit Lake will be constructed in bedrock with a 3 to 5 m overburden range (A.C.A. 2012). The approximate depth of the Pit Lake will be 150 m and the surface area will be approximately 32 hectares. The EIS Closure plan predicts it will take 9 years for the Pit Lake to fill, therefore overflow during the Operational Phase and into the Post-closure Phase is not expected. The quality of the water within the Pit Lake has been modeled in the Preliminary Water Balance Model (Tetra Tech 2014) and provided for use in this SLRA. Although the hydrology underlying the Pit Lake area is reported to have very low hydraulic conductivity, the AMEC report (2014a) has identified that water within the Pit has the potential of infiltrating the groundwater aquifer and travelling to drinking water wells to the East, and eventually reaching Thunder Lake. AMEC has reported it is difficult to reliably model groundwater data downgradient during the Closure Phase. Regular monitoring to assess groundwater quality will be scheduled (AMEC 2014b).

Effluent Discharge

During the Operational Phase contaminated water will be treated in the cyanide destruction circuit with subsequent attenuation in the TSF. By destroying cyanide prior to discharging the tailings to the storage facility, potential cyanide contamination situations such as dam seepage or tailings facility overflow during extreme storm events late in the project life are eliminated. By design, the cyanide treatment circuit will destroy cyanide to a level acceptable for direct discharge to the environment and reduce the environmental safety requirements placed on the TSF.

In addition, as documented in the EIS in Section 3.0, during the Operational Phase a RO plant will be operational. The RO plant will meet the effluent concentrations included in Tables 4 and 5 and as provided in the EIS Commitment Registry. Increased recirculation of water for mine use will occur with the operation of a RO plant which increases the dilution of the effluent (Tetra Tech WEI 2014a and 2014b). Further details of the RO plant construction are reported in Section 3 of the EIS.

In the Operational Phase, effluent water will be pumped from the RO plant to the selected location in Blackwater Creek via a pipeline. All existing surface drainage ways coinciding with site infrastructure will be diverted around the infrastructure to prevent potential contamination of fresh water and to minimize the quantity of water being processed through the site. Site infrastructure (ore pad, waste rock storage, and processing plant) will be located on sites contoured such that surface run-off can be captured independently of surrounding surface water and processed through the plant as described in Section 3.0 of the EIS. Any contaminated surface water will be collected in a minimum number of collection ponds and be pumped to the RO plant during operations.

Closure and reclamation of the WRSA will consist of placing a water-shedding cap over the WRSA that is tied into the up-gradient clay soil and vegetation of the cap and disturbed areas. The tailings beach will be similarly capped. Runoff collection ditches will be realigned to direct runoff into the open pits. All disturbed areas surrounding the WRSA that are not required for mine operation will be decommissioned and vegetated.

Once open pit mining and waste rock backfill operations have been completed the pits will be prepared for closure and flooding. Clean, locally sourced material will be used to construct a perimeter berm. A passive spillway will be constructed to allow the Pit Lake to eventually discharge to Blackwater Creek. The elevation of the spillway will be set to ensure the lake level is maintained within the overburden above the bedrock. This will ensure that the waste rock that has been placed in the pit and the pit walls remain underwater during the Post-Closure phase. Any hydraulic connections with the underground operations, such as exploration drill holes, will be sealed as encountered during underground operations. The water for pit filling will come from three sources: surface water runoff and precipitation; secondary treatment discharge; and groundwater from wells outside of the mine zone of influence (see EIS Chapter 11, Table 11.1). It is assumed that there will be no groundwater inflows due to the underground mine dewatering.

2.4 Site Physical and Regional Characterization

The Goliath Gold Project area exhibits rolling terrain, and is drained principally by Blackwater Creek, and its associated minor tributaries. The reconnaissance information and site-specific environmental setting information is summarized in Table A below.

Table A: Site-Specific Environmental Setting Information

Feature	Description
Climate	Regional air temperature follows an annual sinusoidal pattern with minimum average daily temperature occurring in January and maximum average daily temperature occurring in July. Between November and March, temperatures are typically below freezing. The diurnal temperature range is similar during spring, summer and winter (approximately 10°C) but is less during the fall (7°C). (KCB 2012). Based on historical observations at Dryden, mean annual precipitation at the Project site is 705 mm, of which, between 20% to 24% falls as snow. Hydrological Atlas of Canada estimates for lake evaporation in the ranges from 500 mm to 600 mm per year while estimates for potential evapotranspiration are between 510 mm and 560 mm. Lake evaporation and potential evapotranspiration are both upper bounds of actual evaporation and evapotranspiration, respectively. Actual evaporation and evapotranspiration are limited by the availability of moisture stored in the soil or by vegetal water consumption (KCB 2012).
Nearest Residence	There are residences within a 4 km radius of the centre of the Property.
Topography	The Project topography is characterized by low-lying areas of thicker sedimentary deposits primarily of glacial origin, on higher ground, bedrock can be exposed influenced by glaciation. Elevations in the area generally vary between 370 m and 430 m above sea level (AMEC, 2014).
Surface Waterbodies	The Project is located within the Wabigoon Basin. The Project is drained primarily by the Blackwater Creek and tributaries, which flow south toward Wabigoon Lake. East of the Project, the area is primarily drained by Hughes Creek and Nuggett Creek to Wabigoon Lake. Wabigoon Lake is approximately 2.5 km south of the Project. The City of Dryden has 7,717 residents that obtain their drinking water directly from Wabigoon Lake which is piped 2 km and then treated within a water treatment plant operated by the City of Dryden (City of Dryden 2013) (Ontario Ministry of Environment 2014). West of the Project, Little Creek and the Hoffstrom's Bay Tributary drain toward Thunder Lake. Thunder Lake is located approximately one kilometer west of the Project. (AMEC 2014).
Soils	The Soils are predominantly moderately drained Luvisols, Gleyols, and Podzols, (KCB 2012). The Luvisols are generally well drained, characterized by an illuviated Bt horizon that has an accumulation of silica-clay. The gray luvisol of the Dryden-Kenora area typically have clay, clay loam, sandy loam, or silt loam texture. These characteristics make the soil have a moderate agricultural capability (KCB 2012).

Table A: Site-Specific Environmental Setting Information

Feature	Description
	The Glesyols of the Dryden-Kenora are poorly drained and saturated. They are commonly identified by hue and mottling in the lower horizons (an indication of reducing conditions) associated with saturation. The texture is silt loam to medium coarse. They can be found underlain by outwash that is calcareous and lacustrine in origin (KCB 2012). The podzols typically occur in coarse- to medium-textured, acid parent materials, under forest or heath vegetation in cool to very cold humid to perhumid climates. The Dryden-Kenora podzols are well drained and have B horizons in which the dominant accumulation product is amorphous material composed mainly of humified organic matter combined in varying degrees with aluminum and iron (KCB 2012).
Surficial Geology	The regional surficial geology is characterized as a discontinuous mantle of Quaternary surficial deposits overlying the Archaean bedrock. Within the project area there are three main types of surficial geology. The rolling glaciolacustrine plains make up almost 70 percent of the Project Area. It is composed of varved clay and bedrock knobs. The remaining area included 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 (A.C.A. 2012).
Bedrock	The majority of the bedrock geology consists of the volcano-plutonic Eagle-Wabigoon-Manitou Greenstone Belt in the Wabigoon Subprovince of the Archaean Superior Province. The Project is located on the north side of the regional Wabigoon fault, which is observed at surface just north of the Village of Wabigoon (PEA 2012). The southern part of the Project site is underlain by the Thunder River Mafic Metavolcanic rocks. (AMEC 2014).
Water Wells	A total of 77 water wells fall within the zone of impact (ZOI) as defined by the 1 m drawdown contour (AMEC 2014). Ontario Ministry of Environment (OMOE) water well map shows two wells within 1 km of the Project site (Appendix B).
Hydrogeology	The overburden hydrogeological flow range between 4.6E-07 m/s and 1.3E-06 m/s with a geometric mean of 9.2E-07 m/s and an arithmetic mean of 9.8E-07 m/s. (AMEC 2014). The bedrock hydrology is divided into three regions, Shallow (0-10 meters below surface grade (mbsg)), Intermediate (10-400 mbsg), and Deep (>400 mbsg). The hydraulic conductivity was reported that it may approach 1E-06 m/s, 1E-07 m/s to 1E-08 m/s; and 1E-09 m/s), respectively.

2.5 Land Use Relevant to the Project and SLRA

The land use for the actual Project itself is industrial land use. The focus of the SLRA is to assess potential risk for human and animal receptors surrounding the Site and potentially impacted by mine-related contaminants. Therefore both Residential and Agricultural land use standards/guidelines were applied to develop exposure scenarios in the SLRA. Residential land use was applied for humans living in the general radius of the Project site and Agricultural land use was applied to animals living on food sourced from the general radius of the Project site.

2.6 Previous Assessments

Information for the SLRA was gathered from various previous assessments including:

Baseline

- Klohn Crippen Berger (KCB). 2012. M09706A01, Treasury Metals Inc. Goliath Gold Project, Baseline Study, November 2010 to November 2011. Report prepared for Treasury Metals Inc. by Klohn Crippen Berger, September 2012.
- Ecometrix. 2013. Draft Geochemistry Evaluation of the Goliath Gold Project, September 2013.
- DST Consulting Engineers, 2014a. Terrestrial Wildlife Baseline Study. Report prepared for Treasury Metals Inc. by DST Consulting Engineers, February 2014.
- DST Consulting Engineers, 2014b. Treasury Metals Inc. Goliath Gold Project Fisheries Baseline Data Summary. Prepared for Treasury Metals Inc. by DST Consulting Engineers, March 2014.
- GCK Consulting, 2014. Treasury Metals Goliath Gold Project, Socioeconomic Baseline Report, Conditions in Northwestern Ontario. Submitted to Treasury Metals Inc. by GCK Consulting, May 2014.

Environmental Impact Statement (EIS)

- AMEC Environment & Infrastructure (AMEC). 2014. DRAFT Treasury Metals Inc. Hydrogeological Pre-Feasibility / EA Support Study Goliath Project. Submitted to Treasury Metals by AMEC Environment & Infrastructure a division of AMEC Americas Limited, 505 Woodward Avenue, Unit 1, Hamilton, Ontario, May, 2014.
- Lycopodium Minerals Canada Ltd. 2014. Goliath Gold Project Pre-Feasibility Water Management Strategy.
- In Lycopodium report: Tetra Tech. 2014. DRAFT Treasury Metals Goliath Project Preliminary Water Quality Model.
- Treasury Metals Incorporated. 2014. Goliath Gold Project Environmental Impact Statement – Section 3.0 Project Description.

Engineering / Feasibility Studies

- A.C.A. Howe International Limited (A.C.A). 2012. Report No. 964, Preliminary Economic Analysis of the Goliath Gold Project, Kenora Mining Division, Northwestern Ontario, Canada. Report prepared for Treasury Metals Inc. by A.C.A. Howe International Limited, Toronto, Ontario, Canada. August 20, 2012.

2.7 Valued Components

The EIS has identified the following as Valued Components (VC) for the Project:

Table B: Valued Components for the Project

Environmental Component	VC
Atmospheric	Ambient Air Quality
	Ambient Light
	Ambient Noise
Climate	Climate Change (GHGs)
Surface Water	Surface Water Quality
	Surface Water Quantity
Groundwater	Groundwater Quality
	Groundwater Quantity
Fish and Fish Habitat	Fish Habitat
	Indicator Species (WALL, NRPK, etc.)
Vegetation	Upland Ecosystems
	Wetland Ecosystems
	Rare Plant Species
Wildlife and Habitat	Birds (migratory, waterfowl)
	Mammals (ungulates, furbearers, bats)
	SARA Species
	ESA Species
Socio-economic Environment	**VC**
Social	Community Dynamics
	Human Health and Well-being
Economic	Community Infrastructure and Services
	(Traffic, utilities, etc.)
	Training, Employment, and Income
	Local and Regional Economy
Cultural	Cultural Resources
	Aboriginal Resources and Land Use
	(Traditional hunting, fishing, and plants)
	Recreational Use of Crown Lands

2.8 Assumptions Associated with the SLRA

The SLRA has been completed using the following assumptions. Although certain items are excluded from the SLRA, stakeholders may need to include the items listed below in their EIS as identified by Health Canada in their guidance document titled "Useful Information for Environmental Assessments" (2010) or in other Health Canada Risk Assessment guidance:

- That all sewage generated and hazardous waste temporarily stored at the mine operations will be fully contained and therefore excluded from the RA.

- That no radiological effects are present and therefore excluded from the current scope of work. None of the minerals being mined by Goliath are radioactive.
- If effects from electric and magnetic fields are present they will be addressed in the EIS but not under the RA.
- If effects from noise generated from the construction, or operating phases of the Goliath Mine are present they will be addressed in the EIS but not under the RA.
- The RA will not include a socio-economic nor a health impact effects assessment.
- The RA will not include a physical hazard effects assessment.
- If the baseline report includes toxicology studies that identify unacceptable risks to human or ecological receptors then additional assessment under the Federal Contaminated Sites Action Plan (FCSAP) (2012a), Health Canada Preliminary Quantitative Risk Assessment (PQRA) (2012) or Health Canada Detailed Quantitative Risk Assessment (DQRA) (2010) framework would be required in subsequent phases of work.
- Exposure for receptors was modelled for the Operational and Post-Closure Phases, the two phases with potential to generate mine-related releases.
- The SLRA focuses on the protection of human health. Therefore COCs were identified for human health and these same COCs were used to assess potential exposure and risk for select terrestrial wildlife.
- This SLRA does not include an assessment of potential risk for wildlife with aquatic based diets.
- Site-specific information regarding human site-use was limited for residents of the Village of Wabigoon and the City of Dryden, therefore default, conservative site-use was applied as recommended by Health Canada.
- A Country Foods Assessment was included in the SLRA based on default ingestion rates for First Nations available in the Health Canada DQRA risk model (HC 2011). First Nation exposure was assumed to be the same as residents of the Village of Wabigoon and the City of Dryden.
- Groundwater concentrations leaving the Pit Lake and migrating towards Thunder Lake and/or Wabigoon Lake were not available at the time of this SLRA, as it is reported that hydraulic conductivity of the bedrock in the Pit is very low and releases would likely be minimal (AMEC 2014a). Pit Lake water passively released to Blackwater Creek in the Post-Closure Phase was evaluated using modelled concentrations of total metals of field cell tests.
- If during the SLRA pathways are complete, receptors are identified, and contaminants are present at unacceptable concentrations then additional assessment under the FCSAP (2012a), Health Canada Preliminary Quantitative Risk Assessment (PQRA) (2012) or Health Canada Detailed Quantitative Risk Assessment (DQRA) (2010) framework would be required in subsequent phases of work.

3.0 RISK ASSESSMENT PROCESS

3.1 Risk Assessment Methods

Risk assessment is a standard process used to characterize potential adverse health effects of human and wildlife exposure to environmental hazards. The risk characterization is based on the estimated exposure and toxicity of COCs at the Site, and by determining the level of risk acceptability in the context of the overall objective of the risk assessment. In the case of this SLRA, the objective is to conduct a conservative, Site-specific risk assessment to identify COCs with the potential to cause adverse health effects to human and ecological receptors, based on the proposed land use scenarios. The identification of risks in this process does not mean that health effects are actually occurring, but rather that predicted/modelled concentrations of parameters are sufficiently elevated to warrant further assessment.

Risk can only occur if there are links between sources of exposure and humans or ecological receptors (e.g., plants, soil invertebrates, mammals), and if COCs are sufficiently high enough to cause risk. In other words, the following three elements are required:

- Sources of chemicals must be present;
- Receptors (e.g., humans, plants or animals) must be present; and
- Exposure pathways must exist between the source of the chemicals and the receptors.

In the absence of any one of the three elements (chemicals, exposure pathway or receptor), risks cannot occur.

The risk assessment process is based on four components, which are described in more detail below:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

Problem Formulation

The purpose of the Problem Formulation component is to identify the chemicals, receptors, and exposure pathways that are applicable for the Site. The COCs were identified as part of the baseline; however, further refinement of the COCs was completed to focus on parameters that are most applicable to the individual human health and ecological risk assessments. Individual pathways included in the guideline derivation for human and ecological health were reviewed for the current and surrounding land use – Agricultural for animals and Residential for human receptors.

Human and ecological receptors were chosen by focusing on humans and terrestrial receptors (e.g., plants and soil invertebrates, wildlife, and livestock) that are or may be present in the vicinity of the Site. Human receptors were selected by examining the activities that might occur under Residential land use scenarios. Wildlife receptors were selected by considering those that are valued by local stakeholders, and those that are considered to be listed as sensitive or of concern by provincial regulators.

The objective of the exposure pathway identification is to determine all of the potential routes by which humans and ecological receptors could be exposed to COCs in contaminated media from the Site. The results of the Problem Formulation phase are summarized in the development of a conceptual site model (CSM) that depicts the exposure pathways and receptors.

Exposure Assessment

The exposure assessment step results in quantification of the amount of chemical a human or ecological receptor may be exposed to through all of the applicable exposure pathways. In some cases, this includes modeling concentrations in environmental media for which data has not been collected (i.e., vapour and food items). The exposure assessment also considers how much of the chemical is taken into the body by considering the physiological characteristics of a receptor (e.g., body weight, inhalation rate).

Toxicity Assessment

Toxicity reference values (TRVs) are identified in the toxicity assessment. The reference value is the acceptable dose that the receptors can be exposed to on a daily basis without risk of adverse health effects. The reference values used in the SLRA were obtained from peer-reviewed toxicological databases for human and ecological receptors.

Risk Characterization

The final step in a risk assessment is the risk characterization. This step compares the results of the exposure assessment and toxicity assessment and determines whether there is a potential for a chemical to pose an ecological or human health risk. Uncertainties associated with the assessment and their potential impact on the risk estimates are also included. From this, recommendations for remediation or risk management can be made.

Each of the risk assessment steps were completed for human and ecological receptors as described below in Sections 4.0 and 5.0, respectively.

3.2 Risk Assessment Guidance

In Canada, risk assessment has been accepted by provincial and federal governments as a valid method to guide management decisions. The risk assessment methods for this assessment were based on the following provincial and federal guidance documents:

- Health Canada (HC). 2012. Guidance on Human Health Preliminary Quantitative Risk Assessment.
- Health Canada (HC). 2010. Federal Contaminated Site Risk Assessment in Canada (FCSAP): Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{foods}$).
- Science Advisory Board for Contaminated Sites (SAB). 2006. Draft Guidance for Detailed Ecological Risk Assessments (DERA) in British Columbia.
- Federal Contaminated Sites Action Plan (FCSAP). 2012a. Ecological Risk Assessment Guidance.
- Federal Contaminated Site Action Plan (FCSAP). 2012b. Supplemental Guidance for Ecological Risk Assessment –Module C: Standardization of Wildlife Receptor Characteristics.
- Canadian Council of Ministers of the Environment (CCME). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines.

4.0 HUMAN HEALTH SCREENING LEVEL RISK ASSESSMENT

4.1 Introduction

This SLRA was commissioned to include an assessment of the Residential Area land use for people living and recreating in areas of the Project with the potential for exposure to mine-related contamination.

4.2 Problem Formulation

The purpose of the problem formulation is to review the COCs identified in the baseline and determine which are applicable to human health; to identify the ages and activities of the humans that would be present, and to identify the exposure pathways by which humans would come in contact with the COCs. The result of the problem formulation is a CSM, or pictorial presentation, of how humans might be exposed to COCs from the Project, considering a Residential land use scenario. The CSM for the Operational Phase of the Project is presented in Figure 3. The CSM for the Post-closure Phase of the Project is presented in Figure 4.

4.2.1 Refinement of COCs

4.2.1.1 COC Sources and Guidelines

The data used to identify COCs came from numerous sources and was gathered by various consultants. The source of the data, any assumptions applied, the media impacted, and its relevance is presented in Table C below

Table C: Data Used in the SLRA to Identify COCs

Media	Relevance	Reference and Assumptions
Site-specific (Operational and Post-Closure)		
Waste Rock (WR)	A potential source for animals in contact with WR or eating foods growing on WR during the Operational Phase.	EcoMetrix. Sept, 2013. Geochemistry draft report. Calculated totals using 15% MSS, 70% BMS and 15% MSED, data presented in Table 3.1.
Tailings	A potential for animals in contact with tailings or eating foods growing on tailings during the Operational Phase.	EcoMetrix. Sept, 2013. Geochemistry draft report Table 3.5. – Pb, Tl KCB. 2012. Baseline Report. – Hg
Dust	A source for City of Dryden residents, First Nations, and recreational users.	RWDI. August, 2013. Draft Air Quality Assessment Treasury Metals Incorporated – Goliath Gold Mine Wabigoon, Ontario. Table 5
Drinking Water Blackwater Creek	A source included in estimating exposure for animals and people (recreational users) drinking out of Blackwater Creek impacted by direct effluent discharge.	Tetra Tech. August 2014. Preliminary Water Quality Model. Operational = Field Cell, TSF Intermediate, Total metals. Post-Closure = Field Cell Data, Final Pit Lake, Total metals. A site specific dilution factor was applied.
Surface Water Wabigoon Lake and Blackwater Creek	A source included in estimating exposure for City of Dryden residents, First Nations, and recreational users, bathing or in contact with waters in Blackwater Creek or Wabigoon Lake.	Tetra Tech. August 2014. Preliminary Water Quality Model. Operational = Field Cell, TSF Intermediate, Total metals. Post-Closure = Field Cell Data, Final Pit Lake, Total metals. A site specific dilution factor was applied.
Fish Tissue	A source included in estimating exposure for residents of Dryden, First Nations, and recreational users fishing in Wabigoon Lake.	DST. March 2014. Goliath Gold Project Fisheries Baseline Report. Only mercury fish fillet data was available and included in the SLRA. There were 11 Walleye tissues from Thunder Lake, 30 from Wabigoon Lake, and 1 from Sauger.
Baseline		
Soil	If a baseline WR or tailings COC is not regulated but is below baseline then the COC is not carried into the SLRA.	KCB. September 2012. Baseline Study Nov 2010 to Nov 2011. Table 6.7, 25 samples used, geomean, median, minimum and maximum data provided.

Media	Relevance	Reference and Assumptions
Site-specific (Operational and Post-Closure)		
Drinking Water - Blackwater Creek Surface Water	If the baseline Blackwater Creek COC concentration is not regulated but is below baseline then the COC is not carried into the SLRA.	DST. August 2014. Final Treasury Aquatic Baseline Report. Rev. 2. SW-TL2 – values from 2012 to 2013 averaged over all sampling events.
Drinking Water - Wabigoon Lake Surface Water	If the baseline Wabigoon Lake COC concentration is not regulated but is below baseline then the COC is not carried into the SLRA.	DST. August 2014. Final Treasury Aquatic Baseline Report. Rev. 2. SW-4 location – values from 2012 to 2013 averaged over all sampling events.

The relevant media, the applied guidelines, and the assumptions applied to derive COCs for the SLRA is presented below:

Soil/Waste Rock/Tailings

COC concentrations in waste rock and tailings were compared to the Canadian Soil Quality Guidelines (CSQG) for the Protection of Environmental and Human Health (PEHH) by Canadian Council of Ministers of the Environment (CCME), 2007, revised 2010, and the Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards (OMOE SCS), the Guidelines for Canadian Drinking Water Quality, August 2012 (CDWQG). Residential land use was applied for humans and Agricultural land use was applied for animals. Waste rock and tailings COCs were also compared to baseline soil concentrations from the area. This information is presented in Table 1 and 2 at the end of the report.

Dust

Predicted COC concentrations in dust were calculated for the Project and compared to the Ontario Ministry of the Environment (419/05) Air Pollution standards and guidelines (April 2012). The 24-hr concentration was calculated for all COCs as well as the annual COC concentration for total suspended particulates (TSP), and particulate matter (PM). Concentrations were calculated to the Property line with the exception of TSP and PM which were also calculated to the closest residence. This information is presented in Table 3 at the end of the report.

Water

Predicted effluent discharge COC concentrations generated by the Preliminary Water Quality Model (Tetra Tech, 2014) were compared to the Provincial Water Quality Objectives (PWQO) and Canadian Council of Ministers of the Environment (CCME) - Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2014, the Guidelines for Canadian Drinking Water Quality, August 2012 (CDWQG), as well as the Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards (OMOE SCS), and the Metal Mining Effluent Regulations Schedule 4 Authorized Limits of Deleterious substances (MMER). Predicted effluent concentrations were also compared to baseline surface water concentrations within either Blackwater Creek or Wabigoon Lake.

People and animals will not be drinking and swimming in mine effluent which is what the predicted COC concentrations represent. Therefore a site specific factor of 6.04 times (Tetra Tech WEI 2014a) was applied to COC effluent concentrations being compared to the guidelines and presented in Tables 4 and 5 at the end of the report. To calculate the site specific factor, the monthly average dilution factor for effluent from the Project site into nearby natural waterways (Blackwater Creek) was estimated and then averaged as a yearly value (Tetra Tech WEI 2014a and 2014b).

The total amount of COCs that would be contained in the creek after effluent discharge ("total load") was also calculated and is provided in Tables 4 and 5. Total load was calculated using the baseline concentration in Blackwater Creek combined with the incoming load and flow from the RO plant. Total load takes into account the existing background concentration in Blackwater Creek. The total load provides an exposure that is more representative of what people and animals would be exposed to within Blackwater Creek and Wabigoon Lake. Wabigoon Lake is a source of drinking water for the City of Dryden and is used for swimming.

Upon closure the waste rock will be submerged in pit waters at the Project site. The AMEC report (2014a) identifies that the water within the proposed pit has the potential to migrate into the groundwater aquifer and travel towards Thunder Lake, and potable water wells along Thunder Lake and potentially Wabigoon Lake, but hydraulic conductivity of the bedrock in which the Pit Lake will exist is very low and releases to groundwater are likely to be minimal (AMEC 2014a). It is expected to take 9 years after operations cease for the Pit Lake to fill completely. No releases are expected during the time it takes to fill the Pit Lake (EIS Sections 3 and 11). After the Pit Lake is filled, a passive discharge to Blackwater Creek is expected. The modelled pit water concentrations, combined with the expected dilution, were used to select COCs for the Post-Closure Phase surface water exposure pathway. As with the Operational Phase data, a total load exposure concentration was estimated to account for the addition of effluent to existing baseline concentrations in Blackwater Creek.

It is relevant to point out that two types of tests were used by TML to calculate the potential mine effluent discharging into Wabigoon Lake and Blackwater Creek: Field cell testing and HTC testing. Field cell data is more representative of field conditions and was used to model exposure concentrations for the Operational Phase and Post-Closure Phase of the mine. Both total and dissolved metals were quantified using the field cell test. Total metal results were used for the SLRA.

Food

The SLRA has been expended to contain a Country Foods Assessment, to assess potential human exposure to mine-related COCs within food sources impacted by mine activity. It is relevant to identify that during the baseline fish tissues were collected and mercury was quantified. Table 6 presents the calculated 90th percentile concentration of mercury in fish tissues that were collected during the baseline assessment. These were compared to the Ontario MOE Guide to Eating Ontario Sport Fish 2013-2014 which has minimum guidelines for the protection of sensitive and general public members within the population. In addition, as a baseline value for lead in fish tissue, the calculated 90th percentile of lead in fish tissue as measured in the KCB 2012 study are presented in Table 6. Both mercury and lead tissue concentrations are used in Country Foods Assessment.

4.2.2 Identification of COCs

A summary of the parameters evaluated as COCs, comparison to the CCME, OMOE, CDWQG, and MMER and the rationale for or against retaining each parameter as a human health COC are presented in Tables 1 to 6 (attached at the end of this report). COCs were identified and then selected for assessment in the SLRA for both human and animal receptors. The first step was COC identification and it involved comparing COCs to generic regulatory guidelines/standards. The second step was COC selection and it involved retaining COCs for assessment based on the number of media with COC exceedances for the protection of human health.

COCs were identified by comparing concentrations that were measured in samples that were collected during the baseline investigation or predicted using a model. A parameter was identified as a COC if the maximum/modelled concentration, or the concentration after applying a dilution factor in the case of effluent, exceeded the most conservative of the applicable human health guidelines. A baseline or background concentration denotes the amount of a substance found naturally in an area (site-specific). If the parameter was not regulated, then it was not retained for assessment if it met or was below the natural background concentration for that media.

The COCs identified for the SLRA are presented in Table D below.

Table D: Summary of Identified COCs

Media Applied using guidelines/standards	COCs Identified– Operational	COCs Identified – Post- Closure
Waste Rock	Aluminum, Arsenic, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Mercury, Nickel, Zinc	None – Waste Rock will be covered
Tailings	Arsenic, Cadmium, Copper, Lead, Mercury, Zinc	None – Tailings will be covered
Surface Water Blackwater Creek – Relevant for animals	None	None
Surface Water Pit Lake – Relevant for animals	None	None
Drinking Water Blackwater Creek – Relevant for humans	None	None
Drinking Water Wabigoon Lake – Relevant for humans	None – No COCs were selected for Blackwater Creek	None – No COCs were selected for Blackwater Creek

Mercury and lead were selected as the human health COCs requiring evaluation in the SLRA.

The maximum lead concentration exceeded all of the federal or provincial regulatory criteria derived for the protection of human health for waste rock and the average concentration exceeded the Residential Land Use (RL) standards. Lead also exceeded all of the federal or provincial regulatory criteria for tailings.

The maximum mercury concentration exceeded the provincial regulatory criteria derived for the protection of human health for waste rock. Mercury concentrations in tailings were not available to include in the SLRA. Therefore mercury concentrations in waste rock were used to represent mercury concentrations in tailings. Mercury concentrations in dust were not calculated (see Table 3 at end of this report) and therefore exposure to mercury in dust was based solely on concentrations in waste rock.

Mercury was also selected as a COC due to its bio-accumulative properties. Mercury and lead are both neurotoxins so these COCs may be of particular interest to the community and as a public health concern.

Dust specific COCs

Both total suspended particulate matter (TSP) and particulate matter 10% (PM) were calculated at the property line as well as the nearest residence. Point of Impingement concentrations (POI) exceeded the OMOE limit at the property line but not at the nearest residence. Dust control measures will be in place for all phases of the project as required. It is likely that this will be in the form of a water truck to keep roads damp during the summer. Within the mill dust collectors will be utilized at transfer points and at the primary crusher to keep fugitive dust emissions to a minimum however exposure of dust to residents in the area and recreational users is possible.

For the purposes of the SLRA it is assumed that construction and mine workers will use the appropriate PPE to reduce dust exposure when dust concentrations are high, and the above control measures fail to keep the TSP and PM concentrations below the POI within the property line at the site. No other dust COCs exceeded the POI as identified in Table 3 at the end of this report, therefore no additional COCs were identified for the SLRA.

4.2.3 Receptor Identification

Humans potentially impacted by mine-related COCs were identified under both the Residential and Recreational Land Use Scenario. Residential Land Use is defined by both CCME (2014a) and OMOE (2011) as a site where humans, including all members of a family of all ages and where humans may come to work. The City of Dryden is situated approximately 20 km west from the proposed Project site and the Village of Wabigoon is situated approximately 4 km southeast of the proposed Project site.

There is also recreational use in the area such as fishing, water-skiing, wind surfing, kayaking and swimming on Wabigoon Lake or one of the many close surrounding lakes. In the winter ice fishing is known to occur (Patricia Regional Tourist Council 2013).

First Nation groups that are in closest proximity to the proposed mine site, attend school in the Wabigoon/Dryden area, do their primary shopping in the immediate area and use Wabigoon and Dryden as their primary source of medical and other services are the Wabigoon Lake Ojibway Nation, Eagle Lake First Nation and the local Métis Nation of Ontario. This information was identified by the TML PD (2014).

A summary of the receptors evaluated in the SLRA, and the corresponding rationale for the receptor selection is provided below in Table E.

Table E. Residential Land - Potential Human Receptors of Concern

Receptor	Age Group	Rationale
Village of Wabigoon and City of Dryden Residents	Adult (20+ years) Teen (12 -19 years) Child (5 – 11 years) Toddler (7 months to 4 years) Infant (0 – 6 months)	The Village of Wabigoon is the nearest town to the proposed mine site and the residents of the City of Dryden drinking water source is from Wabigoon lake.
First Nation Residents	Adult (20+ years) Teen (12 -19 years) Child (5 – 11 years) Toddler (7 months to 4 years) Infant (0 – 6 months)	For the purpose of this SLRA the First Nation (FN) residents were not evaluated separately from the Village of Wabigoon and City of Dryden residents. Country food harvesting of wild game, plants and fish are evaluated for FN residents using default values and modelled concentrations in food items.
Recreational Users	Adult (20+ years) Teen (12 -19 years) Child (5 – 11 years) Toddler (7 months to 4 years) Infant (0 – 6 months)	Recreational use is reported to occur yearlong through various activities.
Mine Employees or Construction Workers	Adult (20+ years)	This SLRA assumes that proper safety procedures and personal protective equipment (PPE) will be used when humans are working on the mine site therefore this receptor was not evaluated separately from the City of Dryden residents.

Direct access to the Project site is limited for the above receptors (excluding the mine employees and construction workers). As identified by TML in the PD the general public will not have access to the site. The PD reports to be no natural features within the Project site that would draw the general public since the area is dominated by marshes and contains no lakes or other recreational or natural features of interest.

4.2.4 Exposure Pathway Identification

Identification of human exposure pathways is the process of identifying all of the applicable pathways where humans may come in contact with COCs on or near the Project site. The pathways considered in this step include all of the pathways evaluated by CCME in the derivation process for their respective soil quality guidelines, and other pathways as deemed applicable for this Site. For this SLRA, direct soil contact, ingestion of contaminated food, surface water or groundwater as drinking water, surface water dermal contact and vapour inhalation were considered. The pathways are evaluated in the sections that follow.

4.2.4.1 Direct Soil Contact and Dust

Humans can come into direct contact with soil COCs through incidental ingestion, dermal contact, and dust inhalation. Direct soil contact as a potential pathway in the problem formulation, with the exception of dust inhalation, was eliminated from further consideration since all humans will have restricted access to the proposed mine site or, in the case of workers on the site, proper PPE will be enforced.

As identified in the TML PD (2014) and recommended in the Environmental Air Quality Assessment Report (RWDI 2014) dust control measures will be in place for all phases of the project as required. It is likely that this will be in the form of a water truck to keep roads damp during the summer. Within the mill dust collectors will be utilized at transfer points and at the primary crusher to keep fugitive dust emissions to a minimum, however exposure of dust to residents in the area and recreational users is possible. Table 4 of the RWDI report identifies that the main source of dust generation during the Operational and Closure Phase will be dust from haul roads constructed with waste rock, and wind erosion of tailings. During both the Operational and Closure Phases dust will be generated from haul roads, and at closure dust from the tailings will not be an input source since the tailings will be covered.

Dust inhalation is an exposure pathway that was carried forward into the SLRA for the Operational Phase because this pathway is relevant, receptors are present, and COCs exceed the guidelines.

4.2.4.2 Food Chain Exposure

It is possible that Village of Wabigoon, City of Dryden residents and First Nations consume produce from backyard gardens and from gathering native plants and berries near the Project area. As the mine location is significantly removed from backyard areas, the food chain exposure focusses on gathering of native plants and berries.

The KCB baseline report identifies that the Ontario MOE has been monitoring mercury levels since the 1960s because of extensive mercury contamination from historical sources, and a sport fish consumption advisory has been issued within the Wabigoon River System (KCB 2012). Historical mercury contamination occurred when the Dryden pulp and paper mill discharged elemental mercury into the English-Wabigoon River System. It is noted that the discharge location of elemental mercury was downstream of the Duke Street Dam that separates Wabigoon Lake from the Wabigoon River (based on the address of the current Domtar pulp and paper mill). Mercury levels have decreased since the 1970s but may still present a potential risk to human or ecological health (Kinghorn et al 2006 in KCB 2012). Fish ingestion was evaluated as part of the Country Foods Assessment using incremental contribution values for mercury and lead.

The baseline report confirmed that the City of Dryden, First Nations, Construction workers, and Recreational users commonly hunt wild game within the Wildlife Management Unit area that the Project is located (GCK Consulting 2014). The quantities and frequency of consumption was not identified in the baseline reports. The average harvest has been provided from the Ontario Ministry of Natural Resources (Tables F and G).

Table F. Estimates for Estimated Resident White-tailed Deer Hunting Activity and Harvest in Wildlife Management Unit 8 (2008-2012) (MNR 2013)

YEAR	ESTIMATES FOR RESIDENT HUNTERS			
	Estimated # Active Hunters	Estimated Antlered Harvest	Estimated Antlerless Harvest	Estimated Total Harvest
2008	1394	571	635	1206
2009	1352	601	453	1055
2010	1394	624	592	1216
2011	1475	543	605	1148
2012	1552	608	696	1304

Table G. Estimated Resident Moose Hunting Activity and Harvest in Wildlife Management Unit 8 (2006-2012) (MNR 2013)

YEAR	ESTIMATES FOR RESIDENT HUNTERS				
	Estimated # Active Hunters	Estimated Bull Harvest	Estimated Cow Harvest	Estimated Calf Harvest	Estimated Total Harvest
2006	1398	123	51	44	218
2007	1485	97	37	32	166
2008	1184	98	38	30	166
2009	1261	63	25	22	110
2010	1145	62	24	37	123
2011	975	53	44	10	106
2012	809	48	26	15	89

The information presented above shows that consumption of wild game is an applicable exposure pathway for humans living within the area potentially impacted by the Project. This pathway was assessed as part of the Country Foods Assessment of the SLRA.

The Country Foods Assessment used the ingestion rates and exposure frequencies for all country foods of FN residents as presented in the Health Canada model (HC 2011). This should provide an upper-bound estimate of intake for all Country Foods for all residents.

4.2.4.3 Groundwater Ingestion

A total of 77 water wells fall within the zone of impact (ZOI) as defined by the 1 m drawdown contour (AMEC 2014a). The Ontario Ministry of Environment (OMOE) water well map also confirms the presence of two wells within 1 km of the Site (Appendix B). Groundwater was identified as a potential pathway in the SLRA because there are groundwater wells within 1 km of the Project site. However, this pathway was not carried forward as groundwater is not likely to be impacted by effluent during the Operational Phase on the mine, no COCs during the Operational Phase exceeded the guidelines, and groundwater impacts in the Post-Closure Phase are expected to be negligible as the bedrock in which the Pit Lake will be located has a very low hydraulic conductivity (AMEC 2014a).

4.2.4.4 Surface Water Ingestion

Mine effluent water will be pumped to a selected location in Blackwater Creek via a pipeline. Blackwater Creek connects to Wabigoon Lake, which is the City of Dryden's drinking water source.

This pathway was not carried forward as no COCs during the Operational Phase exceeded the guidelines (Table 4) or in Post-Closure (Table 5).

4.2.4.5 Surface Water Dermal Contact

Areas of natural surface water are present in the area of the Project, and therefore humans would come into dermal contact with water during recreational activities.

This pathway was not carried forward as no COCs during Operational Phase (see Table 4) or the Post-Closure Phase (Table 5) exceeded the guideline.

4.2.4.6 Vapour Inhalation

Volatile COCs in soil and groundwater can volatilize into the indoor or outdoor air breathing space. As there are no residential buildings within 30 m of the Project site, as per CCME guidance (CCME 2008) the soil to indoor air pathway can be considered to be incomplete. CCME (2012) recommends that the contributions from air be excluded if the COC is not volatile. Heavy metal COCs retained in the SLRA, such as lead, are not known to be volatile (CCME 2012).

Due to the distance of the Village of Wabigoon (4 km) and the City of Dryden (20 km) from the Project site, the fact that there will be no residences on the Project site and the non-volatile nature of the selected COCs both indoor and outdoor vapour inhalation were not considered an operable pathway for the Project.

4.2.5 Conceptual Site Model

A summary of the human health problem formulation for Residential Land Use during the mine's Operational Phase is provided in a CSM as Figure 3, and a summary of the human health problem formulation for Residential Land Use during the mine's Post-Closure Phase is provided in a CSM as Figure 4. The visual representation includes details of contaminant sources, contaminant transport mechanisms, secondary sources (i.e., uptake through the food chain), COCs, human receptors of concern, and potentially complete exposure pathways for Residential Land Use.

The exposure pathways from contaminant source to receptor that could be complete are displayed on Figures 3 and 4 by red type. The exposure route is displayed by arrows, indicating the pathway for uptake of impacted media by a receptor. In Figure 3, the potentially complete pathways to humans are dust inhalation, dermal contact with soil or soil ingestion; food ingestion; and dermal contact with or ingestion of surface water. Runoff from waste rock or tailings may enter the surface water after secondary treatment, which is the most likely contact point for humans. However, animals may be exposed directly to impacted surface water or to waste rock and tailings.

As shown in Figure 4, many exposure pathways are no longer potentially complete during the Post-Closure Phase because the waste rock will be submerged or encapsulated, and tailings will be encapsulated. Again, wildlife may be directly exposed to Pit Lake water, but humans are more likely to ingest effluent that is passively discharged to

Blackwater Creek from the Pit Lake and that subsequently flows to Wabigoon Lake (a drinking water source for the City of Dryden). Groundwater pathways are considered incomplete as hydraulic conductivity of the Pit Lake bedrock, the encapsulated TSF and the encapsulated above grade waste rock is very low. For completeness, an assessment of Country Foods was conducted for the Post-Closure scenario, assuming that plants could grow on the tailings and waste rock with no decrease in concentrations due to the cover (a conservative assumption).

4.3 Exposure Assessment

The exposure assessment includes an estimation of the amount of exposure to each of the COCs that humans would get from the Project site for each of the exposure pathways. The amount of exposure depends upon the concentrations of COCs in various media (e.g., concentrations in surface water and dust), the amount of time or number of events that a person is in contact with these media, and the rate at which humans ingest drinking water. The concentrations and the ingestion values used in the risk assessment are presented below in Section 4.3.1.

4.3.1 Exposure Point Concentrations

The concentrations of human health COCs in soil and dust are referred to as exposure point concentrations (EPC), as humans are directly exposed to them via ingestion, inhalation or dermal contact. Concentrations of COCs in the exposure media were estimated or modeled for dust and waste rock concentrations were used for soil concentrations. A table of the selected COC concentrations used in each exposure medium is in Table H below.

Table H: Summary of Selected Human Health COC Concentrations

Media	Mercury	Lead
Waste Rock (maximum concentration) – Table 1	0.62 mg/kg	2362.85 mg/kg
Dust – Table 3	-	0.166 ug/m3
Post-Closure tailings/waste rock concentration	0.62 mg/kg	870 mg/kg
Blackwater Creek Concentration (wild game drinking water) [1]	0.02 ug/L	3.37 ug/L

[1]Total concentration in Blackwater Creek (background + operational discharge from RO plant, Table 4)

4.3.2 Exposure Intake Parameters

The Health Canada Detailed Quantitative Risk Assessment (DQRA) model (HC 2011) was used to calculate the risks to each class of receptors from the selected COCs. The default receptor characteristics (e.g., intake rates, exposure frequencies) and exposure parameters were applied in the DQRA model for each of the receptor types evaluated under the Residential and Recreational Land Use. These are presented in Tables I and J below.

Table I: Summary of Default Receptor Characteristics Used in the DQRA Model

Receptor	Infant	Toddler	Child	Teen	Adult
Age	0 - 6 mo.	7 mo. - 4 y	5 - 11 y	12 - 19 y	>= 20 y
Lifestage Length (y)	0.5	4.5	7	8	60
Body weight (kg)	8.2	16.5	32.9	59.7	70.7
Soil ingestion rate (g/d)	0.02	0.08	0.02	0.02	0.02
Inhalation rate (m3/d)	2.2	8.3	14.5	15.6	16.6
Water ingestion rate (L/d)	0.3	0.6	0.8	1	1.5

Receptor	Infant	Toddler	Child	Teen	Adult
Time spent outdoors (h/d)	1.5	1.5	1.5	1.5	1.5
Time spent outdoors (h/d) – applied	1.5	1.5	1.5	1.5	1.5
Skin surface area (cm2)					
- hands	320	430	590	800	890
- arms	550	890	1480	2230	2500
- legs	910	1690	3070	4970	5720
- total	3620	6130	10140	15470	17640
Soil loading to exposed skin (g/cm2/event)					
- hands	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
- surfaces other than hands	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Soil monolayer loading rate (mg/cm2)	5	5	5	5	5
Water adherence to skin (L/cm2)	7.00E-06	7.00E-06	7.00E-06	7.00E-06	7.00E-06

Table J: Summary of Default Exposure Parameters Used in the DQRA Model

Scenario	Residential	Urban Recreational	Country Foods Ingestion
Hours per day at site	24	2	
Hours per day outdoors	-	2	
Days per week	7	2	
Weeks per year	52	35	
Dermal exposure events per day	1	1	
Water contact events per day	1	1	
Duration of water contact per event (hr)	0.5	0.5	
Exposure Duration (years)	80	80	
Years for carcinogen amortization	80	80	
Ingestion of Root Vegetables (g/day)			105
Ingestion of Other Vegetables (g/day)			67
Ingestion of Wild Game (g/day)			85
Ingestion of Fish (g/day)			95

4.3.3 Exposure Scenarios

The exposure scenarios were selected for the Project and applied recommended land use defaults from the DQRA HC model (HC 2011). Operational Phase values were evaluated for each scenario below.

Scenario 1: Resident/First Nation – Exposed to dust.

Scenario 2: Recreational User – Exposed to dust.

Scenario 3: Country Foods Ingestion – Ingestion of wild game, plants and fish.

The Country Foods Assessment is further described in Section 4.5.3.

4.4 Toxicity Assessment

The toxicity assessment involves identification of the potentially toxic effects of the COCs and the determination of the amount of the COCs that can be taken into the body without experiencing adverse health effects. This value is called a Toxicity Reference Value (TRV). For chemicals that do not cause cancer, there is a threshold exposure level below which no observable adverse health effects occur. Above the threshold, adverse health effects may occur, and can increase in severity with increasing exposure to the substance. For chemicals that can cause cancer (carcinogens), a non-threshold TRV is considered applicable. Even at low doses, there is some risk of genetic damage. The following section evaluates the carcinogenicity of the selected COCs and summarizes the TRVs that were used in the risk assessment.

4.4.1 Evaluation of COCs Carcinogenicity

Health Canada, the USEPA, and the International Agency for Research on Cancer (IARC) categorize chemicals as to their carcinogenicity. For each parameter, the regulatory agencies evaluate evidence from human and animal studies, and classify the data in terms of whether the information is adequate to suggest that a chemical is a carcinogen or not. The classifications typically consider whether information is sufficient to classify a substance as a carcinogen, or if there is limited, inadequate, or no data, or if there is evidence of non-carcinogenicity. As new research becomes available, the USEPA, IARC, and Health Canada then adjust their provisional classification based on the results of new studies or other supporting evidence of carcinogenicity. The USEPA, IARC, and Health Canada classification systems based on a weight of evidence are shown in the below table.

Table K: Weight of Evidence Classification System for Carcinogenicity

Health Canada	IARC	USEPA	Description
I	1	A	Human carcinogen
II	2A	B B1 B2	Probable human carcinogen Limited human evidence available Inadequate human evidence; sufficient animal evidence
III	2B	C	Possible human carcinogen
IV	3	D	Not classifiable as to human carcinogenicity
V	4	E	Evidence of non-carcinogenicity for humans

Under this paradigm, it is assumed that if a chemical is known or suspected to be a carcinogen in humans or laboratory animals (Health Canada Group I or II), the chemical has the potential to cause cancer at any level of exposure. This is referred to as a non-threshold effect. For chemicals with non-carcinogenic effects (Health Canada Group III, IV, and V), there is a threshold below which no adverse impacts are expected. The below table summarizes the weight-of-evidence carcinogenic classifications for the selected COCs.

Table L: Weight of Evidence Carcinogenic Classification for Site COCs

COCs	Health Canada	IARC	USEPA
Mercury	IV	Group 3	C
Lead	IIIB	Group 2A	B2

Based on the above, mercury and lead will be assessed as a non-carcinogen.

4.4.2 Toxicity Benchmarks

A reference value for a chemical with non-carcinogenic effects is called a "Tolerable Daily Intake" (TDI) and represents an acceptable daily dose of that chemical; this dose is expressed in units of µg/kg-day. The TRV for a volatile COC with non-carcinogenic effects is called a "Tolerable Concentration" (TC) and is expressed in units of mg/m3. Default TRVs were used from the DQRA model for mercury and lead (HC 2011). The TRVs selected for this SLRA are outlined in the table below.

Table M: Human Health COC and Key Toxicological Effects

Selected COC	TRV Toddler (ug/kg bw/day)	TRV Adult (ug/kg bw/day)	Critical Effect	Reference
Mercury	0.0003	0.0003	The central nervous system is probably the most sensitive target for elemental mercury vapour exposure (ICPS Inchem 2003). Mercury is lipophilic and is therefore will bioaccumulate and biomagnify within a food chain.	HC 2011
Lead	0.0036	0.0036	Behavioural and learning disabilities in children (Health Canada 2012). Systolic blood pressure increases in adults (Health Canada 2012).	HC 2011

4.5 Risk Characterization

In risk characterization, the ratio of estimated exposure and toxicity reference values for both carcinogenic and non-carcinogenic chemicals provides estimates of risks. The following sections describe methods to calculate only non-carcinogenic risk estimates, as no carcinogenic parameters were included in the selected COCs.

4.5.1 Non-Carcinogenic Risk Characterization

Risk estimates for non-carcinogenic COCs are defined as hazard quotients. Hazard quotients (HQ) are calculated based on a ratio of the estimated exposure and the TRVs (Tolerable Daily Intake (TDI) or Tolerable Concentration (TC)) according to the following equation:

$$\text{Hazard Quotient (HQ)} = \frac{\text{Estimated Daily Dose (mg/kg-day or mg/m}^3\text{)}}{\text{Tolerable Daily Intake (TDI)(mg/kg-day) or Tolerable Concentration (TC)(mg/m}^3\text{)}}$$

Hazard quotients were then compared to threshold risk levels, below which a substance is considered to pose a negligible risk to human health. The risk target HQ of 0.2 for threshold contaminants was applied as recommended in the Health Canada PQRA Guidance (HC 2012).

4.5.2 Risk Assessment Scenarios

The Health Canada spreadsheet tool for Human Health Detailed Quantitative Risk Assessment (DQRA) (Version: December 2011) was used to model for the Human Health component of this report. All evaluated pathways were modelled together to determine the overall risks. Appendix C contains risk assessment model input and output. As discussed in Section 4.3.3, two scenarios, for the Operational Phase, were selected for the Project site and are included in Appendix C; no COCs were selected for the Post-Closure Phase exposure pathways. The details of each scenario used in SLRA are presented in the Table N below.

Table N: Information Included for Human Exposure Scenarios Used in the SLRA

Scenario	Receptor	Exposure Sources
1	City of Dryden Resident, and First Nation Resident	Dust exposure from Table 3 attached, and maximum waste rock from Table 1 attached.
2	Recreational User	Dust exposure from Table 3 attached, and maximum waste rock from Table 1 attached.
3	Country Foods Ingestion by First Nation Resident	Waste Rock and Tailings Exposure, Incremental Water Concentrations

4.5.3 Country Foods Assessment

A Country Foods Assessment was conducted for the proposed mine site to assess potential human exposure through harvested foods from the site or fish harvested from Wabigoon Lake. As the project is not active, all estimates are based on predicted, modeled concentrations as directed by guidance (HC 2010) to provide a conservative estimate of risk. Guidance and reference documents used in the assessment of country foods included:

- Federal Contaminated Site Risk Assessment in Canada (FCSAP): Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{foods}$), Health Canada, 2010.
- Ontario Ministry of Natural Resources and Forestry, 2014. Moose Resource Report, Wildlife Management Unit 8.
- Baes, CF, RD Sharp, AL Sjoreen, RW Shor. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. September. ORNL-5786.

It was assumed that ingestion of foods by First Nations would provide an upper-bound estimate of all ingestion of foods harvested within the project area. As the proposed project area will not be used agriculturally or residentially, no assessment of homegrown foods was included. Foods assessed were wild game, harvested plants or berries, and fish. Based on local information as presented in Appendix EE, the following food items were the focus of this assessment:

- Berries and plants (such as blueberries);
- Wild game (moose, deer, hare, grouse); and
- Fish (walleye from Wabigoon Lake, minnows and dace from Blackwater Creek).

The total area of the tailings and waste rock footprints relative to the potential areas in which harvesting would occur were taken in to account. The tailings and waste rock pile have an estimated total footprint of 125 ha. The wildlife management unit in which the proposed project is located totals 539400 ha (Wildlife Management Unit 8) (OMNRF 2014). The potential blueberry habitat in the area (used as a proxy for all harvested plants) is 6341.2 ha (as described in Appendix EE). The fish used for evaluation in this assessment were walleye from Wabigoon Lake, as they are the highest trophic level fish for which tissue samples were available (DST 2014). Other fish of interest in Wabigoon Lake could be perch, pike and sauger. Tissue concentrations for lead from fathead minnows and dace from Blackwater Creek (KCB 2012) were used as well, as no tissue samples for lead were available for fish in Wabigoon Lake.

The analysis of wind-dispersed dust indicated that no substantial concentrations of any analyte would be dispersed beyond the fenceline during operations and no dispersion is expected post-closure, Therefore, the impacts of wind-dispersed particulates was not included in the evaluation of country foods.

Soil concentrations for lead and mercury were 870 mg/kg for lead and 0.62 mg/kg for mercury; both values were those of the tailings pile (Table H). These are higher than the average concentrations of the waste rock pile and are therefore conservative estimates of long-term exposure. Additionally, the tailings pile and waste rock pile will be covered at closure, further decreasing the exposure of wildlife or plants to the concentrations of lead and mercury used here. During operations, no gathering activities would occur and foraging by animals would be minimal due to human activity at the project and fencing of the area. Therefore, this is a conservative approach to estimating tissue concentrations in terrestrial plants and animals.

Concentrations of lead and mercury in wild game are based on the ecological assessment results in Section 5, and detailed in Appendix D of the SLRA. Concentrations in fish tissue were calculated based on the incremental contribution of mine effluent and pit lake effluent (post-closure). The values used are predictive rather than measured, as the Mine is in the planning stages and no applicable tissue samples are available to gauge impacts of the mine processes on the surrounding flora and fauna. For that reason, the predicted concentration of mercury and lead in soil or water (adjusted for foraging range and habitat quality) were used to estimate the concentration of each analyte to which a human could be exposed through the harvesting of game. For the harvesting of plants from the tailings area, a spatial adjustment was used to account for the portion of plants that could be harvested from the mine-impacted area relative to all harvesting area.

All estimates of concentrations of lead and mercury in harvested foods are described below.

4.5.4 Wild Game Tissue Concentrations

To assess uptake of lead and mercury to humans through harvesting of wild game, total exposure of moose, deer, grouse, and hare were used. The exposures to the terrestrial mammals were based on estimates of soil ingestion, plant ingestion, and water ingestion for the animal as calculated for the ecological SLRA, and shown below in Table B. The modified wildlife dietary exposure model by Sample and Suter (1994) and is detailed in Appendix D of the SLRA.

Table O. Wild Game COPC Intakes

Game	COPC	Total intake by Game: Operational (mg/day)	Tissue Concentration (mg/kg)	Total intake – Post Closure (mg/day)	Tissue Concentration (mg/kg)
Snowshoe Hare	Lead	2.83	8.50E-04	2.54E-04	7.61E-08
	Mercury	0.014	1.06E-04	2.71E-07	2.09E-09
White-Tailed Deer	Lead	34.8	1.04E-02	1.52E-04	4.56E-08
	Mercury	0.36	2.73E-03	1.63E-07	1.25E-09
Moose	Lead	NA	NA	1.27E-04	3.80E-08
	Mercury	NA	NA	1.36E-07	1.04E-09
Ruffed Grouse	Lead	1.20	3.59E-04	1.93E-04	5.79E-08
	Mercury	0.0070	5.35E-05	2.06E-07	1.59E-09

The estimated total exposure per day for moose, deer, rabbit, and grouse are listed in Table O. The estimated daily intake of each animal was adjusted for the biotransfer factor (USEPA 1999) to estimate a tissue concentration for consumption is also presented in Table B. The biotransfer factor for mercury is 7.7E-03 d/kg ingested food (USEPA 1999) and is 3.0E-04 d/kg-ingested food for lead (USEPA 1999) based on beef transfer of analyte from food to tissue. Therefore, the equation to estimate tissue concentration available for human ingestion was:

C tissue (mg/kg) = Intake (mg/day) x BTF (day/kg)

To estimate the total amount of each analyte for all wild game ingested (as the risk assessment equation uses one value for total amount of wild game ingested per day), the tissue concentrations were summed to provide a maximum concentration for human exposure. This conservative approach provides the highest estimate of tissue concentration, as it assumes that all tissue concentrations are additive (i.e. greater than any one game species). The summed values are shown below in Table P. Note that moose are not expected to graze on the tailings or waste rock during operations due to fencing and human activity that would deter moose from the area, and were excluded from the operational phase wild game tissue concentration. The summed tissue values were further assumed to represent all game that could be harvested, when in fact the size of the tailings and waste rock footprint (125 ha, the area in which the mammals could be exposed to the analytes) relative to the wild life management area (WMU 8, the area for which hunting activities would occur annually, is 539,000 ha) is very small (OMNRF 2014a). The WMU 5, adjacent to the project site, is even larger at 1,076,300 ha (OMNRF 2014b). There is only a small likelihood that the animal harvested would have grazed only in the footprint of the tailings and waste rock pile, when the size of the wildlife management unit from which all game are harvested is as large as 539,000 ha to 1,076,300 ha.

These concentrations were used to assess human consumption of wild game for both the operational period and post-closure phase, although the likelihood of deer foraging on the tailings or waste rock during operations is remote. The likelihood of moose being present during operations was considered too remote to include them in the operational phase analysis. Further, the cover material to be placed on the tailings and waste rock post-closure will also limit wild game exposure to the mine materials.

All wild game tissue concentration calculations are shown in Table 7.

Table P. Estimated Human Exposure Concentration from Wild Game

Game Species	Operational (mg/kg)		Post-Closure (mg/kg)	
	Mercury	**Lead**	**Mercury**	**Lead**
Moose	NA[(1)]	NA[(1)]	1.04E-09	3.80E-08
Deer	2.73E-03	1.04E-02	1.25E-09	4.56E-08
Hare	1.06E-04	8.50E-04	2.09E-09	7.61E-08
Grouse	5.35E-05	3.59E-04	1.59E-09	5.79E-08
Total	2.89E-03	1.16E-02	5.98E-09	2.18E-07

(1) Moose are not expected to be present during operations due to fencing and human activity.

4.5.5 Plants

In order to estimate plant tissue concentrations, the following transfer factors were used to estimate uptake of lead and mercury from soil to a plant. This assessment assumes that the plant is grown on the tailings or waste rock pile directly, at the tailings concentrations noted in Table H.

Chemical-specific transfer factors for plants are listed in Table Q. These value were used with the waste rock and tailings concentrations for lead and mercury. This analysis is targeted to the post-closure scenario, as no gathering activities are expected to occur during the operational period of the mine. For conservatism, the tailings concentrations were used as representative of soil concentrations for the post-closure period, as they represent an upper-bound concentration. This analysis does not assume any decrease in concentration due to the planned cap, which will reduce exposure concentrations. Both vegetative and root/berry concentrations were calculated and used to estimate human intake.

Table Q. Soil to Plant Transfer Factors

Analyte	Soil to Plant (mg COPC in dry tissue per mg/kg soil) vegetative	Soil to Plant (mg COPC in dry tissue per mg/kg soil) root or berries	Reference
Lead	0.0049	0.0015 [2]	Sheppard 2009
Mercury	0.1	0.03	USEPA 1999
Dry-to-Wet Weight Conversion Factor [1]	0.126	0.222	Baes et al 1984

1 Risk calculation from HC requires intake concentration in wet weight.
2 Average of Fruit and Root transfer factors from Sheppard 2009.

The HC DQRA spreadsheet requires that the concentrations in food products be estimated based on the wet weight of the food item. Therefore, these values were adjusted for dry-to-wet weight concentrations using a factor of 0.126 for vegetables (above ground) and 0.222 for root vegetables (Baes et al 1984). The transfer factors for lead are from Sheppard 2009, which did not contain recommended values for mercury. Therefore the mercury transfer factors are from USEPA 1999. The mercury transfer factor for roots and berries is the higher of those presented in USEPA 1999 for root or fruit transfer from soil to plant.

To estimate an exposure concentration, the following equation was used:

$$C_{plant} = C_{soil} \times TF \times DTW$$

Where

C_{plant} = Concentration in plant tissue (mg/kg)

C_{soil} = Concentration in soil (mg/kg)

TF = Transfer factor (vegetative or root)

DTW = Dry-to-wet weight conversion

The plant concentration was then spatially adjusted for the size of the tailings and waste rock footprint (125 ha) relative to the potential gathering areas in the region (the size of blueberry habitat of 6341 ha). This adjustment accounts for the relative portion of the harvested plants that could be gathered from the proposed mine site as compared to the areas that are known to be potential harvest areas (Appendix EE). Results are shown below in Table R.

Table R. Exposure concentration for plant intake by humans

Analyte	Concentration in Soil (mg/kg)	Concentration in Plant (mg/kg dry weight)		Human Dietary Intake (mg/kg wet weight of plant)	
		Vegetative	Root/Berry	Vegetative	Root/Berry
Lead	870	39.15	9.83	0.0106	0.0057
Mercury	0.62	0.06	0.02	0.000154	0.0000814

These concentrations represent post-closure exposure only, as during operations, site access will be controlled and no gathering activities could take place. They are conservative post closure concentrations, as the tailings and waste rock will be covered and plants should not be impacted by these materials. All calculations related to estimating tissue concentration in plants are contained in Table 8.

4.5.6 Fish

For the assessment of exposure from fish, the additional potential impact to Wabigoon Lake waters, and therefore the potential incremental increase in fish tissue concentrations, were evaluated using the estimated outflow from the project and the existing measured concentrations in Wabigoon Lake. Water concentrations for lead and mercury have been estimated during operations (output from RO plant) or after closure (passive outflow from pit lake). For Hg, the concentration in the RO plant output was 0.003 µg/L, with an outflow of 535,455 m^3/year; for the post-closure phase, the Hg concentration was 0.0056 µg/L with a passive discharge from the pit lake of 362,534 m^3/yr. For lead, the operational concentration in RO plant outflow was 0.17 µg/L; in the post closure phase, it was 0.53 µg/L. These values were used to assess incremental exposures in water concentrations, with a corresponding increase in fish tissue that could be consumed by humans.

Based the operational estimate of RO plant effluent concentration and discharge rate, and the estimated pit lake concentration and passive outflow discharge rate, the estimated the amount of discharge relative to background conditions was calculated as shown in Table S. The water concentrations of Wabigoon Lake and Wabigoon Lake outflow are from DST 2014b. Incremental Increases in concentration were calculated as:

> Incremental Contribution = (Discharge concentration x Discharge flow rate) / (Wabigoon concentration x Wabigoon Flow rate).

Table S. Incremental Lead and Mercury Contribution

	Wabigoon Lake (outflow rate = 466,795,008 m^3/year)	Operational Phase (RO plant discharge rate = 535,455 m^3/year)		Post-closure Phase (Passive pit lake discharge rate = 362,534 m^3/year)	
Analyte	Concentration (µg/L)	Concentration (µg/L)	Contribution (%)	Concentration (µg/L)	Contribution (%)
Lead	0.95	0.17	0.021	0.53	0.04
Mercury	0.028	0.003	0.012	0.00056	0.0016

By comparison, the contribution of background concentrations in Blackwater Creek (0.02 µg/L for Mercury and 3.76 µg/L for lead) to Wabigoon Lake are 2.74% for lead and 0.49% for mercury, based on creek flow of 3,234,573 m3/year.

It was assumed that the increase in concentration would directly correlate to an increase in tissue concentration of mercury and lead (100% uptake and retention in tissue by fish). The baseline fish tissue concentrations as reported for Trophic level 4 fish in Wabigoon Lake as measured in the baseline study (DST 2014b for walleye) were used to assess the incremental tissue concentration for mercury. For lead, tissue samples from Wabigoon were not available; tissue samples of fish from Blackwater Creek were therefore used for this analysis (KCB 2012). The fish sampled from Blackwater Creek included fathead minnows, white sucker, finescale dace, and northern pearl dace These fish are a lower trophic level than walleye and pike and are generally smaller, which may result in an underestimate of lead concentration in tissue of fish from Wabigoon. However, it is a reasonable approximation of potential impacts.

The tissue increase was calculated as:

Incremental concentration (mg/kg) = Current tissue concentration (mg/kg) x Contribution (%).

The incremental tissue concentrations were then input to the HC DQRA spreadsheet for analysis of the hazards to humans associated with this incremental tissue concentration in fish. All calculations related to fish tissue concentrations are contained in Table 9.

Table T. Incremental Tissue Concentration

Analyte	Measured Current Tissue Concentration (mg/kg)[1]		Operational Phase Incremental	Post-Closure Phase Incremental
	Wabigoon (walleye) Tissue concentration (mg/kg)	BWC fish Tissue concentration (mg/kg)	Tissue Concentration (mg/kg)	Tissue Concentration (mg/kg)
Lead	NA	0.036	7.4E-6	1.6E-5
Mercury	0.3251	NA	4.1E-5	5.3E-6

[1] the 90th percentile measured tissue concentration

4.5.7 Hazard Assessment

The HC model (2011) presents one total hazard quotient for each chemical assessed. Table U, below, presents the additional hazards associated with country foods ingestion from all pathways.

Table U. Hazard Quotients for Country Foods Assessment

	Wild Game (mg/kg)	Plant (vegetative) (mg/kg)	Plant (root/berry) (mg/kg)	Fish (mg/kg)	HQ
Operational					
Lead	1.16E-02	NA	NA	7.4E-06	1.66E-02
Mercury (1)	2.89E-03	NA	NA	4.1E-05	5.04E-02
Total					**6.70E-02**
Post-Closure					
Lead	2.18E-07	1.06E-02	5.71E-03	1.6E-05	4.19E-02
Mercury (1)	5.98E-09	1.54E-04	8.14E-05	5.3E-06	7.25E-03
Total					**2.69E-02**

(1) Even if all mercury in fish is evaluated as methylmercury, the HQ does not change. Estimated HQ for methylmercury at these exposure concentrations is 1.18E-3 in the operational phase and 1.53E-3 in the post-closure phase.

Even with conservative exposure assumptions, the incremental amount of hazard does not exceed 0.2. The HQs associated with incremental mercury exposures (if mercury in fish is considered methyl mercury) is less than 0.04. The hazard is highest for lead in harvested plants; however, this again assumes that plants will grow on the tailings and waste rock at the highest concentration estimated for tailings. In reality, the tailings and waste rock piles will be covered and will be unlikely to be absorbed by plants, and the average concentrations in the footprint will be lower than that used here.

4.5.8 Risk Estimate Results

A summary of non-carcinogenic risk estimates calculated for exposure to the Project site is presented in Tables V and W below for the two scenarios detailed in Section 4.5.2 above. It is noted that the results presented in Tables V and W represent risk estimates inclusive of only evaluated pathways (e.g., dust inhalation, country foods ingestion) for each of the selected COCs and for the Operational Phase.

The complete model information and output is provided in Appendix C for all age groups. Only the results for the most critical age group are presented in Tables V (for mercury) and W (for lead) below. Table X presents the results for the most critical age group for the post-closure Country Foods Assessment for lead and mercury.

The risk estimate results for the Project Operational Phase are presented in Tables V and W below. Post-closure risks are presented in Table X.

Table V: Risk Estimate Summary for Mercury – Operational Phase

Exposure Pathway	**Highest HQ for Each Scenario**			**Age Groups Affected**
	Scenario 1	**Scenario 2**	**Scenario 3**	
Soil – Inhalation	4.94E-08	1.27E-08	--	None
Country Foods	--	--	5.04E-02	None
Total	**4.94E-08**	**1.27E-08**	**5.04E-02**	
Acceptable Risk Thresholds	**All Pathways = 0.2**			

Table W: Risk Estimate Summary for Lead – Operational Phase

Exposure Pathway	**Highest HQ for Each Scenario**			**Age Groups Affected**
	Scenario 1	**Scenario 2**	**Scenario 3**	
Soil – Inhalation	1.45E-03	3.72E-04	--	None
Country Foods	--	--	1.66E-02	None
Total	**1.45E-03**	**3.72E-04**	**1.66E-02**	
Acceptable Risk Thresholds	**All Pathways = 0.2**			

Mercury and lead risk estimates were below the risk threshold during the Operational Phase of the Project for all residents, and recreational users potentially exposed to mercury and lead in dust.

Table X: Risk Estimate Summary for Lead and Mercury in Country Foods - Post-Closure

Exposure	HQs for Each Analyte		Age Groups Affected
	Lead	Mercury	
Country Foods	4.19E-02	7.25E-03	None
Total	**4.19E-02**	**7.25E-03**	
Acceptable Risk Thresholds	**All Pathways = 0.2**		

Country foods ingestion in the post-closure phase were below the risk threshold.

4.6 Conclusions

Table Y below provides a summary by scenario of COCs exceeding the acceptable risk threshold for Village of Wabigoon and City of Dryden residents, First Nation residents, and recreational users. The human health SLRA found that under the predicted conditions and estimated concentrations of COCs for the Operational and Post-Closure Phases, there were no unacceptable risks to humans from exposure to mine-related dust or surface water effluent.

Table Y: Summary of Selected COCs Exceeding the Risk Threshold for Human Health

Scenario	Operational Impacts	Post-Closure
1/ Residents/ FN exposed to dust from Project site	None	Not a complete pathway
2/ Recreational users exposed to dust from Project site	None	Not a complete pathway
3/Country Foods Assessment	None	None

The results of the human health component of this SLRA indicate that risk estimates did not exceed the acceptable threshold during the Operational Phase of the Project, and there were no completed exposure pathways for waste rock or soil in the Post-Closure Phase. There were no COCs selected for surface water exposure pathways in either the Operational or Post-Closure Phases.

The drinking water source for residents of the City of Dryden is Wabigoon Lake which has historically elevated mercury levels (KCB 2012). A fish consumption advisory exists, although it is possible that sport fishing and subsistence fishing continues within Wabigoon Lake. While modelled data from the Operational and Post-Closure Phases of the mine indicate that effluent will not exceed background or standards for any metal and any incremental hazard associated with fish is minimal and below levels of concern, closure plans should pay particular interest to the release of these metals.

The overall level of confidence associated with the calculated risk estimates is moderate for lead and low for mercury. This level of confidence could be increased through the collection of site-specific resident and First Nation site-use that in turn would allow for the refinement of exposure parameters to generate the current risk estimates.

4.7 Recommendations

Further refinement of exposure parameters, site use, pit water transport in groundwater and effluent migration/dilution during the Post-Closure Phase is recommended. TML could address the exposure risk during Post-Closure Phase through the execution of a plume and dilution model study. A water plume study combined with an effluent discharge rate could provide a more accurate prediction of concentrations in surface water and groundwater over time. Fish tissue concentrations of lead for walleye and other upper trophic level fish in Wabigoon Lake would also help verify that the Country Foods Assessment of lead ingestion was sufficiently conservative.

If there are increases in the Operational or Post-Closure effluent discharge concentrations compared to those used in the SLRA then this could pose a risk to residents. Such potential risks will need to be addressed if the secondary treatment does not perform as is assumed here for the Operational Phase or if conditions arise that change the effluent concentration assumptions made for the Post-Closure Phase. It is recommended that COC releases are monitored to maintain a health-protective level.

5.0 ECOLOGICAL SCREENING LEVEL RISK ASSESSMENT

5.1 Introduction

A wildlife ecological SLRA was completed to determine if contamination at the Site may result in levels of risk exceeding regulatory benchmarks for wildlife receptors that may use the Site for habitat and/or foraging.

Mine-related COCs were identified and the COCs assessed in the SLRA were those exceeding the human health guidelines. The human health SLRA identified and assessed two COCs in dust – mercury and lead. Although plants, fish, and animals are identified during the initial phases of the SLRA, only animals being hunted or trapped by residents of the City of Dryden, First Nation Residents, Recreational Users, and Mine workers were quantitatively evaluated in the SLRA. The three key receptors assessed in the wildlife assessment were the Snowshoe Hare, White-tailed Deer, Moose, and Ruffed Grouse.

5.2 Wildlife Problem Formulation

The problem formulation defines the ecological exposure setting by identifying COCs, wildlife receptors of concern, and potentially complete exposure pathways between COCs in mine-related media and wildlife receptors of concern. It provides the necessary context and rationale for conducting the wildlife ecological assessment. The result of the problem formulation is a CSM, or pictorial presentation, of how wildlife might be exposed to COCs from the Project site for both the Operational and Post-Closure Phases.

The CSM is based on current and future Agricultural Land Use and is presented for the Operational Phase and Post-Closure Phase in Figures 3 and 4, respectively. Agricultural Land Use is the most stringent soil guideline because it assumes that crop and livestock production, as well as habitat for wildlife and native vegetation is present. Agricultural land use was applied because it is most similar to a wildland setting where plants will be abundant, and wildlife will be foraging on these plants within the Project area.

TETRA TECH

5.2.1 Contaminants of Concern Refinement

The COCs are presented in Tables 1 to 6, and are contained in the various TML baseline reports, or were provided to the Risk Assessment team by the EIS team. The maximum COC concentration was compared to the soil, dust, or surface water guidelines. If any COCs met the background or relevant guidelines they were not assessed in the SLRA. For the Operational Phase, waste rock, tailings, and effluent discharge to Blackwater Creek after treatment in the RO plant were the media evaluated. For the Post-Closure Phase, waste rock and tailings will not be accessible, so the medium of interest was Pit Lake water and its passive discharge to Blackwater Creek.

Soil, waste rock, and tailings COCs were identified if they exceeded either of the CCME or OMOE generic guidelines under Agricultural land use. Surface water COCs were identified if they exceeded the CCME, OMOE, or MMER guidelines specific to the protection of aquatic life and background concentrations. The COCs identified in the ecological risk assessment are presented in Table Z below.

Table Z: Contaminants of Concern Identified in the Wildlife Risk Assessment

Media	COCs
Waste rock	Aluminum, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc
Tailings	Arsenic, cadmium, copper, lead, mercury, zinc
Surface Water in Pit Lake – Operational	None
Surface Water in Pit Lake – Post-Closure	Lead and Mercury
Surface Water in Blackwater Creek – Operational	Lead and Mercury
Surface Water in Blackwater Creek –Post- Closure	None

The identified list of COCs was further refined as the focus of this SLRA was for human health, so therefore the COCs that were retained for the human health SLRA were also those retained for the wildlife SLRA. The COCs retained in the human SLRA were mercury and lead in waste rock and tailings and therefore these two COCs were also retained in the wildlife SLRA. For completeness of the assessment, mercury and lead were also assessed for surface water in Blackwater Creek for the Operational Phase and in the Pit Lake water for the Post-Closure Phase even though they did not exceed the aquatic life criteria. Note that there were no significant exceedances of aquatic life criteria in the Pit Lake after Closure, nor in discharges to Blackwater Creek from the Pit Lake after Closure (Table 4). Exposure to mercury and lead in Pit Lake water were assessed for the Post-Closure Phase; copper and cobalt in Pit Lake water in the Post-Closure Phase also slightly exceeded background (baseline concentrations from Blackwater Creek) but were not retained as COCs because neither exceeded background or aquatic life criteria after including dilution in Blackwater Creek, and copper was below the MMER value.

5.2.2 Identification of Terrestrial Plant and Wildlife Receptors of Concern

The ecological SLRA identifies the plants and animals present at the site so that receptors can be selected that are representative of the potentially complete exposure pathways and feeding guilds at the site. Although only key wildlife receptors were retained for assessment in this SLRA it is important to identify all potential plants and animals that are likely present, and potentially exposed to mine-related COCs at a site.

The identification of plant and wildlife receptors potentially using terrestrial habitats at the Project site and surrounding area was completed using the following criteria:

- If the plant or animal was present in the project area (or expected to occur based on the habitats present);
- Life history requirements; and
- Species of Conservation concern or cultural / economic importance.

The first step in the selection of plant and wildlife receptors was to compile lists of terrestrial species potentially present at the Site. To do so, the ecozone and ecoregion in which the Site is located were identified and terrestrial plant and wildlife species known to occur in this zone and region were inventoried. Following this step, a species-at-risk desktop inventory was conducted to identify any endangered, threatened, or special concern species likely to be present at the Site.

The Project is located within the largest ecozone in Ontario, the Ontario Shield Ecozone. This ecozone includes extensive wetlands and boreal forests. Within the ecozone, the Project is situated within the Lake Wabigoon Ecoregion (Ecoregion 4S), within the Lower English River Section of the Boreal Forest Region. This ecoregion is characterized by a range of forest types (mixed forest 25 percent, sparse forest 24 percent, and coniferous forest 14 percent) and open water (24 percent). Typical tree species include trembling Aspen (*Populus tremuloides*), Balsam Poplar (*Populus balsamifera*), Jack Pine (*Pinus banksiana*), Spruces (*Picea glauca, Picea marina*), White Birch (*Betula papyrifera*) and Willows (Salix spp.) (KCB 2012, DST 2014).

The Project site is located in a low density rural area, with some limited local agriculture focused on cattle, as well as logging activities in the area. Immediately adjacent areas show mainly second growth poplar-dominated forests and wetlands. The local study area land cover is 62 percent forest, 21 percent water, 9 percent developed land, 8 percent wetland, and less than 1 percent barren land.

To identify potential wildlife receptors on the Project site, wildlife information from the following sources was reviewed:

- The Ecological Framework of Canada information for Ecoregion 159 (Ecological Framework of Canada 2014);
- The Environment Canada Species at Risk Act (SARA); and
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011) and Ontario (SARO).

A summary of the plant and wildlife species identified as potentially being present in the general area of the Project during the literature review is provided in the baseline study reports. If plant and wildlife were confirmed present during the baseline studies, or expected to be present (due to habitat quality and niche size), or if they were listed by either COSEWIC or SARO or cultural / economic important then, they were considered relevant receptors for the SLRA. These receptors are listed in Table AA below:

Table AA: Relevant Plant and Wildlife Receptors Potentially Present Within the Project Site Area

Species	Basis for Inclusion
Plants	
Wild Rice (*Zizania palustris*)	cultural importance
Floating Marsh Marigold (*Caltha natans*)	only plant SARA detected during surveys
Mammals	
Little Brown Myotis (*Myotis lucifugus*)	COSEWIC , and SARO Listed
Northern Myotis (*Myotis septentrionalis)*	COSEWIC , and SARO Listed
Moose (*Alces alces*)	cultural / economic importance
Beaver (*Castor canadensis*)	cultural / economic importance
Snowshoe Hare (*Lepus americanus*)	cultural / economic importance
Red Fox (*Vulpes vulpes*)	cultural / economic importance
White-tailed Deer (*Odocoileus virginianus*)	cultural / economic importance
Amphibian/Reptiles	
Snapping Turtle (*Chelydra serpentina*)	SARA, COSEWIC , and SARO Listed
Northern Leopard Frog (*Rana pipiens*)	SARA Listed
Birds	
Bald Eagle (*Haliaeetus leucocephalus*)	COSEWIC , and SARO Listed
Peregrine Falcon (*Falco peregrinus*) –	SARA, COSEWIC , and SARO Listed
Black Tern (*Chlidonias niger*)	SARO Listed
Common Nighthawk (*Chordeiles minor*)	SARA, COSEWIC , and SARO Listed
Barn Swallow (*Hirundo rustica*)	COSEWIC Listed
Canada Warbler (*Cardellina canadensis*)	SARA, COSEWIC , and SARO Listed
Olive-sided Flycatcher (*Contopus cooperi*)	SARA, COSEWIC , and SARO Listed
American White Pelican (*Pelecanus erythrorhynchus*)	SARO Listed
Bobolink (*Dolichonyx oryzivorus*)	COSEWIC , and SARO Listed
Eastern Whip-poor-will (*Caprimulgus vociferous*)	SARA, COSEWIC , and SARO Listed
Golden Eagle (*Aquila chrysaetos*)	SARO Listed
Least Bittern (*Ixobrychus exilis*)	SARA, COSEWIC , and SARO Listed
Short-eared Owl (*Asio flammeus*)	SARA, COSEWIC , and SARO Listed
Yellow Rail (*Coturnicops noveboracensis*)	SARA, COSEWIC , and SARO Listed
Rusty Blackbird (Euphagus carolinus)	SARA, and SARO Listed
Ruffed Grouse (*Bonasa umbellus*)	cultural / economic importance

5.2.3 Identification of Aquatic Receptors of Concern

The identification of aquatic receptors of concern was completed using the following criteria:

- If the plant or animal was present in the Project area (or expected to occur);
- Life history requirements; and
- Species of Conservation concern or Cultural / economic importance.

The first step in the selection of aquatic receptors was to compile lists of aquatic species potentially present at the Site. To do so, the ecozone and ecoregion in which the Site is located were identified and aquatic plant and wildlife species known to occur in this zone and region were inventoried. Following this step, a species-at-risk desktop inventory was conducted to identify any endangered, threatened, or special concern species likely to be present at the Site.

The Project is located within the Lower English River Section of the Boreal Forest Region, of the Lake Wabigoon Ecoregion (Ecoregion 4S). It is also within the northern limits of the Ontario Ministry of Natural Resources and Forestry (MNRF) Fisheries Management Zone (FMZ) 5. Ranging from the Manitoba border east to Quetico Provincial Park and the United States border north to the Wabigoon River Watershed, the total area covers 44,360 km^2 (KCB 2012, DST 2014b).

Aquatic habitat surrounding the Project site is generally of low to moderate value (FPTWG 2011, KCB 2012, DST 2014b). Substrates of lakes and streams are primarily dominated by fines (silts and clays), spawning gravels required for some species (i.e., walleye, sucker, lake whitefish) are limited. The aquatic vegetation required for northern pike and muskellunge spawning is more abundant. In-stream cover is available mostly in the form of pools, woody debris and vegetation (overhanging, emergent and submergent). Thunder Lake and Wabigoon Lake support diverse fish populations that include large predatory fish such as walleye and northern pike; therefore these waterbodies must contain suitable spawning and rearing habitat. Assessed streams indicate that suitable habitat is present for small forage fish species (KCB 2012, DST 2014b).

To identify potential aquatic receptors on the Site, fisheries information from the following sources was reviewed:

- Ontario Ministry of Natural Resources Natural Heritage Information Centre;
- The Ecological Framework of Canada information for Ecoregion 159 (Ecological Framework of Canada 2014); and
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (COSEWIC 2011).

No records of endangered or listed fish were found within the regional study area and none were encountered during field surveys.

A summary of the aquatic species identified as potentially being present in the general area of the Project during the literature review is provided in the baseline reports. If an aquatic species was confirmed present during the baseline studies, or expected to be present (due to habitat quality and niche size), or if they were listed by either COSEWIC or SARO or Cultural / economic important then, they were considered relevant aquatic receptors for the SLRA. These receptors are listed in Table BB below:

Table BB: Aquatic Receptors Potentially Present Within the Project Site Area

Species	Rationale for Selection
Northern Pike (Esox lucius)	cultural / economic importance
Smallmouth Bass (Micropterus dolomieu)	cultural / economic importance
Walleye (Sander vitreus)	cultural / economic importance
Muskellunge (Esox masquinongy)	cultural / economic importance
Lake Whitefish (Coregonus clupeaformis)	cultural / economic importance
Lake Trout (Salvelinus namaycush)	cultural / economic importance
White Sucker (Catostomus commersoni)	cultural / economic importance

5.2.4 Receptors Evaluated in the Risk Assessment

While there are many species that could be present in the surrounding Project area, it is not practical to evaluate all species. For the purposes of the SLRA, the species selected for evaluation are those that are expected to forage and live in habitats surrounding the Project area and to be hunted/harvested for food by either the residents of Dryden, mine workers, or first nation residents. Representative receptors selected for the risk assessment are those that are of commercial or recreational value to residents of the Village of Wabigoon and the City of Dryden. The following criteria from Sample et al. (1997) and FCSAP (2012a) were used to select the receptors evaluated in the risk assessment:

- Year round residents at the Project site;
- Dominant within local biological communities, or functioning as keystone species within nearby ecosystems;
- General type and feeding niche;
- Of aesthetic value or of value to the local human population; or
- Of recreational importance.

Consideration was also given to the following factors when making receptor selections:

- Visual evidence of the species at the Site during the reconnaissance biological survey completed during the summer;
- Presence based upon habitat quality identified during the reconnaissance biological survey;
- Home range small enough to have a significant portion of foraging and exposure occur at the site; and
- Small body size (increases relative exposure per unit of body weight).

Based on the Project site information provided above, three key wildlife receptors were selected. The representative receptors selected for this SLRA as well as the trophic level represented and rationale for selection is presented in Table CC below.

Table CC: Wildlife Receptors Assessed in the SLRA

Wildlife Receptor	Rationale for Selection	Trophic Level
Snowshoe Hare	Hare have a small home range that would be fully contained to the Project site. There is sufficient habitat of moderate quality in the vicinity of the site. They are likely hunted by humans living in the area. They have a small body size which increases exposure. They are year round residents.	Primary Consumer – Herbivorous Mammal
White-tailed Deer	Deer have a home range size that would be partially contained to the Project site. There is sufficient habitat of moderate quality in the vicinity of the site. They are actively hunted by humans living in the area. They are year round residents.	Primary Consumer – Herbivorous Mammal
Moose	Moose have a home range size that would be partially contained to the Project site. There is sufficient habitat of moderate quality in the vicinity of the site. They are actively hunted by humans living in the area. They are year round residents.	Primary Consumer – Herbivorous Mammal

Wildlife Receptor	Rationale for Selection	Trophic Level
Ruffed Grouse	Grouse have a small home range that would be fully contained to the Project site. There is sufficient habitat of moderate quality in the vicinity of the site. They are likely hunted by humans living in the area. They have a small body size which increases exposure. They are year round residents.	Secondary Consumer – Omnivorous Bird

Wildlife with aquatic-based diets that would inhabit wetlands and creeks, such as Blackwater Creek, were not identified and carried into the SLRA. The scope of the current SLRA includes identification and screening level assessment of potential risk due to exposure from mine-related COCs for fish and other aquatic life (i.e., aquatic plants and invertebrates), but excludes wildlife with aquatic-based diets. The habitat quality for areas surrounding the Project site is moderate, and the area contains numerous creeks and tributaries draining into Blackwater Creek which based on the current Project plan will receive effluent discharge into their waters. These receptors are relevant and could use portions of the Project site as habitat and for foraging.

5.2.5 Exposure Pathway Identification and Screening

Exposure pathways are the means by which a receptor comes in contact with COCs. Ecological receptors may be exposed to mine-related COCs from the Project site through direct or indirect pathways. Direct pathways are those in which the receptor comes in contact with the COCs in environmental media such as soil, where the source of impacts occurs. Indirect exposure pathways are those in which the exposure results from a secondary source, such as food chain exposure via ingestion of vegetation, insects, mammals, etc. and drinking water. All relevant exposure pathways are presented below, and when COCs do not exceed the guidelines (or background), then the exposure pathway is not carried forward into the risk assessment.

5.2.5.1 Direct Contact with Waste Rock or Tailings

Plants, soil invertebrates, and animals that burrow or dig for food may come into direct contact with COCs present in waste rock or tailings. Direct contact with soil COCs is typically considered for surficial soil, as the majority of animal activity and plant fine root colonization is relevant to the upper 1.0 meter to 1.5 meters, as identified by CCME (2008). For waste rock and tailings this pathway is considered complete at the Project site during the Operational Phase but not the Post-Closure Phase of the Project. This is because during the Operational phase animals can roam freely in areas proposed for waste rock and tailings piles, since these areas will not be fenced off. All plants on the site were assumed to be exposed to waste rock and tailings, and their roots have the potential to take up COCs from either of these media. During the Closure Phase of the Project all waste rock and tailings will be covered and revegetated, or submerged beneath water. Therefore during the Closure and Post-Closure Phases this pathway is considered incomplete. This exposure pathway was carried forward into the SLRA using tailings concentrations for lead and waste rock concentrations for mercury (as tailings concentrations for mercury were not available) for the Operational Phase because this pathway is relevant, receptors are present, and COCs exceed the guidelines.

Terrestrial soil invertebrates are also exposed to COCs through direct contact with both waste rock and tailings. Typically waste rock is not considered bioaccessible/bioavailable for terrestrial wildlife. Habitat quality would be low in the vicinity of the waste rock, and would not likely be an attractant to wildlife given that other higher quality habitat is available in the area. The likelihood that COCs will be taken up from waste rock is extremely low considering that:

waste rock is large, angular, has a very small surface area to volume ratio, and soil will not have the opportunity to deposit onto waste rock to allow for plant growth because the waste rock pile will be continually growing during the operation on the Project site (for roads and to infill the pit). Even particles that break off of the waste rock are not likely to be very bioavailable given the large particle size. There will also be significant human disturbance and vehicular traffic during the Operational Phase that will deter wildlife from using the Project site and surrounding area.

COC uptake from tailings is more likely to occur than from waste rock, but even this exposure will be quite low considering the low habitat quality that tailings provide, and thus it is conservative to include this pathway in the assessment. Tailings will be milled on the Project site and therefore will have a high surface area to volume ratio, once processed in the TSF the tailings will be placed in the tailings ponds and on the shore to provide a beach area that could be used by plants, invertebrates and wildlife.

Although direct contact with soil contaminants via dermal exposure is possible for birds and mammals, it is considered a minor exposure pathway since feathers and fur effectively reduce dermal exposure by limiting COCs contact with skin (Sample et. al. 1996). Therefore, this pathway was not evaluated for wildlife in the SLRA.

5.2.5.2 Ingestion of Tailings

Birds and mammals often ingest soil either inadvertently or intentionally when ingesting vegetation or grooming. All birds and mammals were assumed to be exposed to tailings at the Project during the Operational Phase of the Project, but not during the Closure and Post-Closure Phases. Therefore this exposure pathway was carried forward into the SLRA because this pathway is relevant during the Operational Phase, birds and mammals are present, and COCs exceed the guidelines. During the Operational Phase tailings concentrations were used as soil concentrations. Tailings will be encapsulated at closure of the mine and will not constitute a completed exposure pathway for the Post-Closure Phase.

5.2.5.3 Ingestion of Plants, Soil Invertebrates, and Prey

Plants and soil invertebrates can take up COCs from tailings into their tissues, which are then subsequently consumed by wildlife. Small mammals that are exposed to tailings and food can also accumulate COCs into their body. All birds and mammals were assumed to have access to plants and soil invertebrates exposed to tailings during the Operational Phase of the Project, but not during the Closure and Post-Closure Phases. Therefore this exposure pathway was carried forward into the SLRA because this pathway is relevant during the Operational Phase, birds and mammals are present and could use the Project site to forage, and COCs exceed the guidelines.

5.2.5.4 Particle Inhalation

Exposure to COCs via particulate inhalation was considered a minor pathway relative to other exposure pathways such as soil contact and soil and food ingestion and therefore, was not evaluated in this assessment. This approach is considered reasonable because none of the retained COCs are volatile and a dust suppression program will be implemented during the Operational Phase of the Project that will significantly reduce the amount of dust generated from waste rock used for roads on the Site.

5.2.5.5 Water Exposure Pathways

There are a number of waterbodies that will receive mine effluent within a 5 km radius of the Project site. The main water body that will directly receive mine-effluent discharge is Blackwater Creek, which directly drains into Wabigoon Lake (Figures 1 and 2). Fish are confirmed present in both Blackwater Creek and Wabigoon Lake, birds and mammals would likely use Blackwater Creek for drinking water, and COCs exceed the CCME and Ontario protection of aquatic life guidelines. In addition during part of the Operational Phase and throughout the entire

Closure Phase of the Project a Pit Lake will be created on the Project site. This will be used to cover waste rock and will contain effluent and groundwater. Depending upon the habitat quality it could be used by waterfowl and wildlife for drinking water. During the Post-Closure Phase the Pit Lake may support small fish and other aquatic life.

Therefore, the surface water pathway was carried forward into the SLRA because this pathway is relevant during the Operational and Closure/Post-Closure Phases. The exposure pathway included in the SLRA is for wildlife exposed to surface water and drinking water. The scope of the current SLRA did not include assessing exposure pathways for aquatic receptors or wildlife with aquatic based diets, although these were complete and COCs are present that exceed the protection of aquatic life guidelines.

5.2.6 Conceptual Site Model

A summary of the contaminant transport mechanisms, potentially impacted media, wildlife ecological receptors of concern, COCs, and potentially complete exposure pathways is presented pictorially in a comprehensive CSM for the Operational and Post-Closure Phases of the Project (Figures 3 and 4). Only complete exposure pathways are identified and were evaluated further in the risk assessment.

5.3 Wildlife Exposure Assessment

The exposure assessment includes an estimation of the dose of each COC that wildlife receptors would receive from the Site for soil ingestion, and drinking water ingestion exposure pathways. The amount of exposure depends on the concentration of COCs in relevant media (e.g., concentrations predicted in soil) and is specific to the retained wildlife receptors.

5.3.1 Exposure Point Concentrations

Exposure to Hare, Deer, Moose and Grouse were determined by estimating the COC concentrations for each exposure pathway for all relevant sources, and calculating total exposure using a wildlife diet model. Data used in the SLRA as well as the wildlife diet model calculations are presented in Appendix D. The wildlife diet model is presented in Appendix D and is based on the diet model included in the USEPA's Wildlife Exposure Factors Handbook (1993). The rationale behind COC identification and selection is presented in Section 4.2.1 and the COCs are limited to: mercury and lead. One composite sample was available for tailings COCs, baseline surface water COC concentrations were averages, and Operational and Post-Closure Phase surface water concentrations were modelled based on COC concentrations obtained from the Preliminary Water Balance Model (Tetra Tech EBA 2014).

For the current SLRA only the worst case scenario COC concentrations were carried into the SLRA and used in the diet model to derive risk estimates for wildlife. Therefore the surface water COC concentrations used were those discharged in effluent from the RO plant and diluted in Blackwater Creek for the Operational Phase, and for the Post-Closure Phase the Pit Lake concentrations were used as the exposure point concentrations.

5.4 Wildlife Toxicity Assessment

The objective of the toxicity assessment is to define the acceptable dose (as mg COC per kg body weight of the receptor) that wildlife can be exposed to on a chronic basis without risk of adverse health effects. The wildlife assessment uses literature-derived TRVs measuring long-term chronic exposure. For example chronic reproductive exposures would include exposure for any duration greater than 1/3 of a species' gestation period, and chronic growth measures would include exposure for any duration greater than 1/10 of a plant or animal specie's lifespan. The USEPA's Eco SSL TRVs were used and are based on a comprehensive literature review that selected TRVs based on studies demonstrating no or low observable adverse effect levels (NOAELs and LOAELs). The USEPA typically selects a TRV based on the growth, reproduction, and survival endpoints that documented effects for those endpoints based on the highest NOAEL that is lower than the lowest LOAEL.

For wildlife, the goal is not to protect each individual from any potentially toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained (SAB 2006). Various online databases and print resources were used to gather a relevant and robust set of TRVs for mammals and birds and the results are presented in Tables D4 and D5 of Appendix D. These included:

- USEPA Ecological Soil Screening Levels (Eco SSL) and TRVs (various dates) – This was the first preferred resource used in the SLRA as these TRVs were derived using a large number of studies with strict evaluation criteria for mercury and lead TRVs for Hare, Deer, Moose and Grouse. The SLRA used the USEPA TRVs directly without modification; and
- Toxicological Benchmarks for Wildlife (Sample et al. 1996) – This was the second preferred resource used in the SLRA to derive mercury and lead TRVs for Hare, Deer, Moose and Grouse.

A summary of TRVs used in the SLRA is presented in Table DD below. Tables D4 and D5 of Appendix D contain additional information regarding the endpoints measured, rationale behind the TRV selection, and the reference from which the TRV was obtained.

Table DD: Summary of Toxicity Reference Values for Wildlife

Receptor	COC	TRV (mg/kg-day)
Mammal – Hare, Deer and Moose	Mercury	1.0
	Lead	4.7
Bird - Grouse	Mercury	0.900
	Lead	1.6

5.5 Wildlife Risk Characterization

Risk estimates for Hare, Deer, Moose and Grouse were quantified by calculating a hazard quotient (HQ). The methodology used to calculate HQ values and the results are presented below.

5.5.1 Hazard Quotient Assessment

The potential for wildlife hazards can be estimated numerically using a HQ. A HQ is the ratio of the potential exposure to a single chemical to an estimated Toxicity Reference Value (TRV), at which no or minimal adverse effects are likely to occur during the lifetime of that animal.

HQs were calculated for each COC-receptor combination as follows:

$$\text{Hazard Quotient} = \frac{\text{Estimated Exposure (mg/kg-day)}}{\text{Toxicity Reference Value (mg/kg-day)}}$$

If the HQ is less than or equal to 1.0, the COC is considered to pose a negligible hazard to wildlife. Hazard quotients in excess of 1.0 should be reviewed and consideration given towards the assumptions used to estimate exposure, and the uncertainty used to derive the TRVs.

HQ for Hare, Deer, Moose and Grouse were calculated using the concentrations presented in Table H of Section 4.3.1, or in Tables 1 to 6.

5.5.2 Wildlife Hazard Quotient Results

Table EE below presents the HQs calculated for Hare, Deer, Moose and Grouse exposed to mercury and lead in tailings and mine effluent discharged to surface water in Blackwater Creek. Refer to Appendix D for calculated results.

Table EE: Hazard Quotient Results for Wildlife

Wildlife Receptor	COC	HQ – Operational Phase	HQ- Closure/Post-Closure Phase
Snowshoe Hare	Mercury	0.01	<1
	Lead	0.5	<1
White-tailed Deer	Mercury	0.005	<1
	Lead	0.1	<1
Moose	Mercury	0.003	<1
	Lead	0.1	<1
Ruffed Grouse	Mercury	0.01	<1
	Lead	**1.2**	<1

HQ values greater than 1.0 are shown in bold font.

HQs for Hare, Deer and Moose were less than 1.0 for mercury and lead for the Operational Phase and Closure/Post-Closure Phase based on the maximum estimated concentration of these COCs in tailings and surface water.

HQs for Grouse were less than 1.0 for mercury based on the maximum estimated concentration of these COCs in tailings and surface water. The HQ for lead was greater than 1.0 for the Operational Phase, but less than 1.0 for the Closure/Post-Closure Phase. The elevated lead HQ (1.2) for Grouse is due to the ingestion of soil invertebrates assumed to be living in the tailings.

The lead risk estimate for Grouse is based on a lead concentration in the tailings using a limited dataset, and a maximum concentration. The risk estimate also assumes that Grouse would obtain half of their food from the plants and invertebrates living in the tailings at the Project site. If it is assumed that the Grouse obtain only one third of their food from the Project area then the HQ falls below 1.0. The Project site during the Operational phase will also have significant human disturbance and vehicular traffic that will deter wildlife such as Grouse from using the area. In addition there will likely be a significant amount of habitat that will be replaced by a very large waste rock pile, which will further deter wildlife from using the area. These factors combined support the conclusion that the lead exposure and risk are overestimated for Grouse.

5.6 Wildlife SLRA Conclusions

Based on the calculated HQs, estimated risks for wildlife were below risk thresholds for Hare, Deer and Moose exposed to mercury and lead for both the Operational and Closure/Post-Closure Phases. For Grouse, the HQ for mercury was below the risk threshold for the Operational Phase. Whereas the HQ for lead was just above the risk threshold (HQ = 1.2) for Grouse exposed to lead from the ingestion of tailings and food (plants, invertebrates) from the tailings during the Operational Phase. The HQ falls below the risk threshold when the assumption is made that Grouse obtain one third rather than one half of their food from plants and invertebrates living on the tailings. These HQ were derived using a very small set of COC concentrations in tailings, and modelled surface water concentrations.

In addition, forage fish are present within Blackwater Creek and habitat quality for fish within this system is moderate. Therefore fish would likely be exposed to the mine-related COCs proposed to be discharged in effluent. Depending upon the habitat quality, wildlife may use the waters in Pit Lake as drinking water. Risk estimates for fish and aquatic animals were evaluated for discharges to Blackwater Creek in the Operational and Post-Closure Phases, and to Pit Lake water in the Post-Closure Phase; results showed that there was little potential for risk to the aquatic receptors in these water bodies (wildlife with aquatic based diets were not assessed in the SLRA). However, as shown in Tables 1 (waste rock), 2 (tailings), and 4 (surface water) (attached at the end of this report), there is the potential for metals other than mercury and lead to have adverse impacts on wildlife. One way TML could address the exposure risk associated with these COCs is through the execution of a plume and dilution model study, and to model exposures to wildlife with aquatic based diets.

6.0 SLRA UNCERTAINTY ANALYSIS

The risk assessment process has inherent uncertainties associated with the calculations and assumptions used. When data were not available, assumptions used in the risk assessment erred on the side of conservatism to prevent underestimating risks. Thus, the potential risks presented in the risk assessment are likely to be higher than the actual risks experienced by a potentially exposed population. Uncertainty identified in the exposure assessment, toxicity assessment, and risk characterization steps of Sections 4.0 and 5.0 of the SLRA are presented below. The overall intent of the uncertainty analysis is to identify sources of uncertainty that contribute to the overall level of confidence that can be placed on the risk estimates, which aids the process of making decisions regarding the potential use of mitigation or remediation measures at a site.

In addition Section 2.7 provides a list of the assumptions applied in the SLRA. In some instances the assumptions were applied and defaults were used when site-specific information was unavailable. The application of default assumptions often reduces the uncertainty but may lead to an over-prediction of risk for receptors.

6.1 Exposure Assessment Uncertainties

6.1.1 Data Collection/Evaluation

- A low number of tailings samples were used to predict future tailings COC concentrations which contribute a high level of uncertainty in the COC concentrations used in the wildlife diet model. Only one composite tailings sample was provided and it is unknown whether this sample is representative of average or maximum COC concentrations.
- Mercury concentrations in tailings were not available to include in the SLRA. Therefore mercury concentrations in waste rock were used to represent mercury concentrations in tailings. There is a high level of uncertainty associated with this assumption, and the risk estimate for mercury may over or under represent the risk associated with wildlife exposed to tailings at the Project site.
- Mercury concentrations in dust were calculated from waste rock concentrations and were not calculated for air at the POI.
- No plant or soil invertebrate tissue samples were collected and therefore literature based regression-derived concentrations based on tailings concentrations were used for the SLRA. There is uncertainty associated with these although values derived using regression equations are intended to be conservative.
- Natural variability is an integral component of sustainable habitat features and is often difficult to quantify. A low degree of certainty exists for data representing natural variability (over space and time) at the Project site for mine-effluent being discharged to surface water, or infiltrating groundwater during both Operational and

Closure Phases of the Project. The uncertainty surrounding this dataset is further explained in the Preliminary Water Quality Model (Tetra Tech 2014).

- The socio-economic component of the Project would need to address issues of community concerns, which would need to include the additional discharge of metals to Wabigoon Lake which may also impact sport fishing and tourism, and which seem to be an important economic factor for the region.

6.1.2 Exposure Point Concentrations and Exposure Estimates

The main uncertainties associated with the exposure point concentrations and exposure estimates are:

- If site utilization by the identified receptors is not uniform (for example, receptors had access to only a small portion of the Site), it is possible that COC concentrations in these areas may be lower or higher than those used in this assessment, thereby resulting in lower or higher risk estimates.
- The use of regression equations to model tissue concentrations for plants and ground invertebrates is expected to be conservative and likely overestimates exposure concentrations. This is because regression models were derived through studies conducted on a small range of plants and ground invertebrates that do not account for varying uptake rates and metabolism of COCs. Since Site-specific conditions are not equivalent to controlled laboratory conditions since factors such as soil particle size, pH, organic matter content, moisture and alter COC uptake from soil to an animal. There is a high amount of uncertainty in these values.
- All surface water concentrations were estimated or modelled values, and exposure point concentrations also relied upon dilution factors based on estimated discharge rates and flow rates of Blackwater Creek. To the extent that actual site conditions do or do not meet the assumptions made in the modelling of concentrations, or in the discharge and flow rates, the exposure point concentrations in surface water may be over- or underestimated. There is a moderate level of uncertainty associated with these concentrations, which may be reduced with continued refinement of modelled predictions and monitoring of site conditions.

6.2 Toxicity Assessment Uncertainties

For a potential risk to be present, both exposure to the COCs and toxicity at the predicted exposure level must exist. The toxicological uncertainties primarily relate to the methodology by which TRVs are developed and would be commonly encountered during risk assessments. These uncertainties may result in overestimates or underestimates of risks.

The toxicity assessment was also conducted to individually assess each COC. In reality, COCs are present as a mixture on the Project site and, thus toxic effects of one COC may be influenced by one or more other COCs through synergistic, additive, or antagonistic interactions. These interactions may result in overestimates or underestimates of risks as compared to the estimates presented in this risk assessment.

6.3 Risk Characterization Uncertainties

Use of a deterministic (point estimate) approach to characterize risks likely overestimates risks since it assumes that receptors are exposed to one concentration only (maximum) and not the range of concentrations at a site. This approach is standard for SLRA so that risks are not underestimated.

There is a moderate level of confidence in the extrapolation from endpoints used in toxicity tests in the literature to population and community level effects in the field for the wildlife receptors at the Site. Risk is likely overestimated by HQs because the TRVs assume that COCs are 100% available for uptake into terrestrial organisms.

6.4 Specific Human Health Considerations

The Wabigoon system has reported historically high mercury levels (KCB 2012) and releases to the system from past industrial activities; the addition of any additional metals with neurotoxic endpoints (such as mercury or lead) may have effects that are more serious than predicted by the risk assessment because these COCs affect the same system within the body (nervous system). The effects may occur at lower levels of discharge because of the ambient conditions of sediment in the lake and a community that might have a higher-than-average level of mercury in their food and water. However, the Operational Phase data indicate that, since water will be treated in a reverse osmosis plant prior to release, effluent concentrations will meet background (for mercury) or water quality objectives. The data for Closure/Post-Closure water quality and effluent release from the Pit Lake modelled at this time also indicate that releases to Blackwater Creek through passive discharge will not adversely impact surface water quality. Any changes to the secondary treatment plant that result in higher effluent concentrations or any changes to the Pit Lake water quality estimates will need to be evaluated with the particular concerns of the City of Dryden and surrounding communities in mind.

The risk estimates calculated for humans in the current SLRA do not include mercury obtained from the ingestion of food such as fish and wild game. The current risk estimates for humans are based solely on dust exposure from soil. Due to the toxicological properties of mercury it is important to derive a comprehensive exposure that includes all sources for humans. Therefore the risk estimates for mercury likely underestimate the potential risk for humans.

7.0 SLRA CONCLUSIONS AND RECOMMENDATIONS

7.1 Human Health Conclusions

For this SLRA, air, surface water, and drinking water exposures were evaluated. After the COC refinement step, mercury and lead were the only human health COCs identified, and water pathways were found to be incomplete due to a lack of COCs.

The results of the human health component of this SLRA indicate that risk estimates do not exceed the acceptable threshold for receptors identified during the Operational Phase of the Project. No COCs were identified for the Post-Closure Phase of the Project and therefore risk estimates were not generated for that project phase.

Mercury and lead were assessed in the SLRA and risk estimates were acceptable for humans exposed to mercury and lead in dust during the Operational Phase (this pathway will be incomplete in the Closure and Post-Closure Phases). No release of COCs in surface water above background or PWQO in either the Operational or Post-Closure Phase is expected based on operational plans, secondary treatment of water, and Post-Closure modelled concentrations. As the drinking water source for residents of the City of Dryden is Wabigoon Lake, and it has historically elevated mercury concentrations (KCB 2012), any additional releases to surface or groundwater of COCs in the Closure and Post-Closure Phases of the mine will require evaluation to assure that background conditions are maintained.

The overall level of confidence associated with the calculated risk estimates is moderate for lead and low for mercury. This level of confidence could be increased through the collection of site-specific data on resident, First Nation, and mine worker site-use that would in turn allow for the refinement of exposure parameters to generate the current risk estimates.

7.2 Ecological Conclusions

Based on the calculated HQs, estimated risks for wildlife were below risk thresholds for Hare, Deer and Moose exposed to mercury and lead for the Operational and Closure/Post-Closure Phases. For Grouse, the HQs for mercury were below risk thresholds for both the Operational and Closure/Post-Closure Phases, and for lead during the Closure/Post-Closure Phase. Whereas the HQ for lead was just above the risk threshold (HQ = 1.2) for Grouse exposed to lead from the ingestion of tailings and food (plants, soil invertebrates) from the tailings during the Operational Phase. The HQ falls below the risk threshold when the assumption is made that Grouse obtain one third rather than one half of their food from plants and soil invertebrates living on the tailings. These HQ were derived using a very small set of COC concentrations in tailings, and modelled surface water concentrations.

In addition, forage fish are present within Blackwater Creek and habitat quality for fish within this system is moderate. Therefore fish would likely be exposed to the mine-related COCs proposed to be discharged in effluent. Depending upon the habitat quality wildlife with aquatic based diets may use the waters in Pit Lake as drinking water. Risk estimates for fish and other aquatic life were assessed although wildlife with aquatic based diets were not assessed in the SLRA.

7.3 Overall Recommendations

For the current SLRA certain assumptions were applied and default assumptions were used when site-specific information was unavailable. The application of default assumptions often reduces the uncertainty, but may lead to an over-prediction of risk for receptors. To assess the Closure/Post-Closure Phase, a water plume study combined with an effluent discharge rate could provide a more accurate prediction of concentrations of metals in surface water and groundwater over time. With such data, the COC list could be modified if any metals require assessment.

Wildlife with aquatic based diets that would inhabit wetlands and creeks, such as Blackwater Creek, were not identified and assessed in the SLRA. The scope of the SLRA includes identification of potential risk due to exposure from mine-related COCs for aquatic plants and invertebrates, but does not include wildlife with aquatic-based diets. The habitat quality for areas surrounding the Project site is moderate, and contain numerous creeks and tributaries draining into Blackwater Creek which based on the current Project plan will receive effluent discharge into their waters. These receptors are relevant and could use portions of the Project site as habitat and for foraging. If during the Closure/Post-Closure Phase the effluent concentrations proposed for discharge into Blackwater Creek and within the Pit Lake are not maintained at levels that do not exceed the protection of aquatic life then it is recommended that risk estimates be derived for wildlife with aquatic based diets for all relevant COCs.

Risks and COCs evaluated in this SLRA were based on modelled or predicted concentrations. Risks may need to be re-evaluated in the future if changes to the secondary treatment of surface water are made, or if site conditions change from those used in the SLRA to estimate exposures. It is recommended that site conditions and COC releases are monitored to maintain a health-protective level for fish and wildlife with aquatic based diets and humans drinking water within Blackwater Creek and Wabigoon Lake, or to all receptors exposed to dust from the site.

8.0 CLOSURE

The human health and ecological portions of the report were authored by Ms. Kristy Gabelhouse and Ms. Theresa Lopez. Should you have any questions or comments, please contact the Tetra Tech Inc. project manager Mr. Michel Gregoire.

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TABLES

TABLE 1: COC Selection - Agricultural and Residential Land Use - Soil (Baseline) and Waste Rock

Analyte	Waste Rock Geomean	Waste Rock Average	Waste Rock Minimum	Waste Rock Maximum	Baseline Soil Mean Concentration	Screening Guidelines [1]				COC Refinement
						CCME SQG RL	CCME SQG AL	OMOE SCS (Table 2) RL	OMOE SCS (Table 2) AL	
pH	-	-	-	-	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.
Aluminum	12,047	14,713	3,175	*38,665*	18,552	-	-	-	-	**Retain, maximum above background, but no guideline.**
Antimony	-	-	-	-	<1	20	20	7.5	7.5	No site data provided, do not retain.
Arsenic	7.06	**13.85**	0.55	**92.25**	2.9	12	12	18	11	**Retain, maximum exceeds CCME and OMOE**
Barium	-	-	-	-	96	500	750	390	390	No site data provided, do not retain.
Beryllium	-	-	-	-	0.57	4	4	4	4	No site data provided, do not retain.
Bismuth	-	-	-	-	<1	-	-	-	-	No site data provided, do not retain.
Boron (total)	-	-	-	-	5.8	-	2	120	120	No site data provided, do not retain.
Cadmium	0.14	0.74	0.02	**22.60**	1.4	10	1.4	1.2	1	**Retain, maximum exceeds CCME and OMOE**
Calcium	-	-	-	-	12,780	-	-	-	-	No site data provided, do not retain.
Chromium (total)	17.99	33.01	1.31	**116.30**	48	64	64	160	160	**Retain, maximum exceeds CCME**
Cobalt	**49.17**	**112.72**	3.44	**338.00**	9.9	50	40	22	22	**Retain, maximum and average exceeds CCME and OMOE**
Copper	13.79	24.37	0.64	**190.85**	20	63	63	140	140	**Retain, maximum exceeds CCME and OMOE**
Gallium	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Iron	15,408	17,453	5,055	*45,270*	23,674	-	-	-	-	**Retain, maximum above background, but no guideline.**
Lanthanum	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Lead	17.6	**82.0**	1.1	**2362.85**	8.1	140	70	120	45	**Retain, maximum and average exceeds CCME and OMOE**
Lithium	-	-	-	-	19	-	-	-	-	No site data provided, do not retain.
Magnesium	-	-	-	-	9435	-	-	-	-	No site data provided, do not retain.
Manganese	-	-	-	-	471	-	-	-	-	No site data provided, do not retain.
Mercury	-	0.05	0.005	**0.62**	0.11	6.6	6.6	0.27	0.25	**Retain, maximum exceeds OMOE and Hg is bioaccumulative.**
Molybdenum	-	-	-	-	1.2	10	5	6.9	6.9	No site data provided, do not retain.
Nickel	10.24	16.10	2.59	**69.68**	27	50	50	100	100	**Retain, maximum exceeds CCME**
Phosphorus	-	-	-	-	490	-	-	-	-	No site data provided, do not retain.
Potassium	-	-	-	-	2199	-	-	-	-	No site data provided, do not retain.
Scandium	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Selenium	-	-	-	-	<1	1	1	2.4	2.4	No site data provided, do not retain.
Silver	0.24	0.73	0.01	16.09	0.26	20	20	20	20	Does not exceed guideline, do not retain.
Sodium	-	-	-	-	543	-	-	-	-	No site data provided, do not retain.
Strontium	-	-	-	-	36	-	-	-	-	No site data provided, do not retain.
Sulphur	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Thallium	0.24	0.28	0.05	0.65	<0.5	1	1	1	1	Does not exceed guideline, do not retain.
Thorium	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Tin	-	-	-	-	<5	50	5	-	-	No site data provided, do not retain.
Titanium	-	-	-	-	1,354	-	-	-	-	No site data provided, do not retain.
Tungsten	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Uranium	0.52	0.75	0.13	2.96	1	23	23	23	23	Does not exceed guideline, do not retain.
Vanadium	12.2	16.5	1.2	52.5	49	130	130	86	86	Does not exceed guideline, do not retain.
Zinc	94.3	**305.3**	24.3	**9,414.9**	56	200	200	340	340	**Retain, maximum and average exceeds either or both of CCME and OMOE**
Zirconium	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.

Notes:
All values presented in mg/kg - milligrams per kilograms.
'-' no guideline available or not analysed
COC - Contaminant of Concern
Waste Rock results from Table 3.1 from EcoMetrix Geochemistry draft report (Sept, 2013), except for Mercury. Calculated totals using 15% MSS, 70% BMS and 15% MSED as stated in EcoMetrix Geochemistry draft report (Sept, 2013).
Mercury Waste Rock results from Table 7.10 from KCB draft report (2012). Calculated totals using 15% MSS, 70% BMS and 15% MSED.
Background soil results from Table 6.7 from KCB report Baseline Study Nov 2010 to Nov 2011, Dated September 2012 (25 samples used).
CCME SQG- *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (PEHH)* by Canadian Council of Ministers of the Environment (CCME), 2007, revised 2010.
OMOE SCS (Generic) - *Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.* Full Depth Generic Site Condition Standards in a Potable Ground Water Condition
[1] Values represent most stringent human health or ecological screening value available from given source.

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

TABLE 2: COC Selection - Agricultural and Residential Land Use - Soil (Baseline) and Tailings

Analyte	Tailings Composite	Baseline Soil Mean Concentration	Screening Guidelines [1]				COC Refinement
			CCME SQG RL	CCME SQG AL	OMOE SCS (Table 2) RL	OMOE SCS (Table 2) AL	
pH	8.00	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.
Aluminum	5,000	18,552	-	-	-	-	Below background and no guideline, do not retain
Antimony	11	<1	20	20	7.5	7.5	Does not exceed guideline, do not retain.
Arsenic	**46**	2.9	12	12	18	11	**Retain, exceeds CCME and OMOE**
Barium	-	96	500	750	390	390	No site data provided, do not retain.
Beryllium	-	0.57	4	4	4	4	No site data provided, do not retain.
Bismuth	-	<1	-	-	-	-	No site data provided, do not retain.
Boron (total)	-	5.8	-	2	120	120	No site data provided, do not retain.
Cadmium	**5.3**	1.4	10	1.4	1.2	1	**Retain, exceeds CCME and OMOE**
Calcium	-	12,780	-	-	-	-	No site data provided, do not retain.
Chromium (total)	9.6	48	64	64	160	160	Does not exceed guideline, do not retain.
Cobalt	11	9.9	50	40	22	22	Does not exceed guideline, do not retain.
Copper	**81**	20	63	63	140	140	**Retain, exceeds CCME**
Gallium	-	-	-	-	-	-	No site data provided, do not retain.
Iron	19,000	23,674	-	-	-	-	Below background and no guideline, do not retain
Lanthanum	-	-	-	-	-	-	No site data provided, do not retain.
Lead	**870**	8.1	140	70	120	45	**Retain, exceeds CCME and OMOE**
Lithium	-	19	-	-	-	-	No site data provided, do not retain.
Magnesium	-	9,435	-	-	-	-	No site data provided, do not retain.
Manganese	-	471	-	-	-	-	No site data provided, do not retain.
Mercury	**0.62**	0.11	6.6	6.6	0.27	0.25	**Retain, maximum exceeds OMOE and Hg is bioaccumulative.**
Molybdenum	-	1.2	10	5	6.9	6.9	No site data provided, do not retain.
Nickel	14	27	50	50	100	100	Does not exceed guideline, do not retain.
Phosphorus	-	490	-	-	-	-	No site data provided, do not retain.
Potassium	-	2,199	-	-	-	-	No site data provided, do not retain.
Scandium	-	-	-	-	-	-	No site data provided, do not retain.
Selenium	-	<1	1	1	2.4	2.4	No site data provided, do not retain.
Silver	3.4	0.26	20	20	20	20	Does not exceed guideline, do not retain.
Sodium	-	543	-	-	-	-	No site data provided, do not retain.
Strontium	-	36	-	-	-	-	No site data provided, do not retain.
Sulphur	-	-	-	-	-	-	No site data provided, do not retain.
Thallium	0.17	<0.5	1	1	1	1	Does not exceed guideline, do not retain.
Thorium	-	-	-	-	-	-	No site data provided, do not retain.
Tin	-	<5	50	5	-	-	No site data provided, do not retain.
Titanium	-	1,354	-	-	-	-	No site data provided, do not retain.
Tungsten	-	-	-	-	-	-	No site data provided, do not retain.
Uranium	0.46	1	23	23	23	23	Does not exceed guideline, do not retain.
Vanadium	6.0	49	130	130	86	86	Does not exceed guideline, do not retain.
Zinc	**2,000**	56	200	200	340	340	**Retain, exceeds CCME and OMOE**
Zirconium	-	-	-	-	-	-	No site data provided, do not retain.

Notes:
All values presented in mg/kg - milligrams per kilograms.
'-' no guideline available or not analysed
COC - Contaminant of Concern
Tailings results from Table 3.5 from EcoMetrix Geochemistry draft report (Sept, 2013).
In the absence of mercury tailings data the Waste Rock results from Table 7.10 from KCB draft report (2012) for mercury were used., and converted using calculated totals using 15% MSS, 70% BMS and 15% MSED.
Background soil results from Table 6.7 from KCB report Baseline Study Nov 2010 to Nov 2011, Dated September 2012 (25 samples used).
CCME SQG- *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (PEHH)* by Canadian Council of Ministers of the Environment (CCME), 2007, revised 2010.
OMOE SCS (Generic) - *Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.*
Full Depth Generic Site Condition Standards in a Potable Ground Water Condition.
[1] Values represent most stringent human health or ecological screening value available from given source.

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

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TABLE 3: COC Selection – Dust Deposition – Baseline and Operational

Analyte	Background Concentration (ug/m^3)	Maximum POI Concentration (ug/m^3)	Averaging Period (hr)	Guidelines MOE POI Limit (ug/m^3)	COC Refinement
Total Suspended Particulates - Property Line	33	***384***	24	120	Relevant for workers, do not retain as PPE will eliminate exposure
Total Suspended Particulates - Nearest Receptor	33	66.6	24	120	Does not exceed guideline, do not retain.
PM10 - Property Line	15	***96.5***	24	50	Relevant for workers, do not retain as PPE will eliminate exposure
PM10 - Nearest Receptor	15	25.8	24	50	Does not exceed guideline, do not retain.
PM2.5	10	10.9	24	27	Does not exceed guideline, do not retain.
Dustfall	-	5.5	30 d	7	Does not exceed guideline, do not retain.
Gold	-	0.00263	24	N/A	No guideline, do not retain.
Lead	-	0.166	24	0.5	Does not exceed guideline, do not retain.
Arsenic	-	0.0217	24	0.3	Does not exceed guideline, do not retain.
Barium	-	0.25	24	10	Does not exceed guideline, do not retain.
Bismuth	-	0.00559	24	-	No guideline, do not retain.
Cadmium	-	0.00232	24	0.025	Does not exceed guideline, do not retain.
Cobalt	-	0.00607	24	0.1	Does not exceed guideline, do not retain.
Chromium	-	0.0774	24	0.5	Does not exceed guideline, do not retain.
Manganese	-	0.2860	24	0.4	Does not exceed guideline, do not retain.
Nickel	-	0.00257	24	0.04	Does not exceed guideline, do not retain.
Phosphorous	-	0.263	24	0.35	Does not exceed guideline, do not retain.
Titanium	-	0.918	24	120	Does not exceed guideline, do not retain.
Thallium	-	0.00856	24	0.24	Does not exceed guideline, do not retain.
Vanadium	-	0.0242	24	2	Does not exceed guideline, do not retain.
Uranium	-	0.000673	24	0.03	Does not exceed guideline, do not retain.
Gallium	-	0.0105	24	-	No guideline, do not retain.
Lanthanum	-	0.00877	24	-	No guideline, do not retain.
Scandium	-	0.00294	24	-	No guideline, do not retain.
Thorium	-	0.01070	24	-	No guideline, do not retain.
Platinum	-	0.01	24	0.2	Does not exceed guideline, do not retain.
Rhodium	-	0.00327	24	0.4	Does not exceed guideline, do not retain.
SO2	4	8.02	1	690	Does not exceed guideline, do not retain.
NO2	33	186	1	400	Does not exceed guideline, do not retain.
CO	1248	199	1	36200	Does not exceed guideline, do not retain.

Notes:
'-' no guideline available or not analysed
COC - Contaminant of Concern
POI - Point of Impingement
1. 'Air emission results from Table 5 of RWDI draft Air Quality Assessment (August, 15, 2014).
2. 1-hr, ½-hour, and 24-hour background concentrations were based on 90th percentile values. Annual background values were based on the maximum annual mean value over the most recent available 5-year period.
3. Predicted impacts and thresholds of dustfall are in g/m²/30 days
4. 8-hr predicted CO concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(2)).

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

TABLE 4: COC Selection - Surface Water Impacted by Discharge into Blackwater Creek for Ecological Receptors - Baseline, Operational and Post-Closure

Analyte	Operational (total ug/L)	Operational Output from Reverse Osmosis (RO) plant	Operational Output from Reverse Osmosis plant with 6.04X dilution	Estimated Concentration in BWC below RO Discharge	Post-Closure Pit Lake (total ug/L)	Post-Closure Pit Lake with 9.65X dilution (total ug/L)	Post-Closure Pit Lake Estimated Concentration in BWC below below Passive Outflow	Screening Guidelines [1]				Operational COC Refinement	Post-Closure COC Refinement
								Baseline Concentration - Blackwater Creek (total ug/L)	CCME WQG$_{ECO}$ FW (total ug/L)	PWQO	MMER		
Hardness (mg/L CaCO3)	22.360	22.360	22.360	-	25.390	25.390	-	66.40	-		-	Excluded due to lack of risk-based standards for comparison.	Excluded due to lack of risk-based standards for comparison.
pH	7.14	7.14	7.14	-	7.43	7.43	-	7.31	-	6.5 - 8.5	-	Excluded due to lack of risk-based standards for comparison.	Excluded due to lack of risk-based standards for comparison.
Aluminum	**136.03**	75	12	509.06	**141.19**	14.63	539.64	580.91	100	75	-	Does not exceed for Operational Phase with RO Plant and pH dependent guideline value. Do not retain.	Although concentration in Pit Lake was above available guidelines, the value is not above the background levels and there is no MMER. Once diluted to BWC it was not an issue. Do not retain.
Ammonia	0	20	3	31.50	0	0	30.26	33.40	23.3	20	-	No site data provided. Does not exceed guideline with RO Plant, do not retain.	No site data provided, do not retain.
Antimony	*3.08*	*3.08*	0.51	2.58	*2.53*	0.26	2.50	2.50	-	20	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Arsenic	***5.94***	*5*	1	3.55	*3.33*	0.35	3.31	3.31	5	5 (interim)	500	Does not exceed guideline for Operational Phase with RO Plant, do not retain.	Does not exceed guideline for Post-Closure Phase, do not retain.
Barium	6.71	6.71	1.11	31.84	5.48	0.57	33.14	36	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Beryllium	0.9	0.9	0.15	2.92	0.7	0.07	3.01	3.25	-	11 (variable with hardness)	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Bismuth	0.5	0.5	0.08	2.86	0.5	0.05	2.99	3.25	-	-	-	Below background , no guideline, do not retain.	Below background , no guideline, do not retain.
Boron (total)	32.21	32.21	5.33	143.99	28.12	2.91	149.89	162.5	1500	200	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Cadmium	***0.65***	***0.2***	0.03	0.09	0.06	0.01	0.07	0.07	0.09	0.1 (interim)	-	Does not exceed guideline for Operational Phase with RO Plant and site specific dilution, do not retain.	Does not exceed guideline for Post-Closure Phase, do not retain.
Calcium	6902.2	6902.2	1142.7	16477.41	7765.5	804.72	17095.95	18062.5	-	-	-	Below background , no guideline, do not retain.	Below background , no guideline, do not retain.
Carbonate	6167	6167	1021	-	11081	1148.29	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.	Excluded due to lack of risk-based standards for comparison.
Chloride	*5715.25*	*5715.25*	*946.23*	1228.92	*2673.6*	277.06	691.57	486.25	120000	-	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Chromium	***4.59***	1	0.17	3.36	**1.95**	0.20	3.58	3.75	-	1	-	Does not exceed guideline for Operational Phase with RO Plant. Do not retain.	Although concentration in Pit Lake was above available guidelines, the value is not above the background levels and there is no MMER. Once diluted to BWC it was not an issue. Do not retain.
Cobalt	***2.08***	0.6	0.1	1.59	***2.07***	0.21	1.79	1.76	-	0.9	-	Does not exceed guideline for Operational Phase with RO Plant. Do not retain.	Although concentration in Pit Lake was above available guidelines, the value is slightly above the background levels and there is no MMER. Once diluted to BWC it was not an issue. Do not retain.
Copper	***6.48***	**5**	1	5.15	***6.51***	0.67	5.30	5.18	2	5	300	Does not exceed guideline for Operational Phase with RO Plant and site specific dilution. As well estimated concentration in BWC below RO plant is below baseline. Do not retain.	Although concentration in Pit Lake was above available guidelines, the value is slightly above the background levels and does not exceed the MMER. Once diluted to BWC it was not an issue. Do not retain.
Cyanide	0.22	0.22	0.04	2.21	0.09	0.01	2.31	2.54	5	5	1000	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Gallium	-	-	-	-	-	-	-	-	120	-	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.	No site data provided, do not retain.
Iron	**314.55**	300	50	961.82	**320.57**	33.22	1000.90	1071.38	300	300	-	Does not exceed guideline for Operational Phase with RO Plant, do not retain.	Although concentration in Pit Lake was above available guidelines, the value is not above the background levels and there is no MMER. Once diluted to BWC it was not an issue. Do not retain.
Lanthanum	-	-	-	-	-	-	-	-	-	-	-	No site data provided, and no guideline, do not retain.	No site data provided, and no guideline, do not retain.
Lead	***25.68***	1	0.17	3.37	***5.07***	0.53	3.89	3.76	1 to 1.98 (variable with hardness)	1 (interim)	200	Does not exceed guideline for Operational Phase with RO Plant, do not retain.	Although concentration in Pit Lake was above available guidelines, the value is slightly above the background levels and does not exceed the MMER. Once diluted to BWC it was not an issue. Do not retain.
Lithium	20	20	3.31	156.05	30	3.11	164.63	178.57	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Magnesium	1246.1	1246.1	206.31	4873.30	1457.8	151.07	5096.78	5473.75	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Manganese	53.2	53.2	8.81	95.64	54.2	5.62	98.11	102.66	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Mercury	0.005579	0.02	0.003	0.02	0.005425	0.00056	0.02	0.02	0.026	0.2	-	For Operational Phase the RO plant is to meet Mercury background levels which is below the guideline. Do not retain.	Does not exceed guideline for Post-Closure Phase. Do not retain.
Molybdenum	1.07	1.07	0.18	2.94	0.84	0.09	3.02	3.25	73	40	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Nickel	*16.86*	*16.86*	2.79	8.12	*16.51*	1.71	7.60	6.68	150	25	500	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Nitrate	*6883.24*	*6883.24*	*1139.61*	1003.8	*5458.6*	565.66	540.02	30.5	550000	-	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Phosphorus	**40**	30	4.97	52.89	**40**	4.15	55.11	56.68	Ranges from 4 to 100 based on trophic level (guidance framework)	30 (interim)	-	Phosphorus guideline has trigger ranges based on trophic level. Does not exceed guideline for Operational Phase with RO Plant. Do not retain.	Phosphorus guideline has trigger ranges based on trophic level. Does not exceed guideline for Post-Closure Phase with site specific dilution. Do not retain.
Potassium	1440.3	1440.3	238.46	2657.29	1432.1	148.40	2724.83	2858.75	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Scandium	-	-	-	-	-	-	-	-	-	-	-	No site data provided, and no guideline, do not retain.	No site data provided, and no guideline, do not retain.
Selenium	***4.59***	***4.59***	0.76	3.38	**1.94**	0.20	3.06	3.18	1	100	-	Does not exceed guideline for Operational Phase with RO Plant and site specific dilution. Do not retain.	Although concentration in Pit Lake was above available guidelines, the value is below the background levels and there is no MMER. Once diluted to BWC it was not an issue. Do not retain.
Silicon	27.5	27.5	4.55	2320.43	0	0	2446.56	2700	-	-	-	Below background , no guideline, do not retain.	Below background , no guideline, do not retain.
Silver	0.05	0.05	0.01	0.43	0.05	0.01	0.45	0.49	0.1	0.1	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Sodium	5205.9	5205.9	861.9	3025.88	*2677.4*	277.45	2666.16	2665	-	-	-	Below background for Operational Phase. No guideline, do not retain.	Does not exceed background for Post-Closure Phase with site specfic dilution. No guideline, do not retain.
Strontium	30	30	5	39.87	30	3.11	40.42	41.50	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Sulphate	*15179.5*	*15179.5*	*2513.2*	3947.87	*15312*	1586.74	3329.82	2088.57	-	-	-	Exceeds background, no guideline, do not retain.	Exceeds background, no guideline, do not retain.
Sulphur	5070.1	5070.1	839.4	-	5114.4	529.99	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.	Excluded due to lack of risk-based standards for comparison.
Thallium	***177.29***	0.3	0.05	0.88	0.16	0.02	0.90	0.98	0.8	0.3	-	Does not exceed guideline for Operational Phase with RO Plant. Do not retain.	Does not exceed guideline for Post-Closure Phase. Do not retain.
Thorium	-	-	-	-	-	-	-	-	-	-	-	No site data provided, and no guideline, do not retain.	No site data provided, and no guideline, do not retain.
Tin	0.4773	0.4773	0.08	2.86	1	0.10	3.04	3.25	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Titanium	3.5	3.5	0.58	20.17	3.7	0.38	21.12	22.93	-	-	-	Below background, no guideline, do not retain.	Below background, no guideline, do not retain.
Tungsten	-	30	5	32.14	-	-	-	32.50	-	30	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.	No site data provided, do not retain.
Uranium	2.78	2.78	0.46	14.34	2.58	0.27	14.97	16.25	15	5	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Vanadium	0.76	0.76	0.13	3.31	0.61	0.06	3.44	3.74	-	6	-	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Zinc	*22.52*	*22.52*	3.73	13.87	*22.23*	2.30	13.36	12.44	30	30	500	Does not exceed guideline, do not retain.	Does not exceed guideline, do not retain.
Zirconium	-	*4*	1	3.68	-	-	-	3.63	-	4	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.	No site data provided, do not retain.

Notes:
All values presented in μg/L - micrograms per Litre, unless otherwise specified.
"-" no guideline established or was not analyzed for.
COC - Contaminant of Concern
BWC - Blackwater Creek
Site specific dilution factor of 9.65X for Closure Phase and 6.04X for Operational Phase is calculated from the monthly average dilution factor for effluent from the Project site into nearby natural waterways (Blackwater Creek) was estimated and then averaged as a yearly value (Tetra Tech 2014).
Operational values from calculated values. The model used is based upon the water balance titled "Goliath Gold Project Pre-Feasibility Water Management Strategy", (Lycopodium, June 2014) and the geochemical characterization work titled "DRAFT Geochemical Characterization of the Goliath Gold Project" (Ecometrix, September 2013).
Operational output with RO plant is a combination of values. If colored blue then value used is the calculated operational value. Otherwise value is the concentration in the Commitment Registry of the EIS.
Estimated Concentration in BWC below RO Discharge takes into account the into account the existing background concentration in Blackwater Creek (BWC). Conc in BWC (ug/L) = total load in BWC/ total flow in BWC calculated as (BWC flow * BWC background conc)+(RO flow * RO conc))/(BWC flow + RO flow)
BWC Background/Baseline Concentrations are from "FINAL Treasury Aquatic Baseline Report 2014 rev 2. (DST, 2014). Mean concentration calculated using values from multiple sampling events.
It is noted that there are parameter that have elevated Baseline concentrations above RO effluent (e.g., Aluminum, Phosphorus) and also RO effluent parameters that are below BWC Baseline (e.g, Ammonia, antimony).
CCME WQG- *Canadian Water Quality Guidelines for the Protection of Aquatic Life* by Canadian Council of Ministers of the Environment (CCME), 2007, revised 2014.
PWQO - Ontario Ministry of the Environment, 1994. Water management: policies, guidelines, provincial water quality objectives of the Ministry of the Environment.
OMOE SCS (Generic) - *Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.* Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
MMER - Metal Mining Effluent Regulations Schedule 4 , Authorized Limits of Deleterious substances
[1] Values represent most stringent human health or ecological screening value available from given source.

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

TETRA TECH

TABLE 5: COC Selection - Drinking Water Impacted by Discharge to Blackwater Creek (or Wabigoon Lake) - Baseline, Operational and Post-Closure

Analyte	Operational (total ug/L)	Operational Output from Reverse Osmosis (RO) plant	Operational Output from Reverse Osmosis plant with 6.04X dilution	Operational Estimated Concentration in BWC below RO Discharge	Post-Closure Pit Lake (total ug/L)	Post-Closure Pit Lake with Blackwater Creek 9.65X dilution (total ug/L)	Post-Closure Pit Lake Estimated Concentration in BWC below below Passive Outflow	Screening Guidelines [1]					COC Refinement
								Baseline Concentration - Blackwater Creek (total ug/L)	CDWQG (total ug/L)	PWQO	OMOE SCS RL (Table 2)	MMER	
Hardness (mg/L CaCO3)	22.360	22.360	22.360	-	25.390	25.390	-	66.40	-	-	-	-	Excluded due to lack of risk-based standards for comparison.
pH	7.14	7.14	7.14	-	7.43	7.43	-	7.31	6.5-9	6.5 - 8.5	6.5-8.5	-	Excluded due to lack of risk-based standards for comparison.
Aluminum	**136.03**	75	12	509.06	**141.19**	14.63	539.64	580.91	-	75	-	-	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Ammonia	0	20	3	31.50	0	0	30.26	33.40	-	20	-	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.
Antimony	*3.08*	*3.08*	0.51	2.58	*2.53*	0.26	2.50	2.50	6	20	6	-	Does not exceed guideline, do not retain.
Arsenic	***5.94***	*5*	1	3.55	*3.33*	0.35	3.31	3.31	10	5 (interim)	25	500	Does not exceed guideline for Post-Closure Phase and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Barium	6.71	6.71	1.11	31.84	5.48	0.57	33.14	36	1000	-	1000	-	Does not exceed guideline, do not retain.
Beryllium	0.9	0.9	0.15	2.92	0.7	0.07	3.01	3.25	-	11 (variable with hardness)	4	-	Does not exceed guideline, do not retain.
Bismuth	0.5	0.5	0.08	2.86	0.5	0.05	2.99	3.25	-	-	-	-	Below background, no guideline, do not retain.
Boron (total)	32.21	32.21	5.33	143.99	28.12	2.91	149.89	162.5	5000	200	5000	-	Does not exceed guideline, do not retain.
Cadmium	***0.65***	***0.2***	0.03	0.09	0.06	0.01	0.07	0.07	5	0.1 (interim)	2.7	-	Does not exceed guideline for Post-Closure Phase and does not exceed guideline for Operational Phase with RO Plant and with site-specific dilution. Do not retain.
Calcium	6902.2	6902.2	1142.7	16477.41	7765.5	804.7	17095.95	18062.5	-	-	-	-	Below background, no guideline, do not retain.
Carbonate	6167	6167	1021	-	11081	1148.29	-	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.
Chloride	*5715.25*	*5715.25*	*946.23*	1228.92	*2673.6*	277.06	691.57	486.25	250000 AO	-	790000	-	Does not exceed guideline, do not retain.
Chromium	***4.59***	1	0.17	3.36	**1.95**	0.20	3.58	3.75	50	1	50	-	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Cobalt	***2.08***	0.6	0.1	1.59	***2.07***	0.21	1.79	1.76	-	0.9	3.8	-	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Copper	***6.48***	5	1	5.15	***6.51***	0.67	5.30	5.18	1000 AO	5	87	300	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Cyanide	0.22	0.22	0.04	2.21	0.09	0.01	2.31	2.54	200	5	66	1000	Does not exceed guideline, do not retain.
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Iron	**314.55**	300	50	961.82	**320.57**	33.22	1000.90	1071.38	300 AO	300	-	-	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Lanthanum	-	-	-	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Lead	***25.68***	1	0.17	3.37	***5.07***	0.53	3.89	3.76	10	1 (interim)	10	200	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Lithium	20	20	3.31	156.05	30	3.11	164.63	178.57	-	-	-	-	Below background, no guideline, do not retain.
Magnesium	1246.1	1246.1	206.31	4873.30	1457.8	151.07	5096.78	5473.75	-	-	-	-	Below background, no guideline, do not retain.
Manganese	**53.2**	**53.2**	8.81	95.64	**54.2**	5.62	98.11	102.66	50 AO	-	-	-	Does not exceed guideline for Post-Closure Phase with site-specific dilution and does not exceed guideline for Operational Phase with RO Plant and with site-specific dilution. Do not retain.
Mercury	0.005579	0.02	0.003	0.02	0.005425	0.00056	0.02	0.02	1	0.2	0.29	-	Does not exceed guideline for Post-Closure Phase and for Operational Phase the RO plant is to meet Mercury background levels which is below the guideline. Do not retain.
Molybdenum	1.07	1.07	0.18	2.94	0.84	0.09	3.02	3.25	-	40	70	-	Does not exceed guideline, do not retain.
Nickel	*16.86*	*16.86*	2.79	8.12	*16.51*	1.71	7.60	6.68	-	25	100	500	Does not exceed guideline, do not retain.
Nitrate	*6883.24*	*6883.24*	*1139.61*	1003.79	*5458.6*	565.66	540.02	30.50	45000	-	-	-	Does not exceed guideline, do not retain.
Phosphorus	**40**	30	4.97	52.89	***40***	4.15	55.11	56.68	-	30 (interim)	-	-	Does not exceed guideline for Post-Closure Phase with site specific dilution and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Potassium	1440.3	1440.3	238.46	2657.29	1432.1	148.40	2724.83	2858.75	-	-	-	-	Below background, no guideline, do not retain.
Scandium	-	-	-	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Selenium	*4.59*	*4.59*	0.76	3.38	1.94	0.20	3.06	3.18	10	100	10	-	Does not exceed guideline, do not retain.
Silicon	27.5	27.5	4.55	2320.43	0	0	2446.56	2700	-	-	-	-	Below background, no guideline, do not retain.
Silver	0.05	0.05	0.01	0.43	0.05	0.01	0.45	0.49	-	0.1	1.5	-	Does not exceed guideline, do not retain.
Sodium	5205.9	5205.9	861.9	3025.88	*2677.4*	277.45	2666.16	2665	200000 AO	-	490000	-	Does not exceed guideline, do not retain.
Strontium	30	30	5	39.87	30	3.11	40.42	41.50	-	-	-	-	Below background, no guideline, do not retain.
Sulphate	*15179.5*	*15179.5*	*2513.2*	3947.87	*15312*	1586.74	3329.82	2088.57	500000 AO	-	-	-	Does not exceed guideline, do not retain.
Sulphur	5070.1	5070.1	839.4	-	5114.4	529.99	-	-	-	-	-	-	Excluded due to lack of risk-based standards for comparison.
Thallium	***177.29***	0.3	0.05	0.88	0.16	0.02	0.90	0.98	-	0.3	2	-	Does not exceed guideline for Post-Closure Phase and does not exceed guideline for Operational Phase with RO Plant. Do not retain.
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	No site data provided, do not retain.
Tin	0.4773	0.4773	0.08	2.86	1	0.10	3.04	3.25	-	-	-	-	Below background, no guideline, do not retain.
Titanium	3.5	3.5	0.58	20.17	3.7	0.38	21.12	22.93	-	-	-	-	Below background, no guideline, do not retain.
Tungsten	-	30	5	32.14	-	-	-	32.50	-	30	-	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.
Uranium	2.78	2.78	0.46	14.34	2.58	0.27	14.97	16.25	20	5	20	-	Does not exceed guideline, do not retain.
Vanadium	0.76	0.76	0.13	3.31	0.61	0.06	3.44	3.74	-	6	6.2	-	Does not exceed guideline, do not retain.
Zinc	*22.52*	*22.52*	3.73	13.87	*22.23*	2.30	13.36	12.44	5000 AO	30	1100	500	Does not exceed guideline, do not retain.
Zirconium	-	*4*	1	3.68	-	-	-	3.63	-	4	-	-	No site data provided. Does not exceed guideline for Operational Phase with RO Plant, do not retain.

Notes:

All values presented in μg/L - micrograms per Litre, unless otherwise specified.

"-" no guideline established or was not analyzed for.

COC - Contaminant of Concern

Site specific dilution factor of 9.65X for Closure Phase and 6.04X for Operational Phase is calculated from the monthly average dilution factor for effluent from the Project site into nearby natural waterways (Blackwater Creek) was estimated and then averaged as a yearly value (Tetra Tech 2014).

Operational values from calculated values. The model used is based upon the water balance titled "Goliath Gold Project Pre-Feasibility Water Management Strategy", (Lycopodium, June 2014) and the geochemical characterization work titled "DRAFT Geochemical Characterization of the Goliath Gold Project" (Ecometrix, September 2013).

Operational output with RO plant is a combination of values. If colored blue then value used is the calculated operational value. Otherwise value is the concentration in the Commitment Registry of the EIS.

Estimated Concentration in BWC below RO Discharge takes into account the into account the existing background concentration in Blackwater Creek (BWC). Conc in BWC (ug/L) = total load in BWC/ total flow in BWC calculated as (BWC flow * BWC background conc)+(RO flow * RO conc))/(BWC flow + RO flow)

Blackwater Creek Background/Baseline Concentrations are from "FINAL Treasury Aquatic Baseline Report 2014 rev 2. (DST, 2014). Mean concentration calculated using values from multiple sampling events.

It is noted that there are parameter that have elevated Baseline concentrations above RO effluent (e.g., Aluminum, Phosphorus) and also RO effluent parameters that are below BWC Baseline (e.g, Ammonia, antimony).

CDWQG - Guidelines for Canadian Drinking Water Quality. August 2012.

OMOE SCS (Generic) - *Ontario Ministry of Environment, Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act.* Full Depth Generic Site Condition Standards in a Potable Ground Water Condition

MMER - Metal Mining Effluent Regulations Schedule 4 , Authorized Limits of Deleterious substances

[1] Values represent most stringent human health or ecological screening value available from given source.

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

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TABLE 6: COC Selection - Mercury Fish Tissue Concentration

Substance	Baseline Fish Tissue Concentration [1]	Screening Guidelines [2]		COC Refinement
		Sensitive Population Minimum Level	**General Public Minimum Level**	
Lead	0.036	NA	NA	
Mercury	0.3251	0.26	0.61	Below general public minimum level. Do not expect baseline levels in

Notes:

All values presented in mg/kg - milligrams per kilograms dry weight.

COC - Contaminant of Concern

1. Lead tissue results from from KCB report Baseline Study Nov 2010 to Nov 2011, Dated September 2012 (42 fillet samples used); and mercury results from DST 2014 b. Fish sampled from Thunder and Wabigoon Lake.
2. Ontario MOE Guide to Eating Ontario Sport Fish 2013-2014

Shade and Italics	Exceeds Background
Shade and Bold	Exceeds a Guideline

TABLE 7: Wild game - Biotransfer Factor Approach

Mercury - operational

	Total Intake	BW animal	BTF d/kg	Tissue
	mg/kg-day	kg		conc
Moose	0.003513778	400	7.70E-03	NA
Deer	0.004733481	75	7.70E-03	2.73E-03
Hare	0.010616999	1.3	7.70E-03	1.06E-04
Grouse	0.011589658	0.6	7.70E-03	5.35E-05
	TOTAL			2.89E-03

Mercury - post closure

	Total Intake	BW animal	BTF d/kg	Tissue
	mg/kg-day	kg		conc
Moose	3.39063E-10	400	7.70E-03	1.04E-09
Deer	2.17E-09	75	7.70E-03	1.25E-09
Hare	2.08654E-07	1.3	7.70E-03	2.09E-09
Grouse	3.43976E-07	0.6	7.70E-03	1.59E-09
	TOTAL			5.98E-09

Lead - operational

	Total Intake	BW animal	BTF d/kg	Tissue
	mg/kg-day	kg		conc
Moose	0.344	400	3.00E-04	NA
Deer	0.464	75	3.00E-04	1.04E-02
Hare	2.18	1.3	3.00E-04	8.50E-04
Grouse	1.997	0.6	3.00E-04	3.59E-04
	TOTAL			1.16E-02

Lead - post closure

	Total Intake	BW animal	BTF d/kg	Tissue
	mg/kg-day	kg		conc
Moose	3.17E-07	400	3.00E-04	3.80E-08
Deer	2.03E-06	75	3.00E-04	4.56E-08
Hare	1.95E-04	1.3	3.00E-04	7.61E-08
Grouse	3.21E-04	0.6	3.00E-04	5.79E-08
	TOTAL			2.18E-07

TABLE 8: Metals in Plants

	Soil	vegetative	Dry plant	dry to wet	Amount collected by humans			Soil	root/fruit	Dry plant	dry to wet	Amount collected by humans	
	Conc (mg/kg)	TF	Conc	conv	Fractionation			Conc (mg/kg)	TF	Conc	conv - root	Fractionation	
						mg/kg							mg/kg
Pb	870	4.90E-03	4.26	0.126	1.97E-02	1.06E-02	**Pb**	870	1.50E-03	1.31	0.222	1.97E-02	5.71E-03
Hg	0.62	1.00E-01	0.06	0.126	1.97E-02	1.54E-04	**Hg**	0.62	3.00E-02	0.02	0.222	1.97E-02	8.14E-05

Notes:
Potential blueberry habitat is 6341.2 ha. (App EE)
Size of Tailing and waste rock is 125 ha
Adjustment = tailings size/potential = 0.019712357

TF from Sheppard for lead
TF from Baes for mercury

TABLE 9: Fish Tissue Concentration Calculations

Hg Operational Phase				
Hg in RO effluent x RO discharge rate / Wabigoon Hg conc x flow rate				
0.00012				
increase of .012%		fish tissue concentration is 0.33 mg/kg		
0.33*.00012 is				
4.1E-05	mg/kg			

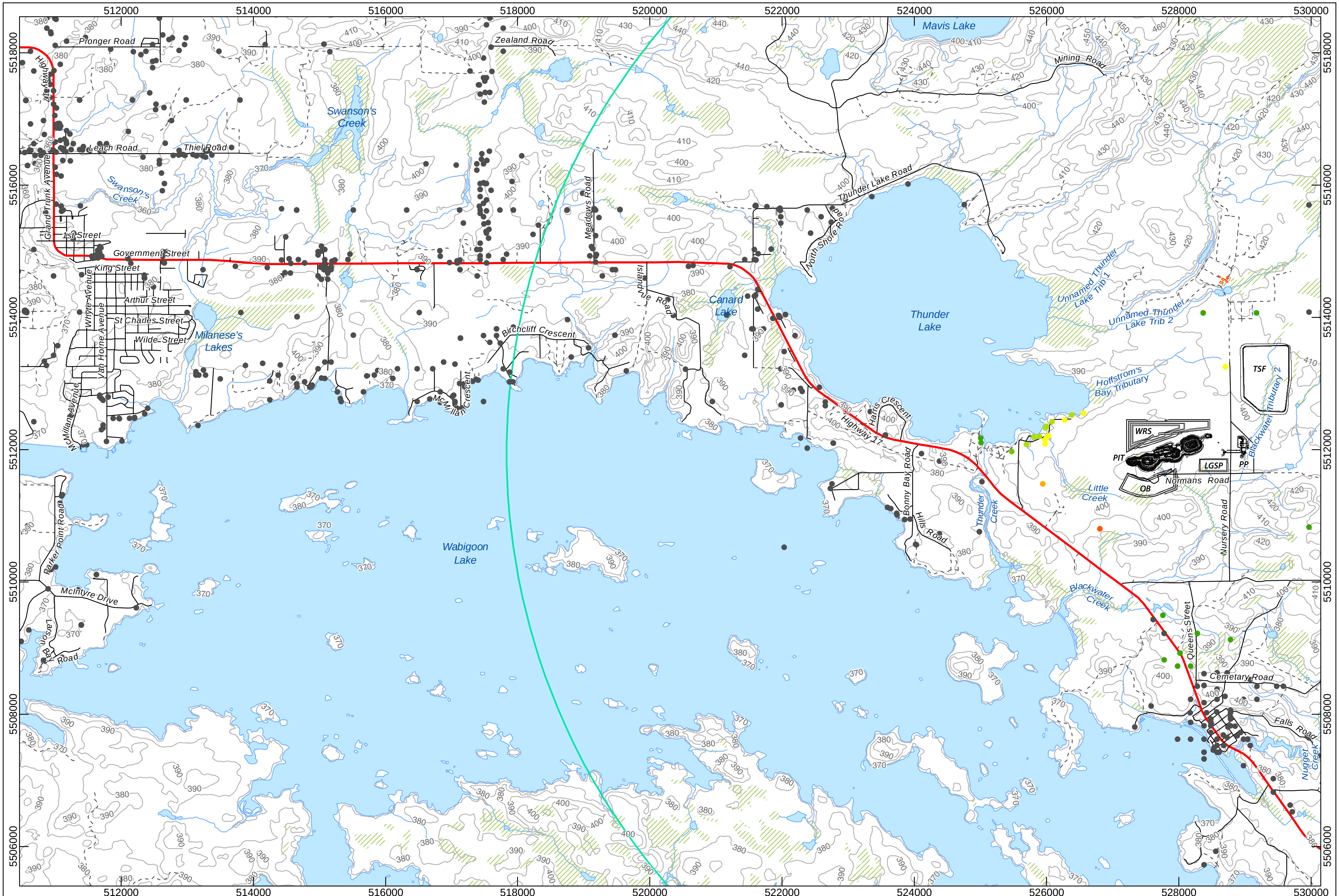
Pb Operational Phase							
Pb in RO effluent x RO discharge rate / Wabigoon Pb conc x Wabigoon flow rate							
0.00021							
increase of .021%		fish tissue concentration of 0.036 mg/kg (90th percentile from KCB study)					
0.036*.00021 is							
7.4E-06	mg/kg						

Hg Post closure				
Hg in Pit Lake effluent x Passive flow rate / Wabigoon Hg conc x flow rate				
0.000016				
increase of .0016%		fish tissue concentration is 0.33 mg/kg		
0.33*.000016 is				
5.3E-06	mg/kg			

Pb Post closure							
Pb in Pit Lake effluent x Passive flow rate / Wabigoon Pb conc x flow rate							
0.0004							
increase of .04% is		fish tissue concentration of 0.036 mg/kg (90th percentile from KCB study)					
0.036*.0004 is							
1.6E-05	mgkg						

Notes:
values in blue used in HQ spreadsheet

FIGURES



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Goliath Project Site Layout During Operations

FIGURE 1 | REV.00

NOT FOR CONSTRUCTION

TREASURY METALS INC.

DESIGN:	*AT*	*29 JUL. 2014*
GIS:	*AT*	*04 SEP. 2014*
CHECK:	*XX*	*ADD DATE*
REVIEW:	*XX*	*ADD DATE*

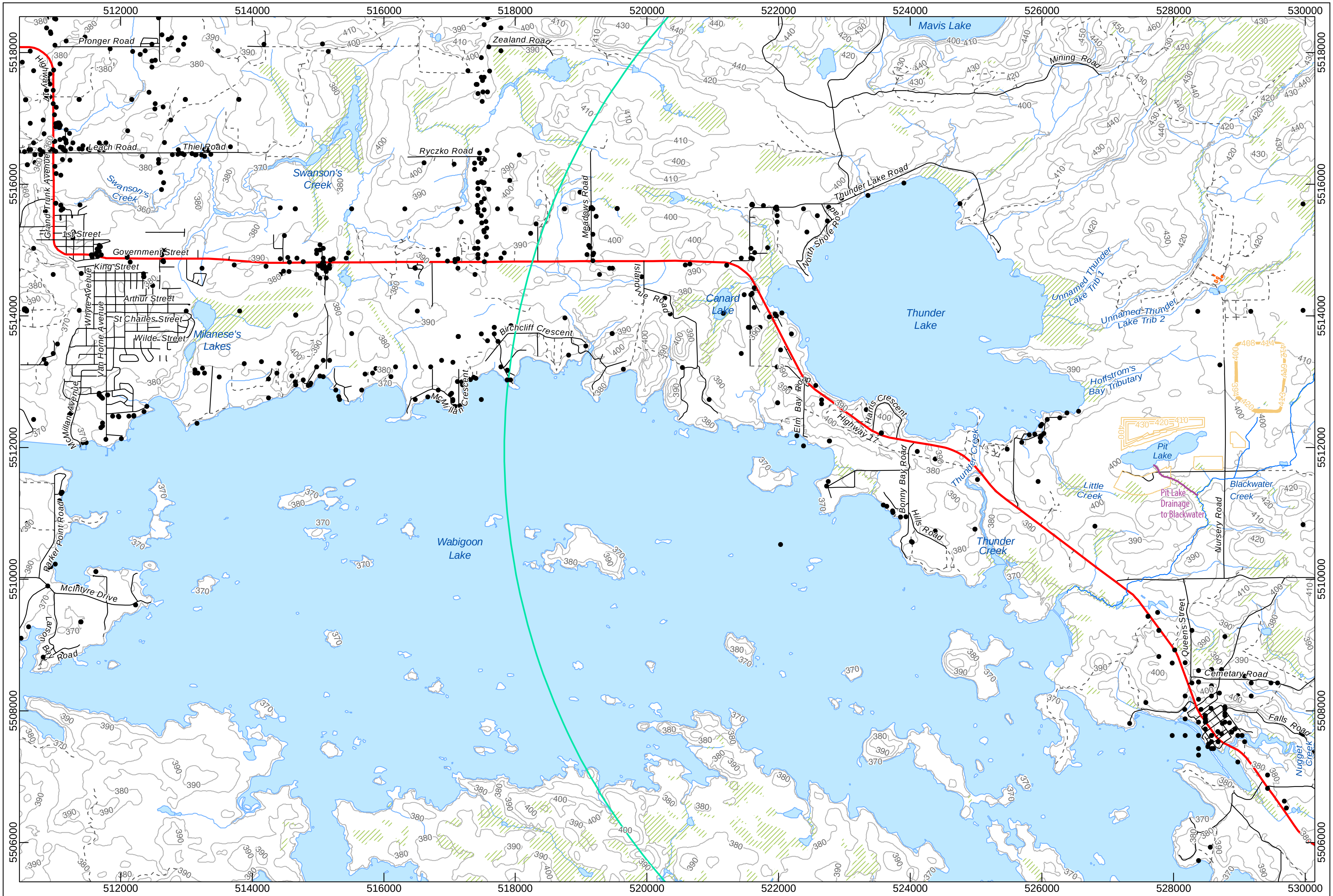
10km Radius from Pit Centroid
Mine Infrastructure
Tree Nursery Buildings
Highway
Local Road
Recreational Road
Waterbody
Wetland Area
Regular Elevation Contour
Watercourse

Potential Well Drawdown (m)
No Drawdown
2
5
10
20
30
50
70

0 1,000 2,000
Meters

N

Notes:
1. UTM Zone 15N, NAD83
2. Base Data Source: OBM
3. 1:75 000 scale NTS
4. Well Data from MOE
LGSP - Low-grade Stockpile
OB - Overburden Storage
PP - Processing Plant
PIT - Open Pit
TSF - Tailings Storage Facility
WRS - Waste Rock Storage



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Goliath Project Site in Post-Closure

FIGURE 2 | REV.00

NOT FOR CONSTRUCTION

TREASURY METALS INC.

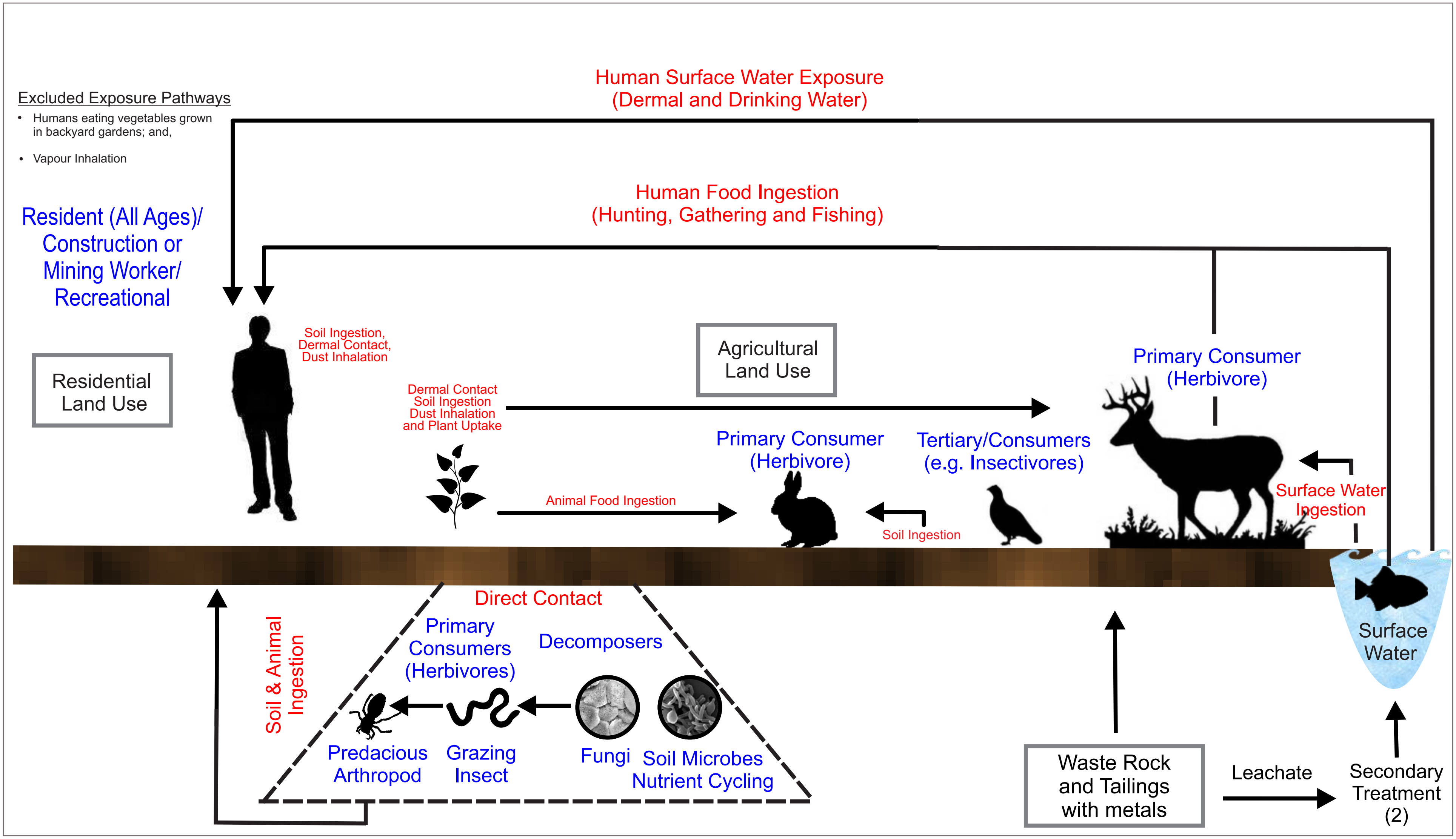
DESIGN: AT 29 JUL. 2014
GIS: AT 05 SEP. 2014
CHECK: AT 12 SEP. 2014

10km Radius from Pit Centroid
Blackwater Creek
Tree Nursery Buildings
TSF
Highway
Local Road
Recreational Road
Waterbody
Wetland Area
Regular Elevation Contour
Watercourse
MOE Registered Well

0 1,000 2,000
Meters
N

Notes:

1. *UTM Zone 15N, NAD83*
2. *Base Data Source: OBM*
3. *1:75 000 scale NTS*
4. *Well Data from MOE*



Text Legend

Receptor (blue)
Pathway (red)
Source (green)

Land Use — Land Use Applied

NOTES

1. Assumes current land use unless otherwise specified
2. Secondary treatment (RO Plant) discharge is to Blackwater Creek

STATUS: ISSUED FOR USE

CLIENT

TREASURY METALS INCORPORATED

TETRA TECH

SCREENING LEVEL RISK ASSESSMENT FOR THE GOLIATH MINE SITE

SLRA Conceptual Site Model - Operational Phase Land Use

PROJECT NO.	DWN	CKD	REV
ENVMIN03018-01.003	CLS	JW	0

OFFICE	DATE
EBA-EDM	October 2014

Figure 3

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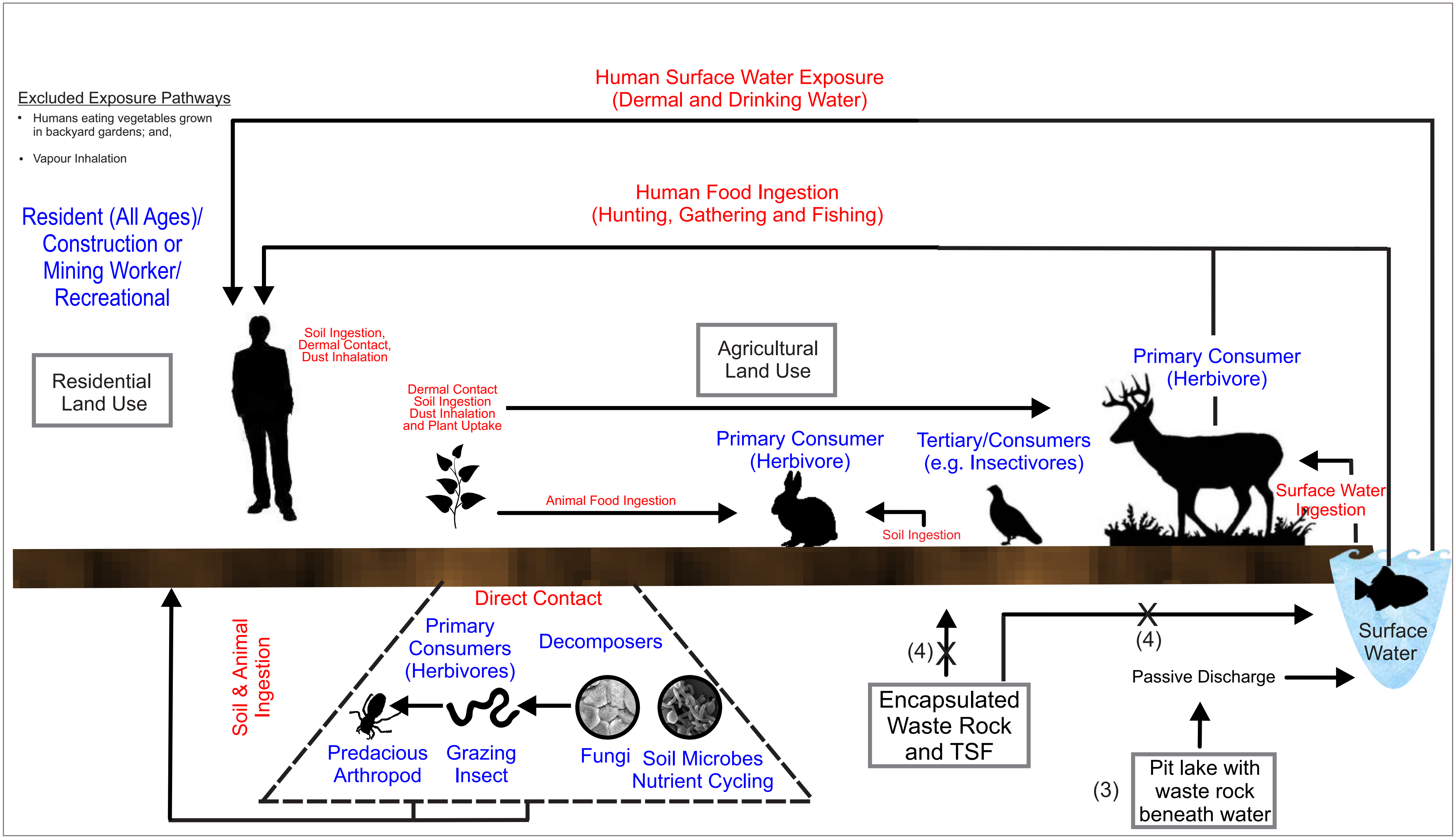

Text Legend

Receptor (blue)	Land Use	Land Use Applied
Pathway (red)		
Source (green)		

NOTES

1. Assumes current land use unless otherwise specified
2. Pit Lake discharges to a tributary to Blackwater Creek which then flows into Black water Creek
3. Groundwater conductivity is very low. Pathway is considered incomplete
4. Above grade waste rock and TSF is capped as described in EIS. Releases to soil, surface water and groundwater are negligible and pathway is considered incomplete

STATUS: ISSUED FOR USE

CLIENT

TREASURY METALS INCORPORATED

TETRA TECH

SCREENING LEVEL RISK ASSESSMENT FOR THE GOLIATH MINE SITE

SLRA Conceptual Site Model - Post-Closure Phase Land Use

PROJECT NO.	DWN	CKD	REV
ENVMIN03018-01.003	CLS	JW	0

OFFICE	DATE
EBA-EDM	October 2014

Figure 4

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APPENDIX A
GENERAL CONDITIONS

GENERAL CONDITIONS

GEOENVIRONMENTAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.1 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of TETRA TECH’s client. TETRA TECH does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than TETRA TECH’s Client unless otherwise authorized in writing by TETRA TECH. Any unauthorized use of the report is at the sole risk of the user.

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1.2 ALTERNATE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed TETRA TECH’s instruments of professional service); only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of TETRA TECH’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except TETRA TECH. The Client warrants that TETRA TECH’s instruments of professional service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

1.4 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of the report, TETRA TECH may rely on information provided by persons other than the Client. While TETRA TECH endeavours to verify the accuracy of such information when instructed to do so by the Client, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

BACKGROUND INFORMATION RELEVANT TO IDENTIFYING RECEPTORS FOR THE AREAS SURROUNDING THE GOLIATH MINE PROJECT

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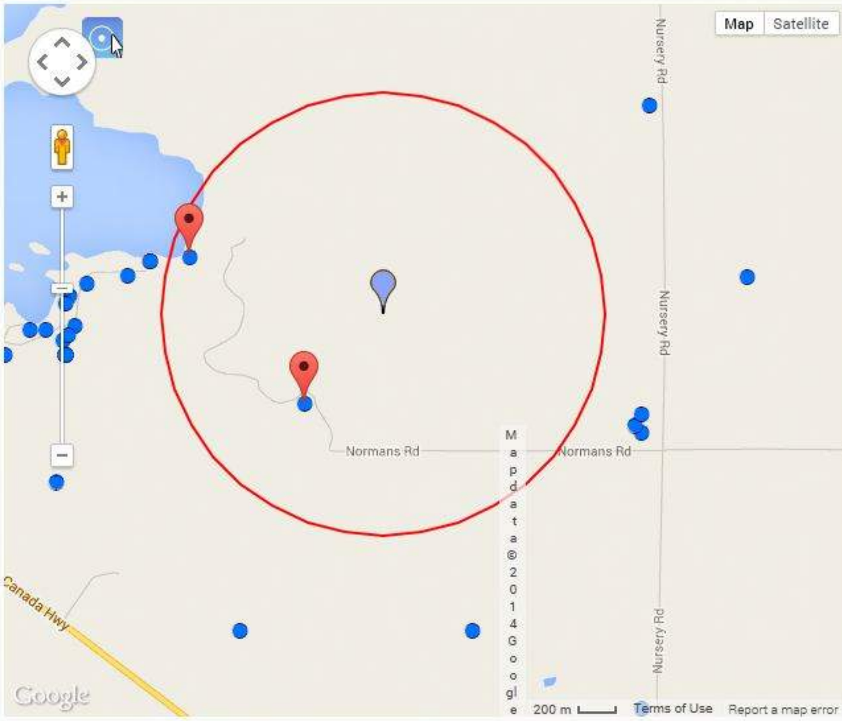
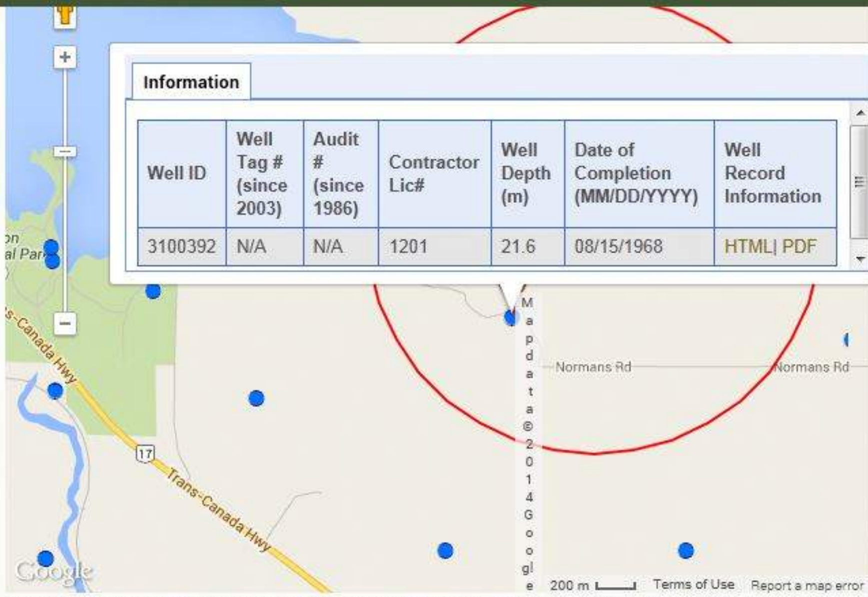


Latitude:49.77539, Longitude:-92.64273 (UTM Zone:15, Easting:525724, Northing:5513719)

Recommended for you

How to use a Ministry of the Environment map



Well ID	Well Tag # (since 2003)	Audit # (since 1986)	Contractor Lic#	Well Depth (m)	Date of Completion (MM/DD/YYYY)	Well Record Information
3100392	N/A	N/A	1201	21.6	08/15/1968	HTML| PDF

Latitude:49.75770, Longitude:-92.64908 (UTM Zone:15, Easting:525276, Northing:5511751)

Note: Data is in English only.The Distance(KM) column represents the distance between your search location and the permit location in the specific row.

Show 10 entries Search:

Well ID	Well Tag # (since 2003)	Audit # (since 1986)	Contractor Lic#	Well Depth (m)	Date of Completion (MM/DD/YYYY)	Well Record Information	Distance (KM)
3100392	N/A	N/A	1201	21.6	08/15/1968	HTML| PDF	0.56
3100264	N/A	N/A	3304	30.5	11/17/1967	HTML| PDF	0.95

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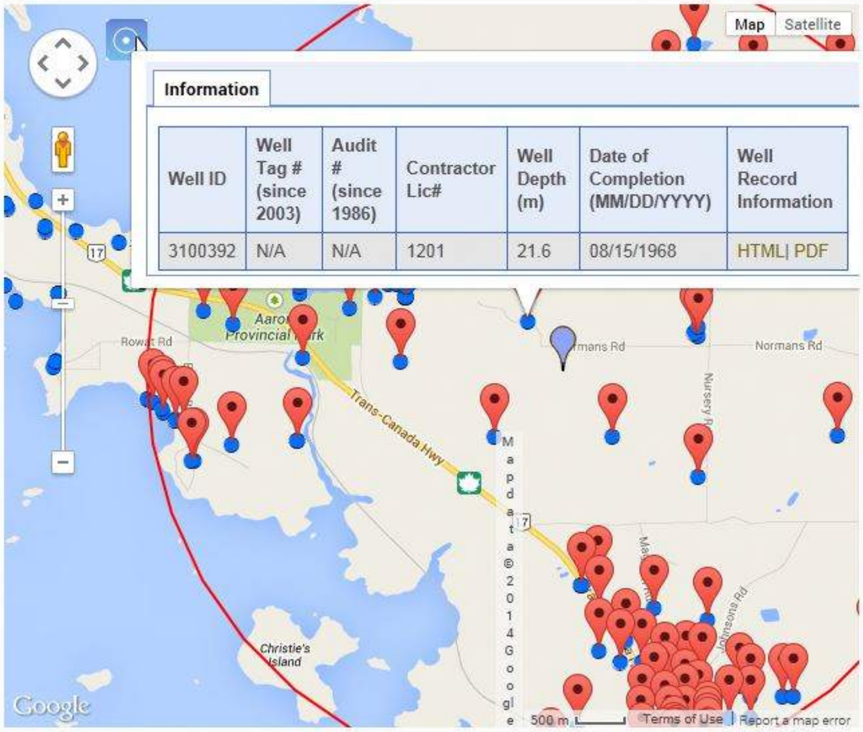

Information

Well ID	Well Tag # (since 2003)	Audit # (since 1986)	Contractor Lic#	Well Depth (m)	Date of Completion (MM/DD/YYYY)	Well Record Information
3100392	N/A	N/A	1201	21.6	08/15/1968	HTML| PDF

Latitude:49.73358, Longitude:-92.68787 (UTM Zone:15, Easting:522493, Northing:5509056)

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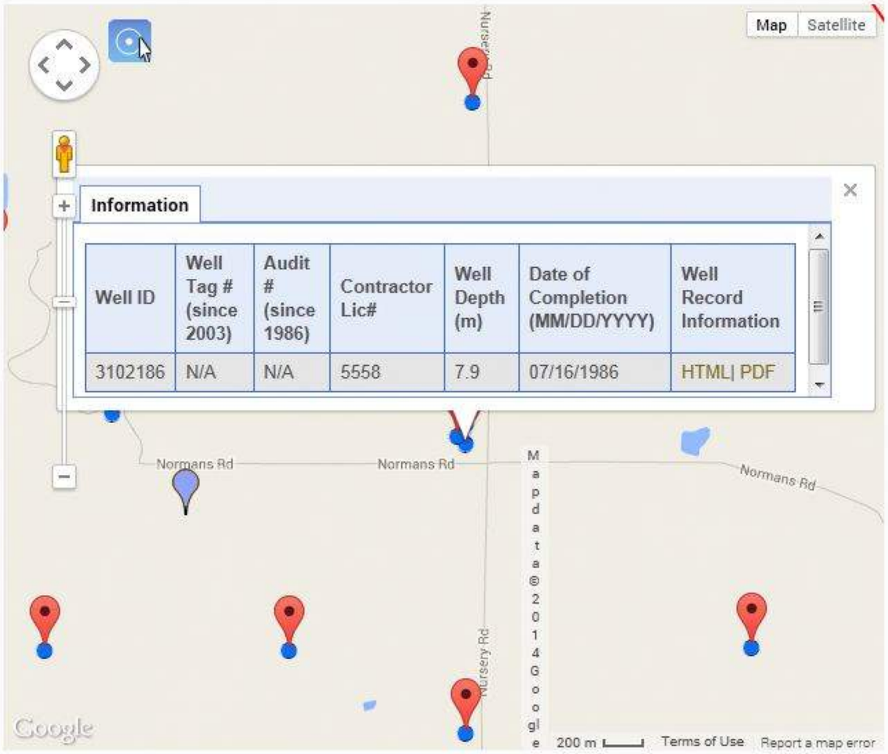

Information

Well ID	Well Tag # (since 2003)	Audit # (since 1986)	Contractor Lic#	Well Depth (m)	Date of Completion (MM/DD/YYYY)	Well Record Information
3102186	N/A	N/A	5558	7.9	07/16/1986	HTML| PDF

Latitude:49.76901, Longitude:-92.63045 (UTM Zone:15, Easting:526611, Northing:5513015)

Recommended for you

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Ontario

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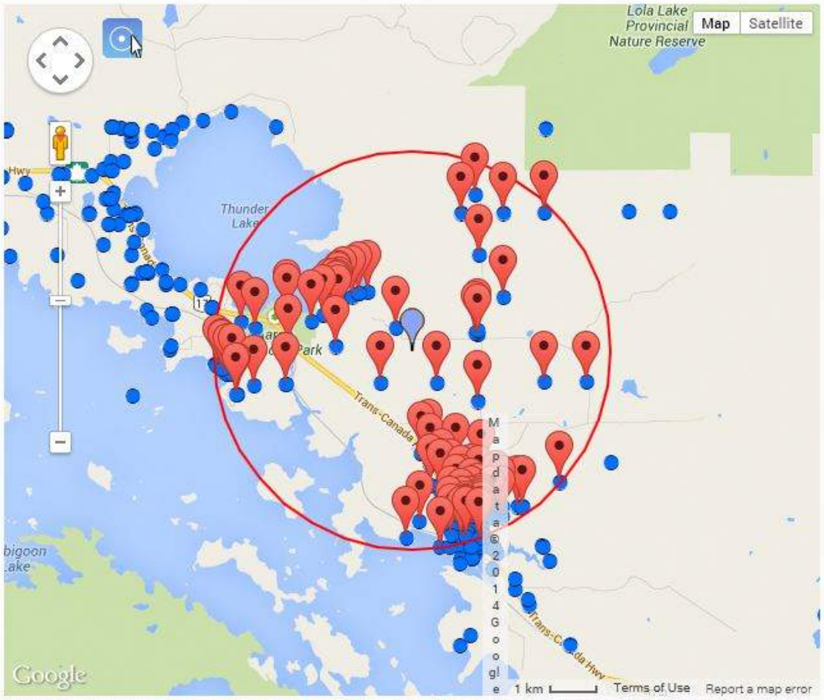


Latitude:49.74201, Longitude:-92.72873 (UTM Zone:15, Easting:519545, Northing:5509982)

Note: Data is in English only.The Distance(KM) column represents the distance between your search location and the permit location in the specific row.

Recommended for you

How to use a Ministry of the Environment map

UM 11|5|Z 5|2|7|1|1|2|0 Con IV
5|R 5|5|1|1|1|6|3|0 Lot 8
EV. 6|R 1|1|2|7|0
BSIN 5|1|1

52 F/15 E

3100392

CODED

7

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District ~~Wabigoon~~ Kenora   Township, Village, Town or City Barclay Improvement District (ZEALAND)

Con. IV   PT Lot 8 ~~Lot # IV Parcel KR337~~   Date completed (day) August (month) 1968 (year)

[redacted] Address BOX 403 DRYDEN

Casing and Screen Record

Inside diameter of casing 4 ½ in.
Total length of casing 61 ft
Type of screen Johnson's #8
Length of screen five feet
Depth to top of screen 61 ft. 6 in
Diameter of finished hole 4 ½ in.

Pumping Test

Static level 25 ft.
Test-pumping rate Two one half. G.P.M.
Pumping level 46 ft.
Duration of test pumping 18 hr.
Water clear or cloudy at end of test cloudy
Recommended pumping rate one G.P.M.
with pump setting of 50 feet below ground surface

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
BROWN CLAY	0	18		
BLUE CLAY	18	20		
RED CLAY	20	26		
BLUE CLAY	26	64		
COURSE SAND & Boulders	64	71	64-71	F
WATER IN COURSE SAND & Boulders				
WATER IS FRESH.				

9.3

For what purpose(s) is the water to be used? Househol (Domestic)

Is well on upland, in valley, or on hillside? upland

Drilling or Boring Firm AQUA WELL DRILLING

Address DRYDEN ONTARIO BOX 8 Site 17, RR#1

Licence Number #2867

Name of Driller or Borer COLIN F. FRASER

Address DRYDEN, ONTARIO

Date AUGUST 1968 <Original signed by>

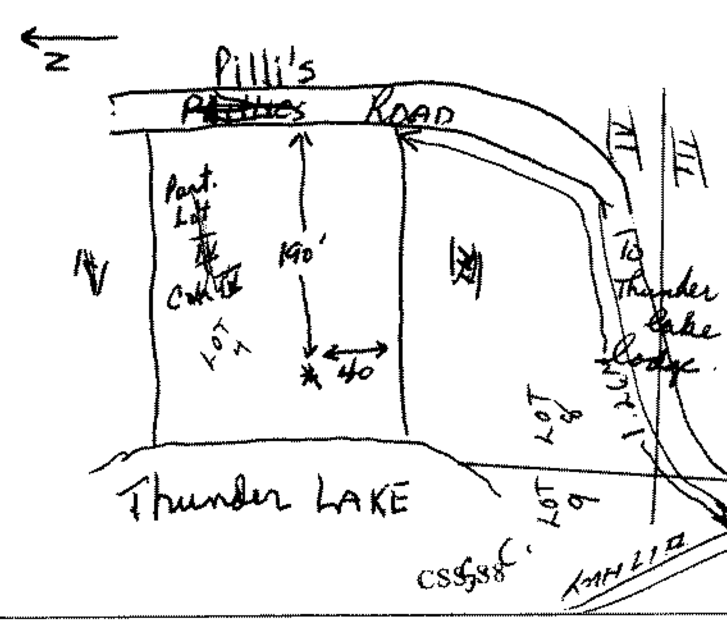
(Signature of Licensed Drilling or Boring Contractor)

PARCLE KR 337

LOT 4

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 7 15M-60-4138

OWRC COPY

52 F/15 E

MM | 1 | 1 | 5 | Z | 5 | 2 | 7 | 1 | 1 | 2 | 0 | Con IV

M | 5 | R | 5 | 5 | 1 | 1 | 1 | 6 | 3 | 0 | Lot 8

ov. | 6 | R | 1 | 1 | 2 | 7 | 0 |

sin | 5 | 1 | 1 |

CODED

3100392

7

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District ~~Wabigoon~~ Kenora   Township, Village, Town or City Barclay Improvement District (ZEALAND)

Con. IV   PT Lot ~~Pt Lot # IV Parcel KR337~~ 8   Date completed (day) August (month) 1968 (year)

[redacted] Address BOX 403 DRYDEN

Casing and Screen Record

Inside diameter of casing 4½ in.

Total length of casing 61 ft

Type of screen Johnson's #8

Length of screen five feet

Depth to top of screen 61 ft. 6 in

Diameter of finished hole 4½ in.

Pumping Test

Static level 25 ft.

Test-pumping rate Two one haff. G.P.M.

Pumping level 46 ft.

Duration of test pumping 18 hr.

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with pump setting of 50 feet below ground surface

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Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
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BLUE CLAY	26	64		
COURSE SAND & Boulders	64	71	64-71	F
WATER IN COURSE SAND & Boulders				
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9.3

For what purpose(s) is the water to be used? Household (Domestic)

Is well on upland, in valley, or on hillside? upland

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Licence Number #2867

Name of Driller or Borer COLIN F. FRASER

Address DRYDEN, ONTARIO

Date AUGUST 1968

<Original signed by>

(Signature of Licensed Drilling or Boring Contractor)

PARCLE KR 337

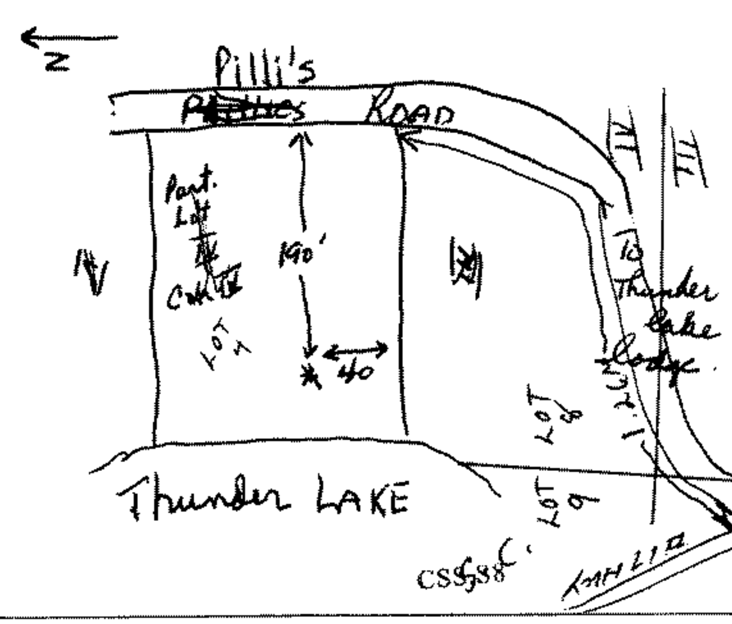
Form 7 15M-60-4138

OWRC COPY

LOT 4

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 3102186 | MUNICIP 31136 CON 04

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
[redacted]	...land	4	6

[redacted] ...bigoon Ont.

DATE COMPLETED DAY 16 MO 7 YR 86

ELEVATION | RC | BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
Grey	Clay		Firm	0	11
Red	Clay		Firm	11	11½
Grey	Clay		Firm	11½	18
Grey	Clay		Firm	18	22
Grey Blue	Clay		Soft	22	26
		Rock		26	

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
30	1 ☐ STEEL 2 ☒ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	18	+1	26
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER | PUMPING RATE: GPM | DURATION OF PUMPING: HOURS MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
7 FEET	2 FEET	FEET	6½ FEET	FEET	6 FEET

1 ☐ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM | PUMP INTAKE SET AT: FEET | WATER AT END OF TEST: 1 ☐ CLEAR 2 ☒ CLOUDY

RECOMMENDED PUMP TYPE: ☒ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING: 2 FEET | RECOMMENDED PUMPING RATE: ½ GPM

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE

1 ☐ DOMESTIC
2 ☒ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

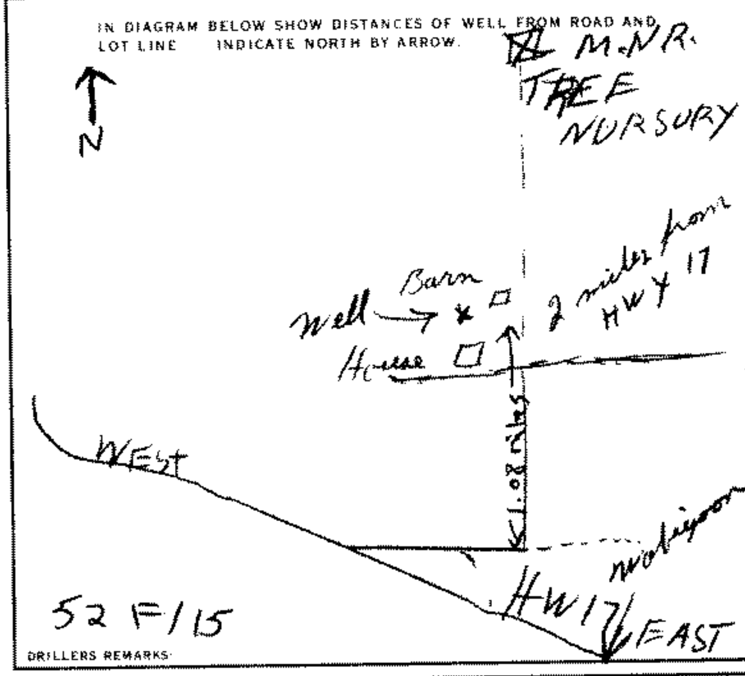
METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☒ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

353

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



52 F/15

DRILLERS REMARKS

CONTRACTOR

NAME OF WELL CONTRACTOR: EINO STENBERG | LICENCE NUMBER: 5558
ADDRESS: Box 35 OXDRIFT ONT
NAME OF DRILLER OR BORER: ✓ | LICENCE NUMBER: 5558
SIGNATURE OF CONTRACTOR: <Original signed by> | SUBMISSION DATE DAY 13 MO 12 YR 86

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 5558 | DATE RECEIVED 291286
DATE OF INSPECTION | INSPECTOR
REMARKS: WDE
CSS S

FORM NO. 0506-4-77 FORM 7

MINISTRY OF THE ENVIRONMENT COPY

APPENDIX C
HUMAN HEALTH INFORMATION

HEALTH CANADA DQRA SPREADSHEET

USER INPUT SHEET

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	October 2014	Comment:	Scenario 1 - Resident/Worker Operational

PROBLEM FORMULATION

Potential Land Uses (Yes/No)

		Default
Agricultural	No	Yes
Residential/urban parkland	Yes	Yes
Commercial with daycare	No	Yes
Commercial without daycare	No	Yes
Industrial	Yes	Yes
Industrial - outdoors	Yes	Yes
Urban recreational	No	Yes
Remote wild lands	No	Yes
Construction/utility work	Yes	Yes
Other		No
specify:		

Exposure Scenario Residential — Default: Residential

Receptor Groups (Yes/No)

		Default
General public or residents	Yes	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Operative Pathways (Yes/No)

		Default
Inadvertent ingestion of soil	No	Yes
Inhalation of fugitive dust	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	Yes	Yes
Dermal contact with soil	No	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	No	No

Vapour Transport Modelling

		Default
Vapour source for exposure calculations		Most Conservative
Model applied for soil to indoor air		NA
Model applied for groundwater to indoor air		NA
Model applied for soil vapour to indoor air		NA

Active Critical Receptors (Yes/No)

		Default
Infant	Yes	Yes
Toddler	Yes	Yes
Child	Yes	Yes
Teen	Yes	Yes
Adult	Yes	Yes
Construction/Utility Worker	Yes	No
Other		No
specify:		

Contaminant Concentrations

Chemical Name	required	Mercury, inorganic (ionic)	Lead				
Soil (mg/kg)	required	0.62	2362.85				
Mole Fraction in Soil (unitless)	optional						
Groundwater - source (mg/L)	optional						
Mole Fraction in Groundwater (unitless)	optional						
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional		0.000166				
Soil vapours (> 1 m below foundation) (mg/m3)	optional						
Subslab/shallow soil vapour (<1 m) (mg/m3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						

Risk Assessment Endpoints

		Default
Acceptable hazard index:		0.2
Acceptable cancer risk:		1.00E-05
Evaluate early lifestage cancer risks?		No

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

FATE AND TRANSPORT MODEL INPUT

	Value	Default	Models Affected
Soil Type		sand	PS, V-H, V-C, V-O, GW
Significant vehicle traffic on unpaved roads?		No	P-O
Site Characteristics			
Source Length (m)		10	GW, V-O
Source Width (m)		10	GW, V-O
Depth to Groundwater (m)		3	GW, V-O
Depth from Surface to Contamination (m)		0	GW, V-O
Thickness of Contamination (m)		3	GW
Distance - Contaminated Soil to Building (m)		1	V-H, V-C
Distance - Contaminated GW to Building (m)		1	V-H, V-C
Depth Below Building to Vapour Sample (m)		1	V-H, V-C
Distance to potable water user (m)		0	GW
Distance to Bathing/Swimming Water (m)		0	GW
Particulate Concentration in Air (ug/m^3)		0.76	P-O
Wind Speed in Mixing Zone (m/s)		4	V-O
Hydrological Parameters			
Recharge (m/y)		0.28	GW
Soil/Groundwater Characteristics	sand		
Vadose Zone			
Dry Bulk Density (g/cm3)		1.660	PS, V-C
Water Content (g/g dry wt)		0.033	PS, V-C
Capillary Zone			
Thickness of Capillary Zone (cm)		17	V-C
Water Content (g/g dry wt)		0.152	V-C
Aquifer/Contaminated Zone			
Saturated Hydraulic Conductivity (m/y)		320	GW
Hydraulic Gradient (m/m)		0.028	GW
Organic Carbon Fraction (g/g)		0.005	PS, GW
Soil Temperature (^{o}C)		21	PS, PGW
Depth of unconfined aquifer (m)		5	GW
Vapour Transport Properties			
Soil Vapour Permeability (cm^2) - CCME model		8.00E-08	V-C
Building Type		Residential - Slab on Grade	V-H, V-C
Building Characteristics	Residential - Slab on Grade		
Building length (m)		12.25	V-C
Building width (m)		12.25	V-C
Building mixing height (m)		3.6	V-H, V-C
Thickness of building foundation (cm)		11.25	V-C
Depth to base of foundation (m)		0.1125	V-C
Air exchanges per hour		0.5	V-C
Pressure differential (Pa)		40	V-C
Crack Area (cm^2)		994.5	V-C
Additional Vapour Intrusion Parameters (Health Canada model)			
Apply biodegradation adjustment?		No	V-H
Apply groundwater mass flux check?		No	V-H
Apply source depletion check?		No	V-H
Additional Groundwater Model Parameters			
Apply biodegradation during transport?		No	GW

OPTIONAL SECTIONS

User-defined Chemicals

NOTE: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the DQRA report.

	Chemical 1	Chemical 2	Chemical 3
Name			
CAS Number			
Chemical class (organic/inorganic)			
Tolerable daily intake (mg/kg/d) - infant			
Tolerable daily intake (mg/kg/d) - toddler			
Tolerable daily intake (mg/kg/d) - child			
Tolerable daily intake (mg/kg/d) - teen			
Tolerable daily intake (mg/kg/d) - adult			
Tolerable concentration (mg/m^3)			
Oral slope factor $(mg/kg/d)^{-1}$			
Dermal slope factor $(\mu g/cm^2/d)^{-1}$			
Inhalation slope factor $(mg/kg/d)^{-1}$			
Inhalation unit risk $(mg/m^3)^{-1}$			
Relative dermal absorption factor			
Relative retention factor from soil			
Viable epidermal thickness factor			
Test animal skin area (cm^2)			
Organic carbon partitioning coefficient (mL/g) - Koc			
Log Kow (unitless)			
Henry's Law constant at 25°C (unitless) - H'			
Henry's Law constant at 25°C (atm-m3/mol) - H			
Water Solubility at 25°C (mg/L)			
Molecular Weight (g/mol)			
Diffusivity in air (cm2/s)			
Diffusivity in water (cm2/s)			
Vapour Pressure at 25°C (atm)			
Normal Boiling Point (K) - optional			
Critical Temperature (K) - optional			
Enthalpy of Vaporization @ Boiling Point (cal/mol) - optional			
Biodegradation Adjustment Factor (unitless)			
Half-Life - unsaturated zone (days)			
Half-Life - saturated zone (days)			

NOTE: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor **Results for this receptor are on "User-Defined" tab**

Name		Defaults
Age group		Toddler
Lifestage duration (y)		4.5
Body weight (kg)		16.5
Soil ingestion rate (g/d)		0.08
Inhalation rate (m^3/d)		8.3
Water ingestion rate (L/d)		0.6
Time spent outdoors (h/d)		1.5
Skin surface area (cm^2)		
- hands		430
- arms		890
- legs		1690
- total		6130
Soil loading to exposed skin (g/cm^2/event)		
- hands		0.0001
- surfaces other than hands		0.00001
Soil monolayer loading rate (mg/cm^2)		5
Water adherence to skin (L/cm^2)		0.000007
Food ingestion (g/d)		
- root vegetables		105
- other vegetables		67
- fish		56
- wild game		0

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day at site		24
Hours per day outdoors		1.5
Days per week		7
Weeks per year		52
Dermal exposure events/day		1
Water contact events per day		1
Duration of water contact event (h)		1
Days/year contaminated food ingestion		365
Exposure duration (years)		60
Years for carcinogen amortization		60

SUMMARY OF DQRA RESULTS

Version: **December 12, 2011**

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	October 2014	Comment:	Scenario 1 - Resident/Worker Operational

		Maximum Hazard/Risk Estimates					
		Mercury, inorganic (ionic)	**Lead**				
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		4.94E-08	1.45E-03	NA	NA	NA	NA
Hazard Index - Total		4.94E-08	1.45E-03	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Cancer Risk - Total Lifetime		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Mercury, inorganic (ionic)	**Lead**				
Total - critical age group	Toddler	Toddler	NA	NA	NA	NA
Oral/Dermal - non-cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Total - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters

Vapour Intrusion Model Parameters — **NOTE**: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value

Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Soil vapour alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

NOTES/COMMENTS

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

HEALTH CANADA DQRA SPREADSHEET

USER INPUT SHEET

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	October 2014	Comment:	Scenario 2 - Recreational / Operational

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	Yes	Yes
Commercial with daycare	No	Yes
Commercial without daycare	No	Yes
Industrial	Yes	Yes
Industrial - outdoors	Yes	Yes
Urban recreational	No	Yes
Remote wild lands	No	Yes
Construction/utility work	Yes	Yes
Other		No
specify:		

Exposure Scenario	Urban Recreational	Residential

Receptor Groups (Yes/No)		Default
General public or residents	Yes	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	No	Yes
Inhalation of fugitive dust	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	Yes	Yes
Dermal contact with soil	No	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	No	No

Vapour Transport Modelling		
Vapour source for exposure calculations		Most Conservative
Model applied for soil to indoor air		NA
Model applied for groundwater to indoor air		NA
Model applied for soil vapour to indoor air		NA

Active Critical Receptors (Yes/No)		Default
Infant	Yes	Yes
Toddler	Yes	Yes
Child	Yes	Yes
Teen	Yes	Yes
Adult	Yes	Yes
Construction/Utility Worker	Yes	No
Other		No
specify:		

Contaminant Concentrations

Chemical Name	required	Mercury, inorganic (ionic)	Lead				
Soil (mg/kg)	required	0.62	2362.85				
Mole Fraction in Soil (unitless)	optional						
Groundwater - source (mg/L)	optional						
Mole Fraction in Groundwater (unitless)	optional						
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional		0.000166				
Soil vapours (> 1 m below foundation) (mg/m3)	optional						
Subslab/shallow soil vapour (<1 m) (mg/m3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						

Risk Assessment Endpoints		Default
Acceptable hazard index:		0.2
Acceptable cancer risk:		1.00E-05
Evaluate early lifestage cancer risks?		No

Precluding Conditions for Fate and Transport Models	
Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

FATE AND TRANSPORT MODEL INPUT

	Value	Default	Models Affected
Soil Type		sand	PS, V-H, V-C, V-O, GW
Significant vehicle traffic on unpaved roads?		No	P-O
Site Characteristics			
Source Length (m)		10	GW, V-O
Source Width (m)		10	GW, V-O
Depth to Groundwater (m)		3	GW, V-O
Depth from Surface to Contamination (m)		0	GW, V-O
Thickness of Contamination (m)		3	GW
Distance - Contaminated Soil to Building (m)		1	V-H, V-C
Distance - Contaminated GW to Building (m)		1	V-H, V-C
Depth Below Building to Vapour Sample (m)		1	V-H, V-C
Distance to potable water user (m)		0	GW
Distance to Bathing/Swimming Water (m)		0	GW
Particulate Concentration in Air (ug/m^3)		0.76	P-O
Wind Speed in Mixing Zone (m/s)		4	V-O
Hydrological Parameters			
Recharge (m/y)		0.28	GW
Soil/Groundwater Characteristics	sand		
Vadose Zone			
Dry Bulk Density (g/cm3)		1.660	PS, V-C
Water Content (g/g dry wt)		0.033	PS, V-C
Capillary Zone			
Thickness of Capillary Zone (cm)		17	V-C
Water Content (g/g dry wt)		0.152	V-C
Aquifer/Contaminated Zone			
Saturated Hydraulic Conductivity (m/y)		320	GW
Hydraulic Gradient (m/m)		0.028	GW
Organic Carbon Fraction (g/g)		0.005	PS, GW
Soil Temperature (^{o}C)		21	PS, PGW
Depth of unconfined aquifer (m)		5	GW
Vapour Transport Properties			
Soil Vapour Permeability (cm^2) - CCME model		8.00E-08	V-C
Building Type		Residential - Slab on Grade	V-H, V-C
Building Characteristics	Residential - Slab on Grade		
Building length (m)		12.25	V-C
Building width (m)		12.25	V-C
Building mixing height (m)		3.6	V-H, V-C
Thickness of building foundation (cm)		11.25	V-C
Depth to base of foundation (m)		0.1125	V-C
Air exchanges per hour		0.5	V-C
Pressure differential (Pa)		40	V-C
Crack Area (cm^2)		994.5	V-C
Additional Vapour Intrusion Parameters (Health Canada model)			
Apply biodegradation adjustment?		No	V-H
Apply groundwater mass flux check?		No	V-H
Apply source depletion check?		No	V-H
Additional Groundwater Model Parameters			
Apply biodegradation during transport?		No	GW

OPTIONAL SECTIONS

User-defined Chemicals

NOTE: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

	Chemical 1	Chemical 2	Chemical 3
Name			
CAS Number			
Chemical class (organic/inorganic)			
Tolerable daily intake (mg/kg/d) - infant			
Tolerable daily intake (mg/kg/d) - toddler			
Tolerable daily intake (mg/kg/d) - child			
Tolerable daily intake (mg/kg/d) - teen			
Tolerable daily intake (mg/kg/d) - adult			
Tolerable concentration (mg/m^3)			
Oral slope factor $(mg/kg/d)^{-1}$			
Dermal slope factor $(\mu g/cm^2/d)^{-1}$			
Inhalation slope factor $(mg/kg/d)^{-1}$			
Inhalation unit risk $(mg/m^3)^{-1}$			
Relative dermal absorption factor			
Relative retention factor from soil			
Viable epidermal thickness factor			
Test animal skin area (cm^2)			
Organic carbon partitioning coefficient (mL/g) - Koc			
Log Kow (unitless)			
Henry's Law constant at 25°C (unitless) - H'			
Henry's Law constant at 25°C (atm-m3/mol) - H			
Water Solubility at 25°C (mg/L)			
Molecular Weight (g/mol)			
Diffusivity in air (cm2/s)			
Diffusivity in water (cm2/s)			
Vapour Pressure at 25°C (atm)			
Normal Boiling Point (K) - optional			
Critical Temperature (K) - optional			
Enthalpy of Vaporization @ Boiling Point (cal/mol) - optional			
Biodegradation Adjustment Factor (unitless)			
Half-Life - unsaturated zone (days)			
Half-Life - saturated zone (days)			

Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the DQRA report.

NOTE: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor **Results for this receptor are on "User-Defined" tab**

Name		Defaults
Age group		Toddler
Lifestage duration (y)		4.5
Body weight (kg)		16.5
Soil ingestion rate (g/d)		0.08
Inhalation rate (m^3/d)		8.3
Water ingestion rate (L/d)		0.6
Time spent outdoors (h/d)		1.5
Skin surface area (cm^2)		
- hands		430
- arms		890
- legs		1690
- total		6130
Soil loading to exposed skin (g/cm^2/event)		
- hands		0.0001
- surfaces other than hands		0.00001
Soil monolayer loading rate (mg/cm^2)		5
Water adherence to skin (L/cm^2)		0.000007
Food ingestion (g/d)		
- root vegetables		105
- other vegetables		67
- fish		56
- wild game		0

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day at site		24
Hours per day outdoors		1.5
Days per week		7
Weeks per year		52
Dermal exposure events/day		1
Water contact events per day		1
Duration of water contact event (h)		1
Days/year contaminated food ingestion		365
Exposure duration (years)		60
Years for carcinogen amortization		60

SUMMARY OF DQRA RESULTS

Version: **December 12, 2011**

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	October 2014	Comment:	Scenario 2 - Recreational / Operational

		Maximum Hazard/Risk Estimates					
		Mercury, inorganic (ionic)	**Lead**				
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		1.27E-08	3.72E-04	NA	NA	NA	NA
Hazard Index - Total		1.27E-08	3.72E-04	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Cancer Risk - Total Lifetime		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Mercury, inorganic (ionic)	**Lead**				
Total - critical age group	Toddler	Toddler	NA	NA	NA	NA
Oral/Dermal - non-cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Total - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters

Vapour Intrusion Model Parameters — **NOTE**: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value

Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Soil vapour alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

NOTES/COMMENTS

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

HEALTH CANADA DQRA SPREADSHEET

USER INPUT SHEET

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	February 2015	Comment:	Country Foods - Resident/Worker Operational

PROBLEM FORMULATION

Potential Land Uses (Yes/No)

	Value	Default
Agricultural	Yes	Yes
Residential/urban parkland	Yes	Yes
Commercial with daycare	No	Yes
Commercial without daycare	No	Yes
Industrial	Yes	Yes
Industrial - outdoors	Yes	Yes
Urban recreational	No	Yes
Remote wild lands	No	Yes
Construction/utility work	Yes	Yes
Other		No
specify:		

Exposure Scenario Residential (Default: Agricultural)

Receptor Groups (Yes/No)

	Value	Default
General public or residents	Yes	Yes
Employees	Yes	Yes
Canadian native communities	Yes	No
Other	No	No
specify:		

Operative Pathways (Yes/No)

	Value	Default
Inadvertent ingestion of soil	No	Yes
Inhalation of fugitive dust	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	Yes	Yes
Dermal contact with soil	No	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	Yes	No

Vapour Transport Modelling

	Value	Default
Vapour source for exposure calculations		Most Conservative
Model applied for soil to indoor air		NA
Model applied for groundwater to indoor air		NA
Model applied for soil vapour to indoor air		NA

Active Critical Receptors (Yes/No)

	Value	Default
Infant	Yes	Yes
Toddler	Yes	Yes
Child	Yes	Yes
Teen	Yes	Yes
Adult	Yes	Yes
Construction/Utility Worker	Yes	No
Other		No
specify:		

Contaminant Concentrations

Chemical Name	required	Mercury, inorganic (ionic)	Lead	Methyl mercury			
Soil (mg/kg)	required	0.62	870				
Mole Fraction in Soil (unitless)	optional						
Groundwater - source (mg/L)	optional						
Mole Fraction in Groundwater (unitless)	optional						
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Soil vapours (> 1 m below foundation) (mg/m3)	optional						
Subslab/shallow soil vapour (<1 m) (mg/m3)	optional						
Root vegetables (mg/kg wet weight)	optional	0.00E+00	0.00E+00				
Other vegetables (mg/kg wet weight)	optional	0.00E+00	0				
Fish (mg/kg wet weight)	optional	4.06E-05	7.39E-06	4.10E-05			
Wild game (mg/kg wet weight)	optional	2.89E-03	1.16E-02				

Risk Assessment Endpoints

	Value	Default
Acceptable hazard index:		0.2
Acceptable cancer risk:		1.00E-05
Evaluate early lifestage cancer risks?		No

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

FATE AND TRANSPORT MODEL INPUT

	Value	Default	Models Affected
Soil Type		sand	PS, V-H, V-C, V-O, GW
Significant vehicle traffic on unpaved roads?		No	P-O
Site Characteristics			
Source Length (m)		10	GW, V-O
Source Width (m)		10	GW, V-O
Depth to Groundwater (m)		3	GW, V-O
Depth from Surface to Contamination (m)		0	GW, V-O
Thickness of Contamination (m)		3	GW
Distance - Contaminated Soil to Building (m)		1	V-H, V-C
Distance - Contaminated GW to Building (m)		1	V-H, V-C
Depth Below Building to Vapour Sample (m)		1	V-H, V-C
Distance to potable water user (m)		0	GW
Distance to Bathing/Swimming Water (m)		0	GW
Particulate Concentration in Air (ug/m^3)		0.76	P-O
Wind Speed in Mixing Zone (m/s)		4	V-O
Hydrological Parameters			
Recharge (m/y)		0.28	GW
Soil/Groundwater Characteristics	sand		
Vadose Zone			
Dry Bulk Density (g/cm3)		1.660	PS, V-C
Water Content (g/g dry wt)		0.033	PS, V-C
Capillary Zone			
Thickness of Capillary Zone (cm)		17	V-C
Water Content (g/g dry wt)		0.152	V-C
Aquifer/Contaminated Zone			
Saturated Hydraulic Conductivity (m/y)		320	GW
Hydraulic Gradient (m/m)		0.028	GW
Organic Carbon Fraction (g/g)		0.005	PS, GW
Soil Temperature (^{o}C)		21	PS, PGW
Depth of unconfined aquifer (m)		5	GW
Vapour Transport Properties			
Soil Vapour Permeability (cm^2) - CCME model		8.00E-08	V-C
Building Type		Residential - Slab on Grade	V-H, V-C
Building Characteristics	Residential - Slab on Grade		
Building length (m)		12.25	V-C
Building width (m)		12.25	V-C
Building mixing height (m)		3.6	V-H, V-C
Thickness of building foundation (cm)		11.25	V-C
Depth to base of foundation (m)		0.1125	V-C
Air exchanges per hour		0.5	V-C
Pressure differential (Pa)		40	V-C
Crack Area (cm^2)		994.5	V-C
Additional Vapour Intrusion Parameters (Health Canada model)			
Apply biodegradation adjustment?		No	V-H
Apply groundwater mass flux check?		No	V-H
Apply source depletion check?		No	V-H
Additional Groundwater Model Parameters			
Apply biodegradation during transport?		No	GW

OPTIONAL SECTIONS

User-defined Chemicals

NOTE: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the DQRA report.

	Chemical 1	Chemical 2	Chemical 3
Name			
CAS Number			
Chemical class (organic/inorganic)			
Tolerable daily intake (mg/kg/d) - infant			
Tolerable daily intake (mg/kg/d) - toddler			
Tolerable daily intake (mg/kg/d) - child			
Tolerable daily intake (mg/kg/d) - teen			
Tolerable daily intake (mg/kg/d) - adult			
Tolerable concentration (mg/m^3)			
Oral slope factor (mg/kg/d)$^{-1}$			
Dermal slope factor (μg/cm^2/d)$^{-1}$			
Inhalation slope factor (mg/kg/d)$^{-1}$			
Inhalation unit risk (mg/m^3)$^{-1}$			
Relative dermal absorption factor			
Relative retention factor from soil			
Viable epidermal thickness factor			
Test animal skin area (cm^2)			
Organic carbon partitioning coefficient (mL/g) - Koc			
Log Kow (unitless)			
Henry's Law constant at 25^{o}C (unitless) - H'			
Henry's Law constant at 25^{o}C (atm-m3/mol) - H			
Water Solubility at 25^{o}C (mg/L)			
Molecular Weight (g/mol)			
Diffusivity in air (cm2/s)			
Diffusivity in water (cm2/s)			
Vapour Pressure at 25^{o}C (atm)			
Normal Boiling Point (K) - optional			
Critical Temperature (K) - optional			
Enthalpy of Vaporization @ Boiling Point (cal/mol) - optional			
Biodegradation Adjustment Factor (unitless)			
Half-Life - unsaturated zone (days)			
Half-Life - saturated zone (days)			

NOTE: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Results for this receptor are on "User-Defined" tab

Name		Defaults
Age group		Toddler
Lifestage duration (y)		4.5
Body weight (kg)		16.5
Soil ingestion rate (g/d)		0.08
Inhalation rate (m^3/d)		8.3
Water ingestion rate (L/d)		0.6
Time spent outdoors (h/d)		1.5
Skin surface area (cm^2)		
- hands		430
- arms		890
- legs		1690
- total		6130
Soil loading to exposed skin (g/cm^2/event)		
- hands		0.0001
- surfaces other than hands		0.00001
Soil monolayer loading rate (mg/cm^2)		5
Water adherence to skin (L/cm^2)		0.000007
Food ingestion (g/d)		
- root vegetables		105
- other vegetables		67
- fish		95
- wild game		85

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day at site		24
Hours per day outdoors		1.5
Days per week		7
Weeks per year		52
Dermal exposure events/day		1
Water contact events per day		1
Duration of water contact event (h)		1
Days/year contaminated food ingestion		365
Exposure duration (years)		60
Years for carcinogen amortization		60

SUMMARY OF DQRA RESULTS

Version: **December 12, 2011**

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	February 2015	Comment:	Country Foods - Resident/Worker Operational

		Maximum Hazard/Risk Estimates					
		Mercury, inorganic (ionic)	**Lead**	**Methyl mercury**			
Hazard Quotient - Oral/Dermal		5.04E-02	1.66E-02	1.18E-03	NA	NA	NA
Hazard Quotient - Inhalation		4.94E-08	5.77E-06	NA	NA	NA	NA
Hazard Index - Total		5.04E-02	1.66E-02	1.18E-03	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Cancer Risk - Total Lifetime		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Mercury, inorganic (ionic)	**Lead**	**Methyl mercury**			
Total - critical age group	Toddler	Toddler	Toddler	NA	NA	NA
Oral/Dermal - non-cancer effects	Toddler	Toddler	Toddler	NA	NA	NA
Inhalation - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Total - non-cancer effects	Toddler	Toddler	Toddler	NA	NA	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters

Vapour Intrusion Model Parameters — **NOTE**: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value

Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Soil vapour alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

NOTES/COMMENTS

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

HEALTH CANADA DQRA SPREADSHEET

USER INPUT SHEET

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	February 2015	Comment:	Country Foods- Resident/Worker Opost-Closure

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	Yes	Yes
Residential/urban parkland	Yes	Yes
Commercial with daycare	No	Yes
Commercial without daycare	No	Yes
Industrial	Yes	Yes
Industrial - outdoors	Yes	Yes
Urban recreational	No	Yes
Remote wild lands	No	Yes
Construction/utility work	Yes	Yes
Other		No
specify:		

Exposure Scenario	Residential	Agricultural

Receptor Groups (Yes/No)		Default
General public or residents	Yes	Yes
Employees	Yes	Yes
Canadian native communities	Yes	No
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	No	Yes
Inhalation of fugitive dust	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	Yes	Yes
Dermal contact with soil	No	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	Yes	No

Vapour Transport Modelling		
Vapour source for exposure calculations		Most Conservative
Model applied for soil to indoor air		NA
Model applied for groundwater to indoor air		NA
Model applied for soil vapour to indoor air		NA

Active Critical Receptors (Yes/No)		Default
Infant	Yes	Yes
Toddler	Yes	Yes
Child	Yes	Yes
Teen	Yes	Yes
Adult	Yes	Yes
Construction/Utility Worker	Yes	No
Other		No
specify:		

Contaminant Concentrations

Chemical Name	required	Mercury, inorganic (ionic)	Lead	Methyl mercury			
Soil (mg/kg)	required	0.62	870				
Mole Fraction in Soil (unitless)	optional						
Groundwater - source (mg/L)	optional						
Mole Fraction in Groundwater (unitless)	optional						
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Soil vapours (> 1 m below foundation) (mg/m3)	optional						
Subslab/shallow soil vapour (<1 m) (mg/m3)	optional						
Root vegetables (mg/kg wet weight)	optional	8.14E-05	5.71E-03				
Other vegetables (mg/kg wet weight)	optional	1.54E-04	1.06E-02				
Fish (mg/kg wet weight)	optional	5.28E-06	1.56E-05	5.28E-05			
Wild game (mg/kg wet weight)	optional	5.89E-09	2.18E-07				

Risk Assessment Endpoints		Default
Acceptable hazard index:		0.2
Acceptable cancer risk:		1.00E-05
Evaluate early lifestage cancer risks?		No

Precluding Conditions for Fate and Transport Models	
Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

FATE AND TRANSPORT MODEL INPUT

	Value	Default	Models Affected
Soil Type		sand	PS, V-H, V-C, V-O, GW
Significant vehicle traffic on unpaved roads?		No	P-O
Site Characteristics			
Source Length (m)		10	GW, V-O
Source Width (m)		10	GW, V-O
Depth to Groundwater (m)		3	GW, V-O
Depth from Surface to Contamination (m)		0	GW, V-O
Thickness of Contamination (m)		3	GW
Distance - Contaminated Soil to Building (m)		1	V-H, V-C
Distance - Contaminated GW to Building (m)		1	V-H, V-C
Depth Below Building to Vapour Sample (m)		1	V-H, V-C
Distance to potable water user (m)		0	GW
Distance to Bathing/Swimming Water (m)		0	GW
Particulate Concentration in Air (ug/m^3)		0.76	P-O
Wind Speed in Mixing Zone (m/s)		4	V-O
Hydrological Parameters			
Recharge (m/y)		0.28	GW
Soil/Groundwater Characteristics	sand		
Vadose Zone			
Dry Bulk Density (g/cm3)		1.660	PS, V-C
Water Content (g/g dry wt)		0.033	PS, V-C
Capillary Zone			
Thickness of Capillary Zone (cm)		17	V-C
Water Content (g/g dry wt)		0.152	V-C
Aquifer/Contaminated Zone			
Saturated Hydraulic Conductivity (m/y)		320	GW
Hydraulic Gradient (m/m)		0.028	GW
Organic Carbon Fraction (g/g)		0.005	PS, GW
Soil Temperature (^{o}C)		21	PS, PGW
Depth of unconfined aquifer (m)		5	GW
Vapour Transport Properties			
Soil Vapour Permeability (cm^2) - CCME model		8.00E-08	V-C
Building Type		Residential - Slab on Grade	V-H, V-C
Building Characteristics	Residential - Slab on Grade		
Building length (m)		12.25	V-C
Building width (m)		12.25	V-C
Building mixing height (m)		3.6	V-H, V-C
Thickness of building foundation (cm)		11.25	V-C
Depth to base of foundation (m)		0.1125	V-C
Air exchanges per hour		0.5	V-C
Pressure differential (Pa)		40	V-C
Crack Area (cm^2)		994.5	V-C
Additional Vapour Intrusion Parameters (Health Canada model)			
Apply biodegradation adjustment?		No	V-H
Apply groundwater mass flux check?		No	V-H
Apply source depletion check?		No	V-H
Additional Groundwater Model Parameters			
Apply biodegradation during transport?		No	GW

OPTIONAL SECTIONS

User-defined Chemicals

NOTE: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the DQRA report.

	Chemical 1	Chemical 2	Chemical 3
Name			
CAS Number			
Chemical class (organic/inorganic)			
Tolerable daily intake (mg/kg/d) - infant			
Tolerable daily intake (mg/kg/d) - toddler			
Tolerable daily intake (mg/kg/d) - child			
Tolerable daily intake (mg/kg/d) - teen			
Tolerable daily intake (mg/kg/d) - adult			
Tolerable concentration (mg/m^3)			
Oral slope factor (mg/kg/d)$^{-1}$			
Dermal slope factor (μg/cm^2/d)$^{-1}$			
Inhalation slope factor (mg/kg/d)$^{-1}$			
Inhalation unit risk (mg/m^3)$^{-1}$			
Relative dermal absorption factor			
Relative retention factor from soil			
Viable epidermal thickness factor			
Test animal skin area (cm^2)			
Organic carbon partitioning coefficient (mL/g) - Koc			
Log Kow (unitless)			
Henry's Law constant at 25^{o}C (unitless) - H'			
Henry's Law constant at 25^{o}C (atm-m3/mol) - H			
Water Solubility at 25^{o}C (mg/L)			
Molecular Weight (g/mol)			
Diffusivity in air (cm2/s)			
Diffusivity in water (cm2/s)			
Vapour Pressure at 25^{o}C (atm)			
Normal Boiling Point (K) - optional			
Critical Temperature (K) - optional			
Enthalpy of Vaporization @ Boiling Point (cal/mol) - optional			
Biodegradation Adjustment Factor (unitless)			
Half-Life - unsaturated zone (days)			
Half-Life - saturated zone (days)			

NOTE: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor **Results for this receptor are on "User-Defined" tab**

Name		Defaults
Age group		Toddler
Lifestage duration (y)		4.5
Body weight (kg)		16.5
Soil ingestion rate (g/d)		0.08
Inhalation rate (m^3/d)		8.3
Water ingestion rate (L/d)		0.6
Time spent outdoors (h/d)		1.5
Skin surface area (cm^2)		
- hands		430
- arms		890
- legs		1690
- total		6130
Soil loading to exposed skin (g/cm^2/event)		
- hands		0.0001
- surfaces other than hands		0.00001
Soil monolayer loading rate (mg/cm^2)		5
Water adherence to skin (L/cm^2)		0.000007
Food ingestion (g/d)		
- root vegetables		105
- other vegetables		67
- fish		95
- wild game		85

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day at site		24
Hours per day outdoors		1.5
Days per week		7
Weeks per year		52
Dermal exposure events/day		1
Water contact events per day		1
Duration of water contact event (h)		1
Days/year contaminated food ingestion		365
Exposure duration (years)		60
Years for carcinogen amortization		60

SUMMARY OF DQRA RESULTS

Version: **December 12, 2011**

User Name:	KG	Site:	Goliath
Proponent:	Treasury Metals Inc.	File #:	704-ENVMIN03018-01
Date:	February 2015	Comment:	Country Foods- Resident/Worker Opost-Closure

		Maximum Hazard/Risk Estimates					
		Mercury, inorganic (ionic)	**Lead**	**Methyl mercury**			
Hazard Quotient - Oral/Dermal		7.25E-03	4.19E-02	1.52E-03	NA	NA	NA
Hazard Quotient - Inhalation		4.94E-08	5.77E-06	NA	NA	NA	NA
Hazard Index - Total		7.25E-03	4.19E-02	1.52E-03	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Cancer Risk - Total Lifetime		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Mercury, inorganic (ionic)	**Lead**	**Methyl mercury**			
Total - critical age group	Infant	Infant	Toddler	NA	NA	NA
Oral/Dermal - non-cancer effects	Infant	Infant	Toddler	NA	NA	NA
Inhalation - non-cancer effects	Toddler	Toddler	NA	NA	NA	NA
Total - non-cancer effects	Infant	Infant	Toddler	NA	NA	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters

Vapour Intrusion Model Parameters — **NOTE**: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value

Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Soil vapour alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

NOTES/COMMENTS

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

APPENDIX D
ECOLOGICAL INFORMATION

APPENDIX D: WILDLIFE DIET MODEL INPUT AND EXPLANATION

The purpose of completing a wildlife diet uptake model was to estimate a total exposure concentration for each COC and selected wildlife receptor with terrestrial based diets so that separate estimates of risk using hazard quotients (HQ) could be calculated for each wildlife receptor.

The total oral exposure experienced by an individual is the sum of the exposures attributable to each source and may be calculated using a diet model (Sample and Suter 1994). For mammals and birds that may receive exposure from multiple environmental media, exposure is determined by equations that include input factors such as ingestion rates, time spent in the area, diet composition, and size of the animal. Wildlife input factors were combined with site-specific exposure point concentrations (EPC) and used in a diet model to estimate exposure concentrations for hare, deer, and grouse exposed to COCs from the Goliath Mine Site.

The following information is presented in Appendix D.

- Table D1 presents the hare, deer, and grouse input factors (e.g., body weight, territory size, soil ingestion rate, dietary composition, food ingestion rate) that were used in the wildlife diet model;
- A complete description and breakdown of the wildlife diet model. This includes the two model runs completed for the operational and post-closure phases which are presented in Tables D3-1 and D3-2;
- Table D6 presents the toxicity reference values (TRVs) used for mammals and birds; and,
- The HQs generated for hare, deer, and grouse are presented in Table D7.

1.0 EXPOSURE EQUATIONS

The exposure estimations for wildlife are based on a modified wildlife dietary exposure model by Sample and Suter (1994). This model derives exposure for livestock receptors using concentrations in soil, and contaminated food items as presented below. Tables D3-1 and D3-2 of Appendix D present the results of the model runs used to derive mercury and lead exposure concentrations for hare, deer, and grouse.

Receptor Exposure - Body Weight (BW) Normalized Daily Dose:

– $E_{bw\ total} = (E_{total} / BW) \times (HQF)$

Where:

– Ebw total = total body weight normalized daily exposure (mg/kg bw day)

– E total = total exposure from all pathways (mg/day)

– BW = body weight of species (kg)

– HQF = dose adjustment factor (unitless)

Habitat Quality or Dose Adjustment Factor:

- Wildlife $HQF_{site\text{-}specific} = (A_{site} / FA) \times HQ \times UE$

Where:

- HQF = habitat quality factor (unitless)
- A site = area of tailings (ha)
- FA = foraging range of species (ha). For the SLRA the FA was conservatively assumed to equal entire area of the Project for each receptor
- Habitat Quality = habitat quality (unitless); equal to 0.5
- UE = uptake/assimilation efficiency (unitless); a conservative estimate equal to 1; assumes 100% assimilation of the contaminant

Average foraging areas were chosen from the FCSAP (2012) document, and the FA value equivalent to the area of the site was used in the HQF equation presented above. Normally if the foraging range of a wildlife receptor is less than or equal to the size of the site, then the FA = 1. This makes the site-specific HQF equal to one, which would be the case for the hare. If the foraging range of the wildlife receptor is greater than the size of the site, as is the case for the deer and grouse, then the FA would be calculated to represent the fraction of their diet that would be potentially obtained from the site. Due to the screening nature of the RA a conservative assumption was applied that all three wildlife could obtain all of their food from the tailings located on the Project site. It is unlikely that hare, deer, and grouse would be able to obtain all of their food within the perimeters of the tailings pile/beach based on the limited habitat quality provided by the tailings. Therefore, it was assumed that each of the three receptors could spend up to half of their time foraging for food within the confines of the tailings area during both operational and post-closure at the Project. Therefore, a HQ of 0.5 was assumed based on the limited habitat quality provided by the tailings. The HQF likely over represents the amount of time that each animal would likely spend at the Project site, but will not under represent their exposure. Site-specific exposures were ultimately divided by a TRV to generate separate estimates of risk using hazard quotients (HQ) for each wildlife receptor.

Total Receptor Exposure:

Exposures were calculated as daily doses of COC, identified in Tables D3-1, and D3-2 of Appendix D.

$$E_{total} = E_{food} + E_{soil} + E_{drinking\ water}$$

Where:

- E_{total} = total exposure from all pathways (mg/day)
- E_{food} = exposure from food consumption (mg/day)
- E_{soil} = exposure from soil consumption (mg/day)

Food Ingestion:

- $E_{food} = C_{food} \times (P \times FIR_{food})$

Where:

- E food = exposure from food consumption (mg/day)
- C food = COC concentration in food (mg/kg) dry wt
- P = proportion of the food type in the diet, as identified in Table D1 of Appendix D. Both hare and deer were assumed to have a diet composed 100% of plants while grouse had a diet composed of 85% plants and 15% soil invertebrates.
- FIR_{food} = food ingestion rate (kg/day) dry wt

Food ingestion rates were calculated for wildlife receptors using the Nagy (1987) allometric equations for birds and mammals, as presented in the Wildlife Exposure Factors Handbook (1993). Calculated Food Ingestion Rates (FIR) are presented in Table D1 of the Wildlife Diet Model, in Appendix D.

Ingestion of Soil:

- $E_{soil} = (C_{soil} \times SIR_{soil})$

Where:

- E soil = exposure from soil (mg/day)
- C soil = COC concentration in soil (mg/kg) dry wt
- SIR_{soil} = ingestion rate of soil (kg/day) dry wt

Soil ingestion rates were calculated for wildlife receptors using values presented in the Wildlife Exposure Factors Handbook (1993), or by using species-specific database searches. Calculated Soil Ingestion Rates (SIR) are presented in Table D1 of the Wildlife Diet Model, in Appendix D.

2.0 EXPOSURE POINT CONCENTRATIONS

Sources of COCs were calculated for relevant environmental media from the Goliath Mine Site. This included COC concentrations in tailings, plants, and ground insects.

2.1 Soil/Tailings

Tailings are a source of exposure during the operational phase of the Project. Maximum tailings concentrations for lead was obtained from the EcoMetrix Geochemistry draft reprort (2013). Tailings COCs were generated from one composite sample. No tailings concentrations were available for mercury therefore the mercury concentration in waste rock from the KCB Baseline report (2012) was used to represent the mercury concentration in tailings.

During the closure phase of the Project the tailings will be encapsulated at closure with a pioneer layer to fill voids, a water shedding layer of clay to minimize penetration of water, and a soil layer to support vegetation. The encapsulation will tie into the surrounding clay soils to minimize runoff and shallow groundwater penetration. Baseline soil concentrations were used to represent exposure during the post-closure phase of the Project.

2.2 Plants/Vegetation

Plants are a common food source for hare, deer, and grouse. Maximum COC concentrations in the composite tailings sample were estimated using a literature-derived regression model for mercury and lead. The regression equation used was from Bechtel et al. (1998) and is presented below and in Table D2 of Appendix D:

ln(Pb in plants dw) = -1.33 + 0.56*ln(Pb in taillings dw)

ln(Hg in plants dw) = -0.996 + 0.544*ln(Hg in taillings dw)

2.3 Soil Invertebrate

Ground insects, specifically soil invertebrates, are a common food source for grouse. Maximum COC concentrations in soil invertebrate tissues were estimated using a literature-derived regression model for mercury and lead.The regression equation used was from Sample et al. (1998) and is presented below and in Table D2 of Appendix D:

ln(Pb in soil invertebrate dw) = -0.218 + 0.807*ln(Pb in tailings dw)

ln(Hg in soil invertebrate dw) = -0.684 + 0.118*ln(Hg in tailings dw)

TABLE D1: EXPOSURE ASSESSMENT PARAMETERS USED IN THE WILDLIFE DIET MODEL

Species	Parameter	Parameter Abbreviation	Units	Value	Reference
Surface Area of Impacted Soils on the Site = 125 ha					
Snowshoe Hare	Body Weight (average)	BW	kg	1.3	FCSAP Azimuth 2012
(herbivorous mammal)	Foraging Range (average)		ha	1.6	FCSAP Azimuth 2012
wet wt	Ingestion water	WIR	L/kg BW /day	0.1	FCSAP Azimuth 2012
dry wt	Ingestion soil (6.3%)	SIR	kg/day	0.01	Calculated with FCSAP Azimuth 2012 data
dry wt	Ingestion food	FIR	kg/day	0.09	Nagy, 1987; In Wildlife Exposure Handbook USEPA 1993.
	Diet composition Used in SLRA	Vegetation	%	100	FCSAP Azimuth 2012
White-tailed Deer	Body Weight (average)	BW	kg	75	FCSAP Azimuth 2012
(herbivorous mammal)	Foraging Range (average)		ha	30 to 2435	FCSAP Azimuth 2012
wet wt	Ingestion water	WIR	L/kg BW /day	0.06	FCSAP Azimuth 2012
dry wt	Ingestion soil (<2%)	SIR	kg/day	0.05	Calculated with FCSAP Azimuth 2012 data
dry wt	Ingestion food	FIR	kg/day	2.39	Nagy, 1987; In Wildlife Exposure Handbook USEPA 1993.
	Diet composition Used in SLRA	Vegetation	%	100	FCSAP Azimuth 2012
Moose	Body Weight (average)	BW	kg	400	FCSAP Azimuth 2012
(herbivorous mammal)	Foraging Range (average)		ha	460	FCSAP Azimuth 2012
wet wt	Ingestion water	WIR	L/kg BW /day	0.05	FCSAP Azimuth 2012
dry wt	Ingestion soil (<2%)	SIR	kg/day	0.19	Calculated with FCSAP Azimuth 2012 data
dry wt	Ingestion food	FIR	kg/day	9.46	Nagy, 1987; In Wildlife Exposure Handbook USEPA 1993.
	Diet composition Used in SLRA	Vegetation	%	100	FCSAP Azimuth 2012
Ruffed Grouse	Body Weight (average)	BW	kg	0.552	FCSAP Azimuth 2012
(omnivorous bird)	Foraging Range (average)		ha	1 to 180	FCSAP Azimuth 2012
wet wt	Ingestion water	WIR	L/kg BW /day	0.07	FCSAP Azimuth 2012
dry wt	Ingestion soil (<2%)	SIR	kg/day	0.0008	Calculated with US EPA 1993 data
dry wt	Ingestion food	FIR	kg/day	0.04	Nagy, 1987; in Wildlife Exposure Handbook USEPA 1993.
	Diet composition Used in SLRA	Ground Insects	%	15	FCSAP Azimuth 2012
		Vegetation	%	85	FCSAP Azimuth 2012

Notes:
SIR was calcluated using FIR and incidental soil or sediment ingestion rate percentage
Wildlife FIR was calculated using the following equations:
a/ Mammal FIR = 0.0687*(BW (kg)^0.822).
b/ Avian FIR = 0.0582*(BW(kg)^0.651).
FIR obtained from Nagy 1987, SIR obtained from multiple sources (refer to Table 1)
c/ Mammal WIR = 0.099 * (BW(kg)^0.9)
d/ Avian WIR = 0.059 * (BW(kg)^0.67)

TABLE D2: BIOACCUMULATION FACTORS USED TO CALCULATE COC CONCENTRATIONS IN SOIL INVERTEBRATES AND PLANTS

COC	BAF - Bioaccumulation Factor Soil to Soil Invertebrate[a]	BAF - Bioaccumulation Factor Soil to Plant [b]
COPC		
Lead	ln(Pb in soil invertebrate dw) = -0.218 + 0.807*ln(Pb in taillings dw)	ln(Pb in plants dw) = -1.33 + 0.56*ln(Pb in taillings dw)
Mercury	ln(Hg in soil invertebrate dw) = -0.684 + 0.118*ln(Hg in tailings dw)	ln(Hg in plants dw) = -0.996 + 0.544*ln(Hg in taillings dw)

Notes:

a/ BAF obtained from Sample et al. 1998 - earthworms; Table 12.

b/ BAF obtained from Bechtel et al. 1998 - above ground plants; Table 7.

TABLE D3-1: ECOLOGICAL DIET MODEL FOR WILDLIFE EXPOSED TO MINE-RELATED COCS DURING THE OPERATIONAL PHASE

Receptor	Body Weight (BW) (kg)	Dry Food Ingestion Rate[a] (FIR) (kg dw/day)	Dry Soil Ingestion Rate (SIR) (kg dw/day)	Surface Water Ingestion Rate (WIR) (L/day)	Food Item (A/B/C/D)	Diet Compostition (P)(%)	COPC	Site-Specific Media Concentrations: Food Source (mg/kg) dry (C_{food})	Site-Specific Media Concentrations: Tailings (mg/kg) dry (C_{soil})	Site-Specific Media Concentrations: Surface Water (mg/L) (C_{water})	Site-Specific Exposure (E): Food: E_{food}= [Sum C_{food} *(FIR*P)]/BW (mg/kg day)	Site-Specific Exposure (E): Soil: E_{soil}= (C_{soil}*SIR)/BW (mg/kg day)	Site-Specific Exposure (E): Water: E_{water}= (C_{water}*WIR)/BW (mg/kg day)	Habitat Quality Factor (HQF) (unitless)	Sum Site-Specific Exposure: $E_{SS\ total}$ (mg/kg day) = (E_{food} + E_{soil} + E_{water}) * HQF
Snowshoe Hare	1.3	0.09	0.005	0.1	A/ vegetation	1.00	mercury	0.28	0.62	0.00002	0.019	0.0026	0.000001538	0.5	0.0106
							lead	11.71	870	0.00337	0.768	3.5936	0.000259231		2.1808
White-tailed Deer	75	2.39	0.05	0.06	A/ vegetation	1.00	mercury	0.28	0.62	0.00002	0.009	0.0004	0.000000016	0.5	0.0047
							lead	11.71	870	0.00337	0.373	0.5543	0.000002696		0.4637
Moose	400	9.46	0.2	0.05	A/ vegetation	1.00	mercury	0.28	0.62	0.00002	0.007	0.0003	0.0000000025	0.5	0.0035
							lead	11.71	870	0.00337	0.277	0.4115	0.000000421		0.3442
Ruffed Grouse *	0.6	0.04	0.0008	0.07	A/ vegetation	0.85	mercury	0.28	0.62	0.00002	0.022	0.0009	0.000002536	0.5	0.0116
							lead	11.71	870	0.00337	2.748	1.2461	0.000427355		1.9972
					B/ ground insects	0.15	mercury	0.46	0.62	0.00002	* Plant and ground insect concentrations were added together to derive exposure for Ruffed Grouse.				
							lead	189.46	870	0.00337					

Niche of all receptors (and subsequently exposure) is fully contained to the Site.

TABLE D3-2: ECOLOGICAL DIET MODEL FOR WILDLIFE EXPOSED TO MINE-RELATED COCS DURING THE POST-CLOSURE PHASE

Receptor	Body Weight (BW) (kg)	Dry Food Ingestion Rate[a] (FIR) (kg dw/day)	Dry Sediment Ingestion Rate (SIR) (kg dw/day)	Dry Soil Ingestion Rate (SIR) (kg dw/day)	Surface Water Ingestion Rate (WIR) (L/day)	Food Item (A/B/C/D)	Diet Compostition (P)(%)	COPC	Site-Specific Media Concentrations: Pit Lake (mg/L) (C_{water})	Site-Specific Exposure (E): Water: E_{water}= (C_{water}*WIR)/BW (mg/kg day)	Habitat Quality Factor (HQF) (unitless)	Sum Site-Specific Exposure: $E_{SS\ total}$ (mg/kg day) = (E_{food} + E_{soil} + E_{water}) * HQF
Snowshoe Hare	1.3	0.09	n/a	0.005	0.1	A/ vegetation	1.00	mercury	0.000005425	0.000000417	0.5	0.0000002
								lead	0.00507	0.000390000		0.0002
White-tailed Deer	75	2.4	n/a	0.05	0.06	A/ vegetation	1.00	mercury	0.000005425	0.000000004	0.5	0.000000002
								lead	0.00507	0.000004056		0.000002
Moose	400	9.5	n/a	0.2	0.05	A/ vegetation	1.00	mercury	0.000005425	0.000000001	0.5	0.0000000003
								lead	0.00507	0.000000634		0.00000032
Ruffed Grouse *	0.6	0.04	n/a	0.0008	0.07	A/ vegetation	0.85	mercury	0.000005425	0.000000688	0.5	0.0000003
								lead	0.00507	0.000642935		0.0003
						B/ ground insects	0.15	mercury	0.000005425	* Plant and ground insect concentrations were added together to derive exposure for Ruffed Grouse.		
								lead	0.00507			

Niche of all receptors (and subsequently exposure) is fully contained to the Site.

TABLE D4: TOXICITY REFERENCE VALUES FOR MAMMALS

COC	Endpoint	TRV (mg/kg/d)	Rationale	Reference
Mercury	NOAEL	1.01	A NOAEL of 1 mg/kg-day was reported for effects on reproduction (i.e., kit weight, fertility and kit survival) in laboratory mink that were exposed to 1.01 mg/kg-day of mercury (as mercuric chloride) in their diet throughout gestation (six months). Fertility and kit survival were not reduced, and kit weight was reduced by 9%; these responses were considered to be representative of a NOAEL. Exposure was considered to be chronic because it occurred during a critical life stage. No LOAEL for inorganic mercury was identified.	Sample et al. 1996
Lead	NOAEL	4.7	2,429 papers with possible toxicity data for lead for either avian or mammalian species. Of these studies, 2,157 were rejected for use. Of the remaining papers, 219 contained data for mammalian test species. The TRV is equal to the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth or survival.	USEPA Eco-SSL, 2005

TABLE D5: TOXICITY REFERENCE VALUES FOR BIRDS

COC	Endpoint	TRV (mg/kg/d)	Rationale	Reference
Mercury	LOAEL	0.9	A LOAEL of 0.9 mg/kg-day and a NOAEL of 0.45 mg/kg-day were reported for reproduction for Japanese quail that were exposed to mercuric chloride in the diet for one year.	Sample et al., 1996
Lead	NOAEL	1.63	2,429 papers with possible toxicity data for either avian or mammalian species. Of these studies, 2,157 were rejected for use. Of the remaining studies, 54 contained data for avian test species. The TRV is equal to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth or survival.	USEPA Eco-SSL, 2005

TABLE D6: SUMMARY OF TOXICITY REFERENCE VALUES FOR THE WILDLIFE DIET MODEL

Receptor	COC	TRV (mg dw/kg bw/day)
Mammal	Mercury	1.01
	Lead	4.7
Bird	Mercury	0.9
	Lead	1.63

TABLE D7: SUMMARY OF HAZARD QUOTIENTS FOR WILDLIFE EXPOSED TO MINE-RELATED COCS DURING THE OPERATIONAL AND POST-CLOSURE PHASES OF THE MINE

Receptor	COC	Total Exposure (E_{total})		Toxicity Reference Value (mg/kg bw/day)	Hazard Quotient (HQ = E / TRV)	
		Operational $E_{OP\ total}$ (mg/kg bw/day)	Post-Closure $E_{CL\ total}$ (mg/kg bw/day)		Operational HQ (HQ_{OP})	Post-Closure HQ (HQ_{CL})
Snowshoe Hare	Mercury	0.0106	0.000000209	1.01	0.01	0.0000002
	Lead	2.1808	0.000195000	4.7	0.5	0.00004
White-tailed Deer	Mercury	0.0047	0.000000002	1.01	0.005	0.000000002
	Lead	0.4637	0.000002028	4.7	0.1	0.0000004
Moose	Mercury	0.0035	0.0000000003	1.01	0.003	0.0000000003
	Lead	0.3442	0.000000317	4.7	0.1	0.0000001
Ruffed Grouse	Mercury	0.0116	0.000000344	0.9	0.01	0.0000004
	Lead	1.9972	0.000321467	1.63	**1.2**	0.0002