EAGLE GOLD MINE

RECLAMATION AND CLOSURE PLAN

Version 2022-01

OCTOBER 2022

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DOCUMENT CONTROL

Submission History

Version Number	Version Date	Document Description and Revisions Made
2014-01	Aug 2014	Original submission in support of an application to the Yukon Water Board for a Type A Water Use License for the full Construction, Operation and Closure of the Project. Version 2014-01 was also submitted to the Department of Energy, Mines and Resources in support of an application for a Quartz Mining Licence allowing the full Construction, Operation and Closure of the Project.
2016-01	Oct 2016	Revised based on information provided by the Yukon Water Board (YWB), Yukon Government, the First Nation of Nacho Nyak Dun (FNNND), and other interveners during the regulatory approvals phase of the Project and to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.
2018-01	Jul 2017	Revisions made to reflect the current site general arrangement and submitted to the Yukon Water Board in response to an information request in relation to the Type A WUL Amendment Application.
2018-02	Aug 2017	Minor revision made in support of an application to the Yukon Water Board for a Type A Water Use License amendment for the Project.
2018-03	Oct 2018	Revised to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.
2020-01	Oct 2020	Revised to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.
2022-01	Oct 2022	Revised to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.

Version 2022-01 of the Reclamation and Closure Plan (the Plan) for the Eagle Gold Mine (the Mine) has been revised in September 2022 to update Version 2020-01 submitted to the Yukon Water Board in October 2020.

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List of Acronyms and Abbreviations

ADR ... adsorption, desorption and recovery
ARD ... acid rock drainage
CCBA ... Comprehensive Cooperation Benefit Agreement
CSL ... Contango Strategies Limited
CWTS ... constructed wetland treatment system
DGDC ... Dublin Gulch diversion channel
DRP ... Decommissioning and Reclamation Plan
EMR ... Yukon Government Department of Energy, Mines, and Resources
FN ... First Nations
FNNND ... First Nation of Na-Cho Nyäk Dun
ha ... hectares
HLF ... heap leach facility
HRT ... hydraulic retention time
KPL ... Knight Piésold Ltd.
LSA ... local study area
m ... metres
m^2 ... square metres
m^3/ha ... cubic metres per hectare
Mine ... Eagle Gold Mine
ML ... metal leaching
MLU ... Mining Land Use
MWh/y ... megawatt hours per year
NSR ... net smelter return
PLS ... pregnant leach solution
PTS ... passive treatment system
QMA ... *Quartz Mining Act*
QML ... quartz mining licence
RoW ... right of way
RRC ... removal rate coefficient

RSA ... regional study area

SCP ... seepage collection pond

UTM ... Universal Transverse Mercator

VGC ... Victoria Gold Corp.

WMP ... water management plan

WRSA ... waste rock storage area

WUL ... Water Use Licence

MWTP ... mine water treatment plant

YESAA ... *Yukon Environmental and Socio-economic Assessment Act*

YESAB ... Yukon Environmental and Socio-economic Assessment Board

YG ... Yukon Government

yrs ... years

YT ... Yukon Territory

YQMA ... Yukon Quartz Mining Act

YWA ... Yukon Waters Act

YWB ... Yukon Water Board

1 INTRODUCTION

Victoria Gold (Yukon) Corp. (VGC) currently operates and will complete progressive and final closure and reclamation of the Eagle Gold Mine. The Eagle Gold Mine ("the Mine") is located 85 km from Mayo, Yukon using existing highway and access roads (Figure 1-1). The Mine (Figure 1-2) involves open pit mining and gold extraction using a three-stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over the mine life.

This *Reclamation and Closure Plan* (RCP) addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances from existing development. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed.

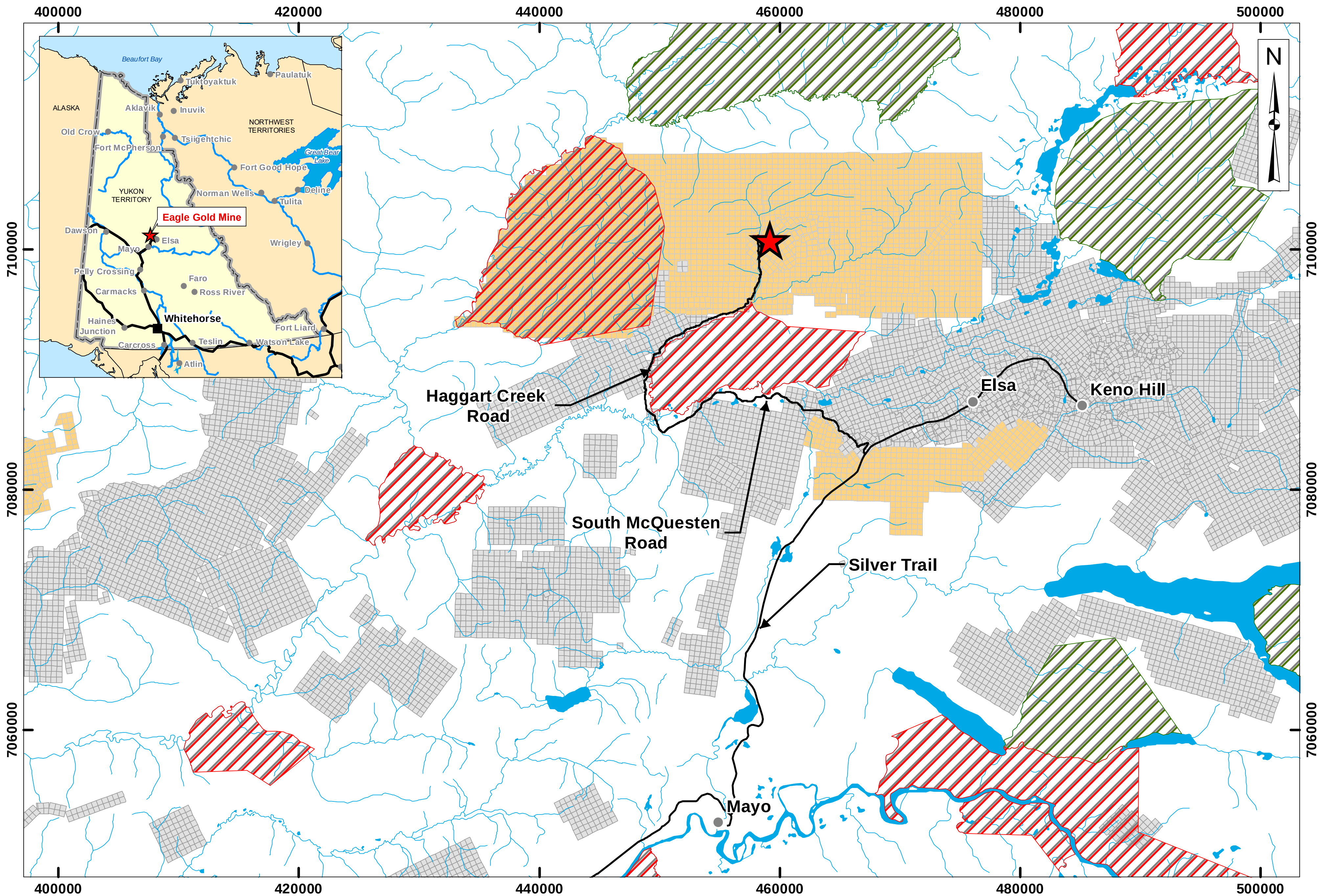
The Mine has received regulatory approvals that allow the construction, operation, and closure pursuant to the *Yukon Waters Act,* which covers the administration of Type A and B Water Use Licences (WUL) and the *Yukon Quartz Mining Act*, which covers the administration of Quartz Mining Licenses (QML). The Mine is being operated in accordance with the terms of the Type A WUL QZ14-041-1 and the QML QML-0011. The Mine operations commenced in July 2019 and commercial production was declared in July 2020.

This current version of the RCP (Version 2022-01) is submitted to Yukon Water Board (YWB) and the Department of Energy, Mines and Resources (EMR) in accordance with Clause 148 (b) of QZ14-041-1 and Clause 7.2 of QML-0011 that require an update to the RCP every 2 years. The previous version of the RCP (Version 2020-01) was submitted to the Yukon Water Board (YWB) and Yukon Government (YG); however, the RCP (Version 2018-03) remains the approved version.

At present, VGC has posted a reclamation bond in the amount of $68,662,300 with the Government of Yukon, as represented by the Minister of Energy, Mines and Resources, as Obligee.

1.1 SCOPE OF THE RECLAMATION AND CLOSURE PLAN

This RCP has been specifically scoped to fulfill the requirements of the Type A WUL QZ14-041-1 and QML-0011 issued for the Mine through utilization of the EMR and YWB guidance document *Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance,* released August 2013. This guide provides overall guidance about expected processes for developing RCPs and performance outcome for reclamation and closure. This RCP should be considered as a living, dynamic document that will be refined throughout mine planning, development and operation.



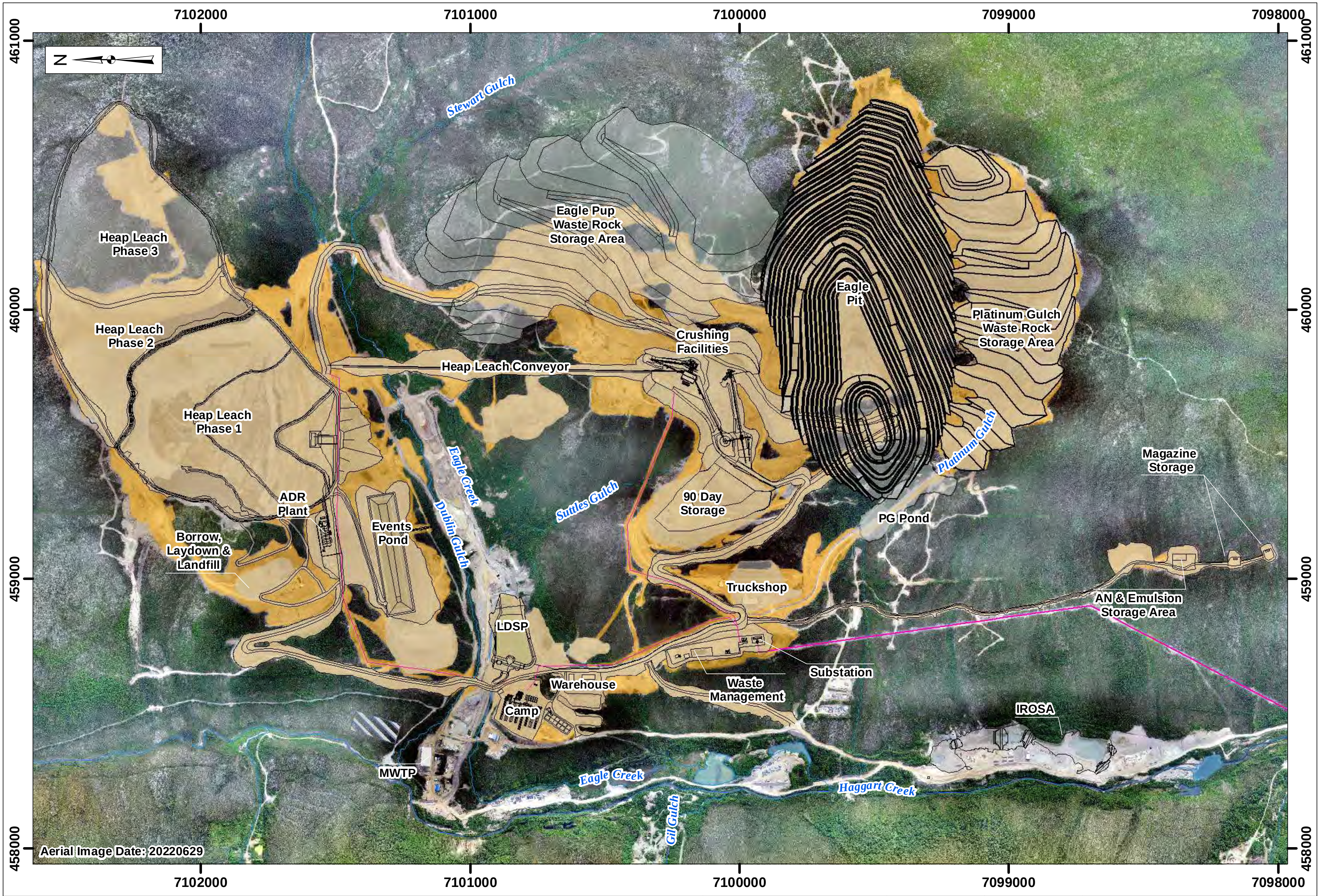
Legend:

- ★ Eagle Gold Mine
- Victoria Gold Claims
- Other Claims
- ● Town / Village
- Road
- Watercourse
- Category A Settlement Land
- Category B Settlement Land

VICTORIA GOLD CORP

Projection:	Drawn By:	
NAD 83 Zone 8N	HC	**EAGLE GOLD MINE YUKON TERRITORY**
Date: 2020/01/27	Figure: 1-1	**Mine Location**

0 3 6 12 Kilometres



Legend:

- Major Facility
- Site Power
- Reserved Area
- Current Construction and Mining Impacted Areas
- Watercourse - Perennial
- Watercourse - Ephemeral
- Watercourse - Intermittent

VICTORIA GOLD CORP

0 125 250 500
Metres

Projection:	Drawn By:	EAGLE GOLD MINE YUKON TERRITORY
NAD 83 UTM Zone 8N	HC	
Date: 2022/10/01	Figure: 1-2	End of Mine Life General Arrangement

2 RECLAMATION AND CLOSURE PLANNING

The overall strategy for the RCP is to provide the proposed approach to decommission mine features, reclaim landforms, and provide a monitoring program to implement until mitigation measures have achieved the closure objectives. The focus of the RCP is to guide the return of the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. The objectives of the RCP are to address water quality, physical stability (stable landforms), land use, aesthetics, and public health and safety.

Section 2.1 below presents a brief outline of the current status of reclamation and research planning for the Mine site and Section 10 outlines the ongoing and planned reclamation research for VGC's closure planning.

2.1 STATUS OF RECLAMATION AND CLOSURE PLANNING

Figure 2-1 below illustrates that the closure planning for mining projects is a continuum, and that the details contributing to closure implementation strategy, including level of design, should increase as a mine moves through the mine life cycle. As closure planning increases in detail, the information is integrated into development and operational decision making. The Eagle Gold Mine is considered to be within the early operations period, with commercial production declared on July 1, 2020. Critical site-specific data has been collected for various disciplines and engineering detail has been advanced to support more detailed closure planning as discussed herein. The programs and engineering advanced to date has been informed by prior regulatory reviews and it is anticipated that the additional work contemplated in 2023 and 2024 will allow for additional detailed input from stakeholders, beyond the review and approval process, as is contemplated in Figure 2-1.

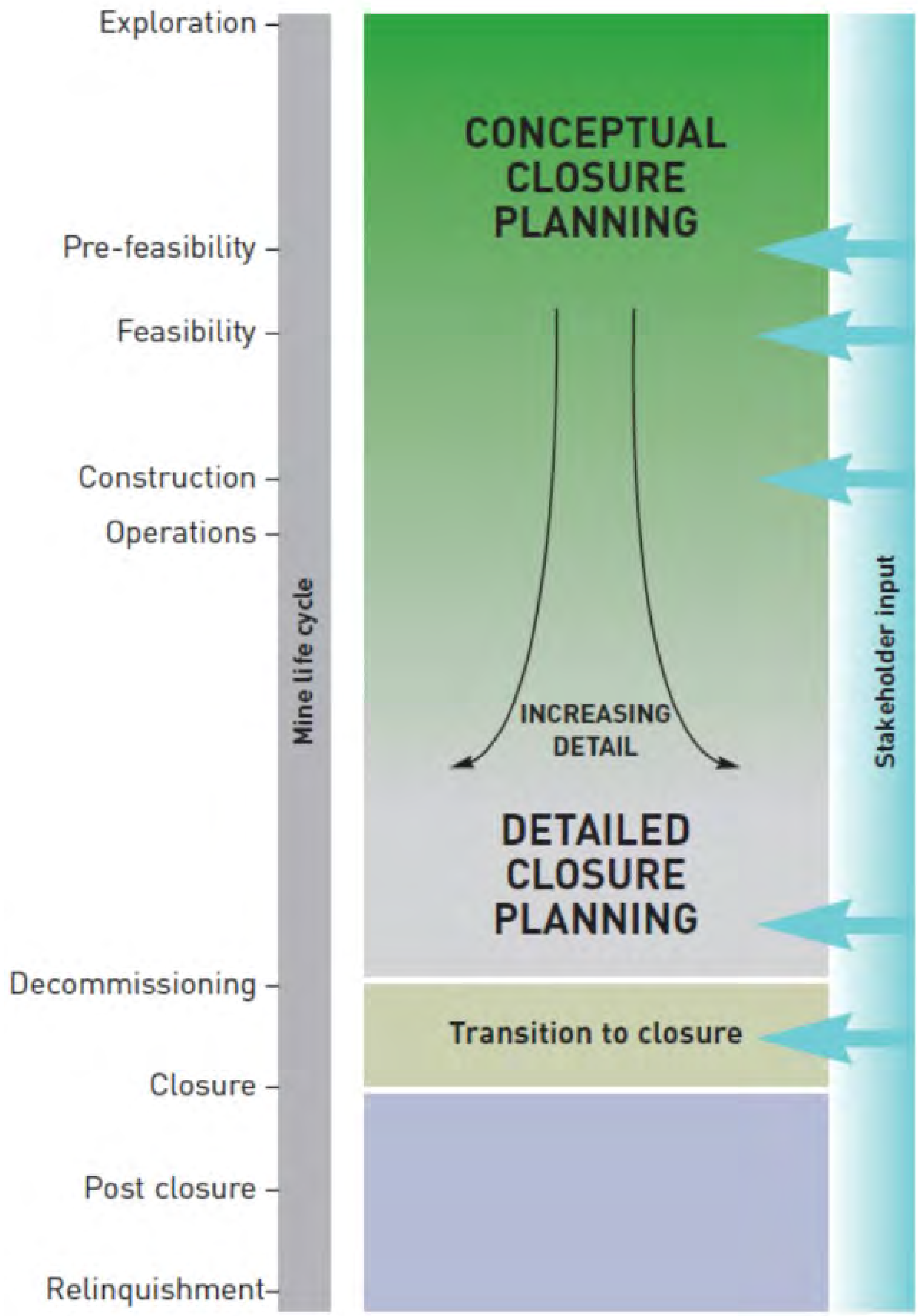


Figure 2-1: Continuum of Closure Planning Relative to Mine Life Cycle

2.2 SUMMARY OF RECLAMATION RESEARCH COMPLETED TO DATE

VGC has developed reclamation research programs to be implemented during the Operations Phase to identify, characterize, evaluate and optimize closure practices, as described in Section 10. Several closure and reclamation research programs are on-going and/or planned, including engineered cover design test plots, growth media and revegetation trials, passive treatment research and natural groundwater attenuation programs.

An important component of the reclamation planning process is ongoing reclamation research with the objective of developing the methods required to implement a successful reclamation program. Reclamation research will focus primarily on the key closure methods proposed for the site.

A reclamation research program has been developed and initiated to provide proof of concept for these techniques in the Mine setting. Major elements of the reclamation and closure research programs are presented in Section 10 and the status of these programs to date is summarized in Table 2-2.

Table 2-1: Reclamation Research Completed to Date

Research Program	Status
Revegetation	Laberge Environmental Services conducted vegetation trials at the Peso Mineral Exploration Site located nearby but independent of the Mine site. The objective of the revegetation program was to test the viability of incorporating biochar and other soil amendments into the Project with the goal of refining and improving the reclamation and revegetation plan. 2018 was the final year of these trials and the results from monitoring of the revegetation trials are presented in Appendix A. In 2019, 2020, and 2021, revegetation programs were completed on a number of exposed surfaces created during Mine construction. The programs utilized commercially available northern seed mixes. willow staking, pole drain installations, wattle fence installations and jute mat placement to manage areas identified as having some erosion and sediment release potential and to also inform candidate species selection for closure revegetation and erosion control selection for closure stabilization. These programs are described further in Section 7.4 Seed trials of native species were initiated in 2020 and are ongoing, these are described further in Section 10.1.2.
Soil Covers	O'Kane Consultants has updated the research program on engineered covers to align with the current Mine plan and included additional detail on execution of the research plan. A pilot scale cover trial was initiated in 2020 on the PG WRSA and is ongoing. This information and the updated status of this program is provided below in Section 10.2 and Appendices G. Additionally, a Vegetation Rooting Study is planned to support the refinement of closure cover system designs (as summarized in Section 10.3 with additional detail provided in Appendix B).
Passive Water Treatment	Ensero Solutions updated preliminary wetland designs to align with the current Mine plan. This information is described in detail in Sections 8.8 through 8.10. An on-site pilot bioreactor program was initiated during 2019 and is ongoing; it is described in Section 10.4. Bench-scale trials have also been initiated with site visit to identify substrate and vegetation borrow sources completed in July 2021 and with bench-scale trials commissioned in September 2022 (Appendices L and M).

Research Program	Status
HLF Detoxification	The plan for testing biological detoxification and in-heap bioreactor for CN destruction and metals removal is provided in Appendix C, with recent supplemental information provided in Appendix N.
Groundwater Attenuation	The groundwater arsenic attenuation study is described in Section 10.6. This work has not yet commenced.

2.3 FIRST NATION OF NA-CHO NYAK DUN ENGAGEMENT

VGC has engaged in a wide range of consultation activities and have made early and ongoing consultation with the First Nation of Na-Cho Nyäk Dun (FNNND) a priority to ensure an opportunity for input at all key stages of Mine development. Currently, ongoing revegetation program (see Section 7.4) continues to benefit from participation of FNNND citizens, as well as provision of seed for the program by Yukon Seed and Restoration, which is a local company jointly owned by Na-Cho Nyäk Dun Development Corporation (51%), Core Geosciences Services Inc. (34%), and Maureen Huggard (15%).

It is acknowledged that FNNND input on the RCP has been primarily through regulatory reviews over the past years. It is VGC's intention to continue FNNND involvement in closure planning through regulatory reviews as well as through separate engagement and consultation initiatives. Future Failure Modes Effects Analyses (FMEA) will be conducted as part of closure planning as the Mine advances in accordance with the requirements for Reclamation and Closure Planning for Quartz Mining Projects – Plan Requirements and Closure Costing Guidance (YWB and EMR August 2013). It is expected that FMEA will be conducted once further information is available from the reclamation research programs (cover trials, passive water treatment trials, etc.), operations phase environmental monitoring programs, and when reclamation and closure options are advanced to incorporate the results and observations from those programs. When conducting the FMEA, VGC will encourage FNNND participation in the identification and characterization of failure modes and their effects for Mine closure.

VGC and the FNNND entered into a Cooperation and Benefits Agreement (CBA) that applies to exploration and mine development conducted by VGC within the FNNND Traditional Territory. Details and objectives of the CBA are presented below in Section 2.5.

2.4 STAKEHOLDER ENGAGEMENT

VGC have engaged in a wide range of consultation activities and have made early and ongoing consultation with the FNNND, the Village of Mayo, Yukon Government and other stakeholders a priority to ensure an opportunity for input at all key stages of Mine development.

Consultation efforts carried out have been well received and well attended. Additional feedback on the RCP has been received from stakeholders throughout the regulatory review processes.

2.5 COMPREHENSIVE COOPERATION AND BENEFITS AGREEMENT

VGC and the FNNND signed a comprehensive Cooperation and Benefits Agreement (CBA) on October 17, 2011. The CBA applies to the Eagle Gold Mine development and exploration activities conducted by VGC anywhere in FNNND Traditional Territory located south of the Wernecke Mountains.

The objectives of the CBA are to:

- Promote effective and efficient communication between VGC and the FNNND in order to foster the development of a cooperative and respectful relationship and FNNND support of VGC's exploration activities and the Mine.
- Provide business and employment opportunities, related to the Mine, to the FNNND and its citizens and businesses in order to promote their economic self-reliance.
- Establish a role for the FNNND in the environmental monitoring of the Mine and the promotion of environmental stewardship.
- Set out financial provisions to enable the FNNND to participate in the opportunities and benefits related to the Mine.
- Establish a forum for VGC and the FNNND to discuss matters related to the Mine and resolve issues related to implementation of the CBA.

The construction and production activities undertaken to date have resulted in the execution of multiple significant contracts with Yukon based companies, of which over half have economic connection to the FNNND Development Corporation by either First Nation business or local business.

3 CLOSURE OBJECTIVES AND DESIGN CRITERIA

The following closure objectives and closure measures are based on previous experience and standard practices, as well as the Yukon Mine Site and Reclamation Closure Policy Financial and Technical Guidelines (Yukon Government 2013). The technical guidelines provide mining proponents with direction on reclamation and closure objectives, which must or should be considered. The guidelines present three elements: purpose, objectives and practice. The practices outlined include reference to principal legal requirements, policy detail pursuant to the Yukon Mine Site Reclamation and Closure Policy, and possible strategies for achieving the desired objectives.

Principles and approaches for reclamation planning from the Reclamation and Closure Planning for Quartz Mining Projects guidance document (Yukon Government 2013) are incorporated into Section 3.0. To achieve its purpose, the guide has the following objectives:

- Describing the context for mine closure planning in the Yukon, and the rationale for requirements to submit RCPs and liability estimates;
- Describe the principles, philosophy and broad objectives for closure planning for Yukon mining projects;
- Describe the information expectations for RCPs and liability estimates; and
- Identify key sources of additional guidance for preparing RCPs and liability estimates.

The guidance document includes: methods for developing fundamental reclamation and closure objectives, methods for conducting community and regulatory engagement, reclamation and closure principles and principles for estimating liability. The intent of this section is to present the closure goals, objectives, and criteria for reclamation and closure of the Mine, in the context of closure planning that is objectives-based.

Table 3-1 below includes reclamation and closure objectives to be achieved for reclamation and closure projects in Yukon for each recognized value. Information from this table has been incorporated into the development of closure objectives described in Table 3-2.

Table 3-1: Fundamental Mine Reclamation and Closure Objectives (YG 2013)

Value	Reclamation and Closure Objectives
Physical Stability	All mine-related structures and facilities are physically stable and performing in accordance with designs. All mine-related structures, facilities and processes can withstand severe climatic and seismic events.
Chemical Stability	Release of constituents and waste products from mine related waste materials occurs at rates that do not cause unacceptable exposure in the receiving environment.
Health and Safety	Reclamation eliminates or minimizes existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features. Reclamation and closure implementation avoids or minimizes adverse health and safety effects on the public, workers and wildlife.
Ecological Conditions and Sustainability	Reclamation and closure activities protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and restore environments that have been degraded by mine-related activities. The mine site supports a self-sustaining biological community that achieves land use objectives.
Land Use	Lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, waste rock storage areas, etc.) are restored to conditions

Value	Reclamation and Closure Objectives
	that enable and optimize productive long-term use of land. Conditions are typical of surrounding areas or provide for other land uses that meet community expectations.
Aesthetics	Restoration outcomes are visually acceptable.
Socio-economic Expectations	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations.
Long-term Certainty	Minimize the need for long-term operations, maintenance and monitoring after reclamation activities are complete.
Financial Considerations	Minimize outstanding liability and risks after reclamation activities are complete.

3.1 RECLAMATION AND CLOSURE OBJECTIVES

An objectives-based approach has been adopted for the development of VGC's RCP. In an objectives-based approach, the closure goal is supported by closure principles that guide the selection of clear closure objectives for all Mine components. For each closure objective, a set of closure options is considered that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective.

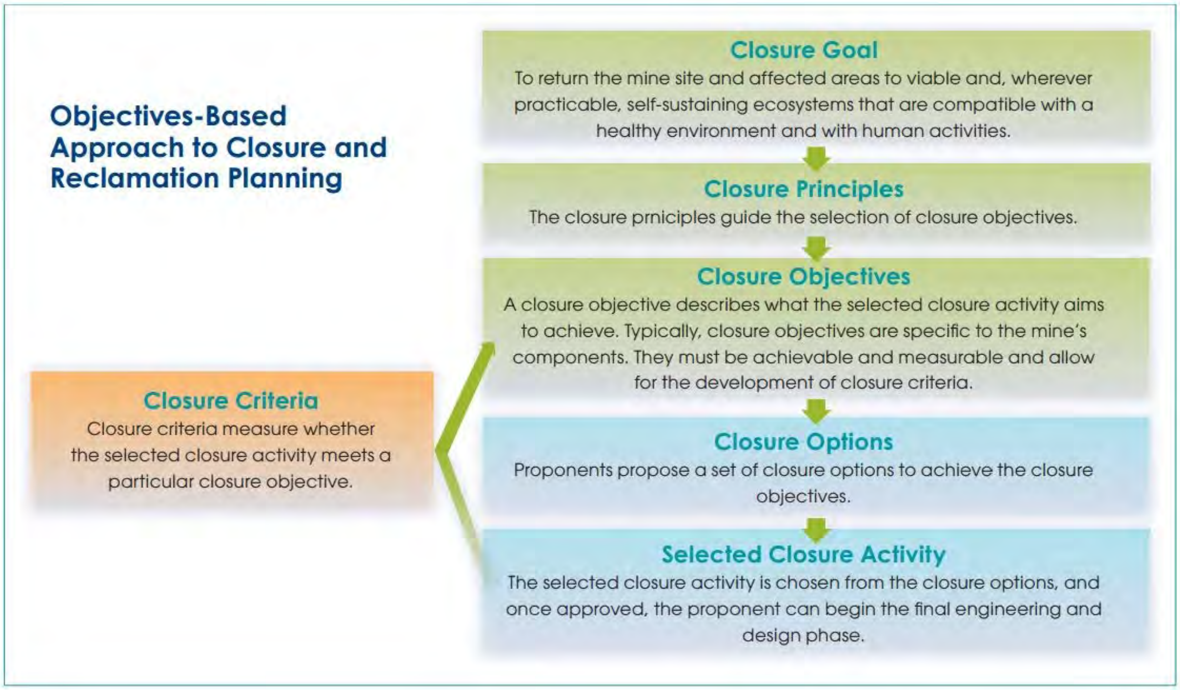


Figure 3-1: Objectives-based Approach to Closure and Reclamation Planning (from MVLWB/AANDC 2013)

Details defining an objectives-based approach, adapted from the MVLWB/AANDC (2013) are presented below and in some instances where information has been gathered from additional authors, sources are cited.

3.1.1 Closure Goal

The closure goal is the guiding statement and starting point for closure and reclamation planning. Establishment of goals are meant to ensure the long-term success of the program by developing a clear and executable plan. The closure goal is met when the proponent has satisfied all closure objectives.

For the Mine, the closure goal at all mining operations is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

3.1.2 Closure Principles

Closure principles guide the selection of closure objectives. Four core closure principles applicable to the Mine include:

- physical stability;
- chemical stability;
- no long-term active care requirements; and
- future use (including aesthetics and values).

3.1.3 Closure Objectives

Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be achievable and allow for the development of measurable closure criteria. Objectives are short-term concrete stepping stones toward achieving a goal and should be specific, appropriate and realistic (Huggard and Nadeau 2013). Selected closure objectives found in the Yukon Mine Site and Reclamation Closure Policy – Financial and Technical Guidelines (2013) directly relate to the closure goal and closure principles required for the RCP.

Component-specific closure objectives, categorized under the four closure principles presented above, are intended to be objectives-based and non-prescriptive. The purpose of implementing performance-based objectives is to encourage research and innovation resulting in cost-effective applications while ensuring public health and safety and environmental protection are met (Yukon Government 2013).

3.1.4 Closure Options and Selected Closure Activity

Closure options are potential activities that could be implemented to ensure that progressive and post-closure reclamation meets the stated closure objectives. These should utilize and adhere to the best available practices and technologies suitable to the site for each of the mine components.

Closure activities are chosen based on the closure options for each Mine component and outlines specific actions and measures to be undertaken. Established literature, bench scale, or pilot testing should support the activity so that stakeholders can be reasonably assured that the option will be successful. Reclamation research (detailed below) also provides certainty to planning appropriate activities. The selected closure activity may change prior to the final RCP based on factors such as environmental considerations, stakeholder input, the availability of new technologies/practices, the results of environmental monitoring programs, or the results of specific reclamation research.

3.1.5 Closure Criteria

Closure criteria are standards that measure the success of selected closure activities in meeting closure objectives. Also referred to as targets (Doran 1981), closure criteria should be clearly established to evaluate reclamation and restoration projects (Ruis-Jaen and Aide 2005) by meeting the closure objectives for each project component. Closure criteria should be measurable, realistic, and achievable within a specified time frame (Huggard and Nadeau 2013) to ensure successful reclamation of project components. Closure criteria can be site-specific or adopted from provincial/territorial/federal standards and can be narrative statements or numerical values.

3.1.6 Reclamation Research

Studies and investigations which are aimed at providing site-specific performance information, proof of concept and ultimately design refinement for closure measures are best referred to as reclamation research. Reclamation research includes engineering studies and/or focused research undertaken with the intention of reducing uncertainties to an acceptable level. It is the results of targeted reclamation research programs which provide the technical basis for mitigation and reclamation technologies that will be incorporated into both primary closure and contingency planning.

3.1.7 Closure Monitoring

Major mine monitoring programs typically consists of three phases:

- Assessment – Baseline conditions of ecosystems that will potentially be affected by the mine (complete);
- Operational – confirms or refutes accuracy of predictions of mine effects that were made during the environmental assessment (ongoing); and
- Transition/Post-Closure – monitoring that begins with the start of the approved decommissioned and reclamation activities, and carries on into the post-closure period (outlined in this RCP).

Defining monitoring needs during the assessment phase ensures that measurable targets are relevant to achieving the overarching goals of the closure plan. Monitoring of closure components at the Mine will continue until such a time that closure objectives have been met.

3.1.8 Eagle Gold Mine Reclamation and Closure Objectives

The goal of the RCP is to return the Mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. This goal guides the selected closure scenario for the Mine through the above-mentioned objectives-based closure planning method. Fundamental closure planning objectives developed by Yukon Government (2013) in the Reclamation and Closure Planning for Quartz Mining Projects have been used to guide the development of detailed objectives that are site-specific, defined by factors that include environmental conditions, site conditions and community expectations.

These clearly defined closure objectives and tangible criteria against which to measure performance are presented in Table 3-2. The detailed site-specific objectives were developed to address physical stability, chemical stability, health and safety, ecological conditions and sustainability, land use, aesthetics, socio-economic expectations, long-term certainty and financial considerations.

Table 3-2: Summary of Decommissioning and Reclamation Planning for Mine Components

Mine Component	Fundamental Objective	Closure Objectives	Closure Measures	Closure Criteria
Water Retention and Water Conveyance Structures	Physical Stability	Engineered and natural drainages at, and adjacent to the site, are physically stable in the long term. Flows are conveyed into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions.	Maintain suitable gradients to permit flow and reduce infiltration and erosion. For steeper slopes, larger rip rap or energy dissipation structures will need to be put in place to avoid erosion. Design facilities to minimize contact of surface flow with mine influenced soils. Modify channel patterns, where necessary, to achieve enhanced stability, and to benefit water quality conditions and other objectives. Ditches and channels for water conveyance will have a stable cross-section (including consideration of cross-sectional and longitudinal sectional conditions, and the use of various armoring techniques as needed). They may be lined or unlined depending on the longitudinal slopes and associated flow velocities. Lining will consist of rip rap, grouted rip rap or synthetic liners. Pipes carrying water through all seasons will be buried to avoid freezing.	Visual monitoring indicates that the banks and bottoms of closure conveyance channels and ponds are not degraded, and/or producing an unacceptable amount of erosion, sediment transfer or sedimentation, which will be quantified by whether effluent water quality meets the criteria for total suspended solids and turbidity. The design flow at closure for all ditches, channels, and other structures on site (storage ponds, spillways, culverts, seepage pipes) is selected as the 100-year flood. Water conveyance channels will be trapezoidal in shape with side slopes >2:1 Maximum channel gradients are not to exceed the natural topographic gradient and be less than 10%. Culvert minimum diameters are set at 750mm. Pipes identified for burial will be buried below the long-term seasonal frost depth determined for the site.
	Chemical Stability	Surface water discharge from the site provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.	Convert ponds to passive treatment systems (Events Pond and Lower Dublin South Pond) as needed, or construct a passive treatment system (Platinum Gulch). Direct and convey contact water from pits, waste rock storage areas and the heap leach facility to passive treatment systems.	Meet Effluent Quality Criteria in discharge from passive treatment systems to achieve Water Quality Objectives in Haggart Creek.
Open Pit	Health and Safety	Humans and wildlife are protected from topographic hazards associated with the pit and pit lake.	Build safety berms with highwalls and control access to the pit area. Barriers to benches and former pit roads will be constructed to prevent egress.	No human incidents leading to injury or wildlife incidents leading to mortality related to the topographic hazards associated with pit and pit lake.
	Physical Stability	Open pit is able to withstand severe climatic and seismic events.	Perimeter areas within the overburden layer will be re-sloped and re-vegetated.	Visual monitoring indicates that the perimeter conditions are stable (i.e., no headscarp tension cracking or sloughing, perimeter berms are not degraded and are fully functioning).
	Chemical Stability	Surface water discharge from pit lake provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.	Open pit floor area will be flooded to the level of the west side of the open pit. Pit lake discharge will be through engineered controlled outflow and then conveyed to the site ditching system. Water quality modeling suggests that direct discharge of pit lake water via a ditching system to Haggart Creek is possible while still achieving water quality objectives, or alternatively discharge will be conveyed to a passive treatment system and then discharged to Haggart Creek	Meet Effluent Quality Criteria in discharge from pit lake or passive treatment system to achieve Water Quality Objectives in Haggart Creek.
Waste Rock Storage Areas and Temporary Stockpiles	Physical Stability	Waste Rock Storage Areas are physically stable with minimal erosion, subsidence, or slope failure, as well as able to withstand severe climactic and seismic events.	Stack waste rock during operations in accordance with the design to achieve stable configurations. Regrade the WRSAs and 90-day stockpile to 2.5:1 ratios prior to cover placement. Engineer covers on waste rock storage areas and any remaining stockpiles to reduce infiltration, encourage vegetation growth, control runoff, and minimize erosion.	Visual monitoring indicates that the regraded bench surfaces and slopes of storage areas and stockpiles are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation, which will be quantified by whether effluent water quality downstream of the facilities meets the criteria for total suspended solids and turbidity.

Mine Component	Fundamental Objective	Closure Objectives	Closure Measures	Closure Criteria
	Chemical Stability	Runoff and seepage quality from downstream passive treatment systems provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.	Construct stable engineered covers in combination with passive treatment systems to yield water quality acceptable for discharge. Construct covers with enhanced engineered improvements to minimize infiltration, control runoff, and minimize erosion. Convert the LDSP to a passive treatment system to treat seepage from the EP WRSA and then discharge to Haggart Creek. Construct a passive treatment system downgradient of the PG WRSA to treat seepage from the PG WRSA and then discharge to Haggart Creek. The mine water treatment plant will remain on the Mine site for a period of at least 5 years after it was last required to treat effluent discharged from the site if necessary.	Meet Effluent Quality Criteria in discharge from passive treatment systems to achieve Water Quality Objectives in Haggart Creek.
Heap Leach Facility	Physical Stability	Heap Leach Facility is physically stable with minimal erosion, subsidence, or slope failure, as well as able to withstand severe climatic and seismic events.	The construction of a store-and-release cover will start when cyanide destruction is complete (meets criteria). Progressively building closure cover (and re-grading to 2.5:1 slope) during draindown stage. Construct cover on the HLF with enhanced engineered improvements to minimize infiltration, encourage vegetation growth, control runoff, and minimize erosion.	Visual monitoring indicates that the regraded bench surfaces and slopes of the heap leach facility are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation, which will be quantified by whether effluent water quality downstream of the facilities meets the criteria for total suspended solids and turbidity.
	Chemical Stability	Drain-down and cyanide destruction are conducted in controlled and efficient manner that provides for optimal water quality conditions in receiving waters. Runoff and seepage quality from downstream passive treatment systems provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.	The transition period (additional gold recovery – Phase 4 and rinsing – Phase 5), and the heap drain-down (Phase 6) are planned and managed and fully integrated with water management plan. Cyanide destruction using in-situ biological treatment or active treatment during rinsing and drain-down phases. Rinsing and recirculation to enhance degradation of cyanide and neutralization of heap solution. Construct stable engineered covers in combination with passive treatment systems to yield water quality acceptable for discharge. Convert Events Pond to passive treatment system to treat seepage from the HLF and then discharge to Haggart Creek. The mine water treatment plant will remain on the Mine site for a period of at least 5 years after it was last required to treat effluent discharged from the site if necessary.	Meet cyanide destruction criteria (i.e., rinsing and CN destruct will occur until CN concentrations in drain-down are ≤0.03 mg/L) Meet Effluent Quality Criteria in discharge from passive treatment system to achieve Water Quality Objectives in Haggart Creek.
Mine Infrastructure	Health and Safety	Potential threats to public health and safety are removed. Facilities are decommissioned in a safe manner.	Mine site structures not required will be decommissioned and removed (partially or completely).	No human incidents leading to injury or wildlife incidents leading to mortality related to the topographic hazards.

Mine Component	Fundamental Objective	Closure Objectives	Closure Measures	Closure Criteria
	Physical Stability	Reclaimed areas and any remaining structures are physically stable.	Decommissioning and demolition of mine infrastructure will ensure physical stability and remove potential hazards /threats to the public safety and health. Closure measure will include: • Decommissioning of facilities in a safe manner; • Ensuring physical stability of any remaining structures; • Removal/proper disposal of hazardous reagents, chemicals and materials; • Removal and decommissioning mechanical, electrical equipment and motors; • Demolition of steel structures; • Removal or break up and burial in situ of concrete slabs; • Bulk earthworks will be completed, foundations broken up and buried in situ; • Foundations with rebar will be left in place; • Foundations demolished and buried; • Pad areas re-graded as necessary, scarified, and re-vegetated.	Visual monitoring of reclaimed areas and remaining structures indicates that surfaces and slopes of regraded and decommissioned areas are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation, which will be quantified by whether there are no threats to human or wildlife safety and effluent water quality downstream of the facilities meets the criteria for total suspended solids and turbidity.
Roads and Other Access	Land Use	Access to Mine areas that were not accessible before Mine initiation is removed. Access for FNNND to specific areas is re-established. FNNND access through Mine site to traditional hunting grounds is re-established. Invasive species colonization at linear features in closure is minimized, eliminated or managed.	Decommission, scarify and vegetate non-essential roads to provide a means of protection to public safety and encourage development of wildlife habitat. Vegetation to follow practices that prevent establishment of invasive species. The public South McQuesten / Haggart Creek Road will remain. Potato Hills access will be preserved (requested by FNNND), as well as other mine access roads associated with on-going and historical exploration activities that are covered under separate permit authorizations. Other roads to remain in place to be identified in coordination with FNNND.	FNNND and public access retained for identified roads. No invasive species identified during revegetation of reclaimed roads, or during follow-up monitoring activities during closure Visual monitoring of the restored stream channels indicates that the streambanks and beds are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation.
	Health and Safety	Provide for public safety.	Unnecessary culverts associated with a decommissioned road will be removed; stream channels will be restored and stabilized.	
Overall Mine Site	Ecological Conditions and Sustainability Land Use Health and Safety Aesthetics	Conduct reclamation activities at the mine site that provides for long-term physical stability, successful re-vegetation, natural development of native species and communities, and the return of the developed land to sustainable wildlife habitats. Geological values and heritage features associated with mine site are protected in the long term.	Establish self-propagating early seral native plant communities. Encourage opportunities for progressive reclamation over the Mine life. Prepare and use designated soil salvage locations to store salvaged top soil and organics for reclamation. Develop growth media borrow locations. Develop re-vegetation plans according to prescriptions which include native species. Identify sites of significant heritage value and include them in the historic sites registry to protect these through reclamation and closure activities. Closure activities will be conducted to restore the sites to an aesthetic condition consistent with surrounding areas.	Site revegetation targets are met. *(To be developed)* Sites with heritage value are avoided and protected during reclamation and closure activities.
	Socio-economic Expectations	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations; maximizing benefits for NND businesses and citizens	Closure activities will be performed in a manner consistent with the CBA, and where possible utilize local and Yukon businesses in the performance of the work.	Socio-economic closure targets are met. *(To be developed)*

Mine Component	Fundamental Objective	Closure Objectives	Closure Measures	Closure Criteria
Temporary Closure Site Conditions	Physical Stability Chemical Stability Health and Safety	Ensure public health and safety and protection of the environment in the event of a temporary closure and to manage risks associated with potential abandonment of site.	Care and maintenance of facilities. Site water and solution management/treatment as required.	Operation/Closure criteria apply.

3.2 DESIGN CRITERIA

Reclamation and closure planning has been guided by many design criteria, ranging from regulatory and guidance based-criteria, constraints imposed by the Mine location and history, and criteria established through consultation with stakeholders.

Design criteria that are relevant to closure are presented in this section by closure component, including the applicable geotechnical, hydrologic, and/or water quality criteria for that component. Each section also includes references to the guidance documents, reports and analysis that support the design criteria.

3.2.1 Open Pit

A range of geologic, economic and geotechnical inputs were used to develop the open pit design for the Mine to maximize value while minimizing potential risk.

Over the life of the Mine, the Eagle pit will be advanced in four major stages. Based on the surface topography, the open pit is scalloped-shaped with a lower west highwall. To maintain access to the primary crusher, a single ramp will spiral down to the bottom of the final pit. This ramp will also connect to the external access road that leads to the truck shop. No ramps will be maintained inside the final pit above the crusher elevation to minimize stripping requirements.

Over the life of the Eagle pit, based on the current mine plan and regulatory approvals, approximately 86 Mt of ore will be placed on the HLF, 15 Mt of run of mine ore (i.e., blasted rock from the pit potentially reclassified as economic based on operational and financial considerations) at this time will be placed with 101 Mt of waste in waste rock storage areas. During the operations period, ore production will increase to the nominal production rate of 29,500 t/d on an annual average basis.

Using the designed phases and cut-off grade strategy, a detailed production schedule was developed. Operational constraints were added to ensure realistic mining sequences with scheduling conducted quarterly for the first two years of production, and then annually.

Open pit closure objectives relate to health and safety, physical stability and chemical stability, as follows:

- Humans and wildlife are protected from topographic hazards associated with the pit and pit lake
- The physical stability of the open pit is able to withstand severe climatic and seismic events.
- Surface water discharge from pit lake provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.

These objectives will be met by building safety berms with highwalls and controlling access to the pit area. Barriers to benches and former pit roads will be constructed to prevent egress, while perimeter areas and the upper benches within the overburden layer will be re-sloped and re-vegetated. Once mining has ceased, groundwater seepage from pit walls and drain holes will be allowed to fill the pit and form a pit lake. The lake will then discharge to the Platinum Gulch passive treatment system (PG PTS).

Thus, the success of these closure measures will be evaluated against the following criteria:

- No human or wildlife incidents will occur that are related to the topographic hazards associated with pit and pit lake.

- The pit geometry (bench widths, inter-lift slopes and overall slope) is being developed to meet the design criteria for the pit stability as described in the *Mine Development, Operations and Material Management Plan*.
- Visual monitoring of the pit indicates that the perimeter conditions are stable (i.e., no headscarp tension cracking or sloughing, perimeter headscarp is not degraded and are fully functioning)
- Effluent quality criteria are met in discharge from the pit lake or passive treatment system and water quality objectives in Haggart Creek are met.

3.2.2 Waste Rock Storage Areas

Design acceptability criteria for slope stability analyses for the WRSAs applicable to closure are based on the "Guidelines for Mine Waste Dump and Stockpile Design" (Hawley & Cunning, 2017). The suggested minimum factor of safety (FoS) presented in the guidelines are re-produced in Table 3-4 with each minimum FoS reflecting different levels of confidence in the understanding of site conditions, material parameters, and consequences of instability. The recently published Hawley & Cunning (2017) guidelines are considered an update and improvement to the previous (BCMWRPRC 1991) interim design acceptability criteria, which did not distinguish between important factors such as the size of facility, consequence of failure or confidence in foundation conditions.

Table 3-3: Suggested WRSF Stability Acceptance Criteria (Hawley & Cunning, 2017)

Consequence[1,3]	Confidence[2,3]	Static analysis		Pseudostatic	Maximum allowable strain
		Minimum FoS	Maximum PoF	Minimum FoS	
Low	Low	1.3 - 1.4	10 - 15%	1.05 - 1.1	≤ 1%
	Medium	1.2 - 1.3	15 - 25%	1.0 - 1.05	≤ 1.5%
	High	1.1 - 1.2	25 - 40%	1.0	≤ 2%
Moderate	Low	1.4 - 1.5	2.5 - 5%	1.1 - 1.15	≤ 0.75%
	Medium	1.3 - 1.4	5 - 10%	1.05 - 1.1	≤ 1%
	High	**1.2 - 1.3**	**10 - 15%**	**1.0 - 1.05**	**≤ 1.5%**
High	Low	≥ 1.5	≤ 1%	1.15	≤ 0.5%
	Medium	1.4 - 1.5	1 - 2.5%	1.1 - 1.15	≤ 0.75%
	High	1.3 - 1.4	2.5 - 5%	1.05 - 1.1	≤ 1%

Notes:

1. **Consequence**

   Low Consequence: waste dumps and stockpiles with overall fill slopes less than 25° and less than 100 m high and repose angle slopes less than 50 m high. No critical infrastructure or unrestricted access within potential runout shadow. Limited potential for environmental impact. Long-term (> 5 years) exposure for sites subject to very low to low (< 350 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to high (1000-2000 mm) annual precipitation; dry season construction/operation only for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   Moderate Consequence: waste dumps with overall fill slopes less than 30° and less than 250 m high, or with repose angle slopes less than 100 m high. No critical infrastructure or unrestricted access, or robust containment/mitigative measures to protect critical infrastructure and access within potential runout shadow. Potential for moderate environmental impact, but manageable. Long-term (> 5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to high (1000-2000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   High Consequence: waste dumps with overall fill slopes more than 30° and more than 250 m high, or with repose angle slopes more than 200 m high. Critical infrastructure or unrestricted access within potential runout shadow with limited runout mitigation/containment measures. Potential for high environmental impact that would be difficult to manage. Long-term exposure (> 5 years) for sites subject to high (1000 – 2000 mm) annual precipitation; medium (1-5 years) exposure for sites subject to very high (> 2000m) annual precipitation or intensive rainy season(s).

2. **Confidence**

   Low Confidence: limited confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Poorly defined or optimistic input parameters; high data variability. For proposed structures, investigations at the conceptual level with limited supporting data. For existing structures, poorly documented or unknown construction and operational history; lack of monitoring records; unknown or poor historical performance.

   Moderate Confidence: – moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Input parameters adequately defined; moderate data variability. For proposed structures, investigations at the pre-feasibility level with adequate supporting data. For existing structures, reasonably complete construction documentation and monitoring records; fair historical performance.

   High Confidence: high confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Well-defined, conservative input parameters; low data variability. For proposed structures, investigations at the feasibility level with comprehensive supporting data. For existing structures, well documented construction and monitoring records and good historical performance.

3. In cases where the guidance for consequence or confidence conflicts or is unclear, selection of the appropriate level should be based on judgment, and the rational for the selection should be documented.

The EP and PG WRSA designs were determined by the Engineer of Record (EoR) to fall within the moderate consequence and high confidence categories. Corresponding minimum recommended factors of safety are 1.2 to 1.3 for static and 1.0 to 1.05 for pseudostatic loading conditions according to the guidelines.

Based on an evaluation of the potential seismic activity for the Mine site, the seismic design event utilized for the WRSAs design is an earthquake with a 1-in-475-year return period that generates a peak horizontal ground acceleration (PGA) of 0.14 g.

The EoR concluded the following from the results of the slope stability analyses:

- Stability of the bottom lifts, founded on colluvium soils control stability of both the PG (1027.5 m bench) and EP (947.5 m bench) WRSAs with static safety factors of 1.3 calculated for the lowest bench of each facility. Safety factors for the initial, temporary waste rock benches planned in the upper PG valley (1252.5 m and 1162.5 m benches) indicate static safety factors of 1.2 due to the steeper natural ground surface;
- Individual lifts placed over existing waste rock rather than native foundation soils indicate significantly higher safety factor of 1.5 for static loading which exceeds the minimum acceptable safety factor;
- Safety factors for large-scale failures involving multiple waste rock benches exceed minimum requirements with safety factors of 1.4 to 1.9 for the EP and PG WRSAs;
- The minimum acceptable safety factor for pseudostatic analyses of 1.05 was met or exceeded for all cases except the initial, temporary and isolated PG 1252.5 m bench which yielded a 1.03 safety factor; this bench is no longer isolated but is now buttressed by additional lifts built below this bench and so this is no longer a factor.
- Sensitivity analyses indicate that WRSA stability is sensitive to pore water pressures within the bottom waste rock benches and foundation soils beneath the toes for both the PG (1027.5 m bench) and EP (947.5 m bench) facilities. The stability analyses have been conducted assuming that the rock drains beneath the bottom benches will work as designed and drain freely, and that static water levels will not exceed more than 1 or 2 meters above the pre-mine ground surface;

- Potentially thaw-unstable ice-rich materials were identified in the upper Eagle Pup drainage. The EP WRSA is being constructed in a bottom-up sequence, thereby buttressing the upper lifts potentially founded on ice-rich materials; and,
- Liquefaction potential of colluvium soils beneath the WRSAs is considered to be low.

Waste rock storage area closure objectives relate to physical stability and chemical stability, as follows:

- WRSAs are physically stable with minimal erosion, subsidence or slope failure, as well as being able to withstand severe climactic and seismic events.
- Runoff and seepage quality from downstream passive treatment systems meets water quality criteria. And provides for necessary conditions to sustain functioning aquatic life and habitat similar to the conditions existing without the mine.

These objectives will be met by stacking waste rock during operations in accordance with the design to achieve stable configurations; and engineering covers to reduce infiltration, encourage vegetation growth, control runoff, and minimize erosion. Further, the covers will be constructed stable engineered covers in combination with passive treatment systems (the LDSP-PTS and the PG-PTS) to yield water quality acceptable for discharge. Also, the mine water treatment plant will not be decommissioned for a period of at least five years after it was last required to treat effluent discharged from the site if necessary.

Thus, the success of these closure measures will be evaluated against the following criteria:

- The geometry of both the EP WRSA and PG WRSA (bench widths, lift heights, inter-bench slopes and overall slope) is being developed to meet the design criteria for WRSA stability as described in the *Waste Rock and Overburden Facility Management Plan.*
- Visual monitoring indicates that any regraded bench surfaces and slopes of storage areas and stockpiles are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation.
- Effluent quality criteria are met in discharge from the passive treatment systems and water quality objectives in Haggart Creek are met.

3.2.3 Heap Leach Facility

Regulations and permitting requirements for Heap Leach Facilities in the Yukon Territory are not expressly stated, but rather, they have historically relied on regulations from other regions and on precedence established from other successful projects. Previous studies (Scott Wilson 2010) selected Brewery Creek, the gold mine (operational from 1996 until 2002) located approximately 55 km east of Dawson City, Canada as the example facility to follow for permitting guidelines. This was understood to be the only HLF permitted in the Yukon, the design of which was based on the Nevada State guidelines and associated permitting limitations. This approach was carried into the feasibility study and through final design along with best engineering practice.

The Heap Leach Facility design standards adopted for the project include:

- The regulatory requirements of Yukon and Canada;
- The Yukon Water Board Licensing Guidelines (2009);
- The existing project Water Use License permit requirements;

- Guidelines from the Canadian Dam Association (2013, 2014); and
- Permitting requirements of the State of Nevada. These are not regulatory requirements in the Yukon, but are considered as standards for best practice.

As stated above, there are currently no published international standards for the design and construction of a heap leach facility. Nevada State Guidelines provide minimum standards for heap leach facilities and have been adopted for the Mine. North American standards for the design of embankment dams were used where applicable, specifically the Canadian Dam Association (CDA 2014) guidelines. Table 3-5 summarizes the main technical and permitting requirements for the State of Nevada for the key elements of the HLF design.

Table 3-5: Summary of Design Requirements for the State of Nevada

Heap Leach Feature	Description
Leach Pad	System must have containment capability equal to or greater than that of a composite liner consisting of a synthetic liner over one foot of compacted soil at a permeability of 1 x 10^{-6} cm/s or 1 x 10^{-5} cm/s if a leak detection system is used beneath portions of the liner with the greatest potential for leakage.
	Synthetic liners must be rated as having resistance to fluid passage equal to a permeability of less than or equal to 1 x 10^{-11} cm/s.
Solution Ponds	System must have a primary synthetic liner and a secondary liner that meet the above-described liner specifications. The synthetic liners must be separated by a fluid transmission layer which is capable of transmitting leaked fluids at a rate that will ensure that excessive head will not develop on the secondary liner.
Solution Management and Containment	Process components must be demonstrated to have the capacity to "withstand" the runoff from a 100-year, 24-hour precipitation event. In addition, facility fluid management systems must demonstrate the capability of remaining "fully functional and fully contain all process fluids including all accumulation resulting from a 25-year, 24 hour precipitation event. The foregoing standards are minimal and additional containment capacity may be required if surface water bodies or human populations are in close proximity to the facility, or if groundwater is shallow.
Foundations	Consider static / dynamic loads and differential movement or shifting.
Construction QA/QC	Regulations require that each applicant develop and carry out a quality assurance and quality control program for liner construction. A summary of the QA/QC program must be submitted with as-built drawings after construction has been completed.
Neutralization/Detoxification of Spent Ore	Spent ore, whether it is to be left on pads or removed from a pad, must be rinsed until it can be demonstrated either the remaining solid material, when representatively sampled does not contain levels of contaminants that are likely to become mobile and degrade the waters of the state under the conditions that will exist at the site, or, the spent ore is stabilized in such a manner as to inhibit meteoric waters from migrating through the material and transporting contaminants that have the potential to degrade the waters of the state.

3.2.3.1 Design Basis

The Yukon Water Board Licensing Guidelines for Type A Quartz Mining Undertakings provide specific guidance for selected mine site earthworks facilities, as follows:

"General: Type A quartz mining undertakings may vary significantly in their magnitude and in the potential environmental effects associated with them. The guidelines contained in this document assume the development of a mine with significant potential environmental impacts such as those resulting from acid rock drainage or the failure of a large tailings impoundment. Projects such as this are considered to fall into the Very High Consequence of Failure category described in the Canadian Dam Safety Guidelines (January 1999). In situations where this category is not appropriate for some reason, the Board is prepared to consider well developed and documented

justification for the use of alternative consequences of failure criteria developed in accordance with the Canadian Dam Safety Guidelines."

Further, specific design guidance is included as follows:

- The design, construction, operation, maintenance and surveillance of dams and associated water management structures should be carried out in a manner which is consistent with the recommendations contained in the Canadian Dam Safety Guidelines (January 1999) for the Very High Consequence Category, unless compelling reasons consistent with the Canadian Dam Safety Guidelines for a lower consequence category are provided.
- Long-term dams and associated water management structures should be designed to withstand the Maximum Credible Earthquake (MCE) and pass the Probable Maximum Flood (PMF). Shorter term structures may be built to lesser standards but a compelling rationale for the selected criteria must be provided.
- Heaps should be designed to have a minimum factor of safety under static loading of 1.3 for short term cases (i.e. within the mine life) and 1.5 for long term cases (i.e. abandonment) as described in the Investigation and Design of Mine Dumps (British Columbia Mine Dump Committee, 1991). The factor of safety for dams should be as recommended in the Canadian Dam Safety Guidelines (January 1999).
- Designs for dams and associated water management structures, rock dumps, and heaps should recognize the probable presence of permafrost and should include appropriate measures to manage permafrost and maximize the stability of the structures consistent with recommendations contained in the Canadian Dam Safety Guidelines (January 1999).

Although the 1999 and 2007 CDA are referenced are referenced by the regulatory guidance documents summarized above, the latest version of the CDA guidelines (2013), including the Application of Dam Safety Guidelines to Mining Dams Technical Bulletin (2014), was used for the Mine.

BGC (2017b) performed a dam breach analysis to provide input into evaluating the HLF embankment hazard classification, per Canadian Dam Association (2013) guidelines. The results confirm that the confining embankment can be classified as a Significant dam (i.e., there is no permanent population or infrastructure at risk in the inundation path, and restoration of fish and wildlife habitat is highly possible). Nevertheless, the WUL for the Mine imposes an Extreme dam classification (the most stringent possible) for hydrologic and storage criteria. Thus, the Extreme hydrologic and storage criteria have been used for the HLF design. The WUL does not include a requirement to impose more conservative geotechnical criteria beyond those specified in the CDA guidelines; nevertheless, geotechnical criteria applied here assume a High hazard dam classification. The dam classifications used here also consider the input from the Application of Dam Safety Guidelines to Mining Dams (CDA 2014) and have been vetted during consideration and consultation between owner and regulators.

3.2.3.2 Design Criteria

The parameters and criteria are presented in the Heap Leach Facility Detailed Design Report (BGC 2017). The following supporting information to the Heap Leach Facility Detailed Design Report provide rationale for geotechnical design criteria: Seismic Peak Ground Accelerations for Design, Slope Stability Analyses and Settlement Analysis.

Heap leach facility closure objectives relate to physical stability and chemical stability, as follows:

- The HLF is physically stable with minimal erosion, subsidence or slope failure, as well as being able to withstand severe climactic and seismic events.
- Drain-down and cyanide destruction are conducted in controlled and efficient manner that provides for optimal water quality conditions in receiving waters.
- Runoff and seepage quality from the downstream passive treatment system meets water quality criteria. and provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the mine.

These objectives will be met by managing the transition period (i.e., additional gold recovery, rinsing and draindown) so that it is fully integrated to meet water management plan objectives. This includes destructing cyanide during rinsing and using biological treatment (or active as needed) during rinsing draindown, the constructing a stable cover system with a two-stage passive treatment system (HLF-PTS) for a period of at least five years after it was last required to treat effluent discharged from the site if necessary.

The success of these closure measures will be evaluated against the following criteria:

- The geometry of both the HLF (bench widths, lift heights, and overall slope) is being developed to meet the design criteria for HLF stability as described in the *Heap Leach Process and Facilities Management Plan.*
- Visual monitoring indicates that any regraded bench surfaces and slopes of storage areas and stockpiles are not degraded, and/or producing an unacceptable amount of slope failure, erosion, sediment transfer or sedimentation.
- The draindown period will be deemed complete when seepage rates are XX L/s and/or the in-heap pond is XX% of capacity (values to be determined).
- Effluent quality criteria are met in discharge from the passive treatment system and water quality objectives in Haggart Creek are met.

3.2.4 Water Management Facilities

For the purpose of the Water Management Plan (Version 2020-01), the Mine area has been subdivided into a number of hydrologic watersheds and sub-watersheds. The watershed boundaries are based on the proposed end of mine topography.

Closure objectives for water retention and water conveyance structures relate to physical stability and chemical stability, as follows:

- engineered and natural drainages at, and adjacent to the site, are physically stable in the long term;
- flows are conveyed into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions.

These objectives will be met by:

- maintaining suitable gradients to permit flow and reduce infiltration and erosion, and using larger rip rap or energy dissipation structures as needed;
- designing facilities to minimize contact of surface flow with mine influenced soils;

- modifying channel flow patterns, where necessary, to achieve enhanced stability, and to benefit water quality conditions and other objectives;
- ditches and channels will have a stable trapezoidal cross-section (including consideration of cross-sectional and longitudinal sectional conditions, and the use of various armoring techniques as needed); they may be lined or unlined depending on the longitudinal slopes and associated flow velocities. Lining will consist of rip rap, grouted rip rap or synthetic liners;
- pipes carrying water through all seasons will be buried to avoid freezing; and
- closure and post-closure monitoring will be conducted in a timely manner with respect to seasonal variability and/or upset events, which will allow an adequate response to implement maintenance activities or repair system failures.

A risk-based approach was used to select appropriate design storm events for water management facilities. This approach weighs the likelihood of failure, versus the consequence of failure, on a case-specific basis. Design storm events were developed by assessing the annual recurrence of precipitation events of a given magnitude, as described in the Eagle Gold Project Water Management Plan Version 2020-01. In response to concerns expressed by the FNNND and YCS regarding the appropriateness of using the same criteria for closure as used for construction and operations, a recent review of design criteria for water management infrastructure was conducted by Lorax (2022) provided as Appendix J. Two significant findings of this analysis include:

- a comparison of modelled peak flows used to inform water management infrastructure design with measured peak 15-minute flows from Project site hydrometric stations indicate that the design flows resulting from a 1:100-year or 1:200-year 24-hour event are an order of magnitude greater than anything measured at site to date, including freshet driven runoff events. The 1:10-year modelled peak flow is double the highest measured peak flow, suggesting that the design peak flows for the ditches and culverts are substantially overestimated, especially when considering that both the Camp and Potato Hills stations have recorded several rainfall events equivalent to or greater than the 1:10-yr 24-hr event of 38 mm; and
- due to the overestimations, the 1:100-year and 1:200-year rainfall events used for water management infrastructure design are not expected to surpass the original design estimates after accounting for climate change under the conservative Representation Concentration Pathway (RCP) 6.0 scenario.

Thus, design criteria have not been adjusted and the success of the closure measures will be evaluated with the design criteria as listed in Table 3-6. The design storm events will be used as input parameters in any rainfall-runoff type storm water models (e.g., HEC-HMS, PCSWMM, TR-55) used for sizing water management infrastructure. Design criteria for various design elements are listed in Table 3-6.

Table 3-6: Water Management Design Criteria

Infrastructure Element	Design Element	Design Basis Criteria
Unlined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Maximum Depth (mm): Type 1 or 2	300
	Minimum Width (mm): Type 2	500

Infrastructure Element	Design Element	Design Basis Criteria
	Minimum Grade (%): Type 1 or 2	1.00
	Maximum Grade (%): Type 1 or 2	1.70
	Maximum Side Slopes: Type 1 or 2	3H:1V
	Maximum Velocity (m/s): Type 1 or 2	1.5
Lined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Design Storm Event (above major infrastructure)	1 in 100-year
	Maximum Depth (mm)	500
	Minimum Grade (%): Type 3 / Type 4	1.00 / 0.50
	Maximum Grade (%): Type 3 / Type 4	4.5 / 15
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.33 / 4.0
Pipes	Design Storm Event	1 in 10-year, 24-hour
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances)	1 in 200-year, 24-hour
	Design Storm Event (downstream of the Lower Dublin South Pond)	1 in 1000-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0
Temporary Sediment Control Ponds and Exfiltration Areas	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 100-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5

Infrastructure Element	Design Element	Design Basis Criteria
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (100-year event)	0.5
Permanent Sediment Control Ponds	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 200-year, 24-hour
	Design Storm Event (overflow spillway – dam)	1 in 1000-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (200-year event)	0.5
	Dewatering (pumping capability)	Full Dewater in 24 hours

4 EXISTING ENVIRONMENT DESCRIPTION

Section 4 presents a summary of existing conditions for bio-physical components including climate, surface water, groundwater, vegetation and wildlife, soil and bedrock and seismicity. Environmental baseline data were collected between 2007 and 2017, construction phase data were collected between 2017 and 2019, and data collection as part of operations monitoring is ongoing. In addition to the reports noted below, the latest monitoring data is reported in the 2021 Annual Report (VGC 2022a), available on the YWB Waterline website registry for QZ14-041-1 under the Reports section, and in the Environmental Characterization Report (VGC 2022b), available through EMR.

4.1 CLIMATE

Baseline climate information for the Mine is available on the YWB Waterline website registry for QZ14-041 in the following:

- Environmental Baseline Report: Climate (Stantec 2010a) - Exhibit 1.3.1
- Environmental Baseline Report: Climate 2011 Update (Stantec 2012a) - Exhibit 1.3.2
- Climate Baseline Summary (KP 2013a) - Exhibit 1.3.3
- Hydrometeorology Report (KP 2013c) - Exhibit 1.3.14

The latest climate information is available under the YWB Waterline website registry for QZ14-041-1 in the Eagle Gold Climate Data Report (Lorax 2022a) - Appendix L to the Eagle Gold Project 2021 Annual Report and summarized in the Environmental Characterization Report (VGC 2022b).

The latest climate information is available under the YWB Waterline website registry for QZ14-041-1 in the Eagle Gold Climate Data Report (Lorax 2022a) - Appendix L to the Eagle Gold Project 2021 Annual Report and summarized in the Environmental Characterization Report (VGC 2022b).

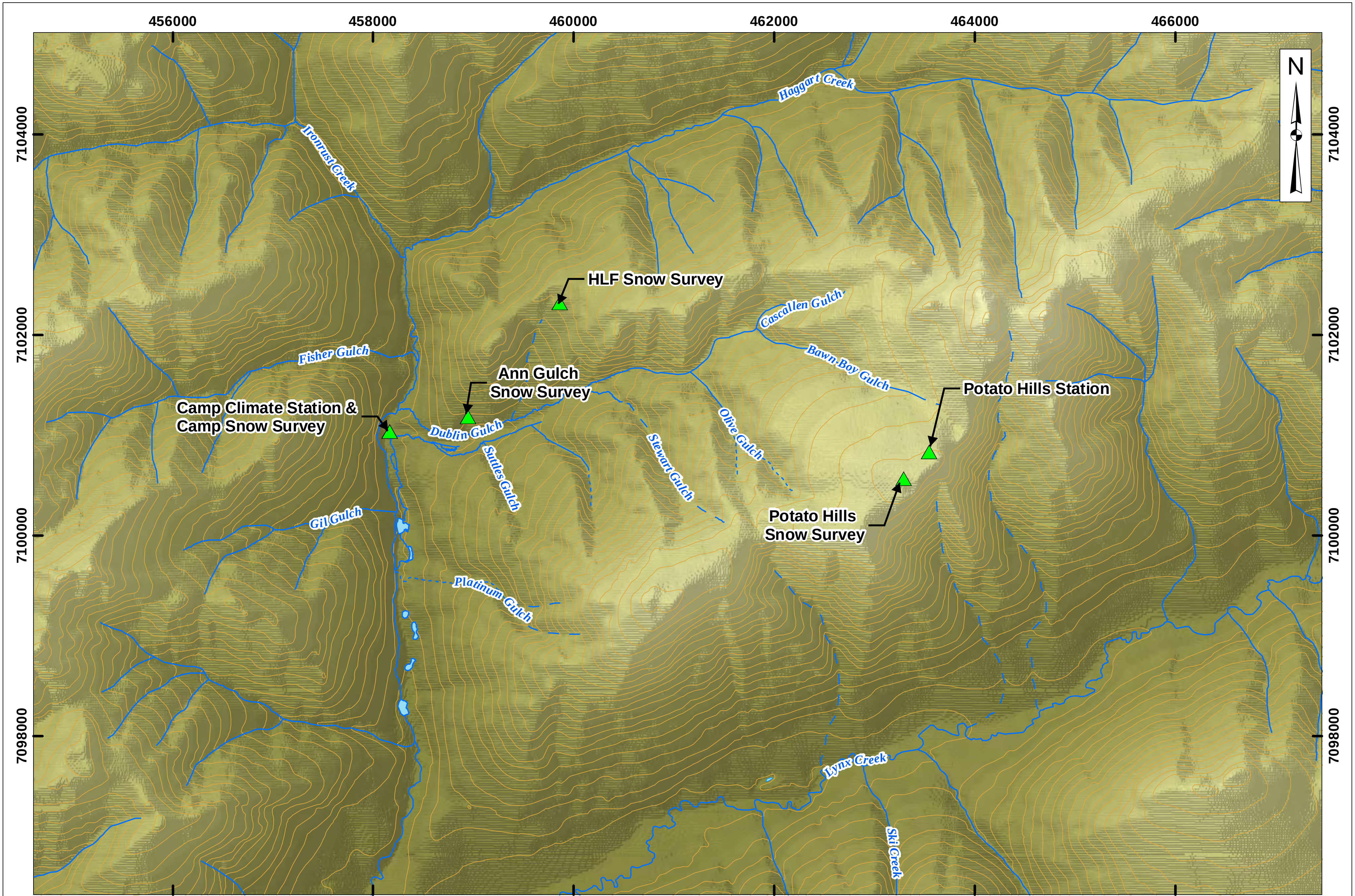
Site specific climate data have been collected and analyzed from two climate stations that were established on the Project site from 1993 – 1996 and again in 2007 and 2009. One station was installed at Potato Hills (1,420 m asl) in August 2007, while a second station was installed near the camp (823 m asl) in August 2009. These sites were the same locations established by a prior operator in the Project area from 1993 – 1996. The lower Camp station was re-located to a nearby site (778 m asl) in September 2010 due to construction of new camp facilities. The stations characterize climatic conditions in the upper and lower elevations of the Project area which exhibits significant variability due to elevation and physiography (Figure 4-1).

The Project climate stations and snow survey locations, as well as regional climate station in proximity to the project area, are presented in Table 4-1.

Table 4-1: Project Climate Stations

Station	Elevation (m asl)	Latitude/ UTM E	Longitude/ UTM N	Record Period
Project Site Climate Stations				
Camp Station	782	458,164	7,101,036	2009-present
Potato Hills Station	1420	463,544	7,100,833	2007-present
Project Site Snow Survey Locations				

Station	Elevation (m asl)	Latitude/ UTM E	Longitude/ UTM N	Record Period
Camp Snow Survey	782	458,164	7,101,036	2009-present
Ann Gulch Snow Survey	875	458,945	7,101,185	2012-2017
HLF Snow Survey	1078	459,859	7,102,319	2019-present
Potato Hills Snow Survey	1420	463,290	7,100,568	2009-present
HLF 3b (Bench and Slope)	1066	459,295	7,102,063	2021-present
HLF 4b (Bench and Slope)	1049	459,602	7,102,212	2021-present
HLF 5b (Bench and Slope)	1048	459,580	7,102,207	2021-present



Legend:

Snow/Climate	Perennial
Contour (100ft)	Ephemeral
	Intermittent

VICTORIA GOLD CORP

0 0.25 0.5 1
Kilometres

Projection: NAD 83 Zone 8N

Drawn By: HC

Date: 2020/06/01

Figure: 4-1

EAGLE GOLD PROJECT
YUKON TERRITORY

Project Climate Station Locations

4.1.1 Temperatures

Although mean monthly air temperatures measurably differ between the Camp station (782 m asl) and Potato Hills station (1,420 m asl), the mean annual air temperature at the project site for both sites are similar at -3.7°C at the Camp station and -3.6°C at the Potato Hills Station over their respective periods of record. At the Camp station, monthly average temperature ranges from -20.0°C in November to 13.4°C in July, and -15.1°C in December to 10.9°C in July at the Potato Hills station. The minimum (maximum) recorded daily average temperatures were -43.8°C (22.0°C) and -36.6°C (22.9°C) at the Camp and Potato Hills stations, respectively. The minimum (maximum) recorded 15-minute temperatures were -46.4°C (31.6°C) and -37.6°C (31.7°C) at the Camp and Potato Hills stations, respectively.

During the months of March to October inclusive, the standard lapse rate applies, with temperatures decreasing with rising elevation, and are approximately 3°C cooler at the upper station, on average. However, during the winter months of November to February, temperature inversions are common at the Project site, with temperatures approximately 2.5°C cooler on average in the valley bottom than at the height of land.

Table 4-2 summarizes the mean temperatures recorded at the Camp and Potato Hills climate stations.

Table 4-2: Project Site Mean Monthly Temperatures

Location	Year	Mean Temperature °C												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Potato Hills Station (1,420 m asl)	2007	-	-	-	-	-	-	-	-	1.0	-6.9	-12.0	-15.2	-
	2008	-17.7	-17.2	-11.3	-4.8	3.3	8.7	8.1	5.3	1.9	-7.7	-10.8	-18.6	-5.1
	2009	-19.3	-17.2	-16.7	-4.4	M	M	12.6	7.4	3.3	-5.3	-12.8	-11.9	-
	2010	-14.5	-9.7	-9.4	-1.8	5.2	8.8	10.5	9.7	2.3	-5.3	-11.7	-18.2	-2.9
	2011	-15.5	-18.3	-13.9	-5.6	4.8	8.8	10.3	7.0	4.1	-5.7	-18.0	-13.0	-4.6
	2012	-19.8	-11.1	-13.4	-1.9	3.1	11.3	10.9	M	M	-8.4	-18.8	-19.4	-
	2013	-17.6	-11.3	-14.2	-10.4	2.8	12.1	11.6	11.0	3.0	-2.9	-16.0	-19.5	-4.3
	2014	-10.0	-15.9	-11.5	-3.4	5.6	8.7	11.8	8.7	2.1	-5.6	-11.6	-11.4	-2.7
	2015	-14.4	-13.8	-9.6	-2.3	8.6	8.6	9.5	7.1	0.1	-3.7	-13.5	-13.6	-3.1
	2016	-9.2	-10.4	-6.2	M	7.2	12.0	12.2	9.3	2.8	-6.8	-10.1	-16.2	-
	2017	-13.0	-13.3	-16.7	-3.2	4.5	9.7	M	M	M	M	-17.4	-10.2	-
	2018	-14.4	-16.9	-12.0	-6.1	M	M	M	M	M	-3.3	-9.9	M	-
	2019	-16.0	M	-5.1	-3.5	M	11.1	13.6	8.9	M	M	-10.8	M	-
	2020	-17.4	-16.1	M	-6.0	M	8.3	8.9	8.6	2.8	-8.4	-14.9	-13.4	-
	2021	-10.2	M	-14.7	-7.6	2.5	11.0	12.2	8.4	1.3	-4.7	-14.9	-21.5	-4.4
	All Years	-14.9	-14.3	-11.7	-4.5	5.0	9.8	10.9	8.3	2.3	-5.8	-13.4	-15.1	-3.6
Camp Station (782 m asl)	2009	-	-	-	-	-	-	-	10.5	6.2	-2.6	-13.6	-17.3	-
	2010	-17.1	-10.8	-6.9	1.1	8.3	12.1	13.6	12.1	4.4	-3.4	-13.5	-24.1	-2.0
	2011	-22.9	-21.3	-15.9	-3.2	7.7	11.5	12.8	9.2	5.1	-2.8	-20.7	M	-
	2012	-25.2	-12.2	-13.4	0.4	5.9	13.3	12.6	10.5	5.0	M	-24.1	-25.9	-
	2013	-21.6	-13.3	-15.5	-8.6	5.0	14.2	14.0	11.9	5.5	-2.5	-18.7	-26.7	-4.7
	2014	-14.9	-23.4	-13.8	-1.8	7.0	11.0	13.4	10.6	3.7	-3.5	-15.8	-15.2	-3.6
	2015	-19.4	-18.1	-11.5	-0.1	10.1	11.2	12.2	9.0	2.9	-1.5	-15.1	-15.2	-3.0

Location	Year	Mean Temperature °C												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	2016	-13.1	-13.5	-5.1	2.3	8.2	12.4	13.6	11.5	4.1	-8.3	-13.7	-21.9	-1.9
	2017	-19.6	-18.8	-17.2	-1.4	7.3	M	M	11.8	6.3	-4.1	-22.9	-16.6	-
	2018	-19.4	-24.3	-11.9	-3.7	5.9	11.8	13.8	9.9	1.9	-3.8	-12.8	-16.0	-3.9
	2019	-20.4	-23.1	-6.2	-0.9	8.7	13.0	15.2	8.6	5.3	-4.6	-14.4	-18.7	-3.1
	2020	-26.8	-20.2	-15.7	-3.4	7.0	10.9	11.9	11.1	4.8	-7.9	-19.7	-16.8	-5.4
	2021	-15.5	-25.6	-14.6	-5.4	5.9	14.1	13.9	10.9	3.7	-1.8	-17.0	-25.6	-4.8
	All Years	-19.7	-18.7	-12.3	-2.1	7.3	12.3	13.4	10.6	4.5	-3.9	-17.1	-20.0	-3.6

NOTES:
1. Values are calculated from average daily temperatures.
2. Data is considered missing for a month when there are less than 25 days of data available for that month (beginning of data record until end of 2021).
3. Monthly values in italics for the Potato Hills station, for the period of 2013 through 2015 have been infilled using monthly regression relationships with temperature data from the Camp station.
4. Monthly values in gray for the period of June 2014 to March 2015, May through July 2016, November 2019 and January to February 2020 were recorded by a standalone HOBO temperature sensor.
5. 'M' denotes data missing due to a sensor/datalogger malfunction.
6. Source: Lorax 2022a.

4.1.2 Rainfall

Historically, precipitation data was collected at the Project site using tipping bucket rain gauges, which were not been adapted to measure snowfall. Therefore, the precipitation data presented in Table 4-3 is for rainfall only, collected between the months of March and October, inclusive. The precipitation gauges were replaced with all-season instruments (Geonor weighing cell gauges) in 2020, and thus these data accurately represent total solid phase precipitation. Generally, precipitation falls as snow from November through March, with precipitation falling as a mix of rain and snow in April and October. Rainfall data for March is included in the table below, where the temperature record indicates that precipitation would have fallen as rain (i.e., daily average air temperature was above zero).

Table 4-3: Project Site Monthly Rainfall Data

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Apr-Sep
Camp Station (782 masl)	2009	-	-	-	-	-	-	-	-	35.0	*8.0*	S	S	-	
	2010	S	S	5.0	9.0	20.0	62.0	34.0	28.0	25.0	*12.0*	S	S	195.0	178.0
	2011	S	S	11.0	10.0	16.0	31.0	75.0	44.0	40.0	*9.0*	S	S	236.0	216.0
	2012	S	S	13.0	1.0	22.0	18.0	74.6	29.8	24.0	*4.8*	S	S	187.2	169.4
	2013	S	S	8.6	10.4	34.6	25.6	28.4	35.2	58.6	*25.2*	S	S	226.6	192.8
	2014	S	S	5.4	8.8	9.2	52.8	43.2	70.4	28.8	*23.2*	S	S	241.8	213.2
	2015	S	S	20.8	13.0	8.2	28.8	64.0	62.0	38.6	*13.4*	S	S	248.8	214.6
	2016	S	S	6.2	4.4	14.0	32.6	55.0	31.0	25.6	*2.6*	S	S	171.4	162.6
	2017	S	S	S	2.2	24.4	M	M	12.8	20.4	*6*	S	S	-	-
	2018	S	S	12.0	1.4	63.2	49.4	1.6	34.4	4.6	*12.4*	S	S	179	154.6
	2019	M	M	M	M	M	M	M	M	M	M	M	M	-	-
	2020	M	M	M	M	M	156.2	165.7	89.7	71	60.9	46.3	28.5	-	-
	2021	27.0	23.7	16.4	12.6	82.5	39.0	83.2	154.4	107.3	58.9	36.0	41.7	682.6	479.0

Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Apr-Sep
	All Years Mean	S	S	10.9	7.3	29.4	49.5	62.5	53.8	39.9	19.7	41.1	35.1	263.2	220.0
	All Years Maximum	S	S	20.8	13.0	82.5	156.2	165.7	154.4	107.3	60.9	46.3	41.7	682.6	479.0
	All Years Minimum	S	S	5.0	1.0	8.2	18.0	1.6	12.8	4.6	2.6	36.0	28.5	171.4	154.6
Potato Hills Station (1420 masl)	2007	S	S	S	-	-	-	-	24.0	100.8	*2*	S	S	-	-
	2008	S	S	3.4	4.8	58.4	52.0	201.2	130.0	11.2	*1.2*	S	S	462.2	457.6
	2009	S	S	S	3.0	M	50.8	12.6	75.4	44.4	*1.2*	S	S	-	-
	2010	S	S	1.0	6.2	16.4	77.2	45.8	39.4	4.2	*5.4*	S	S	195.6	189.2
	2011	S	S	0.2	7.2	21.2	38.0	92.8	83.8	34.4	*0.4*	S	S	278	277.4
	2012	S	S	S	0.6	9.6	24.2	64.8	37.8	21.0	*4.6*	S	S	162.6	158.0
	2013	S	S	2.2	0.2	29.6	33.2	18.0	18.2	63.8	*10.0*	S	S	175.2	163.0
	2014	S	S	S	M	M	M	M	M	M	*M*	S	S	-	-
	2015	S	S	S	M	M	M	M	48.5	27.1	*10.0*	S	S	-	-
	2016	S	S	D	D	14.5	23.0	38.3	42.6	24.6	*0.6*	S	S	-	-
	2017	S	S	D	D	16.2	25.8	46.3	21.8	53.0	*6.1*	S	S	-	-
	2018	S	S	D	D	D	46.5	13.5	77.0	4.0	*3.8*	S	S	-	-
	2019	S	S	D	D	D	D	18.5	D	D	D	S	S	-	-
	2020	S	S	D	D	D	101.2	103.5	68.5	63.7	44.2	18.3	19	-	-
	2021	*14.2*	21.0	58.7	10.9	60.3	29.8	68.2	112.3	66.4	43.5	15.6	25.1	526.1	347.9
	All Years Mean	S	S	13.1	4.7	28.3	45.6	60.3	59.9	39.9	10.2	17.0	22.1	254.7	265.5
	All Years Maximum	S	S	58.7	10.9	60.3	101.2	201.2	130.0	100.8	44.2	18.3	25.1	462.2	457.6
	All Years Minimum	S	S	0.2	0.2	9.6	23.0	12.6	18.2	4.0	0.4	15.6	19.0	162.6	158

NOTES:

1. Winter precipitation data (October through April in many years) are unreliable due to the majority falling as snow. The months where no rainfall was recorded due to freezing conditions are denoted by an 'S'. The exception is after October of 2020, following the installation of an all-season Geonor precipitation gauge at both climate stations.
2. Data for the month of October are in italics, as rainfall is not measured for the entire month.
3. M' denotes when there are less than 25 days of data available for that month.
4. In August 2015, the primary rain gauge at the Potato Hills Station was replaced by a standalone tipping bucket rain gauge. The replacement gauge is deployed each spring (i.e., in April or May) then decommissioned in the autumn (October). Missing data at Potato Hills Station denoted by 'D' indicate time periods during which the standalone tipping bucket rain gauge was not functioning.
5. February 2021 precipitation value is estimated from the difference between the Feb. 1 and Mar. 1 Potato Hills snow water equivalent values.
6. Source: Lorax 2022a

4.1.3 Snow Depth

Snow data has been collected at three snow courses at the Project site. The snowpack surveys were conducted near each climate station since 2009 and a third station (in the area of the HLF) was added to the program in 2013. Sampled information included snow depth, snow density and snow water equivalent (SWE).

At the Project site, the annual maximum SWE value generally occurs in late-March or early-April. Field measurements from site show that snow density is generally lower earlier in the season, corresponding to colder temperatures, but increases through winter as the snowpack deepens, consolidates and as snow melt progresses.

The Potato Hills snow survey was conducted in the immediate vicinity of the weather station from 2009 to 2011. However, due to the exposed location, snow redistribution resulted in variable measurements, and therefore the survey was moved to its current and more sheltered location in 2012, several hundred metres to the south-east. Note that high snowpacks did not allow access to the Potato Hills snow course in March 2012, and therefore the survey was conducted at Stewart Gulch that year. In 2013, an additional snow survey station was established on the south-facing slopes near Ann Gulch. Snow surveys conducted at the Heap Leach Facility (HLF) in 2019 through 2021 were primarily above or below the diversion ditch established above Phase 1 of the HLF.

Field methods followed the survey techniques according to Yukon Environment (2009) and Ministry of Environment of British Columbia (MOE, 1981). Snow survey data is summarized in Table 4-4.

Collection of SWE, snow depth and density data in additional areas of the area of the HLF were initiated in 2021 (Table 5-5).

Table 4-4: Snow Survey Data

Year	Camp Station (782 m asl)				Ann Gulch (Snow Survey #2; 995 m asl)				HLF Station (1,078 m asl)				Potato Hills Station (1,420 m asl)			
	Survey Date	Depth (cm)	SWE (mm)	Density (%)	Survey Date	Depth (cm)	SWE (mm)	Density (%)	Survey Date	Depth (cm)	SWE (mm)	Density (%)	Survey Date	Depth (cm)	SWE (mm)	Density (%)
2009	2009-04-21	69	112	16%	-	-	-	-	-	-	-	-	2009-04-21	126	410	33%
2010	2010-03-31	50	99	20%	-	-	-	-	-	-	-	-	2010-03-31	103	278	27%
	2010-04-21	69	112	16%	-	-	-	-	-	-	-	-	2010-04-21	126	405	32%
2011	2011-03-28	55	93	17%	-	-	-	-	-	-	-	-	2011-03-28	105	251	24%
2012	2012-03-20	78	161	21%	-	-	-	-	-	-	-	-	2012-03-20	99	237	24%
	2012-04-20	56.4	79	14%	-	-	-	-	-	-	-	-	2012-04-22	117	262	22%
2013	-	-	-	-	2013-02-20	69.6	97	14%	-	-	-	-	2013-02-28	95.6	185	19%
	2013-03-02	60.9	108	18%	2013-03-02	66.9	115	17%	-	-	-	-	-	-	-	-
	2013-04-02	59.3	108	18%	2013-04-02	61.8	117	19%	-	-	-	-	2013-04-03	90	190	21%
	2013-05-05	57.6	106	18%	2013-04-16	62.2	85	14%	-	-	-	-	-	-	-	-
	-	-	-	-	2013-05-03	58	105	18%	-	-	-	-	2013-05-05	116.8	167	14%
2014	2014-03-12	56.8	126	22%	2014-03-12	51	94	18%	-	-	-	-	2014-03-11	97.5	276	28%
	2014-04-02	54.6	100	18%	2014-04-02	46	98	21%	-	-	-	-	2014-04-02	96.2	275	29%
	-	-	-	-	-	-	-	-	-	-	-	-	2014-05-08	69.6	258	37%
2016	2016-03-02	53	118	22%	2016-03-02	52.6	117	22%	-	-	-	-	2016-03-02	95.4	214	22%
	2016-04-09	38	140	37%	2016-04-09	22.2	115	52%	-	-	-	-	2016-04-10	107.4	257	24%
	-	-	-	-	-	-	-	-	-	-	-	-	2016-05-03	95.0	226	24%
2017	2017-03-17	50.9	89	17%	2017-03-17	50.3	100	20%	-	-	-	-	2017-03-17	84.0	206	25%
	2017-04-13	46	117	25%	2017-04-13	30.1	82	27%	-	-	-	-	2017-04-13	98.0	244	25%
	2017-05-04	7	28	40%	2017-05-04	0	0	NA	-	-	-	-	2017-05-03	89.0	236	27%
2018	2018-02-28	53	100	19%	-	-	-	-	-	-	-	-	2018-02-28	85.1	203	24%
	2018-04-04	53.9	109	20%	-	-	-	-	-	-	-	-	2018-04-04	90.5	219	24%
	2018-05-16	-	-	-	-	-	-	-	-	-	-	-	2018-05-16	80.7	226	28%
2019	2019-03-02	48.3	94	20%	-	-	-	-	2019-03-02	56.2	119	21%	2019-03-02	78.7	205	26%
	2019-04-01	25.3	72	31%	-	-	-	-	2019-04-02	37.2	93	25%	2019-04-01	79.3	171	22%
	2019-04-30	0.0	0	-	-	-	-	-	2019-04-30	31.7	71	18%	2019-04-30	91.0	200	22%
	2019-05-16	0.0	0	-	-	-	-	-	-	-	-	-	2019-05-16	48.3	111	23%
	2019-06-01	0.0	0	-	-	-	-	-	-	-	-	-	2019-06-01	0.0	0	-
2020	2020-03-07	89.8	157	18%	-	-	-	-	2020-03-07	108.7	229	21%	2020-03-13	188.5	431	23%
	2020-04-05	93.9	199	22%	-	-	-	-	2020-04-10	108.1	262	24%	2020-04-10	140.5	297	21%
	2020-05-02	40.1	142	35%	-	-	-	-	2020-05-02	50.3	176	35%	2020-05-02	130.3	384	29%
2021	2021-01-15	51.2	74	15%	-	-	-	-	-	-	-	-	-	-	-	-
	2021-01-30	50.3	77	15%	-	-	-	-	-	-	-	-	2021-02-03	92.6	216	23%
	2021-02-26	63.1	108	17%	-	-	-	-	2021-02-26	75.3	140	19%	2021-02-28	100.1	237	24%
	2021-03-30	62.3	113	18%	-	-	-	-	2021-03-30	78.1	116	15%	2021-03-29	108.9	168	15%
	2021-04-28	38.0	95	26%	-	-	-	-	-	-	-	-	2021-04-28	95.6	230	24%
	-	-	-	-	-	-	-	-	-	-	-	-	2021-06-01	16.4	70	32%

NOTES:

1. Snow survey data for Potato Hills collected on 2012-03-20 is from the Stewart Gulch survey (Snow Survey #2) at 995 m asl (see Figure 2-1).
2. No snow surveys were conducted at site in 2015.
3. Snow survey data for the HLF collected on 2019-04-02 from above and below the diversion ditch.
4. Snow survey data for the HLF collected on 2019-04-30 from above the diversion ditch.
5. The Potato Hills Station SWE value for 2020-03-13 was estimated from the average March snow density value (22%) and the measured snow depth on this date, to correct for an error in the SWE measurements.

Table 4-5: Snow Survey Data for Heap Leach Facility Snow Courses Initiated in 2021

Year	Elevation (m asl)	Latitude (°)	Longitude (°)	Snow Survey	Survey Date	Depth (cm)	SWE (mm)	Density (%)
2021	1,370	64.0172	-135.8064	1370 Bench	2021-04-01	22.3	46	21%
	1,066	64.0429	-135.8335	HLF 3b (Bench)	2021-01-16	21.5	42	14%
				HLF 3b (Slope)	2021-01-16	29	52	18%
				HLF 3b (Bench)	2021-02-27	29.4	80	19%
				HLF 3b (Bench)	2021-03-30	27.5	72	17%
	1,049	64.0443	-135.8273	HLF 4b (Bench)	2021-01-16	96.2	247	26%
				HLF 4b (Slope)	2021-01-16	33.6	60	18%
				HLF 4b (Bench)	2021-01-30	93.9	302	32%
				HLF 4b (Bench)	2021-02-27	100.2	266	27%
				HLF 4b (Bench)	2021-03-30	105.9	297	28%
	1,048	64.0442	-135.8277	HLF 5b (Bench)	2021-01-16	67.4	121	18%
				HLF 5b (Slope)	2021-01-16	59	89	15%
				HLF 5b (Bench)	2021-01-30	62.1	124	20%
				HLF 5b (Bench)	2021-02-27	71.1	161	23%
				HLF 5b (Bench)	2021-03-30	75.9	188	25%

Continuous snow depth data has also been collected at the Camp climate station since 2012, as shown in Figure 4-2. The evolution of the snowpack for the 2012 to 2021 time-period shows the pack depth accumulation through the months of November and December, typically reaching maximum depth by mid-March each year. These data then show snowpack depth remains deep and relatively stable to April.

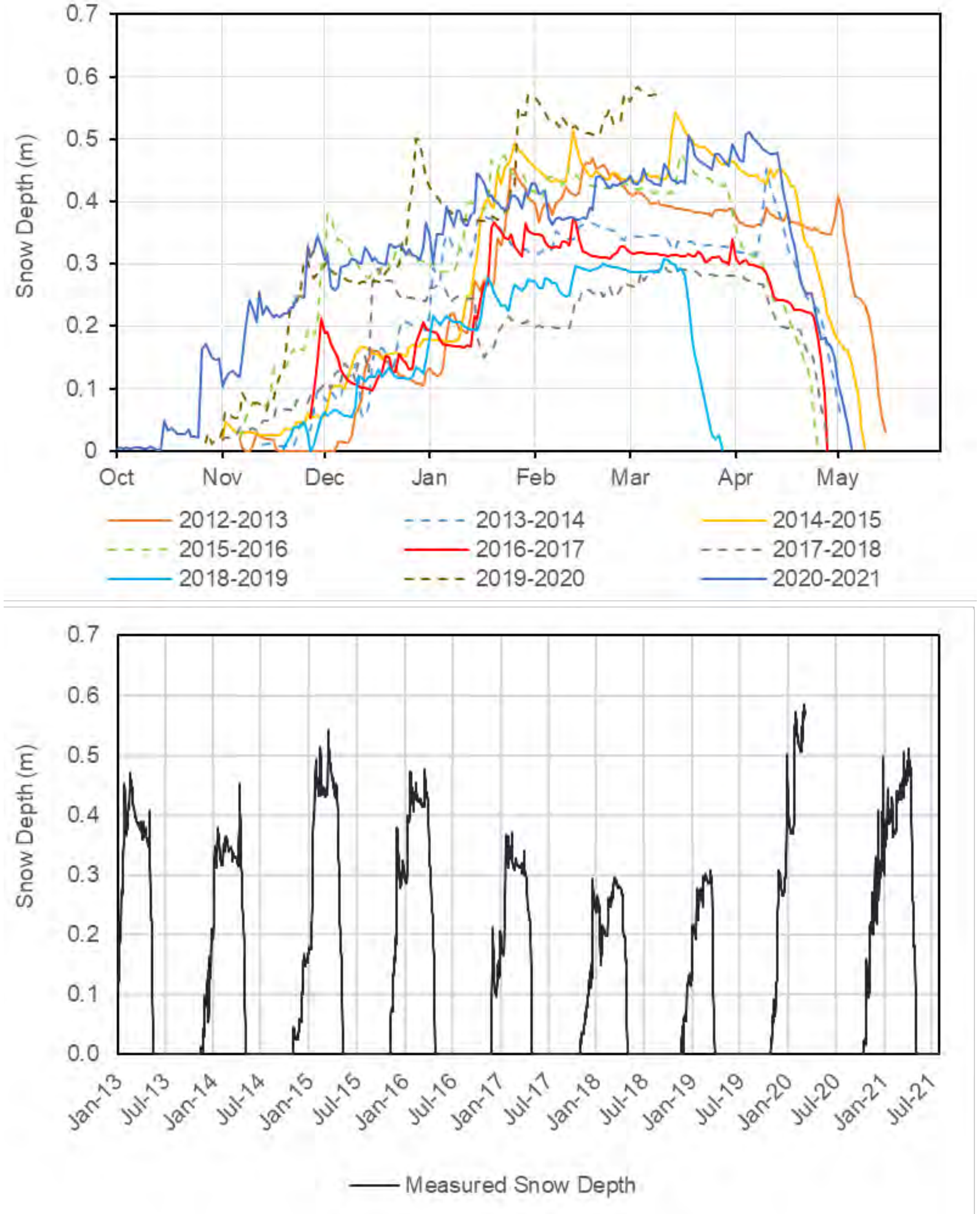


Figure 4-2: Summary of Continuous Snow Depth Data for the Camp Climate Station (2012-2021)

4.1.4 Wind Speed and Direction

Wind speed and direction are measured on-site at the Potato Hills and Camp climate stations at 15-minute intervals and data are available for the period from August 2007 through December 2021 and August 2009 through December 2021, respectively. The Project site wind speed data are presented in Table 4-6.

The mean annual wind speed for Potato Hills and Camp is 2.5 m/s (9 km/hr) and 1.2 m/s (4.7 km/hr), respectively. The mean monthly wind speeds for both stations are higher in the spring, summer and autumn and lower in the winter. The maximum recorded gust speed at the Camp station was 23.5 m/s over a 15-minute interval (August 15, 2016). At the Potato Hills station, wind speeds averaged 23.5 m/s over a 1-hour period (November 3, 2010; 15-min maximum gust of 23.9 m/s). The predominant wind direction for Potato Hills and Camp is from the west-northwest and north to north-northwest, respectively.

Table 4-6: Project Site Monthly Average Wind Speed

Climate Station	Wind Speed (m/s)													
	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Camp Station (782 masl)	2009	-	-	-	-	-	-	-	1.4	1.2	1.2	1.1	0.7	-
	2010	1.2	1.1	2.2	2.0	1.9	1.5	1.4	1.3	1.5	1.2	0.7	1.0	1.4
	2011	0.6	1.2	1.3	1.8	1.7	1.5	1.3	1.2	1.4	0.9	0.9	0.2	1.2
	2012	0.9	1.2	1.6	1.4	1.9	1.3	1.4	1.3	1.5	1.1	1.3	0.7	1.3
	2013	0.8	0.9	1.2	2.2	1.5	1.7	1.5	1.3	1.6	0.8	0.7	0.7	1.2
	2014	0.1	0.8	1.3	1.5	1.8	1.6	1.5	1.2	1.2	1.3	0.9	0.5	1.2
	2015	0.2	0.3	1.1	1.4	1.6	1.6	1.2	1.2	1.3	1.1	0.7	0.0	1.0
	2016	0.7	0.7	1.4	1.5	1.7	1.5	1.2	1.3	1.2	1.2	0.5	0.5	1.1
	2017	R	R	1.6	1.7	1.6	2.1	1.3	1.2	1.0	0.8	0.5	R	-
	2018	0.5	0.7	1.3	1.7	1.5	1.5	1.5	1.4	1.4	1.1	0.7	0.8	1.2
	2019	0.3	0.8	1.3	1.8	1.7	1.8	1.5	1.5	1.2	1.0	1.0	1.1	1.3
	2020	1.1	1.0	1.4	1.6	1.9	1.4	1.4	1.3	1.0	1.1	0.8	1.0	1.2
	2021	0.7	1.0	1.4	1.6	1.6	3.5	1.4	0.3	1.1	0.8	1.4	0.5	1.3
	Average	0.6	0.9	1.4	1.7	1.7	1.7	1.4	1.2	1.3	1.0	0.9	0.6	1.2
Potato Hills Station (1420 masl)	2007	-	-	-	-	-	-	-	2.3	2.3	3.0	3.0	0.8	-
	2008	2.8	3.7	3.6	3.6	3.6	3.1	3.1	2.8	1.7	1.3	2.6	3.1	2.9
	2009	3.2	2.5	3.2	3.0	3.1	2.7	2.9	2.0	2.0	3.4	2.3	2.1	2.7
	2010	2.1	2.1	3.9	3.6	2.7	2.0	2.6	2.7	3.0	2.8	1.5	1.0	2.5
	2011	2.0	3.2	3.4	3.2	3.4	2.0	1.8	2.3	1.2	0.4	2.0	1.4	2.2
	2012	0.0	0.2	1.4	2.0	2.9	1.8	1.9	2.0	2.9	2.5	2.6	0.7	1.7
	2013	1.7	0.7	2.9	4.8	2.6	2.3	2.5	1.8	2.9	2.2	2.1	2.2	2.4
	2014	1.6	2.6	2.5	3.0	2.7	M	M	M	M	M	M	M	-
	2015	M	M	M	M	M	M	0.9	1.8	2.5	1.4	0.0	0.0	-
	2016	1.3	2.7	2.8	M	M	M	M	2.1	2.1	1.6	1.3	0.6	-
	2017	2.2	2.8	2.5	3.1	2.6	2.5	M	M	M	M	1.6	1.0	-
	2018	2.8	2.7	2.7	3.2	M	M	M	M	M	2.5	0.7	M	-
	2019	0.7	M	3.0	3.1	M	2.8	2.0	M	M	M	M	M	-
	2020	M	M	M	2.7	M	2.3	2.5	2.4	2.6	2.2	2.5	2.7	-
	2021	2.3	M	2.6	3.1	2.7	2.9	2.1	2.4	2.0	2.9	3.9	2.6	2.9
	Average	1.9	2.6	2.9	3.2	2.9	2.4	2.2	2.2	2.3	2.2	2.0	1.5	2.5

Notes:

1. Zero value for January 2012 is likely due to icing of the wind sensor.
2. 'M' denotes data missing when there are less than 25 days per month due to a sensor malfunction and R an indicator the wind sensor affected by rime.
3. Source: Lorax 2022a

4.1.5 Relative Humidity

Relative humidity is measured on-site at the Potato Hills and Camp site climate stations and data are available for the period from August 2007 through December 2021 and August 2009 through December 2021, respectively. The mean annual relative humidity for Potato Hills and Camp is 77% and 71%, respectively. The mean monthly relative humidity values for Potato Hills are lowest in the spring (62% to 67% in the months of March through May) and higher throughout the rest of the year (71% to 88% in the months of June through February). The mean monthly relative humidity values for Camp are lowest in the spring (56% to 65% in the months of March through May) and higher throughout the rest of the year (62% to 81% in the months of June through February). All monthly average relative humidity values from both climate stations are provided in Figure 4-3.

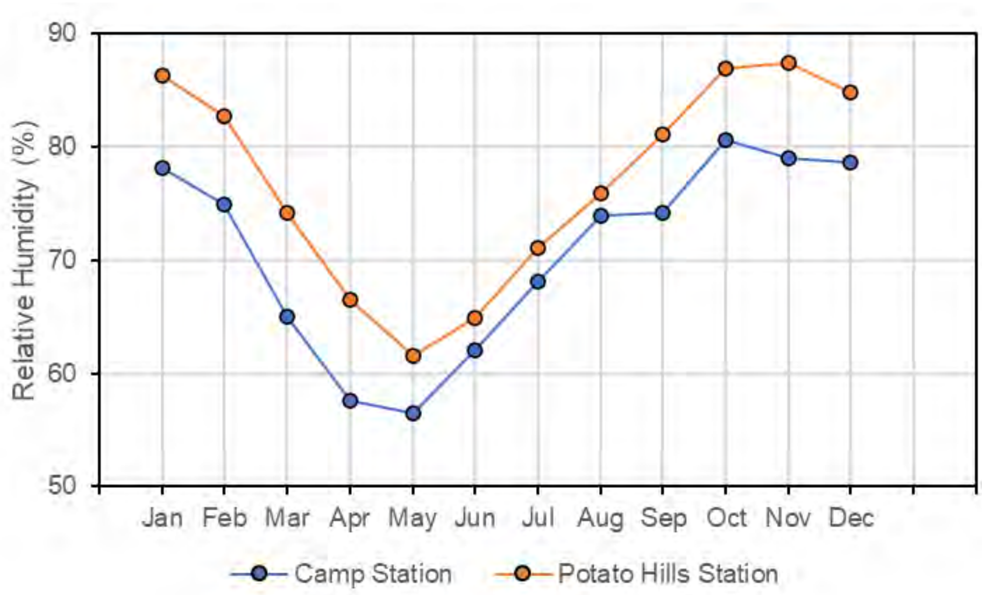


Figure 4-3: Average Monthly Relative Humidity for the Period of Record

4.1.6 Barometric Pressure

Barometric pressure is measured on-site at the Potato Hills and Camp site climate stations and data are available for the period from August 2007 through December 2021 and August 2009 through December 2021, respectively. A standalone HOBO sensor measured barometric pressure at the Potato Hills station in January and February 2020, but malfunctioned thereafter, resulting in no further usable data collected in 2020 or 2021. Average barometric pressure data are collected on hourly increments at each of the project climate stations. Annual average barometric pressure is 84.9 kPa at the Potato Hills station, and 91.9 kPa at the Camp station. Barometric pressure tends to be highest in summer (May through August) with 85.6 kPa and 92.2 KPa recorded at the Potato Hills and Camp stations respectively and lowest during November, with 84.5 kPa and 91.6 kPa recorded at Potato Hills and Camp stations, respectively.

4.1.7 Solar Radiation

Solar radiation is measured on-site at the Potato Hills and Camp site climate stations and data are available for the period from August 2007 through December 2021 and August 2009 through December 2021, respectively. Given the high-latitude location of the Project site, day length, and therefore solar radiation, fluctuate greatly on a seasonal basis. The average annual minimum of 1 W/m^2 (Camp station) and 3 W/m^2 (Potato Hills station) occur in the month of December, while the average annual maximum of 227 W/m^2 and 218 W/m^2 occur in May and June at the Camp station and in May at the Potato Hills station, respectively. The Camp station location in the valley bottom results in slightly lower incident solar radiation, presumably due to the shading effect of the surrounding terrain.

4.1.8 Potential Evaporation

15-minute potential evaporation (PE) rates were computed for the Camp station using available climate and the Ref-ET calculator – a compiled, stand-alone computer program that calculates reference evapotranspiration (ASCE, 2005). For the period of available record (January 2013 to December 2021), a 15-minute climate input file was prepared for the site (Lorax, 2022a). May to end-September PE for the Camp station is estimated to range from 367-448 mm with the Priestley-Taylor equation resulting in average PE estimates similar to values calculated using the Penman-Monteith equation. 2021 PE estimates using the Priestley-Taylor equation substantially exceeded the historical average, a similar result to that noted in the 2020 data following sensor servicing and calibration. A potential reason for this increase is the abnormally high solar radiation measured at Camp station during this period and the considerable influence exerted by solar radiation in the Priestley-Taylor equation. The highest monthly rates of PE are expected in May, June, July and August of each year.

4.2 SURFACE WATER

4.2.1 Hydrology

Hydrology and streamflow conditions at the Mine site are described in a number of hydrology related baseline reports. These include the following reports available on the YWB website registry for QZ14-041:

- Environmental Baseline Report: Hydrology (Stantec 2010b) - Exhibit 1.4.1
- Environmental Baseline Data Report: Hydrology 2011 Update (Stantec 2012b) - Exhibit 1.4.2
- Hydrology Baseline Data Summary (KP 2013) - Exhibit 1.4.3

The latest hydrology and streamflow information is available under the YWB Waterline website registry for QZ14-041-1 in the Eagle Gold Streamflow Monitoring Report - 2021 Updated (Lorax 2022b) - Appendix C to the Eagle Gold Project 2021 Annual Report.

The majority of the Project site lies within the Dublin Gulch watershed, a second order tributary to the larger Haggart Creek watershed, which is a major tributary of the South McQuesten River. The South McQuesten River joins the Stewart River, which flows west to its eventual confluence with the Yukon River.

The hydrology of the region is characterized by a dominant snowmelt driven freshet signature, which typically occurs between early May and early June. The recession limb of the freshet tapers to a lower summer flow regime reflective of groundwater primarily, which is punctuated by periodic rainfall driven runoff events, typically one to four days in duration. Base flows are lowest in the winter and flow sub-ice; in the smaller creeks, groundwater is depleted in the winter and no flow conditions under the ice are typical.

In larger tributaries, groundwater discharge maintains limited amounts of streamflow below the ice throughout the winter (i.e., November through end March). Aufeis (i.e., groundwater that seeps and freezes onto- and adjacent to local watercourses) is present in several places throughout streams at the Project site. As with shelf ice in the streams, aufeis melts during the freshet, but may in some cases persist into the early summer.

The current surface water baseline data collection program commenced in 2007 and has included up to 23 streamflow monitoring stations. The locations, and data collection and monitoring frequency of the program within the Project area has evolved somewhat since 2007 due primarily to changing program objectives associated with the requirements of environmental assessment and water licensing processes and the continuing development of the Project. Table 4-7 provides a summary of automated and manual streamflow monitoring stations, as well as the year or years in which streamflow data were collected.

Table 4-7: Summary of Streamflow Monitoring Stations

Drainage Basin	Monitoring Site	Type of Station	Year(s) of Record
Haggart Creek	W4 - DS Dublin Gulch	Automatic	2007 - ongoing
	W5 - US Lynx Creek	Automatic	2007 - ongoing
	W22 - US Dublin Gulch	Automatic	2007 - ongoing
	W23 - DS Lynx Creek	Manual	2007 – 2011, 2018 - ongoing
	W29 - DS Eagle Creek	Automatic Manual Automatic	2010 – 2015 2016 – 2019 2020 – ongoing
	W39 – US South McQuesten River	Manual	2017 - ongoing

Drainage Basin	Monitoring Site	Type of Station	Year(s) of Record
	W99 – US 15 Pup	Automatic	2019 - ongoing
Eagle Creek	W27 – Midway, near camp	Automatic	2007 - ongoing
	W45 - US Haggart Creek	Manual Automatic	2012, 2013 2018 - ongoing
	W61 - US Suttles Gulch	Manual	2009 - 2011
	W62 - DS Suttles Gulch	Manual	2009 - 2011
	WECP - Eagle Creek Pond	Manual Automatic	2009, 2010 2011 - 2013
	W10 - Suttles Gulch	Manual	2010, 2011
Dublin Gulch	W1 - US Stewart Gulch	Automatic	2007-ongoing
	W21 - Dublin Gulch near mouth	Manual Automatic[2]	2007 – 2013, 2018 2019 - ongoing
	W32 - Ann Gulch	Manual	2010, 2011
	W26 - Stewart Gulch at flume	Manual Automatic	2007 - 2011 2010, 2012-ongoing
	W36 - Stewart Gulch	Manual	2009
	W31 - Olive Gulch	Automatic	2009-2010
	W52 - Dublin US Olive	Manual	2009
	W51 - Dublin DS Cascallen	Manual	2009
	W20 - Bawn Boy Gulch	Manual Automatic Manual	2007, 2008 2009 2020 - ongoing
	W30 - Cascallen Gulch	Manual	2009
Lynx Creek	W6 - Lynx Creek US Haggart	Automatic	2007 - ongoing
	W13 - Lynx Creek midway	Automatic	2007
South McQuesten River	W49 – DS Haggart Creek	Manual	2017 - ongoing

Note: 1. Automated stations are not continuous through the winter
2. Water level sensor malfunctioned in 2019 and 2020, therefore no continuous water level data are available for these years

Stantec (2010b and 2012b) and Lorax (2022b) provide a comprehensive review of regional data and a baseline hydrology data summary for the project site through 2021.

4.2.1.1 Monitoring Methods

The continuous streamflow monitoring stations noted in Table 4-7 consist of a permanent staff gauge, pressure transducer and datalogger that record water level continuously at 15 minute intervals. Discharge measurements were conducted during periodic station visits and related to the corresponding water level at time of measurement from which stage-discharge rating curves were developed. The continuous streamflow gauging stations are typically installed prior to the spring freshet and removed at the end of the open-water season in late October or early November to avoid damage from winter freeze.

4.2.1.2 Waterbodies Watercourses, and Drainage Basins

The hydrology local study area includes the Dublin Gulch, Eagle Creek, and Haggart Creek (above the Lynx Creek confluence) drainage basins (Figure 4-4). The basin areas of these water bodies are 10.4 km^2, 4.7 km^2, and 98 km^2 respectively. The basins are characterized by high relief (750 to 800 m asl), steep gradients (mean gradient of 18%), and well-vegetated slopes.

Dublin Gulch, Eagle Creek, and Haggart Creek are all perennial streams. Several of the tributaries in the Project area are intermittent streams (i.e., the stream becomes dry at sections along the water course where flow goes subsurface) or ephemeral streams (i.e., the stream channel has little to no groundwater storage and flow is in response to snowmelt of heavy rains). With construction of the Mine, flows from Platinum Gulch, Suttles Gulch and Eagle Pup that previously reported to lower Eagle Creek (W45) are now being captured by the site water managed ditches and report to the Lower Dublin South Pond (LDSP).

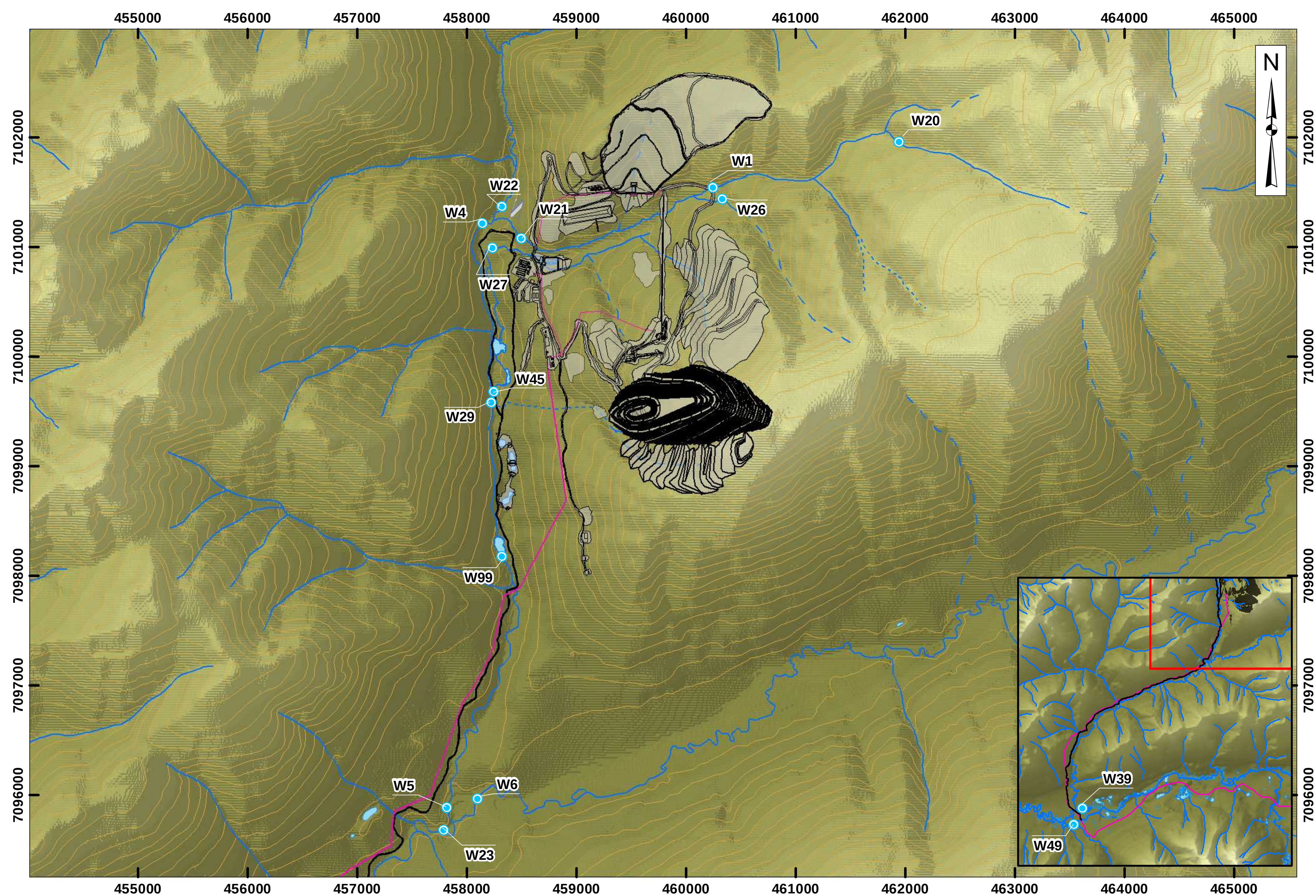
4.2.1.3 Stream Flows

The open-water season pattern is characterized by freshet-generated peak flow in May to early June, followed by a relatively rapid recession to low base flow throughout July and August. Heavy rain events caused short-term increases in stream flow with storm-event recessions being generally rapid in the late summer and fall, both reflective of low groundwater storage capacity of the basins. Winter flows, though not continuously gauged, have been measured and observed by field personnel in Haggart Creek and lower Dublin Gulch and are the lowest flows of the year reflective of base flow contributions. These seasonal changes are represented in the hydrograph for Haggart Creek at station W4 (Figure 4-5). Monthly summaries and hydrographs for all the gauged streams are provided in Lorax (2022b). Summary of monthly average discharge, unit yield and runoff for Project site hydrometric stations is presented in Table 4-8.

Table 4-8: Summary of Monthly Average Discharge, Unit Yield and Runoff for Project Site Hydrometric Stations

Station (Discharge Area)	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average/ Total
W1 (6.8 km^2)	Average Discharge (m^3/s)	--	--	--	0.024	0.255	0.110	0.091	0.088	0.089	0.099	0.069	--	0.103
	Average Yield (L/s/km^2)	--	--	--	3.5	37.5	16.1	13.4	13.0	13.0	14.6	10.1	--	15.2
	Runoff (mm)	--	--	--	5	63	39	35	33	34	21	4	--	234
W4 (76.9 km^2)	Average Discharge (m^3/s)	--	--	--	0.780	2.281	1.176	0.858	0.903	0.917	0.829	--	--	1.106
	Average Yield (L/s/km^2)	--	--	--	10.1	29.7	15.3	11.2	11.7	11.9	10.8	--	--	14.4
	Runoff (mm)	--	--	--	10	56	38	30	31	31	16	--	--	211
W5 (97.5 km^2)	Average Discharge (m^3/s)	--	--	--	--	3.088	1.450	1.060	1.041	1.049	1.106	--	--	1.466
	Average Yield (L/s/km^2)	--	--	--	--	31.7	14.9	10.9	10.7	10.8	11.3	--	--	15.0
	Runoff (mm)	--	--	--	--	64	36	29	28	28	14	--	--	199
W6 (100.9 km^2)	Average Discharge (m^3/s)	--	--	--	--	3.653	1.158	0.933	1.127	1.203	1.061	0.574	--	1.387
	Average Yield (L/s/km^2)	--	--	--	--	36.2	11.5	9.2	11.2	11.9	10.5	5.7	--	13.7
	Runoff (mm)	--	--	--	--	63	25	23	29	31	15	3	--	191
W21 (66.8 km^2)	Average Discharge (m^3/s)	--	--	--	--	0.280	0.123	0.067	0.118	0.074	0.055	--	--	0.120
	Average Yield (L/s/km^2)	--	--	--	--	27.68	13.8	7.5	14.3	8.3	6.1	--	--	13.0
	Runoff (mm)	--	--	--	--	74.15	18	8	7	6	1	--	--	115
W22 (66.8 km^2)	Average Discharge (m^3/s)	--	--	--	0.531	2.211	1.009	0.713	0.832	0.794	0.764	0.937	--	0.974
	Average Yield (L/s/km^2)	--	--	--	7.9	33.1	15.1	10.7	12.5	11.9	11.4	14.0	--	14.6
	Runoff (mm)	--	--	--	13	60	38	27	30	30	15	15	--	228
W26 (1.3 km^2)	Average Discharge (m^3/s)	--	--	--	--	0.029	0.016	0.011	0.014	0.011	0.007	--	--	0.015
	Average Yield (L/s/km^2)	--	--	--	--	22.3	12.2	8.9	10.5	8.5	6.0	--	--	11.4
	Runoff (mm)	--	--	--	--	40	26	23	28	21	6	--	--	144

Station (Discharge Area)	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average/ Total
W27 ($2.7\ km^2$)	Average Discharge (m^3/s)	--	--	--	0.007	0.054	0.027	0.024	0.021	0.019	0.023	--	--	0.025
	Average Yield ($L/s/km^2$)	--	--	--	2.507	20.0	10.0	8.7	7.8	6.9	8.7	--	--	9.2
	Runoff (mm)	--	--	--	3.033	38	24	20	20	18	9	--	--	131
W29 ($8\ km^2$)	Average Discharge (m^3/s)	--	--	--	--	2.886	1.163	1.099	1.170	1.081	0.968	--	--	1.395
	Average Yield ($L/s/km^2$)	--	--	--	--	33.5	13.5	12.8	13.6	12.6	11.2	--	--	16.2
	Runoff (mm)	--	--	--	--	43	28	34	35	33	18	--	--	191
W99 ($90.1\ km^2$)	Average Discharge (m^3/s)	--	--	--	1.503	2.657	1.595	0.915	0.990	0.936	1.077	--	--	1.382
	Average Yield ($L/s/km^2$)	--	--	--	17.0	30.1	18.1	10.4	11.2	10.6	12.2	--	--	15.7
	Runoff (mm)	--	--	--	19	81	45	27	30	27	11	--	--	240



Legend:

- Hydrology Station
- Major Facility
- Site Power
- Perennial Watercourse
- Ephemeral Watercourse
- Intermittent Watercourse

VICTORIA GOLD CORP

0 250 500 1,000
Meters

Projection: NAD 83 Zone 8N

Drawn By: HC

Date: 2022/03/27

Figure: 4-4

EAGLE GOLD PROJECT
YUKON TERRITORY

Location of Streamflow Monitoring Stations

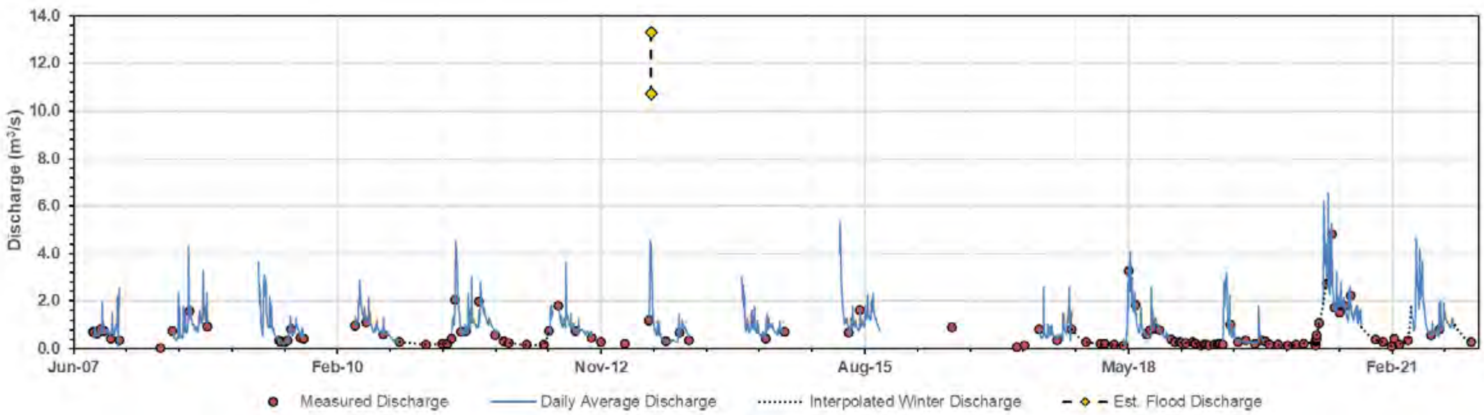


Figure 4-5: Haggart Creek (W4) Average Daily Discharge Record (2007-2021)

4.2.2 Water Quality

Surface water quality conditions at the Mine site are described in a number of related baseline reports. These include the following reports available on the YWB website registry for QZ14-041:

- Environmental Baseline Report: Water Quality and Aquatic Biota (Stantec 2012d)- Exhibit 1.4.4
- Baseline Water Quality Report (Lorax 2013) - Exhibit 1.4.5

The latest water quality information is available under the YWB Waterline website registry for QZ14-041-1 in the Water Quality Summary in Support of QZ14-041 Annual Report (Lorax 2022c) - Appendix D to the Eagle Gold Project 2021 Annual Report.

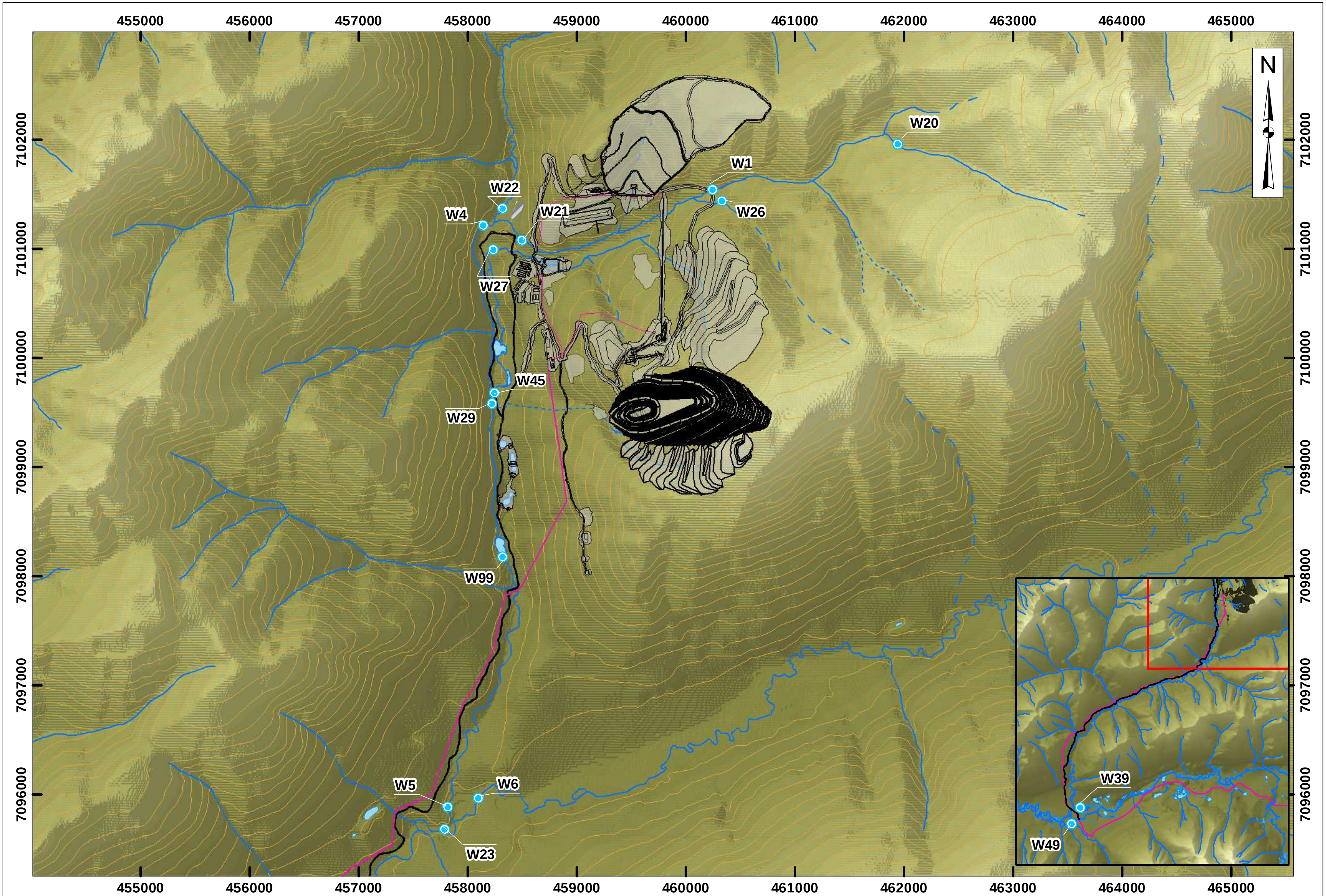
The current study area (Table 4-9 and Figure 4-6) includes the Haggart Creek, Dublin Gulch, Eagle Creek basins, which have been subject to placer mining in the past, and the Lynx Creek basin, which has not been subject to placer mining. Sites within the Haggart Creek, Dublin Gulch, and Eagle Creek drainage basins were selected upstream and downstream of the Project footprint, where possible. Lynx Creek drains a large catchment to the south of the Project area that will be unaffected by development activities.

Table 4-9: Water Quality Sampling Locations and Rationale by Drainage

Site	Location	Site Type	Rationale	Coordinates	
				North	East
Haggart Creek Drainage					
W22	Haggart above Dublin Gulch	Reference	Above Project influence	7,101,377	458,319
W4	Haggart below Dublin Gulch	Exposure	Below Project influence	7,101,223	458,144
W29	Haggart below Eagle Cr	Exposure	Below Project influence	7,099,583	458,225
W5	Haggart above Lynx Cr	Exposure	Below Project influence	7,095,887	457,815
W23	Haggart below Lynx Cr	Exposure	Below Project influence	7,095,682	457,790
W99	Haggart above 15 Pup	Exposure	Below Project Influence	7,098,180	458,322
W39	Haggart above S. McQuesten	Far Field	Below Project influence	7,086,504	449,780
Dublin Gulch Drainage					
W20	Bawn Boy Gulch	Reference	Above Project influence	7,101,961	461,945

Site	Location	Site Type	Rationale	Coordinates	
				North	East
W1	Dublin above Stewart Gulch	Reference	Above Project influence	7,101,545	460,249
W26	Stewart Gulch	Reference	Above Project influence	7,101,443	460,331
W21	Dublin above Haggart Cr	Exposure	Below Project influence	7,101,261	458,359
Eagle Creek Drainage					
W27	Eagle Creek midway	Exposure	Below Project influence	7,100,997	458,235
W45	Eagle above Haggart Cr	Exposure	Below Project influence	7,099,684	458,243
Lynx Creek Drainage					
W6	Lynx above Haggart Cr	Reference	No Project influence	7,095,964	458,099
South McQuesten River Drainage					
W49	S. McQuesten below Haggart	Far Field	Below Project influence	7,085,495	449,221

Procedures for collecting data and information on conditions in streams of the study area have used methods consistent with standards under Yukon and federal legislation. Water samples have been collected midstream following methods outlined in the BC Freshwater Biological Sampling Manual (BC Ministry of Water, Land Air Protection 2003). Grab samples were collected from just below the surface, facing upstream and using narrow mouth bottles. Samples requiring filtration and/or preservation were dealt with as soon as possible after returning to shore. All samples and blanks were kept in coolers with ice packs until arrival at the laboratory. In situ measurements were also taken on each sampling date for pH, temperature, conductivity and dissolved oxygen.



Legend:

- Hydrology Station
- Major Facility
- Site Power
- Perennial Watercourse
- Ephemeral Watercourse
- Intermittent Watercourse

VICTORIA GOLD CORP

0 250 500 1,000
Meters

Projection:	Drawn By:	EAGLE GOLD PROJECT YUKON TERRITORY
NAD 83 Zone 8N	HC	
Date: 2022/03/27	Figure: 4-6	Surface Water Quality Monitoring Stations

4.2.2.1 Dublin Gulch Drainage

Water quality in Dublin Gulch is characterized using monitoring data from stations W1 and W21 (Figure 4-6). Upper Dublin Gulch (W1) drainage includes inputs from Bawn Boy Gulch (W20), Olive Gulch and Stewart Gulch (W26). These stations are all upstream of current mining operations. Data from station W20 in the upper reaches of Dublin Gulch in Bawn Boy Gulch is also considered as it strongly influences trace element concentrations in Dublin Gulch, in particular the arsenic signature throughout the stream. Station W26 in Stewart Gulch is also discussed as naturally elevated As concentrations exist and contribute to the overall As loading in Dublin Gulch.

The headwaters of Dublin Gulch originate in Bawn Boy Gulch and water quality is characterized by soft waters, with monthly median hardness values ranging from approximately 15 mg/L to 35 mg/L at station W20. Following inputs from Olive Gulch, and presumably influxes of groundwater, hardness values increase in Dublin Gulch at W1 during lower flow periods to values between roughly 50 mg/L to 70 mg/L. Values for conductivity and alkalinity demonstrate pronounced seasonal fluctuations, with minima coinciding with freshet periods in May and June and an approximate two- to three-fold increase in concentration between freshet and other times of the year. Overall, such trends in stream salinity reflect varying proportions of snow-melt driven surface runoff (lower ionic strength) and groundwater inputs (higher ionic strength) as driven by the seasonal water balance.

Baseline concentrations for sulphate in Dublin Gulch exhibit very low concentrations in the headwaters of Bawn Boy Gulch (e.g., 3 mg/L to 8 mg/L) with gradually increasing concentrations downgradient through the catchment. Stewart Gulch contains higher concentrations of sulphate (6 mg/L to 44 mg/L) compared to that measured at W1 immediately upstream (5 mg/L to 20 mg/L) in Dublin Gulch. Unlike the dissolved ions, elevated TSS concentrations in Dublin Gulch generally coincide with the peak snowmelt month of April and May. At station W1 for the period of 2007 to 2020 the median and 95th percentile May TSS concentrations are roughly 30 mg/L and 240 mg/L, respectively. At most other flow periods of the year, TSS values in Dublin Gulch at W1 were generally at or below the analytical detection limit of 3.0 mg/L.

Nutrient values, as represented by NH_3-N, NO_3-N, NO_2-N and dissolved orthophosphate, are present at very low concentrations and well below water quality guidelines for the protection of aquatic life throughout Dublin Gulch.

Median monthly concentrations of total trace elements are low (e.g., Sb, Cu, Co, Cr, Pb, Ni, Hg, Se, U and Zn) and present at concentrations well below their respective water quality guideline. However, Dublin Gulch is characterized by elevated total and dissolved As concentrations throughout its reaches. Indeed, Dublin Gulch represents the most significant background contribution of As to the Haggart Creek system. One of the primary sources of As in Dublin Gulch occurs in its headwaters in Bawn Boy Gulch. Monthly median total and dissolved As at W20 for the monitoring period 2007 to 2020 ranged from 0.061 mg/L to 0.075 mg/L (total) and from 0.047 mg/L to 0.073 mg/L (dissolved). Arsenic in Bawn Boy Gulch is present primarily in the dissolved form. Olive Gulch and Stewart Gulch also provide significant As loadings to Dublin Gulch but at lower concentrations than in Bawn Boy, with total and dissolved As concentrations typically on the order of 0.022 mg/L to 0.030 mg/L for both drainages.

The baseline period for lower Dublin Gulch, as measured at monitoring station W21, spans the period of 2007 to 2017. Unlike upper Dublin Gulch, construction and mine operation activities have occurred upstream of W21 and have influenced water quality in lower Dublin Gulch since construction commenced in 2017. Accordingly, the existing conditions at W21 are characterized by data collected for the period 2018 to 2020. Values of hardness, conductivity and alkalinity in lower Dublin Gulch at W21 are typically higher than values at W1 in upper Dublin Gulch; this likely reflects the contribution of higher conductivity, alkalinity and hardness waters from Stewart Gulch

(W26) and possibly from the contribution from groundwater discharges at lower elevations in the catchment. Sulphate concentrations in lower Dublin Gulch as measured at W21 range from monthly median values of 9 mg/L to 60 mg/L for the baseline period of 2007 to 2017 and from 14 mg/L to 104 mg/L for the existing condition period of 2018 to 2020. These sulphate values at W21 are greater than measured upstream in Dublin Gulch at W1.

During the baseline period, monthly median TSS concentrations ranged from 3.0 mg/L to roughly 7.0 mg/L with a maximum observed TSS concentration of 31 mg/L in May 2014. Greater sampling frequency at W21 during the construction and operations period of 2018 to 2020 has indicated that higher TSS concentrations have occurred more frequently. Monthly median TSS values for 2018 to 2020 range from 3.0 mg/L to 384 mg/L with the highest median concentrations occurring in April and May. The corresponding 95th percentile measured TSS values for April and May over the same period at W21 are 2139 mg/L and 390 mg/L, respectively.

Monthly median total and dissolved As concentrations are similar during the baseline period of 2007 to 2017 and range from approximately 0.025 mg/L to 0.038 mg/L. Median total As concentrations at W21 since 2018 have increased relative to the baseline, particularly for the freshet months of April and May and while reflecting higher sampling frequency are also due to the high TSS contributions from snowmelt-generated sediment-laden runoff coming from the Dublin Gulch road upstream of W21 and downstream of W1. As with W1, total As concentrations at station W21 are directly correlated with elevated TSS.

Figure 4-7 illustrates the relationship between total As concentrations and elevated TSS levels during episodic higher flow events at stations W1 and W21 for the period 2007 to 2020.

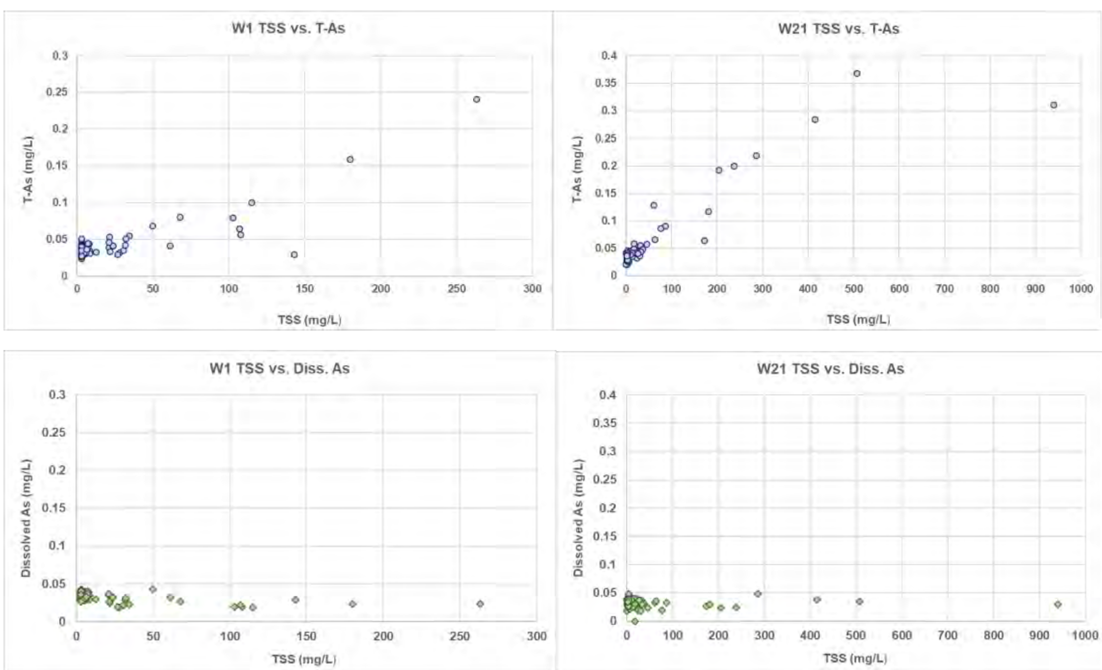


Figure 4-7: Relationship Between TSS, Total and Dissolved Arsenic Concentrations at W1 and W21 (2007-2020)

4.2.2.2 Haggart Creek Drainage

Haggart Creek is the largest project affected stream and the primary receiving environment stream for the Project. The main monitoring stations on Haggart Creek are shown on Figure 4-6 and include stations W22 (upstream of project activities), W4 (immediately downstream of the confluence with Dublin Gulch), W29 (downstream of Dublin Gulch, Eagle Creek, Gil Gulch and Platinum Gulch confluences), W99 (upstream of 15 Pup), W5 and W23 (immediately upstream and downstream, respectively of the confluence with Lynx Creek).

Baseline and existing conditions in upper Haggart Creek (W22) are reflected in data collected from 2007 to 2021. The pH in upper Haggart Creek at station W22 is circumneutral throughout the year with values generally ranging between 7.5 and 8.0. Alkalinity values exhibit seasonal trends with the lowest monthly median concentrations occurring during the freshet period of May-June of approximately 40 mg/L to 60 mg/L (as $CaCO_3$) and higher monthly median concentrations during the remainder of the year. These higher median alkalinity values range from approximately 80 mg/L to 90 mg/L (as $CaCO_3$) during July-October and from 100 mg/L to 120 mg/L during the winter low flow months of November-April. Upper Haggart Creek is characterized by moderately hard to hard waters, with monthly median hardness values ranging from approximately 70 mg/L during freshet to over 180 mg/L during lower flow periods. Monthly median sulphate concentrations in upper Haggart Creek are higher during non-freshet flow conditions, ranging between ~60 mg/L to 95 mg/L as compared to peak snowmelt periods where sulphate values typically less than 30 mg/L are observed. Nutrient parameters, as represented by nitrogen species (NH_3, NO_3, NO_2) and dissolved orthophosphate in upper Haggart Creek are low throughout the year.

Median TSS concentrations in upper Haggart Creek are generally low for most of the year (e.g., ~3.0 mg/L), although higher concentrations are observed during freshet in May. Median TSS for May is approximately 17 mg/L and the 90th percentile is 65 mg/L and reflects elevated suspended solids during higher flow periods particularly during freshet.

Most trace metal parameters are present at concentrations at or below their respective analytical detection limit. In general, median monthly concentrations of total trace elements are low for all parameters monitored and below their respective generic water quality guideline provided by BC Ministry of Environment and Climate Change Strategy (BC) and/or Canadian Council of Ministers of Environment (CCME) with exception of total and dissolved Al observed during freshet. May monthly median dissolved Al concentrations (0.14 mg/L) naturally exceed the generic water quality objective of 0.05 mg/L. Monthly median total arsenic (As) concentrations are less than 0.001 mg/L for all flow periods with the exception of peak flows in May where median concentrations of total As approach 0.002 mg/L; however, these baseline values are below the water quality guideline of 0.005 mg/L. The 90th percentile total As concentrations at W22 range between 0.0014 mg/L to 0.0062 mg/L and these higher concentrations are all associated with higher TSS levels (e.g., 13 to 65 mg/L) occurring during freshet periods. Conversely, monthly median dissolved As concentrations are more consistent throughout the year and generally narrowly range between 0.0006 mg/L to 0.0008 mg/L.

The chemistry and water quality of Haggart Creek changes following the addition of Dublin Gulch waters that enter Downstream of station W22 and immediately upstream of station W4. As noted above, baseline water quality in Dublin Gulch has been characterized as being soft to moderately hard water, nutrient poor and naturally elevated in arsenic. Other trace elements in Dublin Gulch are present at generally low concentrations. As such, water quality immediately downstream of the confluence with Dublin Gulch at W4 is generally similar to that observed at W22 with the notable exception of higher concentrations of total and dissolved arsenic derived from loadings from Dublin Gulch.

Monitoring stations below the Haggart Creek confluence with Dublin Gulch are considered receiving environment station and as such baseline period for these stations is defined as prior to 2019. Monthly water quality data collected for the Project is compared to each stations baseline water quality condition. For stations W4 and W23, the baseline water quality is represented by monitoring results for the period 2007 to 2018. For station W29, the baseline period spans 2009 to 2018. Station W99 was added in 2019 and therefore does not have a "baseline" record of measurements to which trend analysis is applicable. Haggart Creek exhibits strong flow-based variability and therefore data was compared among months between years as the most appropriate approach rather than assessing water quality changes observed over consecutive months.

Determination as to whether parameters measured in 2021 are exhibiting an increasing trend has been based on consideration of the natural variability in the baseline. Specifically, monthly mean 2021 observations for adaptive management (AMP) key parameters are compared to baseline monthly mean +1 and +2 standard deviations (e.g., 68th and 95th percentile). Monthly mean 2021 values within +1 standard deviation of baseline values are considered to be unchanged; values measured within +2 standard deviations are considered to be within the natural observed variability. Monthly mean 2021 values measured above +2 standard deviations of the baseline and above the Tier 3 water quality objective of (WQO) of the WUL are considered to be an increase over the baseline condition. In some instances, and for some parameters, monthly mean 2021 values were measured above the Tier 3 WQO but below +2 standard deviations of baseline conditions. In these instances, no specific action is considered currently necessary due to high background conditions.

Station W4 is located downstream of the confluence of both Dublin Gulch and where the discharge via Ditch C enters Haggart Creek. In 2021, discharge via Ditch C to Haggart Creek only occurred during the period of July 12 to July 23, November 12 to November 20. A trend analysis summary of W4 baseline water quality, for the period 2007 to 2018, compared to monthly mean 2021 water quality data for the open water period of April to October is presented in Table 4-10.

As illustrated, most parameters were measured at W4 during 2021 at concentrations very similar to baseline values (e.g., ≤ +2 std. dev.); only TSS, total As and total Fe were measured at concentrations greater than the baseline variability and greater than the respective Tier 3 WQO. The elevated total As monthly mean for July is attributable to poor mixing at W4 during discharge via Ditch C. The elevated TSS and total As measured in August at W4 appears to be related to elevated TSS in Haggart Creek and Dublin Gulch. Water quality samples at W22, W21 and W4 were collected on three (3) sampling events on August 5, 15 and 27. Haggart Creek upstream of Dublin Gulch at W22 measured TSS concentrations of 3 mg/L, 98 mg/L and 31 mg/L, respectively. Similarly, TSS at W21 in lower Dublin Gulch measured values of 23 mg/L, 13 mg/L and 49 mg/L, respectively.

The elevated total As monthly mean for November is attributable to the lower assimilative capacity and poor mixing at W4 during discharge via Ditch C.

As such, all "elevated" total As concentrations, total Fe and TSS values measured at W4 must be viewed with caution and are not likely representative of fully mixed conditions and therefore biased upwards due to the sampling location. Potential impacts from the Project may also be more appropriately assessed based on consideration of Haggart Creek sites W29, W99 and W23.

Table 4-10: Summary Comparison of Key Water Quality Parameters at W4 for Baseline Period (2007-2018) to 2021 Monthly Mean Values Relative to AMP Threshold

Parameter	T1	T2	T3	W4 - Haggart Creek																							
				April			May			June			July			August			September			October			November		
				Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean
TSS			15	6	7	3	70	102	53	31	48	4	4	5	9	9	13	44	4	4	6	4	4	5	4	5	13
SO_4	231.8	262.7	309	100	107	94	28	38	46	50	56	52	68	77	65	64	72	51	70	92	54	70	76	55	77	82	74
Cl	112.5	127.5	150	0.5	0.5	0.5	2.3	3.3	0.5	0.5	0.5	0.5	0.5	0.5	2.4	0.5	0.5	0.5	0.6	0.7	0.5	0.6	0.8	0.5	0.5	0.5	2.6
NO_3-N	2.3	2.6	3	0.144	0.156	0.159	0.046	0.065	0.066	0.794	1.253	0.079	0.058	0.067	0.170	0.061	0.071	0.058	0.102	0.126	0.070	0.169	0.204	0.092	0.160	0.175	0.274
NO_2-N	0.015	0.017	0.02	0.001	0.001	0.0010	0.0047	0.0067	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0041	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0099	0.0164	0.0010	0.0010	0.0010	0.0026
NH_3-N	0.848	0.961	1.13	0.005	0.005	0.005	0.009	0.012	0.006	0.008	0.010	0.005	0.005	0.005	0.011	0.015	0.022	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.008
CN_{WAD}	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Diss- Al	0.075	0.085	0.1	0.007	0.010	0.002	0.221	0.286	0.082	0.050	0.070	0.018	0.013	0.017	0.015	0.023	0.033	0.025	0.015	0.019	0.012	0.008	0.010	0.015	0.004	0.005	0.005
T-Sb	0.015	0.017	0.02	0.0006	0.0008	0.0003	0.0007	0.0009	0.0018	0.0009	0.0011	0.0004	0.0005	0.0005	0.0032	0.0005	0.0005	0.0006	0.0005	0.0005	0.0004	0.0005	0.0006	0.0004	0.0004	0.0005	0.0017
T-As	0.0064	0.0072	0.0085	0.0093	0.0141	0.0025	0.0255	0.0377	0.0343	0.0151	0.0228	0.0051	0.0059	0.0079	0.0198	0.0057	0.0070	0.0095	0.0072	0.0092	0.0059	0.0067	0.0084	0.0068	0.0050	0.0064	0.0208
T-Cd	0.00015	0.00017	0.0002	0.00003	0.00004	0.00002	0.00010	0.00014	0.00008	0.0000	0.0000	0.00001	0.00002	0.00002	0.00002	0.00003	0.00004	0.00002	0.00003	0.00005	0.00001	0.00001	0.00002	0.00001	0.00002	0.00002	0.00002
T-Co	0.003	0.0034	0.004	0.00047	0.00065	0.00027	0.00192	0.00275	0.00148	0.00064	0.00097	0.00016	0.00012	0.00013	0.00029	0.00022	0.00030	0.00050	0.00016	0.00018	0.00016	0.00015	0.00017	0.00019	0.00016	0.00018	0.00048
T-Cu	0.00375	0.00425	0.005	0.00074	0.00096	0.00050	0.00511	0.00678	0.00427	0.00258	0.00378	0.00073	0.00065	0.00074	0.00160	0.00104	0.00140	0.00164	0.00073	0.00084	0.00054	0.00098	0.00131	0.00074	0.00097	0.00129	0.00104
T-Fe	0.75	0.85	1	0.47	0.69	0.17	3.09	4.50	2.66	1.42	2.25	0.19	0.11	0.14	0.27	0.31	0.48	0.87	0.11	0.14	0.17	0.10	0.12	0.18	0.09	0.11	0.40
T-Pb	0.00578	0.00655	0.0077	0.00065	0.00099	0.00005	0.00275	0.00407	0.0050	0.00178	0.00286	0.00012	0.00006	0.00006	0.00068	0.00017	0.00025	0.00093	0.00010	0.00013	0.00013	0.00007	0.00008	0.00013	0.00006	0.00007	0.00093
T-Mn	0.878	0.995	1.17	0.104	0.140	0.080	0.208	0.302	0.122	0.046	0.063	0.030	0.030	0.037	0.022	0.033	0.039	0.054	0.034	0.038	0.033	0.033	0.037	0.044	0.041	0.048	0.040
T-Hg	0.000015	0.000017	0.00002	0.000011	0.000013	0.000005	0.000032	0.000047	0.000029	0.000037	0.000055	0.000005	0.000011	0.000013	0.000005	0.000011	0.000013	0.000005	0.000011	0.000013	0.000005	0.000010	0.000013	0.000005	0.000010	0.000013	0.000005
T-Mo	0.0548	0.0621	0.073	0.00018	0.00023	0.00016	0.00042	0.00062	0.00024	0.00080	0.00109	0.00029	0.00032	0.00041	0.00141	0.00031	0.00038	0.00034	0.00066	0.00092	0.00033	0.00061	0.00086	0.00037	0.00069	0.00101	0.00076
T-Ni	0.087	0.099	0.116	0.0024	0.0030	0.0021	0.0057	0.0075	0.0047	0.0025	0.0035	0.0011	0.0010	0.0012	0.0016	0.0012	0.0015	0.0019	0.0010	0.0011	0.0010	0.0010	0.0011	0.0013	0.0013	0.0015	0.0015
T-Se	0.0015	0.0017	0.002	0.00026	0.00031	0.00025	0.00021	0.00025	0.00017	0.00022	0.00025	0.00017	0.00020	0.00024	0.00033	0.00021	0.00025	0.00014	0.00021	0.00025	0.00013	0.00019	0.00022	0.00013	0.00023	0.00025	0.00036
T-Ag	0.00113	0.00128	0.0015	0.000010	0.000010	0.000010	0.000033	0.000046	0.000037	0.000021	0.000028	0.000010	0.000010	0.000010	0.000012	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000011	0.000012	0.000010	0.000010	0.000010	0.000011
T-U	0.0113	0.0128	0.015	0.0016	0.0017	0.0015	0.0005	0.0006	0.0008	0.0007	0.0008	0.0007	0.0010	0.0011	0.0025	0.0009	0.0011	0.0007	0.0010	0.0011	0.0008	0.0012	0.0014	0.0009	0.0013	0.0014	0.0028
T-Zn	0.0285	0.0323	0.038	0.0058	0.0072	0.0044	0.0148	0.0201	0.0138	0.0069	0.0098	0.0030	0.0034	0.0041	0.0033	0.0033	0.0041	0.0043	0.0034	0.0044	0.0030	0.0032	0.0033	0.0030	0.0042	0.0049	0.0038

All units in mg/L
Baseline period for W4 2007 – 2017

Colour Coding Legend for Trend Assessment	
Monthly 2021 mean is ≤ any Tier and≤ Baseline 2 stdev	no action
Monthly 2021 mean is ≥ any Tier but≤ Baseline 2 stdev	high background
Monthly 2021 mean is ≥ Tier 2 < Tier 3≥ Baseline 2 stdev	monitor
Monthly 2021 mean is ≥ Tier 3 > Baseline 2 stdev	Upward trend

Water quality parameters at W29 in 2021 were present at concentrations very similar to the observed baseline values (e.g. ≤ +2 std. dev.) during the baseline period of 2009 to 2018 (Table 4-11). Exceptions to these observations occurred in May 2021, where elevated TSS, and total As were present in concentrations greater than AMP T3 and baseline values for the same period. The elevated TSS above +2 standard deviations is, in part, a result of modifications to the 2009 to 2017 baseline dataset. Specifically, during the WUL process in 2015 for the Eagle Gold Project, regulators requested that water quality data associated with samples measuring greater than 50 mg/L TSS be ignored in developing site specific water quality objectives. As such, values exceeding 50 mg/L have been eliminated and the data is biased to the lower TSS concentrations as well as total As and total Fe as these parameters are closely correlated to TSS.

Station W99 was added in 2019 and therefore does not have a true “baseline” record of measurements to which trend analysis is applicable. In 2021, May and October observed mean monthly total As concentrations were greater than the AMP T3 threshold of 0.0085 mg/L (Table 4-12). Elevated concentrations of total Hg above the WQO were also observed in May 2021. The elevated As concentrations measured appear to be associated with elevated TSS at W99 on those sampling occasions. However, it should be noted that without historical baseline data it is not possible to determine whether these concentrations would have fallen within observed baseline values (e.g. ≤ +2 std. dev.). The reason for the observed elevated TSS and total As on October 3 is not clear as upstream monitoring locations in Haggart Creek (e.g., W4 and W29) did not record elevated values for TSS or total As on that sampling date.

Table 4-11: Summary Comparison of Key Water Quality Parameters at W29 for Baseline Period (2009 – 2018) to 2021 monthly Mean Values Relative to AMP Threshold Values

Parameter	T1	T2	T3	W29 - Haggart Creek																							
				April			May			June			July			August			September			October			November		
				Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean
TSS			15	10	14	3	41	55	68	3	3	3	3	3	4	10	15	55	4	5	5	5	7	5	3	3	3
SO_4	231.8	262.7	309	100	107	100	36	40	44	55	63	57	70	79	72	73	84	55	65	67	58	71	78	60	85	91	82
Cl	112.5	127.5	150	0.9	1.1	0.5	2.8	3.7	0.7	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.7	0.5	0.6	0.7	0.9	1.2	1.6	0.6
NO_3-N	2.3	2.6	3	0.139	0.148	0.152	0.046	0.055	0.065	0.083	0.094	0.080	0.059	0.069	0.064	0.065	0.081	0.058	0.098	0.116	0.074	0.124	0.136	0.096	0.154	0.162	0.104
NO_2-N	0.015	0.017	0.02	0.0010	0.0010	0.0010	0.0056	0.0074	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
NH_3-N	0.848	0.961	1.13	0.0050	0.0050	0.005	0.0069	0.0079	0.005	0.0096	0.0119	0.013	0.0050	0.0050	0.006	0.0124	0.0173	0.006	0.0140	0.0200	0.006	0.0124	0.0177	0.005	0.0050	0.0050	0.005
CN_{WAD}	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Diss- Al	0.075	0.085	0.1	0.003	0.004	0.002	0.130	0.165	0.086	0.022	0.027	0.018	0.013	0.016	0.008	0.021	0.031	0.025	0.010	0.011	0.013	0.007	0.009	0.014	0.003	0.004	0.003
T-Sb	0.015	0.017	0.02	0.0007	0.0008	0.0005	0.0009	0.0010	0.0013	0.0006	0.0006	0.0004	0.0008	0.0008	0.0005	0.0011	0.0014	0.0006	0.0007	0.0007	0.0004	0.0007	0.0008	0.0005	0.0006	0.0007	0.0005
T-As	0.0064	0.0072	0.0085	0.007	0.0093	0.0032	0.014	0.0176	0.0255	0.005	0.0061	0.0045	0.007	0.0091	0.0050	0.008	0.0108	0.0068	0.0074	0.0090	0.0057	0.0075	0.0095	0.0074	0.0047	0.0055	0.0036
T-Cd	0.00015	0.00017	0.0002	0.00002	0.00002	0.00002	0.00008	0.00011	0.00007	0.00002	0.00002	0.00001	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	0.00001	0.00003	0.00004	0.00002	0.00002	0.00002	0.00001
T-Co	0.003	0.0034	0.004	0.00033	0.00045	0.00020	0.00110	0.00141	0.00100	0.00011	0.00012	0.00015	0.00012	0.00012	0.00012	0.00022	0.00031	0.00040	0.00012	0.00013	0.00018	0.00029	0.00041	0.00021	0.00011	0.00011	0.00011
T-Cu	0.00375	0.00425	0.005	0.00126	0.00169	0.00050	0.00430	0.00497	0.00349	0.00094	0.00113	0.00075	0.00077	0.00090	0.00057	0.00111	0.00154	0.00156	0.00085	0.00100	0.00057	0.00092	0.00116	0.00082	0.00050	0.00050	0.00053
T-Fe	0.75	0.85	1	0.62	0.92	0.12	2.00	2.60	1.66	0.14	0.19	0.16	0.12	0.15	0.11	0.36	0.57	0.72	0.10	0.13	0.16	0.51	0.79	0.18	0.04	0.05	0.04
T-Pb	0.00578	0.00655	0.0077	0.0009	0.0013	0.00006	0.0022	0.0029	0.00305	0.0002	0.0002	0.00012	0.0001	0.0002	0.00011	0.0005	0.0008	0.00066	0.0003	0.0004	0.00022	0.0005	0.0007	0.00018	0.0001	0.0001	0.00005
T-Mn	0.878	0.995	1.17	0.068	0.081	0.097	0.108	0.135	0.103	0.018	0.021	0.034	0.039	0.049	0.043	0.037	0.044	0.054	0.040	0.044	0.044	0.051	0.064	0.061	0.057	0.070	0.055
T-Hg	0.000015	0.000017	0.00002	0.000010	0.000010	0.000005	0.000010	0.000010	0.000057	0.000010	0.000010	0.000005	0.000011	0.000013	0.000005	0.000011	0.000013	0.000006	0.000010	0.000013	0.000005	0.000011	0.000013	0.000005	0.000010	0.000013	0.000005
T-Mo	0.0548	0.0621	0.073	0.00020	0.00023	0.00017	0.00018	0.00020	0.00027	0.00025	0.00026	0.00024	0.00037	0.00046	0.00027	0.00035	0.00042	0.00029	0.00042	0.00050	0.00030	0.00036	0.00043	0.00030	0.00026	0.00029	0.00023
T-Ni	0.087	0.099	0.116	0.0028	0.0034	0.0020	0.0044	0.0050	0.0038	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0016	0.0018	0.0011	0.0012	0.0011	0.0012	0.0015	0.0014	0.0012	0.0014	0.0011
T-Se	0.0015	0.0017	0.002	0.00023	0.00025	0.00025	0.00022	0.00027	0.00020	0.00024	0.00024	0.00017	0.00021	0.00025	0.00018	0.00024	0.00029	0.00016	0.00023	0.00026	0.00014	0.00023	0.00027	0.00016	0.00023	0.00025	0.00019
T-Ag	0.00113	0.00128	0.0015	0.000010	0.000010	0.000010	0.000027	0.000035	0.000024	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000011	0.000010	0.000010	0.000010	0.000010
T-U	0.0113	0.0128	0.015	0.0021	0.0023	0.0020	0.0007	0.0008	0.0009	0.0009	0.0009	0.0008	0.0012	0.0014	0.0011	0.0014	0.0017	0.0009	0.0013	0.0014	0.0009	0.0014	0.0016	0.0012	0.0017	0.0018	0.0015
T-Zn	0.0285	0.0323	0.038	0.007	0.008	0.0035	0.012	0.015	0.0098	0.003	0.004	0.0030	0.005	0.006	0.0030	0.003	0.004	0.0038	0.003	0.004	0.0030	0.004	0.005	0.0030	0.003	0.003	0.0030

All units in mg/L
Baseline period for W4 2007-2017, samples with TSS<50 mg/L excluded

Colour Coding Legend for Trend Assessment	
Monthly 2021 mean is ≤ any Tier and ≤ Baseline 2 stdev	no action
Monthly 2021 mean is ≥ any Tier but ≤ Baseline 2 stdev	high background
Monthly 2021 mean is ≥ Tier 2 < Tier 3 ≥ Baseline 2 stdev	monitor
Monthly 2021 mean is ≥ Tier 3 > Baseline 2 stdev	Upward trend

Table 4-12: Summary Comparison of Key Water Quality Parameters at W99 for 2019 to 2021 monthly Mean Values Relative to AMP Threshold Values

W99 - Haggart Creek

Parameter	T1	T2	T3	April			May			June			July		
				Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean
TSS			15	19	25	3	45	62	39	17	26	3	3	4	3
SO_4	231.8	262.7	309	98	102	107	58	82	45	72	90	52	82	83	76
Cl	112.5	127.5	150	3.4	4.3	0.5	0.7	0.8	0.7	0.5	0.5	0.5	0.5	0.5	0.6
NO_3-N	2.3	2.6	3	0.104	0.113	0.152	0.204	0.312	0.060	0.068	0.075	0.082	0.063	0.066	0.066
NO_2-N	0.015	0.017	0.02	0.0011	0.0012	0.0010	0.0017	0.0021	0.0010	0.0016	0.0019	0.0010	0.0010	0.0010	0.0010
NH_3-N	0.848	0.961	1.13	0.0158	0.0209	0.006	0.0067	0.0067	0.006	0.0056	0.0056	0.005	0.0122	0.0158	0.006
CN_{WAD}	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	-	0.005
Diss- Al	0.075	0.085	0.1	0.013	0.015	0.002	0.191	0.269	0.085	0.066	0.095	0.023	0.008	0.010	0.009
T-Sb	0.015	0.017	0.02	0.0015	0.0018	0.0005	0.0010	0.0011	0.0016	0.0006	0.0007	0.0004	0.0007	0.0007	0.0005
T-As	0.0064	0.0072	0.0085	0.0197	0.0231	0.0034	0.0178	0.0228	0.0333	0.0042	0.0045	0.0046	0.0038	0.0040	0.0052
T-Cd	0.00015	0.00017	0.0002	0.00004	0.00005	0.00002	0.00006	0.00008	0.00008	0.00003	0.00004	0.00001	0.00001	0.00002	0.00001
T-Co	0.003	0.0034	0.004	0.00065	0.00072	0.00018	0.00108	0.00140	0.00108	0.00038	0.00050	0.00017	0.00011	0.00012	0.00013
T-Cu	0.00375	0.00425	0.005	0.00222	0.00260	0.00050	0.00373	0.00479	0.00390	0.00231	0.00310	0.00098	0.00063	0.00065	0.00060
T-Fe	0.75	0.85	1	0.99	1.19	0.09	1.89	2.49	1.61	0.70	1.00	0.23	0.09	0.11	0.11
T-Pb	0.00578	0.00655	0.0077	0.0019	0.0024	0.00005	0.0023	0.0030	0.00451	0.0008	0.0011	0.00018	0.0001	0.0001	0.00013
T-Mn	0.878	0.995	1.17	0.132	0.148	0.090	0.108	0.132	0.105	0.053	0.058	0.038	0.049	0.049	0.052
T-Hg	0.000015	0.000017	0.00002	0.000005	0.000005	0.000005	0.000050	0.000068	0.000030	0.000007	0.000007	0.000005	0.000005	0.000005	0.000005
T-Mo	0.0548	0.0621	0.073	0.00034	0.00040	0.00018	0.00025	0.00030	0.00027	0.00019	0.00019	0.00024	0.00019	0.00019	0.00028
T-Ni	0.087	0.099	0.116	0.0027	0.0029	0.0017	0.0039	0.0048	0.0038	0.0025	0.0032	0.0013	0.0010	0.0010	0.0011
T-Se	0.0015	0.0017	0.002	0.00024	0.00026	0.00025	0.00018	0.00022	0.00016	0.00014	0.00015	0.00018	0.00015	0.00016	0.00013
T-Ag	0.00113	0.00128	0.0015	0.000019	0.000023	0.000010	0.000033	0.000044	0.000027	0.000013	0.000015	0.000010	0.000010	0.000010	0.000010
T-U	0.0113	0.0128	0.015	0.0027	0.0031	0.0022	0.0011	0.0015	0.0010	0.0011	0.0014	0.0007	0.0013	0.0014	0.0011
T-Zn	0.0285	0.0323	0.038	0.006	0.007	0.0032	0.010	0.013	0.0105	0.004	0.004	0.0030	0.003	0.003	0.0030

Parameter	August			September			October			November		
	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean
TSS	5	6	31	3	3	2	3	3	15	3	3	5
SO_4	86	86	56	92	92	61	82	82	64	90	90	72
Cl	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.9
NO_3-N	0.058	0.058	0.065	0.060	0.060	0.079	0.118	0.118	0.102	0.141	0.141	0.124
NO_2-N	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
NH_3-N	0.0050	0.0050	0.005	0.0201	0.0201	0.005	0.0050	0.0050	0.005	0.008	0.008	0.006
CN_{WAD}	-	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Diss- Al	0.004	0.004	0.031	0.004	0.004	0.013	0.006	0.006	0.014	0.002	0.002	0.004
T-Sb	0.0006	0.0006	0.0006	0.0006	0.0006	0.0004	0.0005	0.0005	0.0011	0.0006	0.0006	0.0005
T-As	0.0037	0.0037	0.0074	0.0030	0.0030	0.0053	0.0029	0.0029	0.0192	0.0030	0.0030	0.0040
T-Cd	0.00001	0.00001	0.00003	0.00001	0.00001	0.00001	0.00001	0.00001	0.00003	0.00002	0.00002	0.00001
T-Co	0.00013	0.00013	0.00056	0.00011	0.00011	0.00016	0.00010	0.00010	0.00060	0.00012	0.00012	0.00013
T-Cu	0.00057	0.00057	0.00215	0.00058	0.00058	0.00059	0.00063	0.00063	0.00205	0.00081	0.00081	0.00062
T-Fe	0.11	0.11	1.09	0.04	0.04	0.12	0.05	0.05	1.07	0.04	0.04	0.07
T-Pb	0.0002	0.0002	0.00084	0.0001	0.0001	0.00009	0.0001	0.0001	0.00189	0.00006	0.00006	0.00010
T-Mn	0.063	0.063	0.065	0.067	0.067	0.046	0.056	0.056	0.080	0.067	0.067	0.047
T-Hg	0.000005	0.000005	0.000006	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005	0.000005
T-Mo	0.00019	0.00019	0.00029	0.00029	0.00029	0.00031	0.00021	0.00021	0.00030	0.00025	0.00025	0.00021
T-Ni	0.0010	0.0010	0.0022	0.0010	0.0010	0.0011	0.0010	0.0010	0.0023	0.0009	0.0009	0.0008
T-Se	0.00012	0.00012	0.00014	0.00012	0.00012	0.00013	0.00020	0.00020	0.00015	0.00014	0.00014	0.00013
T-Ag	0.000010	0.000010	0.000017	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
T-U	0.0014	0.0014	0.0009	0.0017	0.0017	0.0010	0.0014	0.0014	0.0012	0.0018	0.0018	0.0013
T-Zn	0.003	0.003	0.0044	0.003	0.003	0.0030	0.003	0.003	0.0048	0.0030	0.0030	0.0030

All units in mg/L
No baseline available for W99 – sampling commenced in April 2019

Colour Coding Legend for Trend Assessment	
Monthly 2021 mean is ≤ any Tier and ≤ Baseline 2 stdev	no action
Monthly 2021 mean is ≥ any Tier but ≤ Baseline 2 stdev	high background
Monthly 2021 mean is ≥ Tier 2 < Tier 3 ≥ Baseline 2 stdev	monitor
Monthly 2021 mean is ≥ Tier 3 > Baseline 2 stdev	Upward trend

Water quality at W23 reflects loadings from Dublin Gulch and all mine related inputs as well as additional loadings from Lynx Creek. Water quality observed in 2021 at W23 relative to the baseline period of 2007 to 2017 indicated that most parameters measured in 2021 were at concentrations very similar to those observed during baseline monitoring. Indeed, most parameters were present at a concentration within +1 standard deviation of the baseline monthly mean concentration with the exception of As in July and October (Table 4-13). The measured concentration of total As on July 10, 2021 at W23 (0.0093 mg/L) is anomalous as no discharge was occurring into Haggart Creek at that time. Sampling on July 10 at W23 did not coincide with sampling at W99, W29 or W4 at upstream locations in Haggart Creek so the extent of the elevated levels in Haggart Creek or the potential source cannot be ascertained. However, water quality data collected on July 10 at station W5, located immediately upstream of W23 and upstream of the confluence with Lynx Creek also indicated a relatively high total As concentration of 0.0087 mg/L. The elevated total As value at W23 for October coincides with the observed value at upstream station W99 (0.019 mg/L) and W5 (0.019 mg/L); as above, without any clear connection to Project or other activities, the contributing factors for the elevated concentrations are unknown.

Table 4-13: Summary Comparison of Key Water Quality Parameters at W23 for Baseline Period (2007 – 2018) to 2021 monthly Mean Values Relative to AMP Threshold Values

Parameter	T1	T2	T3	W23 - Haggart Creek																							
				April			May			June			July			August			September			October			November		
				Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean	Baseline 1 stdev	Baseline 2 stdev	2021 mean
TSS			*15*	15	22	3	91	135	29	45	67	3	4	4	13	3	3	4	9	13	2	3	3	10	3	3	3
SO_4	*231.8*	*262.7*	*309*	89	89	106	24	30	19	53	60	63	74	82	66	72	79	59	68	75	63	74	82	65	91	99	87
Cl	*112.5*	*127.5*	*150*	0.5	0.5	0.5	1.5	2.2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.5	0.6	0.7	0.5	0.6	0.7	0.5
NO_3-N	*2.3*	*2.6*	*3*	0.179	0.191	0.221	0.035	0.042	0.034	0.071	0.084	0.077	0.055	0.065	0.064	0.068	0.082	0.060	0.099	0.118	0.081	0.160	0.179	0.113	0.205	0.222	0.144
NO_2-N	*0.015*	*0.017*	*0.02*	0.0010	0.0010	0.0010	0.0030	0.0044	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
NH_3-N	*0.848*	*0.961*	*1.13*	0.0071	0.0083	0.005	0.0100	0.0124	0.007	0.0299	0.0427	0.005	0.0050	0.0050	0.005	0.0158	0.0225	0.006	0.0118	0.0168	0.005	0.0133	0.0187	0.005	0.006	0.006	0.005
CN_{WAD}	*0.005*	*0.005*	*0.005*	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Diss- Al	*0.075*	*0.085*	*0.1*	0.006	0.008	0.002	0.167	0.215	0.132	0.038	0.052	0.011	0.019	0.027	0.019	0.010	0.013	0.022	0.017	0.022	0.012	0.008	0.010	0.016	0.004	0.005	0.004
T-Sb	*0.015*	*0.017*	*0.02*	0.0015	0.0021	0.0005	0.0010	0.0012	0.0007	0.0014	0.0019	0.0005	0.0006	0.0007	0.0007	0.0006	0.0006	0.0005	0.0007	0.0008	0.0005	0.0005	0.0006	0.0008	0.0005	0.0005	0.0005
T-As	*0.0064*	*0.0072*	*0.0085*	0.0291	0.0436	0.0044	0.0178	0.0238	0.0116	0.0271	0.0398	0.0048	0.0055	0.0061	0.0093	0.0059	0.0063	0.0060	0.0072	0.0084	0.0056	0.0056	0.0061	0.0135	0.0046	0.0047	0.0043
T-Cd	*0.00015*	*0.00017*	*0.0002*	0.00006	0.00008	0.00001	0.00011	0.00015	0.00007	0.00016	0.00024	0.00001	0.00003	0.00004	0.00002	0.00003	0.00004	0.00002	0.00003	0.00004	0.00001	0.00003	0.00004	0.00002	0.00002	0.00002	0.00001
T-Co	*0.003*	*0.0034*	*0.004*	0.00086	0.00130	0.00010	0.00149	0.00213	0.00071	0.00267	0.00414	0.00010	0.00010	0.00010	0.00025	0.00010	0.00010	0.00017	0.00020	0.00026	0.00010	0.00019	0.00026	0.00037	0.00024	0.00032	0.00010
T-Cu	*0.00375*	*0.00425*	*0.005*	0.00325	0.00492	0.00050	0.00554	0.00719	0.00336	0.00612	0.00882	0.00074	0.00087	0.00097	0.00128	0.00085	0.00096	0.00120	0.00172	0.00225	0.00076	0.00097	0.00114	0.00160	0.00087	0.00106	0.00052
T-Fe	*0.75*	*0.85*	*1*	1.77	2.78	0.04	2.63	3.79	1.20	0.75	1.04	0.08	0.07	0.10	0.45	0.09	0.12	0.23	0.14	0.19	0.10	0.09	0.13	0.66	0.04	0.05	0.03
T-Pb	*0.00578*	*0.00655*	*0.0077*	0.0032	0.0051	0.00005	0.0037	0.0055	0.00141	0.0078	0.0123	0.00006	0.0001	0.0001	0.00065	0.0001	0.0001	0.00021	0.0005	0.0007	0.00006	0.0003	0.0004	0.00102	0.00036	0.00055	0.00005
T-Mn	*0.878*	*0.995*	*1.17*	0.092	0.123	0.035	0.154	0.217	0.083	0.305	0.472	0.019	0.021	0.023	0.037	0.025	0.029	0.032	0.035	0.043	0.032	0.032	0.037	0.052	0.033	0.037	0.032
T-Hg	*0.000015*	*0.000017*	*0.00002*	0.000009	0.000009	0.000005	0.000042	0.000061	0.000016	0.000044	0.000061	0.000005	0.000042	0.000062	0.000005	0.000040	0.000059	0.000005	0.000038	0.000056	0.000005	0.000047	0.000068	0.000005	0.000016	0.000022	0.000005
T-Mo	*0.0548*	*0.0621*	*0.073*	0.00050	0.00057	0.00054	0.00035	0.00041	0.00032	0.00089	0.00116	0.00051	0.00056	0.00058	0.00051	0.00060	0.00064	0.00049	0.00076	0.00093	0.00054	0.00077	0.00091	0.00051	0.00087	0.00106	0.00058
T-Ni	*0.087*	*0.099*	*0.116*	0.0026	0.0039	0.0007	0.0047	0.0062	0.0028	0.0052	0.0076	0.0008	0.0007	0.0008	0.0010	0.0008	0.0009	0.0012	0.0011	0.0013	0.0010	0.0009	0.0011	0.0016	0.0009	0.0011	0.0007
T-Se	*0.0015*	*0.0017*	*0.002*	0.00109	0.00138	0.00043	0.00094	0.00133	0.00022	0.00111	0.00147	0.00027	0.00100	0.00138	0.00028	0.00104	0.00141	0.00024	0.00104	0.00143	0.00026	0.00090	0.00124	0.00027	0.00081	0.00108	0.00028
T-Ag	*0.00113*	*0.00128*	*0.0015*	0.000029	0.000039	0.000010	0.000049	0.000072	0.000022	0.000033	0.000046	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000015	0.000018	0.000010	0.000015	0.000018	0.000010	0.000017	0.000021	0.000010
T-U	*0.0113*	*0.0128*	*0.015*	0.0017	0.0017	0.0020	0.0004	0.0005	0.0003	0.0011	0.0013	0.0009	0.0011	0.0011	0.0010	0.0010	0.0011	0.0008	0.0011	0.0012	0.0009	0.0013	0.0015	0.0011	0.0016	0.0017	0.0014
T-Zn	*0.0285*	*0.0323*	*0.038*	0.011	0.016	0.0030	0.014	0.019	0.0081	0.023	0.035	0.0030	0.003	0.004	0.0037	0.003	0.004	0.0030	0.005	0.006	0.0030	0.004	0.005	0.0034	0.0044	0.0052	0.0030

All units in mg/L
Baseline period for W23 2007-2017

Colour Coding Legend for Trend Assessment	
Monthly 2021 mean is ≤ any Tier and ≤ Baseline 2 stdev	no action
Monthly 2021 mean is ≥ any Tier but ≤ Baseline 2 stdev	high background
Monthly 2021 mean is ≥ Tier 2 < Tier 3 ≥ Baseline 2 stdev	monitor
Monthly 2021 mean is ≥ Tier 3 > Baseline 2 stdev	Upward trend

4.2.2.3 Lynx Creek Drainage

Lynx Creek is an undisturbed catchment that drains into Haggart Creek downstream of the project area. Monitoring in Lynx Creek has occurred primarily at station W6, at the mouth of Lynx Creek and immediately prior to entering Haggart Creek (Figure 4-6).

Baseline water quality for Lynx Creek spans the monitoring record from 2007 to 2020. Lynx Creek at station W6 is characterized by moderately hard to hard waters, with monthly median hardness values ranging from approximately 70 mg/L during the snowmelt period to approximately 235 mg/L during winter baseflows. Similarly, monthly median values for conductivity, hardness, and alkalinity demonstrate pronounced seasonal fluctuations, with minima coinciding with freshet periods in May during peak periods of snowmelt-driven runoff. Nutrient levels as indicated by NH_3-N, NO_3-N, NO_2-N and orthophosphate are low throughout all flow periods. Nitrate-N values for the open water period vary narrowly between 0.04 mg/L and 0.08 mg/L and NH_3-N monthly mean values are typically around 0.005 mg/L and 0.006 mg/L. Baseline monthly median concentrations for sulphate in lower Lynx Creek are approximately 60 mg/L to 95 mg/L during non-freshet flow conditions as compared to peak snowmelt periods where values of between 20 mg/L and 40 mg/L sulphate are observed.

TSS concentrations in Lynx Creek show seasonal and flow patterns similar to the other catchments described previously. Peak TSS values occur during the snowmelt runoff period in May and June. Monthly median TSS values observed for the baseline period for May and June range between 9.0 mg/L and 13 mg/L. The 95th percentile values for those same months are 57 mg/L and 62 mg/L, respectively. The maximum observed TSS concentration observed at W6 occurred in May and was 80 mg/L. During the remainder of the open water period and winter, median TSS values in Lynx Creek were generally below the analytical detection limit of 3.0 mg/L.

In general, monthly median concentrations of total and dissolved trace elements are low for all parameters with the exception of As. Monthly median total arsenic concentrations at W6 in lower Lynx Creek range from 0.0054 mg/L to 0.0076 and are consistently above the generic water quality guideline for As for the protection of aquatic life of 0.005 mg/L. The maximum measured total As concentration in Lynx Creek was 0.013 mg/L and coincided with the peak TSS concentration of 80 mg/L. Apart from short-duration elevated TSS conditions, most of the As in Lynx Creek is present as dissolved As. Monthly median dissolved As concentrations are similar to total values and range from 0.0055 mg/L to 0.0065 mg/L. Like upper Haggart Creek and Dublin Gulch, dissolved As concentrations in Lynx Creek are unaffected by elevated TSS values. Although no anthropogenic disturbances occur in the Lynx watershed, the presence of arsenic in drainage waters indicates that arsenic mineralization in the broader area is prevalent and not just limited to the Dublin Gulch catchment. This posit is supported by an extensive sampling of individual drainages in the upper Lynx watershed that occurred in August 2012. Some tributaries in upper Lynx Creek showed elevated dissolved As concentrations (values ranging from 0.0012 to 0.0086 mg/L) indicating that As mobility is not limited to the immediate project area or Dublin Gulch and its tributaries in particular.

4.3 GROUNDWATER

Hydrogeologic baseline characterization studies were conducted from 2009 to 2012 and previous investigations were conducted in 1995 and 1996 (GeoViro 1996 and Knight Piésold 1996a, b, c). This information is available in available on the YWB Waterline website registry for QZ14-041 in the following:

- Environmental Baseline Report: Hydrogeology (Stantec 2011b) - Exhibit 1.4.6

- Environmental Baseline Data Report: Hydrogeology 2011-2012 Update (Stantec 2012c) - Exhibit 1.4.7
- Groundwater Data Report (BGC 2013b) - Exhibit 1.4.8
- Aquifer Test for Camp Water Supply (Stantec 2010c) - Exhibit 1.4.9
- Lower Dublin Gulch Valley Aquifer Tests (BGC 2012f) - Exhibit 1.4.10
- Open Pit Pumping Tests (BGC 2012g) - Exhibit 1.4.11
- Production Well Completion Report for PW-BGC12-04 (BGC 2013c) - Exhibits 1.4.12.1 to 1.4.12.5
- Eagle Gold Project Numerical Hydrogeologic Model (BGC 2014) - Exhibits 1.4.13.1 to 1.4.13.5

Additional information is available under the YWB Waterline website registry for QZ14-041-1 in the following:

- Eagle Gold Groundwater Quality Characterization Report (Core Geoscience Services 2017) - Exhibit 1.19.8
- Eagle Gold Project 2020 Numerical Hydrogeological Model Updated - Final (BGC 2020) - Appendix J to the Eagle Gold Project 2019 Annual Report
- 2021 Hydrograph and Groundwater Quality data update – Appendices G and H to the Eagle Gold Project 2021 Annual Report

4.3.1 Hydrogeologic Setting

There are two principal water-bearing units in the Project area: deeper relatively low permeability bedrock and the near-surface moderately permeable surficial deposits.

Surficial materials at the site comprise a thin layer of overburden (typically less than 10 m thick) that is generally composed of a thin veneer of colluvium in the uplands, while alluvium and reworked placer tailings dominate in the valley floors. Deposits along the lower Dublin Gulch valley generally wary from 0 to 30 m thick between Eagle Pup and Haggart Creek. Discontinuous, relatively warm (typically 0° to -10° celsius) permafrost is present on northeast to northwest facing slopes with a highly variable distribution in the overall area. Because of its discontinuous nature, permafrost is assumed to have limited influence on the groundwater flow system. The bedrock of the project area can be broadly divided into the Hyland Group metasediments and intrusive rocks of the Dublin Gulch stock.

Results from hydrogeologic tests conducted in the bedrock to date show that the hydaulic conductivity of the intrusive and metasediment units is generally similar and assoicated with fractures, although considerable variation in results is apparent for each unit at any given depth (i.e., 2 to 4 orders of magnitude). Meaured hydraulic conductivity ranges from $3x10^{-5}$ to $4x10^{-3}$ m/s in placer and fluvial overburden materials, and $4x10^{-7}$ to $3x10^{-5}$ m/s for colluvium. Within bedrock, hydraulic conductivity estimtes from site data range from $2x10^{-6}$ to $2x10^{-8}$ m/s and exhibit a decreasing trend with depth. Specific storage estimated from pumping tests ranged from $8x10^{-6}$ m^{-1} to $1x10^{-5}$ m^{-1} for bedrcok and from approximately $3x10^{-5}$ m^{-1} to $6x10^{-3}$ m^{-1} for overburden (BGC, 2019).

Further details of the spatial distribution and characteristics of these materials are found in Stantec (2010d) and BGC (2014, 2019).

4.3.2 Groundwater Occurrence

Generally, groundwater has been observed deeper (approximately >6 m below ground) at higher elevations and shallow to artesian in lower elevations and in valley bottoms. Springs and seeps have been observed in a few locations where valley bottoms have narrowed. These are typically associated with the re-emergence of a stream from channel deposits (i.e., a gaining reach). In these instances (e.g., Eagle Pup, Stewart Gulch), thin alluvium overlying shallow bedrock is the likely cause of the emergence. Groundwater levels within the lower Dublin Gulch valley have been observed to have seasonally delayed trends due to higher groundwater levels during spring freshet and/or associated with rainstorms and lower groundwater levels during dry summer periods.

Groundwater elevation data exhibit common seasonal trends in all monitored locations, characterized by relatively high-water levels corresponding to spring freshet and fall precipitation events, and relatively low water levels related to dry summer and frozen winter conditions. Small but discernible responses to precipitation events were observed in all monitoring well records.

Hydraulic head observations were available from vibrating wire piezometers (VWP) and monitoring wells, pumping wells or standpipe piezometers installed between 1995 and 2019. Data collection at a portion of these locations is still ongoing, both manually and with dataloggers.

Based on the available data, the water table is generally shallow (within 10 m of ground surface) at low elevations near the valley bottoms and along creeks and gulches. At ridge tops within the Project area the water table is typically deeper with measured water depths up to 40 m below ground surface. The interpreted piezometric surface appears to generally mimic the surface topography.

The measured values indicate that seasonal fluctuations in groundwater elevation range from less than 2 m near creeks (e.g., MW10-DG6, MW09-DG4, VWP nest BH-BHC11-68), gulches and at low elevations in the valleys, and up to 4 to 15 m in higher elevation ridges (e.g., MW96-9b, VWP nest BH-BGC11-73).

Continuous head data indicate that groundwater elevations decline through the winter and spring (i.e. November to April), and are highest during the summer and fall quarter (i.e. June to September). The seasonal variation in groundwater levels is consistent with the seasonal precipitation and temperature trends. The groundwater levels recorded in 2021 generally reflect similar trends to previous years. Greater amounts of precipitation were received in 2021 than is typical for the Project area, and groundwater elevations have recovered from the lower groundwater elevations observed in 2019. In some locations (e.g., MW96-9B), peak groundwater elevations were slightly higher than the historical range, likely in response to the high precipitation values observed in 2021.

4.3.3 Groundwater Flow

Groundwater flow in the bedrock occurs in fractures and fault zones, while preferentially flowing through more permeable (and porous) sediments within the surficial deposits. General orientation of groundwater flow contours mimic the topography of the site as groundwater flows from the highest areas to lowest. Throughout most of the Project area the groundwater divides of each sub-basin approximately coincide with the surface water divides (i.e., groundwater from the Eagle Pup and Suttles Gulch drain to Eagle Creek, while groundwater from Ann and Stewart Gulch Basins drain to Dublin Gulch). In the lower Dublin Gulch valley, the groundwater divide between the Eagle Creek and Dublin Gulch basins in the placer tailings is not clearly defined. Field observations suggest that at times the divide migrates across the valley so that groundwater from the Dublin Gulch basin may flow towards Eagle Creek. This shifting is seasonal and also due in part to the variability in the timing of the freshet and/or rainfall events across the entire watershed.

Groundwater recharge occurs at higher elevations throughout the Dublin Gulch-Eagle Creek drainage basin and ultimately discharges to surface water (in some cases as seeps and springs) at lower elevations in the valley or directly to surface streams, or ultimately into Haggart Creek. The main groundwater flow in conjunction with the highest groundwater elevations is expected to occur during the snowmelt in late spring (e.g., May to June) after thawing of the shallow sediment.

4.3.4 Surface Water - Groundwater Connectivity

Base flow values represent the groundwater contributions to streams. Groundwater contributes to stream flows where the groundwater table elevation intersects the ground surface, typically these intersections are located in stream channel inverts (e.g., Eagle Pup appears in mid-channel where the valley is well confined by bedrock); however, they also appear as seepage from slopes within the placer deposits of the lower Dublin Gulch valley. Groundwater from the lower Dublin Gulch valley likely contributes a measurable portion of the baseflow to Haggart Creek. The baseflow contributions to the streams maintain flow in the larger creeks during the drier months of the year (including winter flows).

4.3.5 Groundwater Flow Properties

The hydraulic conductivity of the colluvial, alluvial, and till deposits was generally higher than that of the placer material, and the variable hydraulic conductivity seen in the bedrock is typical of fractured crystalline rock, which showed decreasing hydraulic conductivity with depth. The test data did not demonstrate a measurable difference in the hydraulic conductivities of granodiorite and metasedimentary rock. This suggests that the flow properties of both rock types are similar.

The bedrock hydraulic conductivity dataset includes over 80 packer tests and slug tests conducted in over 50 boreholes and six pumping tests; two 24-hour duration tests carried out in the Open Pit area and in the upper reaches of Bawn Boy Gulch in 1996 (GeoViro, 1996), two pumping tests (a 7-day test in the lower Dublin Gulch valley and a 5-day test in the Open Pit area) carried out in 2011 (BGC, 2012e and 2012f), and a 10-day test in the lower Dublin Gulch valley in 2012 (BGC, 2013b). Results of the pumping tests are typically considered to be more representative of the larger scale (bulk) hydraulic conductivity of the rock mass. Results of the two GeoViro pumping tests at MW96-11 and MW96-19, conducted at depths less than 55 m yielded hydraulic conductivity values ranging from $3x10^{-7}$ m/s to $5x10^{-7}$ m/s. Mean results of the two pumping tests conducted in 2011 by BGC were $8x10^{-6}$ m/s in the lower valley (at PW-BGC11-01) and $9x10^{-8}$ m/s in the Open Pit area (at PW-BGC11-02) at depths up to 100 m and 140 m below ground, respectively. Results from the 2012 testing of PW-BGC12-04 in the lower Dublin Gulch valley bedrock aquifer are about an order of magnitude higher ($9.0x10^{-5}$ m/s) than results from 2011 testing; however, these results are specific to an 18 m thick zone targeted by the well, whereas the 2011 well was tested over a thicker (37 m) zone.

Generally, the hydraulic conductivity of the intrusive units and metasediments is similar and tends to decrease with depth, although considerable variation in results is apparent for each unit at any given depth. The general trend of decreasing hydraulic conductivity is common in bedrock settings as described by Rutqvist and Stephansson (2003).

4.3.6 Groundwater Quality

The groundwater quality data suggests that the chemical composition of groundwater in the Project area depends on the local and up gradient rock-types. Groundwater quality data are collected in Eagle Pup, and Dublin, Suttles, Ann, Stewart, Olive, Bawn Boy and Platinum Gulches.

Groundwater quality data collected from 1995-2016 was characterized in 2017 prior to construction activities to represent baseline groundwater quality (Core Geoscience Services, 2017). In an effort to better characterize, and respond to potential changes to groundwater quality during the life of the mine, if necessary, VGC continues to build upon this report and work towards creating management triggers for groundwater quality. Groundwater quality trends from 2009/2010 to 2021 for Ann Gulch and Eagle Pup wells are discussed below.

Groundwater quality data for wells within the Ann Gulch drainage (which is the location) for the period of 2010 through 2021 is provided in Figure 4-8 and Figure 4-9. The wells monitored in Ann Gulch include MW10-AG6, MW10AG3A, MW10-DG6, MW19-DG6RB, MW19-DG6RA, and MW19-HLF1B. Due to construction activities, MW10-DG6 was decommissioned and replaced with MW19-DG6R A/B. MW10-AG3A was also decommissioned during 2020.

Parameter observations include the following:

- pH has remained neutral to slightly basic for the duration of the monitoring program.
- Aluminum generally fluctuates between 1 order of magnitude with the exception of MW19-HLF1B in April 2021.
- Arsenic levels were relatively stable from 2009-2019 (the period of continuous record at the wells established prior to decommissioning) with the exception of one outlier at MW10-DG6 which had a result 4 orders of magnitude lower than historical samples. New wells were established in 2019 and there is minor variability observed at MW19-HLF1B.
- Cadmium shows MW19-DG6RB as stable since sampling began in 2019 and MW18-DG6RA has a decreasing trend over time.
- Copper at all historic stations have a variability of approximately one order of magnitude over time. In 2021 MW19-DG6RB shows a slight increase and MW19-HLF1B has decreased and over 2 years.
- Lead values in wells that were drilled in 2019 (MW19-HLF1B and MW19-DG6RA&B show higher concentrations then decommissioned baseline wells, methodology for results has produced different Method Detection Limit. The quality in the new wells are close to or at MDL.
- Iron displays a large variability between stations but each station shows consistent ranges over 2009 to 2021.
- Selenium displayed results for MW19-DG6RB at detection limits in 2021. MW19-HLF1B shows a slight increase over the 3 years of monitoring.

Figure 4-8: Ann Gulch Drainage Groundwater Quality Data

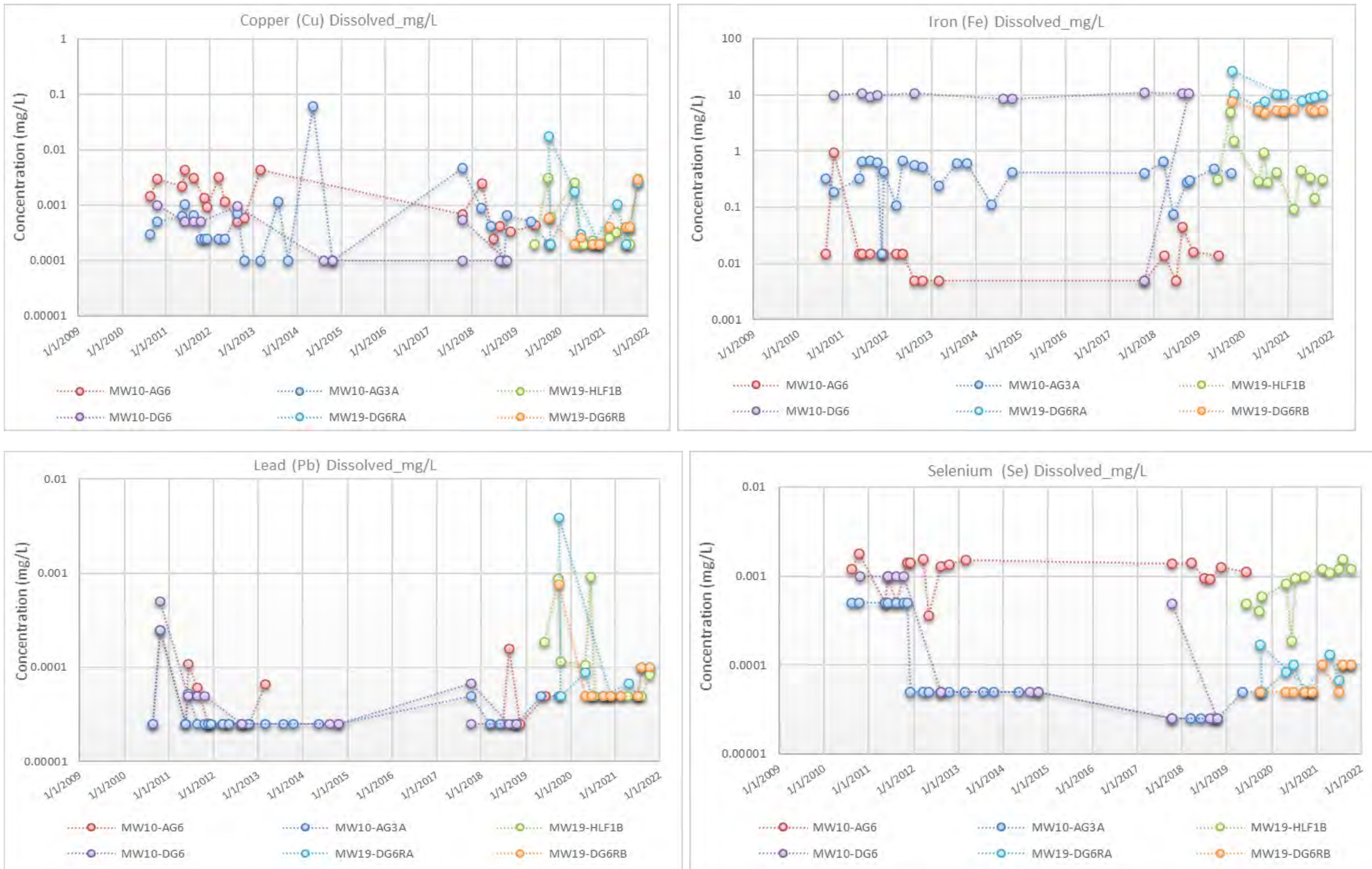


Figure 4-9: Ann Gulch Drainage Groundwater Quality Data

Well information has been gathered in the Eagle Pup drainage area at two locations since 2009 (MW96-13A, MW96-15) and an additional station was installed in 2019 (MW19-EPW1A), and is presented in Figure 4-10 and Figure 4-11. MW96-9B is located in the Bawn Boy drainage and is considered a background site that is discussed herein with the Eagle Pup sites and has been monitored since 2019:

- pH in the Eagle Pup drainage is neutral to slightly basic.
- Aluminum concentrations have remained relatively constant with MW96-13A showing a slight decrease in dissolved concentrations. While MW19-EPW1A shows a slight increase since the well was established in 2019.
- Arsenic concentrations at MW96-15 have displayed a stable range of 0.1 - 0.3 mg/L throughout the dataset. MW19-EPW1A had a stable to downward trend over 2 years.
- Cadmium concentrations for the majority of the samples are within one order of magnitude. MW96-13A has the highest variability over the dataset. Most samples taken in 2021 are close to or at MDL.
- Copper concentrations measured at MW96-9B shows a downward trend over time, MW96-13A is close to detection limit throughout 2021.
- Iron concentrations at MW96-13A have low variability over the four-year monitoring period and MW96-15 has a variability of one order of magnitude from 2009-present.
- Lead concentrations display a historic concentration range close to detection limits for MW96-15 and MW96-13A. MW19-EPW1A and MW96-9B show a decreasing trend in 2019 and are closer to detection limit in 2021.
- Selenium concentrations at station MW96-13A have been measured at or near to the detection limit of the time from 2009 to 2021. MW96-15 displayed selenium concentrations close to the detection limit from 2009 to 2014, and have generally remained within an order of magnitude. Concentrations remained near method detection limits for the MW96-9B station and MW19-EPW1A displays concentrations within an order of magnitude to the neighbor stations with a small range.

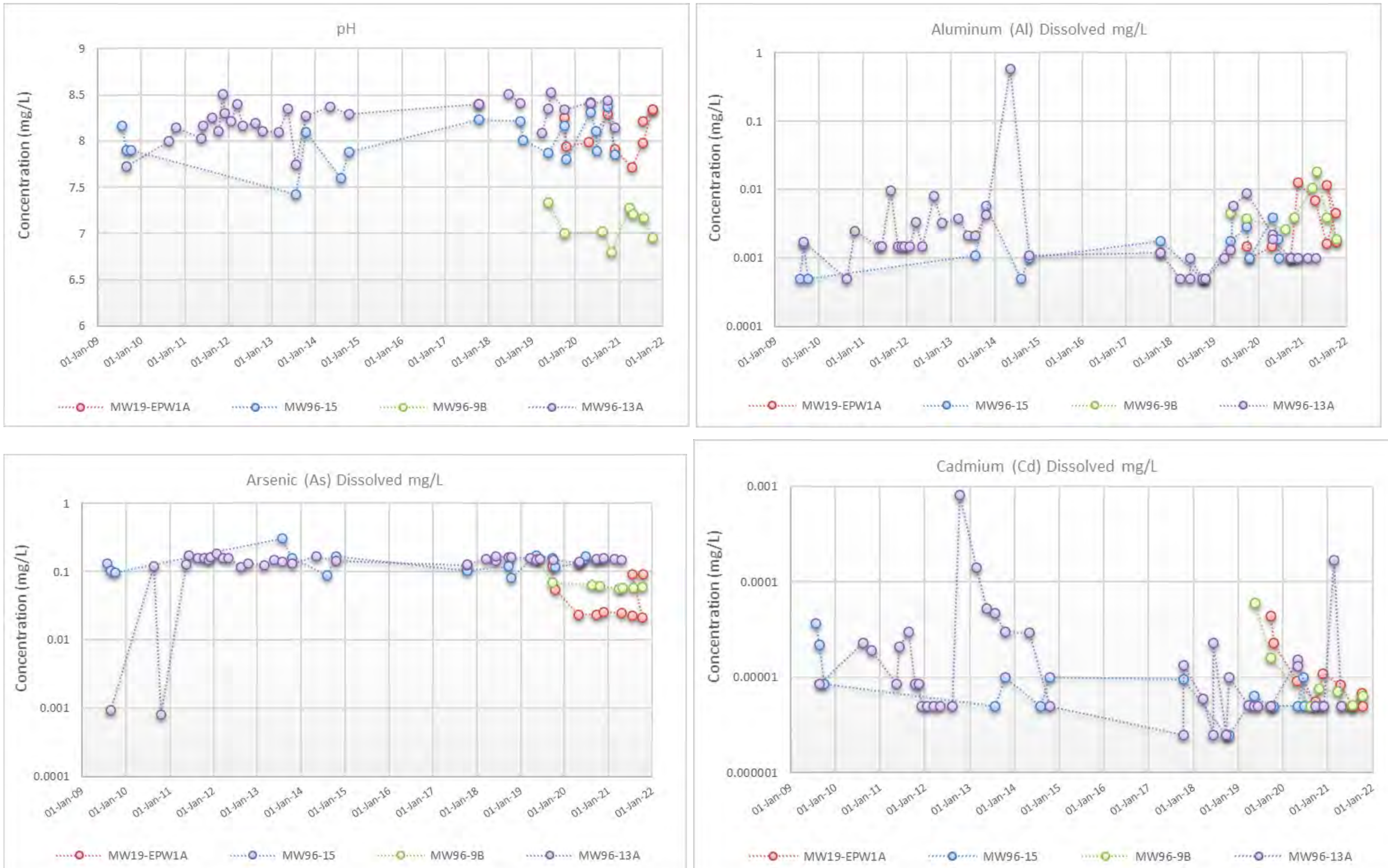


Figure 4-10: Eagle Pup and Bawn Boy Drainage Groundwater Quality Data

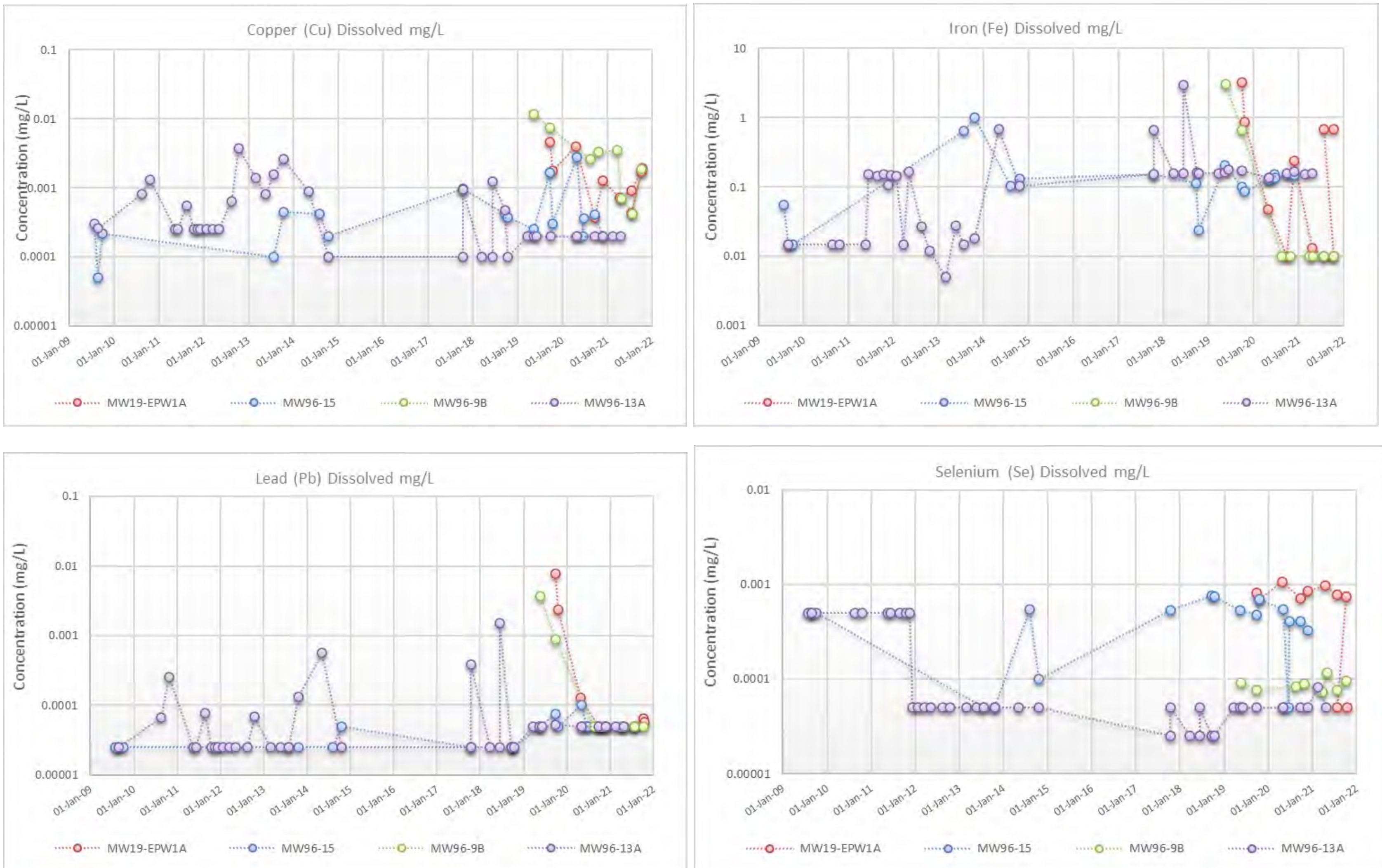
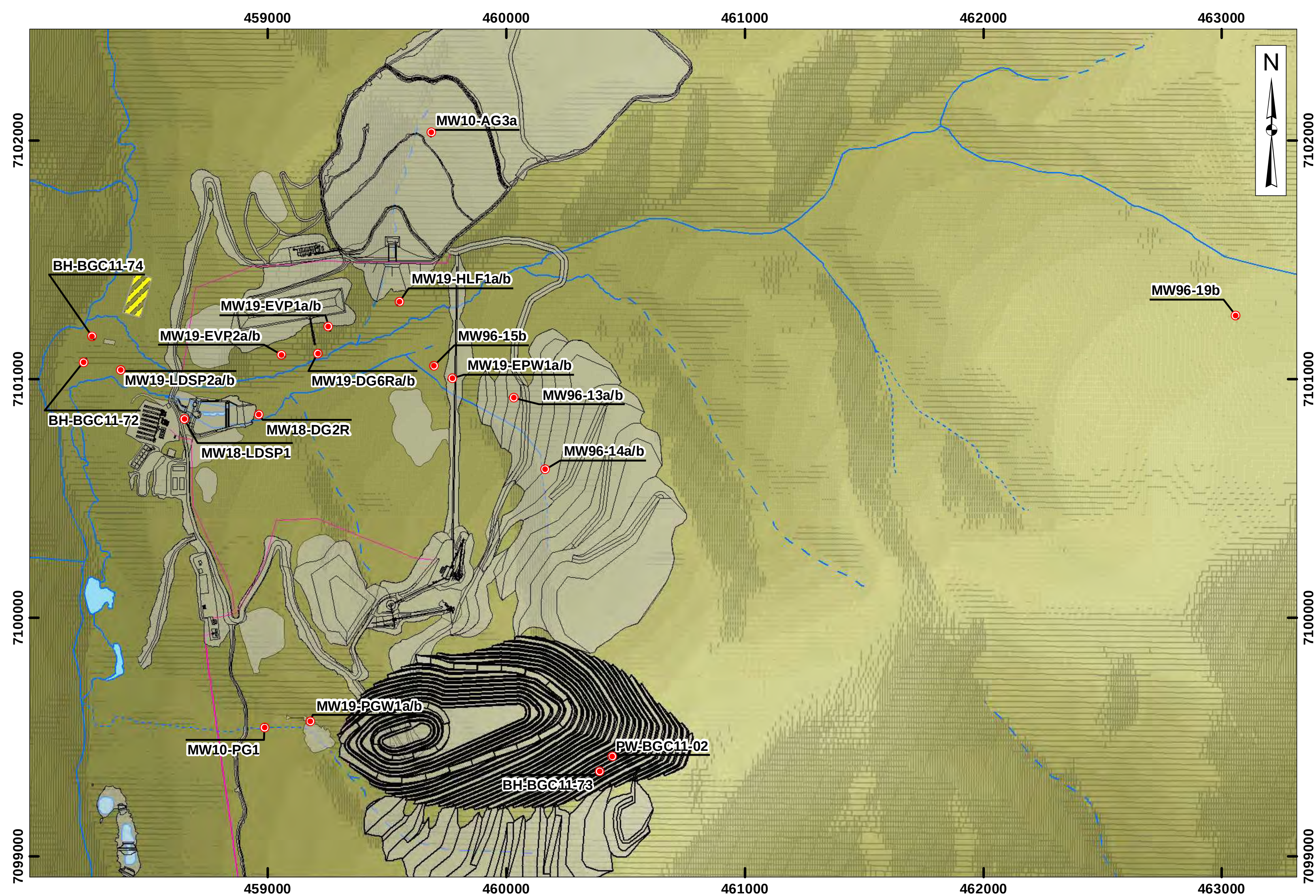


Figure 4-11: Eagle Pup and Bawn Boy Drainage Groundwater Quality Data



Legend:

- Groundwater Monitoring Location
- Major Facility
- Site Power
- Reserved Area
- Perennial Watercourse
- Ephemeral Watercourse
- Intermittent Watercourse

VICTORIA GOLD CORP

0 125 250 500 Meters

Projection:	Drawn By:	EAGLE GOLD PROJECT YUKON TERRITORY
NAD 83 Zone 8N	HC	
Date:	Figure:	Site Plan with Groundwater Monitoring Locations
2022/03/27	4-12	

4.4 VEGETATION

The information below summarizes Stantec (2011c) and Laberge (2021). Vegetation baseline study areas consist of a Local Study Area (LSA), a Regional Study Area (RSA), and a Road Corridor Study Area (RCSA). For the purposes of the vegetation assessment, the RSA and RCSA were combined to form the Regional Assessment Area (RAA), while the Local Assessment Area (LAA) includes the baseline LSA and a buffered area adjacent to the transmission line and access road.

The current vegetation monitoring program commenced in 2018 and has been designed to evaluate changes to metal deposition and uptake within vegetation during the construction and operational phases of the Project. Specifically, metal burden in and on plant tissues is measured annually during the growing season of each year to help identify whether any trends may be attributed to the Project.

4.4.1 Land Cover (Ecosystem Mapping)

Terrestrial ecosystem mapping (TEM) was completed for an area of approximately 7,538 ha surrounding the Project. This included 1:10,000 scale mapping of the 1,606 ha LSA covering the area where Project disturbances were/are expected and the 7,538 ha RSA. The 1:20,000 RSA mapping is used to provide regional context. Ecosystem mapping (1:20,000) was also prepared for the one kilometre wide Road Corridor Study Area (RCSA) along the 44.8 km long access road (4,580 ha). A Project specific ecosystem classification system, based on field data collected in 2009 and literature review, was developed for the study areas. A completed description of the TEM methodology is provided in Stantec (2011c). The area occupied by each of the vegetated and non-vegetated ecosystem units summarized by ecological zone (i.e., Forested and Subalpine) for the study areas is provided in Table 4-14. The table also presents the area covered by disturbances such as main roads, exploration trails, seismic lines, and mining activity such as placer, trenching or drilling prior to construction of the Project. A total of 21 vegetated ecosystem units and nine non-vegetated units were mapped.

Two ecological zones were delineated in the baseline study areas: the Subalpine zone and the Forested (Boreal) zone. The majority of Project activities occur in the Forested zone. The Subalpine zone, which covers 1,502 ha in the RSA, occurs on the ridge tops and high plateaus above approximately 1,225 masl. Baseline condition tree cover was discontinuous or absent at this elevation, and the vegetation is dominated by dwarf birch, willows, ericaceous shrubs, herbs, mosses, and lichens. The highest points within the three study areas is 1,520 masl. These upper elevations are dominated by dwarf-shrub, heath and lichen communities.

The Forested zone (11,450 ha), which is part of the northern boreal forest (Boreal Cordillera Ecoregion), includes the valley bottoms, and the slopes of the mountains below the treeline. The elevation range of this zone in the three study areas is 600 masl up to the Subalpine zone, about 1,225 masl. Open canopy stands of black spruce are generally present on moist sites and on the lower portions of north facing slopes. However, coniferous dominated forests consisting of white and black spruce are found along creeks and rivers and on well drained sites. Ericaceous shrubs and feather mosses are most common in the understory of the coniferous forests. On the upper slopes, open subalpine fir stands are predominant with trees becoming smaller and more spread out with increasing elevation; the cover of willows, dwarf birch and ericaceous shrubs increase as the canopy opens. Mixed forests, consisting of white spruce, trembling aspen, and Alaska birch are also present on warm aspects or near-mesic sites that have been disturbed by forest fire. Small deciduous stands dominated by aspen (warm aspects) and Alaska birch are also occasionally present in the study area.

Table 4-14: Summary of Mapped Ecosystem Units

Ecological Zone	Map Code	Eagle Gold Ecosystem Name	LSA (ha)	RSA (ha)	RCSA (ha)	Totals (ha)
Forested	AK	Aspen – Kinnikinnick	13.7	63.0	47.7	124.4
Forested	AW	Alaska birch-White spruce-Willow	30.3	383.3	280.1	693.7
Forested	BL	Dwarf birch-Lichen	10.4	31.6	0.1	42.1
Forested	BS	Black spruce-Sphagnum	-	163.1	319.6	482.7
Forested	CL	Cliff	-	0.3	-	0.3
Forested	ES	Exposed Soil	2.7	0.3	-	3.0
Forested	FC	Subalpine fir-Cladina	353.6	1,363.7	59.7	1,777.0
Forested	FF	Subalpine fir-Feathermoss	95.9	729.8	41.5	867.2
Forested	FM	Subalpine Fir-Labrador tea	93.9	1,012.7	116.8	1,223.4
Forested	FP	Subalpine fir–Dwarf birch-Crowberry	61.6	128.7	0.4	190.7
Forested	GB	Gravel Bar	0.1	0.1	16.1	16.3
Forested	MA	Marsh	-	0.5	19.5	20.0
Forested	OW	Open Water	-	-	66.2	66.2
Forested	PD	Pond	-	-	1.9	1.9
Forested	PH	Balsam poplar-Horsetail	-	-	16.0	16.0
Forested	PM	Placer Mine	5.1	14.6	18.0	37.7
Forested	RI	River	0.1	30.2	75.4	105.7
Forested	RO	Rock Outcrop	3.1	23.2	0.4	26.7
Forested	SA	Dwarf birch-Northern rough fescue	35.3	93.4	-	128.7
Forested	SC	Black spruce-Cladina	-	18.0	401.5	419.5
Forested	SF	White spruce-Feathermoss	4.6	-	374.9	379.5
Forested	SH	White spruce-Horsetail	25.0	139.4	423.8	588.2
Forested	SL	Black spruce-Labrador Tea-Feathermoss	166.7	852.7	1,989.8	3,009.2
Forested	TA	Talus	4.4	5.6	-	10.0
Forested	WG	Willow-Groundsel	28.1	70.1	11.3	109.5
Forested	WH	Willow-Horsetail	10.5	-	35.8	46.3
Forested	WM	Willow-Mountain sagewort	-	67.3	-	67.3
Forested	WS herb stage	Willow-Sedge	0.4	8.3	15.1	23.8
Forested	WS shrub stage	Willow-Sedge	-	-	38.3	38.3
Subalpine	BL	Dwarf birch-Lichen	60.8	151.2	–	212.0
Subalpine	ES	Exposed Soil	0.1	0.4	–	0.5
Subalpine	FP	Subalpine fir–Dwarf birch-Crowberry	56.4	232.4	–	288.8
Subalpine	MM	Mountain heather meadow	4.0	33.8	–	37.8
Subalpine	MW	Mountain avens – Dwarf willow	7.3	32.6	–	39.9
Subalpine	RO	Rock Outcrop	–	11.1	–	11.1

Ecological Zone	Map Code	Eagle Gold Ecosystem Name	LSA (ha)	RSA (ha)	RCSA (ha)	Totals (ha)
Subalpine	SA	Dwarf birch-Northern rough fescue	249.2	176.7	–	425.9
Subalpine	TA	Talus	3.5	26.1	–	29.6
Subalpine	WG	Willow-Groundsel	11.8	–	–	11.8
Subalpine	WM	Willow-Mountain sagewort	25.9	0.3	–	26.2
Subtotals			**1,364.7**	**5,853.7**	**4.370.1**	**11,588.5**
Pre Project-Construction Disturbances			241.3	78.4	210.5	530.2
Totals			**1,606.0**	**5,932.1**	**4,580.5**	**12,118.6**

4.4.2 Metals in Vegetation

To characterize baseline levels of trace metal concentrations in vegetation, samples were collected and analyzed for a full suite of metals at nine locations in and around the LSA during the ecological mapping field survey. Samples consisting of leafy branches or stems and/or leaves were collected from willows species and graminoids at each site. All samples were analyzed using inductively coupled plasma mass spectrometry (ICP-MS) at CANTEST in Richmond, BC. Mercury concentrations were determined using Cold Vapour Atomic Absorption Spectrophotometry or Cold Vapour Atomic Fluorescence Spectrophotometry.

Results of the analysis were compared to dietary tolerances of cattle based on thresholds outlined in Puls (1994). Tolerances of cattle were used since the dietary tolerance of wild ungulates is generally not known. All elements were below toxic levels for dietary intake by cattle for all sites and species sampled based on dietary guidelines. Barium concentration was high, but not toxic/excessive, in grasses at one site and willows at another. Phosphorus and potassium concentrations were deficient for all sites and all plant species.

Four sites were established as part of the EMSAMP, with samples collected annually since August 2018. The levels of metals found in the foliar samples collected in 2021 represent the fourth year of assessment for sites D-1(B) and D-3, third year for sites D-2B and D-4B and second year for D-5 (Laberge 2021). The data gives a general idea of the metal burden (uptake from soil in tissues as well as through dust deposition) in various species in different ecological zones. General observations of the data collected to date include:

- There was a slight increase in arsenic concentrations in the dwarf birch and willow leaves at D-1 but most of the other metals decreased in concentration in 2021 in all tissue types.
- There were some minor fluctuations throughout all tissue types at D-2B.
- Four consecutive years of data exist for D-3. There was an increase each year of all of the selected metals in the willow leaves, willow twigs and dwarf birch leaves up to 2020 with concentrations decreasing somewhat in 2021. The Platinum Gulch WRSA has encroached closer to D-3 over the time period. It is likely that dust generated from the off-loading of waste rock to the storage area has possibly lead to the increase in tissue concentrations observed in 2020. The July 2021 precipitation data from the Potato Hills and Camp Climate stations show that 23 mm and 37 mm of rain respectively, fell from July 15 to 24, and may have created a rinsing effect of the foliage prior to sampling, as no dust accumulations were observed on the vegetation during the collection process.
- Data were generally similar each year with some fluctuation over the three years at D-4B.
- Site D-5 now has two years of data. Arsenic and chromium increased in 2021 in all tissue types.

Arsenic is potentially a parameter of concern in the Project area. The soil samples collected to date indicate high naturally occurring levels of arsenic. Arsenic is associated with the gold bearing anomalies in the district and these initial concentrations reflect the natural mineralization of the Project area. Arsenic soil concentrations exceeded the CCME and CSR guidelines in the samples collected in 2018 (Laberge, 2018), 2019 (Laberge, 2019) and 2020 (Laberge 2020a). However, these relatively high soil concentrations are not overly reflected in the plant tissues. This incongruity may be related to the bioavailability associated with arsenic speciation.

It is a general consensus that arsenic is not essential for plants (Laberge 2021). The concentration of arsenic in plants is usually less than 1.0 mg/kg (Abbas, 2018). Arsenic concentrations ranged from 0.148 to 5.15 mg/kg in the 61 individual tissue samples analyzed in 2021. These concentrations are well below the maximum tolerable level of 30 mg/kg arsenic in a dietary source. There was no visible sign of stress in any of the vegetation in the plots. Therefore, the arsenic present in the soil may not be bioavailable to plants or the availability may be limited by the mycelium associated with the vegetation types, which effectively screen out toxins at the root hairs.

4.4.3 Plant Communities and Assemblages

The area occupied by ecosystem units was summarized by various land cover types (or patches) for the study areas (Table 4-15**Error! Reference source not found.**) during the baseline vegetation assessment completed in 2009 and 2010 for the Project (Stantec, 2011c). At the effective date of the assessment, coniferous dominated forest was the most common land cover type found in the LSA (45%), RSA (67%) and RCSA (65%). Dwarf birch dominated ecosystems are the next most common land cover type in the LSA and RSA. They occupied about 29 and 14% of these areas, respectively. These ecosystems dominate the ridge top and plateau found in the Subalpine zone. Disturbances, associated with exploration and previous mining activities cover about 15% of the LSA compared to about 1% of the RSA overall and 5% of the RCSA. Riparian areas (7%) and deciduous forest (3%) are the next most common land cover types in the LSA. Riparian areas are associated with Haggart Creek, Dublin Gulch and ephemeral streams found throughout the LSA. Wetlands are uncommon in both the local and regional study areas, however they are the second most abundant cover type in the RCSA. Non-vegetated units such as rock, talus and exposed soil and dwarf shrub land-cover types each occupy less than one percent of the LSA. The dwarf shrub ecosystem types are found in the Subalpine ecozone.

Table 4-15: Ecosystem Category Summaries

Ecosystem Category	Map Codes	LSA		RSA		RCSA	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
Conifer forest	FC, FF, FM, SC, SF, SL	714.8	45	3,976.9	67	2,984.2	65
Dwarf birch dominated	BL, FP, SA	473.8	29	813.8	14	0.5	<1
Riparian areas*	GB, PH, RI, SH, WG, WM	120.6	7	399.2	7	664.4	15
Deciduous forest	AK, AW, PH	44.0	3	446.3	8	343.8	8
Wetlands	BS, MA, OW, PD, WH, WS	10.8	<1	161.5	3	495.5	11
Rivers	RI	0.1	<1	30.2	<1	75.4	2
Rock/talus/exposed soil	CL, ES, RO, TA	13.8	<1	67.0	1	0.4	<1
Dwarf shrub	MM, MW	11.3	<1	66.4	1	0	0
Mining areas	PM	5.1	<1	14.6	<1	18.0	<1
Disturbances	Na	241.3	15	78.4	1	210.5	5

NOTE: Only riparian ecosystems are listed in the table, although other ecosystems and non-vegetated units are present within the riparian corridors.

Old forest patches occupy about 14% of the LSA. These consist of ecosystems dominated by white or black spruce at lower elevations and ecosystems dominated by subalpine at higher elevations.

Rare plant surveys were conducted in 2009 and 2010 within the local study area and along specific sections of the road in 2010. One rare plant species, island purslane (*Koenigia islandica* L.), was identified at a single location in the LSA. A relatively small patch of this plant, covering about 2 m x 2 m was found in Bawn Boy Gulch.

4.4.4 Wetlands

Wetlands are uncommon in the LSA. These shrub and herb dominated wetlands cover about 10.8 ha (<1%) of the area.

Wetlands are more common in the RSA (3%). These wetlands are associated with the Lynx and Haggart Creek valley bottoms. The nearest major wetland complex identified by Smith, et al. (2004) is located at McQuesten Lake, approximately 25 to 30 km to the east-northeast of the Project. Wetlands are most common in the RCSA (11%) largely due to the fact the access road is located in valley bottoms.

4.5 WILDLIFE

Background information, methods, and results for the baseline wildlife studies conducted for the project are provided in Stantec (2011b). Ongoing monitoring for the Project, since the completion of baseline wildlife studies, includes the annual late winter moose survey, pre-clearing surveys, and completion of incidental wildlife observation records. With the exception of the discussion regarding moose distribution, the information presented for wildlife and wildlife habitat represents pre-construction conditions.

4.5.1 Wildlife Study Areas

4.5.1.1 Local Study Area

The baseline Local Study Area (LSA) consisted of an approximately 18 km^2 area encompassing the Project site and a surrounding buffer ranging from 0.5 to 1 km. The LSA was chosen to encompass the area in which direct effects on wildlife could occur.

4.5.1.2 Access Road Study Area

The Access Road Study Area (ARSA) was designed to assess the potential effects associated with the access road. The ARSA was created by buffering the South McQuesten Road and the Haggart Creek Access Road by 500 m on each side up to the Eagle Gold camp site. The ARSA is approximately 44.8 km in length and 45.8 km^2. The access road study area was intended to provide a baseline for potential disturbance to wildlife resources that may occur due to realignment of the Project access road and use of the road during the Project.

4.5.1.3 Regional Study Area

The Regional Study Area (RSA) consisted of a 23 km by 21 km (483 km^2) area surrounding the Project site. This area was chosen because it is large enough to potentially encompass a grizzly bear home range, raptor nest sites (e.g., cliff habitat), and movement corridors (riparian drainages). It includes the Lynx Creek watershed to the south (which is relatively undisturbed when compared to the majority of the placer-mined drainages in the area), the McQuesten River watershed to the north, and the major habitat types present in the region

4.5.2 Abundance and Distribution of Habitat Types

The wildlife Regional Study Area (RSA) contains two ecological zones:

- The forested zone ranges from 600 m asl elevation to 1,225 m asl and includes the valley bottoms and the slopes of the mountains below the tree line. In the valley bottoms, forests are dominated by open canopy stands of black spruce (*Picea mariana*) with white spruce (*Picea glauca*) found along creeks and rivers. Lower forested habitats adjacent to riparian corridors are areas with high potential to support wildlife. In particular, both moose (*Alces alces*) and grizzly bear (*Ursus arctos*) are likely to use these areas seasonally at differing levels of intensity when forage opportunities are most abundant (e.g., seasonally ripe berries, newly emerged vegetation) or when shelter and insulation from winter weather is required. On the mid to lower slopes, continuous stands of subalpine fir (*Abies lasiocarpa*) occur along with minor components of white spruce, Alaska birch (*Betula neoalaskana*), trembling aspen (*Populus tremuloides*), and black spruce. On the upper slopes and up to tree line, open subalpine fir stands are predominant with trees becoming smaller and more spread out with increasing elevation.
- The subalpine zone occurs on the ridge tops and high plateaus above 1,225 m asl. Here tree cover is discontinuous or absent and the vegetation is dominated by scrub birch (Betula glandulosa), willows (Salix sp.), ericaceous shrubs, herbs, as well as mosses and lichens. The tree and shrub layers found in the subalpine zone are used by moose to support both feeding and cover from spring through fall. Elevations above 1,500 m asl are dominated by ecosystems containing a mixture of shrubs, graminoids, herbs, bryophytes, and lichens.

Terrestrial ecosystem mapping was completed for the LSA following standard methods (Resource Inventory Committee [RIC] 2002). A total of 21 vegetated ecosystem units and nine non-vegetated units were mapped in the LSA. A description of the site characteristics and dominant species for these ecosystems is provided in Stantec (2011c).

Coniferous forest habitat dominates the LSA, covering 66% of the area. It is composed of primarily subalpine fir, white spruce, and black spruce. Dwarf birch (*Betula nana*) dominated ecosystems cover a smaller portion of the LSA (11%). They are represented by dwarf birch, alpine herbs and lichens. Little deciduous forest habitat occurs, covering only seven percent of the LSA. It is dominated by trembling aspen, Alaska birch, and balsam poplar (*Populus balsamifera*). These patterns influence the distribution of wildlife species, as described in the following sections.

4.5.3 Habitats of Special Interest

The Yukon Government has identified Wildlife Key Areas (WKAs), which are used by wildlife for critical life functions (Environment Yukon 2009). The nearest WKA to the Project lies outside the RSA in the South McQuesten River and McQuesten Lake area. It includes summer nesting habitat for ducks in the wetlands upstream of McQuesten Lake; for Peregrine Falcon (*Falco peregrines anatum/tundrius*), Osprey (*Pandion haliaetus*), and Bald Eagle (*Haliaeetus leucocephalus*) on McQuesten Lake; and for Gyrfalcon (*Falco rusticolus*) and Golden Eagle (*Aquila chrysaetos*) immediately north of McQuesten Lake. Based upon local knowledge (Environment Yukon 2009), late-winter moose range is identified approximately 55 kilometres northwest of the Project site, outside of the RSA. No WKA is recorded in the RSA or LSA (Environment Yukon 2009). Information obtained via the Traditional Knowledge and Use Study (Stantec 2010f) indicated that FNNND Settlement Lands south of the Project site and adjacent to the access road and the area north of the Project site near the Potato Hills provide important moose habitat at various seasons.

A number of important habitat types are present within the LSA. They are considered important based upon their relative scarcity within the LSA and their importance for wildlife species that are specialized or considered habitat type obligates. These habitats include:

- Old growth Forest
- Wetlands
- Riparian corridors
- Areas previously disturbed by fire

Approximately 2,077 ha, or 18% of the LSA, is comprised of old growth coniferous forest. These forests consist of ecosystems dominated by white or black spruce at lower elevations and ecosystems dominated by subalpine fir at higher elevations. Old growth forest habitat is important for wildlife species such as American marten (*Martes americana*). Bears may use these areas for hibernation, with dens dug beneath the root wads of large trees. Moose may also seek out mature coniferous forest primarily for warmth in winter.

Wetlands are uncommon and account for approximately 6% of the LSA. They include sphagnum bogs, sedge fens, marshes, ponds, and areas of open water. The majority of wetlands in the LSA are adjacent to the access road, and are associated with the poorly drained valley bottoms along Lynx Creek, Haggart Creek, and portions of the South McQuesten River. While no wetlands have been identified as WKAs within the RSA or LSA, these ecosystems still play important roles for animals that frequent the RSA and LSA, such as preferred feeding habitat for moose and grizzly bear as well as other wildlife species such as Rusty Blackbird (*Euphagus carolinus*). The access road, particularly along the first approximately 20 km leading from the Silver Trail Highway, parallels the South McQuesten River and associated wetlands. This area is known locally as an important calving and rutting area for moose (O'Donoghue 2010a, pers. comm.).

Riparian corridors and drainages account for approximately 10% of the LSA. They are used as travel corridors for many species (including moose and grizzly bear) moving within and between habitat types. Riparian corridors are often attractive to these species as they provide food resources, protective cover, and relatively homogeneous topography, facilitating energy efficient movement. This is particularly true of riparian corridors found in the lower valley bottoms including Lynx Creek, Haggart Creek, and the South McQuesten River. Moose and grizzly bear may move between upper and lower elevation habitats seasonally as well as regular daily movements between forage resource areas and protective cover habitat. Helicopter-based wildlife surveys completed for the Project identified wildlife trails connecting forest habitat and distinct riparian and wetland habitats. Many of these appeared to have long term use, particularly by moose, and appeared to form connections between alpine or sub alpine habitats and lower elevation valley bottoms.

A relatively recent fire (<20 years) occurred on the south facing slope above Lynx Creek within the LSA. This area occupies 481 ha, or 4% of the LSA. Burned areas usually develop early successional vegetation (shrubs and herb species) preferred by grizzly bear and ungulates during early spring and summer. Other species, such as Olive-sided Flycatcher (*Contopus cooperi*), may use the abundance of dead snags for perching and foraging from and adjacent forest habitats for nesting.

4.5.4 Wildlife Resources

The RSA provides habitat for a wide range of wildlife species that typically inhabit the central Yukon area. In addition to those mentioned above, species which have been documented in the RSA and LSA include mammals such as woodland caribou (*Rangifer tarandus caribou)*, black bear (*Ursus americanus*), grizzly bear, wolverine

(*Gulo gulo*), grey wolf (*Canis lupus*), red fox (*Vulpes vulpes*), American marten, snowshoe hare (*Lepus americanus*), and red squirrel (*Tamiasciurus hudsonicus*). Game bird species include Spruce Grouse (*Canachites Canadensis*), Dusky Grouse (*Dendragapus Obscures*), Ruffed Grouse (*Bonasa Umbellus*), and three species of ptarmigan (*Lagopus* sp). Raptors present may include Golden Eagle, Red-tailed Hawk (*Buteo jamaicensis*), Northern Hawk Owl (*Surnia Ulula*), Great Gray Owl (*Strix Nebulosa*), and Gyrfalcon (*Falco Rusticolus*). A variety of passerine or songbird species are also present. They include Dark-eyed Junco (*Junco Hyemalis*), Gray Jay (*Perisoreus Canadensis*), Tree Swallow (*Tachycineta Bicolor*), and Townsend's Solitaire (*Myadestes Townsendi*). Waterfowl species include Trumpeter Swan (*Cygnus Buccinators*), Mallard (*Anas Platyrhynchos*), and Canada Goose (*Branta Canadensis*).

4.5.5 Species at Risk

Species at risk that may occur in the RSA are listed in Table 4-16. In Canada, the status of each species is provided by the *Species at Risk Act* (SARA); Species at Risk Public Registry (Government of Canada 2010) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010).

Table 4-16: Species at Risk

Species	SARA*	COSEWIC
Mammals		
Grizzly bear *Ursus arctos*	No Status	Special Concern
Woodland caribou – northern mountain population *Rangifer tarandus caribou*	Special Concern	Special Concern
Wolverine *Gulo gulo*	No Status	Special Concern
Birds		
Canada Warbler *Wilsonia Canadensis*	Threatened	Threatened
Common Nighthawk *Chordeiles Minor*	Threatened	Threatened
Eskimo Curlew *Numenius Borealis*	Endangered	Endangered
Horned Grebe *Podiceps Auritus*	No Status	Special Concern
Olive-sided Flycatcher *Contopus Cooperi*	Threatened	Threatened
Peregrine Falcon *Falco Anatum* *Falco Tundrius*	Special Concern Special Concern	Threatened Special Concern
Red Knot Calidris Canatus Roseri type	Threatened	Threatened
Rusty Blackbird *Euphagus Carolinus*	Special Concern	Special Concern
Short-eared Owl *Asio Flammeus*	No Status	Special Concern

NOTES:
* SARA listed species are those considered on Schedule 1 of the Species at Risk Act.

The Yukon Wildlife Act lists species as ―specially protected‖, including cougar, Gyrfalcon, Peregrine Falcon and Trumpeter Swan (Yukon Government 2010b). These species are afforded protection under the *Yukon Wildlife Act* because they are considered particularly susceptible to hunting pressure.

While the ranges of species listed in Table 4-16 overlap the LSA, species specific habitat requirements may not be met within the LSA. For example, there is little or no cliff nesting-habitat for Peregrine Falcon or tall grass habitat for Short-eared Owl in the LSA.

4.5.6 Abundance and Distribution of Major Wildlife Species

Baseline surveys confirmed the presence of 31 species of wildlife within the RSA. Information on species of management concern is summarized below.

4.5.6.1 Moose

While moose are not a species at risk, they are hunted and therefore important to both the FNNND and Environment Yukon.

Moose are recognized as an important species for harvest by local First Nations and are consistently reported within the LSA and portions of the RSA. Important calving and rutting areas within these areas have also been identified. Densities of moose in the Mayo area are close to 200 animals for every 1,000 km^2, which is above the Yukon average (Yukon Government 2003). Farther north in the FNNND Traditional Territory, local knowledge acquired via the TKU Study and professional opinion suggest that moose densities are closer to 50 to 100 animals per 1,000 km^2 (Yukon Government 2003). One participant in the TKU Study indicated that Haggart Creek and other creeks in the Project area provide food and shelter for moose in the springtime. While the surveys show that the population is about the same density as it was in the mid 1990s, there is an interest in the community to be proactive about harvest management before population levels decline further (Na-Cho Nyäk Dun Fish and Wildlife Planning Team, 2014).

Moose were the most commonly detected species during baseline surveys. Moose were detected across all surveys and in the widest range of habitat types indicating a relatively strong presence within the RSA. The majority of moose detections from late summer were in lower elevation forested habitat zones. Moose utilize low-elevation forested vegetation types in the RSA during much of the year, particularly in the winter. During the winter period (mid-December through late-April), moose requirements for suitable thermal and foraging habitat becomes increasingly important in order to survive harsh weather conditions. As such, winter thermal and winter feeding habitat life requisites are the focus for habitat modeling conducted for moose.

In winter, moose are more likely to migrate to low elevation forest habitats and riparian areas associated with valley bottoms for optimal thermal shelter, ease of movement via lower snow accumulations in these areas and associated feeding opportunities. Habitats with closed canopies and south-facing slopes accumulate less snow, providing favorable thermal conditions (Moose Management Team 1996). Riparian forests with tall shrub vegetation provide winter browse, including woody twigs of poplar, birch, alder and willow.

During spring through fall, moose are more widely distributed and can occur in any of the vegetation types found in the RSA. In general, ideal habitat conditions contain a mosaic of habitat types, providing a combination of shelter, forage, or reproduction opportunities (Moose Management Team 1996).

One Game Management Zone (GMZ 2, Subzone 2-62) overlaps the RSA. Harvest records between 1999 and 2008 for this subzone indicate a total reported average harvest of 2.1 moose annually within the management zone. Adjacent GMZ subzones report slightly higher harvest rates with an overall average of 3.65 moose per GMZ Subzone per year. No harvest data for the RSA were available from the FNNND.

Late winter aerial moose surveys have been conducted in 2018 and 2019 to document distribution and abundance of moose during construction phase of the Project, and built on the baseline/pre-construction studies conducted from 2011 to 2013.

During the 2020 survey, a total of 91 moose were observed of which 82 were observed within the study area boundary. Most moose were observed as individuals or pairs. The number of moose observed within the survey area in 2020 was similar to 2018 and 2019; however, the number of moose observed in 2018, 2019 and 2020 was considerably higher than in previous surveys. Potential factors for the variation in moose numbers typically include observer bias and seasonal variability in the regional distribution of moose. The latter can be influenced by annual and regional variations in snow characteristics such as depth and hardness. Variability could also be the result of high wolf activity preceding surveys within or near habitats seasonally important to moose.

The methodology utilized for previous Project related surveys was based on that proposed by Yukon Government Department of Environment staff. A revised methodology was trialed by Yukon Government in 2021. The appropriateness of the new methodology for general use remains under review to determine if it can be utilized for other project areas. Once a determination is made (expected to be completed by Yukon Government in 2022), it is anticipated that the Project related methodology will be revised and used in 2023.

4.5.6.2 Woodland Caribou

The northern mountain population of woodland caribou was listed as a species of special concern under Schedule 1 of SARA in 2002 (Government of Canada 2010); however, they are not included in the list of specially protected species by the Yukon Government.

All information suggests that the RSA receives low levels of caribou use and does not provide important habitat for this species. The closest woodland caribou herd to the Project is the Clear Creek Herd, followed by the Hart River and Bonnet Plume Herds (Environment Yukon 2009b). No WKAs for caribou occur within the RSA. Discussions with Yukon Environment staff familiar with the area noted that while woodland caribou are wide ranging, telemetry data indicate that the LSA is peripheral to the range of the Clear Creek herd (approximately 900 individuals) which is largely located on the opposite side of the North McQuesten River (O'Donoghue 2010, pers. comm.). Hunting records between 1999 and 2008 indicate there were no caribou harvests in GMZ Subzone 2-62, which overlaps with the RSA.

Field surveys support the conclusion that caribou are present at low densities within the LSA. Only three caribou detections were recorded when combining all past and present data. All detections occurred within subalpine habitat types within the RSA. One scat detection in the LSA was likely linked to a single individual moving beyond typical herd boundaries. The FNNND report overall declines in the presence of caribou since the 1950s, although they were previously abundant in the Proctor Lake area.

4.5.6.3 Grizzly Bear

While grizzly bears in Canada have no status under SARA or the Yukon Government (Government of Canada 2010), they have been listed special concern by COSEWIC (2010). A species of special concern is stable but vulnerable to decline from inherent conditions such as a low reproductive rate, and vulnerabilities to human activities such as attraction to non-natural food sources that can result in mortality.

Grizzly bears are a wide ranging species that seasonally use a variety of habitat types. The RSA provides a variety of potentially attractive habitats for grizzly, including forested riparian gullies, marsh habitats and subalpine areas. Grizzly bears are omnivorous and opportunistic feeders, using a variety of foods according to seasonal accessibility. Spring and fall feeding were selected as the critical life requisites used for grizzly bear habitat modeling as part of the assessment of Project effects.

Baseline data documented four detections of grizzly bear. Only one of these detections was in the LSA. The remaining three detections occurred in the larger RSA. The LSA at baseline does reflect a modest disturbance regime with exploration activities, drilling, and the creation and maintenance of a secondary road. Additionally, the LSA specifically was not found to contain a seasonally attractive magnet food resource, such as spawning salmon or highly productive berry patches that tend to attract grizzly bears.

Harvest records for Game Management Subzone 2-62 indicate no grizzly bears were reported harvested in the RSA between 1999 and 2008. For the overall region, grizzly bear is the least harvested wildlife species with an annual average rate of 0.1 bears per GMZ Subzone per year.

4.5.6.4 American Marten

The American marten is not listed as a species-at-risk by either Yukon Government or SARA (Government of Canada 2010). Although they are not a species of direct conservation concern, American marten provides significant economic and cultural value to local citizens, including the FNNND.

Marten in the northern boreal forest are closely associated with late successional coniferous stands, especially those dominated by spruce and fir, with complex structure near the ground (i.e., coarse woody debris) (Slough 1989; Buskirk and Powell 1994). Marten typically forage on small mammal species such as red-backed voles (*Clethrionomys rutilus*), birds and bird eggs, crowberries (*Empetrum nigrum*), and occasionally on grouse, ptarmigan, snowshoe hare and moose or caribou carrion when food becomes more scarce (Environment Yukon 2009b). Commonly reported refuge sites include ground burrows, rock piles and crevices, downed logs, stumps, snags, brush or slash piles and squirrel middens (Mech and Rogers 1977; Steventon and Major 1982; Buskirk and Powell 1994).

The FNNND identifies marten as present in, or in the vicinity of the RSA, concentrated in low elevational areas adjacent to riparian corridors. FNNND citizens report recent declines in the local marten population but suggest it might be part of a naturally fluctuating cycle for marten in the region (Stantec 2010f). There were no marten detections during 2009 baseline surveys, however past data (Hallam Knight Piésold Ltd. 1994; 1996a) provided a total of ten detections not linked to any specific habitat type or precise locations.

The LSA contains habitat typically associated with this species. Old growth coniferous forest accounts for approximately 2,077 ha, or 18% of the LSA.

4.5.6.5 Olive-sided Flycatcher

Olive-sided Flycatcher is listed as Threatened on Schedule 1 of SARA (Government of Canada 2010) because of a widespread and consistent population decline over the past 30 years (COSEWIC 2007b). The rate of decline for the Yukon population is estimated at -0.2% per year between 1998 and 2008, lower than the -3.1% estimated national decline for the same period (Environment Canada 2009a).

Olive-sided Flycatcher range within the Yukon extends north to include the Yukon Plateau-North ecoregion (Yukon Government 2010b). Across its range, the flycatcher typically occurs in coniferous and mixed-coniferous forest

(Altman and Sallabanks 2000, COSEWIC 2007b, Kotliar 2007). Clear-cuts and other young (0 to 10 years old) forests are used if they contain snags or residual live trees for singing and foraging perches (Altman and Sallabanks 2000, COSEWIC 2007). Similarly, recent (0 to 30 years old) burns are considered important habitat (Boreal Avian Monitoring Project [BAMP] 2009), likely because of the creation of forest openings and edge habitat, as well as availability of snags and live trees (Altman and Sallabanks 2000; COSEWIC 2007b; Kotliar 2007). Deciduous forests are generally avoided.

A relatively recent fire (<15 years) occurred on the south facing slope above Lynx Creek. The area is approximately 481.5 ha in size and represents potential preferred habitat for this species within the LSA.

Breeding has been confirmed in the region, including four Olive-sided Flycatcher detections in the period 2006 – 2010 on the annual Mayo Landing breeding-bird survey route (US Geological Survey [USGS] 2010). No Olive-sided Flycatchers were detected within the RSA during baseline surveys completed in 2009. However, these surveys were completed outside the breeding-bird nesting period.

4.5.6.6 Rusty Blackbird

Rusty Blackbird is listed as a species of Special Concern on Schedule 1 of SARA (Government of Canada 2010) because of a significant long-term and severe population decline (Savignac 2006). The national rate of decline for Rusty Blackbird is estimated at -6.9% annually during 1988 through 2008. The species appears to be declining faster in Yukon with population declines estimated at -9.1% annually for the same period (Environment Canada 2009b).

Rusty Blackbird is present in the Yukon primarily during the breeding season (early May through late August), although migrants and non-breeding birds may be present until late October and into winter (Semenchuk 1992; Federation of Alberta Naturalists [FAN] 2007). Its range extent includes the Yukon Plateau-North ecoregion, overlying both the LSA and RSA.

In Yukon, Rusty Blackbird nesting locations are closely associated with conifer forest wetlands, including bogs (with or without ponds), fens, muskegs, swamps and wet shrubby meadows (Yukon Government 2007, Avery 1995, Savignac 2006, Shaw 2006). It also uses shrubby riparian areas along the margins of lakes, beaver ponds, rivers, and creeks in coniferous and mixed wood forests (Semenchuk 1992, Avery 1995, Savignac 2006, FAN 2007). Wetlands and riparian areas combined account for approximately 15% of the LSA, or 1,818 ha of habitat potentially suitable for this species. Estimated Rusty Blackbird densities (Avery 1995) suggest this amount of potentially suitable habitat may support less than one Rusty Blackbird bird.

Two Rusty Blackbirds were observed most recently during the annual breeding-bird survey conducted at Mayo Landing in 2004 (USGS 2010). There were no recorded observations of Rusty Blackbirds during 2009 baseline surveys within the LSA or RSA, although as mentioned above, these surveys were completed after the nesting period.

4.5.6.7 2011 Breeding-bird Surveys

Breeding-bird point-count surveys were conducted June 16 – 22, 2011. A total of 605 individuals, consisting of 46 species, were recorded during the surveys. An additional three species were observed incidental to the point-count surveys, bringing the total number of species recorded to 49. Ten Olive-sided Flycatcher were observed within the LSA and along the access road. Three Rusty Blackbirds were observed adjacent to wetland areas along the access road. No other species at risk, raptors, or stick nests were observed.

4.6 GEOLOGY AND SOILS

An Environmental Baseline Report: Surficial Geology, Terrain and Soils (Stantec 2010e) is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.3.5.

Extensive characterization of surficial and bedrock material for geotechnical and geochemical purposes has also been undertaken on the Mine site and are available in the following documents on the YWB Waterline website registry for QZ14-041:

- Geochemical Characterization Report, Eagle Gold Project (SRK 2014) - Exhibit 1.3.12
- Geochemical Characterization of Proposed Excavation Areas and Borrow Sources from the Eagle Gold Project (SRK 2013) - Exhibit 1.3.13
- Site Facilities Geotechnical Investigation Factual Data Report (BGC 2009) - Exhibit 1.3.6
- 2010 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2011a) - Exhibits 1.3.7.1 to 1.3.7.6
- 2011 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012a) - Exhibits 1.3.8.1 to 1.3.8.16
- 2011 Geotechnical Investigation for Mine Site Infrastructure, Foundation Report (BGC 2012b) - Exhibit 1.3.9
- 2012 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012c) - Exhibits 1.3.10.1 to 1.3.40.4
- Estimate of Ice-rich Material (BGC 2012h) - Exhibit 1.3.11

Additional area specific ground condition information is also discussed in various Issued for Construction and As-Built information submitted for each facility to the YWB and EMR either as standalone submission or with the annual reports required by the agencies. The ongoing soil monitoring results are provided as Appendix M to the Eagle Gold Mine 2020 Annual Report. The most recent geochemical monitoring data is provided in the Eagle Gold Mine 2021 Annual report.

4.6.1 Physiography

The Project is situated within the Yukon Plateau North Ecoregion. Nearly all terrain in the ecoregion lays above 900 m asl, with the majority between 1,200 and 1,700 m asl. The majority of the Project site lies within the Dublin Gulch watershed which flows into Haggart Creek and eventually feeds into the McQuesten River. Elevations in the vicinity of the Project range from approximately 730 m asl near the confluence of 15 Pup and Haggart Creek, to about 1,525 m asl at the summit of the Potato Hills which forms the eastern boundary of the Dublin Gulch watershed. The Ecoregion is broken into tablelands by a network of deeply cut broad valleys. While some of these tablelands are remarkably level and non-dissected, with streams flowing at relatively gentle gradients in open valleys, the areas north of the McQuesten River, do not share these features. Instead the majority of the Project area was un-glaciated during the last glacial period (Bostock 1965), and has not been glaciated for more than 200,000 years (Figure 4-13). Much of the Project area displays physiographic characteristics of the unglaciated areas of the region, with narrow, V-shaped valleys and rounded upland surfaces. The valleys are deep and narrow to the head of streams, where they rise steeply and end abruptly.

Despite the extensive time since glaciations, evidence of glacial–ice action is still visible. This historic glaciation is responsible for the formation of the tributaries of Dublin Gulch with cirque-like headwaters, including from east to west, Cascallen, Bawn Boy, Olive, Ann, Stewart, Eagle, Suttles and Platinum Gulches (Figure 4-13). Within these gulches the post-glacial terrain has been modified by gravity, water, and freeze-thaw mechanics, as evidenced by many headscarps of ancient landslides, and observed rock and debris slides. While most of the mass wasting is historic, there are a few areas of ongoing rock fall that continue to modify the terrain, particularly in the Stewart, Bawn Boy, and Olive Gulches. These active areas of rock fall exist generally in the eastern portion of the Local Study Area and outside of the Project area.

4.6.2 Surficial Geology and Soils

4.6.2.1 Surficial Geology

The surficial geology of the Project area has been substantially affected by historic glaciation over 200,000 years ago, including two major glaciation episodes in the Quaternary period; the pre-Reid (~2.5Ma-400ka BP) and the Reid (~200 ka BP) (Bond 1997; 1998a; b). Glacial limits are provided in Figure 4-13. In each case, ice likely originated from the Ogilvie and Wernecke Mountains, with glaciations being more extensive during the pre-Reid period.

Preservation of pre-Reid glacial deposits and landforms is rare. A few intact deposits and diorite erratics at high elevations are the only records left (Bond 1998a). Glacial deposits from the Reid glaciation are moderately preserved. Colluvium, alluvium, and small areas of shallow organics drape the Reid glacial sediments and the interglacial sediments throughout the area.

Dominant surficial materials within the Local Study Area (LSA) are weathered bedrock and colluvium. Competent bedrock outcrops are rare, as sufficient geologic time has passed to allow extensive weathering of exposed rock. In the larger RSA, the dominant material is colluvium, while along the McQuesten Road sections of the RSA, some of the surficial materials are largely coarse-textured fluvial deposits due to the proximity of the road to the river.

4.6.2.2 Soils

The largest influence on soil development in the area of the Project is climate, and the resulting permafrost which is discontinuous throughout the area. Despite over 200,000 years of soil development, pedogenic processes have been slow due to the cold climate and to the short growing season for vegetation, resulting in a predominance of ice-affected and relatively undeveloped soils (Cryosols and Brunisols).

Non-frozen soils encountered in the area of the Project include Brunisols, minor areas of Luvisols (on fine-textured till), and Gleysols (on poorly and imperfectly drained materials). The majority of the soil textures in the area are sandy-silt to silty-sand loam matrix with angular or tabular coarse fragments ranging from gravels to boulders.

Rooting depths are on average 50 cm, but can reach depths of over 120 cm. Baseline arsenic levels are naturally high in the soil as arsenic is often associated with gold bearing anomalies in the region reflecting the natural mineralization of the Project area. The naturally high arsenic concentrations in soils are not reflected as relatively high in the plant tissues and do not limit soil reclamation suitability. This incongruity may be related to the bioavailability associated with arsenic speciation (Laberge, 2020a).

Results from the recent soils monitoring programs indicate that, consistent with prior characterization programs, the soils at the Project are relatively nutrient poor. The soil samples were also analyzed for pH and a suite of 36 metals. The results of the 2020 soil monitoring program are presented in Table 4-17, including comparison with the most recent Canadian Council of Ministers of the Environment (CCME) guidelines, and the Yukon Contaminated Sites Regulations (CSR) for agriculture and parklands. Arsenic exceeded the recommended guidelines at all of the sites. Arsenic soil concentrations have also exceeded the CCME and CSR guidelines in the samples collected in 2018 and 2019, and as noted above, this is most likely attributed to the naturally high arsenic found in the mineralized zones throughout the region.

Chromium concentrations at D-3 exceeded the CSR guideline for agriculture but met the other guidelines. All of the recommended guidelines for chromium were exceeded in the soil collected from D-4B. The CSR and CCME agriculture guidelines for molybdenum was exceeded at D-4B. The CCME guideline for nickel was slightly exceeded at D-3 and D-4B. Soil samples have been collected on two occasions at all sites except for D-5.

Soil samples are collected in different locations of the 200 m^2 area of each site throughout the duration of the sample period (25 years). Changes in concentrations in the soil may not necessarily reflect effects from Project emissions as the differences could be attributable to localized mineralization at a particular place or other contributing factors. This seems to be the situation at D-4B where the concentrations of many of the parameters are very different between the two years. Several metals had much higher concentrations near the east plot, notably aluminum, antimony, arsenic, chromium, cobalt, iron, lead, lithium, mercury, molybdenum, vanadium and zinc. Conversely, concentrations of calcium, phosphorus, selenium, silver, sodium and strontium were higher near the north plot.

The remaining concentrations at all sites were well below the referenced guidelines.

Table 4-17: Results of 2020 Soil Monitoring Compared to CCME and Yukon CSR

Element	CCME (mg/kg)		Yukon CSR (mg/kg)		D-1	D2B	D-3	D4B	D-5
	Agriculture	Parkland	Agriculture	Parkland					
pH	-	-	-	-	5.28	5.07	4.59	5.71	6.6
Antimony (Sb)	20	20	20	20	9.57	3.01	5.13	7.41	16.4
Arsenic (As)	12	12	15	15	20.4	95.7	83.5	33.4	92.7
Barium (Ba)	750	500	750	500	180	156	153	139	71.7
Beryllium (Be)	4	4	4	4	0.57	0.38	0.41	0.28	0.23
Cadmium (Cd)	1.4	10	1.5	1.5	0.185	0.214	0.33	0.34	0.302
Chromium (Cr)	64	64	50	60	32.2	19.1	52.7	121	13.5
Cobalt (Co)	40	50	40	50	8.18	8.25	9.89	10.8	10.4
Copper (Cu)	63	63	90	90	27.5	19.7	28.2	22.1	23.9
Lead (Pb)	70	140	100	100	45.2	17.6	21.5	29.5	32.9
Mercury (Hg)	6.6	6.6	0.6	15	0.0403	0.0373	0.0287	0.0663	0.0229
Molybdenum (Mo)	5	10	5	10	1.41	0.85	1.92	7.51	0.59
Nickel (Ni)	45	45	150	150	25.6	20.3	46.4	68.5	22.6
Selenium (Se)	1	1	2	1	0.45	0.23	0.24	0.31	<0.20
Silver (Ag)	20	20	20	20	0.11	0.19	0.13	0.22	0.22
Thallium (Ti)	1	1	2	-	0.203	0.141	0.18	0.088	0.094
Tin (Sn)	5	50	5	50	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U)	23	23	-	-	1.34	0.966	0.877	0.955	0.926
Vanadium (V)	130	130	200	200	53.1	29.3	41.6	29.3	13.9
Zinc (Zn)	250	250	150	150	111	52.3	77.6	75	84.1

NOTES:

1. Exceedance of any guideline is shaded in grey.
2. Source Laberge 2020a.

4.6.2.3 Permafrost

The project site is located in a region of widespread discontinuous permafrost (Brown, 1979). On the regional scale, permafrost distribution is typically controlled by mean annual temperature and precipitation, whereas on a local scale it is controlled by vegetation, surface sediments, soil moisture, slope aspect, and snow depth. Within the project area, frozen ground occurs typically on north- and east-facing slopes at higher elevations, and within poorly drained areas lower in the valleys. The distribution and thickness of frozen ground is highly variable across the site.

Frozen ground, when observed, is generally encountered immediately below the organic cover. Ground temperatures have been measured with thermistors installed on site in 1995-1996, and 2009-2012. The measured ground temperatures showed the frozen ground to be relatively warm when observed, typically between 0°C and -1°C.

Detailed investigations into the presence, distribution, thickness and temperature of permafrost across the project site and in specific areas where development could occur were conducted in 1995 (Knight Piesold 1996a and 1996b), 1996 (Sitka Corp, 1996), and from 2009 to 2013. Results of these more recent studies are described and summarized in BGC (2010, 2011, 2012a, 2012b, 2012c and 2012d). A total of thirteen thermistor strings were installed in test holes around the site between 2009 and 2019 and continue to be monitored as part of the EMSAMP.

4.6.3 Bedrock Geology

4.6.3.1 Regional Geology

The Eagle Gold deposit is located within the Tintina Gold Province, an area of more than 150,000 km^2 covering parts of Alaska and the Yukon (Figure 4-14). The TGP is defined by more than 15 individual gold belts and districts traditionally mined for their placer resources and more recently recognized for their lode gold potential. Technological advances in heap leach mining have allowed for economically successful recovery of gold at sub-arctic operations such as Fort Knox and Brewery Creek (SRK 2014). The geology of the Eagle Gold Project is provided in a number of references including that of Brown et al. (2001), Goldfarb et al. (2007), Wardrop (2009).

The Project is underlain by Proterozoic to Lower Cambrian-age Hyland Group metasediments and the Cretaceous intrusive Dublin Gulch granodioritic stock. The granodiorite stock is elongate, measuring approximately 5 km in length and trends 070°. It has a maximum width of approximately 2 km. The long axis of the stock is coincident with the axis of the interpreted Dublin Gulch anticline. Sheet-like sills of granodiorite extend from the stock and cut the metasedimentary strata at low angles (Figure 4-15).

The stock has been dated at approximately 93 million years, and is therefore a member of the Tombstone Plutonic Suite. The Hyland Group is composed of interbedded quartzites and phyllitic metasedimentary rocks. The quartzites are variably gritty, micaceous, and massive. Phyllitic metasediments are composed of muscovite-sericite and chlorite. Limestone units are a relatively minor constituent of this stratigraphic sequence and are not significant in the contact zone around the Eagle deposit. The metasedimentary rocks dip at various angles, although all generally dip to the North. Hyland Group rocks take on a more easterly and steeper dipping orientation north of an as yet undefined structure, probably a fault, which runs along the course of Dublin Gulch. Some vein associated mineralisation is found in the Hyland Group but again not in significant amounts in the area local to the Eagle Zone.

The Dublin Gulch stock is comprised of four phases, the most significant of which is granodiorite. Quartz diorite, quartz monzonite, leucogranite and aplite comprise younger intrusive phases that occur predominantly as dikes and sills and cut both the granodiorite and surrounding country rocks. The stock has intruded the Hyland Group metasediments near their contact with the underlying Upper Schist.

Mineralisation in the Eagle Zone consists of sheeted quartz vein systems of differing densities which host gold. Additional to this, disseminated, lower grade gold is found throughout the intrusive body and is associated with arsenopyrite mineralisation, with minor pyrite/pyrrhotite. A model for the mineralisation style was published by Craig Hart in 1999 which describes a ‘Reduced Intrusion-Related Gold System (RIRGS) which also applies to the Fort Knox deposit in Alaska.

4.6.3.2 Deposit Geology

Geologically the deposit can be simplified and described as an intrusive suite, predominantly granodiorite in composition, emplaced within a metasediment package, predominantly phyllitic in nature. The granodiorite has been subdivided into three units, an oxidized unit, an altered unit, and an unaltered unit. Alteration tends to be dominated by albite, potassium feldspar, sericite, carbonate and chlorite and only occurs very locally around veining. While mineralization is associated with the intrusive stock, it is not spatially limited to the intrusive. Gold-bearing veins are found in all of the main geological units including the metasediments.

Gold occurs primarily as pure gold in association with very small amounts of metallic bismuth (Bi) and arsenopyrite (FeAsS). Other vein minerals include pyrite/marcasite (FeS_2) > pyrrhotite ($Fe_{1-x}S$) >>sphalerite ([Zn,Fe]S), chalcopyrite ($CuFeS_2$), galena (PbS), molybdenite (MoS_2) and iron oxides/hydoxides as well as metallic bismuth, Pb-Sb-(Cu,Zn) sulphosalts (e.g. bournonite ($PbCuSbS_3$) and boulangerite ($Pb_5Sb_4S_{11}$) and tetrahedrite ($Cu_{12}Sb_4S_{13}$).

4.6.4 Geochemical Characterization

4.6.4.1 Bedrock

Acid rock drainage and metal leaching (ARD/ML) evaluations to support the environmental assessment and water licensing processes were initiated by VGC in 2007 and are described and summarized by SRK (2013 and 2014). Previous to that, a comprehensive characterization program was conducted by New Millennium Mining Ltd to support a Feasibility Study in 1995/1996 (Lawrence 1997).

The objectives of the characterization program were to provide an assessment of the geochemical behaviour of proposed facilities (i.e., waste rock piles, pit walls, and heap leach facility) associated with the Project and to support engineering decisions and mitigation measures as required. Specifically, for each of these site components, the program focused on the quantification, description and assessment of:

- acid generation and neutralization potential,
- solids metal chemistry,
- mineralogy,
- metal leaching potential,
- rate of sulphide mineral oxidation,

- rate of depletion of neutralization potential,
- relative rate of depletion of neutralization potential compared to acid potential, and
- release rates of elements for input into water quality predictions.

Characterization of the metasediments and granodiorite indicated that carbonates, predominantly calcite, were generally well in excess of sulphides. Calcite content was generally 1 to 4% (from X-ray diffraction) whereas sulphur was most often less than 0.5% (from Leco S and ICP-S). Static testing showed a strong propensity towards non-acid generating conditions with the large majority of samples tested having a neutralization potential to acid potential ratio above 4. Acid rock drainage, or ARD, is therefore not anticipated for the Project.

Kinetic testing based on humidity cell testing and a field barrel program indicate that, although pH conditions are expected to be neutral, some metal leaching may still occur. This may include leaching of sulphate, arsenic, cadmium, manganese, antimony, selenium and uranium, and potentially fluoride, iron, lead, molybdenum, and zinc.

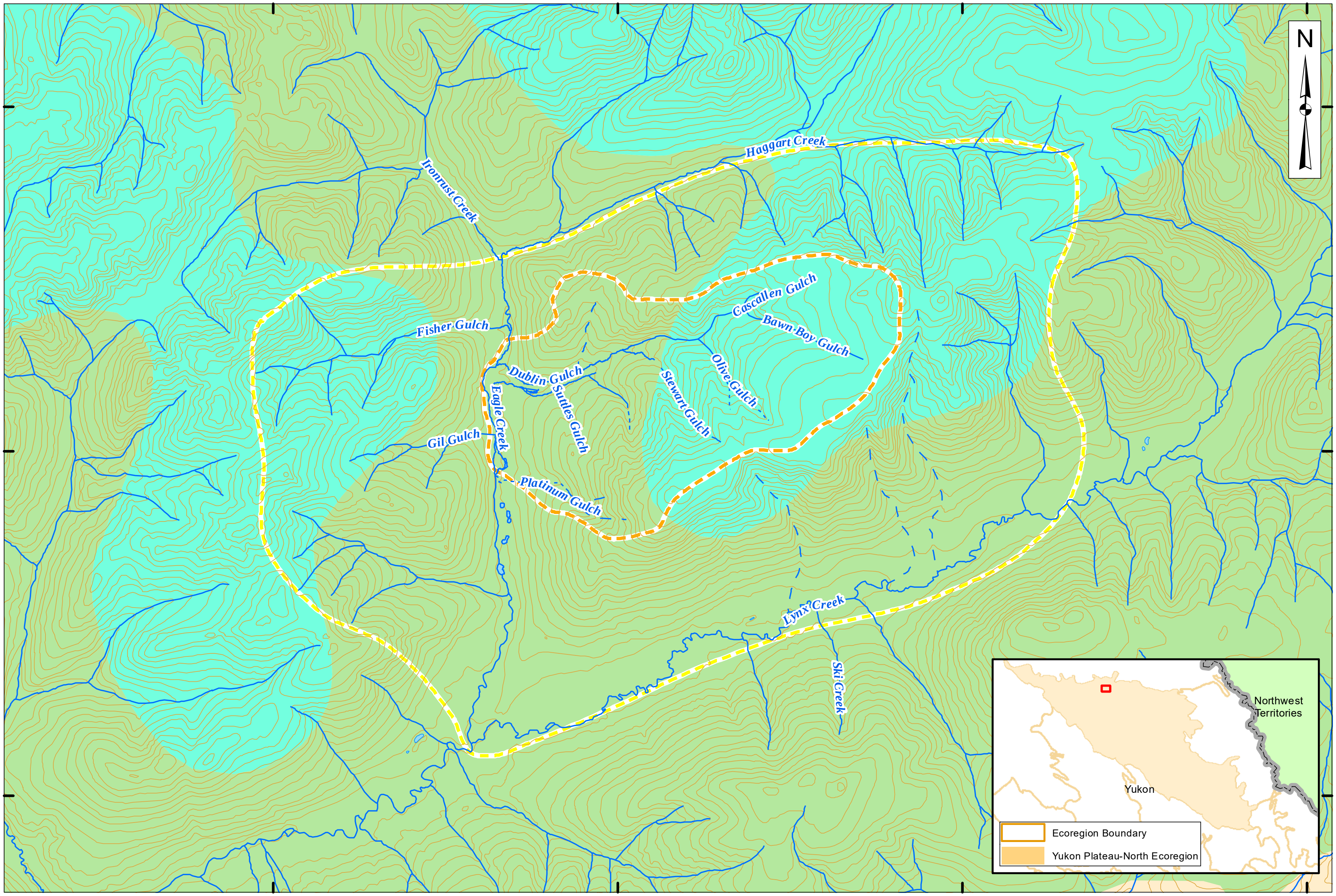
4.6.4.2 Construction Materials

Construction material sampling is undertaken with the purpose of characterizing the geochemistry of proposed excavation areas and borrow sources. A program conducted prior to the construction phase of the Project included 32 samples from the proposed site roads, 19 from placer tailings and alluvium borrow sources, and 19 from potential cut and fill (excavation) areas. Most of these samples (n=66) were from surficial materials, five were from metasedimentary bedrock, and one was from a granodiorite outcrop.

The paste pH for the samples ranged from 4.6 to 8.6 (median values of 6.6). The samples typically had low sulphur and low NP and TIC levels. This is in contrast to the characterization work from the deposit area that states NP in the form of carbonate minerals was present in modest amounts throughout the deposit area (SRK 2010). Based on having a sulphur content of <0.02%, 65% of samples were considered non-reactive. For the remaining samples, based on NP/AP or TIC/AP ratios, 7 to 14% were PAG, 11 to 14% had an uncertain potential for ARD, and 10 to 14% were non-PAG.

During construction activities in 2018 and 2019, 26 and 14 samples, respectively, were collected from various borrow locations to determine if the materials met the geochemical criteria established by the regulatory approvals for construction grade rock. All samples collected met the criteria required for construction or fill purposes, with a pH of at least 5.0, an NP:AP ratio of at least 3:1, and a total sulphide sulphur content of no greater than 0.3%. Samples ranged in pH from 6.6 to 9.2, with a median of 8.1 in 2018 samples and 8.4 in 2019 samples, with Sulphur content ranging from non-detect at < 0.01% to 22% in 2018 samples 0.04% in 2019 samples and a median of 0.02 in 2018 samples and 0.025 in 2019 samples.

During 2020, there were two construction projects that required borrow or fill material: the continuation of the PG Waste Rock Storage Area (WRSA) rock drain construction, and the placement of rip rap material in Ditch B. During 2021, there was one construction project, the EP WRSA rock drain. All samples were analyzed to determine suitability as construction grade material. Results from samples met the criteria required for construction or fill purposes In 2020, samples ranged in pH from 6.88 to 7.85, with a median of 7.41, with Sulphur content ranging from 0.02% to 0.1% and a median of 0.006, as well in all cases, the NP:AP ratio was greater than 3. In 2021, samples ranged in pH from 7.9 to 8.21, with a median of 8.01, and with Sulphur content ranging from <0.01% to 0.06% and a median of 0.033, as well in all cases, the NP:AP ratio was greater than 3.



Legend:

200 Thousand years ago (Reid Glaciation)

3 Million years ago (Pre-Reid Glaciation)

Soils and Vegetation Local Study Area

Soils and Vegetation Regional Study Area

Contour (100ft)

Perennial

Ephemeral

Intermittent

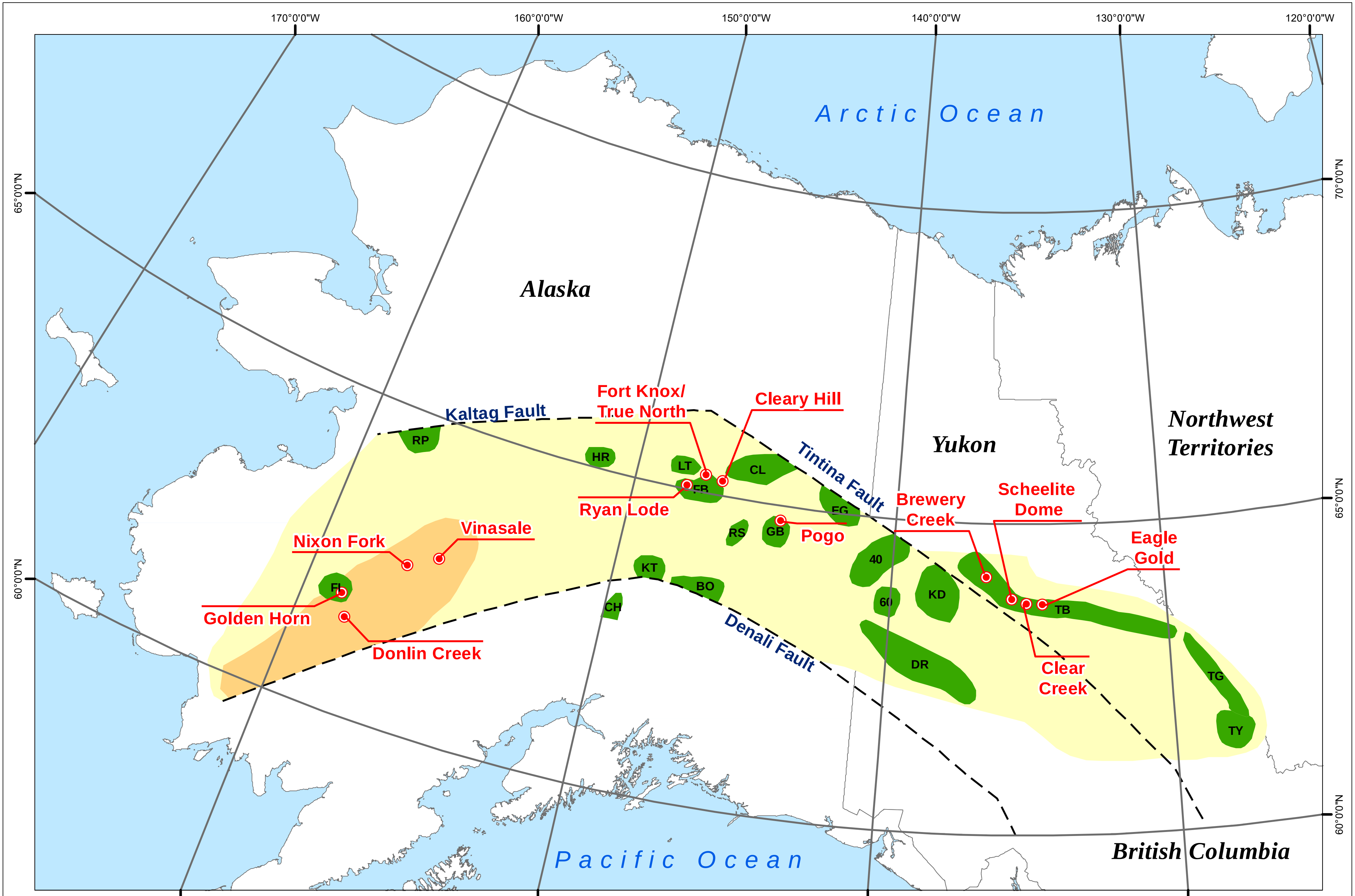
VICTORIA GOLD CORP

0 0.5 1 2 Kilometres

Projection:	Drawn By:
NAD 83 Zone 8N	HC
Date: 2020/06/01	Figure: 4-13

EAGLE GOLD PROJECT YUKON TERRITORY

Regional and Local Study Areas with Glacial Limit Extents



Legend:

- Major Mineral Deposit
- Kuskokwim Basin
- Major Geologic Fault System
- Tintina Gold Belt
- Mining or Placer District

VICTORIA GOLD CORP

0 50 100 200 Kilometers

Projection:

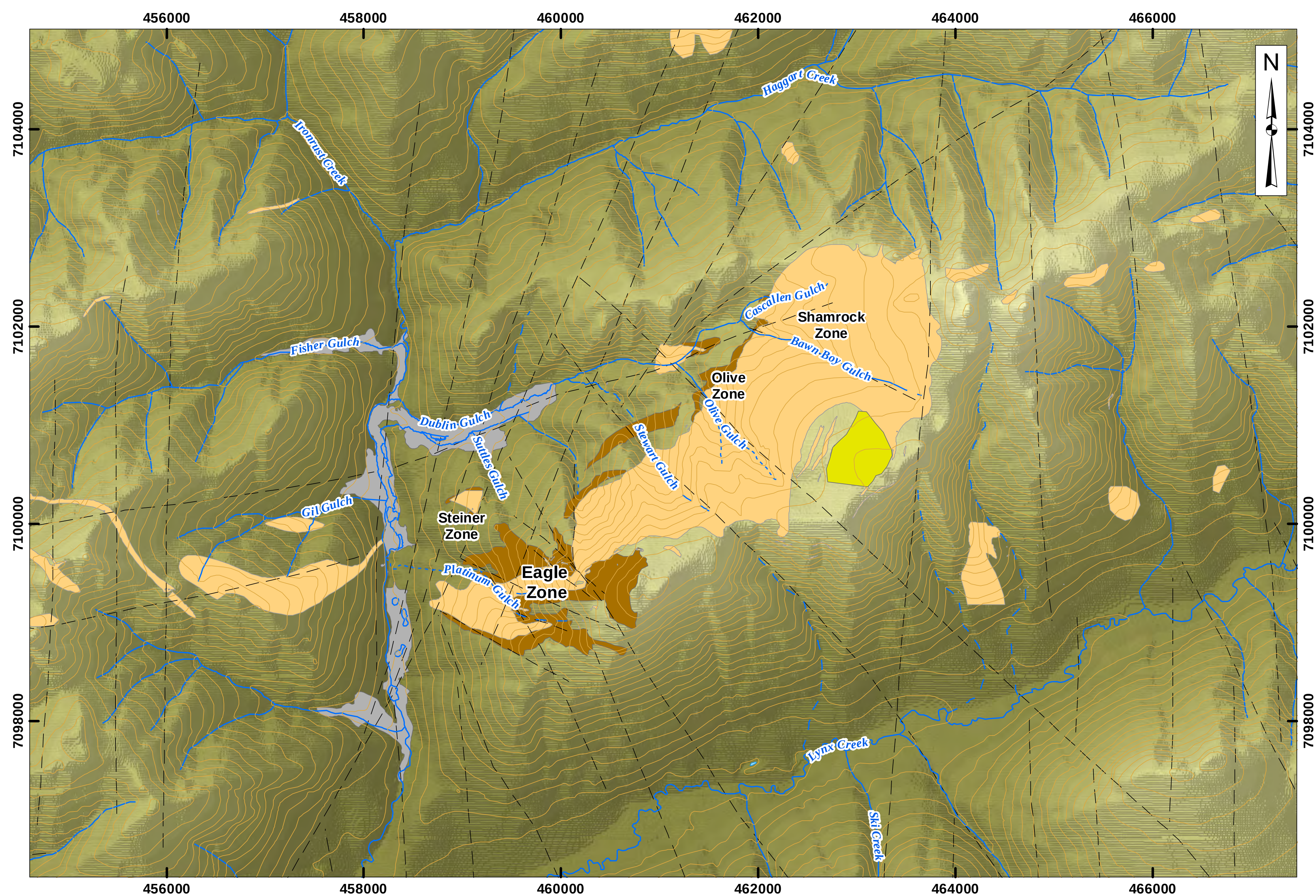
Drawn By: HC

Date: 2020/06/01

Figure: 4-14

EAGLE GOLD PROJECT
YUKON TERRITORY

Main Gold Districts of the Tintina Gold Province



Legend:

- Granodiorite
- Hornfels
- Wolf Tungsten Deposit
- Placer Workings
- Interpreted Geologic Fault
- Contour (100ft)
- Perennial Stream
- Ephemeral Stream
- Intermittent Stream

VICTORIA GOLD CORP

0 0.25 0.5 1
Kilometres

Projection:	Drawn By:	EAGLE GOLD PROJECT YUKON TERRITORY
NAD 83 Zone 8N	HC	
Date: 2020/06/01	Figure: 4-15	Eagle Gold Project Property Geology

4.7 SEISMICITY

A site-specific seismic hazard analysis (TetraTech, 2012) was performed for the Mine. This information is available and is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.9.2.1.3. Tetra Tech recommended a design peak ground acceleration (PGA) of 0.35g for facilities requiring low-probability or maximum credible earthquake (MCE) ground motions. This level of ground motion was estimated for an MCE of moment magnitude 6.0 for the background source area assuming this event occurs directly beneath the site at a depth of 6 km. For facilities requiring a PGA based on a return period of 2,475 years or less, the National Building Code of Canada (NBCC) values may be used.

5 PROJECT DESCRIPTION

The Mine involves the construction, operation, closure and reclamation of a gold mine in central Yukon. The Mine is located 85 km from Mayo, Yukon using existing highway and access roads. The Mine involves open pit mining at a production rate of approximately 10 million tonnes per year (Mt/y) ore, and gold extraction using a three-stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over the life of mine.

Construction of the major fixed Mine facilities (e.g., conveying systems, ADR Plant, warehouses, etc.) began in August 2017 and occurred over approximately two years. The Mine entered the operations phase (defined by VGC as the commencement of ore stacking on the HLF) in July 2019. Commercial production at the Mine was declared in July 2020. Construction and development of the open pit, heap leach pad, and WRSAs will continue throughout the life of mine.

Economic gold-bearing ore and uneconomic barren waste rock are removed from the Eagle pit by conventional drill, blast, shovel and truck mining technology. The footprint of the final open pit is dictated by various operational and geotechnical considerations as mining progresses and is currently assumed to have a surface area of approximately 77 ha. Based on the surface topography, the open pit will be scalloped-shaped with a lower west highwall.

Uneconomic barren waste rock is deposited in one of two waste rock storage areas (WRSAs) or utilized in the construction of various mine facilities. Deposition of waste rock in the Platinum Gulch (PG) WRSA is largely complete with capacity for approximately 300kt remaining. To date, approximately 24.7Mt have been deposited in the PG WRSA. Waste rock deposition in the Eagle Pup (EP) WRSA commenced in 2021. Based on current mine planning, it is assumed that from 2023, waste rock will only be trucked to the EP WRSA. The PG WRSA will contain approximately 25 Mt constructed in 45 m lift heights with a reclaimed footprint of 49 ha . The EP WRSA will contain approximately 93 Mt of waste rock over the LOM contained within a reclaimed footprint of approximately 83 ha. The EP WRSA will also be constructed in 45 m lift heights. The EP WRSA storage volume includes approximately 15 Mt of low-grade material that will be kept segregated and accessible for future processing as feasible.

Economic gold-bearing ore is transported from the open pit by haul truck and delivered to the primary crusher at a rate of up to 29,500 tonnes per day (t/d), based on a 12-month average. Ore is crushed to a passing 80 percent (P80) particle size of 6.5 mm in a 3-stage crushing process. All three crushing stages are located north of the open pit. Ore is crushed and then conveyed by covered conveyor to the secondary crusher, secondary screens and tertiary crushers and screens. During an approximate 90-day period during each winter, ore is temporarily stored on a prepared pad following primary crushing. The stored ore is blended back into the crushing circuit over the rest of the year so that the total ore delivery rate to the HLF is approximately 39,200 tpd.

Crushed ore is delivered and stacked on a lined solution collection pad. Process solution containing cyanide is applied to the ore to extract gold and collected by the HLF pad leachate collection and recovery system. The HLF pad consists of a composite liner system in the upper and lower reaches of the facility. The HLF embankment impounds the lower section of the HLF pad, and forms an In-Heap Pond (essentially a saturated zone within the lower extent of the HLF) for primary storage of pregnant solution. Because the In-Heap Pond is saturated ore, there are no open or exposed surface areas of liquid sodium cyanide solution during normal operations. A lined events pond external to the HLF was constructed for the life of the Mine to temporarily store excess process solution during rare upset events, and/or freshet events as needed. It also collects direct precipitation that occurs on the pond and water transferred from other surface water management infrastructure. Any solution contained in the events pond is used in the heap leach circuit as required.

Gold extraction utilizes cyanide heap leaching technology. Similar technology was employed in Yukon at the Brewery Creek mine in the late 1990s, and has been employed successfully in other cold climates such as the United States of America (Alaska), Chile, Argentina, Turkey and Russia. Process solution containing cyanide is applied to the ore to extract gold and then collected by the HLF leachate collection and recovery system.

Gold-bearing “pregnant” solution (pregnant leach solution [PLS]) is pumped from the HLF to the gold recovery plant. Gold is recovered from the PLS by activated carbon adsorption and desorption, followed by electro-winning onto steel cathodes, and on-site smelting to gold doré. This process is referred to as the adsorption, desorption, and recovery (ADR) process. The gold-barren leach solution that remains after passing through the carbon columns is re-circulated back to the HLF.

Other mine infrastructure includes a camp complex with administration and mine offices, a modular assay laboratory, a mine truck shop (completed in 2021) and water treatment plant (to be essentially constructed by November 2022), a substation, and a guardhouse. Support components also include fuel and explosive storage facilities, a transmission line and an access road into the Mine site.

Figure 1-2 provides the general arrangement for the Mine at the end of active mining operations.

5.1 CURRENT ACTIVITIES

The following primary activities are currently ongoing at the Mine:

- Drill, blast, load, and haul from the Eagle open pit;
- Crushing, conveying, and stacking of ore on the HLF:
- Waste rock deposition in the Eagle Pup and Platinum Gulch WRSAs;
- Final construction of the mine water treatment plant; and,
- Operational water management.

5.2 OPEN PIT

Geologically the deposit can be simplified and described as an intrusive suite, predominantly granodiorite in composition, emplaced within a metasediment package, predominantly phyletic in nature. The granodiorite has been subdivided into three units, an oxidized unit, an altered unit and an unaltered unit, though geochemical differences in these three units are minimal. Alteration tends to be dominated by albite, potassium feldspar, sericite, carbonate and chlorite and only occurs very locally around veining. While mineralization is associated with the intrusive stock, it is not spatially limited to the intrusive. Gold-bearing veins are found in all of the main geological units including the metasediments.

Over the life of the Mine, the open pit will be advanced in four major stages with an ultimate pit size of approximately 1,300 m long and 550 m wide. The minimum elevation of the pit is 810 masl and there will be a maximum crest elevation of approximately 1,390 masl, giving the pit a depth of 475 m along the east highwall. Based on the surface topography, the open pit is scalloped-shaped with a lower west highwall. The west highwall crest elevation is approximately 915 masl. To maintain access to the primary crusher, a single ramp will spiral down to the western side of the pit. This haul road will also connect to the external access road that leads to the truck shop. No ramps will be maintained inside the final pit above the crusher elevation to minimize stripping requirements.

5.3 HEAP LEACH FACILITY

The HLF is being progressively developed in three major phases. The HLF, including the embankment, will occupy an area of approximately 106 ha and contain up to 86 Mt at the end of the LOM.

The HLF is a valley fill design which incorporates a rock filled embankment (dam) that will provide stability to the base of the heap and the stacked ore. The dam also creates an In-Heap Pond that provides storage of pregnant solution within the pore spaces of the ore (essentially a saturated zone within the lower extent of the HLF ore pile) which eliminates the need for downstream process solution ponds. The major design components for the HLF includes the following: the earthfill/rockfill confining embankment (dam) and the In-Heap Pond; a composite liner system; solution recovery wells; associated piping network for solution collection and distribution; a leak detection and recovery system (LDRS); and an Events Pond to contain excess solution that results from extreme precipitation or emergency events or temporary storage for make-up water requirements.

The in-heap solution storage area acts as an In-Heap Pond for the primary storage of pregnant leach solution (PLS). Storage of PLS in the In-Heap Pond is a cold-weather mitigation and has the added benefit that PLS will not be exposed during normal operations.

The heap leach pad consists of two liner systems, the up-gradient liner system and the In-heap Pond liner system. The single composite liner system in the upper portion of the pad (above the in-heap solution storage area) is comprised of a double-side textured 60 mil linear low-density, polyethylene (LLDPE) liner over a geosynthetic clay liner (GCL) system. The double composite liner system in the lower portion of the pad (forming the in-heap solution storage area) is comprised of two discrete layers of LLDPE liner, separated by a layer of geonet material to form the LDRS, over a geosynthetic clay liner (GCL) system.

Process (barren) solution containing cyanide is applied to the ore via a drip irrigation system. The resultant PLS is captured in the solution collection system and flows to the In-Heap Pond. The PLS is recovered via a sump and using pumps and standpipes. The PLS is transferred to the ADR plant for gold recovery. Cyanide is handled and controlled within the irrigation, collection and pumping systems according to the Cyanide Management Plan.

The heap leach pad contains a network of pipes distributed throughout the limits of the facility at the base of the ore pile. This pipe network collects and conveys PLS and any infiltrated stormwater to the In-Heap Pond area where it is be pumped to the process plant via the solution collection wells.

All infrastructure associated with stacking of ore within the Phase 1 limits of the HLF has been built and the liner system for a portion of the Phase 2 area has been installed. Ore is currently being stacked only within the Phase 1 boundary of the HLF with stacking into Phase 2 of the HLF expected to commence prior to the end of 2022.

5.4 WASTE ROCK STORAGE AREAS

Waste rock is deposited within one of two areas:

- Platinum Gulch Waste Rock Storage Area (PG WRSA)
- Eagle Pup Waste Rock Storage Area (EP WRSA)

The WRSAs are located within a short haul distance from the open pit. Waste rock is hauled from the pit via strategically positioned egress points. As part of the mine plan, the upper internal pit ramp will ultimately be mined out and external ramps will be constructed to access the upper lifts of the WRSAs.

The Eagle Pup and Platinum Gulch drainages each consist of a single main channel that broadens in the uplands. The potential magnitude of flow in these drainages, as well as the presence of discharging springs, warrant the construction of engineered rock drains to convey expected flows through the WRSAs. The rock drains beneath the WRSAs have been sized based on the estimated runoff from a 200-year return period precipitation event.

To ensure that the rock drains maintain their flow capacity over time, they are being constructed out of non-metal leaching, non-acid generating, clean, durable intrusive rock with a D_{50} of at least 0.1 m and a maximum particle size of 1m.

Surface runoff and seepage are routed by collection ditches that run along the toe of the WRSAs to the primary lined ditches (Ditch A or Ditch B) and then ultimately into the Lower Dublin South Pond (LDSP). Infiltrated rainfall and snowmelt is captured by the rock drains and conveyed the LDSP.

5.4.1 Platinum Gulch Waste Rock Storage Area

Waste rock placement in the PG WRSA is largely complete and contain approximately 24.7 Mt with a potential 300kt capacity remaining. This additional capacity is expected to be depleted in 2023. The PG WRSA is constructed in 45 m lift heights with an ultimate crest elevation of 1,370 masl. At the end of its operational life, the PG WRSA will have an overall slope of approximately 2.5H:1V. The Platinum Gulch drainage is moderately steep with the valley bottom sloping at approximately 21° in the PG WRSA footprint.

5.4.2 Eagle Pup Waste Rock Storage Area

The EP WRSA will be utilized for the remaining waste rock encountered over the LoM contained within a foot print of 83 ha. It will be constructed in 45 m lift heights with an ultimate crest elevation of approximately 1,250 masl and an overall slope angle of approximately 2.5H:1V. Within the footprint of the WRSA the valley bottom of the Eagle Pup drainage ranges in slope from approximately 8° to 25°.

5.5 WATER MANAGEMENT FACILITIES

A number of water management facilities including ponds and sediment basins, diversions and interceptor ditches, as well as pumping and piping systems have been developed to proactively manage sediment-laden, contact and non-contact water. Further, pumping and piping infrastructure has also been developed for the distribution of fresh groundwater and/or surface water runoff to meet various process and potable water requirements. Details regarding the development and operation of the water management facilities are found in the Construction and Operations Water Management Plan.

5.5.1 Lower Dublin South Pond

The Lower Dublin South Pond (LDSP) is managed as a retention pond that collects water from disturbed areas in the southern section of the Project including runoff and mine water routed from the Eagle Pup WRSA, Platinum Gulch WRSA, the crusher areas in Suttles Gulch, and the open pit. Ditch configurations (i.e., Ditch A and Ditch B) route these contact waters to the LDSP.

The LDSP has been designed as per the *Guidelines for Assessing the Design, Size and Operation of Sedimentation Ponds Used in Mining* (BC MOELP 1996). The LDSP is designed to settle out sediment particles sized 0.005 mm (and larger), while providing a detention time of at least 10 hours. The spillway of the pond is designed to pass the 1000-year, 24-hour storm while still maintaining at least 0.5 m of freeboard.

Water contained within the LDSP is intended to be dispatched to the HLF as makeup water, routed to treatment, or discharged provided that the water meets the discharge requirements. Later in mine life and depending on process water demand, excess water from the LDSP above the assumed process make-up requirements, will be sent to Haggart Creek via the mine water treatment system (as necessary).

At closure, the LDSP will be converted to a constructed wetland treatment system (CWTS) as described in Section 8.

5.5.2 Mine Water Treatment Plant

A Mine Water Treatment Plant (MWTP) is in the final stages of construction with a target for commissioning by end of 2022. The MWTP will treat a varying combination of site contact water originating from the open pit and WRSAs, as well serving as a back-up to treat excess water from the HLF primarily during drain-down and early closure.

During the operations phase of the Mine, the MWTP will primarily be necessary for the treatment of As; however, the design and construction is based on ongoing refinement to the site water balance and water quality models and the requirements of QZ14-041-1. The MWTP will have an average daily treatment flow rate capacity of 8,500 m^3/day with the ability to increase treatment rate to 14,000 m^3/day as may be necessary. Issued for Construction designs for the MWTP have been provided as required under QZ14-041-1 and QML-0011. It is currently anticipated that upon completion of construction, a full MWTP OMS Manual will be provided by the design engineers. This MWTP OMS Manual will form a part of the RCP and will be provided in future submissions.

The MWTP for treatment of general site contact water is housed in a dedicated MWTP building located within the Dublin Gulch valley.

The treatment process for cyanide destruction will be undertaken in the ADR building utilizing a Caro’s acid cyanide neutralization approach within a CIC tank. Peroxymonosulphuric acid (H2SO5), also known as Caro’s acid, is produced by reacting concentrated hydrogen peroxide and sulphuric acid in a controlled temperature environment (Norcross, 1996). The Caro’s acid destruct process is graphically depicted below in Figure 5-1. The calculations used to support the destruction circuit for cyanide are provided in Figure 5-2.

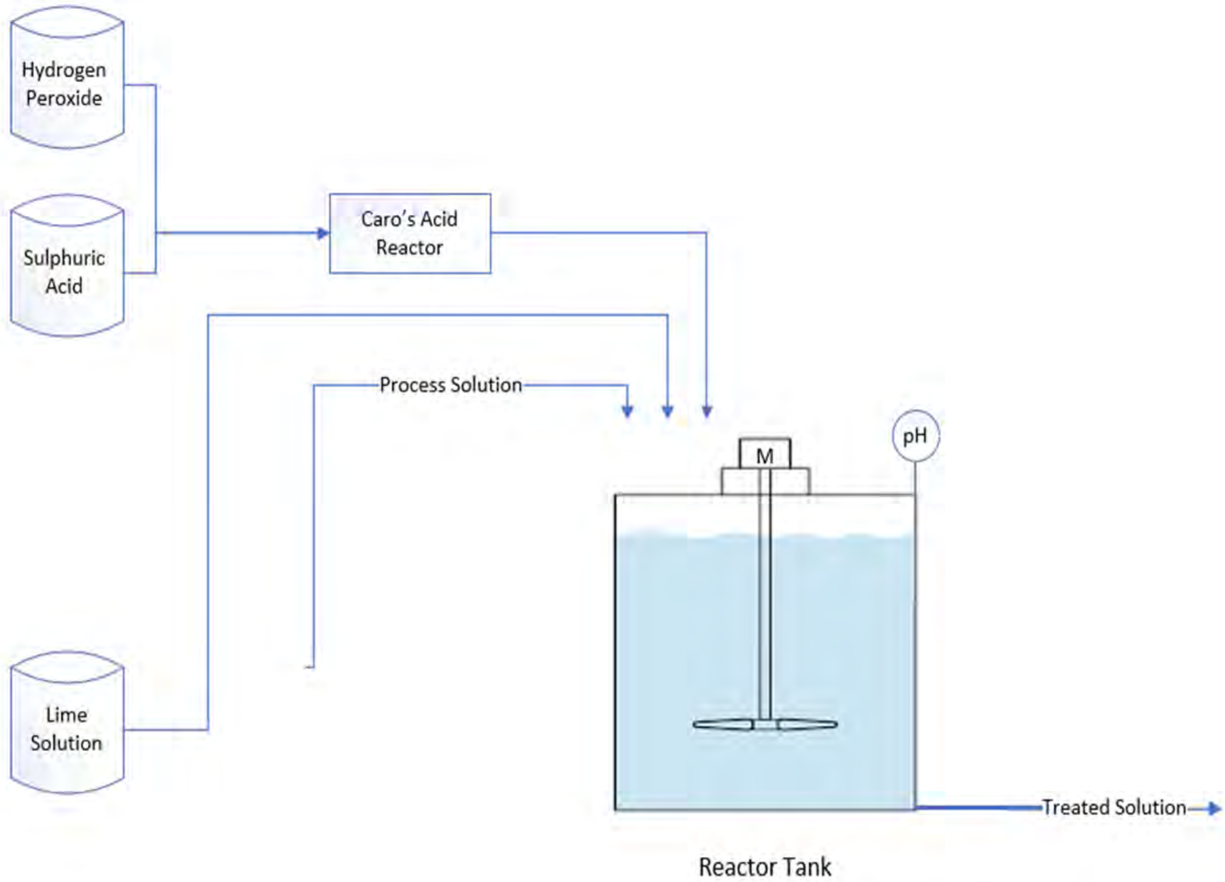


Figure 5-1: Cyanide Destruction Flow Sheet

Formula Weight		
H_2O_2	34.0	g/mol
H_2SO_4	98.1	g/mol
H_2SO_5	114.1	g/mol
CN^-	26.0	g/mol
Reagent Properties		
H_2O_2	70.0%	wt %
	1.29	g/ml
H_2SO_4	94.5%	wt %
	1.84	g/ml
Discharge Water Quality Requirements		
Effluent CN Max	0.03	ppm

CN Destruction Circuit		
MWTP Throughput (assumed normal operational flow rate)	8,500	m^3/day
	354	m^3/hr
CDC Throughput	2,833	m^3/day
	118	m^3/hr
	32.8	L/s
CDC Influent CN Concentration (includes fee and WAD)	50	ppm
CDC Effluent CN^- Concentration Max	0.09	ppm
CDC Effluent CN^- Concentration Removed	49.91	ppm
	99.8%	%
CDC CN^- Removal Rate	5.90	kg/hr

Caro's Acid Circuit Sizing		
H_2SO_5:CN^-	3.00	mol/mol
H_2SO_4:H_2O_2	2.00	mol/mol
Reaction Efficiency	75%	
H_2SO_5 mass flow	17.7	kg/hr
	0.43	tonne/day
	155	tonne/yr
H_2O_2 Solution Requirement	10.1	kg/hr
	0.24	tonne/day
	88	**tonne/yr**
H_2SO_4 Solution Requirement	102	kg/hr
	2.45	tonne/day
	895	**tonne/yr**
H_2O_2 Solution Flow Rate	7.8	L/hr
	0.13	L/min
	0.03	gal/min
	130	mL/min
H_2SO_4 Solution Flow Rate	55.5	L/hr
	0.93	L/min
	0.24	gal/min
	925	mL/min
Reaction Time	5.0	min
Reaction Tank Size	9.8	m^3
CIC Tank Size (Single)	52.2	m^3
Size Factor	5.3	---
Residence Time	**26.5**	**min**

Figure 5-2: Caro's Acid Cyanide Destruct Circuit Sizing Considerations

6 TEMPORARY CLOSURE AND INTERIM CARE AND MAINTENANCE

6.1 DEFINITIONS AND TEMPORARY CLOSURE OBJECTIVES

Mine closure refers to the cessation of mining operations. Temporary closure is defined in the Yukon Mine Site Reclamation and Closure Policy (Financial and Technical Guidelines) as closure that exceeds six months and is not expected to last longer than five years and can include both planned and unplanned closure (Yukon Government 2006). Yukon Government's guidance on the development of Reclamation and Closure Plans (2013) elaborates further:

> *Temporary closure is a closure in which mining related activities cease with the intent of resuming activities in the near future. Temporary closures may be planned or unplanned and could arise from a variety of circumstances including financial challenges, design failures, extreme climatic conditions, etc. Temporary closures may last for weeks, or could extend for years. Maximum durations of temporary closure periods are frequently defined in QMLs and WLs. At the conclusion of a defined temporary closure period, proponents will be required to implement permanent closure measures. In the event of a temporary closure, a full review of the RCP as well as liability estimate and security may be undertaken.*

According to the Type A WUL QZ14-041-1, Temporary Closure is considered to have commenced if notification is provided by the VGC of a planned Temporary Closure or on the first day after no new ore has been placed on the heap for 150 days and no Mining is occurring, and either:

a) once irrigation of the Heap Pad for the production of gold has ceased; or

b) once irrigation of the Heap Pad for the production of gold has occurred for a period of 12 months since the last stacking of ore into the HLF.

This section describes the measures and activities that will be undertaken for the Mine in the event of a temporary closure, and how protecting public health and safety, and the environment will be accomplished. It presents fundamental and site-specific reclamation and closure objectives for temporary closure, and demonstrates how they will be met. The main activities would focus on site stabilization and safety, followed by care and maintenance of all site facilities and routine monitoring until production recommences or full closure is implemented. Depending on the reasons for a temporary cessation of mining operations, the process facilities can be expected to continue to recirculate solutions and recover gold until all economically recoverable gold is processed.

There are certain general objectives that are paramount during temporary closure:

> *In general, temporary closure plans must focus on ensuring public health and safety, protecting the environment and managing risks associated with potential abandonment of a site. (Yukon Government 2013)*

The measures and activities necessary for a temporary closure are similar to those required for an interim care and maintenance (ICM) period. Both scenarios will have the same general objectives and activities to ensure public health and safety, protecting the environment and managing risks.

The following sections identify the fundamental and site-specific closure and reclamation objectives that are relevant to mine components and values during a potential temporary closure of the Mine, with associated temporary closure measures planned to ensure these objectives are met.

6.2 TEMPORARY CLOSURE MEASURES

6.2.1 Physical Stability

Temporary closure objectives are to ensure that all mine-related structures and facilities are physically stable and performing in accordance with designs and that all mine-related structures, facilities and processes can withstand severe climatic and seismic events.

6.2.1.1 Open Pit

A geotechnical engineer will be retained to conduct water management and physical stability monitoring at the Open Pit. The pit will be allowed to fill with water to a pre-determined level during temporary closure if mining operations have advanced to a depth to allow for it. This level will depend on the pit geometry at the time of temporary closure. After the pit has filled to this level, water will be conveyed via ditches/pipes to treatment throughout the temporary closure as necessary.

6.2.1.2 Waste Rock Storage Areas and Temporary Ore Stockpiles

Temporary closure objectives for the WRSAs include:

- Ensure short-term physical stability to minimize erosion, subsidence or slope failure;
- Ensure short-term chemical stability such that runoff and seepage quality meets water quality criteria; and
- Ensure water management remains operational to convey runoff water to water treatment as required.

The following actions will be undertaken during operations to reduce the risk of WRSA physical instability at any point following their construction, including a temporary closure:

- Maintain sloped grading and bench surfaces to minimize surface water infiltration and erosion of downstream slopes;
- Continue with waste rock and heap leach facility management plan to store waste and ore in a chemically stable manner; and
- Maintain surface water collection ditches and the LDSP to control surface drainage.

During a temporary closure, WRSA inspections will be carried out by a geotechnical engineer on the predetermined schedule, as laid out in the Environmental Monitoring, Surveillance and Adaptive Management Plan (EMSAMP). Any repairs or maintenance of the facility, or improvements to runoff, erosion and sediment control will be undertaken on recommendation from the inspections.

6.2.1.3 Mine Infrastructure

The physical stability of the fuel and explosives facility will be maintained by a senior operator throughout the temporary closure. Controlling site access and ensuring the security of the fuel and explosives facilities will be of paramount importance.

6.2.1.4 Heap Leach Facility

The HLF includes primarily the leach pad, embankment and events pond. Temporary Closure Objectives for the HLF will ensure short-term physical stability to minimize erosion, subsidence or slope failure.

There are three factors influencing physical stability of the HLF that will be addressed during temporary closure. These factors are: 1) upslope runoff interception, 2) runoff, erosion and sediment control and 3) dust control. The upslope runoff interception ditches, which route water around the HLF will be maintained by the site caretaker as necessary during temporary closure. This will help to reduce the volume of water introduced into the HLF and limit the volume of water that requires storage and treatment. Precipitation may contribute to runoff, erosion and sediment concerns, which will be monitored and controlled by the site caretaker as required.

6.2.1.5 Water Management Facilities

Temporary closure objectives for water management facilities will ensure short-term physical stability to maintain site-wide water management.

To maintain physical stability throughout temporary closure, sediments will be excavated from ditches, sediment basins and ponds as required. Snow and aufeis will also be removed from the ditches and ponds if accumulation is hindering the performance of the facilities. Ditches will be inspected for physical integrity.

Visual inspections of the water management facilities will be undertaken as required.

6.2.2 Chemical Stability

Temporary closure objectives are to achieve chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge and manage release of constituents at rates that do not cause unacceptable exposure in the receiving environment.

6.2.2.1 Waste Rock Storage Areas and Temporary Ore Stockpiles

Temporary closure measures for the WRSAs will ensure short-term chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge.

Chemical stability of the runoff and seepage from the WRSAs will be maintained through the continued implementation of the water management plan. Periodic visual monitoring of the toes of WRSAs will enable one to search for and identify the emergence of new seeps. Following the identification of a new seep, additional activities (e.g., flow measurements and sample collection), as described in the EMSAMP will also be conducted. Water treatment by the Mine Water Treatment Plant (MWTP) that is deemed necessary, will be implemented as required.

6.2.2.2 Heap Leach Facility

With regard to chemical stability, the HLF includes the leach pad and in-heap pond. Temporary Closure Objectives for the HLF are to achieve chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge.

Chemical stability of the HLF will be maintained and monitored during temporary closure. The site caretaker will be responsible for monitoring and maintenance of the HLF and pond leak detection and recovery systems including emptying the leak collection sumps as required. Drainage from the leak collection sumps will be recycled back into the solution inventory. The groundwater monitoring wells will be maintained throughout temporary closure to enable ongoing monitoring as required by the regulatory approvals.

Water management and leaching from the HLF are concerns during temporary closure. For the period required during any temporary closure, a senior operator will continue to operate HLF pumping, irrigation, solution collection and storage, reagent addition and gold recovery facilities, and maintain the HLF as a zero-discharge facility to the extent possible. Temporary closure of the HLF shall strive to avoid any discharges unless they are necessary to manage excess water volumes within the heap. For the year 2 ICM scenario, and based on Appendix I, recirculation of solution is expected to be sufficient without a need for any treatment and release with the currently installed pumps capable of the solution volumes predicted. Any discharge must meet EQS and may be treated at the MWTP as required (see Section 6.2.2.5). The site caretaker will assist with maintenance of the HLF pumping, irrigation, solution collection and storage facilities as required during temporary closure.

6.2.2.3 Mine Infrastructure

Site infrastructure, including buildings and process machinery, will be emptied/drained of hazardous reagents and process fluids where appropriate and stabilized for temporary closure based on recommendations from mechanical and chemical suppliers, contractors and engineers. This includes the proper storage on site or removal of all hazardous wastes, including waste hydrocarbons, coolants, lubricants, reagents, and process chemicals. A hazardous material inventory and description of hazardous material storage on site will be prepared.

6.2.2.4 Water Management Facilities (Ponds, Pipes and Ditches)

Water management facilities will be inspected and maintained during the period of temporary closure to ensure effective site-wide water management and the ability of the facilities to collect runoff and seepage, provide sufficient water storage, and convey any water requiring treatment to the MWTP.

6.2.2.5 Mine Water Treatment

To ensure the temporary closure objective of chemical stability is met, cyanide detoxification capability and the Mine Water Treatment Plant will be maintained during temporary closure.

Cyanide destruction capability is available on site so that it is readily available to treat excess cyanide contaminated water should the need arise and shall be maintained during temporary closure. A Caro’s acid neutralization process as described in Section 5.5.2 will be utilized for cyanide destruction. The Mine Water Treatment Plant will be commissioned prior to year end 2022 and prior to loading ore on Phase 2 of the HLF and once installed, shall be maintained during temporary closure. Costs associated with the completion and operation of both facilities is considered with the security estimate included within this RCP.

6.2.3 Health and Safety

Temporary closure objectives are to eliminate or minimize existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features or preventing access to areas that are not reclaimed.

6.2.3.1 Open Pit

Pit development will cease in a temporary closure situation. The key temporary closure goal for the Open Pit relates to the protection of human health and safety, and therefore access control is the key temporary closure measure. Areas of particular concern for the public, if any, will be bermed or fenced and posted with warning signs.

6.2.3.2 Heap Leach Facility

If the HLF is not in use for a sufficient amount of time for dust to become a concern, dust control will be carried out by the site caretaker.

6.2.3.3 Mine Infrastructure

Structures and facilities that will require attention and monitoring during a temporary closure at the Mine consist of:

- process offices;
- lab;
- shops and warehouse;
- process plant site;
- primary, secondary and tertiary crusher facilities;
- laydown area;
- gatehouse;
- main sub-station and onsite generators;
- camp/recreation area;
- water treatment plant and water tanks; and
- overland conveyors.

Temporary closure objectives for these facilities will be to remove potential threats to public health and safety and to maintain the physical stability and operational capacity of any remaining structures and assets. The process plant and related facilities will be secured. Gold and non-essential chemicals will be removed from the site. All essential chemicals will remain onsite and will be securely stored within double containment as necessary. The site caretaker will conduct weekly visual inspections of the buildings and solution containment areas. The caretaker will also secure the buildings and maintain the equipment required for solution recirculation and treatment. The solution treatment plant and required chemicals will be maintained.

Infrastructure that is not listed above as mine facilities and ancillary facilities; but exists within the mine footprint, and infrastructure outside the mine footprint (e.g., transmission line and access road upgrades) will also require maintenance throughout a temporary closure.

The bulk explosives inventory will be removed from site and explosives storage containers and facilities will be inspected regularly. Hazardous wastes that will be removed from site include coolants and lubricants. All hazardous fluids will be drained from non-essential machinery and mining equipment based on recommendations from mechanical and chemical suppliers, contractors and engineers.

6.2.3.4 Mine Water Treatment Plant

The appropriate management of site water and solutions is critical to meeting the objective of protecting human health and safety and the environment in the event of a temporary closure. All water management facilities, including the use of the mine water treatment plant, will be managed as if operations were continuing. A detailed description of the management of water during the operational period can be found in the *Water Management Plan* submitted in accordance with Clause 100 of QZ14-041-1 and available on the YWB Waterline website registry for QZ14-041-1. Detailed Issued for Construction designs for the MWTP are available on the YWB Waterline website registry for QZ14-041. A final as built report and a MWTP OMS Manual will be developed by the design engineers and will form part of the RCP once finalized.

The temporary closure objective at the Mine Water Treatment Plant will be to maintain equipment performance throughout the temporary closure period. This will be achieved by securing the buildings and maintaining the equipment required for solution recirculation and treatment. Water quality systems will be monitored as required.

6.2.3.5 Ecological Conditions and Sustainability

Temporary closure objectives are to protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and ensure that the mine area supports a self-sustaining biological community that achieves water quality objectives in the receiving environment and land use objectives outside of the area of disturbance.

During temporary closure, measures to mitigate the risk of wildlife exposure to facilities (i.e., the Events Pond) which may contain dilute sodium cyanide solution, include:

- Fencing and controlling (minimizing) the growth of vegetative cover at any mine site location with compromised water quality (e.g., the Events Pond);
- Not reclaiming the Events Pond shoreline to prevent wildlife use of vegetation; and
- Using Bird Balls™, netting, sound cannons or reasonable alternatives to deter waterfowl or other birds from landing on the pond.

6.2.3.6 Land Use

Temporary closure objectives are to ensure that lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, waste rock storage areas, etc.) do not cause adverse conditions that prevent productive long-term use of land, i.e., conditions which are typical of surrounding areas or provide for other land uses that meet community expectations.

The access road will require periodic visual inspections. Private contractors will be retained to complete maintenance of surface drainage infrastructure, culvert repair or road grading as required. Other miscellaneous infrastructure buildings will be secured and structural inspections and maintenance will be provided by the caretaker as necessary.

6.2.3.7 Aesthetics

Temporary closure objectives are integrated to encourage any restoration activities that are performed are visually acceptable.

However, aesthetics will not be a primary management driver for temporary closure because the mine is primarily being managed so that mining activities can recommence within 5 years or less.

6.2.3.8 Socio-economic Expectations

Temporary closure objectives also include minimizing or preventing adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits.

Temporary closure will be performed by local workers that already were working at the mine, or by local contractors performing the required site management and maintenance work.

6.2.3.9 Site Management

Access control, security and site care and maintenance are key to meeting the critical temporary closure objectives of protecting human health and safety and the environment. The Care and Maintenance Program is the program where a reduced workforce will inspect and maintain property assets, restrict access to mine site locations, manage site chemical and explosive storage, continue to implement the site Water Management Plan, and continue with the operational environmental monitoring for applicable elements. The Care and Maintenance Program will be implemented once the transition from operating mine to suspended activities is achieved. Transition activities before the Care and Maintenance Program is initiated will include:

- Complete all necessary outstanding repairs; and
- Winterize seepage collection systems, mobile equipment, buildings and other site infrastructure.

The temporary decommissioning and closure activities will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to five years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite or readily available through contract services to maintain infrastructure and facilities. All hazardous materials will either be removed from site and/or stored in a safe and secure manner with primary and secondary containments as required to ensure compliance with applicable regulations.

Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.

Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite or readily available through contract services should earthworks be required during the temporary closure phase.

During temporary closure, the security gates on the access road will be locked with warning signs clearly posted at the gates and at key locations around the property indicating risk of entry. All site buildings will be kept locked and secured. The main access road will be maintained for access by the caretakers and operations staff with equipment retained onsite (grader/loader) or readily available through contract services.

The caretakers and operations staff will be responsible for a variety of activities including, but not limited to, the following:

- Supporting site inspections, security controls, first aid, emergency response and communications;
- Supporting water management, MWTP operations, sample collection and site monitoring;
- Supporting site monitoring and sample collection to ensure compliance with regulatory requirements;
- Ensuring critical process equipment such as pumps, generators and some mobile equipment are maintained in operating condition;

- Providing for snow removal and road access;
- In conjunction with VGC's corporate office conducting any relevant administrative responsibilities.

It is currently planned that multiple staff will cover duties on a 24-hour basis as required.

6.2.4 Financial Considerations

Temporary closure objectives are to minimize outstanding liability and risks while the site is in temporary closure.

6.2.4.1 Entire Site

Financial considerations include:

- Transition to the Care and Maintenance Program which includes essential site repairs, if any, and winterization of seepage collection systems, mobile equipment, buildings and other site infrastructure. This will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to five years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite or readily available through contract services to maintain infrastructure and facilities.
- All hazardous materials will be secured at site including with primary and secondary containments as required to ensure compliance with applicable regulations.
- Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.
- Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite or readily available through contract services should earthworks be required during the temporary closure phase.
- Two senior operators will work different rotations to complete water treatment operations and to support HLF pumping activities.
- The main access road will be maintained for access by the caretakers and operations staff with equipment retained onsite (grader/loader) or readily available through contract services.
- The senior operators, caretakers and operations staff will be responsible for a variety of activities including, but not limited to, the following:
  - Supporting site inspections, security controls, first aid, emergency response and communications;
  - Supporting water management and gold recovery, MWTP operations, sample collection and site monitoring;
  - Supporting site monitoring and sample collection to ensure compliance with regulatory requirements;

    - o Ensuring critical process equipment such as pumps, generators and some mobile equipment are maintained in operating condition;
    - o Providing for snow removal and road access; and
    - o In conjunction with VGC's corporate office conducting any relevant administrative responsibilities.
- It is currently anticipated that multiple staff will cover duties on a 24-hour basis as required.

Table 6-1 presents a summary of the care, maintenance and monitoring activities of the various Mine components which would occur in the case of a temporary closure.

Table 6-1: Summary of Care and Maintenance Activities and Monitoring During Temporary Closure

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
Open Pit	Physical Stability	Site inspection for stability	Visual inspections	Weekly
	Water Management	Allow the pit to fill to pre-determined level depending on pit geometry at the time of closure, then continue to convey water to treatment, as necessary		
Waste Rock Storage Areas and Temporary Ore Storage Area	Physical Stability	Site inspection for stability	Visual inspections and water quality and systems monitoring	Weekly
	Chemical Stability	Continue to convey water to treatment Maintain groundwater and surface water quality monitoring stations		
	Water Management	Erosion and sediment control of WRSA surface; rock drain outlet maintenance	Visual inspections as outlined in operating licenses	Weekly – more frequent during freshet as needed
Heap Leach Facility	Physical Stability	Events Pond maintenance; Interceptor ditches maintenance; Runoff, erosion and sediment control Dust control	Visual inspections	Following major rain events and freshet
	Chemical Stability	Maintain groundwater monitoring wells and LDRS sump integrity	Water quality and systems monitoring	Weekly to monthly
	Leaching and Process Recovery System	Maintain process water management including HLF pumping, HLF irrigation, solution collection and storage, reagent addition and gold recovery facilities	Water quality and systems monitoring	Monthly for the term of temporary closure
Water Management Facilities (Ponds, Pipes and Ditches)	Physical Stability	Excavating sedimentation in ditches and ponds; Snow and aufeis removal as necessary	Visual inspections	Following major rain events and freshet
	Chemical Stability	Maintain groundwater and surface water quality monitoring stations	Water quality and systems monitoring	Weekly to monthly
Mine Water Treatment Plant	Equipment Performance	Secure buildings and maintain equipment for solution recirculation and treatment	Water quality and systems monitoring	Daily
Infrastructure Buildings,	Physical Stability	Secure buildings and provide maintenance;	Visual inspections	Quarterly and following freshet

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
Equipment and Pads		Conduct any sediment and erosion control measures as needed		and major rain events
Main Access Road, haul roads secondary roads	Physical Stability	Maintain surface drainage, culvert repair, bridge maintenance, road grading and snow removal	Visual inspections	Quarterly and following freshet and major rain events
Entire Site	Security	Secure buildings and provide maintenance; Continue to restrict access to site; Remove non-essential chemicals and explosives from site. Remove all gold from site. Safely store in secure double containment area all essential chemicals	Visual inspection	Ongoing
	Reporting	Documentation of care and maintenance activities	Not applicable	As required by licenses

6.3 TEMPORARY CLOSURE CRITERIA

The site temporary closure criteria are to maintain water management, and as required, discharge water to meet the effluent quality standards of the Mine. The water quality treatment and discharge criteria during temporary closure are presented in Table 6-2.

Table 6-2: Effluent Water Quality Standards

Parameter[1]	*Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)*
pH	6.5 to 8
TSS	15.00
Cl-	250
SO_4	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH_3-N	7.5
Total Cyanide	1.0
CN_{WAD}	0.03
Al (diss)	0.4
Sb	0.13
As	0.053
Cd	0.00125
Cu	0.026
Co	0.026

Parameter[1]	***Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)***
Fe	6.4
Pb	0.05
Hg	0.00008
Mn	7.7
Mo	0.45
Ni	0.50
Se	0.025
Ag	0.01
U	0.09
Zn	0.23
Acute Lethality 96-h LT50 using rainbow trout[2]	Non-toxic at 100% concentration
Acute Lethality 48-h LT50 using *Daphnia magna*[3]	Non-toxic at 100% concentration

NOTE:
1 All Concentrations are total values, unless otherwise noted
2. pH non-adjusted, Reference Method EPS 1/RM/13
3. pH non-adjusted, Reference Method EPS 1/RM/14

6.4 MONITORING

Monitoring activities for the site will follow the surveillance programs as described in the *Environmental Monitoring, Surveillance and Adaptive Management Plan* and will ensure that information gathered will enable reporting in accordance with clause 145 of QZ41-014-1. These may include, but are not limited to the following:

- Regular inspections of the site to observe and document the condition of any changes to site security, public safety measures, mine infrastructure (e.g., the MWTP), equipment (including equipment and back-up equipment to manage heap fluid), supplies, and staffing;
- Documentation of potential environmental or public health and safety issues;
- Routine physical stability monitoring;
- Routine chemical stability monitoring;
- Regular water quality and flow monitoring;
- Monitoring of existing climatic conditions will continue with operation of the onsite weather station(s);
- No regular air monitoring beyond PM_{10}, $PM_{2.5}$ and TSP is planned; however, visual monitoring of the crushing facility, waste rock storage areas, open pit and HLF conducted daily and weekly;
- Regular inspections of the HLF/ponds and the LDRS including emptying of leak collection sumps, as applicable and to enable VGC to report on the volume of water within the HLF monthly;
- Submittals of inspection and monitoring reports on a regular basis as required;

- Response to any security/safety breaches as required.

Site inspections and monitoring will likely be conducted by vehicle when seasonally possible. Some areas of the site may be inaccessible in winter as snow removal will not be reasonable in some locations. Inspection results will be documented and submitted on a monthly basis as required by QZ14-041-1. The inspection documentation will include details of the financial capacity for VGC to continue the appropriate management of the temporary closure. Reports of changes to the physical status of any part of the site may warrant a follow-up investigation by the appropriate personnel. Some elements of the monitoring program such as geotechnical and structure inspections and non-routine water quality and biological monitoring, will be conducted by appropriate professionals. The results of these inspections will be included in annual reports and other required submittals.

6.5 NOTIFICATION AND REPORTING

If a temporary closure is planned by VGC, a notice will be provided to the YWB and EMR at least 60 days in advance of the temporary closure. The notice provided will include the reasons for entering a temporary closure and the anticipated duration. In accordance with QZ14-041-1, if Temporary Closure lasts longer than 12 consecutive months, an annual notice will be provided in writing to the YWB and the Inspector on or before the anniversary of the date of Temporary Closure and include the reason(s) for and the expected duration of the continuation of Temporary Closure.

If a temporary closure period is determined to have commenced based on the conditions provided in clause 138 of QZ14-041-1 (as shown in Section 6.1), VGC will provide notice to the YWB and EMR within 7 days of the trigger events. VGC will provide notice to the YWB and EMR immediately following any unplanned Temporary Closure.

In addition to the monthly reports specified in Section 6.4, the monthly status report submitted in March, if applicable, will include details with respect to the status of equipment and personnel required for the removal or management of ice and snow from diversions and collections channels and for the undertaking of HLF water management during freshet.

7 PROGRESSIVE RECLAMATION

Reclamation, closure planning, and implementation will provide for progressive reclamation to the greatest extent practical during mining operations. Progressive reclamation is often implemented during operations (or after construction) to reduce environmental effects, support ongoing reclamation research for final closure of the Mine, as well as to reduce the amount of financial security required to be provided and maintained by VGC.

7.1 PLATINUM GULCH WASTE ROCK STORAGE AREA

The completion of waste rock deposition in the Platinum Gulch (PG) WRSA early in the mine life will enable progressive reclamation during the operational life of the Mine. Reclamation will help to reduce dust and infiltration of precipitation and runoff through the cover as well as minimize the visual footprint of the WRSA sooner. For safety reasons, such as falling rock onto worksites below, regrading of the WRSA such that bench faces are 2.5:1 or shallower and major cover placement will start at the end of the Platinum Gulch WRSA lifespan and currently expected to commence in 2023. A cover trial on the 1370 bench of the PG WRSA was established in 2020 that, if stable and meeting closure objectives, will remain in place. Further details on the cover trials on the PG WRSA initiated in 2020 are provided in Section 10.2.

After the PG WRSA cover is completed, a field scale proto passive treatment system (PTS) will be constructed downstream from the WRSA based on on-going research results during the previous years. This PTS will inform part of the reclamation research plan to test treatment methods through seasonal changes, while serving as an on-site demonstration of the potential effectiveness of the design. Over the next few years, and depending on results, design enhancements can be implemented as necessary. See Section 8.10 for further discussion on the PG PTS design and Section 10.4 for further discussion on the PTS research program.

7.2 EAGLE PUP WASTE ROCK STORAGE AREA

The majority of the Eagle Pup WRSA will be closed during the first year of closure; however, progressive reclamation may be performed prior to closure on areas where WRSA limits are reached and resloped to final contour to help reduce dust, minimize infiltration of precipitation and enhance runoff from the covered areas as well as minimize the visual footprint of the WRSA sooner.

7.3 ICE-RICH OVERBURDEN STORAGE AREA

To date, significant quantities of ice-rich overburden have not been encountered and as such local storage of small volumes has been utilized. If any stage of the IROSA is developed, it will be essentially non-active after dumping has ceased, the surface area will be re-vegetated early on during operations to minimize the potential effects of sediment movement during rainfall-runoff and/or freshet and maximize the effect of infiltration. Depending on soil volume requirements for reclamation, some of the IROSA soils may be utilized, and so these areas will need to be reclaimed again.

7.4 REVEGETATION PROGRAM

The objective of the initial revegetation program is to design and implement erosion control measures using revegetation and bioengineering techniques that would act as interim methods to control potential erosion and to also inform final reclamation decisions with respect to appropriate seed mixes and revegetation methods. The revegetation program is targeted for the areas that had been identified as having the potential for erosion and sediment release.

In September and October 2019, the revegetation program was initiated by VGC with expertise provided by Laberge Environmental Services and support from Yukon College students enrolled in the Environmental Certification Program. The revegetation program has continued in subsequent years as summarized in Table 7-1.

Table 7-1: Revegetation and Bioengineering Treated Areas

Year	Location	Method / Installation	Notes
2019	LDSP slopes	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass Test plots with wheatgrass, fescue and bluejoint seeds harvested from Keno area and bluejoint and yarrow seeds harvested from the Mine site
		Willow staking	Eastern shore of the LDSP
		Pole drains	Two pole drains installed in erosion channels
		Wattle fence	Installed upslope of other bioengineering works to support erosion control
		Coco-matting	Geotextile installed upslope of wattle fence to help control any undercutting
		Jute mats	Test location to determine effectiveness of product for slope stabilization and vegetation growth
	Ditch C	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
	HLF Embankment	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
	Events Pond western fill slope	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
	Overland Conveyor drainage ditch	Willow staking	Willows were harvested from donor site but field conditions did not allow installation in 2019
2020	LDSP slopes	Hand seeding	Application of commercially available fowl bluegrass, Rocky Mountain fescue, tufted hairgrass and wheatgrass
		Willow staking	South eastern shore of the LDSP
		Pole drains	Four pole drains installed in erosion channels
		Live Silt Fences	Installed upslope of other bioengineering works within erosion channel
	Slope north of Event Pond spillway	Hand seeding	Application of commercially available fowl bluegrass, Rocky Mountain fescue, tufted hairgrass and wheatgrass
	Exposed laydown area east of warehouses	Hand seeding	Application of commercially available fowl bluegrass, Rocky Mountain fescue, tufted hairgrass and wheatgrass
	Overland conveyor adjacent to Dublin Gulch	Hand seeding	Application of commercially available fowl bluegrass, Rocky Mountain fescue, tufted hairgrass and wheatgrass

Year	Location	Method / Installation	Notes
	Overland conveyor west slope near Eagle Pup	Hand seeding	Application of commercially available fowl bluegrass, Rocky Mountain fescue, tufted hairgrass and wheatgrass
	Overland conveyor east drainage ditch between Dublin Gulch and Eagle Creek	Willow staking	Planted willows stakes harvested from donor site.
2021	LDSP	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 1.0 ha at a rate of 20.1 kg/ha
	90 Day Stockpile	Tree Planting	729 Alder seedlings planted.
	Stewart Gulch	Tree Planting	90 Alder seedlings planted.
	Overburden Stockpile south of LDSP	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 1.2 ha at a rate of 20.1 kg/ha.
	Overburden Stockpile across from Quonsets	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 1.0 ha at a rate of 12.1 kg/ha
	Dublin culvert	Broadcast Seeding Tree Planting	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 0.2 ha at a rate of 20.1 kg/ha.
	Overburden stockpile by Dublin Gulch	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 0.5 ha at a rate of 20.1 kg/ha.
	Ditch A	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 0.5 ha at a rate of 20.1 kg/ha. 151 Alder seedlings planted.
	Ditch B	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 0.6 ha at a rate of 20.1 kg/ha.
	Road along Dublin Creek	Broadcast Seeding	A custom reclamation seed mix comprised of *Poa alpinus, Festuca saximontana, Deschampsia caespitosa & Elymus trachycaulus* was applied over 1.2 ha at a rate of 20.1 kg/ha.

Year	Location	Method / Installation	Notes
	Haggart Creek	Fascine Installation & broadcast seeding	A fascine was installed along Haggart Creek (64°02’37.2” N, 135°51’05.8” W). A 30 m trench was hand dug in the partially frozen ground approximately one meter back from the creek bank. Bundlesof 2.5 cm diameter willow stakes, with branches attached to assist in trapping sediment, were placed into the trench. Five-centimeter diameter anchor posts were pounded into the trench beside the fascine every two meters and one inch diameter posts were installed every 0.5 m. In addition, miscellaneous smaller diameter stakes were added randomly to increase stability. The majority of the willow stakes were little tree willow (*Salix arbusculoides*) with some Alaska willow (*S. alaxensis*) and balsam poplar (*Populus balsamifera*). To increase stability over time, the area was also seeded at a rate of 20 kg/ha with the small seed mix using the following composition: • Alpine bluegrass, 9% PLS • Tufted hairgrass, 87% PLS • Rocky Mountain fescue, 4% PLS

The 2020 program included evaluation of the success of the 2019 program, and the completion of seeding and willow staking in additional areas at the Mine site. Inspection of the areas that were part of the 2019 program showed that there was an outstanding success rate of close to 100% survival of willow staking, while seeded areas all had good growth and coverage of grass. Examples of areas revegetated during 2019 program during an August 2020 inspection are shown in Photo 7-1 and Photo 7-2.

Seeding a steep slope near the LDSP, Sept 2019

Good grass growth on same slope, August 2020

Photo 7-1: Slope Near the Weir Pond in 2019 and 2020

Installed willow staking, Sept 2019

Willows sprouting, August 2020

Photo 7-2: Willow Staking in 2019 and 2020

8 FINAL RECLAMATION AND CLOSURE MEASURES

8.1 CLOSURE SCHEDULE

Due to the extended process to draindown the HLF, the decommissioning and closure process of the Eagle Gold Mine will take several phases over a number of years to complete. The following outlines the activities that are planned to occur for each phase.

Phase 1 – 3 (2019 to 2027): Active mining, and mine closure research as described in Section 10. Complete regrading, as necessary, construct cover on the PG WRSA and develop the passive treatment system (PG PTS) at PG WRSA.

Phase 4 (~2028-2029): Terminate mining and ore production, but continue irrigation of the ore stack for gold production; manage recirculation of the heap solution inventory; open pit begins to fill; complete regrading, as necessary, and build cover on EP WRSA; decommission crushers, some mine roads, temporary ore stockpile, explosives and magazine storage facilities; begin construction of EP-PTS for EP WRSA seepage at the LDSP.

Phase 5 (~2030 to 2031): Terminate gold production and begin rinsing (with in-heap biological cyanide destruction, as needed, and/or with active CN destruction in the MWTP; manage pump-back of heap drain-down solution inventory; LDSP-PTS is in place and being tested; LDSP PTS discharge to Haggart Creek when discharge criteria are met; PG PTS discharge to Haggart Creek when discharge criteria are met;; decommission ADR; begin regrading, as necessary, and building cover on specific sections of the HLF, if feasible.

Phase 6 (~2032 to 2035): Controlled drain-down of heap through an in-heap bioreactor while the drain-down solution is split into two flows: managed pump-back of heap drain-down solution inventory with proportion sent to MWTP). Enhanced evaporation and snowmaking in winter may be incorporated as part of solution management during this phase; begin conversion of Events Pond into PTS - when HLF seepage rate and concentration criteria are met - change from active treatment to passive treatment; open pit finished filling – afterwards flow allowed to drain to Haggart Creek (via PG PTS if necessary); complete regrading, as necessary and building cover on HLF; decommission truck shop and reduce camp size, and decommission remaining site roads.

Phase 7 (~Years 2036 to TBD): All passive treatment systems in place; decommission MWTP once PTSs have been the only required treatment to reach discharge criteria for a period of five years; uncontrolled drain-down of heap – when seepage rate meets meteoric input; close substation and most of the camp infrastructure. Begin post closure monitoring and maintenance.

Phase 8 (~Years TBD): Post-closure monitoring and maintenance – all Mine facilities closed except that which is needed to support monitoring programs and PTS maintenance, as needed.

8.2 ORGANIZATION, SITE ACCESS & SECURITY

A number of personnel will be required on site to implement the various decommissioning and closure tasks. Generally, these tasks entail closure of mine workings, regrading of waste rock and overburden piles, decommissioning of the HLF and MWTP, salvage and removal of infrastructure, equipment and reagents, decommissioning of access roads and reclamation and revegetation of disturbed lands. These activities would be undertaken on a seasonal basis and directed by the onsite manager responsible for decommission and reclamation of the Mine. During site decommissioning, it is anticipated that at least a portion of the existing camp accommodations would remain on site to support site personnel. It is anticipated that during the initial post-closure phase, site security requirements will continue with a caretaker remaining on site following seasonal closure of the site. A site inspection schedule will continue for the period of closure implementation (Phases 4 to 7) and then move into a post-closure monitoring period (Phase 8). Security personnel will no longer be required once decommissioning and reclamation activities are completed on the property. Once the majority of physical reclamation works are performed on the site, the number of employees or contractors required will be reduced. VGC is committed to having FNNND members employed during implementation of the RCP.

Controlled access will be maintained during implementation of the post-closure monitoring phase. Decommissioning and reclamation of haul and site roads will occur once closure measures have been completed at each facility and site access is no longer required.

Prior to decommissioning activities are completed onsite, and following a period of post-closure monitoring, VGC and FNNND will confirm which access roads are to remain open as determined by previous consultation processes.

8.3 SUPERVISION AND DOCUMENTATION OF WORK

All decommissioning and reclamation works will be supervised to ensure that works are constructed according to their design and that the work is properly carried out and documented. The mine manager or the construction supervisor will be responsible for supervising all closure works. Daily inspection procedures would be completed to document work progress, deficiencies and completion. Existing plans for spill response or other site internal procedures for fuel handling, waste disposal, fire control and suppression, health and safety and environmental management systems would be used, refined and followed as necessary.

Environmental inspections and tests conducted prior to the implementation of closure measures will be used to confirm areas requiring clean up.

Plans for all earth works and inspections will be prepared and submitted to the YWB and EMR for review prior to initiation as part of the final detailed RCP required by Clause 153 and 154 of QZ14-041-1. A competent engineer following standard quality control and assurance procedures will inspect and document this construction work. As-built plans and drawings will be completed and the results of the closure work that has been performed on the facilities documented in a final RCP report. This report would then be submitted to the YWB, EMR and appropriate regulatory agencies upon completion of closure activities.

A competent environmental practitioner following standard quality control and assurance procedures will design, direct and document all restoration work. A summary report of the works will then be prepared and submitted to the YWB, EMR, the FNNND and other appropriate regulatory agencies upon completion of closure activities.

Upon completion of the decommissioning and reclamation works, a final site plan report (summary text and drawings) will be prepared to outline the facilities or works remaining on the site following closure. This plan will identify the location of buried concrete structures or scrap and landfill disposal areas. It is expected that this plan would accompany an Application for a Certificate of Closure under the Yukon Quartz Mining Act.

Supervision and documentation of work will be consistent with VGC's commitment to proving the success of reclamation measures and with the overall objectives of the RCP including returning the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

8.4 MINE RECORDS

As noted in the previous section, all relevant decommissioning and reclamation works will be documented. Active Mining period records showing the extent of mine workings would be retained by VGC. Other site records, files and plans will also be archived at the site. Where plans or drawings are required for mine safety reasons, these plans would also be submitted to government mine safety offices. As-built reports for structures completed for closure and the final site closure report will be retained for record by VGC and submitted to government agencies and boards as required.

8.5 ESTIMATED AREAS OF DISTURBANCE AT END OF MINE LIFE

The maximum estimated areas of disturbance and approximate dimensions (Table 8-1) include:

- Open Pit: 77 ha.
- Heap Leach Facility: 102 ha (including the heap embankment).
- Events Pond with approximately 300,000 m^3 of storage capacity.
- Waste Rock Storage Areas
  - Platinum Gulch WRSA:41 ha (prior to final regrading all slopes to 2.5:1).
  - Eagle Pup WRSA:77 ha (prior to final regrading all slopes to 2.5:1).
- For both WRSAs, overall slope angle of 2.5H:1V with construction in 45 m lifts

Table 8-1: Estimate Area of Disturbance at End of Mine Life

Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of 2-Year Peak Liability
Open Pit	77	64
Heap Leach Facility		
Embankment	3.8	3.8
Phase 1	48.9	48.9
Phase 2	20.1	20.1
Phase 3	32.8	0
Events Pond	4.2	4.2
Industrial Infrastructure		
Crushing and Conveying Facilities	13.3	13.3
Truck Shop and Fuel Storage	6.4	6.4
Laydown and Camp Area	4.0	4.0
Process Facility and Water Treatment Plant	3.9	3.9
Explosives Facilities	3.9	3.9
Landfill and Land Treatment Facility, and Substation	3.2	3.2
Waste Rock and Overburden Storage Areas		
Eagle Pup Waste Rock Storage Area	77	61
Platinum Gulch Waste Rock Storage Area	41	41

Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of 2-Year Peak Liability
Reclamation Stockpiles	22.4	22.4
Ice Rich Overburden Storage Area	5.6	5.6
Water Management Structures		
Lower Dublin South Pond	3.9	3.9
Off-Site Infrastructure		
Transmission Line Corridor	16.8	16.8
Miscellaneous Sites and Facilities		
On-Site Access and Haul Roads	63	67
Borrow Pits	17.2	17.2
Gate House	0.8	0.8
Temporary Ore Stockpile	13.2	13.2
Total Estimated Area of Disturbance	**482**	**425**

Based on the requirements for closure covers on the WRSAs and the HLF and topsoil replacement on other disturbed areas, approximately 1.3 Mm^3 of cover material will be required for the closure phase of the Mine. There is currently approximately 1.0 Mm3 of material available for cover development. It is anticipated that the deficit in cover material required for closure (~300,000 m3) will be sourced from topsoil stripped during the ongoing development of the WRSAs and HLF. Any remaining material required for the closure covers on the HLF and WRSA may be sourced from the approximately 2 Mm3 of exploitable placer tailings located in the Dublin Gulch and Haggart Creek valleys (BGC 2012b).

8.6 CLOSURE WATER MANAGEMENT PLAN

8.6.1 Closure Objectives

8.6.1.1 Water Quality Objectives

As with the operational strategy for managing water, mine site water quality will be managed to keep, where possible, unaffected water from contacting mine waste, by the use of covers and diversion ditches, and to satisfy the closure objectives described in Section 3.2.4 The effluent quality objectives were developed assuming seepage from the HLF and WRSAs, and overflow from the Pit Lake will be the primary sources of mine affected water at closure (Lorax 2014b, 2018). Other contact water will be conveyed off the mine site into the Lower Dublin South Pond, which will be in place until reclamation objectives (e.g., during construction of covers) are achieved, runoff can be discharged directly to receiving waters and the LDSP is converted into a PTS. Thus, the performance of the covers, sediment control structures, the PTSs, and the water conveyance features all work together to achieve the water quality objectives.

Site specific water quality objectives (WQO) for receiving environment water quality in Haggart Creek (at stations W4, W29, W99 and W23) were developed for the operations phase to inform adaptive management and are presented in Table 8-2. These WQOs are being further examined as part of closure research and planning process. Water quality objectives and adaptive management thresholds can be found in the Environmental Monitoring, Surveillance and Adaptive Management Plan.

Table 8-2: Water Quality Objectives for the Protection of the Receiving Environment in Haggart Creek (including W4, W29, W99 and W23)

Parameter		Site Specific Water Quality Objective
Dissolved Parameters	Sulphate	309
	Chloride	150
	Nitrate-N	3
	Nitrite-N	0.02
	Ammonia	1.13
	WAD Cyanide	0.005
	Aluminum	0.1
Total Metals	Antimony	0.02
	Arsenic	0.0085
	Cadmium	0.000197
	Copper	0.005
	Cobalt	0.004
	Iron	1.0
	Lead	0.0077
	Mercury	0.00002
	Manganese	1.17
	Molybdenum	0.073
	Nickel	0.116
	Selenium	0.002
	Silver	0.0015
	Uranium	0.015
	Zinc	0.038

8.6.1.2 Water Conveyance Objectives

The objectives for the design of the water conveyance features are to convey affected seepage to the PTS sites without contacting or commingling with other unaffected surface runoff, and to convey otherwise unaffected water away from mine contact areas. The primary affected water conveyance features are:

- From the In-Heap Pond to the HLF-PTS, which will be converted from the Events Pond; a HDPE buried pipe will convey water from the Closure Sump into the Heap PTS.
- From the Eagle Pup seepage emergence point, water will be conveyed via the open channel Ditch B to the LDSP-PTS.
- Continue to convey Platinum Gulch seepage via Ditch B to the PG PTS; pit overflow water (when the pit is filled) will be conveyed to the PG PTS (unless monitoring data indicate it can be discharged directly to Haggart Creek); once it is demonstrated that PG-PTS discharge meets effluent quality criteria, the PG PTS will then discharge to Haggart Creek.

There will be some conveyance features that route water from disturbed areas but are not expected to require treatment in closure as the reclaimed areas become vegetated and sediment load is decreased by the formation of the reclamation cover. These areas include:

- Water shedding off covers
    - On both sides of the heap, runoff from the cover will be conveyed into sediment basins, as needed until the cover is stable and then into Dublin Gulch and Haggart Creek.
    - On both sides of the Eagle Pup WRSA, runoff from the cover will be conveyed into a sediment basin until the cover is stable and then into Dublin Gulch and Eagle Creek/Ditch B.
    - On both sides of the Platinum Gulch WRSA, runoff from the cover will be conveyed into a sediment basin until the cover is stable and then into the Haggart Creek, joining with the treated water from the Platinum Gulch PTS.
- Water collected from disturbed areas including the reclamation and temporary ore stockpile areas.

Discharge from the PTS systems will be conveyed into natural open channels or open channels constructed as per the design criteria in Table 3-6 to discharge locations in Haggart Creek.

8.6.1.3 Transition Strategy

During operations, reclamation research (as described in Section 10) will be performed at the full/demonstration scale at the PG WRSA to evaluate and determine operating performance of covers and PTS. Discharge from the PG PTS will be initially sent via Ditch B to the LDSP until meeting discharge criteria. At closure, when the PTS meets discharge water quality criteria, it will be routed back into the former Platinum Gulch channel.

When the in-heap cyanide concentrations are approaching acceptable concentrations that can be treated in a PTS, the Events Pond (EP) will begin to be converted into a PTS, specifically a two-stage anerobic/aerobic CWTS as described in Section 8.8.2.5. At the same time the heap will begin draindown, the rate controlled by pumping a certain amount to the MWTP, while at the same time recycling the residual fluids back to the heap. As draindown proceeds, a cover will be constructed on the heap. When cover construction is complete and the draindown rate meets the criteria for the HLF-PTS, the closure sump will be activated which will allow water to drain directly to the HLF-PTS. During the time that the HLF-PTS is coming up to full performance (and prior to meeting water quality discharge criteria), the PTS flow will be conveyed to the MWTP. When the HLF-PTS meets discharge criteria, it will be directed into a newly constructed open channel that joins with some of the runoff from the heap cover and undisturbed areas, and then into Haggart Creek.

During operations, dump seepage and pit flows will be conveyed to the LDSP via Ditches A and B and then the MWTP or directly to the MWTP. During early closure Eagle Pup WRSA seepage will be conveyed as described above and flow via gravity to the LDSP-PTS. Discharge will continue to be sent to the MWTP until the LDSP-PTS outflow meets discharge criteria, after which it will discharge into Haggart Creek.

The MWTP will be operational as long as the heap drain-down and the Open Pit and WRSA seepages require treatment, and while the PTSs are becoming active. Following at least five consecutive years in permanent closure where the MWTP was not required to treat effluent discharged from the site, VGC will submit to the Board for Review and Approval a plan for the decommissioning of the MWTP, and implement the plan upon approval.

8.6.1.4 Water Conveyance Network

A water conveyance network has been constructed during operations to safely route water around the main mining components. Details for the water management infrastructure for operations is presented in the *Water Management Plan Version 2020-01* (WMP). The proposed network at closure will incorporate the existing conveyance channels as described in the WMP (with upgrades required in certain locations) complemented with new channels to accommodate the closure objectives.

Different types of cross-sections have been designed for operations and are presented in the WMP to accommodate various gradients and volumes of flow, depending on which ditch or channel is considered. These considerations will also be taken into account, in addition to field observations and input from regulatory agencies and other stakeholders, when developing the water conveyance network at closure. Typical ditch configurations based on the design criteria in Table 3-6 include:

- Unlined ditch with triangular or trapezoidal cross-section for small watersheds;
- Riprap ditch with riprap with a D_{50} of 150 mm for larger watersheds;
- Lined ditch with riprap; alternatively, larger riprap with a D_{50} between 300 and 500 mm could also be used and allow for energy dissipation with flow through the riprap.
- Corrugated half pipe – CHP (or Culvert Lined Ditch): Lined ditch with a steel half pipe to protect against high velocities, in terrain that is steeper than 15%. This cross-section can be used in steep reaches or for spillways.

Typical cross-sections are shown in Figure 8-1 and Figure 8-2.

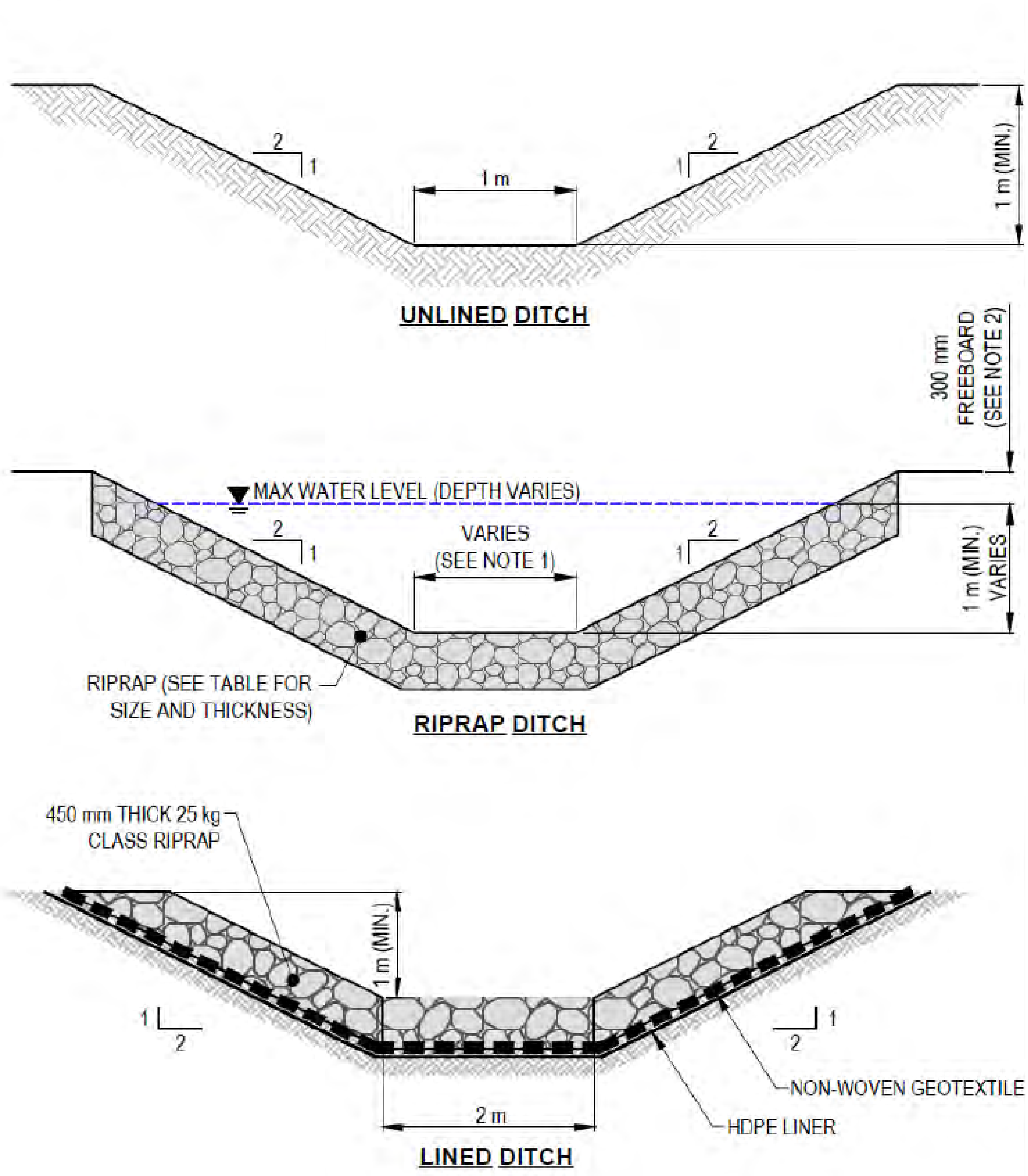


Figure 8-1: Typical Diversion and Collection Ditch Types

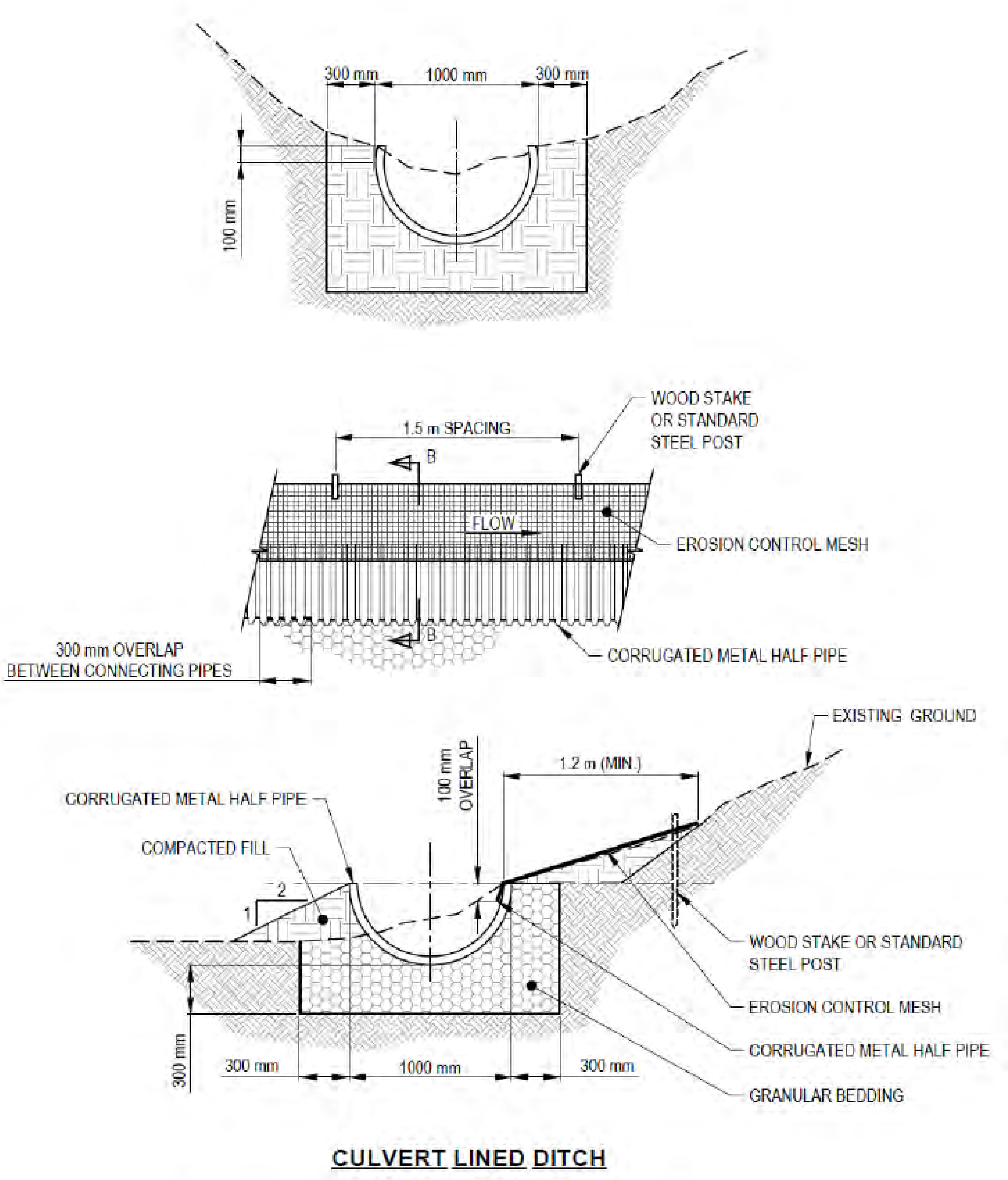


Figure 8-2: Typical Culvert Lined Ditch

The various ditches and channels that compose the water conveyance network are described below.

1) Conveyance channels

A series of diversion ditches, collection channels, and culverts have been designed to intercept non-contact and sediment-laden water.

a. Diversion ditches

Diversion ditches have been and will continue to be constructed up-gradient of disturbed areas to intercept clean surface water runoff. A diversion ditch is a channel lined with vegetation, riprap, or other flexible, erosion resistant material. The main design considerations for closure are the design flow and velocity of the water expected in the channel. During construction and operations, and while considering the findings in Lorax (2022) as summarized in Section 3.2.4, the ditches are sized based on the closure design criteria in Table 8-3 to convey the 10-year 24-hour peak storm for the estimated watershed size, with diversion ditches located upslope of key mine infrastructure sized to convey the runoff from a 100-year 24-hour storm event. Diversion ditch design for operations is shown in Figure 8-1. The majority of diversion ditches that will be required at closure are riprap and lined ditches, with the following characteristics, shown in Table 8-3.

Table 8-3: Typical Diversion Ditch Closure Design Criteria

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Diversion Ditches	Design Storm Event	1 in 10-year, 24-hour
	Maximum Depth (mm)	500
	Minimum Grade (%) riprap / lined	1.00 / 0.50
	Maximum Grade (%): riprap / lined	4.5 / 15
	Maximum Side Slopes: riprap / lined	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): riprap / lined	2.33 / 4.0

b. Collection channels

A collection channel intercepts sediment-laden water runoff from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Collection channels will be used within areas downgradient from closure regrading and covering activities to collect runoff and convey it to the appropriate sediment control measures.

Two large collection ditches (Ditch A and Ditch B) have been built at the downslope perimeter of development including the WRSAs, open pit and crushers, while smaller collection and diversion ditches have been used to direct flow to the main catchment ditches. Collection channels have been sized to convey the runoff from a 100-year 24-hour storm event, as per closure design criteria in Table 8.4, assuming that the entire footprint area has been disturbed and contributes sediment-laden runoff to the seepage collection and recycle ponds. Collection channel design is shown in Figure 8-1. The majority of collection channels that will be required in closure are riprap ditches, with the following characteristics, shown in Table 8-4.

Table 8-4: Collection Channels Closure Design Criteria

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Collection Channels	Design Storm Event	1 in 100-year, 24-hour
	Minimum Depth (mm)	500
	Minimum Width (mm)	1000
	Minimum Grade (%)	1.00 / 0.50
	Maximum Grade (%): riprap / lined	4.5 / 11
	Maximum Side Slopes: riprap / lined	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): riprap / lined	2.75 / 5.0

c. Culverts

Culverts have been sized to convey the 100-year 24-hour storm event peak flow for small watersheds and the 200-year 24-hour peak storm event for stream crossings. Based on the findings in Lorax (2022) and as summarized in Section 3.2.4, the current culvert sizing is adequate for closure. The culverts consist of corrugated metal pipe or corrugated polyethylene tubing and were installed according to the manufacturer's specifications to accommodate the anticipated vehicle loading and to prevent crushing. Any new culverts required for new water conveyance infrastructure built for closure will follow the same criteria. Standard culvert details can be seen in Figure 8-2, while Table 8-5 shows culvert closure design criteria.

Table 8-5: Typical Culvert Design Criteria

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances and downstream of sediment ponds)	1 in 200-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0

For closure, an updated conveyance network is proposed. The proposed water conveyance network at closure is presented in Figure 8-3. This network will be based on the structures already in place, with any needed repairs and complemented with additional structures as needed at closure to meet the water management closure objectives.

It is expected that new ditches will be required, and operations ditches may need to be upgraded and/or repaired to safely convey the 1:100 year flood. All structures will be sized for the 100-year flood based on a 24 hours rainfall event. This is the same methodology that was used for design for operations. Lined diversion ditches and culverts that were sized for the 1:10 year flood will be upgraded for closure. Further, half pipe culverts installed during construction or operations will be replaced using natural rip-rap and likely involve some slope re-grading (depending on site-specific conditions) to meet physical stability objectives.

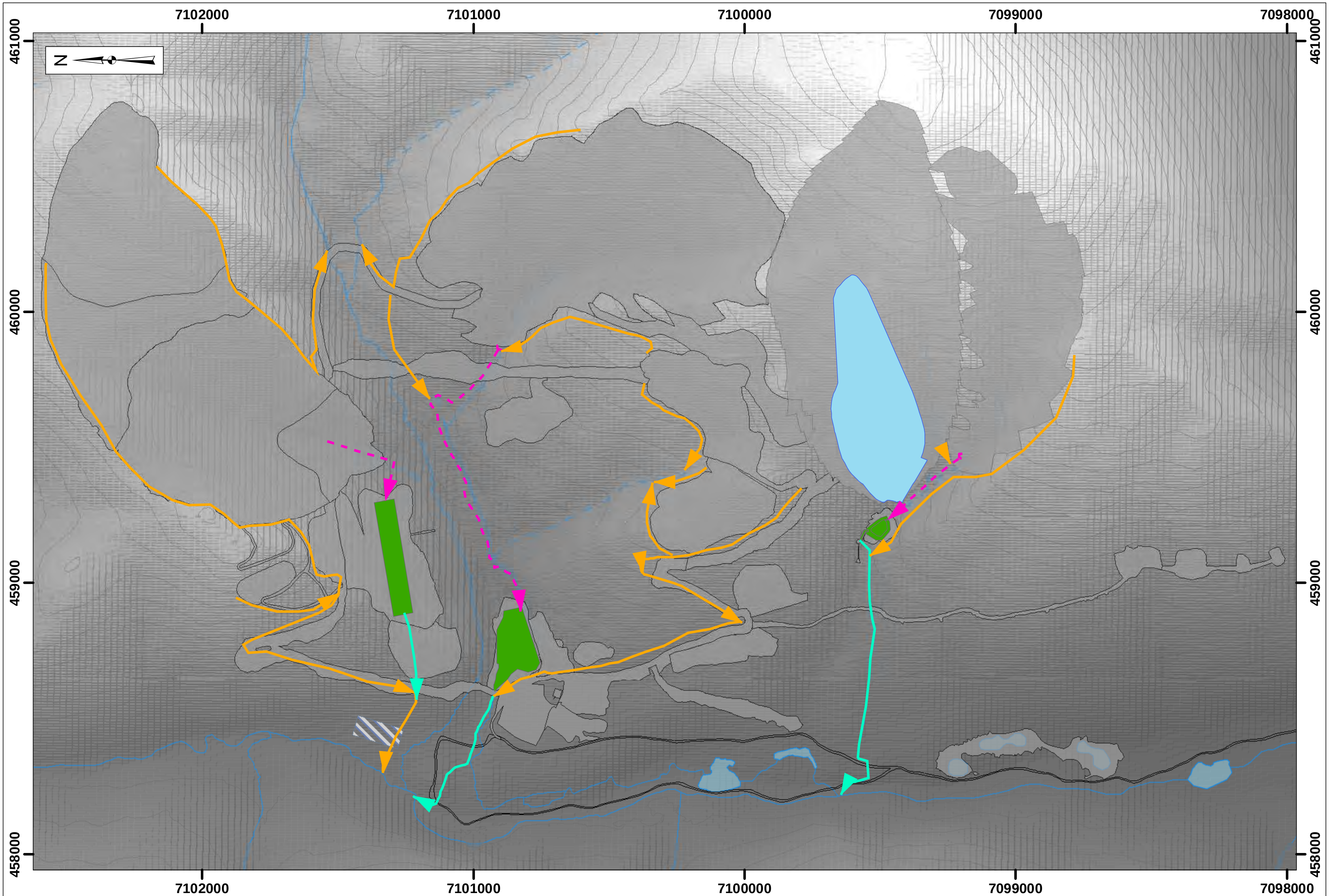
Most of the new ditches that will be built at closure will require cross-sections similar to the riprap and lined cross sections that were designed for operations. Some diversion ditches may have higher design flows in closure than during operations, and these ditches would be lined ditches as necessary where there are longitudinal slopes of more than 2%. For any new ditches or ditches modified due to potential changes in flow management, riprap cross-sections are proposed for slopes between 2 and 5% and lined cross-sections are proposed for slopes between 5 and 15%. For ditches that require expansion or upgrading to accommodate the expanded flow requirements, they could be raised or widened to accommodate the design flow. For new ditches on steeper slopes, a trapezoidal cross-section with larger riprap with a D_{50} varying between 300 and 500 mm could be used instead of the CHP. The base width of the different ditches and channels could vary between 1 and 2 m depending on the calculated design flow for a given catchment.

For closure, existing diversion ditches and collection channels will be consolidated and rip rap will be added to ensure integrity of the channel, if required. Riprap with a D_{50} = 150 mm is generally selected but larger rip rap may be required in steeper reaches.

Energy dissipation basins may be developed, as needed, at the toe of steep reaches for the new ditches. Approximate dimensions are to be 5 m by 5 m, with a minimum water depth of 1m. Erosion protection would use riprap material with a D_{50} between 300 and 500 mm depending on the ditch considered.

A subsurface pipe will convey water the entire way from the HLF sump to the HLF-UMV and then to HLF PTS; the first segment was built during construction of the HLF, while the design and layout of both segments (the second segment to be built during EP to HLF-PTS conversion) are provided in Appendix D.

Seepage from the WRSA's will be conveyed in Ditches A or B to the PTS's; further, based on experience at Minto Mine, seepage collection from the base of the PG WRSA uses a rockfill sump to protect seep drain from freezing and the development of aufeis. This design may be employed at the outlet of the EP WRSA rock drain based on lessons learned at the Mine, the Minto Mine and other northern sites and will be integrated when developing final designs for seepage collection and conveyance.



Legend:

- Contact with Cover
- Seepage
- Treated
- Reclaimed Facility
- Reserved Area
- Constructed Wetland
- Pit Lake
- Contour (25m)
- Watercourse - Perennial
- Watercourse - Ephemeral
- Watercourse - Intermittent

VICTORIA GOLD CORP

0 125 250 500
Metres

Projection:	Drawn By:	
NAD 83 UTM Zone 8N	HC	**EAGLE GOLD MINE YUKON TERRITORY**
Date: 2021/08/30	Figure: 8-3	**Conceptual Closure Water Management Network**

8.7 OPEN PIT

8.7.1 Closure Objectives and Criteria

Open pit closure objectives relate to health and safety, physical stability and chemical stability, as follows:

- Humans and wildlife are protected from topographic hazards associated with the pit and pit lake
- The physical stability of the open pit is able to withstand severe climatic and seismic events.
- Surface water discharge from pit lake provides for necessary conditions to sustain aquatic life and habitat similar to the conditions existing without the Project.

These objectives will be measured using the following criteria:

- No human or wildlife incidents will occur that are related to the topographic hazards associated with pit and pit lake.
- The pit geometry (bench widths, inter-lift slopes and overall slope) is being developed to meet the design criteria for the pit stability as described in the *Mine Development, Operations and Material Management Plan*.
- Visual monitoring of the pit indicates that the perimeter conditions are stable (i.e., no headscarp tension cracking or sloughing, perimeter headscarp is not degraded and are fully functioning)
- Effluent quality criteria are met in discharge from the pit lake or passive treatment system and water quality objectives in Haggart Creek are met.

8.7.2 Closure Measures

Upon cessation of mining, the pit pumps and associated piping will be removed and any other related infrastructure will be cleaned up. Access to the pit will be secured by placement of boulders across roadways, and signage will be used to warn about the presence of highwalls. A safety berm will have been installed around the highwall in operations that will prevent unintended access to the pit by snow machines or other cross terrain vehicles. Once mining has ceased, groundwater seepage from pit walls and drain holes will be allowed to fill the pit and form a pit lake. After approximately eight years, outflow from the pit will flow though engineered structures to into the Platinum Gulch conveyance channel.

The approximate timing of the Pit and Pit Lake development is outlined below:

- Years 1 to 9 pit inflows pumped/conveyed to the LDSP
- Years 9 to 17 open pit is filling and no discharge occurs

After Year 17 open pit discharges directly to Haggart Creek, if discharge criteria are met or to the PG-PTS as needed.

8.8 HEAP LEACH FACILITY

8.8.1 Closure Objectives and Criteria

Closure objectives for the HLF include:

- conducting drain-down and cyanide destruction (passive or active or both) activities in a controlled manner to achieve and maintain chemical stability of heap effluent;
- performing grading to ensure that no slope face is greater than 2.5:1, and cover placement in a manner that will achieve long-term physical stability including minimizing erosion, subsidence or slope failure;
- incorporating design criteria and attributes in the ongoing HLF construction and loading in accordance with the design so that the HLF is able to withstand severe climatic and seismic events;
- reclaiming snow dump locations (note, not developed to date) to ensure that no entrained ore remains;
- achieving long-term chemical stability such that runoff and seepage quality meet water quality criteria; and,
- implementing appropriate contingency measures as required.

The predicted source water quality of the heap at final draindown (i.e., influent into any passive treatment system) shows that the main water quality parameters of potential concern that would drive water treatment requirements are nitrate, $CN_{(WAD)}$, As, Sb, Pb, Hg, and Se, and these parameters require treatment prior to release to Haggart Creek. Thus, the long-term closure measures are designed to address these parameters either by treatment within the heap ore column, in the in-heap pond, or in the passive treatment system to be constructed in the Events Pond.

8.8.2 Closure Measures

The HLF will be the last major feature to be reclaimed after all gold leaching is terminated and the cyanide destruction (either with biological or active treatment processes or both) and rinsing processes are completed, thus the cover will not be placed until approximately two to three years, following the cessation of active mining and placement of ore. The construction of a store-and-release cover system will commence as the HLF draindown process nears completion. WAD cyanide concentrations will firstly be reduced by a rinsing and recycling period (and from additional meteoric inputs during the subsequent draindown process) and then further by the biological treatment process that commences during draindown, and then the formation of the in-heap bioreactor when draindown has been completed such that concentrations meet discharge criteria, and seepage from the facility will be treated with a passive treatment system constructed down gradient of the facility. These measures are detailed below. The in the closure process for the HLF are as follows:

- residual leaching for gold recovery,
- rinsing for initial reduction of cyanide concentrations as described in Appendix N
- draindown and, near then completion, biological treatment,
- Construction of the HLF CWTS which will receive a portion of draindown flows to allow the system to be established;

- formation of in-heap bioreactor
- Confirmation drilling and sampling of the ore pile to confirm CN concentrations;
- Regrading of the ore pile so that no bench faces are steeper than 2.5:1; and,
- Cover placement.

The phases of heap operation and their timing is outlined in Section 8.1.

8.8.2.1 Residual Leaching

After the last ore materials are placed, transition to a residual leaching period will commence. During this phase, diffusion of the cyanide solutions into the heap materials continues and recovery of gold from the heap drainage continues until it is decided that it is economically beneficial to transition to the rinsing and cyanide destruction phase. The exact duration of this residual leaching phase cannot be determined in advance (which will be a cost-benefit tradeoff of commodity prices, operational and overhead costs, and other site-specific factors), but a duration of one year is assumed. During this residual leaching phase, the crushing and stacking equipment is decommissioned, and the primary activities are movement of pipes and leaching equipment around the heap to maintain optimal leach phasing. For the purposes of third-party execution of the closure of the heap, no residual leaching period is contemplated as an Interim Care and Maintenance would commence (which is effectively the rinsing period) rather than the collection of additional revenue (i.e., gold) from the HLF.

8.8.2.2 Rinsing

As the economic recovery of precious metals from the heap is reaching the transition point where the net economic benefits of gold recovery diminishes, the heap operations will transition to a closure phase. The use of a clear definition for this transition point is consistent with the current state of practice for the closure of heap leach facilities in that it articulates the time in which the heap is managed for the reduction of solution inventory rather than economic operation. The term “rinsing” thus refers to recirculation of the solution, including new meteoric inputs or, if undertaken as a standard period rather than considering a 2-year recycling period (i.e., ICM), fresh water. As described in Appendix N, cyanide concentrations will naturally decrease as already formed gold:CN complexes in the heap are “rinsed” out. This was observed at Brewery Creek, where concentrations of total CN were below 10 mg/L prior to the initiation of in-heap biological detoxification. This has also been observed in VGC column studies, where recirculation of solutions alone without any chemical or biological treatment (or fresh water additions) resulted in 98% reduction over 29 weeks of “rinsing”.

In the case of VGC managed closure, this rinsing period would involve rinsing of the ore stack with three pore volumes of water for adequate CN removal. For the end of mine condition of the HLF, this rising period would take an estimate 402 days to complete. This phase will appear similar to the residual leaching phase, in that the primary activities will be movement of pipes and leaching equipment around the heap as necessary to continue to deliver recycled solutions to the heap.

8.8.2.3 Draindown and Cyanide Destruction

During the heap drain-down process, the overall solution inventory will be decreased by processing water through the mine water treatment plant (MWTP) with a portion above a target treatment rate recycled back to the HLF. Depending on the flow rates achieved through the CN destruction circuit and subsequently the Phase 2-5 MWTP the actively treated drain-down period will vary, but is expected to occur over a four-year period, but could be shorter or longer depending on how the draindown process is managed.

For the initial draindown period, active treatment for additional reduction of cyanide concentrations post rinsing is undertaken. As the draindown process is nearing completion, the biological cyanide destruction process will then commence. The solutions that are recirculated back up into the heap will have organic carbon sources amended into them.

During the biological treatment process, the solutions added to the top of the heap will only have residual cyanide concentrations as the biochemical treatment processes will remove most of the active cyanide from solution. This will be achieved by adding sugar solutions (sugar solution with reducing sugars, typically molasses or corn syrup are the most cost effective) to the barren solution exiting the gold recovery circuit, where any residual free or reactive cyanide forms biochemically react with the sugar molecule, forming cyanohydrin. The rate of sugar solution added to the barren solution is designed to both react with residual cyanide in the barren solution, as well as cyanide in the pores of the heap. Thus, the treatment is achieved both in the barren solution tank prior to circulation up to the heap, as well as within the heap, which is termed in situ treatment.

This process is similar to what was done at the Brewery Creek Heap Leach Facility to detoxify the solution inventory to close the heap, and also was successfully pilot tested for the Eagle heap materials (Tetra Tech 2014, Cyanide Destruction Column Studies Report, available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.11.6). The heap treatment column test was able to achieve reduction of 16 mg/L WAD cyanide to less than the detection limit (0.025 mg/L) with a sustained application of a mixture of sugars and trace phosphate. As described in Section 8.8.2.2, concentrations of less than10 mg/L were achieved in bench scale testing undertaken in 2022 when simulated heap fluids were recycled without any treatment or addition processes. This experience and experience elsewhere form the basis for the application approach and dosing rate for the biochemical treatment reagents.

In situ cyanide destruction treatment is a biologically mediated process in which a supplemental reduced carbon syrup (above what is required to directly react with residual cyanide in the barren solution) is added to the heap to degrade cyanide and to facilitate microbial growth within the heap. The reduced carbon promotes a direct consumption of free cyanide and some weak cyanide complexes within the pore water solutions in the heap, which leads to the creation of non-toxic cyanohydrins in the heap. Subsequent degradation of the cyanohydrins and other nitrogen forms is supported by excess carbon (over and above what is required to react with free and weak complexes of cyanide) because the additional carbon supports microbial growth and formation of a fine biofilm on the heap particles that incorporates the reduced nitrogen compounds (cyanohydrins, ammonia). In some cases, the sugar solutions are amended with other nutrients, including phosphate or phosphoric acid, and/or other trace biochemical nutrients to enhance microbial growth. The addition of sugar solutions in the barren solution is performed in phases through the same equipment used to leach the heap, i.e., barren solution tank, pumps, piping, and buried drip emitters and is undertaken nearing the completion of the draindown period. Thus, the only equipment required to detoxify the heap using a biological treatment process will be a heated storage tank located at the ADR and metering pump to deliver sugar solutions into the barren solutions as it is recirculated. The size of the reducing sugars mix tank will be sufficient to hold approximately 60 m^3 of sugar solution.

Depending on the thickness of the areas on the heap, the particular area where the barren solutions amended with reagents will be added will have solution added by drip emitter onto a specific area of the heap for a period of approximately 60 days. This period of time will allow for the sugars/nutrient mixture to react with cyanide in pore waters in that area and biochemically degrade the cyanide species. Each zone in the heap will have solutions applied to that area such that the sugars/nutrients mixture to break through to the base of the heap. Over the subsequent 'rest period' where solutions are not being applied, the residual pore waters will continue to be biologically treated by the native microbes growing in the heap pores and on the surfaces of the heap materials supported by the sugars and nutrients delivered in the initial solution application period. The solution delivery will be accomplished in phases across the heap, similar to the leaching process, with approximately 12 areas successively treated, for a total period of treatment in the heap of approximately two years. During this time period the flow rates and the areas under solution application will be managed to deliver the solutions at the appropriate strength to the area under solution application until breakthrough of reactive sugars is achieved throughout the leach column, then the area under solution application will be moved to a new area, until the entire heap has received solutions that are amended with the appropriate amount of sugars/nutrients. During this two-year period, the costs of treatment includes recirculating solutions (e.g., pumping, moving drip emitters), and the cost of the sugars/nutrient solutions. As this process is undertaken over the final years of the draindown period, the pumping is directly associated with draindown.

This draindown in situ treatment period will then switch from a sugar-based solution to an alcohol-based solution, with the purpose of creating sulfate reducing conditions within the saturated zone of the heap, i.e., the in-heap bioreactor described below. This will allow for the heap drainage to continue to improve and ultimately achieve water quality consistent with that observed in alcohol fed bioreactors. In these conditions, reduction in metal concentrations is also commonly observed as result of the reducing conditions established during microbial metabolic processes, because many metals are less soluble in a reduced state (chromium, copper, selenium, uranium, for instance). Other metals that preferentially sorb to iron or manganese oxides in a more neutral pH range created during the detoxification process will generally decrease, including trace metals such as arsenic and antimony. Metals that form insoluble sulfides will also become substantially treated.

8.8.2.4 Formation of In-Heap Pond Bioreactor

When the cyanide concentrations have decreased in the In-Heap Pond such that the heap outflow to the ADR is consistently below the cyanide EQS concentrations, the treatment strategy will shift to a strategy that will stabilize and further improve the water quality from within the heap for water quality constituents beyond cyanide. As described in Lorax (2018), after cyanide has been degraded the heap drain down water will still be elevated in nitrate, metals and metalloids, and these parameters will require treatment prior to release to Haggart Creek. While the biochemical degradation of cyanide with sugars does not rely on the formation of a reducing condition within the heap pores, the treatment of these constituents will be based on reductive precipitation of metals within the saturated zone within the heap as well as the continued microbial degradation of cyanide destruction by-products (ammonia and thiocyanate) within the unsaturated heap column.

This subsequent phase of in situ treatment will provide a further treatment of constituents within the In-Heap Pond, as well as decreasing metals concentration to sufficient levels to either directly discharge, or at least provide water that is of sufficiently good quality to only require polishing in a passive treatment system (described below).

The saturated in-heap pond will be transformed to become strongly reducing by the addition of alcohol and trace nutrients designed to support biochemical processes that will remove these constituents requiring treatment within the in-heap pond. The processes that will be used to remove/treat these constituents:

8.8.2.4.1 Nitrate

Denitrification is the process where microbes oxidize organic carbon as an electron donor (alcohol is a preferred organic carbon substrate to support denitrification) and reduce nitrate and nitrite to nitrogen gas N_2, which is the gas that comprises approximately 79% of the earth's atmosphere.

$2\ NO_3^- + 10\ e^- + 12\ H^+ \rightarrow N_2 + 6\ H_2O$

Microbes that perform denitrification are found nearly universally (ubiquitous) in soils and rocks. The Tetra Tech (2014) cyanide destruction column studies report on Mine materials showed that the addition of alcohol to the heap materials supported denitrification (initial concentration: 1.3 mg/L; final concentration 0.3 mg/L), and also importantly that ammonia was also removed (60.3 mg/L initial concentration; final concentration 0.79 mg/L).

8.8.2.4.2 Trace Metals and Metalloids (antimony, arsenic, lead, mercury, selenium)

The heap detoxification column study was operated to simulate unsaturated portions of the HLF, with the primary objective to degrade cyanide. The heap columns were not saturated and consequently the highly reducing conditions necessary to achieve sulfate reduction, which will be readily accomplished in the saturated heap column in the in-heap pond, were not achieved in the heap detox columns. However, metals that are of potential concern were reduced, including antimony (41% decrease), arsenic (83% reduced), selenium (68% reduced), and mercury (86% reduced). Lead concentrations did not decrease, but instead increased somewhat, consistent with the lack of sulfate reducing conditions.

With the utilization of the in-heap pond as a sulfate-reducing bioreactor, heavy metals concentrations are expected to be substantially reduced. For instance, the Yankee heap in Nevada was treated using a similar process, where organic carbon was recirculated onto the heap (Harrington, 2002). In leach extractions of heap materials using the meteoric water mobility procedure test, arsenic concentrations decreased from 1.85 mg/L to 0.32 mg/L, and mercury concentrations decreased from 0.5 mg/L to 0.00067 mg/L. Similarly, at the Couer Rochester Stage 1 heap (which similarly had an in-heap pond) selenium decreased from 0.107 mg/L to 0.01 mg/L, and mercury decreased from 0.0114 mg/L to 0.0007 mg/L (all results were composites of sonic drill cores removed from the heap before and after in-heap treatment, then leached using the MWMP procedure).

It is expected that at the end of the rinsing, draindown, biological cyanide destruction, and in-heap bioreactor treatments that the heap solutions can either be directly discharged in accordance with the site discharge criteria, or that the HLF CWTS will be able to polish it using both aerobic and anaerobic processes, as described below.

Once the process described above are complete, perforation of the sump and activation of the closure sump will be undertaken so that flows can be routes to the HLF passive treatment system.

8.8.2.5 HLF Passive Water Treatment

A HLF passive treatment system will be built as the draindown process is underway so as to provide sufficient time for the system to mature. As described in Appendix M, the most recent predicted water quality was used to refine the preliminary size of the Heap Leach Facility (HLF) CWTS. Water chemistry and flow, which can be assumed to represent the range in flow and load to the HLF bioreactor, which is upstream of the HLF CWTS, were developed from the site water balance and water quality GoldSim model. Based on this work, the conceptual HLF CWTS design was advanced to a preliminary design.

Representative conditions from the GoldSim model were selected as the 75th percentile flow rates and water quality to inform the influent chemistry that would enter the HLF bioreactor (which as a result are considered to be conservative as the performance of the bioreactor was not fully contemplated in the HLF CWTS design). This work indicated that the primary constituents requiring treatment were nitrate, nitrite, arsenic, antimony, cobalt, and selenium. Total suspended solids concentrations were on occasion also slightly higher than the EQS. Based on the model outputs, a CWTS with anaerobic and aerobic treatment cells was designed. As with the conceptual designs developed previously, the next phase of the design was based on best available information to date using the water chemistry and flow rates (outlined in Appendix M), proxy removal rate coefficients, and assumptions for water depth and substrate depth based on Ensero's experience with similar CWTS. The current design includes the following preparatory activities and treatment processes:

1. Perforation of the HLF liner to the closure sump allowing seepage to flow under pressure from the closure sump to the PTS.
2. Seepage flow through the closure drain system to the CWTS inlet pond. The CWTS inlet pond will function as an equalization pond to provide some flowrate control to the CWTS during the open water season (May to September).
3. Flow into an anaerobic CWTS which is designed to sequester elements (Sb, Co, and Se) into the sediments through coupled biogeochemical reactions and accretion. The anaerobic CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, containing 10% woodchips as organic matter. The above substrate water depth is 40 cm. An additional 30 cm of freeboard is in the design. The total treatment area is 0.74 hectares.
4. The anaerobic CWTS will be followed by aerobic CWTS to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion. The aerobic CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design. The total treatment area is 0.16 hectares.
5. Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.
6. The water from the retention basis will exit through an engineered cut in the events pond embankment and then directed into a designed channel that will convey the treated water to Haggart Creek.
7. Cells will be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments to ensure that water requiring treatment in the CWTS remains in the CWTS flow path.
8. The CWTS will be planted with local plants, to the greatest extent possible.

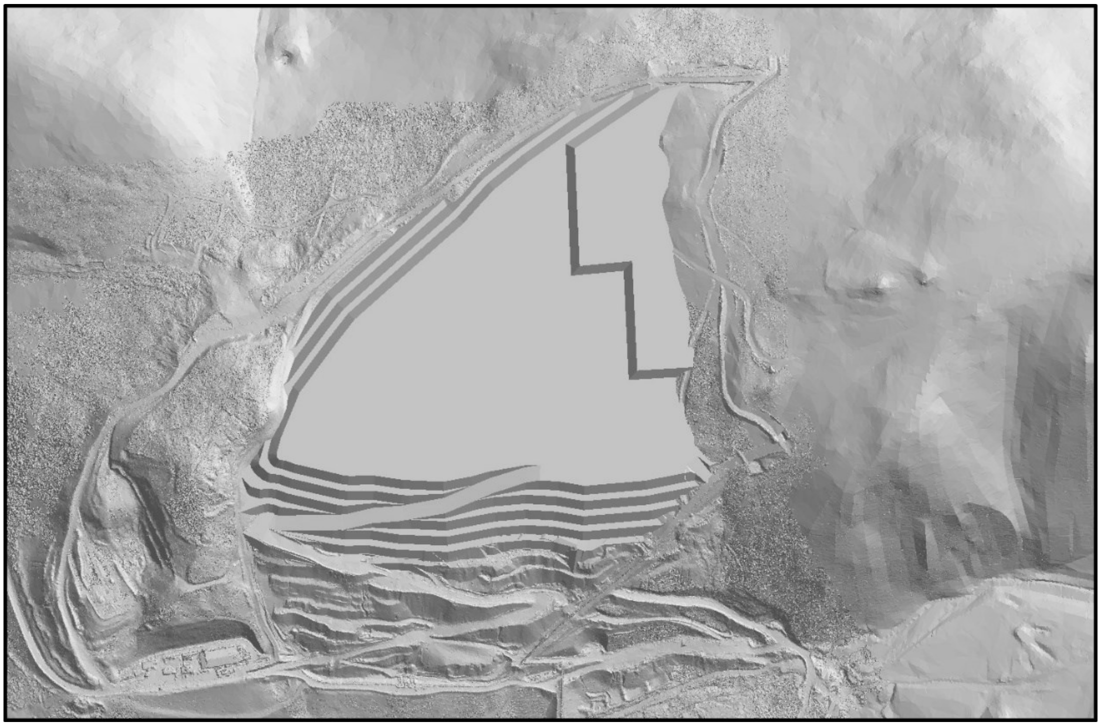
8.8.2.6 Confirmation Drilling and Sampling

As described in Appendix N, a sampling framework to determine the success of the heap detoxication process will be undertaken. The program would include the use of either a sonic or split spoon augur drill rig to advance

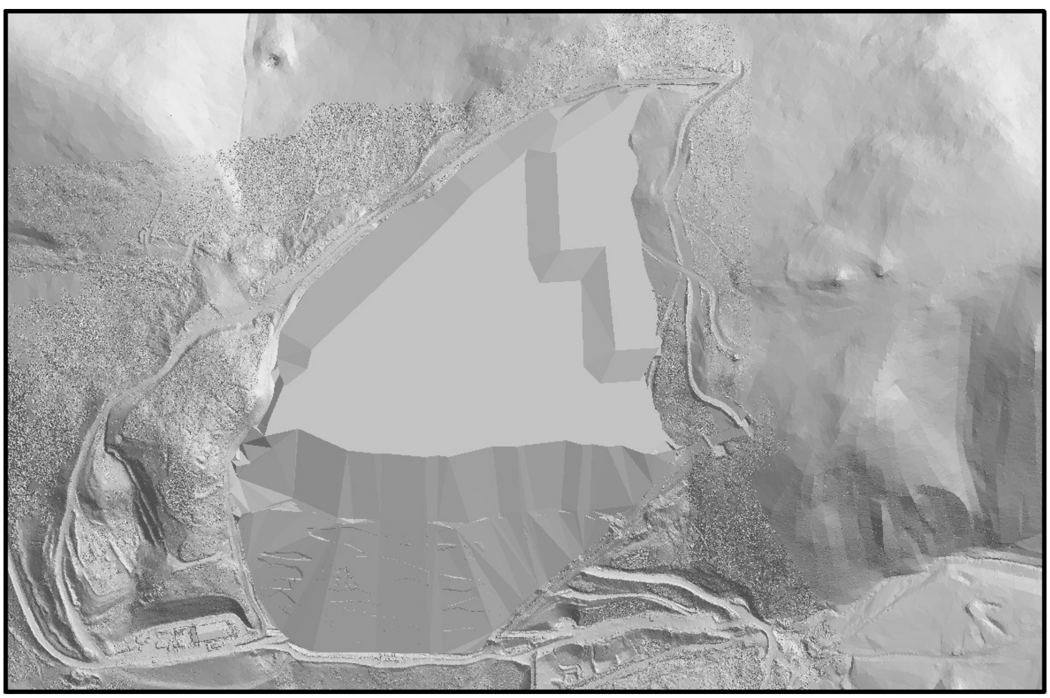
12 holes that would then have a near surface, mid heap and deep heap composite sample collected. The samples would be sampled for meteoric water mobility protocol or similar leach tests to simulate rainwater or snowmelt percolation into the ore stack. The leach extraction from each composite should be compared to the heap drainage chemistry with respect to cyanide parameters. The sampling method would then be used to determine whether the pore water is of similar composition with respect to cyanide as the heap drainage monitored as part of the ongoing water quality monitoring program.

8.8.2.7 Earthworks / Recontouring

Heap Leach material will be loaded as necessary for closure conditions during operations; however, as required by QZ14-041-1, regrading plans have been developed to ensure that all slopes are 2.5:1 or shallower. VGC has undertaken regrading planning for both the Year 2 (2024) and EoM scenarios for the HLF to derive volumes for material movement calculations and true areas for final cover placement. The planning for these activities is provided below. Access for heavy equipment to undertake this work will be developed during normal stacking operations as equipment access to the top of the ore stack is required for normal heap leach facility operation.

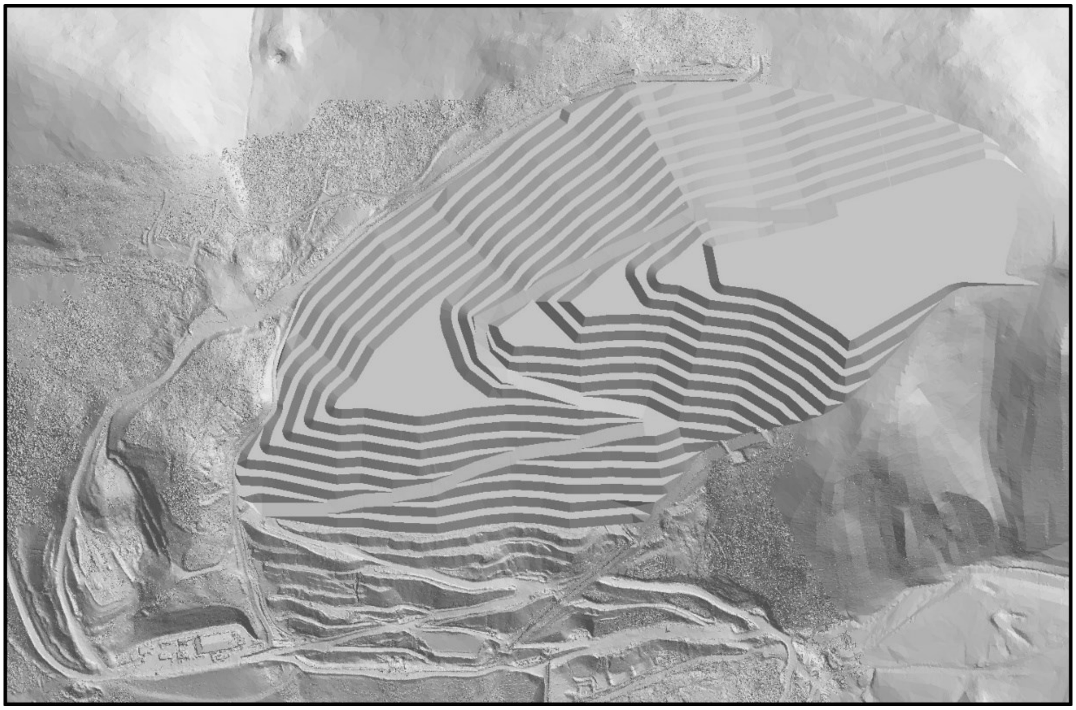


Access for Recontouring

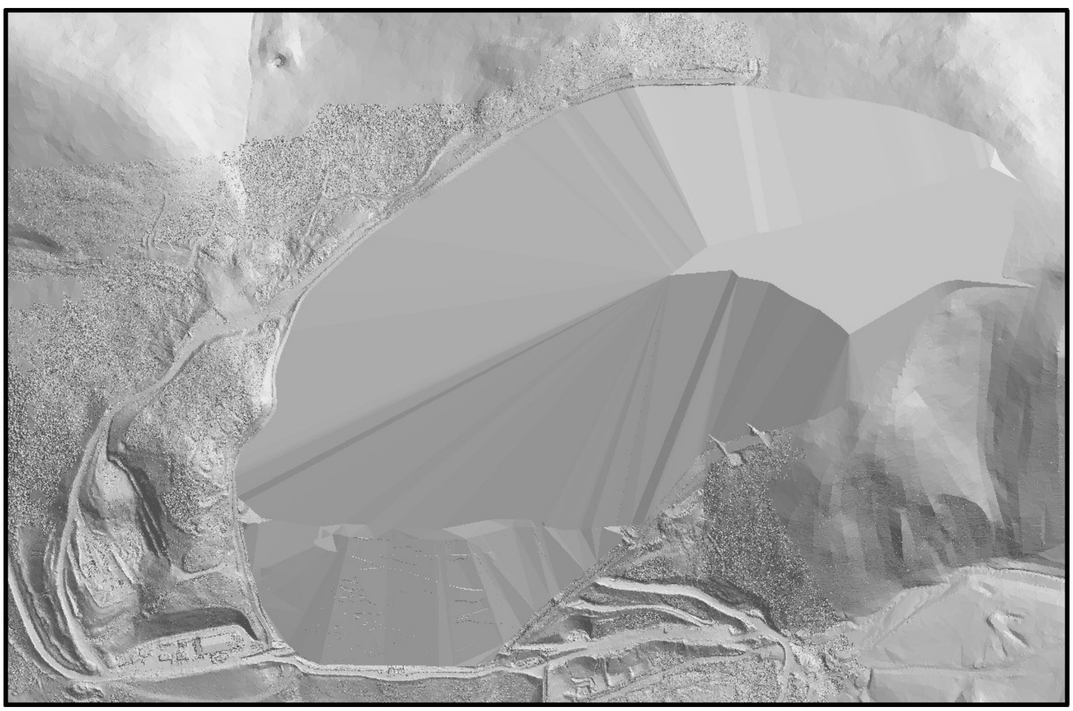


Final Landform at 2.5:1 Slope

Figure 8-4: Heap Leach Recontouring Plan (2024)



Access for Recontouring



Final Landform at 2.5:1 Slope

Figure 8-5: Heap Leach Recontouring Plan (EoM)

8.8.2.8 Final Reclamation Measures for HLF

8.8.2.8.1 Engineered Cover

The HLF is a component of the Mine that requires a cover design based on using locally available materials that limits infiltration to meet water quality objectives. In addition to limiting infiltration, another objective of the cover is to provide a stable growth medium to allow for revegetation. The benefit of a reduced infiltration cover is a reduction in seepage flow rates which will minimize the total loadings from heap leaching processes, and thus minimize the required treatment of a PTS.

The proposed cover to be used during closure is a store and release cover, which reduces infiltration into the underlying material by storing precipitation (similar to a sponge) in the rooting zone of the cover material and then releasing some of the water back to the atmosphere through evapotranspiration from vegetation. The cover comprises a layer of material placed in a loose state and revegetated with selected local species that have high moisture uptake characteristics. A similar store and release cover system was constructed at a similar open pit-heap leach gold mine project (Brewery Creek, YT) that was closed and reclaimed.

Two stages of modelling were conducted to further evaluate cover system designs for the HLF. The first series of models used The Hydrologic Evaluation of Landfill Performance (HELP) 3.90 D Model (2011) to inform the model design and estimate infiltration through the cover (Knight Piesold, 2013). The preliminary model results were considered for the current cover system design.

The currently proposed design, referred to as the 'Base Case', is a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. A field trial of the cover is currently being undertaken on 1370 lift of the PG WRSA (Seciton 10.2). A mixed overburden and topsoil stockpile was relocated to the plateau of the 1370 lift of the PG WRSA and used to construct and monitor a pilot scale cover system. A 0.5 m thickness of cover system, chosen to align with the base case configuration, was constructed on the eastern portion of the plateau area and a portion of the south-southeast slope of the WRSA.

The anticipated hydrological performance of the base-case cover system design was further assessed in Okane 2014 (Appendix E), which provides recommendations to improve long-term performance from a net percolation reduction perspective. The following work was completed

- Reviewed pertinent background information and compiled key inputs for soil-plant-atmosphere (SPA) numerical modelling;
- Developed conceptual model of hydrological performance of the base case cover system design;
- Conducted Base Case and sensitivity analysis numerical simulations of cover system performance using the SPA model VADOSE/W; and
- Developed recommendations for future studies to reduce uncertainties in the current cover system design and identified potential opportunities for improvements in cover system performance using locally available materials.

The objectives of the SPA numerical modelling of the Base Case were to improve the confidence in estimating the mean and range of net percolation rates for the Base Case cover system for input to environmental loading and water treatment assessments, and to assess the:

- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and to
- Examine the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

In total, 43 long-term simulations were completed to determine the sensitivity of the Base Case due to variations in materials, climate, and/or vegetation. The simulations were also completed to evaluate whether, any improvements could be made to the Base Case design. All the scenarios were initially completed without vegetation present so that changes in performance could be directly correlated to changes in materials or climate. Vegetation was then included to further evaluate select scenarios. Finally, the Base Case results presented in the previous section showed little difference in performance between the WRSAs and HLF simulations. The results of these simulations can be summarized as follow:

1.) Slope aspect and gradient have the largest effect on NP rates estimated for both WRSAs and HLF. The added solar radiation on south facing slopes results in a higher AET rate, further drying out the cover in the summer months. In contrast, the north-facing aspect has substantially less solar radiation available to evaporate or transpire water stored in the cover profile. This increases the observed NP rate. A 2:1 slope gradient will result in a larger volume of runoff during the spring melt and high intensity rainfall events.

2.) Virtually no difference exists in predicted NP rates resulting from the use of different materials on-site. Cover system scenarios that used only colluvium or tailings (rather than the 2:1 mix) produced nearly identical NP rates as the 2:1 colluvium-tailings mixture. Layered cover systems of the two materials also produced similar NP rates. Based on these results, there is no advantage, from a NP perspective, to mixing the tailings and colluvium into a single cover system material based on the estimated hydraulic properties of the two material types.

3.) Thickening the cover system provides no reduction in the NP rate, and actually results in an increase in NP. NP rates do not decrease because the energy available for evaporation is low, which creates relatively low hydraulic gradients for removing water from the cover system. Hence, evaporation alone can only remove water stored nearer the surface. The model estimates a slight increase in NP with increased cover thickness because the underlying leached ore of waste rock is a textural discontinuity, which creates a capillary barrier inhibiting NP and keeping water closer to the surface. When the depth of the capillary barrier is increased by increasing the thickness of the cover system, the percolating water is able to get to depth more easily, which increases NP.

4.) The presence of vegetation is vital to hydrological performance of the cover system. The NP rate is reduced by 10% or more for both the WRSAs and HLF when a forest canopy is present. A large part of the improvement from the forested cover system scenario comes from the improvement of AET via canopy interception. The forest canopy intercepts precipitation on the foliage, which reduces the amount of water that infiltrates into the cover system. This intercepted water is then evaporated or sublimated from a location more exposed to solar radiation and wind compared to surface.

5.) The model estimates that the current cover system design adequately meets the water storage requirements for vegetation. Over an 80-year simulation period there were only seven periods when the cover system water volumes dropped near or below the acceptable limit. These are periods when vegetation would be at risk; but it must be noted that the model inputs were set to permit forest vegetation to be capable of removing water up to a suction of 2,500 kPa (based on research of tree species), and that VADOSE/W does not account for all plant survival mechanisms (e.g. dormancy).

6.) In general, material properties that lowered the k_{sat} of various materials resulted in slightly lower NP rates, while increasing the k_{sat} slightly increased NP rates. By increasing or decreasing the k_{sat} of the topsoil by one order of magnitude, the average NP rate varied from 35% to 29% of annual precipitation, respectively. It is essential that thorough testing be completed to verify the hydraulic properties of local topsoil material because the model suggests that k_{sat} also has a large influence on NP rates. Decreasing the heap or waste material k_{sat} also had an effect on the observed NP rate; however, increasing the k_{sat} above a certain threshold had little effect on the NP rate. The effect of varying the k_{sat} of the tailings-colluvium material was also analyzed; however, no measurable difference in the water balance was predicted when the material's k_{sat} was varied by one order of magnitude.

Based on the modelling of the Base Case a profile schematic of the waste rock and heap cover is shown below as Figure 8-4. This conceptual design schematic shows the cover profile for the flat areas on the plateaus and benches, as well as the inter-bench slopes.

As noted above, the ongoing cover trail of a 0.5m cover configuration at the Platinum Gulch WRSA will further inform the cover design for the HLF (Section 10.2). For 2020/2021 cover trial monitoring period, water balance models estimated NP rates of 31% and 37% of effective precipitation for Slope and Plateau locations, respectively. It is expected that NP rates will trend downward as the vegetative cover improves and matures, resulting in lower NP due to more water being pulled from the cover system via evapotranspiration processes. Based on data collected to date for the 2021/2022 monitoring period, data trends suggest that the NP rates for the annual monitoring period will be consistent with the conceptual performance of the base case cover system assumed in the site-wide water balance and water quality model. Water balance model estimates for the second year of monitoring will be conducted when the full year is completed. Continued field trial cover system performance monitoring will provide additional data to help characterize cover system performance on a yearly basis and allow various types of climate years to be evaluated.

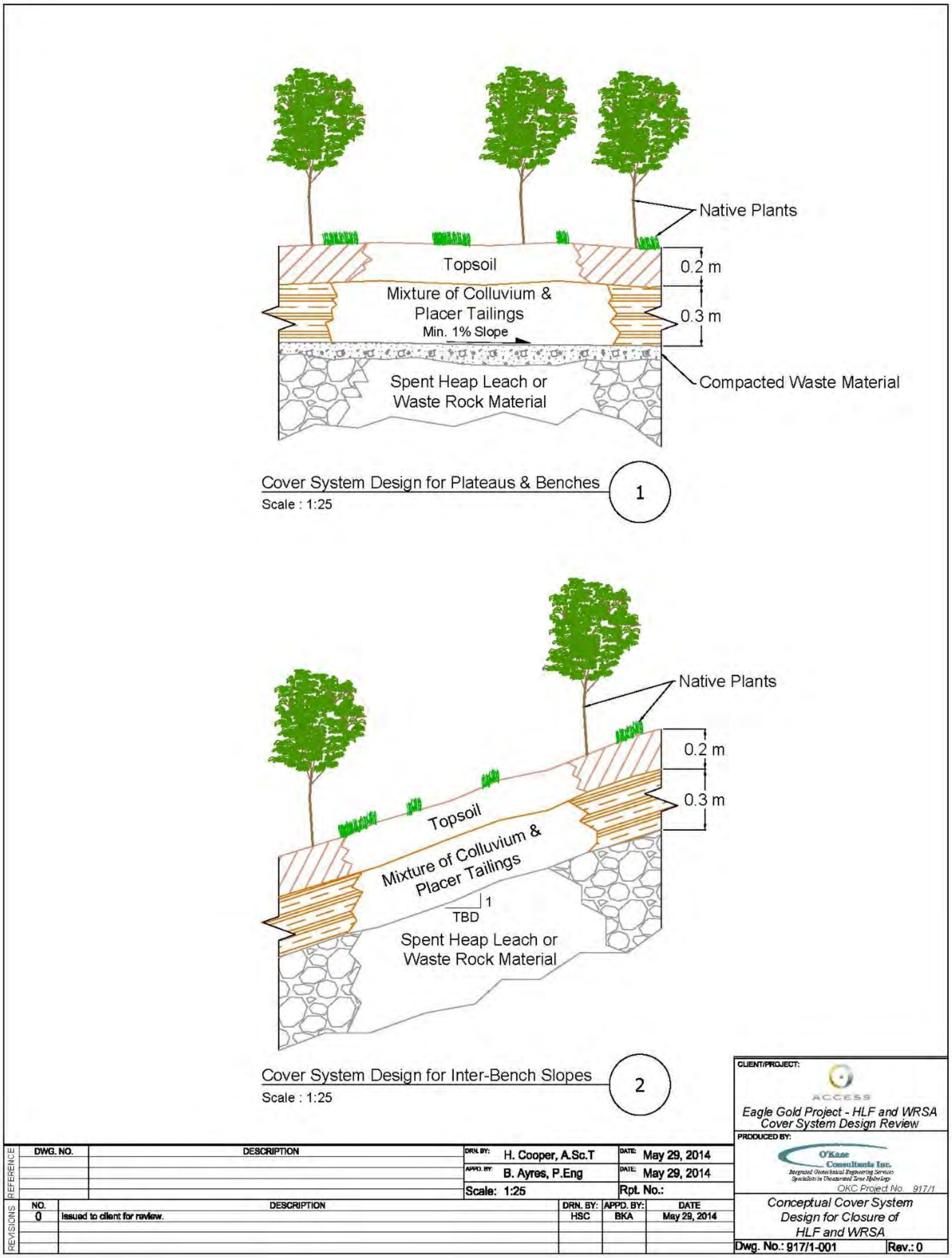


Figure 8-6: Conceptual HLF and WRSA Cover Design Drawings

8.8.2.8.1 HLF Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the HLF. Results from reclamation research trials currently underway as described in Section 7 will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.9 EAGLE PUP WASTE ROCK STORAGE AREA

8.9.1 Closure Objectives and Criteria

Closure objectives for the Eagle Pup WRSA are to ensure long-term physical stability to minimize erosion, subsidence or slope failure; ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria and that area is able to withstand severe climactic and seismic events.

8.9.2 Closure Measures

Initiatives taken during the operations phase will include constructed waste rock slopes and benches that have stable configurations that allow for resloping in accordance with QZ14-041-1 to meet closure criteria.

Closure measures undertaken to achieve the above objectives will include installation of engineered covers to reduce infiltration, encourage vegetation growth and minimize erosion. Engineered covers will be combined with passive treatment systems to yield water quality that is acceptable for discharge.

8.9.2.1 Passive Water Treatment

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Mine. CWTS evaluations are being advanced to fulfill site-specific objectives for passive treatment of waste rock drainage (Platinum Gulch and Eagle Pup). Using predicted closure water quality from each source, each CWTS was sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of constituent removal as the water is treated as it passes through the CWTS, based on treatability of the compound and hydraulic retention time. Removal rate coefficients are based on the treatability of a specific constituent and the HRT of the system, both of which are site-specific based on water chemistry, wetland designs, and characteristics of the system. Removal rate coefficients will be refined through bench-scale and pilot-scale work (see Section 10.4), which will provide the information for final full-scale sizing.

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Mine. CWTS evaluations are being advanced to fulfill site-specific objectives for passive treatment of waste rock drainage (Platinum Gulch and Eagle Pup). Using predicted closure water quality from each source, each CWTS was sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of constituent removal as the water is treated as it passes through the CWTS, based on treatability of the compound and hydraulic retention time. Removal rate coefficients are based on the treatability of a specific constituent and the HRT of the system, both of which are site-specific based on water chemistry, wetland designs, and characteristics of the system. Removal rate coefficients will be refined through bench-scale and pilot-scale work (see Section 10.4), which will provide the information for final full-scale sizing.

The PTS for the EP WRSA will utilize water conveyance infrastructure already established, such that the seepage will flow to the LDSP via Ditch B, where the LDSP will be converted to a PTS for closure (Figure 1-2). The preliminary design parameters for the LDSP CWTS are summarized in Table 8-2. Further detail on design parameters is provided in Appendix M.

Table 8-6: Preliminary Design Parameters for the LDSP CWTS

Parameter	Design Basis	Source/Rationale
Design	Aerobic	Based on Ensero's experience
Arsenic Concentration	0.1565 mg/L	P75 Predicted water quality by Lorax (July 2043)
Flow Rate	960 m^3/day	Adjusted P75 Predicted flow rate by Lorax (July 2043)
Treatment Objective	0.053 mg/L	WUL EQS for As
Proxy Removal Rate Coefficient	0.13 day^{-1} (Zero order reaction kinetics)	Pilot-scale study for a proxy site
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended substrate type is currently under investigation in bench-scale trials.
Water Depth for aerobic CWTS	10 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type is currently under investigation in bench-scale trials.
Treatment Area	0.31 ha	Estimated from month of highest wetland size (July 2043)
Approximate amount of construction fill required for CWTS pond creation	31,000 m^3	Estimate calculated by AutoCAD Civil 3D

Parameter	Design Basis	Source/Rationale
Approximate amount of substrate required for CWTS fill	1,400 m^3	Geometric volume calculation based on CWTS cell dimensions

The preliminary LDSP CWTS was sized using paired arsenic concentrations and flow data for July 2043 to meet the WUL EQS for arsenic (0.053 mg/L). Year 2043 was selected for the preliminary design basis sizing of the LDSP CWTS as it represents a year of closure PTS flows and loads and likely a few years after the need for active treatment. The P75 water quality for July 2043 was used to further the design basis as July, based on flow and water quality data, required the largest wetland size. Using the aerobic proxy removal rate coefficient for arsenic, it is estimated that a 0.31 hectare full-scale wetland may be required to treat the Eagle Pup water to the WUL EQS target for arsenic. The CWTS size will be further refined and evaluated as the design and testing of the CWTS advances. The considered water depth, plants, and substrates for the preliminary design are similar to the those are currently being testing in bench-scale trials for the PG CWTS (see Section 10.4).

For the treatment of arsenic in an aerobic CWTS, the molar ratio of iron to arsenic in the water is an important factor to facilitate arsenic removal. A review of the PTS 2043 water chemistry revealed that in the P75 water chemistry scenario the iron to arsenic molar ratio was 1.9-4.8. A higher iron to arsenic molar ratios (up to 10:1) may be needed to achieve low arsenic concentrations, however, arsenic can be treated at lower iron to arsenic ratios. RRC is currently being refined in the bench-scale trials where the iron to arsenic ration is <1. Should additional iron be needed for the CWTS, it could be passively incorporated by selecting iron-rich soils found locally.

A CWTS would be constructed on Site by constructing the CWTS into the current location of the LDSP and backfilling any unused area in the pond with local sediment (see Drawing number ECA22YT00233-C-300 in Appendix M). The CWTS would be made of flat-bottomed rectangular treatment cells where substrates and plants can be added to create a wetland environment to promote the treatment of primarily arsenic. An elevation change across the area will need to be designed into the CWTS, such that multiple terraced cells may be considered with cascades in between the cells which would be beneficial for promoting or maintaining aerobic conditions.

Assumptions used for LDSP CWTS design are:

- Eagle Pup WRSA seepage will flow through a rip rap lined channel (Ditch B) to convey water to the purposed CWTS at the LDSP. This channel will provide aeration to precipitate elements as oxides.
- Water from Ditch B will first flow to a retention basin upstream of the CWTS.
- The CWTS will be designed to be aerobic to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
- The CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design.
- In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary. The embankments of the wetlands will be a 2.5:1 slope.

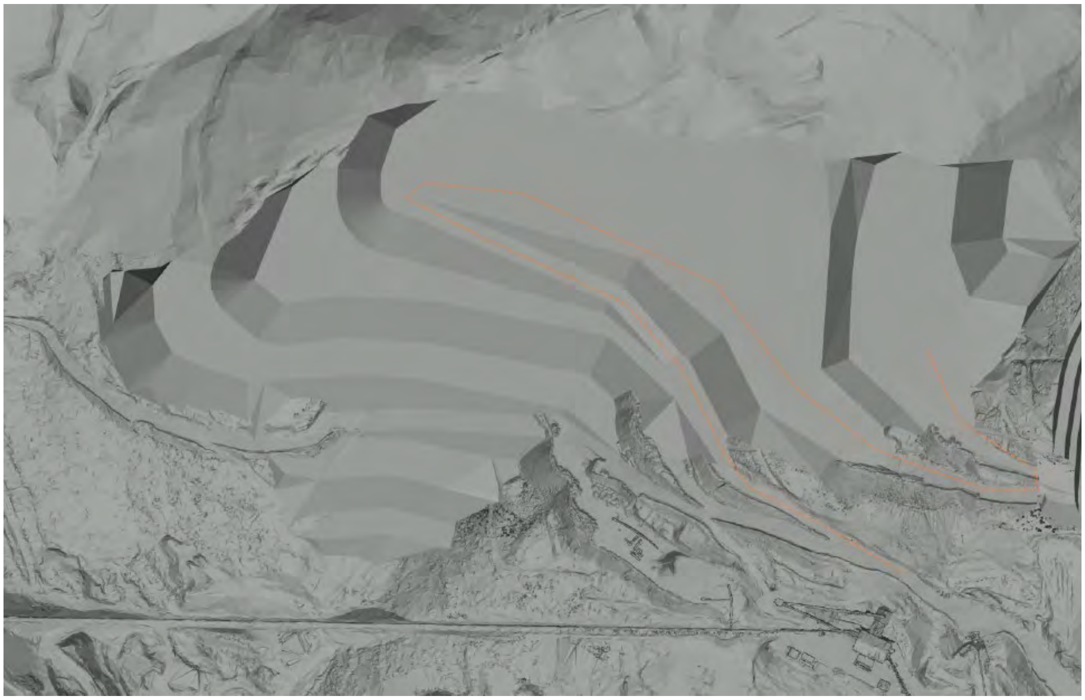
- Flow channels from retention basin into CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with rip rap. Bottoms of wetland cells are level, but there must be a height difference between the retention basin and first cells and between first and second cells to provide aeration of the water.
- Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.
- Flow from the retention basin will exit through the spillway channel into Ditch C. The spillway outlet will be cut down to the elevation of the retention basin.
- Cells should be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments to ensure that water requiring treatment in the CWTS remains in the CWTS flow path.
- The CWTS will be planted with local plants, to the greatest extent possible.

8.9.2.2 Earthworks

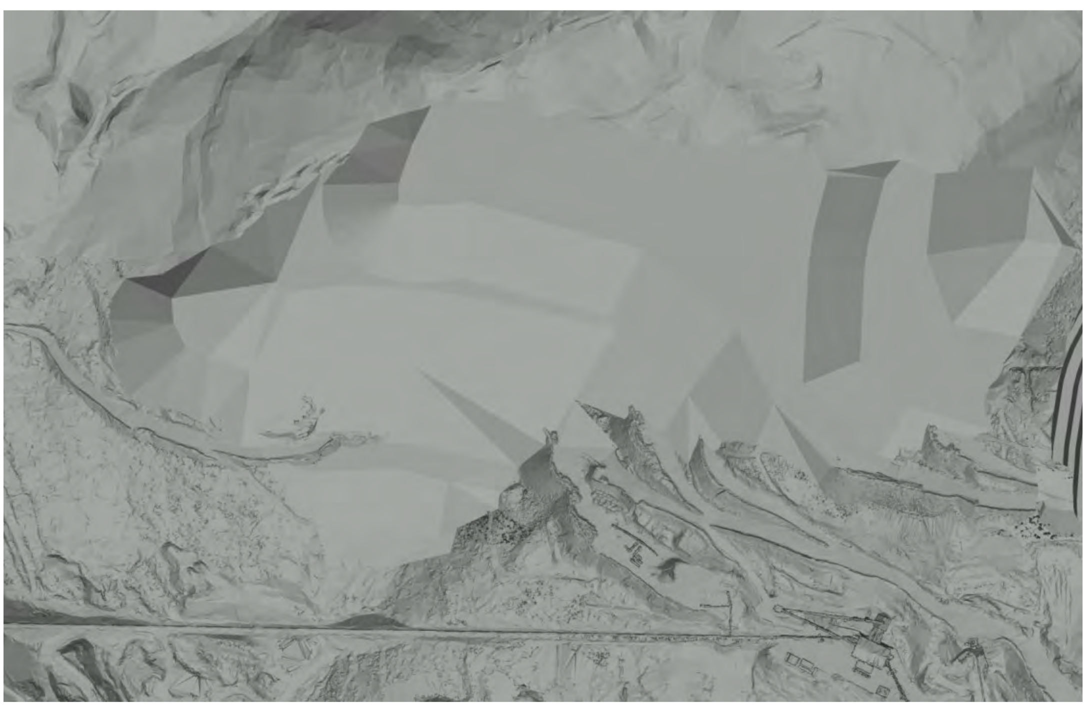
The Eagle Pup WRSA will be constructed so that the final landform will achieve the overall slope design criteria 2.5:1 slope at closure. Additionally, and in accordance with QZ14-041-1, waste rock bench faces will also be regraded so that no area is steeper than a 2.5:1 slope. For the end of mine EP WRSA configuration, approximately 3.4 Mt of waste rock will need to be cut and pushed to satisfy the earthworks objectives for stability. For the 2-year peak estimate (i.e., 2024), to achieve a 2.5:1 slope on all bench faces, approximately 2.9 Mt of waste rock will need to be cut and pushed.

To support these earthworks, a ramp will be utilized for recontouring and cover placement (see Section 8.9.2.3), working from the top lift down. These recontouring plans for the 2-year and End of Mine configurations are presented in Figure 8-5 and Figure 8-6, respectively. At the End of Mine, the additional material at the toe of the Eagle Pup WRSA, due to 2.5:1 sloping of the bottom bench face, will require additional rock drain construction for a total length of approximately 30 m beyond the final dump toe (Figure 8-7).

As part of the final recontouring, the sides of the dump will be tied into the surface water management features/ditches. The flat areas will be compacted, if necessary based on the results of reclamation research (see Section 10.2) and cover modelling, to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, in any case some fraction of the WRSA will be compacted in the areas where grading is being performed or areas that were not compacted by wheel traffic. This preparation will allow for the cover to be placed efficiently across the entire dump, by placing cover material on higher benches and pushing the material down toward the lower bench.

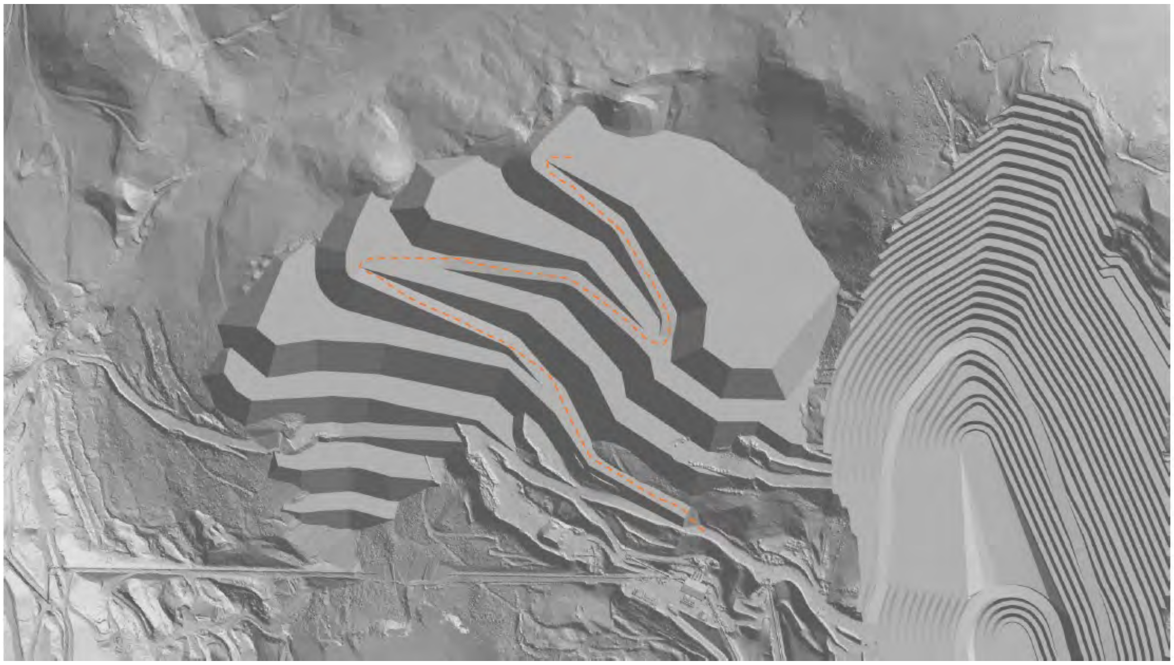


Access for Recontouring

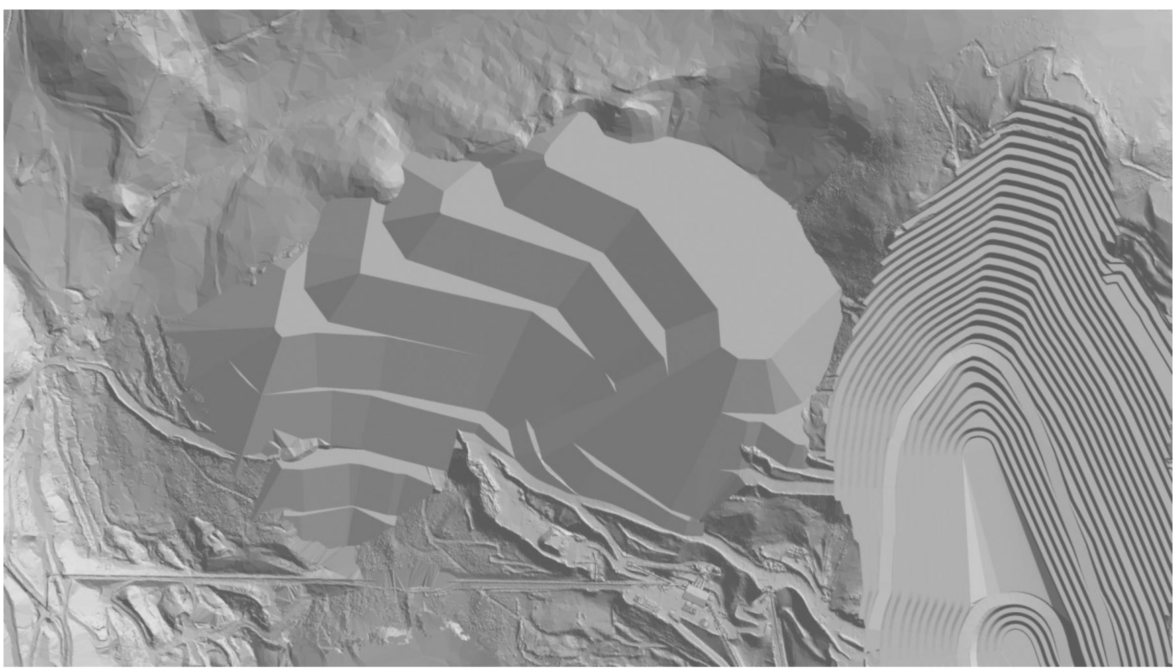


Final Landform at 2.5:1 Slope

Figure 8-7: Eagle Pup WRSA Recontouring Plan (2024)



Access for Recontouring



Final Landform at 2.5:1 Slope

Figure 8-8: Eagle Pup WRSA Recontouring Plan (End of Mine)

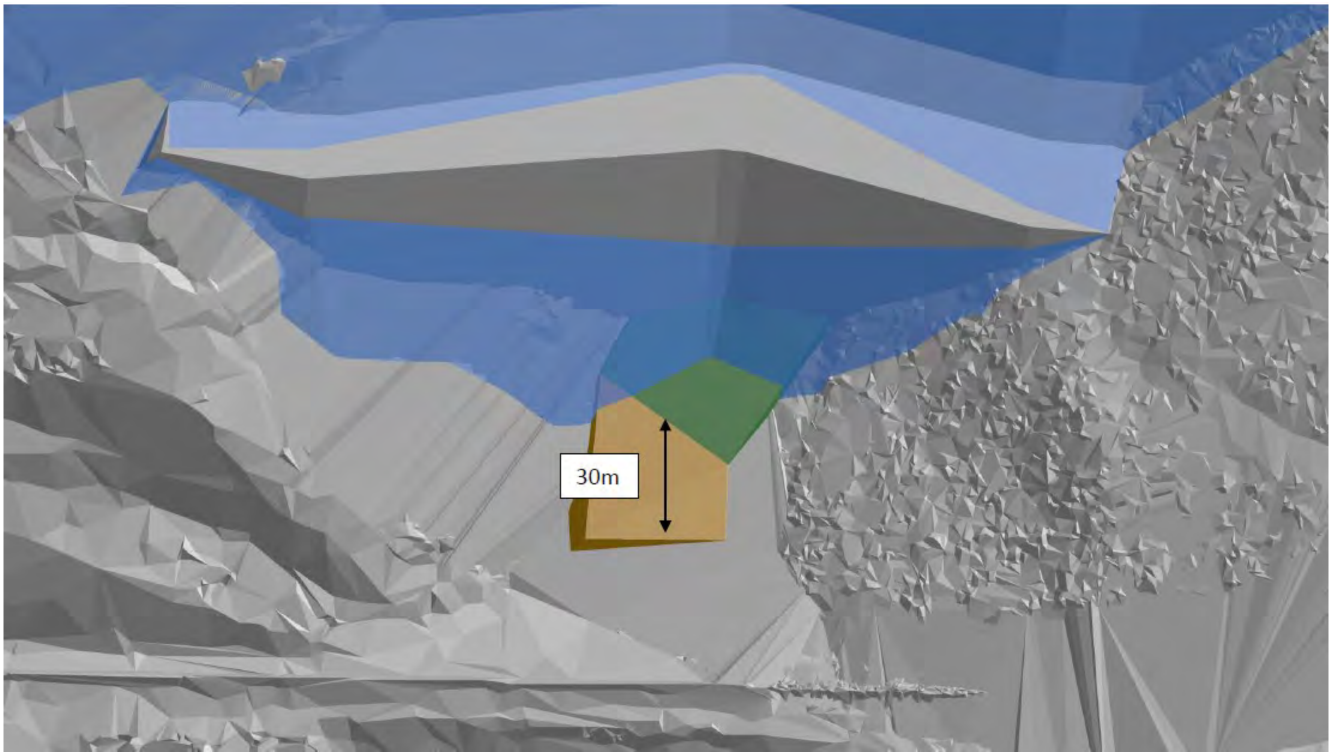


Figure 8-9: Eagle Pup WRSA Rock Drain Extension (End of Mine)

8.9.2.3 Cover Construction

As with the HLF, the EP WRSA design concepts is a 0.5 m store-and-release cover constructed with locally available top soil and tailings/colluvium. The modelling and design work conducted for this facility is the same as the Base Case described in Section 8.8 Heap Leach Facility Closure Measures: Cover Construction. The ongoing cover trails at the PG WRSA will inform the cover design for the EP WRSA (see Section 10.2). Additionally, previous modelling and sensitivity analyses conducted (O'Kane 2014) found very little difference in the performance of the Base Case cover design whether it was covering heap or waste rock materials.

8.9.2.4 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from progressive reclamation (see Section 7.4) and reclamation research trials (see Section 10.1) currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.10 PLATINUM GULCH WASTE ROCK STORAGE AREA

8.10.1 Closure Objectives and Criteria

Closure objectives for the Platinum Gulch WRSA are to ensure long-term physical stability to minimize erosion, subsidence or slope failure; ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria and that area is able to withstand severe climactic and seismic events.

8.10.2 Closure Measures

8.10.2.1 Passive Water Treatment

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Eagle Mine. CWTS evaluations are being advanced to fulfill site-specific objectives for passive treatment at the Eagle Mine site for waste rock drainage (Platinum Gulch and Eagle Pup). Using predicted closure water quality from each source, each CWTS was sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of constituent removal as the water is treated as it passes through the CWTS, based on treatability of the compound and hydraulic retention time. Removal rate coefficients are based on the treatability of a specific constituent and the HRT of the system, both of which are site-specific based on water chemistry, wetland designs, and characteristics of the system. Removal rate coefficients will be refined through bench-scale and pilot-scale work (see Section 10.4), which will provide the information for final full-scale sizing.

The PTS for the Platinum Gulch WRSA will utilize water conveyance infrastructure already established, such that the seepage will flow to Ditch A which will convey flow to a PTS (Figure 1-2). The preliminary design parameters for the Platinum Gulch CWTS are summarized in Table 8-3. Further detail on design parameters is provided in Appendix M.

Table 8-7: Preliminary Design Parameters for the Platinum Gulch CWTS

Parameter	Design Basis	Source/Rationale
Design	Aerobic	Based on Ensero's experience
Arsenic Concentration	0.1751 mg/L	P75 Predicted water quality by Lorax (May 2029)
Flow Rate	2303 m^3/day	Adjusted P75 Predicted flow rate by Lorax (May 2029)
Treatment Objective	0.053 mg/L	WUL EQS for As
Proxy Removal Rate Coefficient	0.13 day^{-1} (Zero order reaction kinetics)	Pilot-scale study for a proxy site
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended

Parameter	Design Basis	Source/Rationale
		substrate type is currently under investigation in bench-scale trials.
Water Depth for Aerobic CWTS	10 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type is currently under investigation in bench-scale trials.
Treatment Area	0.86 ha	Estimated from month of highest load and wetland size (May)
Approximate amount of construction fill required for CWTS pond creation	140,000 m^3	Estimate calculated by AutoCAD Civil 3D. General fill, readily available from site.
Approximate amount of substrate required for CWTS fill	4,100 m^3	Geometric volume calculation based on CWTS cell dimensions

The preliminary PG CWTS was sized using paired arsenic concentrations and adjusted flow data for May 2029 to meet the WUL EQS for arsenic (0.053 mg/L). Year 2029 was selected for the preliminary sizing of the PG CWTS as it represents a peak year for flow to the PTS, which combines Eagle Pit dewatering and waste rock facility seepage flows. The P75 water quality for May 2029 was used as the design basis as May had the highest arsenic load to the wetland and required the largest wetland size. Using the aerobic proxy removal rate coefficient for arsenic, a 0.86 hectare full-scale wetland may be required to treat the PG water to the WUL EQS target for arsenic. The CWTS size will be further refined and evaluated as the design and testing of the CWTS advances.

For the treatment of arsenic in an aerobic CWTS, the molar ratio of iron to arsenic in the water is an important factor to facilitate arsenic removal. A review of the PTS 2029 water chemistry data indicated that the iron to arsenic molar ratio ranged from 0.41-0.91 (in the P75 water chemistry scenario) for the open water season. A similar iron to arsenic molar ratio (0.58) is currently being testing in the bench-scale trials (see Section 10.4). Higher iron to arsenic molar ratios (up to 10:1) may be needed to achieve low arsenic concentrations; however, arsenic can be treated at lower iron to arsenic ratios. Should additional iron be needed for the CWTS, it could be passively incorporated by selecting iron-rich soils found locally.

A CWTS would be constructed on Site by both digging down into the existing soils and placing compacted fill to create flat bottomed rectangular treatment cells where substrates and plants can be added to create a wetland environment that promotes the treatment of primarily arsenic (see Drawing number ECA22YT00233-C-302 in Appendix M). With the elevation change across the area, an extended, rip rap covered slope/cascade will be constructed between the cells which will be beneficial for promoting or maintaining aerobic conditions. Substrate material was analyzed prior to being tested in the in-progress bench-scale trials to inform suitability prior to use in the planned on-site pilot-scale system. As the design of the CWTS advances, any additional material used in the CWTS (e.g., rip rap for cascades) will also need to be analysed to determine its suitability for use prior to construction. Further information on test pits results, ease of construction, and areas of permafrost can be found in Ensero 2022a.

Assumptions used for PG CWTS design are:

- PG WRSA seepage will flow through a rip rap lined channel (upper Ditch A) to convey water to the purposed CWTS. This channel will provide aeration of the water so that the water is oxygenated to support precipitation of arsenic as oxides.
- Water from upper Ditch A will first flow to a retention basin upstream of the CWTS.
- The CWTS will be designed to be aerobic to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
- The CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design.
- In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary. The embankments of the wetlands will be a 2.5:1 slope.
- Flow channels from the retention basin into the CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with rip rap. Bottoms of wetland cells are level, but there must be a height difference between the first and second cells to promote flow and provide aeration of the water.
- Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.
- Cells should be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments.
- The CWTS will be planted with local plants, to the greatest extent possible.
- The sub-base of the CWTS will require components to protect against thawing of permafrost. This will include (but not limited to) a foundation consisting of compacted gravel with low fines content and a layer of extruded polystyrene insulation.

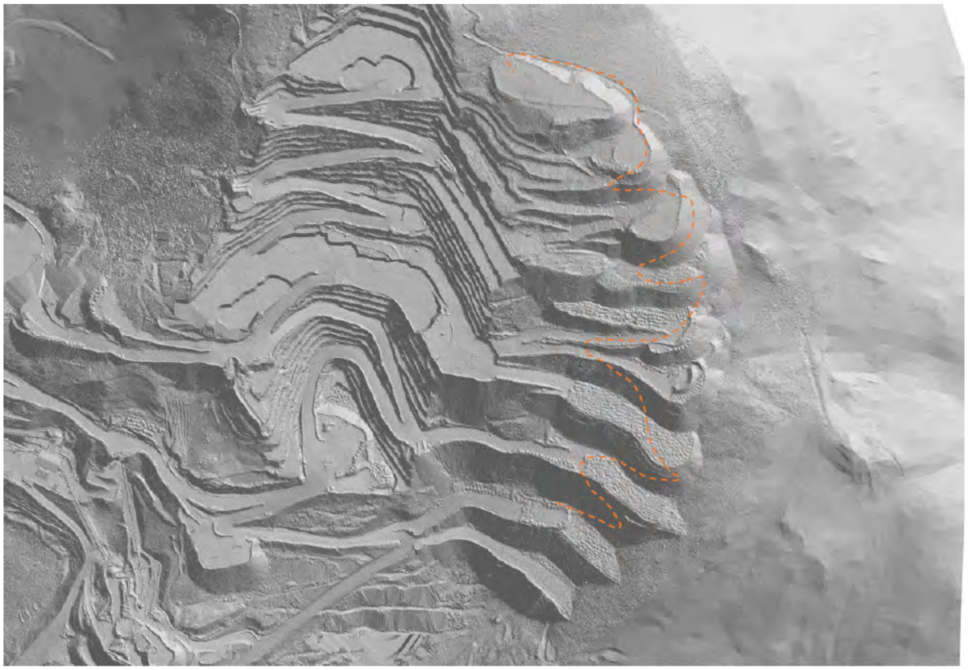
The PTS for the PG WRSA will be used as demonstration scale system during operations. Details of the passive treatment research and schedule are described further in Section 10.4.

The PTS for the PG WRSA will be used as demonstration scale system during operations. Details of the passive treatment research and schedule are described further in Section 10.4. During demonstration scale phase, PTS outflow will continue to be routed to the operational LDSP until it can be demonstrated that the system meets discharge criteria. During the initial closure phases, this discharge may be routed to the pit, or may be discharged to Haggart Creek after treatment in the PG PTS.

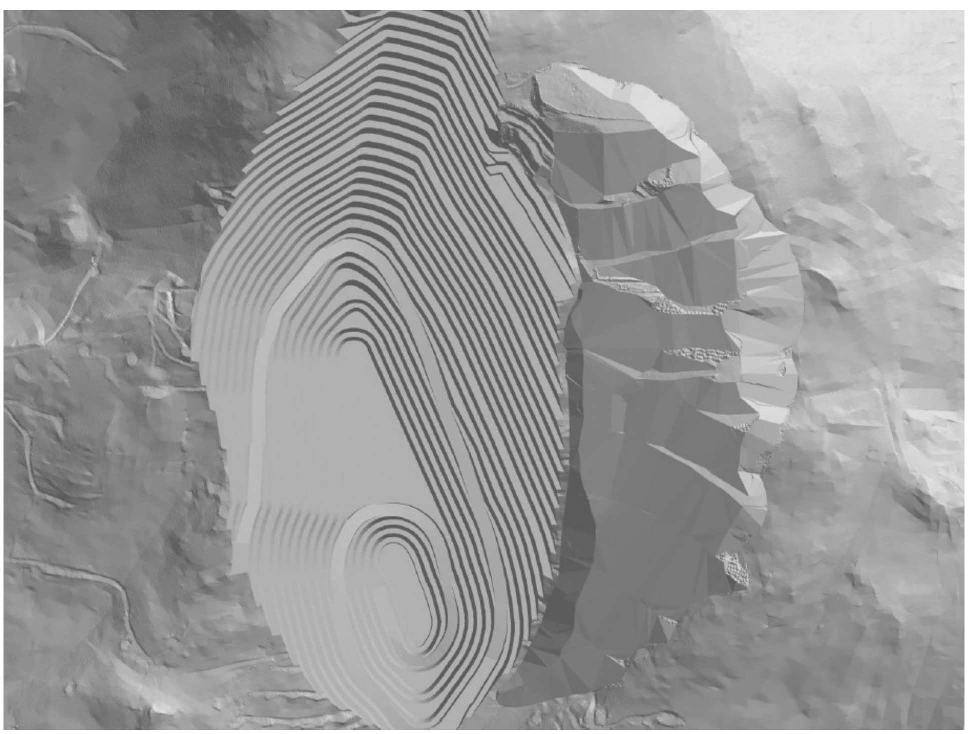
8.10.2.2 Earthworks

The Platinum Gulch WRSA will be constructed so that the final landform will achieve the overall slope design criteria 2.5:1 slope at closure. Additionally, and in accordance with QZ14-041-1, waste rock bench faces will also be regraded so that no area is steeper than a 2.5:1 slope. For the end of mine PG WRSA configuration, approximately 1.6 Mt will need to be cut and pushed. Potential access to achieve the resloping and cover placement (see Section 8.10.2.3) could require creating a 15 m wide, 15% gradient ramp along the southern half of the dump which would allow for the north half to be sloped. The south could then be sloped from top to bottom with the removal of the ramp. Recontouring plans for Platinum Gulch WRSA are presented in Figure 8.8. At the End of Mine, the additional material at the toe of the Platinum Gulch WRSA due to 2.5:1 sloping will require additional rock drain construction 60 m beyond the final dump toe (Figure 8.9).

As part of the final recontour, the sides of the dump will be tied into the surface water management features/ditches. The flat areas will be compacted, as necessary, based on the results of reclamation research and cover modelling, to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, in any case, some fraction of the WRSA will be compacted in the areas where grading is being performed or areas that were not compacted by wheel traffic. This preparation will allow for the cover to be placed efficiently across the entire dump, by placing cover material on higher benches and pushing the material down toward the lower bench.



Access for Recontouring



Final Landform at 2.5:1 Slope

Figure 8-10: Platinum Gulch WRSA Recontouring Plan

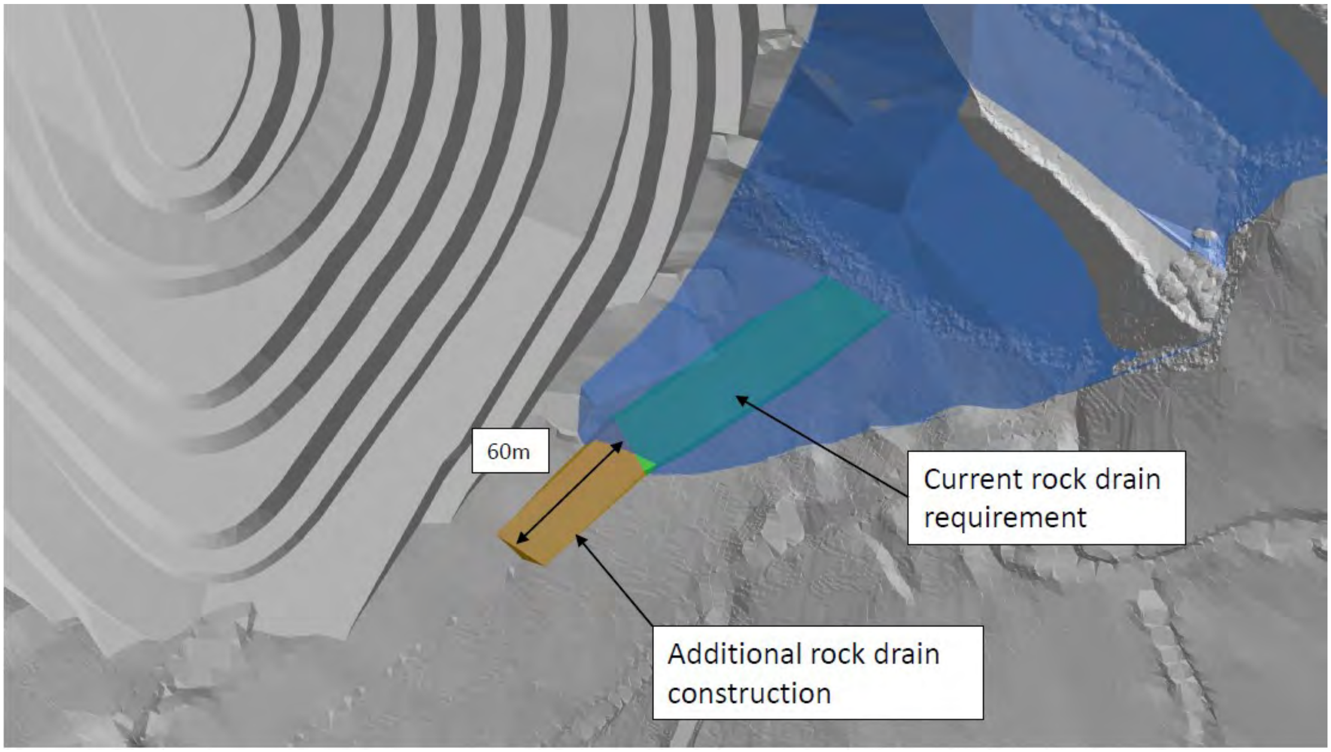


Figure 8-11: Platinum Gulch WRSA Rock Drain Extension

8.10.2.3 Cover Construction

As with the HLF and EP WRSA, the design concept is a 0.5 m thick store-and-release cover constructed with locally available top soil and placer tailings/colluvium. The ongoing cover trails at the Platinum Gulch WRSA will inform the cover design for the PG WRSA (see Section 10.2). Additionally, previous modelling and design work conducted for this facility is the same as the Base Case described in Section 8.8 Heap Leach Facility Closure Measures: Cover Construction. Modelling and sensitivity analyses conducted (O'Kane 2014; Appendix E) found very little difference in the performance of the Base Case cover design whether it was covering heap or waste rock materials.

8.10.2.4 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from progressive reclamation (see Section 7.4) and reclamation research trials (see Section 10.1) currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.11 TEMPORARY ORE STOCKPILES AND PADS

8.11.1 Closure Objectives and Criteria

Closure objectives for ore stockpiles will ensure long-term physical stability to minimize erosion or slope failure. After all the required material is used from the reclamation stockpiles and the ore stockpile, these areas will be regraded and re-vegetated for long term physical stability, and to ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria.

8.11.2 Closure Measures

8.11.2.1 Earthworks

The ore stockpile will be scraped to collect, as much as practical, any residual ore materials, which can be added to the HLF (which will still be in gold recovery mode), and the area contoured to allow drainage to occur, according to the design criteria. Approximately 0.2 m of growth medium will be placed to allow revegetation to occur.

8.11.2.2 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from progressive reclamation (see Section 7.4) and reclamation research trials (see Section 10.1) currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.12 INDUSTRIAL INFRASTRUCTURE

8.12.1 Closure Objectives and Criteria

The objectives for decommissioning and demolition of the mine infrastructure are to ensure physical stability and to remove any potential hazards and threats to the public safety and health. This includes:

- Decommissioning of facilities in a safe manner
- Ensuring physical stability of any remaining structures

8.12.2 Closure Measures

8.12.2.1 ADR Process Facility

The process facilities are set on concrete pads and foundation bases to support the ADR plant, recovery plant, admin facility and assay lab. Internal equipment is supported on steel frames along with elevated concrete piers.

The decommissioning and demolition of the ADR facility will include:

- Removal and proper disposal of hazardous reagents, chemicals and materials
- Decommissioning of mechanical equipment

- Removal of mechanical equipment
- Removal of electrical equipment, motors and controls
- Demolition of steel structures
- Demolition of concrete slabs

The process facility will be cleared, bulk earthworks will be completed and the foundations will be broken up and buried in situ. Any foundations with rebar will be left in place.

Table 8-14: ADR Facility Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
ADR plant / Administration Facility	Pre-engineered steel building	42.3m x 17.9m	Carbon columns Screens Tanks Pumps Misc. equipment	Concrete foundation Concrete grade wall Structural steel columns Elevated concrete floors	Insulation Reagents Chemicals
Recovery plant	Pre-engineered steel building	102m x 35m	Refinery Carbon regen kiln Electrowinning cells Misc. equipment	Concrete foundation Concrete grade wall Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Insulation Reagents Chemicals
Assay lab	Pre-fabricated modular structure	38m x 18m	Lab equipment Chemical disposal equipment HVAC	Wood framing Insulated metal clad walls Ethylene propylene monomer roofing on plywood	Insulation Reagents Chemicals

8.12.2.2 Mine Water Treatment Plant

The mine water treatment plant, currently scheduled for complete construction and commissioning in Q42022, will consist of standard process equipment (tanks, filters, pumps) housed inside a pre-engineered building on a concrete foundation. Once heap drain down is complete and water quality criteria through the PTSs have been achieved for a continuous period of five years, the water treatment plant will be decommissioned and removed. It is anticipated that significant value will be retained in the WTP process equipment. For closure costing purposes, decommissioning and demolition of the water treatment plant includes:

- Removal and proper disposal of hazardous reagents, chemicals and materials
- Decommissioning of mechanical equipment
- Removal and salvage of mechanical equipment
- Removal of electrical equipment, motors and controls
- Removal of fabric sprung structure including steel support structures

- Removal/demolition of concrete support and foundation

Table 8-15: Water Treatment Plant Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Water Treatment Plant	Fabric sprung structure	68.4m x 33.53m	Tanks Pumps Filters Misc. equipment	Concrete foundation Concrete grade wall Structural steel columns	Insulation Reagents Chemicals

8.12.2.3 Crushing and Conveyance Facilities

The crushing and conveyance facilities consists of two crushing buildings and a series of conveyance systems (i.e., covered conveyors and transfer stations) connecting the two buildings. The crushing facilities are set on concrete foundations along with the internal supporting steel structures.

The decommissioning and demolition of the crushing buildings will include:

- Disconnection of power supply
- De-dusting of the area via certified and safe methods
- Decommissioning and disassembling of all conveyor components
- Removal / demolishing any structural supports
- Removal / demolishing any concrete supports
- Backfill pad with colluvium to establish stable landform

The decommissioning and demolition of the conveyance systems will include:

- Disconnection of power supply
- Decommissioning and disassembling of all conveyor components
- Removal / demolishing any structural supports
- Removal / demolishing any concrete supports

Table 8-16: Crushing and Conveyance Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Primary crushing building	Concrete construction	38 m x 19 m	Primary crusher Primary apron feeder Secondary feed conveyor	Concrete walls, foundations Steel platforms Rebar	Dust

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Secondary / tertiary crushing building	Pre-engineered steel building	30 m x 21 m	Secondary and tertiary crushers Feed conveyors Transfer conveyors Dust collectors Plate work 25t overhead crane	Concrete foundation Concrete grade wall Elevated concrete piers Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Dust
Conveying / (No building)	n/a	n/a	Overland conveyors Grasshopper conveyors Radial stackers	n/a	Dust

8.12.2.4 Power Generation and Transmission Infrastructure

A 45 km long power supply line at 69 kV connect to the Yukon Energy Corporation power grid, via a tap point approximately 25 km southeast of the property. The power line is supported on wooden poles constructed parallel to the road access and running to the mine site substation and all the facilities. Power is distributed via two-step down substations and to all the process control, instrumentation and communication systems.

The decommissioning and demolition of the power distribution infrastructure will include:

- De-energizing the main power line and ensuring all power lines are grounded
- Securing any crossings of transmission lines and road
- Disconnection of conductors from insulators, and winding the conductors on reels to be transported off site
- Disassembling of supporting structures from their foundations
- Dismantling of all cross arms, fittings, insulators, pole hardware and guys to be transported offsite
- Removal of grounding rods, grounding wires, and guy anchors
- Backfilling of foundation anchor holes
- Removal and disposal of materials off site
- Demolition of substations foundations, concrete buried in situ. Any concrete with rebar will be left in place.

Table 8-17: Power Generation and Transmission Infrastructure Demolition Summary

Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Power line	n/a	45 km	45 km of 69 kV power	Wooden poles	None

Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
			line Anchors Power line hardware		
69 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	Waste oils and lubricants
25 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	Waste oils and lubricants
Overhead power lines	n/a	n/a	25 kV power lines Anchors Power line hardware	Wooden poles	None

8.12.2.5 Explosives and Magazines

At closure, unused explosives that remain on site will be returned for credit and the explosives magazines and other equipment will be returned to the explosives' supplier. The magazine is a vendor supplied skid trailer that will be transported offsite during closure.

8.12.2.6 Truck Shop

Maintenance on heavy duty equipment including haul trucks, loaders and dozers is completed within an insulated truck shop complete with an inbuilt crane system, and 5 bays including a wash bay and tracked vehicle bay. Once active mining is complete and the majority of the large mining fleet is no longer required, the truck shop will be dismantled.

The decommissioning and demolition of the truck shop will include:

- Removal and proper disposal of hazardous reagents, lubes/oils, chemicals and materials
- Decommissioning of mechanical equipment
- Removal of mechanical equipment, overhead crane
- Removal of electrical equipment, motors and controls
- Demolition of steel structures
- Demolition of concrete slabs

Table 8-18: Truck Shop Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Truck shop and mine dry	Pre-engineered steel building	56 m x 26 m	Wash bay with pressure washer Repair bays Electrical equipment Mechanical equipment Compressor 20t overhead crane	Concrete foundation Concrete grade wall Elevated concrete piers Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Insulation Solvents

8.12.2.7 Fuel Storage Tank Area

Diesel is delivered via trucks to storage tanks located near the camp and generator area. Propane is stored locally to the camp facilities and the ADR.

Table 8-19: Fuel Storage Tank Area Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Diesel storage	n/a	5 x 75,000 L Tanks 1 x 35,000 L Tank 2 x 11,000 L Tank	Tanks Pumps	Earthen berms Containment areas	Diesel sludge
Propane	n/a	3 x 5000 gal Tanks	Tanks Pumps	Concrete foundations Containment areas	Propane

8.12.2.8 Equipment

There will be limited fixed or mobile equipment on site at the end of mine life when reclamation measures are complete. Any equipment present at closure not being used by on-going exploration activities will be removed from the site and either sold or salvaged. Equipment that cannot be sold or salvaged will be hauled off site to a licensed landfill.

8.12.2.9 Industrial Reagents and Hazardous Products

Any remaining industrial reagents or hazardous products will either be returned to the supplier or disposed of by a licensed third-party contractor.

8.12.2.10 Water Supply and Wastewater Structures

Water supply and wastewater conveyance include potable and sewage treatment structures are part of the camp and will be removed with the camp facilities.

The fresh water and firewater systems will be removed at closure if exploration activities are no longer anticipated. This would include the dismantling of the potable water treatment plant and distribution system.

8.13 WATER MANAGEMENT STRUCTURES

8.13.1 Closure Objectives and Criteria

As stated in the Yukon Mine Site and Reclamation Closure Policy Financial and Technical Guidelines, the main closure objective is “to ensure decommissioning of water retention and sediment control structures, and the appurtenances, in such a way that drainage at, and adjacent to the site, is stable in the long term.” Closure objectives will also ensure flows are conveyed into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions.

8.13.2 Closure Measures

8.13.2.1 Sediment and Erosion Control Structures

As described in Section 8.6, existing sediment and erosion control structures will be utilized in the transition to permanent closure, with new sediment control structures to accommodate any new surface water features added. As the covers and reclaimed areas reach maturity, the need for and reliance upon sediment control structures and certain built watercourses will no longer be necessary.

8.13.2.2 Lower Dublin South Pond

The Lower Dublin South Pond will be converted to a PTS at closure (see Section 8.9.2.1).

8.13.2.3 Events Pond

After cyanide concentrations in the heap discharge meet criteria, the Events Pond will be converted for use as a PTS (see Section 8.8.2.5).

8.13.2.4 Main Water Conveyance Channels

As part of the closure plan, Ditches A, B and C will remain in some capacity as they form the network for conveying waste rock and pit seepage, as needed, to PTSs or treated water to Haggart Creek. Thus, closure measures will include reviewing any channel stability issues observed during operations, with the intention of modifying the designs as necessary to maintain stability over the long term. A new ditch will be constructed to convey discharge from the HLF PTS to Haggart Creek (see Section 8.8.2.5).

8.14 HAGGART CREEK ACCESS ROAD

At closure, the Haggart Creek Road will be left in place for future access to the property by the public and existing users.

8.14.1 Access Control

The main access road will remain gated and locked during the active reclamation activities. Access to the mine site will remain restricted and all visitors will be required to sign in and out at the gate house. Once the reclamation activities have been completed, the gate, gate house, and fencing will be removed.

8.14.2 Closure Objectives and Criteria

The responsibility for maintaining the existing Haggart Creek Access Road will be fully returned to Yukon Government to allow public access to meet the following closure objectives: physical stability, ecological viability and sustainability.

8.14.3 Closure Measures

The Haggart Creek Access Road will remain at closure; however, site access and haul roads will be reclaimed. Access to the Potato Hills will be provided (as requested by the FNNND), as well as other mine access roads associated with on-going and historical exploration activities that are covered under separate permit authorizations. However, long-term maintenance of this access is not a requirement nor a part of this RCP. The on-site access and haul roads will be re-contoured, scarified, and revegetated. All culverts associated with these roads that are not used for other purposes will be removed and the stream channels will be stabilized.

8.15 CAMP

8.15.1 Closure Objectives

The closure objective is to remove camp facilities to achieve physical stability, ecological viability and sustainability.

8.15.2 Closure Measures

Once the site is no longer required for mine operations or exploration activities, all equipment and structures will be removed; the septic system will be pumped of contents broken down and backfilled; the area will be re-contoured to stable grades and topography and pre-mining drainage patterns will be restored to the extent feasible and practical. Salvage soil material will be spread directly by dozer pushing from the windrow berms. Salvaged soil that has been stored in designated stockpiles will be hauled by dump trucks and placed at the disturbance sties to be spread by dozer.

Once the disturbance area becomes available for permanent reclamation, it will be revegetated with plant species that are typical of the projected post closure ecosystem (Stantec 2011b), generally native trees and shrubs. Interim reclamation, weed control and surface erosion control of the site will be achieved by seeding with native grass, legume and forb species as listed in Section 10, Table 10-1 and Table 10-2. A native seed collection program will be implemented during the life of the mine to ensure availability of stock.

8.16 EXPLORATION SITES AND TRAILS

The majority of the exploration sites and trails will be removed or encompassed within the planned works. However, any exploration sites and trails required for ongoing exploration activities will remain available for future use. Yukon Government currently holds a bond from VGC for costs associated with reclamation of exploration programs.

8.17 SOLID WASTE STORAGE AREA

8.17.1 Closure Objectives and Criteria

The closure objective is to achieve physical and chemical stability, ecological viability and sustainability of decommissioned solid waste storage area.

8.17.2 Closure Measures

All solid waste will be removed to landfill or removed to appropriate offsite licensed landfill.

8.18 LANDFILL

8.18.1 Closure Objectives and Criteria

The onsite landfill provides a place to remove potential threats to public health, decommission facilities in a safe manner, and ensure physical stability.

The closure objectives are to achieve physical and chemical stability, ecological viability and sustainability.

8.18.2 Closure Measures

Landfill areas will be compacted and capped.

8.19 LAND TREATMENT FACILITY

8.19.1 Closure Objectives and Criteria

The onsite land treatment facility will provide a place to remove potential threats to public health, decommission facilities in a safe manner, and ensure physical stability.

The closure objectives are to achieve physical and chemical stability, ecological viability and sustainability.

8.19.2 Closure Measures

The land treatment facility (LTF) is a permitted facility to treat hydrocarbon contaminated soil. Contaminated solids from fuel/oil spills during operations will be treated in this facility to appropriate levels of remediation before being used as industrial fill as per regulatory requirements.

The closure of this facility is subject to the submission of a formal Closure Plan to YG, along with sampling results which demonstrate the final concentrations of contaminants in the soil being treated. It is expected that upon final closure of the entire site, dismantling and decommissioning activities may reveal or result in soil contamination requiring the relocation of contaminated soil to the LTF and an undetermined number of months of treatment to achieve desired remediation levels. As such, the LTF Closure Plan and final sampling results will be prepared and submitted sometime after final closure of the mine site has begun.

Generally, once the desired contaminant levels have been reached in the final volumes of treated soil, and the Closure Plan has been approved by YG, the soils will be spread at approved locations at the site, recontoured in place and revegetated. If required, additional overburden may be hauled and used as cover material and growth media for revegetation.

8.20 BORROW PITS

8.20.1 Closure Measures

The majority of the borrow pits are located within the footprint of other infrastructure components (i.e. HLF and the open pit) and therefore closure measures described for each respective facility will negate the need for additional measures. Borrow pits that are not located beneath infrastructure components will be stabilized and re-contoured, covered with growth media, and re-vegetated.

8.20.2 Borrow Materials Planning

- Rip-rap will be produced from clean mine rock that meets rip-rap design criteria which may include evaluation for freeze-thaw, soundness, wet abrasion, dry abrasion, and absorption.
- Stockpiles have been be created during the construction activities. In future construction areas, overburden materials will be stripped and segregated. Placer materials will also be collected, processed and used as needed.
- In general, three main reclamation materials (colluvium, placer tailings, topsoil) are anticipated to be used as cover soil or construction materials during closure.

9 PERFORMANCE UNCERTAINTY AND RISK MANAGEMENT

Closure and reclamation plans comprise a series of designs with drawings and specifications that define what will be constructed and coupled with an operating plan that describes how the constructed facilities will operate. Performance uncertainty and risk management are addressed with a failure modes and effects analysis (FMEA) that is intended to be undertaken in 2023.

The purpose and intent of the FMEA is to:

1. address risk of designs and operating procedures not achieving the design intent; and
2. minimize fiscal and environmental risk failure associated with complex, long term performance of engineered systems assembled to achieve closure.

The facilities that were considered to have a potential for high consequence failures were associated with the HLF. The FMEA process has been performed for the following components:

- HLF confining embankment
- In-Heap Pond
- Events Pond
- Liner System
- Leachate Detection/Recovery System
- Overliner Drain Fill
- Solution Collection and Delivery System
- Ore Heap

As these components will continue to be relied upon in some capacity into closure, the FMEA process has informed the closure plan development, especially in the area of heap-based events or water management events around the heap.

The FMEA consequence-severity definitions that were used covered the following categories:

- Biological Impacts and Land Use
- Regulatory Impacts and Closure
- Public Concern and Image
- Health and Safety

Specific failure modes and their effects on the mine site components evaluated led to recommendations for quality control and for potential contingency responses. Some of these have been considered and incorporated in the Environmental Monitoring, Surveillance and Adaptive Management Plan, and others are more focused on operational responses that will ensure that the facility is constructed and operated within the design criteria, which is reflected in the OMS manual specifically around the HLF.

10 RECLAMATION AND CLOSURE RESEARCH PROGRAMS

VGC has and will continue to undertake reclamation and closure research programs prior to decommissioning and closure of the Mine. Research programs (e.g., cover system performance, CWTS lab studies, bioreactor testing, and revegetation trials) have been initiated to support the closure measures. These programs would continue to be implemented, as appropriate, during temporary closure, and/or after mining operations have commenced. Further, additional closure and reclamation research programs will be implemented in the next two years, including additional engineered cover designs and test plots, growth media and revegetation trials, passive treatment research and a natural groundwater attenuation study.

10.1 REVEGETATION TRIALS

10.1.1 Peso Site Trials

Laberge Environmental Services (2012) conducted vegetation trials at the Peso Mineral Exploration Site, located on claims held by VGC and just west of the Mine but independent of the Mine site to test the viability of incorporating biochar and other soil amendments into soil to be used for the closure of the Mine. The objective of the revegetation program at Peso was thus to test the viability of incorporating biochar and other soil amendments into the site.

The Peso site, located approximately 6.5 km west of the Eagle Gold camp at Dublin Gulch was originally staked in 1910 with extensive exploration occurring from 1961 to 1965. Two disturbed areas on this site, which had not revegetated since 1962, were selected for vegetation trials: an old trench and the waste rock dump.

Laboratory analysis results from both sites indicate mineralized soil with little to no nutrient value. The waste rock soil pH is 2.6 and the trench site soil pH is 5.2. While the vegetation trials conducted at the Peso mine site have been conducted on waste rock with somewhat different chemistry than that found at the Eagle Gold Mine (i.e. Eagle Gold Mine soils are less mineralized with neutral to slightly alkaline attributes), there is still much to be gained from the findings, in that the Peso site is only several kilometers away, at a similar elevation and physiography, with the same candidate species and experiencing the same climate conditions. The study results will help guide the ongoing revegetation trials at the Mine site.

Several plant species were chosen for the reclamation seed mix due to their tolerances to acidic, low nutrient levels, drought and/or heavy metal conditions in the growth medium and are presented in Table 10-1 and Table 10-2 below. Seeds, hand collected from local alder and hedysarem, were also added to the seed mixture.

Table 10-1: Peso Waste Rock Site Selected Seed Mix for Reclamation

Festuca ovina	Sheep Fescue
Deschampsia caespitosa	Tufted Hairgrass
Poa glauca	Glaucous bluegrass
Agrostis scabra	Tickle Grass

Table 10-2: Peso Trench Site Selected Seed Mix for Reclamation

Festuca ovina	Sheep Fescue
Deschampsia caespitosa	Tufted Hairgrass

Poa alpine	Alpine bluegrass
Trisetum spicatum	Spike Trisetum

Three blocks consisting of five 1m x 1m plots were established at each site during the summer of 2012. A total of 30 plots were seeded with various amendments at the Peso site in the fall of 2012. Amendments included:

- none,
- compost and biochar,
- compost, biochar and leonardite,
- compost, biochar and dolomite, and
- compost, biochar, dolomite and leonardite.

Dolomite was added to the waste rock dump plots only.

The revegetation plots were assessed annually for species present, number of individuals and overall health of the vegetation within each plot. 2018 was the final year of this program and the work undertaken at that time included additional analysis of soil conditions, metals concentrations of plant tissues, height of above ground growth and rooting depth. The results of the revegetation trial are included in Appendix A.

At the completion of the program, it was found that the plots that were seeded but received no amendments support very little, if any growth over the six-year trial. This was consistent with observations of the general area. Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and help to build up the soil. By year two most of the treated plots supported relatively healthy growth of various grass species. Hedysarum germinated in some plots during year one but was absent in the following years. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighboring forest. Grasses were also dying back in the plots where alder was not prevalent.

In the absence of a suitable growth media or a soil amendment, all nontreated seeded plots produced no to very little growth. The acidic soil conditions at the Peso trench and the waste rock sites present a challenging scenario in relation to the site conditions at the majority of other disturbed sites in the Dublin Gulch area. However, the success of using compost and biochar to achieve robust plant growth on these highly mineralized and acidic soils, especially on the waste rock dump, indicates that revegetation can be successful with minimal effort and resources. Native plants were able to grow on the majority of the treated plots, including on the highly acidic (pH 2.6) Peso mine waste rock dump.

In summary, these trials have proven successful. By using appropriate species and soil amendments, healthy plants have grown, propagated and even thrived on acidic, highly mineralized soils. Revegetation trials are now continuing as part of progressive reclamation revegetation program, as described in Section 7.4. As described and shown in photos in Section 7.4, the results of 2019 revegetation program suggest that the revegetation on site with native species may be successful without amendment addition.

10.1.2 Seeding Trials

Native seed trials were initiated in 2020 to evaluate the success of three native species (Laberge 2020b). Two trial plot locations were selected on slopes of laydown area south of the security gate at km 43 for south and north facing aspects. In each location trial plots were constructed for three species, with duplicates for each, for a total of six 1 m^2 plots per trial location. The species selected for the trial are *Elymus sp.* (wheatgrass), *Festuca altai* (Altai fescue), and *Achillea millefolium* (yarrow). The seeds were purchased from a local supplier (Yukon Seed and Restoration) and are harvested within the local area.

The objective was to apply 500 pure live seeds (PLS) per plot. Since the purity or the germination rate of the supplied local seed was unknown, and the seeds were not completely clean (some chaff etc was present) the amount of seed was doubled. Weights of each species of seed were determined and then an appropriate amount weighed to achieve the approximate number of seeds per plot. This worked out to 0.3 g/plot for yarrow, 1.3 g/plot for fescue and 2.0 g/plot for wheatgrass.

Prior to seeding, each plot was scarified to a depth of approximately 15 cm and any existing vegetation and large rocks were removed. Once the plots were prepared the seeds were scattered evenly throughout the square meter. The seeds were then gently tamped down to ensure good seed/soil contact. A buffer was left between each seeded plot.

Composite soil samples were collected at each site and analyzed by ALS. The coarse, near neutral soil at both sites contained no available phosphate or any form of nitrogen, and very little carbon, as is typical of mineral soils. The soil samples were also analyzed for a suite of 35 metals. Of these boron, sulfur and tin were not detected at either site. Concentrations of applicable metals were compared to the most recent Canadian Council of Ministers of the Environment (CCME) guidelines and the Yukon Contaminated Sites Regulations for agriculture and parklands. Arsenic was the only parameter that exceeded all of the guidelines and did so at both sites. Arsenic is associated with the gold bearing anomalies in the district and these concentrations reflect the natural mineralization of the Project area that have been documented in previous baseline reports.

First year of annual monitoring of the trials was conducted in July 2021. The plots were assessed for establishment of vegetation, with number of plots showing successful establishment of native species (Laberge 2021b). Annual assessments of the plots will continue to measure the progress and allow for refinement of the prescriptions and techniques for application to similar areas requiring erosion control at the Eagle Gold Mine.

10.2 ENGINEERED COVERS

The currently planned end land-use for the reclaimed HLF and WRSA at the Mine site is natural habitat (wilderness). Key design objectives for the HLF / WRSA closure cover systems include long-term geotechnical and geomorphic stability, as well as providing a medium for sustainable growth of native plants. Another key function of the HLF / WRSA closure cover systems is to reduce long-term net percolation (NP) rates to the greatest extent possible using locally available materials for cover system construction. Passive treatment systems will be designed and implemented to handle resultant environmental loadings from the HLF and WRSA post-closure seepage. Stable and adequately designed cover systems will help to minimize the loadings to the passive treatment systems.

Okane Consultants (Okane) (2014)[1] (Appendix E) completed an assessment of the anticipated hydrological performance of a base-case cover system design and is detailed in Section 8.8. An 80-year climate database comprised of daily records using local and regional meteorological data was used to estimate hydrological performance of the base-case cover system design as well as variations to the base-case design. Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

- Hydraulic properties of candidate cover system materials;
- Hydraulic properties of HLF and WRSA waste materials;
- Slope aspect (i.e. solar radiation input and snowpack accumulation / melt); and
- Slope gradient.

The overall objective of the research program for closure cover designs is to build confidence in the initial long-term cover system design performance analyses in terms of NP and to inform eventual large-scale closure cover system construction. Seven research tasks associated with engineered covers include:

Task 1: Update the conceptual model of cover performance;

Task 2: Develop a material characterization plan for candidate cover system materials;

Task 3: Conduct a material compaction trial program for candidate cover system materials;

Task 4: Conduct a material characterization of HLF and WRSA waste materials;

Task 5: Conduct enhanced meteorological monitoring on various slope aspects;

Task 6: Conduct closure cover system field trials for performance monitoring; and

Task 7: Assess the effect of high pH water treatment solids on the heap cover

For further discussion on research on engineered covers is provided in Appendix F.

Tasks 2, 4 and 5 were initiated in summer 2020. A mixed overburden and topsoil stockpile was relocated in early September 2020 to the plateau of the 1370 bench of the Platinum Gulch WRSA. The work had included: Task 2) conducting material sampling before and during cover system construction to characterize the physical and hydraulic properties of the overburden material; Task 4) planning for, procuring and beginning the installation of enhanced meteorological instrumentation, and Task 5) planning for, procuring, and completing installation of enhanced meteorological instrumentation; and Task 6) construction and instrumentation of the cover system field trial on a slope and plateau.

In summer 2021, Task 2, 5, and 6 continued. The work included: Task 2, conducting material sampling to characterize the physical and hydraulic properties of overburden material stockpiles available on site for cover system construction; and Tasks 5 and 6, which included the collection and interpretation of meteorological and

[1] OKC (O'Kane Consultants Inc.). 2014. Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas. Report no. 917/1-01 submitted to Access Consulting Group, April 28, 2014.

cover system performance monitoring data collected at the WRSA cover system trial from the onset of monitoring in October 2020 to November 31, 2021. This work is summarized in Okane 2022a.

Task 3 was initiated in summer 2022, and the on-going work includes continuation of Task 5 and 6 work. The work completed in summer 2022 included Task 3 (conducting a compaction trial program to determine compaction potential of select overburden material available on site) and Tasks 5 (planning for and procuring enhanced meteorological and cover system performance monitoring instrumentation on a north-facing cover system trial) and Task 6 (collection and interpretation of performance monitoring data collected at the 1370 bench WRSA cover system trial). An interim report (Appendix I) provides a progress summary for the period December 1, 2021 to July 31, 2022, covering the period since the previous reporting period that is summarized in Okane 2022a. Tasks 5 and 6 are planned to continue until sufficient data and information are available to complete the design for the PG WRSA cover.

A summary of the work initiated for these tasks is provided below in each task section.

10.2.1 Task 1: Update Conceptual Model of Closure Cover System Design Performance

The conceptual model of closure cover performance will be updated as monitoring and site investigation data are collected and analyzed. This will help refine the previous conceptual model of cover system performance. Monitoring and site investigation data include:

- material characterization programs (Tasks 2 and 3);
- compaction trial program (Task 3)
- meteorological monitoring on various slope aspects (Task 4);
- climate and hydrologic / hydrogeologic (Task 5 and 6; and data collected as part of the EMSAMP); and
- vegetation data (e.g., Vegetation Rooting Study).

The conceptual model has helped to direct the research program and identify key research targets. Continued studies help reduce uncertainty in model assumptions, are used to update the conceptual model and ultimately support the cover system field trial that has begun on the 1370 lift of the PG WRSA (Task 6). The conceptual model will be periodically reviewed and updated as appropriate during updates to the RCP. Ultimately, the model will improve confidence in cover system performance and provide +a basis for design as progressive cover development occurs on the WRSAs.

The current conceptual model of performance of the cover system relies on evapotranspiration (ET) and runoff mechanisms due to the site-specific climate and material factors. During periods of low evaporative potential such as spring and fall, when water surpluses (freshet and large rainfall events) are expected, runoff becomes the dominant NP control mechanism. To manage NP, cover system design components can incorporate components that enhance runoff. The 2014 modelling (Appendix E) conducted by Okane noted that runoff was strongly influenced by slope and cover system grade, and by the presence or absence of frozen ground. The update to the conceptual model will investigate ways to improve the runoff shedding performance of the cover system to manage NP during freshet. For example, increasing the grade of the benches or utilizing a cover structure that allows for better transmission of interflow of the upper unfrozen zone in the spring to improve runoff conveyance could improve performance. Given that most NP is expected to occur in the short freshet, small improvements in runoff performance during this time of year could lead to substantial overall gains in reducing annual NP. Update of the conceptual model will be informed by 1370 lift PG WRSA cover system field trial performance monitoring (Task 5, 6).

Erosion of a cover system and associated landform are a direct result of hydraulic and physical material properties, surface / slope configuration, and the runoff imparted on the system. As such, research will also be conducted to examine, and ultimately balance, runoff and erosion performance of the cover system and will be used to refine the conceptual model. For example, clays and hydrophobic soils can increase surface runoff rates, but rill and interill erosion tends to be higher in materials without coarse material. This research is being informed by material characterization (Task 2) information and the 1370 lift PG WRSA cover system field trial observations (Task 6).

The results of the research and updated conceptual model will be used to assess the cover system configurations that enhance runoff to manage NP while minimizing potential for erosion as much possible, which will then be tested during field trials. This process of closure cover research and design requires flexibility, rather than prescriptive solutions, to produce effective site-specific closure solutions.

10.2.2 Task 2: Material Characterization Program for Candidate Cover System Materials

Material characterization of potential cover system materials provides data to refine material property inputs to the conceptual and numerical models and determine suitability for use in cover system construction The objectives of the material characterization program are to:

- assess material availability and volume,
- quantify certain hydraulic properties that will control the performance of the closure cover systems,
- determine soil fertility for candidate top soil material, and
- evaluate erosion characteristics.

An initial material sampling program was conducted before and during cover system construction on the 1370 bench of the PG WRSA to characterize the physical and hydraulic properties of the overburden material. Six different zones were sampled to account for potential variability in the stockpile material. The material laboratory testing program included particle size distributions (PSDs) including hydrometer analysis, determination of Atterberg limits, standard proctor, hydraulic conductivities, and soil-water characteristic curves. Digital PSD samples were also collected. Data from the material characterization program will aid in the interpretation of performance monitoring data collected as part of the instrumentation program (Task 6). Furthermore, material characterization data serve as a critical input for numerical modelling programs that use performance monitoring data for calibration.

In general, to achieve the overall objective of the material characterization program, the sampling program evaluates three separate elements:

- material availability and volume,
- hydraulic properties, and
- erosion characteristics.

10.2.2.1 Material Availability and volume

Additional overburden stockpile material sampling was conducted in 2021 (Okane 2022b). Test pit samples and logs of six existing reclamation stockpiles that resulted from construction activities were included in the material characterization program. Sample locations were identified based on previous material investigations and site reconnaissance. Between three and six test pits or excavations were completed on each stockpile, which were sampled and logged for material layer depths, color, and initial texture analysis. A digital photographic record was developed for each test pit and the specific location documented using a GPS device. Each stockpile area was surveyed for areal extent by walking the area using survey grade GPS equipment and volumes of each stockpile were estimated.

A total of 26 material samples were collected from the stockpile test pits. Thirteen samples were selected for PSD analyses, and five of these samples were also selected for testing of Atterberg limits. Laboratory results indicated that materials sampled from three of the stockpiles are similar to material used for construction of the cover system field trial in terms of texture as they were well graded, comprising a high proportion of gravel and sand sized particles, with a proportion of fines ranging from approximately 20 to 40%. The other stockpiles were slightly coarser in texture, and material from all stockpiles had low plasticity, similar to the materials incorporated into the cover system field trial.

10.2.2.2 Hydraulic Properties

The results of the material characterization work done in 2020 and 2021 will help to refine the estimated hydraulic properties for cover materials simulated in the 2014 VADOSE/W modelling program, and subsequently provide an increase in the confidence of current estimates of long-term cover system performance.

Five representative samples of potential cover system materials taken from stockpiles in 2021 were submitted for soil fertility characterization testing including detailed salinity, total carbon, and plant available nutrients (Okane 2022b). Soil fertility analyses indicated that most stockpiles are relatively devoid of organic matter and would require amendment to support a sustainable vegetation community. In addition, observations made during the stockpile material sampling program indicate that materials in two of the stockpiles sampled would require screening for removal of large organics.

A future planned component of the material characterization program is to verify the hydraulic properties of local topsoil material, as saturated hydraulic conductivity (ksat) of local topsoil material was shown to have the largest influence on predicted NP rates in the 2014 numerical assessment. A large database of PSDs completed by BGC from a variety of borehole and test pit locations were provided to Okane for the 2014 assessment (BGC 2010, BGC 2011, BGC 2012a and BGC 2012b) and Okane used PSD data to develop hydraulic properties of cover and waste materials for the 2014 assessment. PSD data was not available for the topsoil material and properties for modelling were developed by comparing topsoil materials from similar sites in an extensive material database developed by Okane. Representative samples of topsoil materials will also be submitted for chemical characterization testing. Soil fertility examination for agronomy assessment, including but not limited to, analyses for sodium adsorption ratio (SAR), cation exchange capacity (CEC), pH and EC, organic carbon, exchangeable K, Ca, Mg, macronutrients, and micronutrients will be completed.

Previously, Stantec (2011a) conducted a growth media survey for suitable salvage material based on reclamation suitability of soil and terrain conditions. A soil suitability rating system, originally developed by Alberta Agriculture, Food and Rural Development (AAFRD 1987) and the British Columbia’s Mines Act (MEMPR 2006), was modified to reflect the presence of large stones and boulders as they are not accounted for in the Alberta rated system but needed to be accounted for the Mine. Additional modifications to account for steep or unstable slopes were considered for safety (2011a).

Reclamation suitability ratings of good or fair were designated as soils suitable for reclamation requiring minimal preparation while soils rated as poor (coarse fragments resulting in limited reclamation properties) were regarded as suitable if amended significantly or if higher rated media was available. Soil containing less than 15% by volume cobbles or boulders, with up to 50% total coarse fragments were rated good or fair for reclamation. Rating of poor or unsuitable soils was based on stoniness. Since chemical properties were not deemed to be the most limiting factor for suitability (Stantec 2011a), criteria were based on the most limiting soil physical properties of soil texture, coarse-fragment content, and stoniness.

The results of material characterization fertility test work will aid in assessing fertilizer requirements for revegetation of the cover systems.

10.2.2.3 Erosion Characteristics

Erodibility assessment of the topsoil or surface material would include aspects of the chemical and geotechnical assessment as well as the Emerson crumb test. The cover system material characterization program has been outlined to quantify the coarse fraction, in particular the void ratio, particle angularity and PSD. The coarse fractions are important for resisting rain splash erosion (i.e., interill erosion). Materials susceptible to erosion and not suitable for reclamation of side slopes would be identified. In addition, ongoing observations of the 1370 lift PG WRSA cover system field trial would identify erosion.

Overall, the material characterization program will allow for incorporation of heterogeneity into the conceptual model, as preliminary modelling has demonstrated the sensitivity of the various materials properties to NP performance. Understanding the range of material properties to be included in final closure landscapes will allow for assessment of the range of NP performance across the closure landform. Sample results will increase the sample size for the various materials, allowing development of material property envelopes that can be used to more accurately assess the effect of material variability on predicted cover system performance over a larger range of material heterogeneity.

10.2.3 Task 3: Compaction Trial Program for Candidate Cover System Materials

A pilot-scale field compaction trial was conducted in September 2022 to assess the efficacy of available stockpile materials in possible development of a lower permeability cover system layer. The compaction trial consisted of three test pads constructed to a minimum size of 15 m by 15 m. Each test pad was constructed using stockpiled materials selected based on reported material volumes and characterization resulting from the stockpile material characterization program. The compaction trial program involved permeability and density testing of pre-compacted surfaces, followed by compaction with equipment and subsequent permeability and density testing of post-compacted surfaces. In addition, material samples were collected for laboratory analyses. Results of the compaction trial program will be used to further refine the material properties used in the closure cover system performance model. The results of the compaction trial program, including laboratory results from material samples collected as part of the program are currently pending.

10.2.4 Task 4: Material Characterization Program for HLF and WRSA Waste Materials

Current estimates of long-term cover system performance for the Mine site are based on estimated particle size distributions for the spent heap leach and waste rock material.

Representative samples of spent heap leach and waste rock material will be collected when deemed the material available from the existing facilities is appropriately representative (likely in 2021 and 2022) and submitted for geotechnical characterization. Analyses include PSD, water content, standard Proctor compaction, saturated permeability, and moisture retention. The mine waste characterization program will also help to determine the technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA to help with future detailed cover system design development

Spent heap leach and waste rock materials may break down when exposed to the atmosphere and when mechanical energy is applied. A pilot-scale field compaction trial will be conducted to evaluate the extent to which the waste material can be compacted, thereby reducing its permeability. Large vibratory rollers may be able to reduce the saturated permeability of surface waste material on flatter areas of the HLF and WRSA, such as plateau areas and benches, by one to two orders of magnitude. The intent is to limit net percolation during relatively short-duration seasonal events when the storage capacity of the growth medium layer may be exceeded. Compaction field trials could be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years. The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces. The technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA could then be weighed against the anticipated benefits of reduced net percolation or passive treatment.

The sensitivity results of the 2014 numerical modelling report demonstrated that increasing WRSA waste material k_{sat} by 2-orders of magnitude only resulted in a 4% increase in NP, from 34% to 38%. Likewise, increasing HLF waste material k_{sat} by 2-orders of magnitude only resulted in a 2% increase in NP, from 36% to 38%. For both waste types, the model showed limited sensitivity to the hydraulic conductivity properties of ore and waste material. Regardless, characterization of HLF and WRSA wastes will be used to further refine the material assumptions used in the closure cover performance model. Moreover, by increasing the sample size for the various materials, material property envelopes can be developed to more accurately assess the effect of material variability on predicted results under a larger range of material heterogeneity.

The 2013 Eagle Gold Project Report of Metallurgical Test Work prepared by KCA reported the results from five compacted permeability tests on column tailings. Forte Dynamics also reviewed this work and summarized the results in *Hydraulic Conductivity Testing Review* (2018a). Compacted hydraulic conductivity testing (representing 70m of ore height loading) was performed on P80 7mm samples. Hydraulic conductivity results of this testing ranged from 0.0099 to 0.2607 cm/s, with an average of 0.1036 cm/s. While these results represent a deviation from the parameters used in the 2014 O'Kane assessment, given the limited sensitivity of the model to ore and waste hydraulic conductivity, refinements of this parameter will be made once results of compaction field trials are available.

10.2.5 Task 5: Enhanced Meteorological Monitoring on Various Slope Aspects

10.2.5.1 Objective

The objective of the enhanced hydrological and meteorological monitoring is to characterize different slope aspects to help validate site-specific climate input parameters used in numerical modelling analysis. This will help gain confidence in local (i.e., for each cover) water balance estimations and in the long-term predicted cover system performance. Meteorological monitoring will also examine snow pack sublimation and redistribution of snow, wind speed and incoming solar energy and wind speed. For the Mine, snow pack constitutes a significant portion of the water balance for the mine and can be redistributed by wind, and rainfall can vary due to localized events; therefore, site-specific collection of snow and rain data is important for refinement of water balance inputs.

The first phase of this task is being initiated during October 2020. An automated performance monitoring system is being installed in the upper Platinum Gulch WRSA as part of the pilot cover program on the 1370 m lift. The monitoring system is summarized below and described in more detail in Okane 2021a.

The second phase of this task will be initiated in October 2022. An automated performance monitoring system will be installed on a cover system test pad with a north-facing aspect.

10.2.5.2 Potential Evapotranspiration

Given the relatively high latitude of the Mine site, slope aspect and angle highly influence the amount of solar energy and resultant potential evapotranspiration (PET) applied to various areas of the site. For an exposed plateau or east- or west-facing slope, OKC (2014) (Appendix E) estimated average annual PET to be about 370 mm/yr. However, PET was estimated to be 60% less on north-facing aspects and 50% more on south-facing aspects, resulting in average annual PET rates for these two aspects of about 150 mm/yr and 560 mm/yr, respectively. In short, slope aspect is a critical factor at northern latitudes that will influence long-term net percolation rates realized through the reclaimed HLF and WRSA landforms.

10.2.5.3 Solar Energy and Net Radiometers

Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. For the initial estimates of PET based on slope aspect, calculated values of extraterrestrial radiation (R_a), solar radiation, in addition to short and long wave radiation was employed according to the FAO's method (FAO, 1998). These calculations provide an estimate of major energy balance components when no direct measurements are available. As with most empirical formulas that are fitted across a range of parameters, there are instances where the calculation begins to lose accuracy. The initial calculation of extraterrestrial radiation is dependent on latitude. Although the calculated R_a values have been shown to be accurate over across all latitudes during non-frozen periods, for the winter months in latitudes greater than 55° (N or S), the equations for R_a have limited validity. Reference can be made to the Smithsonian Tables to assess possible deviations if a correction for a region is available.

It is for this reason that the proposed meteorological monitoring program of the cover system trial on the 1370 lift of the PG WRSA incorporated net radiometers on the plateau and south-facing slope. A net radiometer is also planned for installation in 2022 on a north-facing slope cover system trial pad. Net radiometers will provide data to calibrate the assumptions in the radiation portion of the PET calculations of the numerical models. By gathering a full solar cycle (365 days) of net radiation data, the estimates for PET can be refined to reduce uncertainty in the estimates. Furthermore, the direct measurement of net radiation can be used for future updates to the closure cover performance model as the surface conditions of the cover systems evolve on the WRSA's and HLF. As different types of vegetation establish, the albedo and consequently the partitioning of shortwave to long wave radiation will differ, both having implications for PET.

Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system.

10.2.5.4 Site Climate Data

Currently climate data is being collected at two automated stations in the Mine area: the Potato Hill station installed in 2007 and the Camp station installed in 2009. Station details and the climate data that is being collected during this Task are found in the EMSAMP. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the EMSAMP to provide measurement of incoming solar energy for north, west, and south facing slopes.

Climate information is analyzed and summarized annually, for parameters including: precipitation, potential evaporation, snow water equivalent (SWE, from snow surveys), and solar radiation that can be compared to the closure cover performance model inputs. Review of climate data analysis by Lorax (2016) shows that precipitation parameters used in the 2014 closure cover performance model remain conservative, as they are based on the 80-year historic climate database and are higher than site-specific precipitation data collected on site. Precipitation in 2021 was highest recorded on site since 2009 (Lorax, 2021); however, climate variability is expected and is accounted for in the use of the 80-year historic climate database used in the model. Estimates of PET used in Okane (2014) were nearly identical to PET estimates generated based on Lorax (2016) data analyses. Estimates of PET using site-specific data collected during the first year of monitoring at the cover system field trial (Okane, 2022a, Appendix H), are lower than that estimated by Lorax (2021); however, this is expected due to differences in data collection locations (Potato Hills and 1370 bench in Okane, (2022a), and Camp in Lorax (2021).

10.2.5.5 Snow

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in the EMSAMP. The snow course surveys will continue to be conducted at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in the EMSAMP. The surveys will aim to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report NP.

The estimate of SWE within Okane's 2014 numerical assessment (135 mm) does not differ substantially from the Lorax (2021) Camp station SWE results, however, the numerical assessment does not include the variability in SWE the site experiences. Snow water equivalent estimated in Okane (2022a) was 110 mm and 55 mm for the plateau and slope locations of the 1370 lift PG WRSA cover system trial. SWE estimates can be used to refine the closure cover system performance model.

10.2.5.6 Field Program

Automated performance monitoring systems were installed on the 1370 lift PG WRSA cover system trial in October 2020, including one monitoring station on the covered area of the plateau and one monitoring station on the adjacent covered southeast slope. Monitoring of meteorological conditions at the cover system trial includes: 1) net radiometers, 2) snow depth sensors and snow surveys, and 3) a rainfall gauge. Additional meteorological parameters for use in performance monitoring will utilize data collected at primarily at the Potato Hills Station. Analyses of monitoring and other climate data will be an important element in assessing the efficacy of the base case cover system. Cover system performance monitoring will focus on partial elements of atmospheric water and energy balance inputs, along with soil water balance parameters. Measurements of in-situ soil parameters include volumetric soil water content, soil temperature, and soil matric potential, which will provide insight into the partitioning of water at the cover system-atmosphere interface and the cover system-waste material interface.

An automated performance monitoring system will be installed on a north-facing cover system trial pad in October 2022, which will include a net radiometer and snow depth sensor, as well as sensors to measure soil volumetric water content, soil temperature, and soil matric potential. Having sensors on both the plateau and north and south slope aspects ensures that the individual landform elements are captured as distinct units, thus aiding in data interpretation.

10.2.6 Task 6: Closure Cover System Field Trials for Performance Monitoring

10.2.6.1 Objective

The objective of the closure cover system field trials is to increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. Cover system field trials track the evolution of the cover systems in response to site-specific processes (physical, chemical, and biological) to enhance understanding of key characteristics and processes that control cover system performance. Cover system field trials also provide the opportunity to assess and compare the performance of multiple cover system design alternatives. Cover system performance will be assessed based on NP of meteoric waters to the underlying waste material, the runoff of water and the vegetation rooting characteristics. The initial modelled assessment of cover system performance showed little difference in performance between the WRSAs and HLF simulations. Information gained in previous tasks will assist in the development of cover trials on different waste material types and on different slope angles.

Monitoring data will be used to update the cover system model. The results from the updated performance model will inform the optimum cover system design to be trialed at the site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012):

- Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
- Obtain performance monitoring data for calibration of the VADOSE/W model;
- Develop an understanding of key characteristics and processes that control cover system performance; and
- Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

10.2.6.2 Cover System Field Trials

Cover system field trials can be used to further investigate variables, and calibrate the closure cover performance model in terms of:

- Cover system layer thickness;
- Cover system textural differences;
- Vegetation and soil amendments;
- Slope grade, length, aspect, and bench configurations; and
- Surface water management structures adhering to geomorphic principals.

The cover system field trials will be constructed with the same, geotechnically stable, landform cover system integration as intended to be used on the full operation scale facilities. Field trials represent an opportunity to examine landform geomorphic evolution (e.g., the potential for settlement, minor slumping and erosion) and use the information to highlight areas of the design to be refined or bolstered prior to implementation on full scale production facilities.

The cover system field trial would be revegetated using techniques and species outlined by KP (2012a and 2012b) and as informed by the Vegetation Rooting Study. Field trials provide an opportunity to investigate vegetation prescriptions and techniques by monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives.

10.2.6.3 Monitoring Methods

Runoff processes and snowmelt-runoff interactions can be confirmed in the field by using soil matric potential, temperature and water content sensors staggered strategically throughout the cover system profile. In field permeability testing and UAV erosion surveys will also be conducted annually. Runoff collection and monitoring systems can be employed to directly measure the effects of different cover system configurations on runoff. Runoff and erosion monitoring will seek to identify how permeability of the cover trial growth medium will change with time, and how this might influence on runoff and erosion. By better characterizing the in-field conditions of the cover systems water and energy balance, the cover design can be refined to further improve management of snow melt and runoff.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. Information gathered during field trials will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

10.2.6.4 Field Trial

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. Cover trials need to be large enough to properly evaluate construction methodologies and equipment that would be used for full-scale construction and performance monitoring.

Initial efforts to construct and instrument a pilot scale cover system trial began in September 2020. A mixed overburden and topsoil stockpile was relocated to the plateau of the 1370 bench of the Platinum Gulch WRSA. The opportunity was taken to construct and monitor a pilot scale cover system using the relocated overburden. A 0.5 m thickness of cover system, chosen to align with the base case configuration, was constructed on the eastern portion of the plateau area and a portion of the south-southeast slope of the WRSA. Details regarding the construction and instrumentation of the trial, and the ways in which data collected at the trial will be used to advance subsequent areas of research is provided in Okane 2021a and 2021b.

The cover system trial incorporates automated soil and meteorological monitoring stations that consist of soil volumetric water content and soil matric suction sensors, snow depth sensors, a rain gauge, and net radiometers to quantify key surface water and energy balance fluxes. Data is collected by a datalogger powered by battery and solar panel set up. Soil sensors are installed in pairs through the cover system profile to capture data to calculate water and energy fluxes at the interfaces of different material types including between the cover system layers and between the cover system and waste material.

Collection and interpretation of meteorological and cover system performance monitoring data collected at the 1370 lift PG WRSA cover system trial from the onset of monitoring in October 2020 to November 31, 2021, was completed and an interim report summarizing data collected to July 31, 2022 has also been prepared. In general, performance of the cover system since the onset of monitoring was consistent with anticipated performance of the cover system. Details of data collection and interpretation are outlined in Okane (2022a) and Appendix G.

10.2.7 Task 7: Effect of High pH Water Treatment Solids on Heap Cover

The “Eagle Gold Mine Water Treatment Solids Management Plan” (Engineering Analytics, 2014) states that two types of solids will be created during water treatment operations. One type is a low pH solid produced from the iron coagulation water treatment step, and the other is a high pH solid, produced from the sodium hydroxide addition step for metals treatment. The high pH solids will only be produced during the heap draindown period. The low pH solids will be stored in lined facilities that will function as permanent disposal cells. The high pH solids will be pressed to a high solids content (estimated at 70%) which will then be suitable to be co-disposed on the heap in areas that will then be covered.

Specifically, the plan proposes that the high pH solids “will be generated concurrent with the closure of the HLF and, as such, the solids will be incorporated into the HLF. The solids will be periodically trucked to the HLF in areas that are being graded and prepared for capping. Like the spent ore, the caustic solids will be protected from exposure to meteoric water by the capping system. The caustic solids will exhibit similar metals loading as the spent ore and the solids will be geochemically stable in the HLF.” It was further stated during the WUL hearing that the “… design for disposal of water treatment sludges on the heap would be to dig a trench that would be deeper than the root zone” such that the sludges “…would be buried within the heap materials below the cover and below some portion of the heap materials to minimize that potential of uptake of metals into vegetation”.

One of the objectives of the research program is to demonstrate the suitability of the mine water treatment solids for use as heap cover material. The proposal is to mix the high pH solids into the heap materials and then cover the area with the water treatment solids the same as all other covered areas. Thus, the proposed research is focused on the effect of mixing the high pH solids on the heap as a cover basal layer, and not on the cover layer performance.

During the materials characterization program for cover described in Section 10.2.2, materials testing of heap materials with and without compaction will be performed. When high pH solids are first available, a second set of tests paralleling those described in Section 10.2.2 will be performed: Compaction field trials will be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years.

The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces. This set of tests will be duplicated to include areas mixed with high pH solids. The geotechnical testing that is proposed includes specific gravity, Atterberg limits, gradation (sieve and hydrometer), and consolidation testing (oedometer). The consolidation testing would be used to determine void ratio before and after mixing in the water treatment solids, and would include tests on sludge, heap materials, and a mixture of the two. The sludge and the heap materials would also be characterized to compare their geochemical properties. Geochemical testing on both the spent ore, sludge, and mixed spent ore / sludge will include: paste pH (1:2); rinse pH (1:2); 1 M KCl and 4 M HCl extractions; Total S, Sulfide S, ANC, NAG pH, NAG Acidity to pH 4.5 and 7.0, SPLP testing at pH 3 and pH 7, and whole rock analysis.

Because the volume of high pH solids is estimated to be low (calculated to be 238 m^3/year during phase 6 only), only small portions of the heap will actually receive solids prior to the cover placement. While the solids management plan does state: “Uniformly spread over the entire heap, the caustic sludge generated over Phase 6 would represent a 3 mm thick layer under the HLF cap”, this illustrates only that it is a small volume compared to the volume of the heap materials. However, the high pH solids will not be spread uniformly over the surface of the entire heap. For instance, assuming a 10% mixing rate (high pH solids to heap solids), a 70m x 70m by 0.5 m deep zone would accommodate one year of high pH solids production. Thus, the sludge would not be spread over the entire HLF but still spread thin enough so that it could be ripped deep enough into the HLF pad surface so that the rock will maintain grain to grain contact (i.e., sludge just filling part of the void space within the rock), and so that it would have a negligible effect on the geotechnical performance of upper layer of the HLF pad. Based on experience at other sites and from conversations with contractors, conventional equipment (dozer/grader for spreading and ripper/disk) will be used to provide sufficient mixing action. The proposed geotechnical testing will confirm that the performance of this layer has not materially changed.

The plan will include a strategy for implementing the mixing test with sampling under the supervision of a geotechnical engineer such that the mixture achieves the objectives of maintaining grain to grain contact and the sludge fills only part of the void space within the heap leach materials. Close field supervision of the mixing program will help determine optimal field mixing ratios so excessive iterations of the blending operation can be avoided.

The research program will be used to demonstrate the suitability of the mine water treatment solids for use as heap cover material. Information gathered can be analyzed in the site-wide water quality and water balance models for closure to develop a refined picture of water quality management scenarios into closure.

10.3 VEGETATION ROOTING STUDY

10.3.1 Objective

The overall objective of the Rooting Study (Appendix B) is to gather information on plant rooting depths and develop optimal requirements for cover thicknesses to encourage maximum evapotranspiration from covers. The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Mine site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

10.3.2 Two-phased Approach

A two-phased approach is proposed for the vegetation rooting study. The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite

- **Task 3**: Vegetate constructed cover system trial area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.
- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Additional details on of the Rooting Depth Study tasks are provided in Appendix B.

10.4 PASSIVE WATER TREATMENT

Passive water treatment systems are proposed to treat mine waters upon closure. While the predicted water chemistries and site layout are conducive to passive water treatment, it is recognized that additional research is required to optimize and confirm each PTS design and size. Despite being best available estimates for the sizing of the CWTS component of the PTS for closure, these require further refinement and optimization through controlled pilot-scale testing and on-site demonstration. For this reason, a conservative size estimate has been included in the site plan and budgets at this point of closure planning, with the understanding that these will be revisited once the PTS designs are further refined.

The objective of this PTS reclamation research program is therefore to refine, optimize and remove uncertainties associated with the removal rate coefficients and thermodynamic minimums possible for the water predicted at closure for the Mine. More specifically, the proposed program contains four overriding objectives:

1. Refine the PTS or combination of PTSs for post-closure water treatment
2. Scientifically test and optimize PTS configurations
3. Validate function of PTS in cold climate
4. Demonstrate function of the system on site prior to closure

These four objectives will be met through a multi-phase research program. The research program is focused on the evaluation of the PTS to be implemented at the tow of the Platinum Gulch WRSA. The CWTS for Platinum Gulch will be used to guide further passive treatment implementation for other locations at the Eagle Mine, such as for seepage from the Eagle Pup EP WRSA, and the HLF. The phases of research for the PTS include:

- Information review and site visit;
- Bench scale trials;
- On-site demonstration scale; and
- Full-scale implementation.

10.4.1 Methods

The final design will be comprehensive and based on sound scientific principles (biogeochemistry, pilot studies, etc.). PTSs can be developed from concept to sustained performance using a phased approach as described in the following sections. An overall schedule of the program is shown in Section 10.4.2.

10.4.1.1 Phase 1: Information Gathering, Information Review and Site Visit

Phase 1 of the program was completed in 2021. In Phase 1, a review of available information for the Site to inform the initial Platinum Gulch CWTS design and identify potential substrate and plant borrow sources for CWTS construction was completed (Ensero 2022a). The information review included the following:

- Water quality data, including monitoring data and flow and water quality model data;
- Constructability information from previous geotechnical investigations at Site;
- Substrate information from borrow and geochemical investigations; and
- Vegetation information from previous baseline study.

The field program was completed in July 2021 and included the completion of six test pits to support siting the future Platinum Gulch PTS, investigation of four potential substrate borrow locations (with three ultimately selected for sampling during the field program) and identification of three plant species for future offsite bench scale trials (see Section 10.4.1.2). Samples from the selected substrate borrow sources were sent for analytical testing and plants were harvested from the selected plant borrow sources and brought back to Ensero's pilot facility to establish in a nursery for use in bench-scale trials. The findings of this phase are provided in Ensero 2022a.

10.4.1.2 Phase 2: Bench Scale Trials

The bench scale trial program currently is being undertaken through the follow steps in order to develop refinements to the on-site PG CWTS pilot-scale design:

1. Lab scale trial design, design criteria, and inputs, and set-up;
2. Bench-scale trial commissioning (system maturation);
3. Bench-scale trial testing and stagnation phases; and
4. Applying the findings to refine the PG CWTS design for an on-site pilot-scale system.

The bench-scale trial relies on the substrate and vegetation collected during Phase 1. The objective of the CWTS bench-scale trial is to de-risk the implementation of an on-site pilot-scale system by testing multiple designs and inputs at a smaller scale with the intention of using the information to refine the on-site pilot-scale design. The trials will assess the suitability of the substrates and plants sourced from the Site in a CWTS environment and help evaluate the magnitude of potential leaching of constituents.

The bench-scale trials were constructed at Ensero's Saskatoon temperature-controlled greenhouse facility with setup completed and commissioning phase started on September 2, 2022. The bench-scale trials comprise four series each with two treatment cells (Figure 10-1) with either a rip rap channel (Series 1-3) or a cascade (Series 4) between the cells. Cascades designed as a step cascade or sloped rip rap channel will be evaluated to determine their influence on treatment of arsenic and inform on the design of the cascade to be built in the on-site pilot-scale CWTS.

Bins were used to create the cells for each series and were filled with the different substrates collected at Site to a targeted depth of 30 cm. Three different substrates were used in the trials, which were collected from Eagle pup road (described as SUB03), lower Haggart Road (described as SUB07), and the borrow pit at km 42.5 (described as gravel). Of the three plant types harvested from site (*Carex aquatilis, Carex utriculata, and Equisetum*), *Carex aqualitis* established the best within Ensero's greenhouse and was therefore selected for use in the trials. A 10 cm water depth was targeted for the trials and will be evaluated as part of the trial assessment for suitability of plant establishment and ability to maintain aerobic conditions.

The information to be gained from the setup of the different series of trials includes:

- Comparison of substrate types and their risk of leachable metals, and the ability of iron in some substrates to sorb arsenic;
- Need for screening substrate to remove fines;
- Ease of establishment of plants in one substrate versus the other; and
- Difference in arsenic treatment in a rip rap channel versus a step cascade.

A synthetic water recipe was developed based on the modelled water quality data for the month of May (maximum Platinum Gulch PTS water quality for year 2029). The synthetic water recipe was also based on the use of tap water (i.e., some constituents are higher in tap water than the modelled data) and recent water quality data from the Platinum Gulch Seep (i.e., 2020-2022 data set).

To begin commissioning, tap water with additional nutrients began flowing through each series targeting a three-day hydraulic retention time, to maintain aerobic conditions while minimizing water volume requirements on a weekly basis. Nutrients of nitrate, phosphorus, and ammonium (in the form of calcium nitrate tetrahydrate, monopotassium phosphate, and ammonium sulfate) were added to the tap water to promote the establishment and maturation of the *Carex aquatilis*. Weekly monitoring of the cells is currently being performed during the commissioning stage using a YSI handheld multiparameter meter to monitor dissolved oxygen concentrations to ensure that aerobic conditions are maintained. Commissioning (i.e., system maturation) is currently ongoing and is planned to continue for approximately 12 weeks.

Upon completion of the commissioning stage, the testing stage will commence. The testing stage will occur over a two-month period and it is currently planned to test three different hydraulic retention times (HRT) between 0.5 and 3 days, with three separate testing events per HRT.

Bench-scale trials are described further in Appendix L.

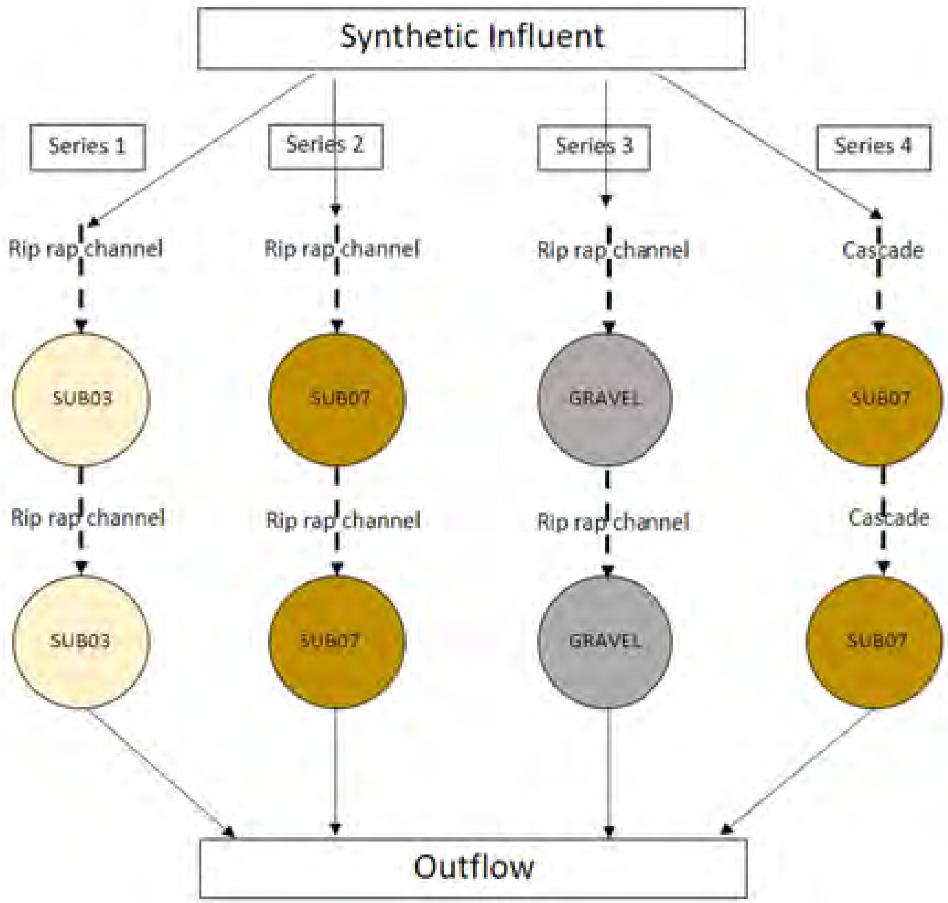


Figure 10-1: Bench Scale CWTS Trial Overview

Pilot Bioreactor Program

In addition to the bench-scale trials described above, a pilot bioreactor program was established on the Project site in 2019. The program, being conducted with guidance from the Yukon Industrial Research Chair - Northern Mine Remediation at the Yukon College Research Centre, expands upon earlier lab scale trials on the removal rates for arsenic, selenium, antimony and other metals under site conditions. The lab scale program and results were described in the 2015 Yukon Research Centre report entitled Arsenic, Antimony and Selenium Removal from Mine Water by Anaerobic Bioreactors at Laboratory Scale. The pilot program includes trial components exposed to ambient freeze-thaw stresses to evaluate the effect of the site climate regime on removal rates. More specifically, the primary objective of the research program is to study freeze-thaw cycles on sulfate reducing bacteria and to assess their efficiency to remove heavy metals (particularly arsenic, selenium and antimony) from mine influenced water (MIW), and in this case MIW originating from Platinum Gulch catchment and the PG WRSA.

The program utilizes mine influenced waters (captured at site collection points along Ditch A or the LDSP pond water, which is then transferred to the trial area) pumped into a 1,000L tank filled once per week though the summer and twice per week during winter. The MIW is then transferred to 200L drums both inside and outside of the bioreactor program shack. The MIW solution is fed with a specified dosage of molasses, which helps to feed the bacteria and allow the bioreactor to work. The bioreactors are monitored weekly and sampled on a periodic basis (weekly to monthly depending on field conditions). VGC continues to work with the YIRC to support the implementation and further development of the program with results of the program to be compiled at the end of the ongoing evaluation term.

10.4.1.3 Phase 3: On-site Demonstration Scale

Phase 3 includes:

1. Design of on-site demonstration scale PTS
2. Construction of demonstration scale PTS at the Mine
3. Performance monitoring of demonstration scale PTS at site

The findings from Phase 2 bench-scale trials will refine the design of the demonstration sclae CWTS for Platinum Gulch. Following bench-scale testing a more rigorous on-site trial will be completed to provide further site-specific information to advance the design and final sizing of a full-scale CWTS for the Platinum Gulch. It is currently envisioned that on-site demonstration scale will include construction of one of the treatment trains currently proposed as part of the Platinum Gulch PTS (see Section 8.10.2.1). The pilot-scale testing will be completed to provide details on plant uptake, fate and distribution of arsenic, evapotranspiration rates, accretion and decomposition rates, and stability of treated constituents including the impact of freezing, thawing and icings from groundwater seeps, and potential stagnation in the CWTS and remobilization of arsenic.

In Phase 3, the demonstration-scale system will be built on site at the Mine and will be sized to allow adequate monitoring and testing for the implementation of the full-scale PTS. It is currently conceptualized that this will be implemented by constructing the PG PTS downgradient of the PG WRSA once the WRSA is closed during early operations. The outflow from the demonstration PTS will be sent to the LDSP to be used as make-up water or to the MWTP to ensure all water that enters the receiving system has been treated by an approved system. During Phase 4, explanatory parameters will be assessed regularly (as in Phase 2).

10.4.1.4 Phase 4: Full-Scale Implementation

The results of Phase 3 will inform any potential changes to the final design of the Platinum Gulch PTS, as well as inform designs of LDSP PTS and HLF PTS. In the final phase, the full-scale PTS will be built prior to or just after closure depending on the system to allow the system to stabilize and mature. Early commissioning of a full-scale PTS will provide additional confidence that the systems are functional and reliable. For the HLF, the PTS will be built as soon as water is available for that system, and the MWTP will remain functional until the PTS has matured, stabilized, and demonstrated an acceptable treatment performance for a designated period of time.

10.4.2 Schedule

The current schedule for implementation of the research program is shown below.

Table 10-3: Passive Treatment Research Program Implementation Schedule

Phase	Start Date	End Date
Phase 1: Information Gathering, Information Review, Site Visit	September 2012	2021

Phase 2: Bench-Scale Trials	2022	2023
Phase 3: On-site Demonstration Scale[a]	2023	2024
Phase 4: Full Scale Implementation	TBD	Into post-closure

Note:
a This will be implemented by constructing one treatment train of the PTS for the PG WRSA

10.5 HEAP BIOLOGICAL DETOXIFICATION AND IN-HEAP BIOREACTOR RESEARCH PROGRAM

This plan is part of the reclamation research is closely paired with the PTS research described in Section 10.4 because it affects the source water quality that will ultimately come to the heap PTS. It addresses uncertainties in the heap detoxification process which will be applied as the heap transitions from leaching into closure. The field-based research is planned to be concurrent with heap leaching operations over a 3-year period at a similar time as the on-site PTS demonstration program. The primary test phase is expected to take approximately 100 days followed by quarterly testing of effluents for up to 12 quarters thereafter to evaluate rebound, stability, and seasonal effects.

A phased Reclamation and Research program to verify the proposed biological detoxification of the heap, including incorporation of data gathered through the operation of the HLF and information from the use of similar technology at heap facilities operated in similar climatic conditions is proposed.

The elements of this research program include:

1. Review of operational parameters of the heap leach facility that could affect the specific approach to in-heap treatment, including water chemistry of heap drainage over time, construction and stacking, use of makeup water, operational observations about duration of leaching in each area, etc.
2. Setup of a sequential test facility adjacent to the heap, including placement of heap materials into two test facilities, including either a lined column or area and/or containers to hold heap materials and allow vadose percolation and saturated treatment in sequence. The test facility will include tanks to hold barren solution and reagents, pumps to apply reagent-amended solutions to the heap containers, and sampling ports.
3. Operation of the columns or containers over a period of several months, simulating full scale application of reagent amended barren solution during the proposed full-scale treatment. The monitoring of the treatment efficiency will include heap materials before treatment, solution chemistry over time as carbon amended water is added and percolated through the unsaturated and saturated heap materials, and sampling of the treated heap solid phase materials after the treatment operation is complete.
4. The treatment test will also include a post-treatment simulation, where heap materials will be covered, and solutions that drain from the columns or containers will be sampled quarterly over 2-3 years to evaluate any rebound or changes in chemistry after the test is completed.

Details of this research plan are provided in Appendix C.

10.6 GROUNDWATER ARSENIC ATTENUATION STUDY

BGC (2014) prepared and calibrated a multi-purpose groundwater model, which has been used to determine the effects of mine operations on groundwater in the mine area. One purpose of the model was to evaluate the direction that seepage from the WRSAs might go, and the potential effect areas. The report states:

> At the end of mine operations, seepage from the WRSAs and 100-day storage area is not simulated to migrate outside of the facility footprints. However, within the WRSA footprints, seepage may report to the underdrains. Seepage originating from the 100 Day Storage Area could migrate to Suttles Gulch. While results for the end of passive closure are similar, seepage is predicted to also migrate west of the 100 Day Storage Area and the Platinum Gulch WRSA where it could discharge to Haggart Creek.

This conclusion was based strictly on a particle-type analysis (“ModPath”) where a particle is modeled to move through groundwater based on hydrodynamic processes, but physical, chemical, or biological reactions that could cause a particular solute, such as arsenic or antimony, to migrate differentially as compared to a model particle, was not considered.

A review of groundwater quality data to current Yukon CSR AW standards identified by Stantec (June, 2012) showed dissolved arsenic exceedances in all sub-basins:

> Arsenic concentrations in Ann Gulch (MW10-AG5), Suttles Gulch (MW09-STU2) and Eagle Pup (MW96-13b) were 3 to 70 times higher than the CSR AW standard; whereas, arsenic concentrations in Platinum Gulch (MW10-PG1 and MW96-23) were 160 to 200 times higher than the CSR AW standard. The highest dissolved arsenic concentrations in the LSA occurred consistently in Platinum Gulch monitoring well MW10-PG1 and ranged from 7.98 mg/L to 9.62 mg/L in November 2011 and December 2012, respectively. These concentrations were approximately two times higher than dissolved arsenic values reported in Dublin Gulch well MW09-DG6, which ranged from 0.938 mg/L to 3.64 mg/L during 2011–2012, and approximately ten to one hundred times higher than concentrations reported in all other LSA sub-basins. Dissolved arsenic concentrations exceeding CSR AW standards were reported in monitoring wells completed in sand and gravel deposits, till deposits, phyllite metasediments and granodiorite bedrock units.

Across the site, dissolved arsenic in groundwater is consistently greater than the Yukon Contaminated Site Regulation for Freshwater Aquatic Life (Y-CSR AW) standards in six of the ten wells sampled and results for total arsenic were greater than the Canadian Council of Ministers of Environment for the protection of Freshwater Aquatic Life (CCME FW) guidelines in all ten wells sampled (BGC, 2012). Other metals also show elevations compared to guidelines, but not as consistently as does arsenic.

Current conditions show that arsenic concentrations significantly change as groundwater transitions from the Dublin Gulch into Haggart Creek. A preliminary evaluation of site chemistry may indicate that predictable chemical changes in major anions and cations as well as changes in iron and manganese concentrations correspond to changes in arsenic concentrations. Less apparent from the current data are trends that could imply causation with respect to solid phase aquifer changes, either from a source or a sink of arsenic or other constituents of interest.

The proposed research program would include the following activities:

- Utilize the existing groundwater information to establish the processes that could likely be controlling constituent migration. Geochemical modeling would be used to derive saturation indices that could indicate the sinks that are currently responsible for metals removal.
- Potential sources of constituents such as the WRSAs would be monitored to determine if the WRSAs are inducing chemistry changes in groundwater that could shift the chemical equilibrium to either favor or reduce the processes that are currently affecting arsenic or other metals' migration
- Known or modeled migration pathways would be further evaluated to determine if specific lithologies provide mechanisms that can be quantified to yield predictions of migration potential or reduction in migration potential under planned operating conditions.

The extent to which seepage from WRSAs does not come to surface will be evaluated, and this work will determine rates of potential migration of constituents in the seepage so that the groundwater monitoring program will be refined.

11 MAINTENANCE

The closure measures are designed to minimize maintenance; however, some facilities will require some minimal maintenance, which is expected to decrease over time as the combined systems work synergistically to achieve a stable, closed site. However, based on current understanding there will be some minimal requirement for maintenance.

Covers:

- All engineered covers will be monitored for erosion and if observed will be repaired and replanted.
- Additional riprap or localized repairs to remove sediment may be required in closure runoff ditches if a large storm occurs shortly after cover placement and prior to vegetation establishment.

Passive Treatment Systems:

- The In-Heap Pond bioreactor reactivity will be largely "charged up" by the in-situ heap cyanide degradation initial treatment. Some alcohol will be added to the In-Heap Pond bioreactor as the pond is drained down. When the cover is fully functional, the need for continued maintenance in Phase 7 onward should decrease or be eliminated entirely.

Water Conveyance Features:

- All ditches will be inspected and may require repairs or maintenance during the first few years post-reclamation while covers and vegetation are being established.
- Sediment settling ponds may require cleanout especially after a large storm just after covers have been placed.

Roads:

- Site roads will be maintained to provide access to areas requiring inspection or other maintenance.

12 MONITORING

Summarization of monitoring programs and methods can be found in *the Environmental Monitoring, Surveillance and Adaptive Management Plan*.

13 RECLAMATION COST ESTIMATE

This version of the RCP has been updated to address QZ14-041-1 Clause 148 (b) and Clause 7.2 of QML-0011 which require the submission of an updated Reclamation and Closure Plan on a two-yearly schedule.

Updated Current, 2-Year Peak Liability and End of Mine (EOM) security calculations are provided as Appendix H. Appendix H is a full closure cost estimate, informed by comments through the regulatory processes, the deliberations of the YWB during the amendment application process, and information gathered through construction, which contains the detailed closure cost estimate tables for each of the specific tasks.

The cost model tasks associated with the reclamation and closure of the Mine include the following:

T1 Cost Summary

The summary table provides an overview of all costs required for the closure and reclamation of the Mine and links to the costs calculated in the other costing tables. Contingency factors for each closure task are presented and built into the total closure costs. Each individual costing table (Tables T2 to T17) is described separately.

T2 Unit Costs

This table lists the unit rates for equipment, personnel, materials, and other rates, which are used repeatedly throughout the cost estimate. Unit rates are based on input received during previous review processes, updated labour rates based on the Yukon Government Fair Wage Schedule (effective April 1, 2022), the Yukon Third Party Equipment Rental Rates (effective February 8, 2019) or recommended rates from prior review processes, developed custom rates based on the configuration of the Mine, estimates based on current site costs, and on the cost to fuel and operate certain installed equipment currently owned by VGC (with associated replacement costs as necessary).

T2a Custom Rate Estimator

This table lists the developed custom unit rates for loading, hauling and placing material for earthworks associated with reclamation, and an estimate of the labour and duration required to cover facilities.

T3 General and Administrative

This task accounts for typical G&A costs that are not directly associated with individual reclamation and closure tasks. Line items include light vehicles, power and heat not directly associated with heap fluid pumping, site security, equipment mobilization and demobilization, access road maintenance (the public South McQuesten/Haggart Creek Roads), travel and camp accommodations. Contractor costs such as profit and insurance are included in the specific unit rate for equipment.

T4 Exploration Disturbances:

No costs are included for this task as exploration disturbance is bonded for under the Class IV Mining Land Use Approval LQ00562. Task has been removed from the cost estimate.

T5 Closure Planning

Costs for closure planning include an update to the closure plan, and costs to implement the reclamation research program which includes engineered cover evaluations, the rooting study, detailed design of the passive treatment systems (and construction of the Platinum Gulch PTS) and the in-heap bioreactor, and site contamination surveys.

T6 Open Pit

Reclamation tasks for the open pit will include removing pumps, placing boulders in the pit entrance to prevent egress by vehicles and establishing rip-rap water conveyance channels. Equipment hours for these tasks are based on experience and costs realized during Mine construction.

T7 Heap Leach Facility

The primary tasks associated with closure and reclamation of the HLF includes regrading of any slope steeper than 2.5:1, placement of the soil cover over the HLF surface (0.3 m colluvium-tailings mixture, 0.2 m overburden/topsoil), implementing the heap passive in-situ treatment process, and the construction of a passive treatment system in the Events Pond. A custom rate has been calculated for haulage and placement of cover material. For the closure cost estimates, no credit is applied for the significant value of gold that would remain within in the HLF in the event that mine closure was required to be undertaken by a third party.

As discussed in Appendix N, additional costs for pumping related to the biological treatment process are unnecessary as the nutrients can be added to the solution being recirculated during the ICM period or, alternatively, during the draindown pumping period.

T8 Waste Rock Storage Areas

The majority of the closure costs for the WRSAs is associated with the regrading of any slope greater than 2.5:1 and haulage and placement of a soil cover over the Eagle Pup and Platinum Gulch WRSA surfaces. A custom rate based on equipment type, haulage distance, and standard productivity considerations is used for the calculation of cover construction rates/costs.

T9 Surface Facilities

Demolition costs for the surface facilities are calculated based on the assumption that no salvage value is credited against the cost of demolition. The majority of the costs for demolition is based on the amount of general and skilled labour needed along with the type of support equipment (crane, excavators, etc.) that will be used. It is likely that significant salvage value will be realized in the facilities, however no value, or credit, for salvage has been included within the security estimates. The final costs for completion of the mine water treatment plant are also considered in T9.

T10 Infrastructure

Infrastructure remaining in addition to the surface facilities primarily consists of modular camp buildings and mobile containers (e.g., the explosives and magazine storage). Costs for removal of these assets are based on labour and equipment hours to disconnect services and haul away. A 0.2 m soil cover is placed over the area and costs for this task are based on unit costs. The costs associated with the removal of the conveyor systems is also considered in this tab.

T11 Waste Disposal and Remediation

The majority of costs associated with this task include offsite hazardous material disposal and the management of hydrocarbon contaminated soils from sources such as around the fuel storage facility and truck maintenance shop. It is assumed that contaminated soils will be managed on site at the land treatment facility and no off-site transportation costs are necessary.

T12 Landfills

Costs to expand the landfill are included in the closure cost estimate to account for the larger capacity necessary for non-salvaged materials buried during demolition. Once the landfill is full, it will be covered with a soil cover, recontoured and revegetated.

T13 Roads and Trails

Closure costs for the roads and trails account for both present and future roads on site, and consider the equipment and labour costs to recontour road crests, scarify the surface and revegetate. Costs for removal of culverts are included along with standard erosion control measures.

T14 Water Management Infrastructure

The major cost driver for water management is associated with upgrading existing ditches for closure and decommissioning groundwater wells. Work on the ponds is considered under the development for the PTSs. Power needed for HLF pumps to recirculate the heap solution inventory during Phase 5 (i.e., the ~ actively managed recirculation and rinsing period) are considered in T16 Interim Care and Maintenance as the duration for rinsing is adequately covered by the ICM period.

T15 Post Closure Care, Maintenance, and Monitoring – Phase 6, 7, and 8

This table includes costs for onsite management, employee transport, ongoing water treatment operating and capital replacement costs, long term funding of reclamation and closure research, monitoring and reporting, and site maintenance. A breakdown of water treatment operating and capital replacement costs are provided. The MWTP construction is scheduled to be completed and commissioned by Q4 2022.

This table also includes costs for power associated with pumping water during Phase 6 (i.e., the actively managed draindown period). Electrical power costs are based on heap draindown volumes from the Forte Dynamics (Appendix I) HLF water balance model. The annual costs and full costs for each of these tasks are presented in this table, along with the Net Present Value (NPV) of the costs as they occur in the future. The NPV costs are calculated in separate tables. NPV is described further below.

The worksheet also provides costs for construction of the LDSP-PTS.

T16 Interim Care and Maintenance

This table provides an allowance for the site to be managed during an interim 2-year period between the time of unanticipated closure (where it is further assumed that the mining proponent is unable to care for the site) and the point in time at which the government is able to initiate formal closure of the facility by third party contractors.

This table includes costs for power needed for HLF pumps to recirculate the heap solution inventory during the 2-year Interim Care and Maintenance period. During Interim Care and Maintenance period, the Phase 5 actively managed recirculation rinsing period will be completed. The time required to rinse the heap is 402 days at the EOM, and 160 days at the 2-Year Peak Liability. These durations were calculated by Forte Dynamics and are based on standard best management practice requirement that pads be rinsed with three pore volumes. For the purpose of current liability, the rinsing duration developed for the 2-Year Peak Liability has been assumed. As discussed in Appendix N, pure recirculation of solution within test columns for the Mine have shown cyanide concentration reduction significantly below the concentrations in which biological treatment can be started. With a 2-year period that includes meteoric contributions to the fluid inventory, VGC is confident that this is more than adequate for rinsing to allow for the next phase of HLF closure to commence.

T17 Quantities

T17a contains quantities of materials and areas of disturbance for the Mine, which are used throughout the other tables in the estimate.

T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on HLF Water Balance Modelling by Forte Dynamics (2022) for recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6. Pumping rates are used to determine the number of pumps that would operate in a given month and the maximum power draw. The electrical power cost of $0.24/kw is used to calculate the monthly and annual power costs. During Phase 6 draindown, pumping rates and associated power costs are reduced as water is directed to the MWTP, until a pumping rate of approximately 20 L/s or less (the point which a metastable equilibrium is reached and cover installation commences, which will further decrease HLF seepage rates and form a new metastable equilibrium) is reached, and pumping is then ceased as recirculation of solution will no longer be required. For conservatism in the cost estimate, the inputs from natural precipitation are modelled in the HLF WBM as if there are no covers placed on the heap (Appendix I). Once the metastable equilibrium point has been reached in the HLF water balance mode, the output flow rates from the site water balance model is relied upon to determine flow and water quality predictions for passive treatment system design.

NPV Calculations

The NPV calculations discount the costs on the assumption that the security for long-term tasks is in a form that will provide a net return of 3%. In accordance with Guideline #F-08 provided in the Yukon Mine Site Reclamation and Closure Policy Financial Guidelines (YG 2014), this rate is based on Government of Canada benchmark bond yields as published by the Bank of Canada[2]. The equation used to determine the discounted value is:

$$NPV = \frac{C}{(1+R)^n}$$

Where C is the full cost;

R is the rate of return; and

n is the number of years from the current year.

This calculation is consistent with Guideline #F-08 provided in the Yukon Mine Site Reclamation and Closure Policy Financial Guidelines (YG 2014) and the BC Ministry of Energy, Mines and Low Carbon Innovation Major Mines Reclamation Security Policy (Interim - 2022). As the security would transfer to Yukon Government, if and when closure obligations were assumed, Yukon Government would then have the ability to choose an appropriate investment vehicle to generate returns on the principle (or remaining) amounts that would offset the impacts of inflation for the purposes of net present value calculations.

[2] https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/

In accordance with the Guideline, discounting has not been applied to the security to be held for reclamation and closure work scheduled within two years and inflation has been applied to those costs.

13.1 BASIS OF COST ESTIMATE

The basis of the cost estimate for the Mine assumes the use of third-party contractors and equipment for implementation of major earthworks and terrestrial tasks. Many of the reclamation tasks may be implemented in-house but the assumption of third-party contractors is consistent with the guidance document. For the basis of the current cost estimate, standard equipment types are included that are locally available (i.e. D-9 dozer, CAT 235 excavator). VGC has refined some of the established rates to account for fuel, maintenance and operator costs, for equipment that is currently owned by VGC's and has been mobilized to site during operations.

Equipment and Personnel Rates Contractor rates and camp costs are based on current contract rates for the Mine assuming a loading rate of less than 50 people (i.e., the highest contract rate), and are based on Yukon Government Fair Wage Schedule, effective April 1, 2022. Custom haul rates are based on site-specific information.

Lump Sum Values: Some costs are presented as a lump sum which could be either a one-time expenditure, repeating periodic cost or specific equipment costs. Many lump sum costs have been derived based on experience with similar tasks at other Yukon mine site or have been developed in consultation with knowledgeable vendors. A review and further breakdown of lump sum costs in excess of $50,000 is provided where necessary.

Indirect Costs: Indirect cost factor rate of 15% includes insurance, taxes, and other administrative costs Site security, project management and engineering are included separately in the estimate.

Contingency Costs: Contingency cost factors are included at rates that range from 15-30% as informed by the rates considered during previous review. Contingency cost factor rates will continue to be reviewed and refined based on detailed engineering, design requirements and implementation strategies in future submissions.

A discussion of the major cost drivers for each of the task elements, along with notable updates to costing assumptions and/or methodology relative to the previous costing iteration, is provided below.

13.2 YEAR 2 PEAK LIABILITY COST ESTIMATE

The activities included within the two-year reclamation cost estimate are based on the current Mine Plan. The specific Mine components that will exist at this point in time are presented in Table 8-1.

To support the development of the 2-Year peak liability cost estimate, feedback from the Reasons for Decision issued in connection with the QZ14-041-1 closure costing review commissioned by the YWB and the third-party review commissioned by EMR have been incorporated. The fully updated, detailed costing model is located in Appendix H.

The updated 2-Year Peak Liability Closure Cost Estimate is $84,950,927.

The following section highlights the rationale behind the most recent costing update and describes specific modifications that have been proposed for individual costing tables.

During prior closure cost estimate reviews, the Project Management and Engineering factor utilized by VGC has been subject to additional scrutiny. Reference has been made to the 2015 report "Mine Closure and Cost

Estimation Guidelines: Indirect Cost Categories" prepared for the Alaskan government by DOWL, a Colorado based engineering firm. In that report it recommends a range of 5-9% for "Contract Administration" and 3-7% for Engineering Redesign (pg 30). In the same report, the average of the reviewed mines was 11.2% (pg. 15). The BC Government reclamation bond calculator guidelines recommend a 10% rate stating "A fee of 10% was considered reasonable mid-range value based on industry standard". The Mackenzie Valley Land and Water Board (MVLWB), in their closure cost estimator guidelines, recommend at the minimum a 5% rate but offer no other value. Based on this additional review or material referenced by reviewers, consideration of standard practice in comparable Canadian jurisdictions, and noting that VGC has included camp costs for PME personnel so that they are an assumed on-site resource rather than purely an off-site resource as is contemplated in the Liability Estimate Guidance YG (2013), a 10% PME factor has again been applied and remains an appropriate mid-range value.

13.2.1 Discussion of Year 2 Closure Costing Tables and Notable Adjustments

T1 Summary

Modifications to T1 from the previous reclamation cost estimate include reconsideration of certain individual contingency rates for each activity based on further consideration of input received and the current Mine status.

Various economic forecasts[3][4][5][6] suggest that inflation rate will trend to the Bank of Canada target of 2% by 2024. To account for uncertainty in these long-term predictions, a stepped down inflation rate has been applied for year 1 and 2 with a return to the 2% target thereafter for the Year 2 costing scenario. Cost inflation has also been applied to contingency costs.

The NPV calculations discount the costs on the assumption that the security for long-term tasks is in a form that will provide a net return of 3%. In accordance with Guideline #F-08 provided in the Yukon Mine Site Reclamation and Closure Policy Financial Guidelines (YG 2014), this rate is based on Government of Canada benchmark bond yields as published by the Bank of Canada[7].

Based on advancement of research, planning and design in certain areas (i.e., regrading volume estimates, refinement of biological treatment process and activities, preliminary designs of CWTS, analysis of water management infrastructure sizing) and guidance provided to VGC during previous review processes, adjustments have been made to the contingency factors for a number of areas.

T2 Unit Costs

This table lists the unit rates for equipment, personnel, materials, and other rates, which are used repeatedly throughout the cost estimate. Rates have been adjusted based on current market rates in Yukon. Additionally, personnel rates were updated based on the Yukon Government Fair Wage Schedule effective April 1, 2022. As

[3] https://www.bankofcanada.ca/2022/07/mpr-2022-07-13/

[4] https://www.reuters.com/markets/us/expected-slow-return-canadas-inflation-target-defuses-rate-cut-bets-2022-08-18/

[5] https://economics.td.com/ca-forecast-tables

[6] https://think.ing.com/forecasts

[7] https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/

discussed above, VGC has retained a 10% project management and engineering based on review of guidance provided to the industry in comparable jurisdictions including guidance documents referenced specifically by the YWB in their review process and average rates considered in those documents.

<u>T3 General and Administrative</u>

Costs reflect power and heat, site security and camp costs.

<u>T5 Closure Planning</u>

The costs associated with Closure Planning have been increased to reflect the currently considered mine disturbance over the next 2 years from the effective date of this RCP. Costs are informed by the costs incurred to date in the preparation of the Eagle Gold Mine Reclamation and Closure Plan, the execution of reclamation research by qualified third party professionals, and are consistent with costs experienced by other mining projects in Yukon and other jurisdictions. The program contemplated for the 2-Year peak liability is virtually identical to the EOM estimate with all major programs consistent between both estimates.

An allowance for the establishment of an additional 50,000 m^2 leach area has been included to account for potential damage to the installed emitter system that may impact delivery of the biological treatment reagents.

<u>T6 Open Pit</u>

The costs associated with closure of the open pit were adjusted to reflect the pit dimensions 2-Years from the effective date of this RCP. The pit will allow for the formation of a pit lake as is also contemplated in the EOM.

<u>T7 Heap Leach Facilities</u>

Areas and volume of material movement for recontouring all slopes to 2.5:1 were updated to reflect the 2-Year peak liability site configuration.

The cost estimate scenario at the end of Year 2 includes provisions for the operation of active treatment of heap solution to the capacity required by QZ14-041-1 (in T9 Surface Facilities). Anticipated costs for a biological treatment process for cyanide destruction and reclamation of potential future snow dump locations are also provided. Confirmation drilling for the purposes of confirmation of biological detoxification have been revised based on Ensero 2022 (Appendix N) and analytical costs have been included.

<u>T8 Waste Dumps</u>

Areas and volume of material movement for recontouring all slopes to 2.5:1 were updated to reflect Year 2 site configuration.

<u>T9 Surface Facilities</u>

Costs have been adjusted to reflect the Mine layout required for compliance with license terms (i.e., final construction activities and operation of the MWTP which will be commissioned in Q4 2022).

<u>T10 Infrastructure</u>

Generally consistent with the costs and tasks considered in RCP versions 2020-01 and 2018-03.

<u>T11 Waste Disposal & Remediation</u>

Generally consistent with the costs and tasks considered in RCP versions 2020-01 and 2018-03.

T12 Landfills

Generally consistent with the costs and tasks considered in RCP versions 2020-01 and 2018-03.

T15 Road and Trails

Costs have been adjusted based on the current and Year-2 planned Mine layout and current unit rates.

T14 Water Management Infrastructure

Costs have been adjusted based on the current and Year-2 planned Mine layout and current unit rates.

T15 Post Closure Care, Maintenance and Monitoring

Post Closure Maintenance and Monitoring was updated based on the current HLF water balance model (Appendix I) and subsequent changes to activity durations. Post closure monitoring and reporting was also increased from 5 to 10 years based on feedback received during previous review processes.

T16 Interim Care and Maintenance

Costs have been adjusted based on the Year-2 planned Mine layout and current unit rates. As described above, Phase 5 rinsing of the heap would occur during the first 240 days of the 2-year Interim Care and Maintenance period. As discussed in Appendix N), additional test work undertaken by VGC and available research indicates that cyanide concentrations can be significantly degraded (certainly to levels that are amendable to a transition to the biological treatment processes) with simple recycling of solution. The laboratory scale results derived during additional VGC testing show this to be the case without the addition of any additional meteoric or fresh water inputs.

The costs for solution recirculation during the interim care and maintenance period are based on the Forte (Appendix I) HLF water balance model ICM period provided in Appendix N which includes modeling of precipitation inputs during the ICM period.

T17 Quantities

T17a was updated to accurately reflect the current and projected Mine configurations.

As described above, T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on optimized Mine HLF Water Balance Modelling by Forte Dynamics (Appendix I) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

13.3 END OF MINE LIFE COST ESTIMATE

The total cost of implementing the Reclamation and Closure Plan at the end of mine (EOM) life as outlined in this document is $106,548,773. A summary of the RCP costs for both the 2-year peak and EOM liability are presented in Table 13.1. The EOM cost estimate reflects the cost to reclaim the full extent of build-out for the open pit, HLF, WRSAs and surface facilities for the Mine (as described in Table 8-1) and assumes that no progressive reclamation has been undertaken during the life of the Mine.

Direct implementation costs for all of the reclamation tasks total approximately $51.2M for the EOM life cost estimate. Indirect costs are 15% of the direct costs and total $7.7M. Direct and indirect costs are then inflated, using a compounding factor, by 2% over the period of interim care and maintenance and implementation. The

EOM cost estimate includes $14.9M for inflation. The plan requires 4 years (Phase 6) to implement and complete followed by 15 years of late closure/post-closure monitoring and maintenance (Phase 7), as well as monitoring and maintenance at 28, and 43 years after the end of mine (Phase 8). The 4-year duration for implementation is driven by the time required to drain down the heap and establish drainage that can be managed passively. As stated above, the duration for draindown considered for the cost estimate conservatively assumes that no covers are placed during the draindown period. The current closure of the HLF would include placing covers sometime during the draindown process.

Future long-term costs for solution draindown, long-term monitoring and maintenance, and post closure decommissioning are calculated on a NPV basis using a discount rate of 3% consistent with the approach for the Year 2 estimate.

13.3.1 Discussion of End of Mine Life Costing Tables and Notable Adjustments

T1 Summary

Previously discussed in Section 13.2.1

Cost inflation is based on the Bank of Canada target of 2%. Cost inflation has also been applied to contingency costs.

For Net Present Value calculations, the input factor is based on the Bank of Canada long term bond yield rate of 3%.

T2 Unit Rates

Previously discussed in Section 13.2.1.

T3 General and Administrative

Previously discussed in Section 13.2.1.

T5 Closure Planning

Previously discussed in Section 13.2.1.

T6 Pit

Previously discussed in Section 13.2.1.

T7 Heap Leach Facility

Previously discussed in Section 13.2.1.

T8 Waste Rock Storage Areas

Previously discussed in Section 13.2.1.

T9 Surface Facilities

Previously discussed in Section 13.2.1.

T10 Infrastructure

Previously discussed in Section 13.2.1.

T11 Waste Disposal and Remediation

Previously discussed in Section 13.2.1.

T12 Landfills

Previously discussed in Section 13.2.1.

T13 Roads and Trails

Previously discussed in Section 13.2.1.

T14 Water Management

Previously discussed in Section 13.2.1.

T15 Post Closure Care, Maintenance and Monitoring

Previously discussed in Section 13.2.1.

T16 Interim Care and Maintenance

As described in Section 13.2.1, T16 was updated to include costs for power to recirculate solution and rinse the heap. At the EOM, Phase 5 rinsing of the heap would occur during the first 402 days of the Interim Care and Maintenance period.

T17 Quantities

T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on the HLF Water Balance Modelling by Forte Dynamics (2022) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

Table 13-1: Summary Table of Estimated Closure Costs

Description of Cost	2-Year Peak Liability	Estimated Cost EOM
Closure Implementation		
T3 General & Administration	$2,170,183	$3,673,726
T5 Closure Planning	$1,971,840	$1,971,840
T6 Pit	$55,856	$55,856
T7 Heap Leach Pad	$6,182,991	$8,938,848
T8 Waste Dumps	$7,529,144	$8,379,570
T9 Surface Facilities	$12,048,857	$12,048,857
T10 Infrastructure	$401,035	$401,035
T11 Waste Disposal and Remediation	$173,135	$173,135
T12 Landfills	$143,126	$143,126
T13 Roads & Trails	$500,120	$475,342
T14 Water Management	$219,450	$219,450
T16 Interim Care & Maintenance	$14,765,544	$14,765,544
Sub-total	$46,161,282	$51,246,330
Indirect Costs	$6,924,192	$7,686,949

Description of Cost	2-Year Peak Liability	Estimated Cost EOM
Contingency Costs	$8,487,752	$9,297,720
Cost Inflation	$6,058,947	$14,942,208
Total Closure Implementation Costs	**$59,144,421**	**$73,875,487**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)		
	NPV (3% DROR)	
Onsite Management	$848,845	$740,888
Transport Costs	$48,854	$40,331
Water Treatment Costs (Phase 6)	-	-
Active Treatment (Phase 6)	-	-
Capital Costs (included in T9, above)	$0	$0
Capital Replacement Costs	$859,018	$1,072,942
Operating Costs	$4,360,535	$7,949,513
Draindown Pumping (Phase 6)	$3,589,185	$4,696,907
Passive Treatment (Phase 7-8)	-	-
Capital Costs	$128,574	$101,198
Operating Costs	$73,582	$81,052
Reclamation & Closure Research Phase 6	$35,022	$56,809
Monitoring & Reporting	$1,820,930	$1,638,839
Post Closure Maintenance (Phase 7/8)	$830,912	$621,933
Sub-Total	$12,595,457	$17,000,411
Indirect Costs	$1,889,319	$2,550,062
Contingency Costs	$2,833,978	$3,825,093
Total Care, Maintenance and Monitoring Costs	$14,484,776	$19,550,473
Total Closure Costs	**$73,629,197**	**$93,425,961**
Contingency Amount	**$11,321,730**	**$13,122,813**
Total Closure Costs (Plus Contingency)	**$84,950,927**	**$106,548,773**

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APPENDIX A

Revegetation Trials on the Peso Site on the Dublin Gulch Property, 2012 to 2018

REVEGETATION TRIALS

ON THE PESO SITE ON THE DUBLIN GULCH PROPERTY

2012 to 2018

Volunteer spruce and shrubs growing with the alder on a plot at the Waste Rock Dump

For
Victoria Gold Corp.

Submitted by

Laberge Environmental Services

April 2019

EXECUTIVE SUMMARY

A six year revegetation trial was conducted at the old Peso mine site on Victoria Gold's Dublin Gulch property located in central Yukon. The latest mining activity and disturbance at Peso occurred in the 1960s and very little natural revegetation had taken place over the ensuing decades. Blocks of plots were established on two sites; an old trenched area and the waste rock dump below the adit. Plots in each block received no treatment or a variety of amendments including biochar, compost, leonardite and dolomite lime prior to seeding with native grasses and locally collected alder seed.

The soil at Peso is acidic, nutrient poor and highly mineralized. Biochar was chosen as one of the amendments due to its ability to transform degraded land. It increases the pH of acidic soils, adds moisture retention to arid soils, provides surface area for microbes and nutrients to use, immobilizes metals and can sequester carbon into the ground for very long periods. Biochar itself is not a fertilizer, and is combined with compost in this trial, to provide nutrients for initial plant growth.

Annual assessments were conducted midsummer from 2013 to 2018. Unsurprisingly, there was minimal, if any, growth on the plots that were seeded but received no amendments, analogous to the surrounding areas. Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and help to build up the soil through litter decomposition. By year two most of the treated plots supported relatively healthy growth of various grass species. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighbouring forest. The shrubs increased in growth over the final years and in 2018 some of the alders had produced seed cones.

Alder is a nitrogen fixing woody plant. Nitrogen is an essential element in plant development and the primary limiting factor for plant growth in boreal forests. The successful growth of this species on the plots provides nitrogen to the soil increasing soil fertility. During the 2018 assessment nitrogen nodules were observed on alder roots. In addition, the decomposition of alder leaves and other alder parts contributes nitrogen to the soil.

In the final year of the trial, soil and foliar tissue samples were collected and analysed for metals. Soil analysis indicated that the growth medium is acidic, nutrient poor and mineralized with very high concentrations of several metals. It appeared biochar was sequestering some metals in the treated plots. Although metal concentrations were extremely high in the soil (i.e arsenic, antimony and lead), these metals were not taken up in large amounts by the plants. Concentrations in the tissues appear relatively similar to those collected at other locations at Dublin Gulch and at other Yukon mine sites.

In summary, these trials have proven successful. With minimal effort, the use of appropriate species and soil amendments have produced healthy plants that have grown, propagated and even thrived on these acidic, highly mineralized soils.

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1.0 INTRODUCTION

1.1 Background

The claims at the Peso site were first staked in June 1910 by J. Alverson and G. Huffman, who sank a 4.9 m shaft in 1912 and trenched until 1916 (Yukon Minfile). In 1948, with antimony in demand, Cecil D. Poli re-staked Alverson's old silver-lead-antimony property as the Peso 1 – 12 claims and trenched the vein by hand. On route back to Haggart Creek he discovered the Rex vein two miles to the southeast. The Peso vein gave 40 ounces of silver per ton and a sample from the Rex vein gave 25 ounces per ton. These properties were optioned in the early 1950s at the height of the boom, but no significant work was done on them (Aho, 2006).

In 1961 Tanar Gold Mines Ltd transferred the claims to a new company, Peso Silver Mines Ltd who carried out extensive exploration from 1961 to 1965, including underground development on the Peso vein. The two main vein zones at Peso Rex contained a reasonably well proven-probable reserve of about 154,000 tons at 20.9 ounces of silver per ton and 3.7% lead (Campbell, 1965). The veins contain abundant pyrite and arsenopyrite, with jamesonite, tetrahedrite and minor shalerite and bismuthinite, including the metallic minerals galena and chalcopyrite (Aurum Geological Consultants, 1992).

M.J. Moreau explored with hand trenching in 1986 and bought the Peso and Rex claims at a Sheriff's sale in August 1988 (Yukon Minfile).

In 1991, M. J. Moreau Enterprises Ltd made a request of Aurum Geological Consultants to prepare a report summarizing the economic potential of the Pierre Property, which included the Peso claims. Results from samples collected in 1991 from the No. 1 Vein (Peso) returned a high silver value of 318.5 ppm which when fire assayed returned 37.8 oz/ton silver (Aurum Geological Consultants, 1992).

In 1994 First Dynasty Mines Ltd acquired claims throughout the area and in 1996 its wholly owned subsidiary, New Millennium Mining Ltd carried out a major drilling program in the Dublin Gulch area.

Stratagold acquired the Dublin Gulch property in 2004 and commenced a drilling program in 2005 to delineate the Eagle Zone. Victoria Gold Corp. assumed control in 2009.

Recent exploration work has been undertaken by Victoria Gold in the Rex/Peso area, however the locations of the trial plots are outside of the active zone and provide a representative site for the revegetation experiment.

1.2 Scope of Work

Victoria Gold Corp has sponsored revegetation research in support of reclamation planning for the Eagle Gold Project at their Dublin Gulch Property. The objective of the revegetation program at Peso is to test the viability of incorporating biochar and other soil amendments into the site with a goal of creating an ultimate reclamation and revegetation plan that will be transferable to the Eagle Gold Project Reclamation and Closure Plan (StrataGold 2014). The Peso site was chosen because 1) there were existing and un-reclaimed facilities (waste dump and trenches) at the site that were located in similar terrain and with similar climatic conditions and geologic properties as the Eagle Gold Project, and 2) unlike other areas within the Eagle Gold Project area subject to exploration, construction and other activities, the established plots at Peso would remain undisturbed.

Biochar is a light charcoal material produced by heating or combusting biomass under low or no oxygen conditions, a process known as pyrolysis. Residues of incomplete organic pyrolysis (e.g., from cooking fires), are thought to be the key component of terra preta soils, a very dark fertile anthropogenic soil known most commonly from the Amazon basin. It was most likely intentionally developed by humans between 450BC and 950AD to improve the poor soil conditions in the Amazonian basin. Terra preta is characterized by high concentrations of low temperature charcoal; quantities of pottery shards; and organic matter such as plants, animals, bones and feces (Bates, 2010). While the biochar process has been known for over a century, recent efforts are underway to recreate the fertile Terra preta like soils through the biochar process (Economist 2009).

One of the greatest benefits of biochar is its capacity to transform degraded land. It adds moisture retention to arid soils, it provides surface area for microbes and nutrients to use, it immobilizes metals and it can lock carbon into the ground for very long periods (Bruges, 2009, Chen et al, 2018). The agronomic and environmental benefits of adding biochar to soils have been investigated for many years, but in the past several years research has begun into the use of biochar for bioremediation of mine-affected soil (Laberge Environmental Services, 2012). For example, Fellet *et al* (2011) found that an increase in biochar content in mine tailings reduced the bioavailability of cadmium, lead, thallium and zinc. In column leaching tests, the sorption of cadmium and zinc to biochar's surfaces reduced their leachate concentrations by 300 and 45 fold respectively (Beesley and Marmiroli, 2011). Therefore, as well as enhancing growing conditions in the soil for successful plant growth, biochar can also help to sequester metals and mitigate leachate water quality.

The organic material (i.e., trees, shrubs and organic surface cover) that will be cleared from the various development areas to make way for mining operations at Eagle Gold, can be processed into biochar on site thus creating a local source and thereby eliminating the introduction of unknown or unwanted components of outsourced biochar. The pyrolysis of plant biomass to generate biochar converts much of the carbon into a form of carbon which is very stable in soils for thousands of years. Thus, by creating biochar from the plant overburden, instead of allowing it to naturally decompose and consequently release carbon dioxide (a greenhouse gas) into the atmosphere, the carbon becomes unavailable and is sequestered. If applicable, Victoria Gold could earn carbon credits by 1) producing its own biochar as a soil amendment for the site's closure activities and 2) planting vegetation. With the introduction of a tax on carbon in the Yukon, the sequestration of carbon through these activities offsets at least some of the carbon dioxide that the mine will emit and thus lowers its carbon footprint.

The Peso plots were established in 2012 and assessed annually until 2018. Additional monitoring was completed in the final year (2018) of the trial, including soil testing, metal analysis of plant tissues, height of above ground growth and rooting depth.

2.0 STUDY AREA

The Eagle Gold Project at Dublin Gulch is located approximately 85 km northeast of the village of Mayo in central Yukon and lies wholly within the traditional territory of the First Nation of the Na Cho Nyak Dun. The project is 100% owned by Victoria Gold Corp and covers an area of approximately 650 square kilometers. Its centre is situated at the confluence of Haggart Creek and Dublin Gulch at the UTM Coordinates 7100950N / 453750E, Zone 8, NAD 83 Datum.

The historic Peso Minesite is located approximately 6.5 km west of the camp at the Eagle Gold Project, near Secret Creek, a tributary to Haggart Creek (Figure 1). The study area lies within the northern region of the Yukon Plateau North ecoregion in the Stewart River sub-basin of the Yukon River watershed. This area is generally characterized by rolling uplands with steep slopes leading into U-shaped valleys (Smith *et al,* 2006). There are two zones within the Eagle Gold Site; subalpine, and open black spruce forests at lower elevations. The subalpine zones (above 1225 masl) are generally dominated by dwarf birch and willows. Other species occurring within the forested areas are Alaska birch, aspen, balsam poplar and white spruce, depending on aspect. Subalpine fir is also found in small pockets at higher elevations (Stantec, 2011).

Climate stations are operational within the Eagle Gold Project area at the Potato Hills Station (1420 masl) and at the Camp Station (782 masl). Knight Piesold Consulting (KPC) examined and summarized the meteorological data collected over a four year period, 2009 to 2012 (KPC, 2013). Since the two climate stations are located at significantly different elevations and thus will have varied temperature and precipitation results due to orographic tendencies, KPC used a reference elevation of 1125m for their analysis and summary. Table 1 summarizes selected climatic parameters for this elevation.

TABLE 1 MEANS FOR SELECTED CLIMATIC PARAMENTERS AT ELEVATION 1125m

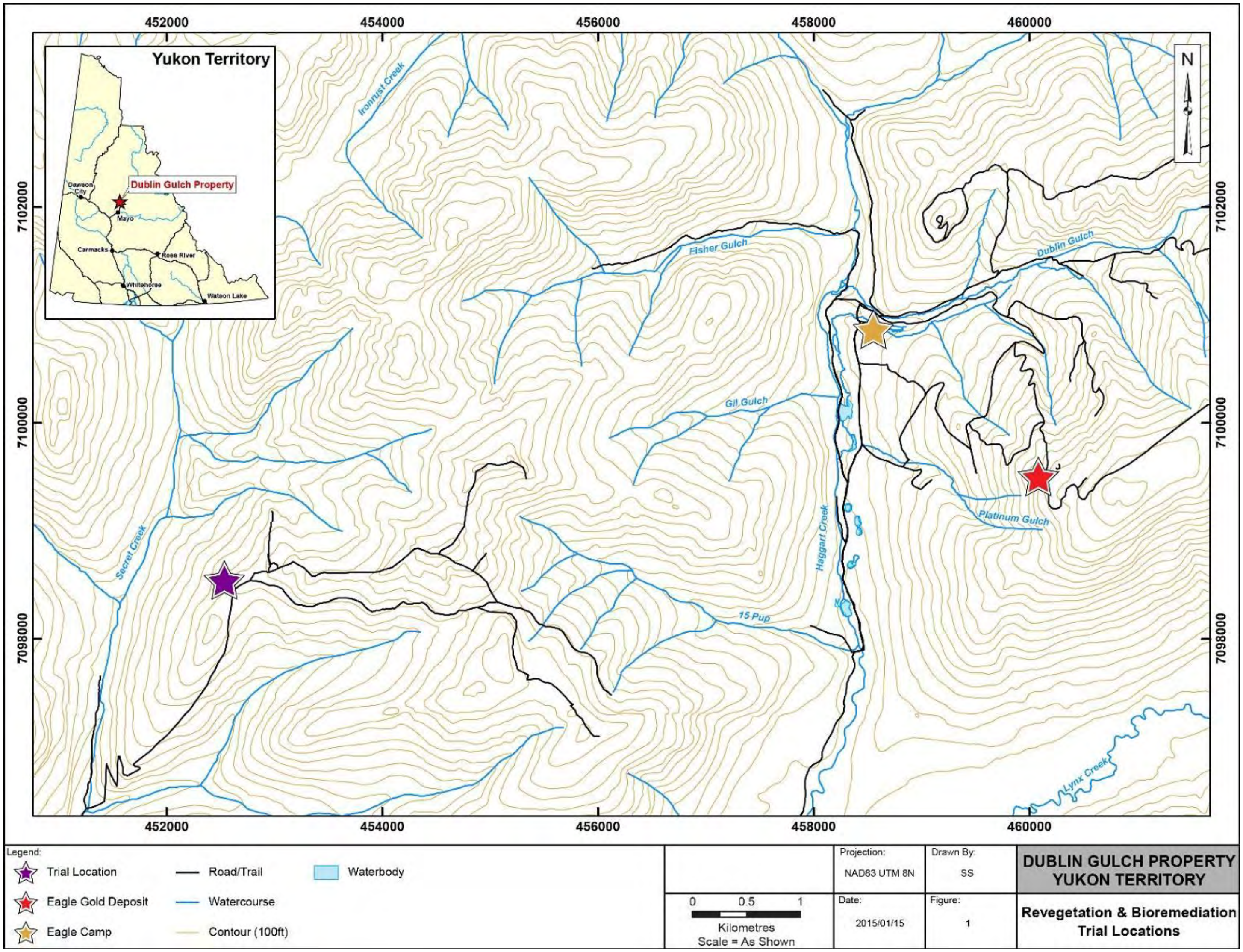
Parameter	Value
Mean annual temperature	-4.2
Mean January temperature	-19.7
Mean July temperature	11.4
Mean annual precipitation	500 mm
Mean annual rainfall	190 mm
Mean annual snowfall (water-equivalent)	310 mm
Mean annual rainfall/snowfall distribution	38% / 62%

Taken from KPC 2013

Since the elevation of the vegetation trials is slightly lower than 1125 m (see Table 2), the above values should be relatively representative of temperature and rainfall at the Peso plots.

The majority of the exploration work at the Peso site was completed during the early 1960s. With the exception of dense growth of alders at the less disturbed sites, very little natural revegetation has taken place in the areas disturbed by historical activities in the Peso area over this time period. Vegetation in the adjacent undisturbed and lesser disturbed sites consists of subalpine fir, white spruce, black spruce and Alaska birch, with occasional balsam poplar and trembling aspen. Mountain alder, dwarf birch, Scouler's willow and blue-green willow are the most common medium to tall shrub species (Laberge and Nacho Nyak Dun Development Corporation, 2004).

FIGURE 1 PESO REVEGETATION TRIAL LOCATIONS ON THE DUBLIN GULCH PROPERTY



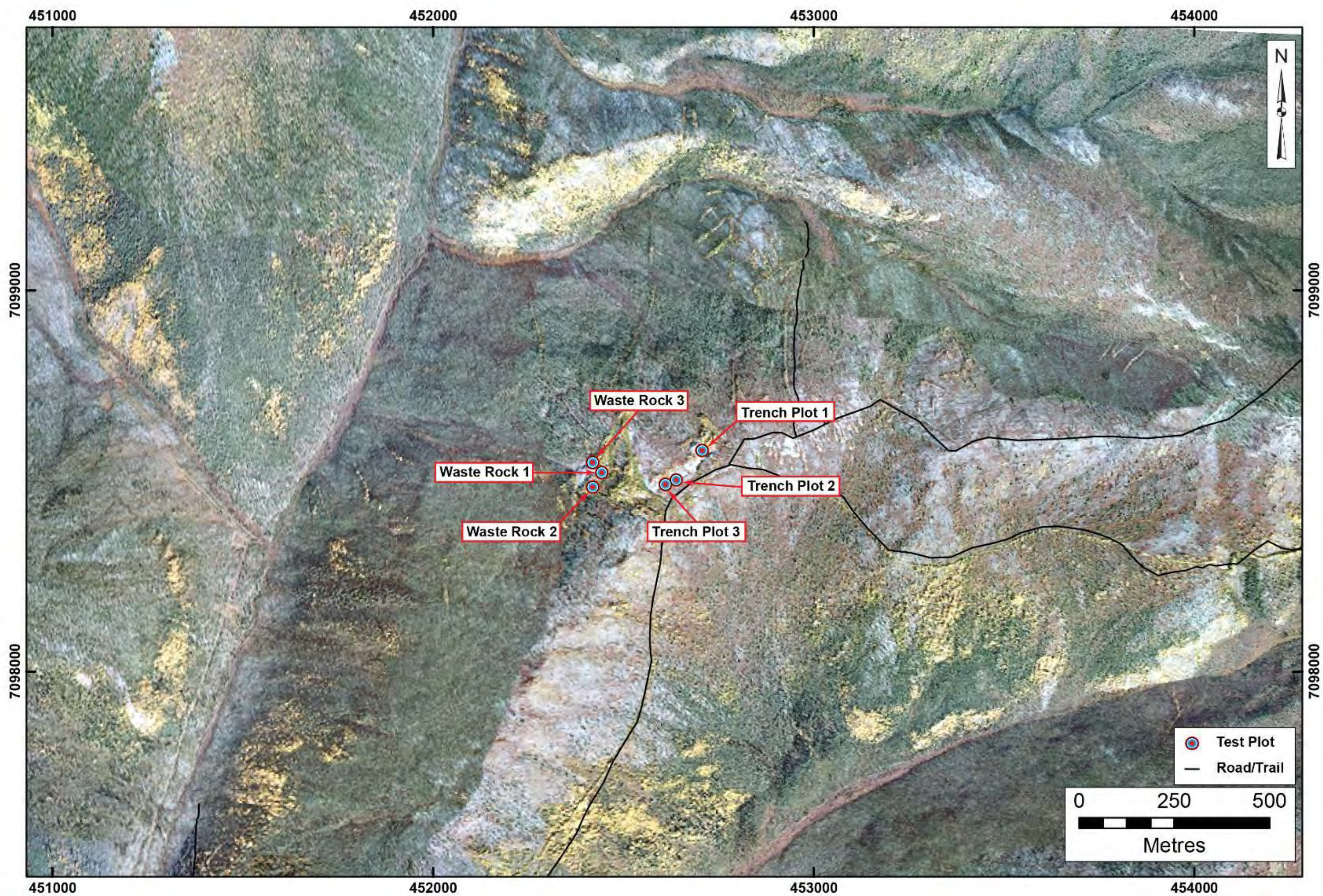
The ground cover includes low shrubs such as Labrador tea, Beauverd's spiraea, kinnikinick, lingonberry, blueberry and crowberry. Dwarf dogwood, toadflax, lupine and fireweed are the most common forb species (Laberge Environmental Services and NND-DC, 2004).

During a reconnaissance trip in June 2012, two sites at Peso were selected for the revegetation trials, an exploration trench and the waste rock dump. Although trenching has been undertaken at the site since the early 1900s, mostly hand trenching, it is assumed that the trench chosen for the trials was a result of bulldozer exploration in the early 1960s by Peso Silver Mines. Three blocks, each containing 5 test plots, were established at the trench site. Block #1 is located north of an exploration trail and the other 2 Blocks are located south.

The Peso adit is located approximately 250 m west of the trench. Peso Silver Mines conducted underground development on the Peso vein resulting in the formation of the waste rock dump on the west facing slope. The waste rock dump covers an area approximately 50 m by 70 m. It is comprised of three lifts varying in thickness from two to six meters. A total of three blocks, each containing 5 test plots, were established on each tier. The locations of the blocks are detailed below in Table 2 and shown on Figure 2.

TABLE 2	**BLOCK LOCATIONS AT PESO**		
Site	**Latitude**	**Longitude**	**Elevation (m)**
Trench:			
Block #1	64° 00.649'	135° 58.038'	1040
Block #2	64° 00.607'	135° 58.119'	1030
Block #3	64° 00.601'	135° 58.154'	1042
Waste Rock:			
Block #1	64° 00.616'	135° 58.360'	992
Block #2	64° 00.595'	135° 58.388'	986
Block #3	64° 00.630'	135° 58.390'	973

FIGURE 2 TEST PLOT LOCATIONS AT THE OLD PESO MINESITE



3.0 STUDY DESIGN

3.1 Soil Analysis

The success of a revegetation project depends firstly on characterizing site-specific conditions such as soil fertility, climate, aspect, elevation, slope, drainage, etc, prior to making any decisions regarding seed mixes and amendments.

For the purposes of this study, a reconnaissance visit to the old Peso mine site was initially conducted on June 24th, 2012. After assessing the area, two areas were chosen for the revegetation trials and are described in Section 2.0. Soil samples were collected from these sites and sent to Maxxam Analytical Laboratory in Burnaby, BC. The complete analytical report can be found in Appendix A and a summary of data in Section 4.1.

The soil was extremely acidic at the waste rock site and strongly acidic at the trench site. Acid tolerant plant species consequently were selected for the revegetation project. Soil samples collected from the waste rock in 2003 showed it to be extremely acidic with a pH value of 2.8 (Laberge, 2004). Soil samples collected near the portal and from the easternmost lobe of the waste rock in 1997 were potentially acid generating following bottle roll tests (Environmental Services, 1998). The soil samples collected in 2012 confirm the strong acidity of the waste rock dump (pH 2.6). Soil testing of the trench area had not been done previously.

All available nutrients were extremely low where detected. Organic matter and total organic carbon were very low at the waste rock site and below the detection limits at the trench site.

Concentrations of antimony, arsenic and lead were extremely high at both sites. Antimony is a trace element and background levels are generally very low. Antimony concentrations are usually much greater at mining and contaminated sites.

Background levels of arsenic in soils are low and rarely exceed 15 mg/kg (Singh, 2005). Arsenic concentrations were very high at the Peso site with much higher levels that appear atypical when compared to other sites sampled for soil geochemistry at the Dublin Gulch site (Burns, 2013, Laberge Environmental Services, 2018a).

Lead concentrations were also extremely high in the two soil samples at Peso and were much greater than documented at other locations at Dublin Gulch.

Generally the metal concentrations were similar at both of the selected trial sites.

3.2 Field Design

3.2.1 Site Preparation

The plots at the two sites were installed on July 19th, 2012. Three blocks of plots were situated on relatively level ground with the same aspect at each site. Each block measured 5m by 2m and contained 10 one-meter square plots. The blocks and plots were measured and demarked with orange fluorescent painted rebar. Labeled flagging tape was added to each corner pin of the plots.

The plots were prepared and seeded from September 18th to 20th, 2012. Each plot to be seeded was scarified first with a hand-cultivator (tine length 15 cm), and then raked with a fine-toothed rake (see Photo #1, Appendix B). Soil amendments were well mixed into the prepared plot and then the seeds were hand broadcast throughout the plot. Each plot was tamped gently but firmly with the back of a rake to create micro-sites and achieve good seed placement.

Every other plot within each block was seeded, allowing the unseeded/untreated plots to represent buffer zones. The implementation of buffer plots ensures that each test plot is isolated and uninfluenced from neighboring plots. As well, each plot can be assessed and closely examined without the risk of trampling on plants on the other test plots. Further details, including photographs are included in a report prepared for Victoria Gold (Laberge, 2013). As described below, due to the differences in acidity at the two sites, slightly different seed mixes and treatments were prepared.

3.2.2 Treatments

The intention of these trials was to determine in a relatively simple manner which amendments might be utilized for successful native plant growth to initiate the restoration process. The amendments used in these trials were biochar, compost, leonardite and dolomite.

Raw biochar chips were obtained locally from Zakuas Farms, Whitehorse, Yukon. Prior to application they were ground in a steel-blade seed grinder to produce a fine, almost powdery mix. It has been well established that biochar on its own (due to the lack of nutrients) is insufficient as an amendment on poor soils (Peltz *et al*, Beesley and Marmiroli, 2011, Beesley *et al*, 2010), hence it was combined with nutrient rich compost for each plot.

Bags of compost were obtained from the co-operative project at the Whitehorse Solid Waste Facility which produces commercial quantities of high quality compost.

Leonardite is defined as a naturally occurring oxidized form of lignite coal that is rich in humic acids. Its main use is as a soil amendment in agriculture and reclamation. For the purposes of this study, leonardite was obtained from Tisdale, Saskatchewan. This leonardite consisted mostly of humic acid with small amounts of fluvic acid and required minimal processing. It was also included with the amendments for some of the plots as an additional source of nutrients.

Due to the relatively higher acidity at the waste rock dump site, commercially available dolomite, purchased from Canadian Tire, was added to the amendment mix at some of the plots to create some buffering capacity.

No other fertilization was used and the plots were not watered at any time. The plots were exposed to the natural conditions that existed at each of the local areas throughout the seasons. Thus, aside from the initial site development and treatment, no other treatment or site modification was implemented.

3.2.2.1 Waste Rock Site

In attempts to control acid generation and enhance soil rehabilitation, the following amendments were used on the waste rock sites; biochar, compost, leonardite and dolomite lime.

The application rates per plot are as follows:

- 6 liters of biochar (just under 1 kg)
- 15 liters (1/2 bag) of compost
- 0.15 kg/m^2 of leonardite
- 3.3 kg/m^2 of dolomite

There were five treatments per block of plots:

Treatment Method #	Treatment Composition
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite
4	Seed, biochar, compost, dolomite lime
5	Seed, biochar, compost, leonardite, dolomite lime

The layout of the plots and treatments per block is presented in Figure 3. Each treatment is represented once per block and three times in total for the site. The shaded plots received no treatments and represent buffers between plots.

FIGURE 3 LAYOUT OF TREATMENTS AND PLOTS AT WASTE ROCK

Waste Rock Block #1 (on top tier near the adit) – seeded and amendments added Sept 18, 2012 @13:00

1 Plot # 1-1		**3** Plot # 1-3		**5** Plot # 1-5
	2 Plot # 1-2		**4** Plot # 1-4	

Waste Rock Block #2 – (on second tier) seeded and amendments added on September 18, 2012 @ 14:30

	2 Plot # 2-2		**4** Plot # 2-4	
1 Plot # 2-1		**3** Plot # 2-3		**5** Plot # 2-5

Waste Rock Block #3 – (on third tier from top) seeded and amendments added on September 18, 2012 @ 16:00

1 Plot # 3-1		**3** Plot # 3-3		**5** Plot # 3-5
	2 Plot # 3-2		**4** Plot # 3-4	

3.2.2.2 Trench Site

The soil at the trench site was not as acidic as on the waste rock dump, with a pH of 5.15, consequently dolomite lime was not included as an amendment. Biochar, compost and leonardite were again applied to the trench plots at the following application rates:

- 3 liters of biochar
- 15 liters (1/2 bag) of compost
- 0.15 kg/m2 of leonardite

There were three treatments per block of plots:

Treatment Method #	Treatment Composition
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite

The layout of the plots and treatments per block is presented in Figure 4. Each treatment is represented five times for the site. The shaded plots received no treatments and represent buffers between plots.

FIGURE 4 LAYOUT OF TREATMENTS AND PLOTS AT TRENCH SITE

Trench Block #1 – seeded and amendments added on September 19, 2012 @ 11:00

1 Plot #1-1A		**3** Plot #1-3		**2** Plot #1-2B
	2 Plot #1-2A		**1** Plot #1-1B	

Trench Block #2 – seeded and amendments added on September 18, 2012 @ 18:00

	1 Plot # 2-1A		**3** Plot # 2-3A	
3 Plot # 2-3B		**2** Plot # 2-2		**1** Plot # 2-1B

Trench Block #3 – seeded and amendments added on September 19th, 2012 @ 10:00.

2 Plot #3-2A		**1** Plot #3-1		**3** Plot #3-3B
	3 Plot #3-3A		**2** Plot #3-2B	

3.2.3 Seed Mix

The species chosen for the trials were determined through consultation of the Yukon Revegetation Manual (Matheus and Omtzigt, 2012) as well as through the observation of species currently growing in the near vicinity of the sites. The appropriate seed mixes were distributed for each plot as per the quantities noted in Table 3. In addition, because alder grows prolifically around the site and is well adapted to localized conditions, a small handful of local alder seeds was collected on site and distributed with the seed mix. Furthermore, alder fixes nitrogen and all parts of the plants contribute nitrogen to the soil during decomposition. Seeds from Hedysarum plants (a nitrogen fixing legume) were also added to the seed mix to increase the nitrogen potential.

The seed mix is slightly different for the two sites due to soil conditions. The soil at the waste rock site was extremely acidic, had little to no nutrient values and was highly mineralized. Several plant species were chosen due to their tolerances to acidic, low nutrient levels, drought and/or heavy metal conditions in the growth medium. The seed rate, adjusted to 1m^2 plot size, is also provided in Table 3. The soil at the trench site was not as acidic as on the waste rock dump and slight alterations were made to the seed mix (Table 3).

TABLE 3 SEED MIX AND RATE OF APPLICATION FOR WASTE ROCK AND TRENCH SITES

Common Name	Scientific Name	Application rate/plot at Waste Rock	Application rate/plot at Trench
Sheep fescue	*Festuca ovina*	0.4 g	0.4 g
Tufted hairgrass	*Deschampsia caespitosa*	0.14 g	0.14 g
Glaucous bluegrass	*Poa glauca*	0.19 g	---
Alpine bluegrass	*Poa alpina*	---	0.21 g
Tickle grass	*Agrostis scabra*	0.04 g	---
Spike Trisetum	*Trisetum spicatum*	---	0.9 g
Bear root	*Hedysarum alpinum*	20 seeds	20 seeds
Alder	*Alnus viridus*	small handful	small handful

The first six plant species are native occurring plants with commercially available accredited seed obtained from BrettYoung$_{TM}$ of Calmar, Alberta. Alder seeds were hand collected from local plants near the plots on the day of planting and spread onto each plot. Hedysarum seeds, previously collected from various sites in the Yukon, were also added to the plots.

4.0 ASSESSMENTS

4.1 Soil

Soil samples were collected from each plot in 2018, including the plots that received no treatment. Surface samples were collected to a depth of 5 to 10 cm, using a stainless steel trowel and placed into resealable plastic bags. All samples were kept cool until delivered to the ALS lab in Whitehorse, Yukon.

The soil was analyzed for pH, organic content, available nutrients and metals. The complete analytical report is presented in Appendix A.

Selected parameters were compared from the untreated plots to the soil samples collected in 2012 (Table 4). As actual plot locations were not yet determined in June 2012, the soil samples were not collected from the exact locations on both years. The results for the 2018 soil sample analysis collected from the untreated plots in each block were averaged to represent the concentrations existing at the Trench and Waste Rock Dump sites.

It appears that the organic matter content has slightly increased over the time period. It was noted that scant vegetation was gradually colonizing the untreated plots as well as the buffer plots. The pH at each location is consistent. Available phosphate was similar however available potassium concentrations were higher in 2018 than in 2012. Some of the metal concentrations were quite different in the two time periods, notably at the waste rock dump, and likely is reflective of the distribution of the disturbed terrain as the waste material was removed from the adit.

TABLE 4 EXISTING SOIL CONCENTRATIONS, 2012 AND 2018

Parameter	MDL	Units	NO TREATMENT			
			Waste Rock		Trench	
			2018	2012	2018	2012
			N=3	N=1	N=3	N=1
Loss on Ignition @ 375 C	1.0	%	1.7	6.1	1.6	4.0
Organic Matter	1.0	%	1.6	0.6	1.5	<0.35
pH (1:2 soil:water)	0.10	pH	2.70	2.62	5.8	5.15
Total Carbon by Combustion	0.05	%	0.50	0.37	0.4	<0.20
Available Phosphate-P	2.0	mg/kg	2.2	2.9	2.9	1.8
Available Potassium	20	mg/kg	27.0	<2.0	28.3	8.5
Aluminum (Al)	50	mg/kg	5,030	2,690	3,230	2,350
Antimony (Sb)	0	mg/kg	1,777	3,680	3,567	3,580
Arsenic (As)	0	mg/kg	2,743	6,150	7,863	9,810
Cadmium (Cd)	0.020	mg/kg	1.3	4.88	4.7	4.28
Chromium (Cr)	0.50	mg/kg	11.7	6.7	11.7	12.2
Cobalt (Co)	0.10	mg/kg	6.04	3.54	5.31	5.33
Copper (Cu)	0.50	mg/kg	161.0	210	125.4	75.9
Iron (Fe)	50	mg/kg	40,700	57,500	50,300	46,300
Lead (Pb)	1	mg/kg	2,427	9,070	7,057	7,330
Mercury (Hg)	0.005	mg/kg	0.131	0.796	0.428	0.410
Nickel (Ni)	0.50	mg/kg	17.6	9.1	11.7	12.0
Selenium (Se)	0.20	mg/kg	5.4	19.30	7.9	12.70
Silver (Ag)	0.10	mg/kg	23.2	89.4	44.4	103.0
Zinc (Zn)	2.0	mg/kg	133.3	252.0	194.3	129.0

Soil samples were also collected from each of the treated plots in 2018 and the analytical data is presented in Tables A-1 (Trench) and A-2 (Waste Rock) in Appendix A. Means for each treatment was calculated and selected parameters tabulated for the Trench (Table 5) and the Waste Rock Dump (Table 6).

Soil pH was raised slightly with the amendments except for plots where leonardite was also included. Leonardite is rich in humic acid and this additional acid limited buffering by the biochar.

Organic matter (%), Total Kjeldahl Nitrogen and total carbon by combustion increased with the addition of amendments.

TABLE 5 MEAN CONCENTRATIONS (N=3) OF EACH TREATMENT, TRENCH

Parameter	MDL	Units	No treatment	Biochar and compost	Biochar, Compost and Lenardite
pH (1:2 soil:water)	0.10	pH	5.8	6.7	6.6
Organic matter	1.00	%	1.5	2.3	2.5
Total Kjeldahl Nitrogen	0.020	%	0.066	0.086	0.094
Total Carbon by Combustion	0.05	%	0.4	1.3	1.3
Available Ammonium-N	1.0	mg/kg	1.8	2.5	2.3
Available Phosphate-P	2.0	mg/kg	2.9	23.0	21.1
Available Potassium	20	mg/kg	28.3	43.3	42.0
Aluminum (Al)	50	mg/kg	3230	3037	2973
Antimony (Sb)	0.10	mg/kg	3567	920	3036
Arsenic (As)	0.10	mg/kg	7863	2697	5007
Cadmium (Cd)	0.020	mg/kg	4.7	0.8	2.6
Calcium (Ca)	50	mg/kg	620	1215	2137
Chromium (Cr)	0.50	mg/kg	11.7	8.6	10.1
Cobalt (Co)	0.10	mg/kg	5.3	3.7	4.0
Copper (Cu)	0.50	mg/kg	125.4	66.4	74.7
Iron (Fe)	50	mg/kg	50300	32100	33367
Lead (Pb)	0.50	mg/kg	7057	1933	3273
Magnesium (Mg)	20	mg/kg	102.0	250.0	253.3
Manganese (Mn)	1.0	mg/kg	246.3	200.7	181.3
Mercury (Hg)	0.0050	mg/kg	0.4	0.3	0.5
Nickel (Ni)	0.50	mg/kg	11.7	8.6	9.4
Phosphorus (P)	50	mg/kg	762	678	805
Selenium (Se)	0.20	mg/kg	7.9	2.4	5.0
Silver (Ag)	0.10	mg/kg	44.4	14.2	21.6
Sulfur (S) *	1000	mg/kg	1733	1100	1600
Zinc (Zn)	2.0	mg/kg	194.3	107.5	96.8

* less than values (<) were excluded from the averaging MDL = method detection limit

The requisite macro nutrients required for all plant growth are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S) and magnesium (Mg) (DalCorso *et al*, 2014). Total Kjeldahl Nitrogen (TKN) is the amount of nitrogen that is in organic form. TKN was present in all of the plots and generally increased with the applied amendments. Phosphorus was present in all plots however available phosphate was absent in a few plots, more so at the waste rock site (probably a function of pH). Total potassium and available potassium were documented at each site and concentrations increased with amendments at the Trench site. There was little change in potassium with the amendments at the waste rock site. Calcium concentrations increased considerably with the amendments at both locations. Magnesium levels fluctuated throughout the study area. Sulphur levels were low at the Trench plots and frequently not detected (Table A-1), whereas high Sulphur concentrations were documented at the waste rock site, reflective of the acid rock drainage potential here.

Essential micro nutrients include iron (Fe), boron (B), nickel (Ni), copper (Cu), manganese (Mn), zinc (Zn) and molybdenum (Mo). Iron concentrations were high throughout the study area and ranged from 17,900 mg/kg to 70,100 mg/kg. Boron and molybdenum levels were very low and were barely detected at some plots. Nickel, copper, manganese and zinc were present at all plots.

Elements that are not essential but however benefit plant growth are sodium (Na), selenium (Se), aluminum (Al) and cobalt (Co). Aluminum is one of the most abundant elements in the earth's crust. Although low levels of aluminum are beneficial for plants due to its role in increasing the bioavailability of nutrient metal ions, high concentrations are toxic to most plants, especially in acidic soils. High concentrations were recorded at all plots. Cobalt was present in low concentrations at all plots. Selenium was also present at all plots, but concentrations increased with amendments at the Waste Rock site. Sodium was not detected at the plots at the Trench site but was present with fluctuating concentrations at the Waste Rock plots.

TABLE 6 MEAN CONCENTRATIONS (N=3) OF EACH TREATMENT, WASTE ROCK DUMP

Parameter	MDL	Units	No treatment	Biochar and compost	Biochar, compost and leonardite	Biochar, compost, dolomite lime	Biochar, compost, dolomite lime, leonardite
pH (1:2 soil:water)	0.10	pH	2.7	3.4	2.7	3.9	3.6
Total Kjeldahl Nitrogen	0.020	%	0.049	0.080	0.103	0.129	0.113
Total Carbon by Combustion	0.05	%	0.50	1.42	2.69	3.10	3.48
Available Ammonium-N	1.0	mg/kg	4.4	6.3	8.4	5.1	6.9
Available Phosphate-P	2.0	mg/kg	2.2	5.1	6.4	ND	15.6
Available Potassium	20	mg/kg	27.0	23.0	20.0	28.5	45.0
Aluminum (Al)	50	mg/kg	5030.0	4863.3	4336.7	4130.0	3360.0
Antimony (Sb)	0.10	mg/kg	1776.7	2855.0	2527.0	2952.7	4283.3
Arsenic (As)	0.10	mg/kg	2743.3	3653.3	4206.7	5466.7	5430.0
Cadmium (Cd)	0.020	mg/kg	1.3	2.4	2.9	3.0	3.2
Calcium (Ca)	50	mg/kg	476.7	918.7	588.7	4916.7	10726.7
Chromium (Cr)	0.50	mg/kg	11.7	12.0	10.0	10.1	6.7
Cobalt (Co)	0.10	mg/kg	6.0	6.0	8.9	6.5	2.0
Copper (Cu)	0.50	mg/kg	161.0	176.8	209.3	280.3	269.7
Iron (Fe)	50	mg/kg	40700.0	38233.3	45566.7	50600.0	47466.7
Lead (Pb)	0.50	mg/kg	2426.7	6400.3	5137.0	5223.3	9410.0
Magnesium (Mg)	20	mg/kg	1427.3	1477.3	677.3	3033.7	5464.0
Manganese (Mn)	1.0	mg/kg	171.0	170.6	161.7	147.9	127.3
Mercury (Hg)	0.0050	mg/kg	0.1	0.3	0.4	0.4	0.6
Nickel (Ni)	0.50	mg/kg	17.6	15.3	20.8	17.1	6.7
Phosphorus (P)	50	mg/kg	437.0	849.7	1011.0	1093.3	1144.0
Selenium (Se)	0.20	mg/kg	5.4	10.6	10.9	12.2	18.0
Silver (Ag)	0.10	mg/kg	23.2	11.8	30.8	45.8	62.9
Zinc (Zn)	2.0	mg/kg	133.3	137.8	174.9	126.2	93.5

* less than values (<) were excluded from the averaging

Plants must deal with the non-essential elements such as arsenic (As), mercury (Hg), silver (Ag), antimony (Sb), cadmium (Cd), lead (Pb) and uranium (U), which may potentially be harmful. Arsenic concentrations were very high throughout the soils in the study area and ranged from 1,240 mg/kg to 11,400 mg/kg. Mercury was detected at all plots. Silver is widely distributed in the earth's crust with an average abundance estimated at 0.07 mg/kg (Taylor, 1964). High concentrations of silver were documented in the soil samples collected from all the plots with some results greater than what the analytical method could determine. Antimony concentrations were very high at the plots with levels ranging from 369 mg/kg to 6,410 mg/kg. The earth's crustal average has been estimated at 0.2 mg/kg (Taylor, 1964). Lead concentrations were also high throughout ranging from 331 mg/kg to 16,600 mg/kg. Cadmium and uranium were present at all plots in fairly low concentrations.

4.2 Vegetation

4.2.1 Annual Assessments on Growth

The trial plots have been assessed on seven different occasions; twice in 2013 (July and September), early August 2014, early August 2015, mid July 2016, early August 2017 and late July 2018. All plots have had six full years of growth opportunity. Photographs chronicling each block and selected plots over the time period are provided in Appendix B.

The results for all seven assessments are presented in Table C-1 for the Trench Site and Table C-2 for the Waste Rock Site, both in Appendix C. The percentage of vegetative cover, species composition and overall health were observed for each plot. Vegetation cover is determined through point-based methods or ocular estimates. Due to the small size of the examined plots ocular estimates were made for the cover of each plot. Ocular estimates have a subjective element. In order to minimize observer variance, one member of the initial field team was present for each of the annual assessments.

The plots that were seeded but received no amendments supported very little, if any, growth over the six years. This is consistent with the general area as the acidic and mineral soils here have limited natural revegetation in the disturbed areas. The other plots with the different amendments sustained various levels of growth over time.

Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and helping to build up the soil. By year two most of the treated plots supported relatively healthy growth of various grass species. Hedysarum germinated in some plots during year one but was absent in the following years. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighbouring forest. Grasses were also dying back in the plots where alder was not prevalent. Table C-3 in Appendix C lists the species, planted and volunteer, that were identified in the plots over the course of the study period.

As the grasses and shrubs lose their leaves, organic matter builds up, which leads to an increase in soil fertility. During the 2018 assessment, nitrogen fixing nodules were observed on the roots of several alder plants on both the trench and waste rock plots (see Photos 40 and 55). Nitrogen is an essential element in plant development and generally the most limiting nutrient in boreal ecosystems. Plants however, cannot directly access nitrogen gas, which makes up about 80% of the atmosphere. Plants absorb the dissolved nitrogen in the soil through their roots in the form of ammonium and nitrates. Legumes (Fabaceae) host a bacteria that fixes nitrogen in root nodules which then becomes available to plants. Alder, of the family Betulaceae, is a non-legume which also fixes nitrogen. The presence of these nodules on the alder roots indicates that nitrogen is being produced on the treated plots both on the Trench and the Waste Rock Dump. The decomposition of alder leaves and plant parts likewise provides available nitrogen. This in turn increases the nutrient levels in the soil allowing other species to grow and become established.

Initially the vegetative cover of the plots increased but generally decreased in years three and four, coinciding with grass die off. Cover typically increased in following years as the shrubs grew larger. The exception to this was the plots that received no amendments (seed only). On some of these plots there initially was some minor growth however it had died back in later assessments. Cover at all of the treated plots in Block 3 of the Waste Rock site also decreased over time.

Plant growth was stressed in the plots that were seeded with no treatment (Treatment #1). The healthiest plots generally occurred at those treated with biochar and compost (Treatment #2), and the addition of dolomite tended to assist in the health at some of the plots at the Waste Rock site. The inclusion of Leonardite did not show any marked improvements in the plots and actually tended to decrease the health in the plants on some of the plots on the Waste Rock site. Although most of the alder on the waste rock amended plots exhibited healthy growth, some plants appeared to be suffering from necrosis – browning of leaves and yellow venation (Photo #81). This is likely the result of high concentrations of metals in the soil coupled with nutrient deficiency.

Some of the grass species were mature and producing seed at several plots commencing in the second year. For the first time, several alder had produced seed cones (Photos 28 and 54) in 2018.

During the annual assessments there had been occasional signs of herbivory.

Rooting depth and length were measured on several of the plants in 2018. Rooting depth ranged from 2 to 5 cm depending on the depth of the humus layer that had been built up over time. The roots then grew laterally above the mineral substrate and tended to average around 7 to 9 cm (Table C-4). The root lengths are likely underestimated due to their fragility and the difficulty involved in removing them from the substrate.

4.2.2 Metals in Foliar Tissues

Foliar samples were collected in 2018 from each plot where possible. Several plots, primarily those that received no treatment, supported very little, if any, growth, preventing the collection of sufficient biomass for analysis. Alder was growing at most of the other plots and was the principal tissue collected. There was insufficient growth of grasses in any of the plots by the sixth year of the trial preventing the analysis of this tissue type. Willow was growing in adequate volume to warrant the individual collection of this shrub at Plot 1-4 on the Waste Rock Dump only. Table 7 describes which species were collected at the various plots.

TABLE 7 FOLIAR SAMPLES COLLECTED PER PLOT

SITE	BLOCK #	PLOT #	ALDER LEAVES	ALDER STEMS	ALDER LEAVES & STEMS	WILLOW LEAVES & STEMS
TRENCH	1	1-1B			√	
		1-2AB	√	√		
		1-3	√	√		
	2	2-3A	√	√		
		2-2	√	√		
	3	3-2AB	√	√		
		3-3AB	√	√		
WASTE ROCK DUMP	1	1-2	√	√		
		1-3	√	√		
		1-4	√	√		√
		1-5	√	√		
	2	2-2	√	√		
		2-3	√	√		
		2-4	√	√		
		2-5	√	√		
	3	3-4			√	√
# of individual samples:			14	14	3*	

* samples collected at Plot #3-4 were combined into one sample due to low biomass

New disposable nitrile gloves were worn for each collection. Where possible, separate samples were collected for the shrub leaves and the current season's growth of twigs. Samples were placed in resealable plastic bags and kept cool until delivered to the ALS laboratory in Whitehorse, Yukon. After the samples were logged in, they were frozen and shipped to the lab in Burnaby, BC, for analysis. The foliar samples were rinsed thoroughly with de-ionized water, homogenized and sub-sampled prior to hot-block digestion with nitric and hydrochloric acids, in combination with the addition of hydrogen peroxide. Metals were analyzed using collision cell inductively coupled plasma-mass spectrometry. Analysis for mercury was done by atomic fluorescence or atomic absorption spectrophotometry.

The complete analytical report is provided in Appendix C. The data has been summarized according to the type of treatment and according to tissue type and is presented below per site.

4.2.2.1 Trench Site

There were three treatments applied to the Trench Site; no treatment, biochar and compost, and biochar, compost and leonardite. There were five plots per block so some treatments were repeated in each block. The tissue samples collected from the same treatment in the same block were combined and analyzed as a single sample. The analytical data for each of the plots is presented in Table C-5 in Appendix C. There were five metals that were below detection at all plots: beryllium, lithium, tellurium, vanadium and zirconium.

The data per treatment has been averaged and tabulated (Table 8). There are no guidelines regarding metal concentrations in vegetation with respect to wildlife consumption (e.g., moose and/or caribou). For reference, Stantec (2011) compared the 2009 baseline Eagle Gold foliar data to the dietary tolerances for beef cattle. These toxic values have also been included in Table 8.

TABLE 8 METALS (mg/kg) IN TISSUES PER AMENDMENT, TRENCH SITE

Parameter	Lowest Detection Limit	No treatment N=1	Biochar and compost N=6	Biochar, compost and leonardite N=6	Toxicity Thresholds
Aluminum (Al)-Total	2.0	33.5	16.40	9.66	>1200
Antimony (Sb)-Total	0.010	5.59	0.915	0.447	
Arsenic (As)-Total	0.020	17.0	2.42	1.72	>10*
Barium (Ba)-Total	0.050	39.5	38.74	32.75	>20**
Bismuth (Bi)-Total	0.010	0.219	0.07	0.035	
Boron (B)-Total	1.0	7.7	7.15	8.33	>200
Cadmium (Cd)-Total	0.0050	ND	0.011	0.01	50 - 500
Calcium (Ca)-Total	20	11000	6156.67	7056.67	
Cesium (Cs)-Total	0.0050	0.136	0.246	0.149	
Chromium (Cr)-Total	0.050	0.22	0.06	ND	>40
Cobalt (Co)-Total	0.020	0.121	0.120	0.088	>30
Copper (Cu)-Total	0.10	6.54	8.06	6.39	>100
Iron (Fe)-Total	3.0	222	54.67	48.37	>4000
Lead (Pb)-Total	0.020	48.0	11.00	6.06	>100
Magnesium (Mg)-Total	2.0	2430	1513.83	1451.67	
Manganese (Mn)-Total	0.050	214	62.68	61.28	2000 - 4000
Mercury (Hg)-Total	0.0050	0.0067	ND	ND	
Molybdenum (Mo)-Total	0.020	3.71	3.39	4.74	10 - 20
Nickel (Ni)-Total	0.20	5.54	2.07	1.34	>1500
Phosphorus (P)-Total	10	938	2122	2013	
Potassium (K)-Total	20	7510	5907	6108	
Rubidium (Rb)-Total	0.050	7.81	11.44	7.82	
Selenium (Se)-Total	0.050	ND	0.14	0.12	5 - 20
Sodium (Na)-Total	20	29	ND	ND	
Strontium (Sr)-Total	0.050	44.0	34.13	31.37	>2000
Thallium (Tl)-Total	0.0020	0.0060	0.0041	0.004	
Tin (Sn)-Total	0.10	0.21	ND	ND	
Uranium (U)-Total	0.0020	0.0180	0.0042	0.00	
Zinc (Zn)-Total	0.50	48.5	31.27	31.42	>5000

* There is no actual toxic value, only what is considered normal or adequate in the referenced table.

** There is no actual toxic value, only what is considered high in the referenced table. ND = not detected

In one of the six plots that received no treatment at the Trench site (Plot #1-1B), there was enough alder growing to warrant tissue analysis. This has allowed for the comparison of no treatment versus treatment on the effects of metal uptake.

The addition of treatments significantly decreased the uptake of the following metals: antimony, arsenic, iron, lead and to a lesser extent chromium, nickel and uranium.

The addition of treatments significantly increased the uptake of the nutrient phosphorus.

There is no actual toxic threshold assigned for arsenic, but the value given is the concentration that is considered “normal” (Stantec, 2011). This value was exceeded in foliar tissues collected from the untreated plot only. Likewise there is no defined toxic concentration for barium although the value presented in the table is considered high. This value was exceeded in all of the treated plots and concentrations were similar.

Alder were the only plants sampled at the Trench site owing to the lack of other species. Due to the small size of alders in Plots 1-1B, alder leaves and twigs were combined and analyzed as one sample. The other plots had sufficient biomass that leaves and stems could be analyzed separately (Table 9). Concentrations of metals were generally higher in leaves than in stems. The exceptions to this include barium, boron, manganese, molybdenum, strontium and zinc where concentrations were greater in the stems.

TABLE 9 FOLIAR METALS (mg/kg) PER TISSUE TYPE, TRENCH SITE

PARAMETER	MDL	ALDER LEAVES AND TWIGS N=1	ALDER LEAVES N=6	ALDER STEMS N=6
Aluminum (Al)-Total	2.0	33.5	18.08	7.64
Antimony (Sb)-Total	0.010	5.59	0.791	0.571
Arsenic (As)-Total	0.020	17.0	2.50	1.64
Barium (Ba)-Total	0.050	39.5	22.35	49.13
Bismuth (Bi)-Total	0.010	0.219	0.059	0.051
Boron (B)-Total	1.0	7.7	6.92	8.57
Cadmium (Cd)-Total	0.0050	ND	0.0057	0.0118
Calcium (Ca)-Total	20	11000	7401.67	5811.67
Cesium (Cs)-Total	0.0050	0.136	0.212	0.183
Chromium (Cr)-Total	0.050	0.22	ND	0.06
Cobalt (Co)-Total	0.020	0.121	0.132	0.073
Copper (Cu)-Total	0.10	6.54	7.21	7.24
Iron (Fe)-Total	3.0	222	65.52	37.52
Lead (Pb)-Total	0.020	48.0	9.06	8.00
Magnesium (Mg)-Total	2.0	2430	1888.33	1077.17
Manganese (Mn)-Total	0.050	214	53.52	70.45
Mercury (Hg)-Total	0.0050	0.0067	ND	ND
Molybdenum (Mo)-Total	0.020	3.71	3.69	4.44
Nickel (Ni)-Total	0.20	5.54	1.90	1.51
Phosphorus (P)-Total	10	938	2456.67	1678.33
Potassium (K)-Total	20	7510	6471.67	5543.33
Rubidium (Rb)-Total	0.050	7.81	10.85	8.41
Selenium (Se)-Total	0.050	ND	0.156	0.10
Strontium (Sr)-Total	0.050	44.0	29.20	36.30
Thallium (Tl)-Total	0.0020	0.0060	0.00	0.0047
Tin (Sn)-Total	0.10	0.21	ND	ND
Uranium (U)-Total	0.0020	0.0180	0.00	0.0025
Zinc (Zn)-Total	0.50	48.5	26.28	36.40

MDL = method detection limit ND = not detected

4.2.2.2 Waste Rock Site

There were five amendments applied to the blocks at the waste rock dump site: no treatment; biochar and compost; biochar, compost and leonardite; biochar, compost and dolomite lime; and biochar, compost, leonardite and dolomite lime. The data per treatment has been averaged and tabulated (Table 10). Sodium, tellurium and zirconium were not detected in any samples and are not included in Table 10.

TABLE 10 METALS IN TISSUES (mg/kg) PER AMENDMENT, WASTE ROCK DUMP

Parameter	MDL	Biochar and compost N=4	Biochar, compost & leondardite N=3	Biochar, compost & dolomite lime N=5	Biochar, compost, leondarite & dolomite lime N=4	Toxicity
Aluminum (Al)-Total	2.0	22.7	43.1	11.4	7.4	>1200
Antimony (Sb)-Total	0.010	1.47	0.81	2.73	2.30	
Arsenic (As)-Total	0.020	4.25	3.34	4.38	2.93	>10*
Barium (Ba)-Total	0.050	4.66	3.09	0.78	0.48	>20**
Beryllium (Be)-Total	0.010	ND	0.019	ND	ND	
Bismuth (Bi)-Total	0.010	0.14	0.09	0.29	0.33	
Boron (B)-Total	1.0	11.9	8.9	5.0	9.5	>200
Cadmium (Cd)-Total	0.0050	0.059	0.036	0.544	0.060	50 - 500
Calcium (Ca)-Total	20	4603	2240	5010	6715	
Cesium (Cs)-Total	0.0050	0.394	0.616	0.566	0.364	
Chromium (Cr)-Total	0.050	0.082	ND	0.078	ND	>40
Cobalt (Co)-Total	0.020	0.308	0.197	0.206	0.140	>30
Copper (Cu)-Total	0.10	10.9	19.0	11.7	10.6	>100
Iron (Fe)-Total	3.0	105.9	104.4	92.7	65.1	>4000
Lead (Pb)-Total	0.020	5.19	2.05	5.04	5.14	>100
Lithium (Li)-Total	0.50	ND	0.6	ND	ND	
Magnesium (Mg)-Total	2.0	937	809	2678	2278	
Manganese (Mn)-Total	0.050	294.5	247.3	70.3	101.6	2000 - 4000
Mercury (Hg)-Total	0.0050	0.0051	ND	ND	0.0051	
Molybdenum (Mo)-Total	0.020	1.01	1.42	2.66	5.00	10 - 20
Nickel (Ni)-Total	0.20	3.3	7.0	2.1	2.2	>1500
Phosphorus (P)-Total	10	1658	1523	1778	1935	
Potassium (K)-Total	20	3645	3737	3634	3755	
Rubidium (Rb)-Total	0.050	11.1	14.7	11.4	11.3	
Selenium (Se)-Total	0.050	0.110	ND	0.062	0.138	5 - 20
Strontium (Sr)-Total	0.050	13.26	7.07	3.08	4.09	>2000
Thallium (Tl)-Total	0.0020	0.0028	0.0061	0.0033	0.0091	
Tin (Sn)-Total	0.10	ND	ND	ND	ND	
Uranium (U)-Total	0.0020	0.0061	0.0128	0.0079	0.0040	
Vanadium (V)-Total	0.10	0.1	ND	ND	ND	
Zinc (Zn)-Total	0.50	43.7	23.0	45.5	58.5	>5000

Note: did not include the multiple species, W3-4. MDL = method detection limit. ND = not detected

There were no plants growing on any of the three untreated plots so comparisons can only be made regarding actual amendment type. The tissues collected from one plot only at Block 3 (Plot #3-4), were excluded from the table as there were a variety of species collected from this plot to increase tissue biomass for analysis. Also, the high metal concentrations had the potential to skew the results and as there were no other tissues from Block 3 it is not possible to tell if the other amendments would have had different uptake concentrations. It has been left out as an outlier in these calculations, however the data is presented in Table C-1 in Appendix C. Generally the highest metal concentrations were documented in the tissues from Plot 3-4, notably antimony, arsenic, bismuth, cadmium, iron, lead, magnesium, manganese and zinc. Of these, only arsenic exceeded the referenced toxicity level.

There generally was not a great range in tissue concentrations for the different treatments and it cannot be suggested that any one of these treatments is obviously better than another in reducing metal uptake. It appears however that for the waste rock dump site an additional amendment to biochar and compost is beneficial.

Similar to the Trench site, the Waste Rock data has been compared to the dietary tolerances for beef cattle in Table 10. There were no exceedances for any parameter. Unlike the Trench site, barium concentrations were low throughout the plots.

The mean concentrations of metals in the types of tissues have been tabulated (Table 11). Alder was also the principal vegetation type at the Waste Rock Dump and leaves and stems were sampled and analyzed separately. There was sufficient willow biomass to allow the analysis of tissues from a different species.

The single sample of willow leaves and stems collected from Plot #1-3 generally had the lowest concentrations of most metals. The combination sample of willow leaves, willow stems, alder leaves and alder stems collected from Plot #3-4 had the greatest concentration of the majority of the metals. When comparing just the alder tissues, levels were frequently lower in the stems than the leaves, or were relatively similar. During an ecological health assessment at the decommissioned Sä Dena Hes mine north of Watson Lake, Azimuth (2014) found that metal concentrations in alder leaves tended to be approximately double of that of twigs. The combination sample containing alder leaves and stems collected from Plot #1-3 typically reported higher concentrations than either those in the leaves or in the stems.

TABLE 11 MEAN METAL CONCENTRATIONS IN FOLIAR TISSUES PER SPECIES AND TYPE, WASTE ROCK

Species	Alder	Alder	Alder	Willow	Alder & Willow
Tissue type	Leaves	Stems	Leaves & Stems	Leaves & Stems	Leaves & Stems
N	7	7	1	1	1
Aluminum (Al)-Total	25.2	5.2	82.6	11.0	40.8
Antimony (Sb)-Total	3.5	0.7	0.910	1.15	32.4
Arsenic (As)-Total	5.3	1.7	7.36	3.88	68.7
Barium (Ba)-Total	1.2	2.9	4.41	0.595	1.88
Beryllium (Be)-Total	ND	ND	0.019	ND	ND
Bismuth (Bi)-Total	0.4	0.1	0.139	0.164	4.29
Boron (B)-Total	8.7	8.7	9.7	5.9	30.7
Cadmium (Cd)-Total	0.016	0.064	0.0737	2.14	6.44
Calcium (Ca)-Total	6202.9	3470.0	3300	6030	9190
Cesium (Cs)-Total	0.573	0.404	0.777	0.0901	0.188
Chromium (Cr)-Total	0.080	ND	ND	ND	0.099
Cobalt (Co)-Total	0.284	0.100	0.256	0.466	0.769
Copper (Cu)-Total	11.1	12.0	34.8	4.68	9.20
Iron (Fe)-Total	131.1	45.5	166	58.5	530
Lead (Pb)-Total	7.6	2.0	2.66	2.60	68.6
Lithium (Li)-Total	ND	ND	0.63	ND	ND
Magnesium (Mg)-Total	2419.1	883.3	791	4770	4840
Manganese (Mn)-Total	134.5	183.3	360	93.0	414
Mercury (Hg)-Total	0.005	ND	ND	ND	0.0121
Molybdenum (Mo)-Total	2.1	3.5	2.22	0.049	1.15
Nickel (Ni)-Total	3.9	1.9	11.3	1.30	1.67
Phosphorus (P)-Total	1985.7	1411.4	1710	2340	3700
Potassium (K)-Total	4268.6	3042.9	3400	4400	7890
Rubidium (Rb)-Total	14.8	8.9	18.1	6.97	18.9
Selenium (Se)-Total	0.101	ND	ND	0.067	0.655
Strontium (Sr)-Total	6.1	7.5	8.47	2.70	8.04
Thallium (Tl)-Total	0.006	0.005	0.0061	ND	0.0165
Tin (Sn)-Total	ND	ND	ND	ND	0.59
Uranium (U)-Total	0.006	ND	0.0203	ND	0.0313
Vanadium (V)-Total	0.1	ND	ND	ND	ND
Zinc (Zn)-Total	34.0	47.2	29.7	107	304
Zirconium (Zr)-Total	0.22	ND	ND	ND	0.23

ND = not detected

5.0 DISCUSSION

No mining activity has taken place at the Peso site since the 1960s. After 50 years the disturbed areas of Peso have had very little natural colonization. There has been sporadic growth in the trench area, mainly shrubs, but the waste rock dump was devoid of any growth.

Phytoremediation, the use of plants to decontaminate soils and waters, has been developed over recent decades. The purpose of phytoremediation is to remove the contaminant from the media into plants. Heavy metals can be removed through plant processes such as uptake, adsorption, transport and translocation, sequestration into vacuoles, hyperaccumulation and, in some cases, volatilization (Bieby Voijant Tangahu et al, 2011). The strategy is to extract metals from contaminated soil and transfer it to the smaller volume of harvestable plants for disposal (Capuana, 2011). However, the purpose of this trial was to determine how to cover the contaminated soils with a sustaining plant community but leave the metals in situ. Uptake of metals into the tissues is not desirable as the resulting vegetation may be consumed by herbivores (from mice to moose). Biochar has the ability to immobilize metals thereby reducing their bioavailability for plant uptake and hence was chosen as an amendment for the Peso trials.

The objective of on-site treatment of contaminated lands using soil amendments is to establish a self-sustaining system that does not rely on additional care, and, ideally, is similar to and provides nearly equal ecological value as the undisturbed adjacent landscape. Without the necessity of an application of a layer of till, the Peso site could be revegetated using biochar and some form of nutrient rich amendment. Dolomite should also be added for the waste rock site. This has implications for the revegetation of other areas eventually requiring reclamation at the Eagle Gold Project site. As areas are cleared, the woody material in the overburden could be turned into biochar on site in easily constructed pits. The remaining stockpiled overburden material can be spread over the area to be revegetated, providing soil material, nutrients, seed banks, and the associated mycorrhiza to allow healthy growth of native plants through direct seeding, planting and natural colonization.

As described in Section 4.1, all of the plots had very high concentrations of metals in the soils, notably antimony, arsenic and lead. This has not been reflected in the tissue samples. With the exception of a couple of plots, very low concentrations of these metals were taken up by the plants. The soil samples from Block 3 at the Waste Rock Dump had the highest concentrations of antimony, arsenic and lead in the study area and correspondingly the single foliar sample collected here contained the highest levels of these metals. (There was only sufficient plant biomass from one plot in this block for analysis.)

There currently is not an available database on metals in plant tissues for the Yukon. A compendium has been prepared by the Yukon College (Soprovich and Janin, 2017) discussing metal concentrations in plants from several mine sites in the Yukon, however the presented information and data is limited. A literature search was conducted in attempts to compare the Peso foliar data with other sites. Only studies that also included soil chemistry data were reviewed. Note that the soil samples were not necessarily collected at the same locations as the vegetation samples, however the data does give an idea of the metal concentrations throughout each study area.

Vegetation and soil samples were collected from four permanent sites at the Eagle Gold Project Site in the summer of 2018 to monitor any effects from the construction activities and basically represent baseline conditions (Laberge, 2018b). Willow and dwarf birch comprised the majority of the foliar samples. Stantec (2011) undertook baseline soil and foliar sampling in 2009 throughout the footprint of the Eagle Gold Project. Vegetation types analyzed included willow, sedge and grasses. Access Consulting Group (2015) devised a vegetation monitoring plan for the Minto Mine and collected soil and vegetation samples in areas that may be influenced by mining activities. Grasses, willows and aspen were the tissues analyzed. As part of a human health and ecological risk assessment, Azimuth (2014) conducted extensive soil sampling throughout the project area at Sä Dena Hes, and submitted several willow and alder twig samples for vegetation analysis.

Neither arsenic nor lead have any beneficial value to plants. These metals were extremely high in the soils at Peso and Table 12 summarizes the range of concentrations in the soil and in the vegetation at each project site. The two sites at Peso have been presented separately. The numbers in brackets after the maximum value indicated the next highest concentration after the outlier is eliminated from the range. As significant numbers of willow and alder samples were collected at Sa Dena Hes, these have been included as separate entries. Only twigs were analyzed.

TABLE 12 METAL CONCENTRATIONS IN SOIL AND FOLIAR TISSUES FROM VARIOUS PROJECTS

Metal	Site	Year	Author	Range of Concentration (mg/kg)			
				Soil	N	Foliar	N
Arsenic	Peso - Trench	2018	LES	1490 to 11,400	15	0.4 to 17.0 (4.09)	13
	Peso - Waste Rock	2018	LES	1240 to 10,900	15	0.7 to 68.7 (7.4)	17
	Eagle Gold	2018	LES	15.1 to 302	4	0.090 to 7.73	60
	Eagle Gold	2009	Stantec	9.4 to 1350	20	<0.1 to 0.4	16
	Minto	2015	Access	1.1 to 9.0	12	0.06 to 0.49	10
	Sa Dena Hes	2013	Azimuth	1.0 to 357	69	willow: 0.006 to 0.012	16
						alder: 0.004 to 7.36	16
	Keno Valley	2003	LES	12.9 to 373	11	<2 to 2.0	18
Lead	Peso - Trench	2018	LES	1160 to 8680	15	2.5 to 48.0 (18.5)	13
	Peso - Waste Rock	2018	LES	331 to 16,600	15	1.0 to 68.6 (15.3)	17
	Eagle Gold	2018	LES	19.8 to 40.6	4	0.036 to 1.55	60
	Eagle Gold	2009	Stantec	5.7 to 85.8	20	<0.1 to 0.2	16
	Minto	2015	Access	2.4 to 7.5	12	0.13 to 0.53	10
	Sa Dena Hes	2013	Azimuth	76 to 10,400	115	willow: 0.042 to 61.4	16
						alder: 0.045 to 5.35	16
	Keno Valley	2003	LES	22.3 to 1350	11	<5 to 3.3	18

The arsenic concentrations in the soil at Peso were far greater than at the other sites, especially when comparing the minimums. The maximum concentration of arsenic documented at Eagle Gold by Stantec was similar to the minimum concentrations reported at Peso. Arsenic concentrations were slightly higher in the tissues collected from Peso than the other sites, although the maximum concentration from alder tissues at Sä Dena Hes were similar to the maximums at Peso (which were mostly alder) when the outliers are excluded.

Generally lead concentrations were much greater in the soils at Peso than the other sites, however there was a comparable maximum lead concentration collected from a site at Sä Dena Hes. Again, the minimum concentrations of lead in the soils were much higher at Peso. Lead in tissues from Peso were somewhat higher than the other sites, even when the outliers where excluded. The exception to this was a willow sample analyzed from Sä Dena Hes which had concentrations almost as great as the sample analyzed from Block 3 at the Waste Rock Dump.

Although Peso is a highly contaminated site regarding metals, the potentially harmful metals do not appear bioavailable as evidenced by the low concentrations in the foliar tissues. Only two samples had a concentration greater than the referenced dietary tolerances for cattle. Arsenic concentrations in the foliar sample collected from an untreated plot at the Trench site slightly exceeded what is considered “normal”. Arsenic in the vegetation sample from Block 3 on the Waste Rock Dump exceeded the tolerance level to a greater extent. All other metals were well below the referenced tolerances. It appears that biochar has been effective in reducing the uptake of metals in plant tissues. The biochar application rate must be sufficient to match and treat the amount of heavy metals that are contained in the soil (Chen et al, 2018). The application rate for the plots on the waste rock was twice that applied to the Trench plots, however, an increase in the application rate may have reduced uptake more efficiently, notably at Block 3.

There is little doubt that amendments are required for plants to grow in the study area. All non-treated seeded plots produced no to very little growth. The acidic soil conditions at the Peso trench and the waste rock sites present a challenging scenario in relation to the site conditions at the majority of other disturbed sites in the Dublin Gulch area. However, the success of using compost and biochar to achieve robust plant growth on these highly mineralized and acidic soils, especially on the waste rock dump, indicates that nothing is impossible.

With minimal effort and resources, native plants were able to grow on the majority of the treated plots, including on the highly acidic (pH 2.6) waste rock dump.

In summary, these trials have proven successful. By using appropriate species and soil amendments, healthy plants have grown, propagated and even thrived on acidic, highly mineralized soils.

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APPENDIX A

SOILS DATA

- **TABLE A-1**
- **TABLE A-2**
- **MAXXAM JOB #: B256252, 2012**
- **ALS Lab Work Order #: L2139940,2018**

TABLE A-1 SOIL DATA, TRENCH SITE 2018

Parameter	Lowest Detection Limit	Units	Block #1			Block #2			Block #3		
			T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2	T2-3A	T3-1	T3-2AB	T3-3AB
Physical Tests (Soil)											
Loss on Ignition @ 375 C	1.0	%	1.2	3.1	3.6	1.3	1.3	1.4	2.3	3.3	3.5
Organic Matter	1.0	%	1.2	2.7	3.1	1.3	1.3	1.4	2.0	2.9	3.0
pH (1:2 soil:water)	0.10	pH	6.30	7.17	6.74	5.88	7.12	6.12	5.17	5.75	6.79
Particle Size (Soil)											
% Sand (2.0mm - 0.05mm)	1.0	%	83.3	83.8	82.5	65.0	65.7	65.2	60.9	64.2	58.0
% Silt (0.05mm - 2um)	1.0	%	15.3	14.1	15.7	28.9	28.6	28.3	34.7	31.0	37.9
% Clay (<2um)	1.0	%	1.4	2.1	1.7	6.1	5.7	6.5	4.4	4.7	4.1
Texture		-	Loamy sand	Loamy sand	Loamy sand	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients (Soil)											
Total Kjeldahl Nitrogen	0.020	%	0.069	0.118	0.132	0.059	0.064	0.063	0.070	0.077	0.088
Organic / Inorganic Carbon (Soil)											
C:N Ratio		-	5.8:1	15.7:1	14.5:1	7:01	8.9:1	6.8:1	7.2:1	20.1:1	17.5:1
Total Carbon by Combustion	0.05	%	0.40	1.86	1.91	0.42	0.57	0.43	0.50	1.55	1.53
Plant Available Nutrients (Soil)											
Available Ammonium-N	1.0	mg/kg	1.8	2.5	3.1	2.0	2.3	1.4	1.7	2.6	2.5
Calcium (Ca)	0.50	meq/100g	0.92	5.33	3.74	0.74	2.26	1.20	<0.50	3.97	4.48
Magnesium (Mg)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Available Phosphate-P	2.0	mg/kg	3.4	46.9	17.9	<2.0	6.8	<2.0	2.3	15.2	24.2
Available Potassium	20	mg/kg	24	51	51	30	39	29	31	40	46
Potassium (K)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Metals (Soil)											
Aluminum (Al)	50	mg/kg	3220	2050	1630	3440	3390	4620	3030	3670	2670
Antimony (Sb)	0.10	mg/kg	3750	818	6410	2360	492	369	4590	1450	2330
Arsenic (As)	0.10	mg/kg	6380	2190	2690	5810	1490	1730	11400	4410	10600
Barium (Ba)	0.50	mg/kg	47.2	32.6	35.6	70.3	65.7	91.3	42.3	40.6	38.6
Beryllium (Be)	0.10	mg/kg	0.13	<0.10	<0.10	0.13	0.11	0.15	0.12	0.13	<0.10
Bismuth (Bi)	0.20	mg/kg	145	26.1	236	504	53.5	30.5	320	91.5	222
Boron (B)	5.0	mg/kg	10.0	<5.0	7.1	7.4	<5.0	8.2	7.4	<5.0	<5.0
Cadmium (Cd)	0.020	mg/kg	4.08	0.427	3.26	3.89	0.564	0.482	6.21	1.53	3.91
Calcium (Ca)	50	mg/kg	578	1830	3890	947	1180	1330	334	634	1190
Chromium (Cr)	0.50	mg/kg	16.6	7.83	5.92	7.33	7.84	10.6	11.2	10.1	13.8
Cobalt (Co)	0.10	mg/kg	7.91	4.18	2.26	2.93	2.84	3.44	5.08	4.21	6.24
Copper (Cu)	0.50	mg/kg	132	55.6	29.8	74.3	50.9	73.3	170	92.7	121
Iron (Fe)	50	mg/kg	56700	31900	17900	51100	28400	39300	43100	36000	42900
Lead (Pb)	0.50	mg/kg	7790	1440	3670	4700	1160	1260	8680	3200	4890
Lithium (Li)	2.0	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Magnesium (Mg)	20	mg/kg	94	312	475	81	84	92	131	354	193
Manganese (Mn)	1.0	mg/kg	278	290	131	277	142	199	184	170	214
Mercury (Hg)	0.0050	mg/kg	0.227	0.169	0.468	0.358	0.146	0.193	0.700	0.571	0.924
Molybdenum (Mo)	0.10	mg/kg	1.45	1.36	1.05	0.85	1.31	1.05	0.79	1.15	1.27
Nickel (Ni)	0.50	mg/kg	20.3	11.5	5.92	5.34	5.52	7.03	9.32	8.65	15.1
Phosphorus (P)	50	mg/kg	581	500	452	1170	1200	1480	534	333	484
Potassium (K)	100	mg/kg	580	460	320	670	630	790	520	470	590
Selenium (Se)	0.20	mg/kg	5.62	1.70	6.76	9.01	1.98	1.68	9.01	3.54	6.42
Silver (Ag)	0.10	mg/kg	>165	15.8	>126	50.7	8.51	7.37	38.0	18.3	35.8
Sodium (Na)	50	mg/kg	<50	<50	<50	<50	<50	<50	<50	<50	<50
Strontium (Sr)	0.50	mg/kg	93.0	35.7	32.6	337	349	483	108	57.1	79.5
Sulfur (S)	1000	mg/kg	1500	<1000	<1000	1700	<1000	<1000	2000	1100	1600
Thallium (Tl)	0.050	mg/kg	0.262	0.149	0.147	0.282	0.118	0.116	0.263	0.180	0.189
Tin (Sn)	2.0	mg/kg	51.0	16.5	24.7	41.3	17.2	18.0	201	38.3	105
Titanium (Ti)	1.0	mg/kg	22.3	28.9	38.7	19.5	<16	18.4	17.3	37.1	<19
Tungsten (W)	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U)	0.050	mg/kg	14.3	1.72	4.75	6.05	2.17	2.17	3.49	2.06	3.12
Vanadium (V)	0.20	mg/kg	18.6	10.4	6.31	10.7	8.41	11.7	10.5	12.7	13.3
Zinc (Zn)	2.0	mg/kg	354	142	70.4	117	85.5	113	112	95.0	107
Zirconium (Zr)	1.0	mg/kg	12.0	3.8	2.1	7.4	7.5	6.2	10.4	8.7	10.2

TABLE A-2 SOIL DATA, WASTE ROCK SITE 2018

Parameter	Lowest Detection Limit	Units	Block #1					Block #2					Block #3				
			W1-1	W1-2	W1-3	W1-4	W1-5	W2-1	W2-2	W2-3	W2-4	W2-5	W3-1	W3-2	W3-3	W3-4	W3-5
Physical Tests (Soil)																	
Loss on Ignition @ 375 C	1.0	%	2.0	2.3	4.4	3.0	9.2	1.4	1.5	3.0	4.8	1.9	1.6	6.1	8.0	9.5	7.9
Organic Matter	1.0	%	1.8	2.1	3.7	2.6	7.5	1.4	1.5	2.6	4.1	1.7	1.5	5.0	6.5	7.7	6.5
pH (1:2 soil:water)	0.10	pH	3.04	4.81	3.25	4.10	5.71	2.75	3.11	3.04	3.28	2.84	2.32	2.41	1.77	4.32	2.20
Particle Size (Soil)																	
% Sand (2.0mm - 0.05mm)	1.0	%	59.4	69.2	80.3	82.3	75.5	37.4	42.6	87.1	73.2	71.2	53.3	69.2	63.7	68.6	68.8
% Silt (0.05mm - 2um)	1.0	%	36.4	27.2	17.2	16.0	20.8	59.4	55.6	11.2	23.6	22.4	40.5	25.4	28.6	26.9	25.0
% Clay (<2um)	1.0	%	4.2	3.6	2.4	1.7	3.7	3.1	1.8	1.7	3.2	6.3	6.2	5.4	7.6	4.5	6.2
Texture		-	Sandy loam	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Silt loam	Silt loam	Sand	Sandy loam / Loamy sand	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients (Soil)																	
Total Kjeldahl Nitrogen	0.020	%	0.062	0.073	0.095	0.115	0.152	0.023	0.033	0.063	0.096	0.046	0.061	0.135	0.150	0.175	0.140
Organic / Inorganic Carbon (Soil)																	
C:N Ratio		-	10.5:1	12.2:1	30.7:1	11.5:1	37.6:1	15.1:1	12.9:1	15.6:1	24:01:00	5.7:1	8.7:1	21.9:1	27.6:1	32.4:1	32:01:00
Total Carbon by Combustion	0.05	%	0.64	0.89	2.91	1.33	5.72	0.34	0.42	0.99	2.31	0.26	0.53	2.95	4.16	5.66	4.47
Plant Available Nutrients (Soil)																	
Available Ammonium-N	1.0	mg/kg	4.1	3.4	3.6	3.3	6.3	2.2	1.8	2.9	4.5	2.8	6.9	13.6	18.6	7.5	11.5
Calcium (Ca)	0.50	meq/100g	<0.50	1.27	<0.50	0.75	11.2	<0.50	<0.50	<0.50	2.84	<0.50	<0.50	<0.50	<0.50	3.60	19.4
Magnesium (Mg)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	2.26	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	1.96	2.12
Available Phosphate-P	2.0	mg/kg	2.2	5.7	6.4	<2.0	15.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.4	<2.0	<2.0	<2.0
Available Potassium	20	mg/kg	27	23	<20	25	45	<20	<20	<20	32	<20	<20	<20	20	<20	<20
Potassium (K)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Metals (Soil)																	
Aluminum (Al)	50	mg/kg	7160	5840	4990	3550	2780	4540	5820	4920	5080	4590	3390	2930	3100	3760	2710
Antimony (Sb)	0.10	mg/kg	1280	542	241	838	3350	1110	333	1320	2100	2360	2940	7690	6020	5920	7140
Arsenic (As)	0.10	mg/kg	3750	3220	2140	3610	3130	1470	1240	2530	2980	2260	3010	6500	7950	9810	10900
Barium (Ba)	0.50	mg/kg	116	72.0	44.3	24.3	46.3	158	196	102	134	86.8	116	47.3	53.7	60.5	48.1
Beryllium (Be)	0.10	mg/kg	0.20	0.18	0.20	0.18	0.13	0.13	0.13	0.27	0.22	0.27	0.14	0.16	0.17	0.17	0.11
Bismuth (Bi)	0.20	mg/kg	110	66.5	21.2	73.4	313	43.5	12.1	132	252	422	246	1020	975	822	1250
Boron (B)	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.2	<5.0	6.7	5.8	<5.0	5.8
Cadmium (Cd)	0.020	mg/kg	1.85	1.29	1.61	1.95	2.40	0.291	0.253	0.442	0.633	0.996	1.81	5.74	6.59	6.44	6.31
Calcium (Ca)	50	mg/kg	452	1150	296	4040	28500	756	1160	899	1540	1390	222	446	571	9170	2290
Chromium (Cr)	0.50	mg/kg	14.2	12.2	11.9	9.60	5.22	10.4	13.9	8.69	8.62	6.91	10.6	9.91	9.40	12.0	7.89
Cobalt (Co)	0.10	mg/kg	9.72	11.6	22.5	14.0	2.54	3.00	4.69	2.24	2.38	1.39	5.39	1.80	1.82	3.01	2.13
Copper (Cu)	0.50	mg/kg	145	172	120	214	229	88.0	59.4	194	194	180	250	299	314	433	400
Iron (Fe)	50	mg/kg	46500	45400	50500	48600	27200	38500	33500	53900	48900	45100	37100	35800	32300	54300	70100
Lead (Pb)	0.50	mg/kg	1870	4570	391	1380	6770	1600	331	2220	3590	4860	3810	14300	12800	10700	16600
Lithium (Li)	2.0	mg/kg	7.5	5.8	5.3	3.2	<2.0	4.7	6.9	2.2	2.2	<2.0	2.4	<2.0	<2.0	<2.0	<2.0
Magnesium (Mg)	20	mg/kg	2250	1820	1620	3190	14800	1410	2350	307	731	212	622	262	105	5180	1380
Manganese (Mn)	1.0	mg/kg	272	238	320	225	207	112	179	83.4	86.7	66.9	129	94.8	81.8	132	108
Mercury (Hg)	0.0050	mg/kg	0.0935	0.0853	0.0327	0.105	0.654	0.0933	0.0465	0.182	0.361	0.302	0.207	0.701	1.05	0.797	0.706
Molybdenum (Mo)	0.10	mg/kg	0.78	1.60	1.69	1.04	2.20	0.77	0.80	1.04	1.89	1.09	1.30	2.57	1.79	2.57	1.94
Nickel (Ni)	0.50	mg/kg	27.6	27.6	48.7	34.2	7.42	8.91	13.2	8.26	8.19	6.94	16.2	5.14	5.46	8.84	5.78
Phosphorus (P)	50	mg/kg	461	827	594	410	914	561	602	1670	1640	1730	289	1120	769	1230	788
Potassium (K)	100	mg/kg	640	580	420	400	700	970	980	1130	1240	1460	670	900	850	870	750
Selenium (Se)	0.20	mg/kg	3.93	5.46	1.04	4.02	12.2	2.46	1.14	4.04	6.75	6.31	9.79	25.1	27.5	25.8	35.5
Silver (Ag)	0.10	mg/kg	17.6	18.9	3.50	16.3	62.9	19.5	4.72	58.0	75.3	>108	32.5	>122	>112	>111	>135
Sodium (Na)	50	mg/kg	149	184	73	<50	55	392	353	92	162	75	106	58	53	94	106
Strontium (Sr)	0.50	mg/kg	26.0	32.8	13.3	17.8	193	90.6	39.4	407	458	565	41.2	188	215	168	141
Sulfur (S)	1000	mg/kg	2900	3400	1600	2400	6700	6300	4000	5900	9000	9800	3900	6300	8500	8400	16600
Thallium (Tl)	0.050	mg/kg	<0.10	<0.15	0.062	<0.10	<0.35	0.151	0.078	0.242	0.301	0.418	<0.20	<0.30	<0.35	0.265	<35
Tin (Sn)	2.0	mg/kg	6.9	7.6	2.6	7.6	33.2	11.3	5.1	21.0	32.2	26.5	33.9	64.0	131	81.7	68.5
Titanium (Ti)	1.0	mg/kg	99.7	75.9	49.8	26.8	<31	274	314	31.1	78.7	10.6	74.2	39.6	39.9	46.0	<47
Tungsten (W)	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U)	0.050	mg/kg	2.41	2.27	2.73	2.99	2.21	0.967	0.785	2.32	2.46	3.87	2.52	6.00	7.07	5.62	6.01
Vanadium (V)	0.20	mg/kg	19.5	15.7	12.9	10.0	8.13	28.0	29.3	14.5	18.0	12.2	17.1	8.07	7.03	9.26	7.35
Zinc (Zn)	2.0	mg/kg	258	249	333	210	121	47.8	54.5	88.7	68.5	69.2	94.1	110	103	100	90.2
Zirconium (Zr)	1.0	mg/kg	3.3	1.4	2.5	7.1	<1.0	4.6	2.5	4.6	4.4	6.8	9.8	1.2	9.7	<1.0	2.9

Your Project #: BIOCHAR RESEARCH
Your C.O.C. #: EB492312

Attention: Ken Nordin
LABERGE ENVIRONMENTAL SERVICES
WHITEHORSE
405 Ogilvie Street
PO Box 21072
Whitehorse, YT
CANADA Y1A 6P7

Report Date: 2012/07/13

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B256252
Received: 2012/06/29, 14:00

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cation Exchange Capacity (1)	4	2012/07/10	2012/07/10	AB SOP-00009	SSMA 18.2, EPA 200.7
Carbon Nitrogen Ratio (1)	4	2012/07/05	2012/07/13	Calc	
Elements by ICPMS (total)	4	2012/07/05	2012/07/05	BBY7SOP-00001	EPA 6020A
Potassium (Available) (1)	4	2012/07/09	2012/07/09	AB SOP-00042	EPA 200.7
Loss on Ignition, Org. & Inorg. Residue (2)	4	N/A	2012/07/06	BBY6SOP-00040	Carter SSMA 44.3
Nitrate-N (Available) (1)	4	2012/07/09	2012/07/09	AB SOP-00023	SM 4110-B
Organic Matter - Calculated from LOI	4	N/A	2012/07/06	BBY6SOP-00040	Carter SSMA 44.3
Phosphorus (Available by ICP) (1)	4	2012/07/09	2012/07/09	AB SOP-00042	EPA 200.7
pH (2:1 DI Water Extract)	4	2012/07/05	2012/07/05	BBY6SOP-00028	Carter, SSMA 16.2
Texture by Hydrometer (1)	3	N/A	2012/07/13	AB SOP-00030	MMFSPA Ch9
Texture Class (1)	3	N/A	2012/07/13	AB SOP-00030	MMFSPA Ch9
Total Kjeldahl Nitrogen - Soil (1)	4	2012/07/13	2012/07/13	AB SOP-00008	EPA 351.1, 351.2
Organic Carbon and Organic Matter (1)	4	2012/07/11	2012/07/11	AB SOP-00012	MMFSPA Ch6

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Calgary Environmental
(2) Loss on Ignition was reported on a dry weight basis.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Tabitha Rudkin, Burnaby Project Manager
Email: TRudkin@maxxam.ca
Phone# (604) 638-2639

==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

Maxxam Job #: B256252
Report Date: 2012/07/13

CARBON NITROGEN RATIO (TKN,TOC)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Misc. Inorganics							
Total Kjeldahl Nitrogen	mg/kg	180	98	18	18	10	6000949
Misc. Inorganics							
Carbon Nitrogen Ratio	N/A	20.1	0.000	0.000	142	N/A	5976738
Organic Matter	%	0.64	<0.35	<0.35	0.44	0.35	5991753
Total Organic Carbon (C)	%	0.37	<0.20	<0.20	0.25	0.20	5991753

RDL = Reportable Detection Limit

NPK (AVAILABLE)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Nutrients							
Available (NH4F) Nitrogen (N)	mg/kg	<2.0	<2.0	<2.0	22	2.0	5985283
Available (NH4F) Phosphorus (P)	mg/kg	2.9	1.8	<1.0	<1.0	1.0	5978596
Available (NH4OAc) Potassium (K)	mg/kg	<2.0	8.5	72	150	2.0	5978595

RDL = Reportable Detection Limit

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Elements							
Cation exchange capacity	cmol+/Kg	<10	<10	48	38	10	5984044
Misc. Inorganics							
Organic Matter	%	6.1	4.0	2.2	1.8	1.0	5976739
Physical Properties							
% sand by hydrometer	%		70	39	23	2.0	5999590
% silt by hydrometer	%		25	48	54	2.0	5999590
Clay Content	%		5.6	12	23	2.0	5999590
Loss on Ignition	%	6.1	4.0	2.2	1.8	1.0	5978220
Texture	N/A		SANDY LOAM	LOAM	SILT LOAM	N/A	5970847

RDL = Reportable Detection Limit

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Physical Properties							
Soluble (2:1) pH	pH Units	2.62	5.15	8.56	8.30	0.010	5974214
Total Metals by ICPMS							
Total Aluminum (Al)	mg/kg	2690	2350	10100	12200	100	5974132
Total Antimony (Sb)	mg/kg	3680	3580	1.32	1.45	0.10	5974132
Total Arsenic (As)	mg/kg	6150	9810	16.3	74.2	0.50	5974132
Total Barium (Ba)	mg/kg	46.0	46.8	90.9	31.5	0.10	5974132
Total Beryllium (Be)	mg/kg	<0.40	<0.40	<0.40	1.29	0.40	5974132
Total Bismuth (Bi)	mg/kg	527	372	9.59	0.14	0.10	5974132
Total Cadmium (Cd)	mg/kg	4.88	4.28	0.223	0.571	0.050	5974132
Total Calcium (Ca)	mg/kg	306	332	31300	35300	100	5974132
Total Chromium (Cr)	mg/kg	6.7	12.2	20.0	19.3	1.0	5974132
Total Cobalt (Co)	mg/kg	3.54	5.33	32.5	7.92	0.30	5974132
Total Copper (Cu)	mg/kg	210	75.9	2420	105	0.50	5974132
Total Iron (Fe)	mg/kg	57500	46300	143000	27900	100	5974132
Total Lead (Pb)	mg/kg	9070	7330	6.27	27.0	0.10	5974132
Total Lithium (Li)	mg/kg	<5.0	<5.0	7.3	20.7	5.0	5974132
Total Magnesium (Mg)	mg/kg	512	<100	46400	7890	100	5974132
Total Manganese (Mn)	mg/kg	927	189	803	640	0.20	5974132
Total Mercury (Hg)	mg/kg	0.796	0.410	<0.050	<0.050	0.050	5974132
Total Molybdenum (Mo)	mg/kg	0.87	0.74	36.1	3.16	0.10	5974132
Total Nickel (Ni)	mg/kg	9.06	12.0	13.9	3.14	0.80	5974132
Total Phosphorus (P)	mg/kg	500	623	527	738	10	5974132
Total Potassium (K)	mg/kg	475	340	2020	839	100	5974132
Total Selenium (Se)	mg/kg	19.3	12.7	1.01	1.13	0.50	5974132
Total Silver (Ag)	mg/kg	89.4	103	2.57	1.21	0.050	5974132
Total Sodium (Na)	mg/kg	<100	<100	104	468	100	5974132
Total Strontium (Sr)	mg/kg	114	134	88.9	77.4	0.10	5974132
Total Thallium (Tl)	mg/kg	0.259	0.169	0.064	0.077	0.050	5974132
Total Tin (Sn)	mg/kg	35.0	38.8	0.75	0.52	0.10	5974132
Total Titanium (Ti)	mg/kg	31.1	5.8	380	549	1.0	5974132
Total Uranium (U)	mg/kg	3.73	4.81	3.31	0.419	0.050	5974132
Total Vanadium (V)	mg/kg	9.8	12.2	43.3	32.0	2.0	5974132

RDL = Reportable Detection Limit

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Total Zinc (Zn)	mg/kg	252	129	59.7	135	1.0	5974132
Total Zirconium (Zr)	mg/kg	9.15	9.77	3.24	6.91	0.50	5974132

RDL = Reportable Detection Limit

General Comments

Results relate only to the items tested.

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: VB256252

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132 DJ	Matrix Spike	Total Antimony (Sb)	2012/07/05		94	%	75 - 125
		Total Arsenic (As)	2012/07/05		99	%	75 - 125
		Total Barium (Ba)	2012/07/05		NC	%	75 - 125
		Total Beryllium (Be)	2012/07/05		105	%	75 - 125
		Total Cadmium (Cd)	2012/07/05		100	%	75 - 125
		Total Chromium (Cr)	2012/07/05		97	%	75 - 125
		Total Cobalt (Co)	2012/07/05		99	%	75 - 125
		Total Copper (Cu)	2012/07/05		90	%	75 - 125
		Total Lead (Pb)	2012/07/05		97	%	75 - 125
		Total Lithium (Li)	2012/07/05		102	%	75 - 125
		Total Manganese (Mn)	2012/07/05		NC	%	75 - 125
		Total Mercury (Hg)	2012/07/05		106	%	75 - 125
		Total Molybdenum (Mo)	2012/07/05		100	%	75 - 125
		Total Nickel (Ni)	2012/07/05		89	%	75 - 125
		Total Selenium (Se)	2012/07/05		102	%	75 - 125
		Total Silver (Ag)	2012/07/05		98	%	75 - 125
		Total Strontium (Sr)	2012/07/05		97	%	75 - 125
		Total Thallium (Tl)	2012/07/05		101	%	75 - 125
		Total Tin (Sn)	2012/07/05		95	%	75 - 125
		Total Titanium (Ti)	2012/07/05		NC	%	75 - 125
		Total Uranium (U)	2012/07/05		99	%	75 - 125
		Total Vanadium (V)	2012/07/05		NC	%	75 - 125
		Total Zinc (Zn)	2012/07/05		NC	%	75 - 125
	QC Standard	Total Aluminum (Al)	2012/07/05		100	%	70 - 130
		Total Antimony (Sb)	2012/07/05		86	%	70 - 130
		Total Arsenic (As)	2012/07/05		89	%	70 - 130
		Total Barium (Ba)	2012/07/05		96	%	70 - 130
		Total Cadmium (Cd)	2012/07/05		91	%	70 - 130
		Total Calcium (Ca)	2012/07/05		89	%	70 - 130
		Total Chromium (Cr)	2012/07/05		98	%	70 - 130
		Total Cobalt (Co)	2012/07/05		87	%	70 - 130
		Total Copper (Cu)	2012/07/05		72	%	70 - 130
		Total Iron (Fe)	2012/07/05		92	%	70 - 130
		Total Lead (Pb)	2012/07/05		94	%	70 - 130
		Total Magnesium (Mg)	2012/07/05		88	%	70 - 130
		Total Manganese (Mn)	2012/07/05		93	%	70 - 130
		Total Mercury (Hg)	2012/07/05		114	%	70 - 130
		Total Molybdenum (Mo)	2012/07/05		91	%	70 - 130
		Total Nickel (Ni)	2012/07/05		72	%	70 - 130
		Total Phosphorus (P)	2012/07/05		87	%	70 - 130
		Total Strontium (Sr)	2012/07/05		82	%	70 - 130
		Total Thallium (Tl)	2012/07/05		90	%	70 - 130
		Total Titanium (Ti)	2012/07/05		105	%	70 - 130
		Total Uranium (U)	2012/07/05		82	%	70 - 130
		Total Vanadium (V)	2012/07/05		99	%	70 - 130
		Total Zinc (Zn)	2012/07/05		72	%	70 - 130
	Spiked Blank	Total Antimony (Sb)	2012/07/05		97	%	75 - 125
		Total Arsenic (As)	2012/07/05		98	%	75 - 125
		Total Barium (Ba)	2012/07/05		97	%	75 - 125
		Total Beryllium (Be)	2012/07/05		104	%	75 - 125
		Total Cadmium (Cd)	2012/07/05		101	%	75 - 125
		Total Chromium (Cr)	2012/07/05		97	%	75 - 125
		Total Cobalt (Co)	2012/07/05		99	%	75 - 125
		Total Copper (Cu)	2012/07/05		100	%	75 - 125
		Total Lead (Pb)	2012/07/05		96	%	75 - 125

Maxxam

Success Through Science®

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: VB256252

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132 DJ	Spiked Blank	Total Lithium (Li)	2012/07/05		98	%	75 - 125
		Total Manganese (Mn)	2012/07/05		95	%	75 - 125
		Total Mercury (Hg)	2012/07/05		106	%	75 - 125
		Total Molybdenum (Mo)	2012/07/05		97	%	75 - 125
		Total Nickel (Ni)	2012/07/05		97	%	75 - 125
		Total Selenium (Se)	2012/07/05		102	%	75 - 125
		Total Silver (Ag)	2012/07/05		97	%	75 - 125
		Total Strontium (Sr)	2012/07/05		95	%	75 - 125
		Total Thallium (Tl)	2012/07/05		93	%	75 - 125
		Total Tin (Sn)	2012/07/05		93	%	75 - 125
		Total Titanium (Ti)	2012/07/05		95	%	75 - 125
		Total Uranium (U)	2012/07/05		95	%	75 - 125
		Total Vanadium (V)	2012/07/05		96	%	75 - 125
		Total Zinc (Zn)	2012/07/05		104	%	75 - 125
	Method Blank	Total Aluminum (Al)	2012/07/05	<100		mg/kg	
		Total Antimony (Sb)	2012/07/05	<0.10		mg/kg	
		Total Arsenic (As)	2012/07/05	<0.50		mg/kg	
		Total Barium (Ba)	2012/07/05	<0.10		mg/kg	
		Total Beryllium (Be)	2012/07/05	<0.40		mg/kg	
		Total Bismuth (Bi)	2012/07/05	<0.10		mg/kg	
		Total Cadmium (Cd)	2012/07/05	<0.050		mg/kg	
		Total Calcium (Ca)	2012/07/05	<100		mg/kg	
		Total Chromium (Cr)	2012/07/05	<1.0		mg/kg	
		Total Cobalt (Co)	2012/07/05	<0.30		mg/kg	
		Total Copper (Cu)	2012/07/05	<0.50		mg/kg	
		Total Iron (Fe)	2012/07/05	<100		mg/kg	
		Total Lead (Pb)	2012/07/05	<0.10		mg/kg	
		Total Lithium (Li)	2012/07/05	<5.0		mg/kg	
		Total Magnesium (Mg)	2012/07/05	<100		mg/kg	
		Total Manganese (Mn)	2012/07/05	<0.20		mg/kg	
		Total Mercury (Hg)	2012/07/05	<0.050		mg/kg	
		Total Molybdenum (Mo)	2012/07/05	<0.10		mg/kg	
		Total Nickel (Ni)	2012/07/05	<0.80		mg/kg	
		Total Phosphorus (P)	2012/07/05	<10		mg/kg	
		Total Potassium (K)	2012/07/05	<100		mg/kg	
		Total Selenium (Se)	2012/07/05	<0.50		mg/kg	
		Total Silver (Ag)	2012/07/05	<0.050		mg/kg	
		Total Sodium (Na)	2012/07/05	<100		mg/kg	
		Total Strontium (Sr)	2012/07/05	<0.10		mg/kg	
		Total Thallium (Tl)	2012/07/05	<0.050		mg/kg	
		Total Tin (Sn)	2012/07/05	<0.10		mg/kg	
		Total Titanium (Ti)	2012/07/05	<1.0		mg/kg	
		Total Uranium (U)	2012/07/05	<0.050		mg/kg	
		Total Vanadium (V)	2012/07/05	<2.0		mg/kg	
		Total Zinc (Zn)	2012/07/05	<1.0		mg/kg	
		Total Zirconium (Zr)	2012/07/05	<0.50		mg/kg	
	RPD	Total Aluminum (Al)	2012/07/05	3.5		%	35
		Total Antimony (Sb)	2012/07/05	NC		%	30
		Total Arsenic (As)	2012/07/05	2.1		%	30
		Total Barium (Ba)	2012/07/05	23.3		%	35
		Total Beryllium (Be)	2012/07/05	NC		%	30
		Total Bismuth (Bi)	2012/07/05	NC		%	30
		Total Cadmium (Cd)	2012/07/05	NC		%	30
		Total Calcium (Ca)	2012/07/05	2.1		%	30
		Total Chromium (Cr)	2012/07/05	3.1		%	30

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: VB256252

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132 DJ	RPD	Total Cobalt (Co)	2012/07/05	0.5		%	30
		Total Copper (Cu)	2012/07/05	4.5		%	30
		Total Iron (Fe)	2012/07/05	0.2		%	30
		Total Lead (Pb)	2012/07/05	4.7		%	35
		Total Lithium (Li)	2012/07/05	NC		%	30
		Total Magnesium (Mg)	2012/07/05	4.3		%	30
		Total Manganese (Mn)	2012/07/05	1.7		%	30
		Total Mercury (Hg)	2012/07/05	NC		%	35
		Total Molybdenum (Mo)	2012/07/05	NC		%	35
		Total Nickel (Ni)	2012/07/05	2.2		%	30
		Total Phosphorus (P)	2012/07/05	3.0		%	30
		Total Potassium (K)	2012/07/05	5.4		%	35
		Total Selenium (Se)	2012/07/05	NC		%	30
		Total Silver (Ag)	2012/07/05	NC		%	35
		Total Sodium (Na)	2012/07/05	NC		%	35
		Total Strontium (Sr)	2012/07/05	12.8		%	35
		Total Thallium (Tl)	2012/07/05	NC		%	30
		Total Tin (Sn)	2012/07/05	NC		%	35
		Total Titanium (Ti)	2012/07/05	2.2		%	35
		Total Uranium (U)	2012/07/05	NC		%	30
		Total Vanadium (V)	2012/07/05	4.4		%	30
		Total Zinc (Zn)	2012/07/05	0.6		%	30
		Total Zirconium (Zr)	2012/07/05	NC		%	30
5974214 NS6	Spiked Blank	Soluble (2:1) pH	2012/07/05		101	%	96 - 104
	RPD	Soluble (2:1) pH	2012/07/05	0.5		%	20
5978220 JGD	Method Blank	Loss on Ignition	2012/07/06	<1.0		%	
	RPD [DV0615-01]	Loss on Ignition	2012/07/06	NC		%	35
5978595 PL	Spiked Blank	Available (NH4OAc) Potassium (K)	2012/07/09		95	%	80 - 120
	Method Blank	Available (NH4OAc) Potassium (K)	2012/07/09	<2.0		mg/kg	
	RPD	Available (NH4OAc) Potassium (K)	2012/07/09	0.4		%	35
5978596 PL	Spiked Blank	Available (NH4F) Phosphorus (P)	2012/07/09		101	%	80 - 120
	Method Blank	Available (NH4F) Phosphorus (P)	2012/07/09	<1.0		mg/kg	
	RPD	Available (NH4F) Phosphorus (P)	2012/07/09	NC		%	35
5984044 DL6	RPD [DV0612-02]	Cation exchange capacity	2012/07/10	NC		%	35
5985283 RP0	Matrix Spike	Available (NH4F) Nitrogen (N)	2012/07/09		100	%	80 - 120
	Spiked Blank	Available (NH4F) Nitrogen (N)	2012/07/09		98	%	90 - 110
	Method Blank	Available (NH4F) Nitrogen (N)	2012/07/09	<2.0		mg/kg	
	RPD	Available (NH4F) Nitrogen (N)	2012/07/09	NC		%	35
5991753 DL6	QC Standard	Organic Matter	2012/07/11		94	%	83 - 118
		Total Organic Carbon (C)	2012/07/11		94	%	83 - 118
	RPD [DV0613-02]	Organic Matter	2012/07/11	NC		%	35
		Total Organic Carbon (C)	2012/07/11	NC		%	35
5999590 KVD	QC Standard	% sand by hydrometer	2012/07/13		99	%	88 - 112
		% silt by hydrometer	2012/07/13		101	%	85 - 115
		Clay Content	2012/07/13		100	%	79 - 121
	RPD	% sand by hydrometer	2012/07/13	4.2		%	35
		% silt by hydrometer	2012/07/13	7.6		%	35
		Clay Content	2012/07/13	15.7		%	35
6000949 IA0	Matrix Spike [DV0615-02]	Total Kjeldahl Nitrogen	2012/07/13		90	%	75 - 125
	QC Standard	Total Kjeldahl Nitrogen	2012/07/13		90	%	75 - 125
	Spiked Blank	Total Kjeldahl Nitrogen	2012/07/13		105	%	75 - 125
	Method Blank	Total Kjeldahl Nitrogen	2012/07/13	<10		mg/kg	
	RPD [DV0615-02]	Total Kjeldahl Nitrogen	2012/07/13	NC		%	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: VB256252

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Validation Signature Page

Maxxam Job #: B256252

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Lili Zhou, Senior analyst, Inorganic department.

Rob Reinert, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B256252 COC #: EB492312 Page: 1 of 1

Invoice To: Require Report? Yes ☐ No ☐

Company Name: Laberge Environmental Services
Contact Name: Ken Nordin
Address: Box 21072 Whitehorse Yukon
PC: Y1A 6P7
Phone / Fax#: Ph: 867 668 6838 Fax: 867 667 6956
E-mail

Report To:

Company Name: same
Contact Name:
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail

PO #:
Quotation #:
Project # : Biochar Research
Proj. Name:
Location:
Sampled by: Ken Nordin

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☐ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

- ◉ Regular Turn Around Time (TAT) (5 days for most tests)
- RUSH (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

ANALYSIS REQUESTED

	* Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) / Field Filtered? Y/N	Field Acidified? Y/N	Total Metals / Field Acidified? Y/N	Cation Exchange Capacity (CEC)	Water Holding Capacity	% Organic Matter	metals	NPK (Nutrients)	pH	Particle size	C:N Ratio	Number of Containers
1	Peso Waste Rock	DV0612		12/06/24 12:00				x	x	x	x	x	x	x	x	
2	Peso Trenches	DV0613		12/06/24 12:00				x	x	x	x	x	x	x	x	
3	WHC A,B,C	DV0614		12/06/26 12:00				x	x	x	x	x	x	x	x	
4	MSGM A,B,C	DV0615		12/06/26 12:00				x	x	x	x	x	x	x	x	
5																
6																
7																
8																
9																
10																
11																
12																

Ken Nordin:
Please Homogenize WHC and MSGM jars A, B and C to form single sample for each.

B256252

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Ken Nordin	12/06/28	17:00	[signature]	2012/06/29	14:00	☐	A) 18 B) 17 C) 18	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

STRATAGOLD CORPORATION
ATTN: Hugh Coyle
Suite 1000 - 1050 W. Pender St
Vancouver BC V6E 3S7

Date Received: 01-AUG-18
Report Date: 29-AUG-18 12:31 (MT)
Version: FINAL

Client Phone: 604-682-5122

Certificate of Analysis

Lab Work Order #: L2139940

Project P.O. #: NOT SUBMITTED
Job Reference: EAGLE GOLD
C of C Numbers:
Legal Site Desc: Victoria Gold Corp.

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-1	L2139940-2	L2139940-3	L2139940-4	L2139940-5
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 375 C (%)	1.2	3.1	3.6	1.3	1.3
	Organic Matter (%)	1.2	2.7	3.1	1.3	1.3
	pH (1:2 soil:water) (pH)	6.30	7.17	6.74	5.88	7.12
Particle Size	% Sand (2.0mm - 0.05mm) (%)	83.3	83.8	82.5	65.0	65.7
	% Silt (0.05mm - 2um) (%)	15.3	14.1	15.7	28.9	28.6
	% Clay (<2um) (%)	1.4	2.1	1.7	6.1	5.7
	Texture	Loamy sand	Loamy sand	Loamy sand	Sandy loam	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.069	0.118	0.132	0.059	0.064
Organic / Inorganic Carbon	C:N Ratio	5.8:1	15.7:1	14.5:1	7:1	8.9:1
	Total Carbon by Combustion (%)	0.40	1.86	1.91	0.42	0.57
Plant Available Nutrients	Available Ammonium-N (mg/kg)	1.8	2.5	3.1	2.0	2.3
	Calcium (Ca) (meq/100g)	0.92	5.33	3.74	0.74	2.26
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Available Phosphate-P (mg/kg)	3.4	46.9 DLHC	17.9	<2.0	6.8
	Available Potassium (mg/kg)	24	51	51	30	39
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	3220	2050	1630	3440	3390
	Antimony (Sb) (mg/kg)	3750	818	6410	2360	492
	Arsenic (As) (mg/kg)	6380	2190	2690	5810	1490
	Barium (Ba) (mg/kg)	47.2	32.6	35.6	70.3	65.7
	Beryllium (Be) (mg/kg)	0.13	<0.10	<0.10	0.13	0.11
	Bismuth (Bi) (mg/kg)	145	26.1	236	504	53.5
	Boron (B) (mg/kg)	10.0	<5.0	7.1	7.4	<5.0
	Cadmium (Cd) (mg/kg)	4.08	0.427	3.26	3.89	0.564
	Calcium (Ca) (mg/kg)	578	1830	3890	947	1180
	Chromium (Cr) (mg/kg)	16.6	7.83	5.92	7.33	7.84
	Cobalt (Co) (mg/kg)	7.91	4.18	2.26	2.93	2.84
	Copper (Cu) (mg/kg)	132	55.6	29.8	74.3	50.9
	Iron (Fe) (mg/kg)	56700	31900	17900	51100	28400
	Lead (Pb) (mg/kg)	7790	1440	3670	4700	1160
	Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Magnesium (Mg) (mg/kg)	94	312	475	81	84
	Manganese (Mn) (mg/kg)	278	290	131	277	142
	Mercury (Hg) (mg/kg)	0.227	0.169	0.468	0.358	0.146

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-6	L2139940-7	L2139940-8	L2139940-9	L2139940-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T2-3A	T3-1	T3-2AB	T3-3AB	W1-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 375 C (%)	1.4	2.3	3.3	3.5	2.0
	Organic Matter (%)	1.4	2.0	2.9	3.0	1.8
	pH (1:2 soil:water) (pH)	6.12	5.17	5.75	6.79	3.04
Particle Size	% Sand (2.0mm - 0.05mm) (%)	65.2	60.9	64.2	58.0	59.4
	% Silt (0.05mm - 2um) (%)	28.3	34.7	31.0	37.9	36.4
	% Clay (<2um) (%)	6.5	4.4	4.7	4.1	4.2
	Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.063	0.070	0.077	0.088	0.062
Organic / Inorganic Carbon	C:N Ratio	6.8:1	7.2:1	20.1:1	17.5:1	10.5:1
	Total Carbon by Combustion (%)	0.43	0.50	1.55	1.53	0.64
Plant Available Nutrients	Available Ammonium-N (mg/kg)	1.4	1.7	2.6	2.5	4.1
	Calcium (Ca) (meq/100g)	1.20	<0.50	3.97	4.48	<0.50
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Available Phosphate-P (mg/kg)	<2.0	2.3	15.2	24.2	2.2
	Available Potassium (mg/kg)	29	31	40	46	27
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	4620	3030	3670	2670	7160
	Antimony (Sb) (mg/kg)	369	4590	1450	2330	1280
	Arsenic (As) (mg/kg)	1730	11400	4410	10600	3750
	Barium (Ba) (mg/kg)	91.3	42.3	40.6	38.6	116
	Beryllium (Be) (mg/kg)	0.15	0.12	0.13	<0.10	0.20
	Bismuth (Bi) (mg/kg)	30.5	320	91.5	222	110
	Boron (B) (mg/kg)	8.2	7.4	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.482	6.21	1.53	3.91	1.85
	Calcium (Ca) (mg/kg)	1330	334	634	1190	452
	Chromium (Cr) (mg/kg)	10.6	11.2	10.1	13.8	14.2
	Cobalt (Co) (mg/kg)	3.44	5.08	4.21	6.24	9.72
	Copper (Cu) (mg/kg)	73.3	170	92.7	121	145
	Iron (Fe) (mg/kg)	39300	43100	36000	42900	46500
	Lead (Pb) (mg/kg)	1260	8680	3200	4890	1870
	Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0	7.5
	Magnesium (Mg) (mg/kg)	92	131	354	193	2250
	Manganese (Mn) (mg/kg)	199	184	170	214	272
	Mercury (Hg) (mg/kg)	0.193	0.700	0.571	0.924	0.0935

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2139940-11 Soil 31-JUL-18 W1-2	L2139940-12 Soil 31-JUL-18 W1-3	L2139940-13 Soil 31-JUL-18 W1-4	L2139940-14 Soil 31-JUL-18 W1-5	L2139940-15 Soil 31-JUL-18 W2-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 375 C (%)	2.3	4.4	3.0	9.2	1.4
	Organic Matter (%)	2.1	3.7	2.6	7.5	1.4
	pH (1:2 soil:water) (pH)	4.81	3.25	4.10	5.71	2.75
Particle Size	% Sand (2.0mm - 0.05mm) (%)	69.2	80.3	82.3	75.5	37.4
	% Silt (0.05mm - 2um) (%)	27.2	17.2	16.0	20.8	59.4
	% Clay (<2um) (%)	3.6	2.4	1.7	3.7	3.1
	Texture	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Silt loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.073	0.095	0.115	0.152	0.023
Organic / Inorganic Carbon	C:N Ratio	12.2:1	30.7:1	11.5:1	37.6:1	15.1:1
	Total Carbon by Combustion (%)	0.89	2.91	1.33	5.72	0.34
Plant Available Nutrients	Available Ammonium-N (mg/kg)	3.4	3.6	3.3	6.3	2.2
	Calcium (Ca) (meq/100g)	1.27	<0.50	0.75	11.2	<0.50
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	2.26	<0.50
	Available Phosphate-P (mg/kg)	5.7	6.4	<2.0	15.6	<2.0
	Available Potassium (mg/kg)	23	<20	25	45	<20
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	5840	4990	3550	2780	4540
	Antimony (Sb) (mg/kg)	542	241	838	3350	1110
	Arsenic (As) (mg/kg)	3220	2140	3610	3130	1470
	Barium (Ba) (mg/kg)	72.0	44.3	24.3	46.3	158
	Beryllium (Be) (mg/kg)	0.18	0.20	0.18	0.13	0.13
	Bismuth (Bi) (mg/kg)	66.5	21.2	73.4	313	43.5
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	1.29	1.61	1.95	2.40	0.291
	Calcium (Ca) (mg/kg)	1150	296	4040	28500	756
	Chromium (Cr) (mg/kg)	12.2	11.9	9.60	5.22	10.4
	Cobalt (Co) (mg/kg)	11.6	22.5	14.0	2.54	3.00
	Copper (Cu) (mg/kg)	172	120	214	229	88.0
	Iron (Fe) (mg/kg)	45400	50500	48600	27200	38500
	Lead (Pb) (mg/kg)	4570	391	1380	6770	1600
	Lithium (Li) (mg/kg)	5.8	5.3	3.2	<2.0	4.7
	Magnesium (Mg) (mg/kg)	1820	1620	3190	14800	1410
	Manganese (Mn) (mg/kg)	238	320	225	207	112
	Mercury (Hg) (mg/kg)	0.0853	0.0327	0.105	0.654	0.0933

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-16	L2139940-17	L2139940-18	L2139940-19	L2139940-20
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W2-2	W2-3	W2-4	W2-5	W3-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 375 C (%)	1.5	3.0	4.8	1.9	1.6
	Organic Matter (%)	1.5	2.6	4.1	1.7	1.5
	pH (1:2 soil:water) (pH)	3.11	3.04	3.28	2.84	2.32
Particle Size	% Sand (2.0mm - 0.05mm) (%)	42.6	87.1	73.2	71.2	53.3
	% Silt (0.05mm - 2um) (%)	55.6	11.2	23.6	22.4	40.5
	% Clay (<2um) (%)	1.8	1.7	3.2	6.3	6.2
	Texture	Silt loam	Sand	Sandy loam / Loamy sand	Sandy loam	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.033	0.063	0.096	0.046	0.061
Organic / Inorganic Carbon	C:N Ratio	12.9:1	15.6:1	24:1	5.7:1	8.7:1
	Total Carbon by Combustion (%)	0.42	0.99	2.31	0.26	0.53
Plant Available Nutrients	Available Ammonium-N (mg/kg)	1.8	2.9	4.5	2.8	6.9
	Calcium (Ca) (meq/100g)	<0.50	<0.50	2.84	<0.50	<0.50
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	0.90	<0.50	<0.50
	Available Phosphate-P (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Available Potassium (mg/kg)	<20	<20	32	<20	<20
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	5820	4920	5080	4590	3390
	Antimony (Sb) (mg/kg)	333	1320	2100	2360	2940
	Arsenic (As) (mg/kg)	1240	2530	2980	2260	3010
	Barium (Ba) (mg/kg)	196	102	134	86.8	116
	Beryllium (Be) (mg/kg)	0.13	0.27	0.22	0.27	0.14
	Bismuth (Bi) (mg/kg)	12.1	132	252	422	246
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	5.2	<5.0
	Cadmium (Cd) (mg/kg)	0.253	0.442	0.633	0.996	1.81
	Calcium (Ca) (mg/kg)	1160	899	1540	1390	222
	Chromium (Cr) (mg/kg)	13.9	8.69	8.62	6.91	10.6
	Cobalt (Co) (mg/kg)	4.69	2.24	2.38	1.39	5.39
	Copper (Cu) (mg/kg)	59.4	194	194	180	250
	Iron (Fe) (mg/kg)	33500	53900	48900	45100	37100
	Lead (Pb) (mg/kg)	331	2220	3590	4860	3810
	Lithium (Li) (mg/kg)	6.9	2.2	2.2	<2.0	2.4
	Magnesium (Mg) (mg/kg)	2350	307	731	212	622
	Manganese (Mn) (mg/kg)	179	83.4	86.7	66.9	129
	Mercury (Hg) (mg/kg)	0.0465	0.182	0.361	0.302	0.207

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-21	L2139940-22	L2139940-23	L2139940-24
	Description	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time				
	Client ID	W3-2	W3-3	W3-4	W3-5
Grouping	**Analyte**				
SOIL					
Physical Tests	Loss on Ignition @ 375 C (%)	6.1	8.0	9.5	7.9
	Organic Matter (%)	5.0	6.5	7.7	6.5
	pH (1:2 soil:water) (pH)	2.41	1.77	4.32	2.20
Particle Size	% Sand (2.0mm - 0.05mm) (%)	69.2	63.7	68.6	68.8
	% Silt (0.05mm - 2um) (%)	25.4	28.6	26.9	25.0
	% Clay (<2um) (%)	5.4	7.6	4.5	6.2
	Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.135	0.150	0.175	0.140
Organic / Inorganic Carbon	C:N Ratio	21.9:1	27.6:1	32.4:1	32:1
	Total Carbon by Combustion (%)	2.95	4.16	5.66	4.47
Plant Available Nutrients	Available Ammonium-N (mg/kg)	13.6	DLHC 18.6	7.5	11.5
	Calcium (Ca) (meq/100g)	<0.50	<0.50	3.60	19.4
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	1.96	2.12
	Available Phosphate-P (mg/kg)	4.4	<2.0	<2.0	<2.0
	Available Potassium (mg/kg)	<20	20	<20	<20
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	2930	3100	3760	2710
	Antimony (Sb) (mg/kg)	7690	6020	5920	7140
	Arsenic (As) (mg/kg)	6500	7950	9810	10900
	Barium (Ba) (mg/kg)	47.3	53.7	60.5	48.1
	Beryllium (Be) (mg/kg)	0.16	0.17	0.17	0.11
	Bismuth (Bi) (mg/kg)	1020	975	822	1250
	Boron (B) (mg/kg)	6.7	5.8	<5.0	5.8
	Cadmium (Cd) (mg/kg)	5.74	6.59	6.44	6.31
	Calcium (Ca) (mg/kg)	446	571	9170	2290
	Chromium (Cr) (mg/kg)	9.91	9.40	12.0	7.89
	Cobalt (Co) (mg/kg)	1.80	1.82	3.01	2.13
	Copper (Cu) (mg/kg)	299	314	433	400
	Iron (Fe) (mg/kg)	35800	32300	54300	70100
	Lead (Pb) (mg/kg)	14300	12800	10700	16600
	Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0
	Magnesium (Mg) (mg/kg)	262	105	5180	1380
	Manganese (Mn) (mg/kg)	94.8	81.8	132	108
	Mercury (Hg) (mg/kg)	0.701	1.05	0.797	0.706

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-1	L2139940-2	L2139940-3	L2139940-4	L2139940-5
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2
Grouping	**Analyte**					
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	1.45	1.36	1.05	0.85	1.31
	Nickel (Ni) (mg/kg)	20.3	11.5	5.92	5.34	5.52
	Phosphorus (P) (mg/kg)	581	500	452	1170	1200
	Potassium (K) (mg/kg)	580	460	320	670	630
	Selenium (Se) (mg/kg)	5.62	1.70	6.76	9.01	1.98
	Silver (Ag) (mg/kg)	>165	15.8	>126	50.7	8.51
	Sodium (Na) (mg/kg)	<50	<50	<50	<50	<50
	Strontium (Sr) (mg/kg)	93.0	35.7	32.6	337	349
	Sulfur (S) (mg/kg)	1500	<1000	<1000	1700	<1000
	Thallium (Tl) (mg/kg)	0.262	0.149	0.147	0.282	0.118
	Tin (Sn) (mg/kg)	51.0	16.5	24.7	41.3	17.2
	Titanium (Ti) (mg/kg)	22.3	28.9	38.7	19.5	DLM <16
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	14.3	1.72	4.75	6.05	2.17
	Vanadium (V) (mg/kg)	18.6	10.4	6.31	10.7	8.41
	Zinc (Zn) (mg/kg)	354	142	70.4	117	85.5
	Zirconium (Zr) (mg/kg)	12.0	3.8	2.1	7.4	7.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-6	L2139940-7	L2139940-8	L2139940-9	L2139940-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T2-3A	T3-1	T3-2AB	T3-3AB	W1-1
Grouping	**Analyte**					
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	1.05	0.79	1.15	1.27	0.78
	Nickel (Ni) (mg/kg)	7.03	9.32	8.65	15.1	27.6
	Phosphorus (P) (mg/kg)	1480	534	333	484	461
	Potassium (K) (mg/kg)	790	520	470	590	640
	Selenium (Se) (mg/kg)	1.68	9.01	3.54	6.42	3.93
	Silver (Ag) (mg/kg)	7.37	38.0	18.3	35.8	17.6
	Sodium (Na) (mg/kg)	<50	<50	<50	<50	149
	Strontium (Sr) (mg/kg)	483	108	57.1	79.5	26.0
	Sulfur (S) (mg/kg)	<1000	2000	1100	1600	2900
	Thallium (Tl) (mg/kg)	0.116	0.263	0.180	0.189	<0.10 DLM
	Tin (Sn) (mg/kg)	18.0	201	38.3	105	6.9
	Titanium (Ti) (mg/kg)	18.4	17.3	37.1	<19 DLM	99.7
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	2.17	3.49	2.06	3.12	2.41
	Vanadium (V) (mg/kg)	11.7	10.5	12.7	13.3	19.5
	Zinc (Zn) (mg/kg)	113	112	95.0	107	258
	Zirconium (Zr) (mg/kg)	6.2	10.4	8.7	10.2	3.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-11	L2139940-12	L2139940-13	L2139940-14	L2139940-15
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W1-2	W1-3	W1-4	W1-5	W2-1
Grouping	**Analyte**					
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	1.60	1.69	1.04	2.20	0.77
	Nickel (Ni) (mg/kg)	27.6	48.7	34.2	7.42	8.91
	Phosphorus (P) (mg/kg)	827	594	410	914	561
	Potassium (K) (mg/kg)	580	420	400	700	970
	Selenium (Se) (mg/kg)	5.46	1.04	4.02	12.2	2.46
	Silver (Ag) (mg/kg)	18.9	3.50	16.3	62.9	19.5
	Sodium (Na) (mg/kg)	184	73	<50	55	392
	Strontium (Sr) (mg/kg)	32.8	13.3	17.8	193	90.6
	Sulfur (S) (mg/kg)	3400	1600	2400	6700	6300
	Thallium (Tl) (mg/kg)	<0.15 DLM	0.062	<0.10 DLM	<0.35 DLM	0.151
	Tin (Sn) (mg/kg)	7.6	2.6	7.6	33.2	11.3
	Titanium (Ti) (mg/kg)	75.9	49.8	26.8	<31 DLM	274
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	2.27	2.73	2.99	2.21	0.967
	Vanadium (V) (mg/kg)	15.7	12.9	10.0	8.13	28.0
	Zinc (Zn) (mg/kg)	249	333	210	121	47.8
	Zirconium (Zr) (mg/kg)	1.4	2.5	7.1	<1.0	4.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-16	L2139940-17	L2139940-18	L2139940-19	L2139940-20
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W2-2	W2-3	W2-4	W2-5	W3-1
Grouping	**Analyte**					
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	0.80	1.04	1.89	1.09	1.30
	Nickel (Ni) (mg/kg)	13.2	8.26	8.19	6.94	16.2
	Phosphorus (P) (mg/kg)	602	1670	1640	1730	289
	Potassium (K) (mg/kg)	980	1130	1240	1460	670
	Selenium (Se) (mg/kg)	1.14	4.04	6.75	6.31	9.79
	Silver (Ag) (mg/kg)	4.72	58.0	75.3	>108	32.5
	Sodium (Na) (mg/kg)	353	92	162	75	106
	Strontium (Sr) (mg/kg)	39.4	407	458	565	41.2
	Sulfur (S) (mg/kg)	4000	5900	9000	9800	3900
	Thallium (Tl) (mg/kg)	0.078	0.242	0.301	0.418	DLM <0.20
	Tin (Sn) (mg/kg)	5.1	21.0	32.2	26.5	33.9
	Titanium (Ti) (mg/kg)	314	31.1	78.7	10.6	74.2
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	0.785	2.32	2.46	3.87	2.52
	Vanadium (V) (mg/kg)	29.3	14.5	18.0	12.2	17.1
	Zinc (Zn) (mg/kg)	54.5	88.7	68.5	69.2	94.1
	Zirconium (Zr) (mg/kg)	2.5	4.6	4.4	6.8	9.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-21	L2139940-22	L2139940-23	L2139940-24	
	Description	Soil	Soil	Soil	Soil	
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	
	Sampled Time					
	Client ID	W3-2	W3-3	W3-4	W3-5	
Grouping	**Analyte**					
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	2.57	1.79	2.57	1.94	
	Nickel (Ni) (mg/kg)	5.14	5.46	8.84	5.78	
	Phosphorus (P) (mg/kg)	1120	769	1230	788	
	Potassium (K) (mg/kg)	900	850	870	750	
	Selenium (Se) (mg/kg)	25.1	27.5	25.8	35.5	
	Silver (Ag) (mg/kg)	>122	>112	>111	>135	
	Sodium (Na) (mg/kg)	58	53	94	106	
	Strontium (Sr) (mg/kg)	188	215	168	141	
	Sulfur (S) (mg/kg)	6300	8500	8400	16600	
	Thallium (Tl) (mg/kg)	<0.30 DLM	<0.35 DLM	0.265	<35 DLM	
	Tin (Sn) (mg/kg)	64.0	131	81.7	68.5	
	Titanium (Ti) (mg/kg)	39.6	39.9	46.0	<47 DLM	
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	
	Uranium (U) (mg/kg)	6.00	7.07	5.62	6.01	
	Vanadium (V) (mg/kg)	8.07	7.03	9.26	7.35	
	Zinc (Zn) (mg/kg)	110	103	100	90.2	
	Zirconium (Zr) (mg/kg)	1.2	9.7	<1.0	2.9	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Additional Comments for Sample Listed:

Samplenum	Matrix	Report Remarks	Sample Comments
L2139940-1	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-10	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-11	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-12	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-13	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-14	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-15	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-16	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-17	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-18	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-19	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-2	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-20	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-21	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-22	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-23	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-24	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-3	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-4	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-5	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-6	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-7	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-8	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-9	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Cadmium (Cd)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Duplicate	Strontium (Sr)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Duplicate	Zinc (Zn)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Certified Reference Material	Chromium (Cr)-Total	RRQC	L2139940-40, -41, -42, -43, -44, -45, -46, -47, -48, -49, -50, -51, -52, -53, -54

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
RRQC	Refer to report remarks for information regarding this QC result.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AG-200.2-A-CCMS-VA	Soil	Elevated Ag in Soil by CRC ICPMS	EPA 200.2/6020A

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Analysis is by Collision/Reaction Cell ICPMS.

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

CAT-XTR-SK	Soil	Ammonium Acetate Extractable Cations	CSSS 19.4 - 1M NH4OAc Extraction @ pH 7

Exchangeable Ca, Mg, Na, and K are extracted from the soil using neutral 1N ammonium acetate, then determined by ICP-OES. This method does not correct for calcium or magnesium extracted from carbonates or free gypsum.

ETL-C:N-RATIO-SK	Soil	Carbon:Nitrogen Ratio - Calculation	Calculation
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

HG-DRY-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

HG-DRY-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (DRY)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

MET-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY)	EPA 200.3/6020A

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MET-DRY-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (DRY)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

NH4-AVAIL-SK	Soil	Available Ammonium-N	Comm Soil Sci 19(6)

Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.

OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

Reference Information

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

PO4/K-AVAIL-SK	Soil	Plant Available Phosphorus and Potassium	Comm. Soil Sci. Plant Anal, 25 (5&6)

Plant available phosphorus and potassium are extracted from the soil usng Modified Kelowna solution. Phosphorous in the soil extract is determined colorimetrically at 880 nm, while potassiumis determined by flame emission at 770 nm.

PSA-1-SK	Soil	Particle Size Analysis:Mini-Pipet Method	SSIR-51 Method 3.2.1

Dry, < 2 mm soil is treated with sodium hexametaphosphate to ensure complete dispersion of primary soil particles. The homogenized suspension is allowed to settle in accordance with Stoke's Law so that only clay particles remain in suspension.To determine the clay fraction, an aliquot of the clay suspension is removed, then dried and weighed. The sand fraction is determined by wet sieving the remaining suspension, then drying and weighing the sand retained on the sieve. The silt fraction is determined by calculation where % Silt = 100 - (%Sand+%Clay)

Reference:
Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

Kalra, Y.P., Maynard, D.G. 1991. Methods manual for forest soil and plant analysis. Forestry Canada. p. 42-45.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L2139940-COFC

ALS Environmental

Chain of Custody / A
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC #

Report To	
Company:	StrataGold Corporation
Contact:	Hugh Coyle
Address:	1000 - 1050 West Pender Street, Vancouver, BC V6E 3S7
Phone:	604-696-6600 Fax:
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑Standard ☐Other	
☑PDF ☑Excel ☑Digital ☐Fax	
Email 1:	hcoyle@vitgoldcorp.com
Email 2:	bonnieburns@northwestel.net
Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c
Client / Project Information	
Job #:	Eagle Gold
PO / AFE:	
LSD:	Victoria Gold Corp.
Quote #:	Q69293, Peso Samples
ALS Contact:	Heather Mackenzie
Sampler:	Bonnie Burns &Crystal Beaudry

Service Requested (Rush for routine analysis subject to availability)
- ◉Regular (Standard Turnaround Times - Business Days)
- ○Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ○Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Carbon to Nitrogen Ratio	Cation Exchange Capacity	Metals, CCME	Particle Size Analysis	Available Ammonium	Organic matter by LOI	Plant Available P and K						Number of Containers
	T1-1AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T1-2AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T1-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-1AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-3A	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-2AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-3AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-4	31-7-17		Soil	X	X	X	X	X	X	X						2

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	1 Aug 2018	16:30	12 D °C	HA	8/2	1 pm	

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GENF 20.00 Front

L2139940-COFC

ALS Environmental

Chain of Custody / Analy
Canada Toll Free: 1
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Report To	
Company:	StrataGold Corporation
Contact:	Hugh Coyle
Address:	1000 - 1050 West Pender Street
	Vancouver, BC V6E 3S7
Phone:	604-696-6600 Fax:
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑ Standard ☐ Other	
☑ PDF ☑ Excel ☑ Digital ☐ Fax	
Email 1:	hcoyle@vitgoldcorp.com
Email 2:	bonnieburns@northwestel.net
Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c
Client / Project Information	
Job #:	Eagle Gold
PO / AFE:	
LSD:	Victoria Gold Corp.
Quote #:	Q69293, Peso Samples
ALS Contact:	Heather Mackenzie
Sampler:	Bonnie Burns & Crystal Beaudry

Service Requested (Rush for routine analysis subject to availability)

- ◉ Regular (Standard Turnaround Times - Business Days)
- ○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Carbon to Nitrogen Ratio	Cation Exchange Capacity	Metals, CCME	Particle Size Analysis	Available Ammonium	Organic matter by LOI	Plant Available P and K						Number of Containers
	W1-5	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-4	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-5	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-4	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-5	31-7-17		Soil	X	X	X	X	X	X	X						2

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
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Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	1 Aug 2018	16:30	12.0 °C	HA	8/2	1pm	

GENF 20.00 Front

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APPENDIX B

PHOTOGRAPHS,

SEPTEMBER 2012 TO AUGUST 2018

TRENCH – BLOCK #1

Photo #1: Trench - Block #1 staked out, July 2012

Photo #2: Each plot was decompacted using a 5-pronged cultivator

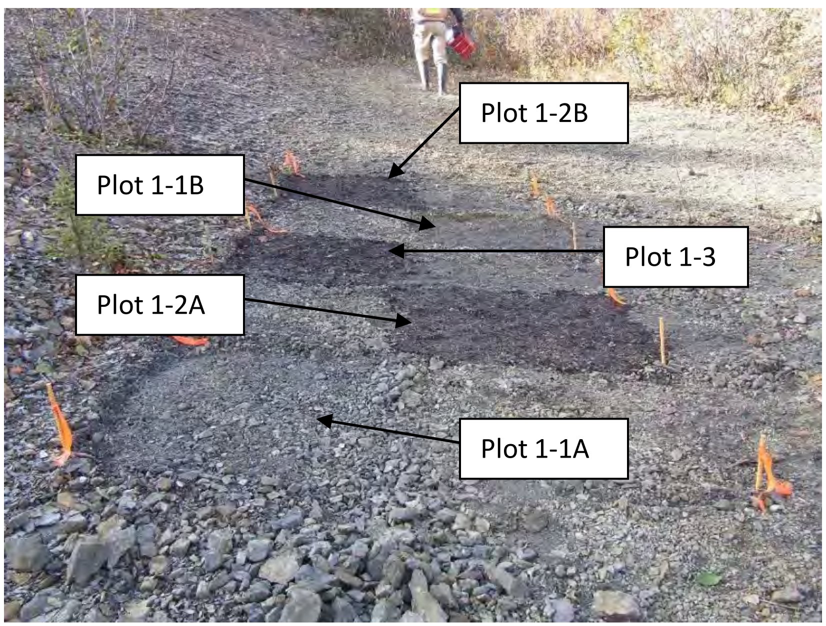


Photo #3: Trench - Block #1 plots prepared, seeded and treated.

Photo #4: Trench – Block #1, July 2013, grass has started growing.

Photo #5: Trench – Block #1, Aug 2014.

Photo #6: Trench – Block #1, alders becoming established, July 2016.

Photo #7: Trench – Block #1, increased growth of alders, Aug 2017.

Photo #8: Trench – Block #1, July 2018.

Photo #9: Trench – Plot #1-3, July 2013.

Photo #10: Trench – Plot #1-3, August 2014.

Photo #11: Trench – Plot #1-3, August 2015.

Photo #12: Trench – Plot #1-3, July 2016.

Photo #13: Trench – Plot #1-3, August 2017.

Photo #14: Trench – Plot #1-3, July 2018.

Photo #15: Trench, Block #1, young alder with long lateral root. 2018.

Photo #16: Root ball of alder plant from Plot #1-2B, July 2018.

TRENCH – BLOCK #2

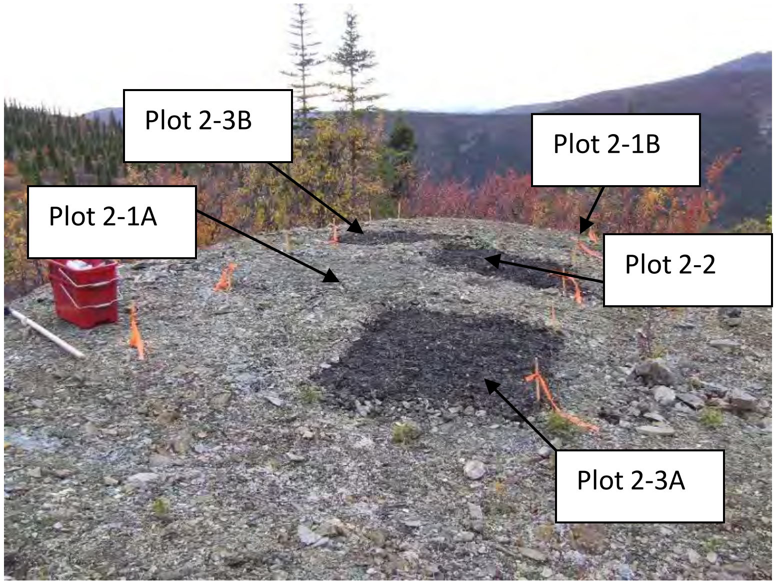


Photo #17: Trench – Block #2 prepared, seeded and treated. September 2012.

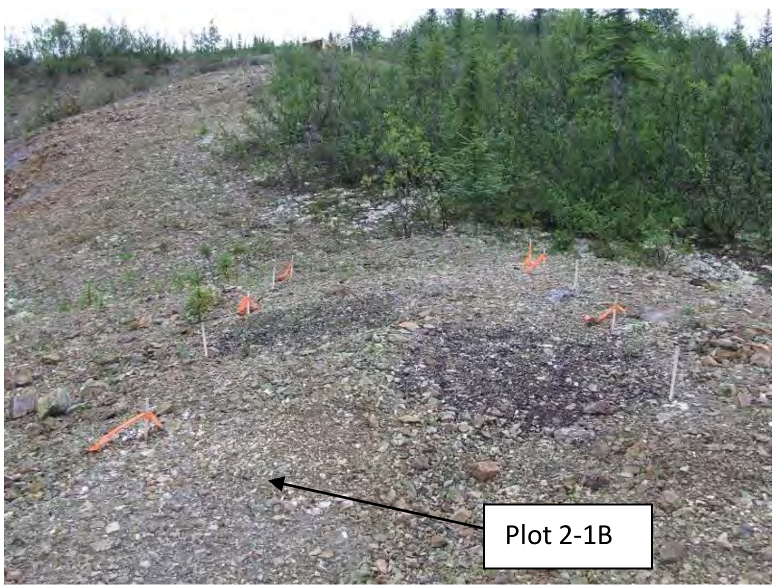


Photo #18: Trench – Block #2, July 2013.

Photo #19: Trench – Block #2, July 2016.

Photo #20: Trench – Block #2, Aug 2017.

Photo #21: Trench – Block #2, July 2018.

Photo #22: Trench, Plot #2-2, July 2013.

Photo #23: Trench, Plot #2-2, August 2014.

Photo #24: Trench, Plot #2-2, July 2015.

Photo #25: Trench, Plot #2-2, July 2016.

Photo #26: Trench, Plot #2-2, August 2017.

Photo #27: Trench, Plot #2-2, July 2018.

Photo #28: The alder in Plot #2-2 has produced seed cones in 2018.

TRENCH – BLOCK #3

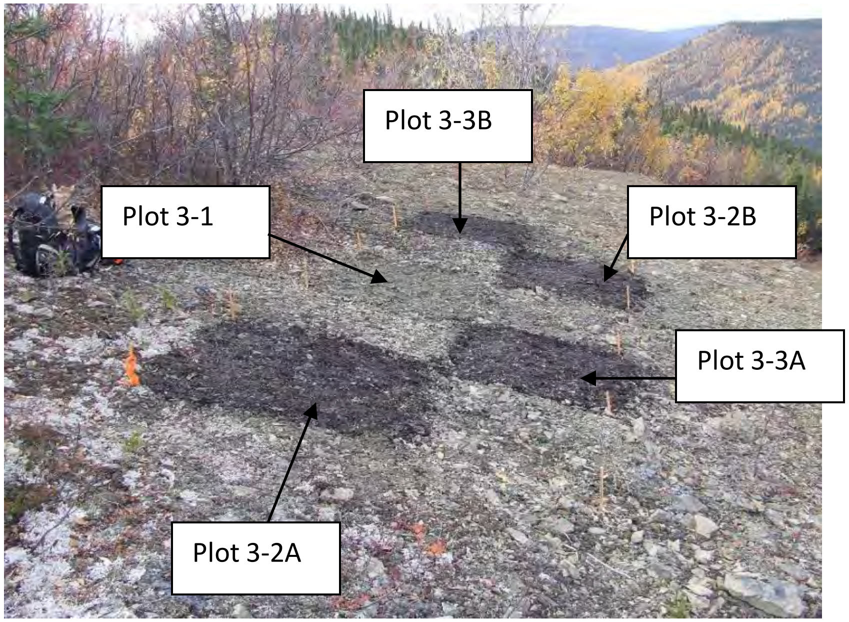


Photo #29: Trench Block #3, prepared, seeded and treated, Sept/12

Photo #31: Trench – Block #3, August 2014, increased growth.

Photo #30: Trench – Block #3, July 2013.

Photo #32: Trench – Block #3, July 2016.

Photo #33: Trench – Block #3, August 2017.

Photo #34: Trench – Block #3, July 2018. Increase alder growth.

Photo #35: Trench, Plot 3-2B, July 2013.

Photo #36: Trench, Plot 3-2B, Aug 2014, healthy grasses.

Photo #37: Trench, Plot #3-2B, August 2015.

Photo #38: Trench, Plot #3-2B, August 2017.

Photo #39: Trench, Plot #3-2B, July 2018

Photo #40: Nitrogen nodule on alder from Plot 3-2B, July 2018.

WASTE ROCK DUMP – BLOCK #1

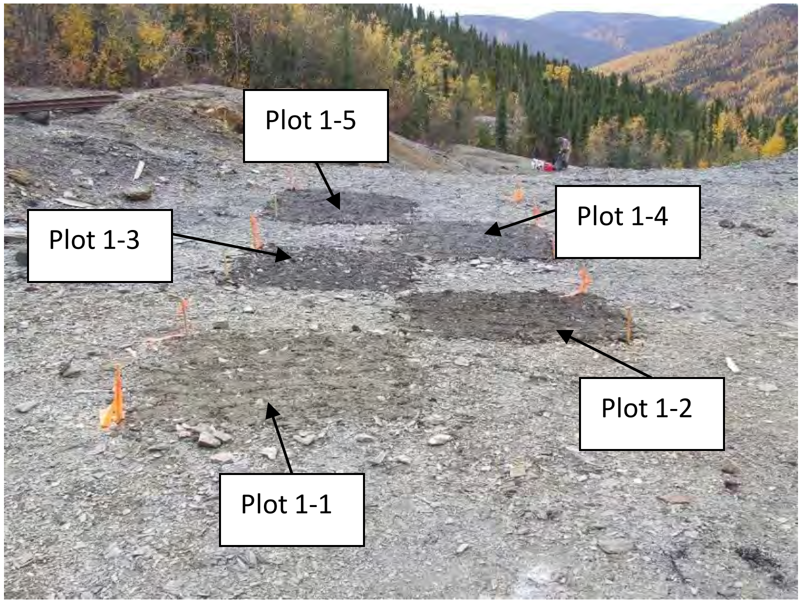


Photo #41: Waste Rock, Block #1, prepared, seeded and treated, Sept 2012.

Photo #43: Waste Rock, Block #1, August 2014, increased grass growth.

Photo #42: Waste Rock, Block #1, July 2013.

Photo #44: Waste Rock, Block #1, July 2016.

Photo #45: Waste Rock, Block #1, August 2017.

Photo #46: Waste Rock, Block #1, July 2018.

Photo #47: Waste Rock, Plot #1-5, very little growth, July 2013.

Photo #48: Waste Rock, Plot #1-5, healthy grass growth, Aug 2014.

Photo #49: Waste Rock, Plot #1-5, alders appearing, Aug 2015.

Photo #51: Waste Rock, Plot 1-5, August 2017.

Photo #50: Waste Rock, Plot #1-5, grasses dying back, July 2016.

Photo #52: Waste Rock, Plot 1-5, July 2018.

Photo #53: Waste Rock, healthy spruce growing among volunteer willow, paper birch and the alders at Plot #1-4.

Photo #54: Waste rock. Seed cones on an alder growing on Plot #1-4. July 2018.

Photo #55: Waste Rock, nitrogen nodules on alder root, Plot #1-2.

WASTE ROCK – BLOCK #2

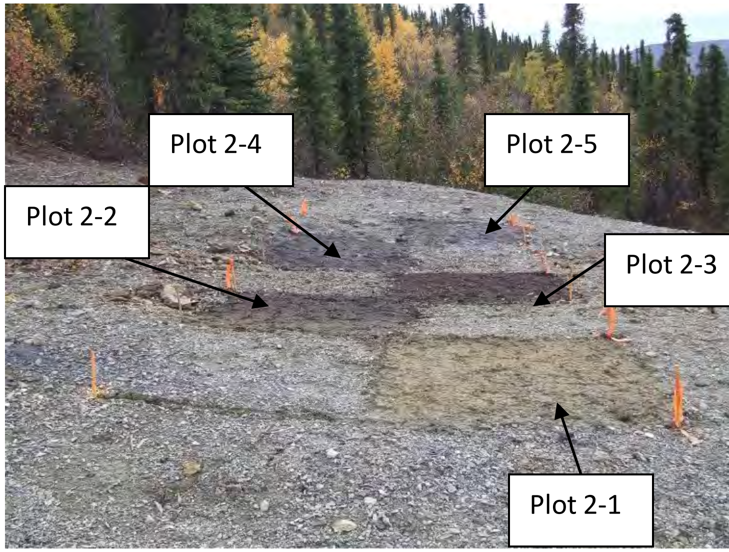


Photo #56 : Waste Rock, Block #2, prepared, seeded and treated, September 2012.

Photo #57: Waste Rock, Block #2, July 2013, good germination.

Photo #58: Waste Rock Block #2, August 2014. Healthy grasses.

Photo #59: Waste Rock, Block #2, July 2016. Alders growing.

Photo #60: Waste Rock, Block #2, August 2017. Alders have increased in growth.

Photo #61: Waste Rock, Block #2, July 2018.

Photo #62: Waste Rock, Plot 2-4, July 2013. Dolomite granules can still be seen.

Photo #63: Waste Rock, Plot 2-4, August 2014. Mature grasses.

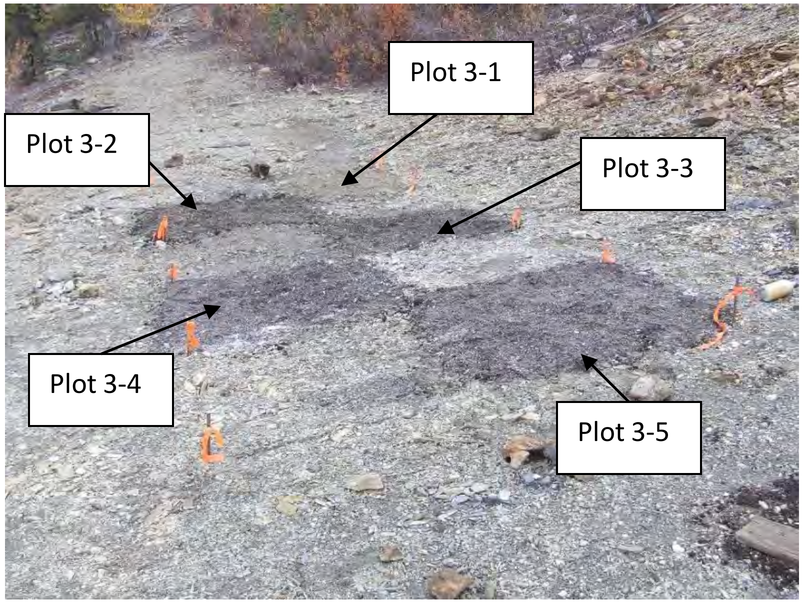
Photo #64: Waste Rock, Plot 2-4, July 2015. Alders growing.

Photo #65: Waste Rock, Plot 204, August 2016.

Photo #66: Waste Rock, Plot #2-4, August 2017.

Photo #67: Waste Rock, Plot #2-4, July 2018. Defoliation evident on stems both in 2017 and 2018.

WASTE ROCK – BLOCK #3



Photo# 68: Waste Rock, Block #3, prepared, seeded and treated. September 2012.

Photo #69: Waste Rock, Block #3, July 2013.

Photo #70: Waste Rock, Block #3, August 2014.

Photo #71: Waste Rock, Block #3, July 2016.

Photo #72: Waste Rock, Block #3, August 2017.

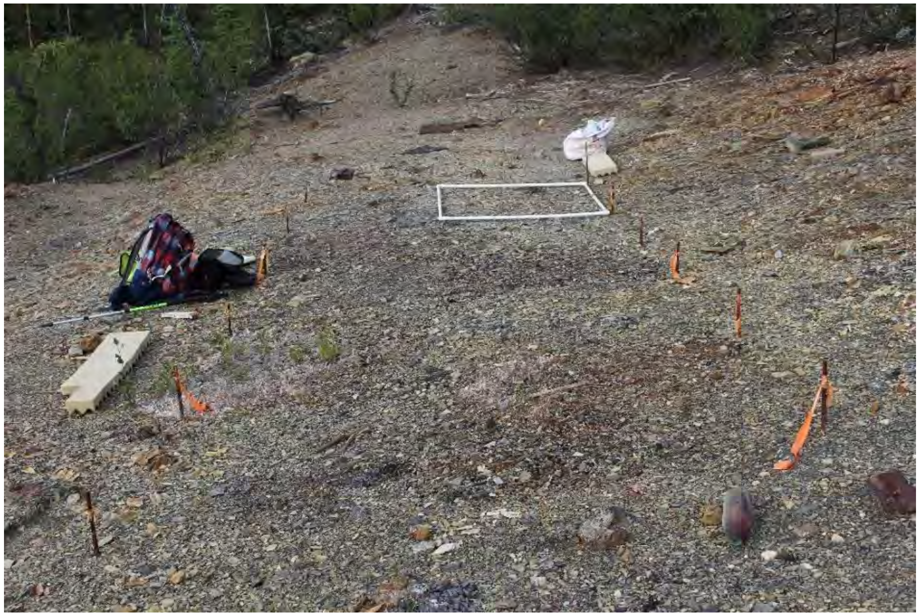


Photo #73: Waste Rock, Block #3, July 2018.

Photo #74: Waste Rock, Plot 3-4, July 2013.

Photo #75: Waste Rock, Plot #3-4, August 2014. Note mature grass.

Photo #76: Waste Rock, Plot #3-4, August 2015.

Photo #77: Waste Rock, Plot #3-4, July 2016. Young willow in plot.

Photo #78: Waste Rock, Plot #3-4, August 2017.

Photo #79: Waste Rock, Plot #3-4, July 2018.

Photo #80: Waste Rock, willows and dwarf birch in Plot 3-4, July 2018.

Photo #81: Necrosis on leaf edges on several alder at Waste Rock, Plot 2-3, July 2018.

APPENDIX C

VEGETATION DATA

- **TABLE C-1**
- **TABLE C-2**
- **TABLE C-3**
- **TABLE C-4**
- **TABLE C-5**
- **TABLE C-6**
- **ALS Lab Work Order #: L2139940, 2018**

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #1

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
1-1A	Jul-13	<1	sparse scraggly grass growth 1 hedysarum	stressed	a few shoots deep in gravel
	Sep-13	<1	unidentifiable grass, mostly brown, 2-3 cm	stressed	some green growth
	Aug-14	0			no growth
	Aug-15	<1	4 alder	good	small, seem healthy
	Jul-16	<1	2 alder 3 dwarf birch, up to 4.5 cm	good	plants are small but appear healthy, no grass
	Aug-17	<1	5 dwarf birch, very small	good	no grass
	Jul-18	<1	1 dwarf birch, 5 cm 3 small alder, <1 cm	struggling stressed	no grass browning of leaves
1-2A	Jul-13	45 - 50	alpine bluegrass unidentifiable grass hedysarum, 7 plants	good	even grass cover
	Sep-13	50	alpine bluegrass < 2cm 2 other grass species up to 4cm alder < 1cm hedysarum, < 2cm	good	Signs of grazing.
	Aug-14	60	alpine bluegrass ticklegrass, max 30 cm sheep fescue, max 30 cm alder, 13 plants	good	lots of tufts of unidentifiable grass 5 - 7 cm tall
	Aug-15	40	alpine bluegrass tickle grass unidentified grasses 12 alder	good	grass shows signs of grazing
	Jul-16	60	unidentified grasses, some possible immature hairgrass alpine bluegrass tickle grass spike trisetum, some in seed sheep fescue 12 alder, robust growth up to 21 cm	good	some accumulated leaf litter, a few small mushrooms present.
	Aug-17	40	Fescue, several mature and producing seed, dominant tufted harigrass, 1 is mature alpine bluegrass ticklegrass spike trisetum, 1 is mature 10 alder , robust growth unidentified small forbs	good	lots of leaf litter and last year's grasses.
	Jul-18	65	alpine bluegrass, 9 cm mature sheep fescue, 33 cm mature tufted hairgrass, 35 cm unidentified grasses, 23, 27 cm 12 alder, 43.5, 65.5, 76 and 58 cm moss	good	all plants look healthy lots of leaf litter - both alder and grasses
1-3	Jul-13	40	alpine bluegrass unidentified grasses hedysarum, 8 plants alder, 3 plants	good	most robust growth in Block #1
	Sep-13	50 - 60	alpine bluegrass, dominant species, < 3cm 3 other grass species up to 5 cm alder, <2 cm hedysarum, < 2cm	good	Signs of grazing.
	Aug-14	70	ticklegrass, max 30 cm, more mature plants than 1-2A alpine bluegrass, avg 4 cm alder, 8 plants sheep fescue, max 22 cm, 1 mature plant	good	Lots of tufts of unidentifiable grass 5 - 6 cm tall. Signs of grazing.
	Aug-15	50	alpine bluegrass tickle grass unidentified grasses 20 alder	good	alders growing significantly Signs of grazing. alder leaf litter
	Jul-16	70	unidentified grasses alpine bluegrass tickle grass spike trisetum sheep fescue tufted hairgrass, 1 in seed, 50.5 cm 1 willow 24 alder, some heights: 30 cm, 21.5 cm, 18.5 cm	good	lots of leaf litter plants look healthy
	Aug-17	60	Fescue, several mature, dominant alpine bluegrass tickle grass 25 alder - robust unidentifed small forbs	good	all plants appear healthy lots of leaf litter % cover includes leaf litter,
	Jul-18	80	alpine bluegrass, 42.5, 38 cm sheep fescue, 52, 48, 56 cm spike trisetum, 27, 40 cm tufted hairgrass, 33.5 cm 25 alder, 50.5, 87, 78, 67, 71 volunteer willow	good	all species of grasses had mature specimens, healthy growth

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
1-1B	Jul-13	<5	unidentified grass hedysarum, 4 plants alder, 1 plant	stressed	but some green growth
	Sep-13	<5	brown grasses, 2 - 4 cm hedysarum	stressed	
	Aug-14	<1	hedysarum, 1 plant	stressed	dead grass from last year
	Aug-15	<1	alder unidentified grasses	stressed	alder stunted
	Jul-16	<1	8 alder, all ≤ 1 cm		1 dwarf birch just ouside plot
	Aug-17	1	14 alder 1 spruce seedling	good	no grasses
	Jul-18	2	ticklegrass, 20.5 cm 20 alder, 4.5 cm 1 spruce seedling lichen moss,	fairly healthy	all alder were very small
1-2B	Jul-13	35	alpine bluegrass unidentified grasses hedysarum alder	good	even coverage of plot
	Sep-13	45	alpine bluegrass, 2 - 3 cm 3 other grass species, 2 - 4 cm alder, < 1cm	good	Signs of grazing. scat in plot
	Aug-14	60	tickle grass, many mature, max 38 cm alpine bluegrass, 3-4 cm, not as many as 1-3 alder, 4 plants some small hedysarum	good	Several tufts of unidentifiable grass. Alder leaf litter from near by.
	Aug-15	45	alpine bluegrass tickle grass unidentified grasses 20 alder	good	Signs of grazing. rabbit scat leaf litter 1 juvenile willow
	Jul-16	55	unidentified grasses tickle grass alpine bluegrass sheep fescue 51 alder, up to 8 cm 7 Salix spp		small black bugs on some plants
	Aug-17	60	alpine bluegrass, some mature, dominant grass ticklegrass tufted harigrass, 1 is mature 48 alder 1 spruce seedling a few willow seedlings	good	even coverage of plot lots of leaf litter
	Jul-18	80	sheep fescue, 73, 49, 45 cm tufted hairgrass, 31, 36, 33 cm alpine bluegrass, immature, 11.5, 13, 16 cm >40 alder, 52, 49, 35, 55, 54 cm several volunteer willow, 13, 11 cm spruce seedling moss		lots of alder leaf litter

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #2

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-3A	Jul-13	25 - 30	unidentified grasses alder, 2 plants hedysarum, 1 plant	good	Buffer plot above 2-3A and beside 2-1A has 14 alder and 1 labrador tea.
	Sep-13	35	alpine bluegrass, <2cm 3 other species of grass alder	good	Signs of grazing. Rabbit pellet spruce seedling
	Aug-14	45	spiked trisetum, 2 mature, up to 27 cms sheep fescue, 5 mature, up to 27 cm alpine bluegrass, <2cm lots of tufts of unidentified grasses alder, 6 plants	good	1 possible volunteer blueberry plant in plot
	Aug-15	40	alpine bluegrass spiked trisetum sheep fescue 6 alder	good	blueberry plant on edge of plot, 2 willow spp, 1 labrador tea in plot
	Jul-16	30	alpine bluegrass sheep fescue 2 alder, one large 53 cm, robust growth 11 dwarf birch 20 Salix spp	somewhat stressed	1 small spruce in plot 3 probable paper birch blueberry on plot edge
	Aug-17	35	unidentified stressed grasses are dominant grass alpine bluegrass, none mature 4 alder, up to 80 cm labrador tea willow seedlings blueberry several dwarf birch moss spruce seedling	grasses - poor others - good	The grasses are stressed but the alders and the volunteer plants are healthy.
	Jul-18	80	1 large alder, 122 cm, ~ a dozen small alder several willow, 18, 12 cm dwarf birch 32 cm labrador tea blueberry, 5.5 cm spike trisetum - sparse growth alpine bluegrass fescue, very small spruce, 12 cm moss	good	large alder has cones
2-1A	Jul-13	<5	sparse straggly grass shoots alder, 3 plants	stressed	
	Sep-13	<5	2 grasses, 2 - 3 cm hedysarum, 1 plant alder	stressed	Most grasses were brown
	Aug-14	<1	small grasses alder, 3 plants	stressed	1 labrador tea in plot
	Aug-15	<1	alder unidentified grass species	stressed	1 labrador tea in plot 1 spruce and willow
	Jul-16	<1	a few unidentified blades of grass 9 dwarf birch subalpine fir Salix spruce	stressed	all plants very small
	Aug-17	<5	labrador tea dwarf birch blueberry spruce seedlings small tufts of dead grass from previous years	good	no grasses, all volunteer plants in plot
	Jul-18	1 to 2	1 alder, 17 cm 19 dwarf birch 4 spruce seedlings	good	

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-2	Jul-13	40	alpine bluegrass unidentified grasses	good	even distribution
	Sep-13	45	alpine bluegrass, 2 cm unidentified grass species up to 5 cm	good	
	Aug-14	50	sheep fescue, several mature, up to 25 cm lots of immature alpine bluegrass, <3 cm spiked trisetum, 3 mature, up to 15 cms tickle grass, 1 mature, up to 23 cm alder, 2 plants	good	good healthy coverage see Photo #23
	Aug-15	45	alpine bluegrass spiked trisetum sheep fescue alder	good	4 willow spp 1 labrador tea in plot
	Jul-16	45	sheep fescue, up to 46 cm alpine bluegrass spike trisetum 2 alder, one large 73 cm 12 Salix spp dwarf birch spruce	good	1 blueberry plant in plot 1 labrador tea below plot
	Aug-17	50	fescue, several mature alpine bluegrass 1 large alder - 130 cm, also small ones labrador tea blueberry spruce seedling	good	some leaf litter
	Jul-18	95	1 giant alder, 189 cm labrador tea dwarf birch several small willow, 4.5 cm fescue, 48 cm moss		the large alder takes up almost the whole plot, has cones (see Photos #27 & 28)
2-3B	Jul-13	20	unidentified tufts of grasses hedysarum, 1 plant	good	
	Sep-13	30	alpine bluegrass, 2 cm 2 species of grass, <4 cm hedysarum	good	Tiny capped mushrooms in plot.
	Aug-14	40	tickle grass, 2 plants up to 20 cm alpine bluegrass, 1 mature, up to 10 cm several tufts of unknown grasses alder, 1 plant	good	2 alders growing just outside of plot
	Aug-15	35	alpine bluegrass spiked trisetum sheep fescue alder	good	1 spruce seedling in plot labrador tea and willow spp
	Jul-16	25	sheep fescue, up to 23.5 cm alpine bluegrass spike trisetum, up to 19 cm unidentified grasses dwarf birch, 19.5 cm 9 Salix spp 4 labrador tea	good	many small shrubs growing in the neighbouring buffer plot (dwarf birch, salix, labrador tea) and 3 paper birch and 3 spruce
	Aug-17	25	unidentified tufts of grasses alpine bluegrass several willow seedlings labrador tea dwarf birch spruce seedling	fair	leaf litter from grasses
	Jul-18	5	dwarf birch, 27.5, 13 cm willows 11, 11, 8.5, 6 cm labrador tea mostly dead grasses moss	volunteer plants appear healthy	very different from 2-3A even tho they both have the same amendments
2-1B	Jul-13	<5	a few blades of unidentified grass hedysarum, 1 plant	stressed	1 spruce seedling in plot
	Sep-13	5	unidentified grass, 3 - 4 cm alder, <1 cm, 4 plants	stressed	most grasses are brown
	Aug-14	<1	quite a bit of dead grass - didn't survive alder, 3 plants	stressed	possible 3 willows in plot
	Aug-15	<1	alder	stressed	willow spp in plot
	Jul-16	1 to 5	unidentified grasses 4 Salix spp 8 dwarf birch 1 paper birch	stressed shrubs fairly healthy	
	Aug-17	1	a few blades of unidentified grass dwarf birch willow seedlings labrador tea spruce seedling	grasses - poor others - good	only 1 tuft of spindly grass volunteer shrubs doing well
	Jul-18	2 to 3	18 dwarf birch, 3.5, 19 cm 5 labrador tea, 8, 12 cm 2 willow, 12, 8 cm spruce	good	volunteer plants are small but healthy

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #3

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
3-2A	Jul-13	40	unidentified tufts of grass - lots alpine bluegrass, alder, 1 plant hedysarum, 2 plants	good	robust healthy plot
	Sep-13	40	alpine bluegrass, 2 cm 2 other grass species, <4 cm hedysarum, <1 cm alder, <1 cm	good	Sign of grazing. Some moss in plot
	Aug-14	60	tufted hairgrass, 4 mature plants, up to 70 cm ticklegrass, mature up to 35 cm sheep fescue, mature up to 35 cm spiked trisetum, mature up to 33 cm alpine bluegrass, lots of immature, < 3cm alder, 1 plant	good	4 volunteer willow in plot, very diverse plot, has the most mature plants
	Aug-15	50	tufted hairgrass sheep fescue alpine bluegrass spiked trisetum tickle grass alder	good	lots of moss, clover willow
	Jul-16	70*	unidentified grasses tickle grass tufted hairgrass alpine bluegrass (only a few plants) 5 alder, tallest 71 cm 11 Salix spp 5 dwarf birch	grasses are stressed other plants appear healthy	lots of moss, large tuft of alsike clover
	Aug-17	65	unhealthy grasses likely fescue - dominant grass alpine bluegrass, immature ticklegrass, mature 1 large alder, 118 cm 3 smaller alder willow labrador tea dwarf birch 1 large tuft of alsike clover moss	poor to good	most plants appear robust and healthy
	Jul-18	65 to 70	alder, 80, 82, 173, 13 cm alsike clover willows, 3 cm fescue spruce seedling dwarf birch, 5 cm	grass - poor others - good	alsike colver is dying back due to shading from the growing alder caterpillar in plot rabbit pellet in plot
3-3A	Jul-13	35	unidentified tufts of grass - lots tufted hairgrass, 1 mature plant	good	
	Sep-13	40	tufted hairgrass, mature, up to 30 cm alpine bluegrass, 2 cm other grasses, 3 cm alder	good	Sign of grazing.
	Aug-14	50	tufted hairgrass, mature, up to 42 cm ticklegrass, mature up to 36 cm sheep fescue, mature up to 30 cm spiked trisetum, mature up to 20 cm alpine bluegrass, lots of immature, 2 - 4 cm alder, 4	good	1 willow in plot
	Aug-15	40	tufted hairgrass alpine bluegrass spiked trisetum sheep fescue tickle grass alder	good	willow lots of moss, 1 mushroom
	Jul-16	65	unidentified grasses tickle grass sheep fescue alpine bluegrass 7 alder up to 37 cm 8 Salix spp 1 possible Hedysarum plant	good	Some moss in plot
	Aug-19	50	tufted hairgrass, mature ticklegrass, mature alpine bluegrass Calamagrotis canadensis, mature fescues, mature 7 alder up to 88 cm dwarf birch willows, labrador tea spruce	good	good biodiversity healthy growth of all plants
	Jul-18	80	alder, 134, 95, 63 cm spike trisetum, 19, 24 cm trufted hairgrass, 19, 26 cm willow, 15, 9, 5.5 cm spruce seedlings moss	good	

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
3-1	Jul-13	5	sparse unhealthy unidentified grass	stressed	in upper right corner only
	Sep-13	5 - 10	unidentified grass, <3 cm alder, <1 cm	stressed	grass is brown
	Aug-14	<5	sheep fescue, immature - small but healthy ticklegrass, 1 mature, 10 cm alder, 10 plants, very small	good	1 labrador tea and 1 tiny spruce seedling in plot, one fairly large aspen growing downhill of plot
	Aug-15	5	tickle grass unidentified grass species alder	good	1 labrador tea 1 willow
	Jul-16	5	unidentified grasses tickle grass alder 8 dwarf birch 2 small spruce		small amount of moss 1 very small blueberry labrador tea
	Aug-17	5 to 10	sparse unhealthy fescue 1 ticklegrass dwarf birch labrador tea willow spruce moss	grasses - poor others - good	grasses appear somewhat stressed, volunteer plants appear to be doing well
	Jul-18	3 to 5	3 alder, 7, 10, 17 cm dwarf birch 5, 4 cm tufted harigrass, 27, 25, 17 cm spruce seedlings, 3 cm labrador tea, 5 cm willow, 6.5, 4.5 cm	grasses - fair others - good	
3-2B	Jul-13	20	unidentified small tufts of grasses alpine bluegrass alder, 3 plants hedysarum, 5 plants	good	
	Sep-13	30	alder, <2cm, 12 plants alpine bluegrass, < 2cm unidentified grass, < 4cm hedysarum, < 2cm	partially stressed	But lots of green healthy plants.
	Aug-14	40	tickle grass up to 15 cm alpine bluegrass unidentified immature grasses alder, approx 20	good	1 willow growing in plot
	Aug-15	35	sheep fescue spiked trisetum alpine bluegrass tickle grass unidentified grasses alder	good	willow, clover in flower
	Jul-16	45	unidentified grasses (may be some sheep fescue) alpine bluegrass tickle grass tufted hairgrass, 40.5 cm 11 alder 13 dwarf birch 7 Salix spp	overall good but some grasses appear slightly stressed	some moss signs of grazing on upper leaves of alder alsike clover in plot 2 paper birch
	Aug-17	40	struggling fescue alpine bluegrass 9 robust alder up to 80 cm willows, spruce seedlings moss dwarf birch	fair to good	the fescues appear somewhat stressed. alders appear very healthy
	Jul-18	75	alder, 26, 120, 139, 94 cm dwarf birch, 21, 8.5 cm willow, 6.5 cm spruce seedling mostly dead grasses - unidentified moss	grasses - poor others - good	alders have grown quite a bit since the previous year - see Photo #39. Alder has nitrogen nodule on root, see Photo #40
3-3B	Jul-13	10 - 15	small tufts of unidentified grasses alpine bluegrass alder, 5 plants hedysarum, 1 plant	fairly good	possible willow in plot
	Sep-13	15 - 20	alpine bluegrass, < 1cm unidentified grass, < 3cm alder, < 1cm hedysarum, < 2cm	good	plants appear healthy although small
	Aug-14	30	unidentified tufts of grass - several alpine bluegrass, immature alder, 9 plants	good	no mature grasses 1 spruce in plot 1 willow in plot
	Aug-15	25	spiked trisetum alpine bluegrass unidentified grasses alder	good	1 spruce seedling willow lots of moss,
	Jul-16	5 to 10	unidentified grasses alpine bluegrass, a few plants 5 alder 8 dwarf birch 5 Salix spp 1 spruce	grasses are stressed other plants appear healthy	lots of moss, not included in cover estimate.
	Aug-17	20	alpine bluegrass fescues 6 alder up to 44 cm dwarf birch willows spruce moss	stressed to healthy	all grasses appear to be struggling, however the grasses growing near the alder appear more healthy. Alder and volunteer plants appear healthy
	Jul-18	45	7 alder, 67, 76, 49 cm dwarf birch, 14, 28, 13, 6.5 cm willow, 9, 4.5, 6 cm grass - mostly dead moss - lots (approx 85 % cover if moss included)	grass - poor others - good	many small dwarf birch sprouting

* = includes moss cover, without moss, approximately 35 % cover

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #1

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
1-1	Jul-13	0			bare plot
	Sep-13	<1	1 blade of unidentifiable grass	stressed	bare plot
	Aug-14	0			bare plot, moist soil
	Aug-15	0			bare plot
	Jul-16	0			bare plot
	Aug-17	0			bare plot
	Jul-18	0			bare plot, ants in plot
1-2	Jul-13	40 - 50	2 species of grass - unidentified alder, 8 plants hedysarum, 2 plants	good	tallest and most robust growth of all plots in block
	Sep-13	60 - 65	tickle grass, some in seed, max 30 cm glaucous bluegrass up to 12 cm sheep fescue (?), 8 cm alder < 1cm hedysarum, < 2cm	good	green healthy growth, signs of grazing
	Aug-14	70	tufted hairgrass, 2 plants up to 40 cm ticklegrass, many plants, avg 35 cm sheep fescue, 3 mature plants, max 35 to 40 cm alder, 7 plants	good	even coverage of plot, 1 willow in plot
	Aug-15	55	tufted hairgrass glaucous bluegrass tickle grass sheep fescue alder	good	willow in plot
	Jul-16	50	unidentified grasses tickle grass sheep fescue tufted hairgrass glaucous bluegrass 5 alders up to 34.5 cm 10 Salix spp	good	some moss lady bug in plot
	Aug-17	50	fescue, some mature 15 alder up to 61 cm spruce willows	stressed to good	mostly dead or stressed grasses, trees are healthy
	Jul-18	50 - 60	6 large alder; heights: 71, 97, 90, 20, 13 cm willows; heights: 15, 9, 4 cm spruce sapling, 12 cm fescue, some mature; 38, 42, 25 cm unidentified grass moss	good some grasses are stressed	several small alder herbivory on one willow nitrogen nodule on alder root - see Photo #55. lots of dead grass ant in plot
1-3	Jul-13	15 - 20	small tufts of unidentified grass alder, 2 plants - very small	good	
	Sep-13	30 - 35	glaucous bluegrass up to 8 cm unidentified grass up to 10 cm alder, <1 cm	good	sporadic cover
	Aug-14	40	ticklegrass, max 35 cm alder, 1 plant	fairly good	uneven distribution, bare sections
	Aug-15	15	tickle grass tufted hairgrass unidentified grasses alder	some grasses are stressed	
	Jul-16	5	ticklegrass unidentified tufts of stressed grasses 2 alders up to 11.5 cm	stressed	
	Aug-17	5	live grasses growing next to alders only 2 alder plants - healthy small dwarf birch	stressed to good	lots of dead or stressed grasses
	Jul-18	~10	3 alder plants	nodule on alder root	dead grasses in plot

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
1-4	Jul-13	10 - 15	small tufts of unidentified grass, at least 2 species	fairly good	
	Sep-13	30 - 35	glaucous bluegrass up to 8 cm unidentified grass up to 4 cm alder, <1 cm	partially stressed	
	Aug-14	50	ticklegrass, many mature plants, up to 30 cm sheep fescue, a few plants, up to 15 cm alder, 5 plants	good	uneven distribution
	Aug-15	20	tickle grass glaucous bluegrass alder	good	willow in plot
	Jul-16	15 to 20	unidentified grasses glaucous bluegrass ticklegrass 13 alder 22 Salix spp 3 spruce	grasses appear somewhat stressed, others appear healthy	herbivory on the alders and on some grasses
	Aug-17	40	fescue, several in seed alders up to 68 cm willows - healthy and growing spruce - growing	good	
	Jul-18	75	alder; heights: 84, 72, 88, 27 cm felt leaf willow; 32, 34 cm another willow species; 34, 30, 15, 12 cm spruce; 28 cm paper birch; 38 cm grass	good	all plants are healthy except for the grasses - only a few green blades and none were mature Some willows had insect damage Seed cones on alder, Photo #54
1-5	Jul-13	5	sparse short growth of grasses	stressed	
	Sep-13	50	glaucous bluegrass, 4 cm tickle grass up to 3 cm unidentified grass up to 4 cm alder, < 2cm hedysarum	good	Signs of grazing. even coverage of growth
	Aug-14	60	tickle grass, mature, max 25 cm immature glaucous bluegrass immature grass - may be sheep fescue alder, 2 plants	good	Several tufts of unidentifiable grass. Photo #48.
	Aug-15	45	sheep fescue tickle grass glaucous bluegrass alpine bluegrass alders	good	willows
	Jul-16	30	unidentified grasses ticklegrass sheep fescue glaucous bluegrass 5 alders up to 61.5 cm 16 Salix spp	grasses appear somewhat stressed, shrubs appear healthy	
	Aug-17	30	ticklegrass - immature fescue 4 large alder up to 111 cm small willow seedlings	fair to good	lots of grass litter grasses appear stressed
	Jul-18	65 - 70	alder; 122, 98, 68, 97 cm fescue; 31, 29 cm spruce seedling willow 8, 6, 8 cm paper birch moss	good	1 of the alders had produced cones previous year's grass litter

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #2

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-1	Jul-13	0	no sign of any growth		bare plot
	Sep-13	0	no sign of any growth		bare plot
	Aug-14	0	no sign of any growth		bare plot
	Aug-15	0	no sign of any growth		bare plot
	Jul-16	0	no sign of any growth		bare plot
	Aug-17	0	no sign of any growth		bare plot, moose tracks in plot
	Jul-18	0	no sign of any growth		bare plot
2-2	Jul-13	35	unidentified tufts of grass - healthy alder, 1 plant, very small hedysarum, 2 plants	good	coverage mostly on east half
	Sep-13	50	ticklegrass up to 16 cm sheep fescue up to 12 cm glaucous bluegrass up to 8 cm alder hedysarum,	good	growth covers most of the eastern half of plot
	Aug-14	60	ticklegrass, mature, max 30 cm alder, 7 plants volunteer willow, 6 plants volunteer spruce, 2 plants	good	growth covers most of the eastern half of plot
	Aug-15	60	tickle grass glaucous bluegrass unidentified grasses alders	good	healthy alder growth, many juvenile willow plants, 2 spruce seedlings, leaf litter
	Jul-16	40	ticklegrass unidentified grasses 51 alder up to 34 cm, many small 16 Salix spp 2 spruce 1 subalpine fir	good	moose had walked thru Block leaf litter blue bug on alder leaf
	Aug-17	60	ticklegrass, mature plants immature fescue many alder of various sizes 2 spruce seedlings willows	good	grass leaf litter coverage mostly on east half
	Jul-18	85	alder; heights: 45, 76, 63, 26, 95 cm 7 spruce	good	some alder leaves have brown edges and some alders have no leaves on the top of the stem - possible defoliation
2-3	Jul-13	45	unidentified tufts of grass - healthy alder, 9 plants	good	more even coverage
	Sep-13	60	ticklegrass up to 11 cm glaucous bluegrass up to 11 cm alder, several small seedlings	good	even cover of plot
	Aug-14	60	ticklegrass, max 38 cm immature sheep fescue alder, >20 plants	good	even distribution
	Aug-15	60	tickle grass unidentified grasses many alder	good	healthy alder growth willow in plot
	Jul-16	40	ticklegrass unidentified grasses many alder, more than in 2-2, up to 36 cm 6 Salix spp 3 paper birch		
	Aug-17	60	numerous alder 5 paper birch 3 spruce willows	good	some of the alder appear to have suffered from browsers and/or defoliators
	Jul-18	60 - 65	alder; 94, 31, 92, 48, 31 cm paper birch; 45, 21 cm	good	some alders have necrosis on some of their leaves, see Photo #81

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-4	Jul-13	50	unidentified tufts of 2 to 3 species of grass - healthy glaucous bluegrass alder, 1 plant	good	even growth on plot
	Sep-13	60	glaucous bluegrass up to 8 cm sheep fescue up to 4 cm ticklegrass up to 3 cm alder, <1 cm	good	even cover of plot
	Aug-14	60	sheep fescue, several mature immature glaucous bluegrass, up to 15 cm alder, 15 plants	good	even distribution 1 volunteer willow plant see Photo #63
	Aug-15	70	tufted hairgrass tickle grass sheep fescue glaucous bluegrass many alder	good	healthy alder growth willow in plot
	Jul-16	80	glaucous bluegrass ticklegrass lots of alder 2 Salix spp 2 spruce 1 paper birch	good	lush growth
	Aug-17	90	tufted hairgrass, several in flower fescue, some mature ticlegrass numerous alder - thick growth willows	good	some of the alder seem to have suffered as in Plot 2-3 (2017)
	Jul-18	95	numerous alder; 45, 103, 82, 94 cm fescue - mature tufted hairgrass mature	good	no leaf disease on alder but tops of stems appear to be stripped by a grazer - Photos #66 & 67
2-5	Jul-13	30	unidentified tufts of grass - healthy hedysarum, 2 plants	good	
	Sep-13	40 - 50	tickle grass up to 30 cm glaucous bluegrass up to 13 cm alder, < 1cm	good	even cover of plot, less robust growth than plot 2-4
	Aug-14	50	tickle grass, many mature, up to 30 cm sheep fescue, several, up to 25 cm alder, 8 plants	good	
	Aug-15	50	ticklegrass glaucous bluegrass unidentified grasses	good	willows in plot
	Jul-16	30	unidentified grasses glaucous bluegrass - couple of plants 16 alder 3 Salix spp 1 paper birch	grasses appear stressed, others look healthy	
	Aug-17	75	numerous alder unhealthy fescue willows spruce seedlings	fair to good	some of the alder seem to have suffered as in Plot 2-3 (2017)
	Jul-18	99	numerous alder some willow dead grass	good	some alders have stripped stems as in Plot 2-4 (2018)

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #3

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
3-1	Jul-13	0	no growth		bare plot
	Sep-13	0	no growth		bare, moist plot
	Aug-14	0	no growth		moose track in plot
	Aug-15	0	no growth		
	Jul-16	0	no growth		bare plot
	Aug-17	0	no growth		bare plot
	Jul-18	0	no growth		old moose prints in bare plot
3-2	Jul-13	30	unidentified tufts of grass alder, 5 plants	partially stressed	growth localized, plants appear stressed on right side
	Sep-13	30	ticklegrass, lots in seed, up to 35 cm glaucous bluegrass up to 8 cm	partially stressed	
	Aug-14	20	ticklegrass, mature, max 33 cm sheep fescue, several mature, max 15 cm	partially stressed	half of plot is bare
	Aug-15	10	tickle grass glaucous bluegrass	stressed	
	Jul-16	<5	ticklegrass glaucous bluegrass	stressed	
	Aug-17	0	no live growth		only dead plant material from previous years
	Jul-18	0	no live growth		only dead plant material from
					previous years
3-3	Jul-13	5	sparse stressed grass growth	stressed	
	Sep-13	5 - 10	unidentified grass up to 5 cm	stressed	
	Aug-14	0	dead grasses from last year's growth	stressed	
	Aug-15	0	no growth		
	Jul-16	0	no growth		
	Aug-17	0	no growth		bare plot
	Jul-18	0	no growth		bare plot
3-4	Jul-13	40 - 50	many tufts of healthy unidentified grasses	good	good growth in lower half
	Sep-13	50	tickle grass, some in seed, up to 4 cm sheep fescue (?), 7 cm glaucous bluegrass, up to 2 cm	good	
	Aug-14	35	ticklegrass, up to 35 cm tufted hairgrass, 1 mature plant, up to 40 cm sheep fescue, 1 mature plant, up to 34 cm	good	healthiest plot in Block #3 see Photo #74
	Aug-15	25	tufted hairgrass tickle grass sheep fescue glaucous bluegrass	good	willow in plot
	Jul-16	15	unidentified grasses glaucous bluegrass ticklegrass tufted hairgass 4 Salix spp 2 dwarf birch	grasses stressed	
	Aug-17	5	1 ticklegrass in seed 1 tuft of glaucous bluegrass 2 alder a few willows small dwarf birch small tufts of fescue	fair to stressed	
	Jul-18	2	several willow; 7, 12, 13, 8, 11, 15.5 cm alder; 4 cm paper birch; 15 cm ticklegrass; 31, 19 cm, mature dwarf birch; 5.5 cm	healthy	See Photo #80
3-5	Jul-13	<10	unidentified grasses	partially stressed	some tufts quite healthy
	Sep-13	10 - 15	glaucous bluegrass, < 2 cm unidentified grass up to 3 cm	stressed	most plants are brown
	Aug-14	<10	tickle grass, a few mature and immature, up to 25 cm glaucous bluegrass, 1 mature, 25 cm stressed stunted grasses dead grass from last year	stressed	good soil moisture
	Aug-15	10	tickle grass	good	
	Jul-16	<5	glaucous bluegrass unidentified grasses	stressed	
	Aug-17	<5	glaucous bluegrass, mature ticklegrass, mature	fair	
	Jul-18	1	a few tufts of ticklegrass; 29, 19 cm	fair	some mature

NOTE: stressed = brown or withered plants
good = green plants showing vigor

TABLE C-3 SPECIES DOCUMENTED AT THE PLOTS		
	Common Name	**Scientific Name**
Planted	Sheep fescue	*Festuca ovina*
	Tufted hairgrass	*Deschampsia caespitosa*
	Glaucous bluegrass	*Poa glauca*
	Alpine bluegrass	*Poa alpina*
	Tickle grass	*Agrostis scabra*
	Spike Trisetum	*Trisetum spicatum*
	Bear root	*Hedysarum alpinum*
	Alder	*Alnus viridus*
Volunteer	Willow	*Salix* spp
	Dwarf birch	*Betula glandulosa*
	Labrador Tea	*Rhododendron groenlandicum*
	Blueberry	*Vaccinium uliginosum*
	White spruce	*Picea glauca*
	Alaska birch	*Betula neoalaskana*
	Alsike clover	*Trifolium hybridum*
	Bluejoint grass	*Calamagrotis canadensis*

TABLE C-4 ROOT LENGTH OF RANDOMLY SELECTED PLANTS			
Site	**Plot #**	**Species**	**Root Length (cm)**
Trench	1-3A	Alpine Bluegrass	7
	1-3A	Alder	9
	1-1B	Alder	7
	1-2B	Sheep Fescue	8
	1-2B	Alpine Bluegrass	6
	1-2B	Alder	7
	2-1A	Alder	9
	2-1A	Dwarf birch	6
	2-2	Alder	8
	2-2	Willow	7
	2-1B	Dwarf birch	7
	2-1B	Dwarf birch	8
	3-2A	Alder	6
Waste Rock Dump	1-2	Willow	9
	1-3	Alder	8
	1-3	Alder	9
	1-5	Willow	4
	2-2	Alder	18
	2-3	Alder	7
	2-4	Alder	7
	2-5	Alder	3
	2-5	Alder	7

TABLE C-5 METAL CONCENTRATIONS (mg/kg) IN FOLIAR TISSUES AT THE TRENCH SITE, 2018

Plot #	T1-1B	T1-2AB	T1-2AB	T1-3	T1-3	T2-2	T2-2	T2-3A	T2-3A	T3-2AB	T3-2AB	T3-3AB	T3-3AB	Range
Species	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	
Tissue Type	Leaves and stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	
Aluminum (Al)-Total	33.5	14.3	12.1	10.0	4.8	20.0	5.2	8.2	<2.0	37.2	9.6	18.8	6.5	4.8 to 37.2
Antimony (Sb)-Total	5.59	1.16	0.963	0.471	1.32	0.127	0.050	0.117	0.044	2.48	0.709	0.391	0.337	0.044 to 5.590
Arsenic (As)-Total	17.0	4.02	2.88	3.40	3.07	1.37	0.626	0.571	0.411	4.09	1.53	1.54	1.31	0.41 to 17.00
Barium (Ba)-Total	39.5	4.61	12.8	5.60	10.5	37.2	62.5	28.2	58.9	36.2	79.1	22.3	71.0	4.6 to 79.1
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	ND to ND
Bismuth (Bi)-Total	0.219	0.058	0.044	0.014	0.072	0.020	<0.010	<0.010	<0.010	0.173	0.060	0.028	0.026	0.014 to 0.219
Boron (B)-Total	7.7	5.5	8.3	7.3	7.7	7.8	10.4	9.4	12.0	4.9	6.0	6.6	7.0	4.9 to 12.0
Cadmium (Cd)-Total	<0.010	0.0052	0.0163	<0.0050	0.0055	<0.0050	0.0163	<0.0050	0.0097	0.0062	0.0111	<0.0050	0.0120	ND to 0.016
Calcium (Ca)-Total	11000	7370	5170	10600	6710	7470	6020	6860	5690	5790	5120	6320	6160	5120 to 11000
Cesium (Cs)-Total	0.136	0.0957	0.258	0.149	0.176	0.330	0.225	0.161	0.104	0.379	0.191	0.159	0.145	0.10 to 0.38
Chromium (Cr)-Total	0.22	<0.050	0.060	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	ND to 0.22
Cobalt (Co)-Total	0.121	0.058	0.030	0.065	<0.020	0.100	0.065	0.054	0.034	0.334	0.132	0.180	0.105	0.03 to 0.33
Copper (Cu)-Total	6.54	6.03	6.12	4.34	5.20	9.61	9.16	7.03	7.85	9.51	7.94	6.75	7.16	4.34 to 9.61
Iron (Fe)-Total	222	64.5	42.6	47.2	26.3	71.6	35.9	68.2	42.6	75.9	37.5	65.7	40.2	26.30 to 222.00
Lead (Pb)-Total	48.0	7.39	5.28	2.46	4.43	11.5	8.24	5.15	5.85	18.5	15.1	9.35	9.09	2.46 to 48.00
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	ND to ND
Magnesium (Mg)-Total	2430	1670	983	1660	780	2170	1230	1960	1290	1930	1100	1940	1080	780 to 2430
Manganese (Mn)-Total	214	42.3	71.2	64.2	74.2	44.9	44.0	30.7	35.3	72.7	101	66.3	97.0	30.7 to 214.0
Mercury (Hg)-Total	0.0067	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	ND to 0.0067
Molybdenum (Mo)-Total	3.71	4.34	6.40	8.51	6.59	1.15	1.73	2.16	3.82	1.98	4.74	3.97	3.38	1.15 to 8.51
Nickel (Ni)-Total	5.54	1.08	0.77	0.55	0.39	3.03	2.66	1.65	1.77	3.05	1.83	2.04	1.64	0.39 to 5.54
Phosphorus (P)-Total	938	2820	1980	2470	1450	2270	1780	2330	1770	2350	1530	2500	1560	938 to 2820
Potassium (K)-Total	7510	5850	5110	5330	4110	7080	6590	7970	7750	6000	4810	6600	4890	4110 to 7970
Rubidium (Rb)-Total	7.81	11.4	11.0	7.09	5.92	10.3	8.64	7.58	6.58	17.5	9.79	11.2	8.55	5.92 to 17.50
Selenium (Se)-Total	<0.10	<0.050	<0.050	<0.050	<0.050	0.241	0.124	0.242	0.116	0.054	<0.050	0.087	0.052	0.052 to 0.242
Sodium (Na)-Total	29	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	ND to 29.0
Strontium (Sr)-Total	44.0	18.0	20.5	22.7	22.8	52.1	60.7	37.2	49.3	23.5	30.0	21.7	34.5	18.0 to 60.7
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.0 to 0.0
Thallium (Tl)-Total	0.0060	0.0021	0.0052	0.0020	0.0058	<0.0020	0.0038	<0.0020	<0.0020	<0.0020	0.0053	<0.0020	0.0032	ND to 0.0060
Tin (Sn)-Total	0.21	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to 0.21
Uranium (U)-Total	0.0180	0.0023	0.0025	<0.0020	<0.0020	0.0092	<0.0020	0.0027	<0.0020	0.0026	<0.0020	<0.0020	<0.0020	ND to 0.0180
Vanadium (V)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to ND
Zinc (Zn)-Total	48.5	24.6	34.5	34.8	43.6	22.1	40.1	25.7	31.7	29.7	36.6	20.8	31.9	20.8 to 48.5
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	ND to ND

ND = not detected

TABLE C-6 METAL CONCENTRATIONS (mg/kg) IN FOLIAR TISSUES AT THE WASTE ROCK DUMP, 2018

Plot #	W1-2	W1-2	W1-3	W1-4	W1-4	W1-4	W1-5	W1-5	W2-2	W2-2	W2-3	W2-3	W2-4	W2-4	W2-5	W2-5	W3-4	Range
Species	Alder	Alder	Alder	Alder	Alder	Willow	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Several Species	
Tissue type	Leaves	Stems	Leaves and Stems	Leaves	Stems	Leaves and Stems	Leaves	Stems	Leaves	Stems	Leaves	Stem	Leaves	Stems	Leaves	Stems		
Aluminum (Al)-Total	27.8	6.9	82.6	14.9	5.1	11.0	13.7	3.8	48.3	7.7	40.7	5.9	22.6	3.5	8.7	3.4	40.8	3.4 to 82.6
Antimony (Sb)-Total	1.85	0.640	0.910	2.35	0.903	1.15	6.08	1.08	2.77	0.629	1.11	0.402	8.51	0.726	1.48	0.575	32.4	0.4 to 32.4
Arsenic (As)-Total	7.37	2.97	7.36	7.31	2.96	3.88	6.72	2.19	5.16	1.51	1.97	0.701	6.84	0.900	2.04	0.778	68.7	0.7 to 68.7
Barium (Ba)-Total	3.64	8.78	4.41	0.513	1.02	0.595	0.573	0.591	1.76	4.47	0.609	4.26	0.960	0.820	0.355	0.417	1.88	0.36 to 8.78
Beryllium (Be)-Total	<0.010	<0.010	0.019	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	ND to 0.01900
Bismuth (Bi)-Total	0.181	0.070	0.139	0.327	0.124	0.164	0.937	0.160	0.252	0.050	0.100	0.037	0.782	0.062	0.156	0.065	4.29	0.037 to 4.290
Boron (B)-Total	17.3	13.3	9.7	3.1	6.7	5.9	15.1	10.8	8.1	9.0	8.3	8.6	4.1	5.2	4.6	7.4	30.7	3.1 to 30.7
Cadmium (Cd)-Total	0.0200	0.166	0.0737	<0.0050	0.0136	2.14	0.0439	0.178	0.0080	0.0420	0.0091	0.0262	0.0088	0.0125	0.0079	0.0093	6.44	0.008 to 6.440
Calcium (Ca)-Total	6860	4550	3300	4790	3450	6030	10900	3670	3570	3430	1490	1930	7640	3140	8170	4120	9190	1490.0 to 10900.0
Cesium (Cs)-Total	0.254	0.148	0.777	1.05	0.578	0.0901	0.239	0.129	0.690	0.483	0.594	0.477	0.668	0.445	0.519	0.569	0.188	0.090 to 1.050
Chromium (Cr)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.082	<0.050	<0.050	<0.050	0.078	<0.050	<0.050	<0.050	0.099	0.078 to 0.099
Cobalt (Co)-Total	0.515	0.146	0.256	0.274	0.140	0.466	0.228	0.110	0.448	0.124	0.285	0.049	0.094	0.055	0.143	0.079	0.769	0.049 to 0.769
Copper (Cu)-Total	11.3	11.6	34.8	12.0	16.9	4.68	9.73	11.7	10.2	10.3	12.1	10.1	13.2	11.9	9.20	11.7	9.20	4.7 to 34.8
Iron (Fe)-Total	123	47.9	166	130	56.8	58.5	97.1	37.6	195	57.8	111	36.3	177	41.3	84.6	41.0	530	36.3 to 530.0
Lead (Pb)-Total	8.84	3.67	2.66	4.28	1.61	2.60	12.3	3.74	6.86	1.37	2.48	1.01	15.3	1.42	3.21	1.32	68.6	1.0 to 68.6
Lithium (Li)-Total	<0.50	<0.50	0.63	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	ND to 0.6
Magnesium (Mg)-Total	1900	689	791	2950	1180	4770	3920	942	734	426	930	706	3330	1160	3170	1080	4840	426.0 to 4840.0
Manganese (Mn)-Total	206	311	360	45.6	70.5	93.0	117	101	262	399	107	275	94.2	48.1	110	78.4	414	45.6 to 414.0
Mercury (Hg)-Total	0.0051	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0051	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0121	ND to 0.012
Molybdenum (Mo)-Total	1.05	1.88	2.22	1.81	5.78	0.049	4.52	5.81	0.158	0.946	0.297	1.73	2.52	3.16	4.48	5.19	1.15	0.05 to 5.810
Nickel (Ni)-Total	4.68	2.01	11.3	2.71	2.00	1.30	2.93	1.50	4.65	2.01	7.23	2.39	2.86	1.81	2.52	1.79	1.67	1.30 to 11.300
Phosphorus (P)-Total	2170	1390	1710	1570	1410	2340	2390	1570	1840	1230	1730	1130	2020	1550	2180	1600	3700	1130 to 3700
Potassium (K)-Total	4800	2650	3400	3130	2750	4400	3870	2830	4460	2670	4960	2850	4360	3530	4300	4020	7890	2650 to 7890
Rubidium (Rb)-Total	11.8	5.14	18.1	15.1	9.79	6.97	11.7	6.54	18.7	8.82	16.9	9.20	14.6	10.5	14.8	12.3	18.9	5.1 to 18.9
Selenium (Se)-Total	0.110	<0.050	<0.050	0.059	<0.050	0.067	0.159	<0.050	<0.050	<0.050	<0.050	<0.050	0.060	<0.050	0.117	<0.050	0.655	0.059 to 0.655
Sodium (Na)-Total	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	ND to ND
Strontium (Sr)-Total	14.6	17.5	8.47	1.86	2.29	2.70	7.92	4.52	7.53	13.4	2.78	9.95	5.46	3.10	2.29	1.62	8.04	1.62 to 17.50
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	ND to ND
Thallium (Tl)-Total	<0.0020	0.0022	0.0061	<0.0020	0.0053	<0.0020	0.0085	0.0162	<0.0020	0.0034	<0.0020	<0.0020	0.0026	0.0021	<0.0020	0.0025	0.0165	0.002 to 0.0165
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.59	ND to 0.590
Uranium (U)-Total	0.0049	<0.0020	0.0203	0.0074	<0.0020	<0.0020	0.0048	<0.0020	0.0072	<0.0020	0.0053	<0.0020	0.0084	<0.0020	0.0031	<0.0020	0.0313	ND to 0.0313
Vanadium (V)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to 0.110
Zinc (Zn)-Total	43.5	76.1	29.7	23.6	41.8	107	82.5	79.7	20.0	35.2	12.6	26.6	24.6	30.7	31.5	40.1	304	12.6 to 304.0
Zirconium (Zr)-Total	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.23	ND to 0.23

STRATAGOLD CORPORATION
ATTN: Hugh Coyle
Suite 1000 - 1050 W. Pender St
Vancouver BC V6E 3S7

Date Received: 01-AUG-18
Report Date: 29-AUG-18 12:31 (MT)
Version: FINAL

Client Phone: 604-682-5122

Certificate of Analysis

Lab Work Order #: L2139940

Project P.O. #: NOT SUBMITTED
Job Reference: EAGLE GOLD
C of C Numbers:
Legal Site Desc: Victoria Gold Corp.

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-25	L2139940-26	L2139940-27	L2139940-28	L2139940-29
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T1-1B - ALDER	T1-2AB - ALDER LEAVES	T1-2AB - ALDER TWIGS	T1-3 - ALDER LEAVES	T1-3 - ALDER TWIGS
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	33.5	14.3	12.1	10.0	4.8
	Antimony (Sb)-Total (mg/kg)	5.59	1.16	0.963	0.471	1.32
	Arsenic (As)-Total (mg/kg)	17.0	4.02	2.88	3.40	3.07
	Barium (Ba)-Total (mg/kg)	39.5	4.61	12.8	5.60	10.5
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.219	0.058	0.044	0.014	0.072
	Boron (B)-Total (mg/kg)	7.7	5.5	8.3	7.3	7.7
	Cadmium (Cd)-Total (mg/kg)	<0.010	0.0052	0.0163	<0.0050	0.0055
	Calcium (Ca)-Total (mg/kg)	11000	7370	5170	10600	6710
	Cesium (Cs)-Total (mg/kg)	0.136	0.0957	0.258	0.149	0.176
	Chromium (Cr)-Total (mg/kg)	0.22	<0.050	0.060	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.121	0.058	0.030	0.065	<0.020
	Copper (Cu)-Total (mg/kg)	6.54	6.03	6.12	4.34	5.20
	Iron (Fe)-Total (mg/kg)	222	64.5	42.6	47.2	26.3
	Lead (Pb)-Total (mg/kg)	48.0	7.39	5.28	2.46	4.43
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	2430	1670	983	1660	780
	Manganese (Mn)-Total (mg/kg)	214	42.3	71.2	64.2	74.2
	Mercury (Hg)-Total (mg/kg)	0.0067	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	3.71	4.34	6.40	8.51	6.59
	Nickel (Ni)-Total (mg/kg)	5.54	1.08	0.77	0.55	0.39
	Phosphorus (P)-Total (mg/kg)	938	2820	1980	2470	1450
	Potassium (K)-Total (mg/kg)	7510	5850	5110	5330	4110
	Rubidium (Rb)-Total (mg/kg)	7.81	11.4	11.0	7.09	5.92
	Selenium (Se)-Total (mg/kg)	<0.10	<0.050	<0.050	<0.050	<0.050
	Sodium (Na)-Total (mg/kg)	29	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	44.0	18.0	20.5	22.7	22.8
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0060	0.0021	0.0052	0.0020	0.0058
	Tin (Sn)-Total (mg/kg)	0.21	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0180	0.0023	0.0025	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	48.5	24.6	34.5	34.8	43.6
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-30	L2139940-31	L2139940-32	L2139940-33	L2139940-34
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T2-2 - ALDER LEAVES	T2-2 - ALDER TWIGS	T2-3A - ALDER LEAVES	T2-3A - ALDER TWIGS	T3-2AB - ALDER LEAVES
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	20.0	5.2	8.2	<2.0	37.2
	Antimony (Sb)-Total (mg/kg)	0.127	0.050	0.117	0.044	2.48
	Arsenic (As)-Total (mg/kg)	1.37	0.626	0.571	0.411	4.09
	Barium (Ba)-Total (mg/kg)	37.2	62.5	28.2	58.9	36.2
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.020	<0.010	<0.010	<0.010	0.173
	Boron (B)-Total (mg/kg)	7.8	10.4	9.4	12.0	4.9
	Cadmium (Cd)-Total (mg/kg)	<0.0050	0.0163	<0.0050	0.0097	0.0062
	Calcium (Ca)-Total (mg/kg)	7470	6020	6860	5690	5790
	Cesium (Cs)-Total (mg/kg)	0.330	0.225	0.161	0.104	0.379
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.100	0.065	0.054	0.034	0.334
	Copper (Cu)-Total (mg/kg)	9.61	9.16	7.03	7.85	9.51
	Iron (Fe)-Total (mg/kg)	71.6	35.9	68.2	42.6	75.9
	Lead (Pb)-Total (mg/kg)	11.5	8.24	5.15	5.85	18.5
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	2170	1230	1960	1290	1930
	Manganese (Mn)-Total (mg/kg)	44.9	44.0	30.7	35.3	72.7
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	1.15	1.73	2.16	3.82	1.98
	Nickel (Ni)-Total (mg/kg)	3.03	2.66	1.65	1.77	3.05
	Phosphorus (P)-Total (mg/kg)	2270	1780	2330	1770	2350
	Potassium (K)-Total (mg/kg)	7080	6590	7970	7750	6000
	Rubidium (Rb)-Total (mg/kg)	10.3	8.64	7.58	6.58	17.5
	Selenium (Se)-Total (mg/kg)	0.241	0.124	0.242	0.116	0.054
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	52.1	60.7	37.2	49.3	23.5
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	<0.0020	0.0038	<0.0020	<0.0020	<0.0020
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0092	<0.0020	0.0027	<0.0020	0.0026
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	22.1	40.1	25.7	31.7	29.7
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-35	L2139940-36	L2139940-37	L2139940-38	L2139940-39
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	T3-2AB - ALDER TWIGS	T3-3AB - ALDER LEAVES	T3-3AB - ALDER TWIGS	W1-2 - ALDER LEAVES	W1-2 - ALDER TWIGS
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	9.6	18.8	6.5	27.8	6.9
	Antimony (Sb)-Total (mg/kg)	0.709	0.391	0.337	1.85	0.640
	Arsenic (As)-Total (mg/kg)	1.53	1.54	1.31	7.37	2.97
	Barium (Ba)-Total (mg/kg)	79.1	22.3	71.0	3.64	8.78
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.060	0.028	0.026	0.181	0.070
	Boron (B)-Total (mg/kg)	6.0	6.6	7.0	17.3	13.3
	Cadmium (Cd)-Total (mg/kg)	0.0111	<0.0050	0.0120	0.0200	0.166
	Calcium (Ca)-Total (mg/kg)	5120	6320	6160	6860	4550
	Cesium (Cs)-Total (mg/kg)	0.191	0.159	0.145	0.254	0.148
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.132	0.180	0.105	0.515	0.146
	Copper (Cu)-Total (mg/kg)	7.94	6.75	7.16	11.3	11.6
	Iron (Fe)-Total (mg/kg)	37.5	65.7	40.2	123	47.9
	Lead (Pb)-Total (mg/kg)	15.1	9.35	9.09	8.84	3.67
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	1100	1940	1080	1900	689
	Manganese (Mn)-Total (mg/kg)	101	66.3	97.0	206	311
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	0.0051	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	4.74	3.97	3.38	1.05	1.88
	Nickel (Ni)-Total (mg/kg)	1.83	2.04	1.64	4.68	2.01
	Phosphorus (P)-Total (mg/kg)	1530	2500	1560	2170	1390
	Potassium (K)-Total (mg/kg)	4810	6600	4890	4800	2650
	Rubidium (Rb)-Total (mg/kg)	9.79	11.2	8.55	11.8	5.14
	Selenium (Se)-Total (mg/kg)	<0.050	0.087	0.052	0.110	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	30.0	21.7	34.5	14.6	17.5
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0053	<0.0020	0.0032	<0.0020	0.0022
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	<0.0020	<0.0020	<0.0020	0.0049	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	36.6	20.8	31.9	43.5	76.1
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	0.22	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-40	L2139940-41	L2139940-42	L2139940-43	L2139940-44
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W1-3 - ALDER LEAVES AND TWIGS	W1-4 - ALDER LEAVES	W1-4 - ALDER STEMS	W1-4 - WILLOW LEAVES AND TWIGS	W2-2 - ALDER LEAVES
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	82.6	14.9	5.1	11.0	48.3
	Antimony (Sb)-Total (mg/kg)	0.910	2.35	0.903	1.15	2.77
	Arsenic (As)-Total (mg/kg)	7.36	7.31	2.96	3.88	5.16
	Barium (Ba)-Total (mg/kg)	4.41	0.513	1.02	0.595	1.76
	Beryllium (Be)-Total (mg/kg)	0.019	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.139	0.327	0.124	0.164	0.252
	Boron (B)-Total (mg/kg)	9.7	3.1	6.7	5.9	8.1
	Cadmium (Cd)-Total (mg/kg)	0.0737	<0.0050	0.0136	2.14	0.0080
	Calcium (Ca)-Total (mg/kg)	3300	4790	3450	6030	3570
	Cesium (Cs)-Total (mg/kg)	0.777	1.05	0.578	0.0901	0.690
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	0.082
	Cobalt (Co)-Total (mg/kg)	0.256	0.274	0.140	0.466	0.448
	Copper (Cu)-Total (mg/kg)	34.8	12.0	16.9	4.68	10.2
	Iron (Fe)-Total (mg/kg)	166	130	56.8	58.5	195
	Lead (Pb)-Total (mg/kg)	2.66	4.28	1.61	2.60	6.86
	Lithium (Li)-Total (mg/kg)	0.63	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	791	2950	1180	4770	734
	Manganese (Mn)-Total (mg/kg)	360	45.6	70.5	93.0	262
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	2.22	1.81	5.78	0.049	0.158
	Nickel (Ni)-Total (mg/kg)	11.3	2.71	2.00	1.30	4.65
	Phosphorus (P)-Total (mg/kg)	1710	1570	1410	2340	1840
	Potassium (K)-Total (mg/kg)	3400	3130	2750	4400	4460
	Rubidium (Rb)-Total (mg/kg)	18.1	15.1	9.79	6.97	18.7
	Selenium (Se)-Total (mg/kg)	<0.050	0.059	<0.050	0.067	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	8.47	1.86	2.29	2.70	7.53
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0061	<0.0020	0.0053	<0.0020	<0.0020
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0203	0.0074	<0.0020	<0.0020	0.0072
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	0.11
	Zinc (Zn)-Total (mg/kg)	29.7	23.6	41.8	107	20.0
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-45	L2139940-46	L2139940-47	L2139940-48	L2139940-49
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W2-2 - ALDER STEMS	W2-3 - ALDER LEAVES	W2-3 - ALDER STEMS	W2-4 - ALDER LEAVES	W2-4 - ALDER STEMS
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	7.7	40.7	5.9	22.6	3.5
	Antimony (Sb)-Total (mg/kg)	0.629	1.11	0.402	8.51	0.726
	Arsenic (As)-Total (mg/kg)	1.51	1.97	0.701	6.84	0.900
	Barium (Ba)-Total (mg/kg)	4.47	0.609	4.26	0.960	0.820
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.050	0.100	0.037	0.782	0.062
	Boron (B)-Total (mg/kg)	9.0	8.3	8.6	4.1	5.2
	Cadmium (Cd)-Total (mg/kg)	0.0420	0.0091	0.0262	0.0088	0.0125
	Calcium (Ca)-Total (mg/kg)	3430	1490	1930	7640	3140
	Cesium (Cs)-Total (mg/kg)	0.483	0.594	0.477	0.668	0.445
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	0.078	<0.050
	Cobalt (Co)-Total (mg/kg)	0.124	0.285	0.049	0.094	0.055
	Copper (Cu)-Total (mg/kg)	10.3	12.1	10.1	13.2	11.9
	Iron (Fe)-Total (mg/kg)	57.8	111	36.3	177	41.3
	Lead (Pb)-Total (mg/kg)	1.37	2.48	1.01	15.3	1.42
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	426	930	706	3330	1160
	Manganese (Mn)-Total (mg/kg)	399	107	275	94.2	48.1
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	0.946	0.297	1.73	2.52	3.16
	Nickel (Ni)-Total (mg/kg)	2.01	7.23	2.39	2.86	1.81
	Phosphorus (P)-Total (mg/kg)	1230	1730	1130	2020	1550
	Potassium (K)-Total (mg/kg)	2670	4960	2850	4360	3530
	Rubidium (Rb)-Total (mg/kg)	8.82	16.9	9.20	14.6	10.5
	Selenium (Se)-Total (mg/kg)	<0.050	<0.050	<0.050	0.060	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	13.4	2.78	9.95	5.46	3.10
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0034	<0.0020	<0.0020	0.0026	0.0021
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	<0.0020	0.0053	<0.0020	0.0084	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	35.2	12.6	26.6	24.6	30.7
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2139940-50	L2139940-51	L2139940-52	L2139940-53	L2139940-54
	Description	Veg	Veg	Veg	Veg	Veg
	Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
	Sampled Time					
	Client ID	W2-5 - ALDER LEAVES	W2-5 - ALDER STEMS	W3-4 - SEVERAL SPECIES	W1-5 ALDER STEMS	W1-5 ALDER LEAVES
Grouping	**Analyte**					
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	8.7	3.4	40.8	3.8	13.7
	Antimony (Sb)-Total (mg/kg)	1.48	0.575	32.4	1.08	6.08
	Arsenic (As)-Total (mg/kg)	2.04	0.778	68.7	2.19	6.72
	Barium (Ba)-Total (mg/kg)	0.355	0.417	1.88	0.591	0.573
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.156	0.065	4.29	0.160	0.937
	Boron (B)-Total (mg/kg)	4.6	7.4	30.7	10.8	15.1
	Cadmium (Cd)-Total (mg/kg)	0.0079	0.0093	6.44	0.178	0.0439
	Calcium (Ca)-Total (mg/kg)	8170	4120	9190	3670	10900
	Cesium (Cs)-Total (mg/kg)	0.519	0.569	0.188	0.129	0.239
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	0.099	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.143	0.079	0.769	0.110	0.228
	Copper (Cu)-Total (mg/kg)	9.20	11.7	9.20	11.7	9.73
	Iron (Fe)-Total (mg/kg)	84.6	41.0	530	37.6	97.1
	Lead (Pb)-Total (mg/kg)	3.21	1.32	68.6	3.74	12.3
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	3170	1080	4840	942	3920
	Manganese (Mn)-Total (mg/kg)	110	78.4	414	101	117
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	0.0121	<0.0050	0.0051
	Molybdenum (Mo)-Total (mg/kg)	4.48	5.19	1.15	5.81	4.52
	Nickel (Ni)-Total (mg/kg)	2.52	1.79	1.67	1.50	2.93
	Phosphorus (P)-Total (mg/kg)	2180	1600	3700	1570	2390
	Potassium (K)-Total (mg/kg)	4300	4020	7890	2830	3870
	Rubidium (Rb)-Total (mg/kg)	14.8	12.3	18.9	6.54	11.7
	Selenium (Se)-Total (mg/kg)	0.117	<0.050	0.655	<0.050	0.159
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	2.29	1.62	8.04	4.52	7.92
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	<0.0020	0.0025	0.0165	0.0162	0.0085
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	0.59	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0031	<0.0020	0.0313	<0.0020	0.0048
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	31.5	40.1	304	79.7	82.5
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	0.23	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AG-200.2-A-CCMS-VA	Soil	Elevated Ag in Soil by CRC ICPMS	EPA 200.2/6020A

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Analysis is by Collision/Reaction Cell ICPMS.

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

CAT-XTR-SK	Soil	Ammonium Acetate Extractable Cations	CSSS 19.4 - 1M NH4OAc Extraction @ pH 7

Exchangeable Ca, Mg, Na, and K are extracted from the soil using neutral 1N ammonium acetate, then determined by ICP-OES. This method does not correct for calcium or magnesium extracted from carbonates or free gypsum.

ETL-C:N-RATIO-SK	Soil	Carbon:Nitrogen Ratio - Calculation	Calculation
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

HG-DRY-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

HG-DRY-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (DRY)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

MET-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY)	EPA 200.3/6020A

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MET-DRY-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (DRY)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

NH4-AVAIL-SK	Soil	Available Ammonium-N	Comm Soil Sci 19(6)

Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.

OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

L2139940-COFC

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COC #

Report To	
Company:	StrataGold Corporation
Contact:	Hugh Coyle
Address:	1000 - 1050 West Pender Street
	Vancouver, BC V6E 3S7
Phone:	604-696-6600 Fax:
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑ Standard ☐ Other	
☑ PDF ☑ Excel ☑ Digital ☐ Fax	
Email 1:	hcoyle@vitgoldcorp.com
Email 2:	bonnieburns@northwestel.net
Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c
Client / Project Information	
Job #:	Eagle Gold
PO / AFE:	
LSD:	Victoria Gold Corp.
Quote #:	Q69293, Peso Samples
ALS Contact:	Heather Mackenzie
Sampler:	Bonnie Burns & Crystal Beaudry

Service Requested (Rush for routine analysis subject to availability)

- ◉ Regular (Standard Turnaround Times - Business Days)
- ○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals	Number of Containers
	T1-1B - alder	31-7-17			X	1
	T1-2AB - alder leaves	31-7-17			X	1
	T1-2AB - alder twigs	31-7-17			X	1
	T1-3 - alder leaves	31-7-17			X	1
	T1-3 - alder twigs	31-7-17			X	1
	T2-2 - alder leaves	31-7-17			X	1
	T2-2 - alder twigs	31-7-17			X	1
	T2-3A - alder leaves	31-7-17			X	1
	T2-3A - alder twigs	31-7-17			X	1
	T3-2AB - alder leaves	31-7-17			X	1
	T3-2AB - alder twigs	31-7-17			X	1
	T3-3AB - alder leaves	31-7-17			X	1
	T3-3AB - alder twigs	31-7-17			X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

NOTE: THERE IS NO TISSUE OPTION IN THE PULL DOWN MENU FOR SAMPLE TYPE ON THIS FORM, BUT THESE ARE TISSUE SAMPLES.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Bonnie Burns	Date (dd-mmm-yy)	Time (hh-mm)	Received by: EHF	Date: 1 Aug 2018	Time: 16:30	Temperature: 12.0 °C	Verified by: HA	Date: 8/2	Time: 1pm	Observations: Yes / No ? If Yes add SIF

7

GENF 20.00 Front

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COC #

Report To
Company: StrataGold Corporation
Contact: Hugh Coyle
Address: 1000 - 1050 West Pender Street
Vancouver, BC V6E 3S7
Phone: 604-696-6600 Fax:

Invoice To Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report? ☐ Yes ☑ No
Company:
Contact:
Address:
Phone: Fax:

Lab Work Order # (lab use only)

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☑ Digital ☐ Fax
Email 1: hcoyle@vitgoldcorp.com
Email 2: bonnieburns@northwestel.net
Email 3: Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c

Client / Project Information
Job #: Eagle Gold
PO / AFE:
LSD: Victoria Gold Corp.
Quote #: Q69293, Peso Samples

ALS Contact: Heather Mackenzie
Sampler: Bonnie Burns & Crystal Beaudry

Service Requested (Rush for routine analysis subject to availability)
◉ Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals	Number of Containers
	W1-2 - alder leaves	31-7-17			X	1
	W1-2 - alder twigs	31-7-17			X	1
	W1-3 - alder leaves and twigs	31-7-17			X	1
	W1-4 - alder leaves	31-7-17			X	1
	W1-4 - alder stems	31-7-17			X	1
	W1-4 - willow leaves and twigs	31-7-17			X	1
	W2-2 - alder leaves	31-7-17			X	1
	W2-2 - alder stems	31-7-17			X	1
	W2-3 - alder leaves	31-7-17			X	1
	W2-3 - alder stems	31-7-17			X	1
	W2-4 - alder leaves	31-7-17			X	1
	W2-4 - alder stems	31-7-17			X	1
	W2-5 - alder leaves	31-7-17			X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	1 Aug 2018	1630	12.0 °C	HA	8/2	1pm	

GENF 20.00 Front

7

L2139940-COFC

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COC #

Report To	
Company:	StrataGold Corporation
Contact:	Hugh Coyle
Address:	1000 - 1050 West Pender Street, Vancouver, BC V6E 3S7
Phone:	604-696-6600 Fax:
Invoice To	Same as Report ? ☑ Yes ☐ No
Hardcopy of Invoice with Report?	☐ Yes ☑ No
Company:	
Contact:	
Address:	
Phone:	Fax:
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑ Standard ☐ Other	
☑ PDF ☑ Excel ☑ Digital ☐ Fax	
Email 1:	hcoyle@vitgoldcorp.com
Email 2:	bonnieburns@northwestel.net
Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c
Client / Project Information	
Job #:	Eagle Gold
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LSD:	Victoria Gold Corp.
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- ○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals	Number of Containers
	W2-5 - alder stems	31-7-17			X	1
	W3-4 - several species	31-7-17			X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

NOTE: THERE IS NO TISSUE OPTION IN THE PULL DOWN MENU FOR SAMPLE TYPE ON THIS FORM, BUT THESE ARE TISSUE SAMPLES.

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Released by: Bonnie Burns	Date (dd-mmm-yy)	Time (hh-mm)	Received by: EHF	Date: 1 Aug 2018	Time: 16:30	Temperature: 12.0°C	Verified by: HA	Date: 8/2	Time: 1 pm	Observations: Yes / No ? If Yes add SIF

7

GENF 20.00 Front

APPENDIX B

Vegetation Rooting Study

StrataGold Corporation

EAGLE GOLD PROJECT
PRELIMINARY VEGETATION ROOTING STUDY

Version 2018-01

JUNE 2018

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1. INTRODUCTION

The purpose of the Vegetation Rooting Study ("the Study") is to establish an approximate range of rooting depths for climax vegetation within the proposed cover system for the Eagle Gold Project ("the Project"). Previous cover analysis for the Project assumed an approximate root penetration depth of 0.5 m based on the rooting systems of common tree species in the Yukon (e.g. white spruce, black spruce, and balsam polar). A more detailed assessment of rooting depth is needed to confirm the current cover model assumptions.

1.1 PROJECT OBJECTIVES AND SCOPE

The benefits of vegetation on cover systems are well documented and rely on plant root water uptake to increase evapotranspiration (ET) through plant transpiration, thus limiting deep seepage to underlying mine waste (Benson et al. 2001, Ayres et al. 2004). Plant transpiration relies primarily on plant water availability, which is largely a function of root distribution within the cover profile, in combination with soil texture. Vegetation acts to remove water from the cover system through transpiration and interception. Therefore, through the addition of vegetation, the amount of water that reaches the surface of the cover system (effective precipitation) is immediately reduced as compared to a bare surface condition. As vegetation density increases, so does the root density. Increasing interception, transpiration and runoff will be the primary mechanisms to reduce net percolation into the cover system. Initial vegetation establishment (typically grasses) following cover system construction provides erosion protection. As the cover system ages and conditions allow, shrubs and eventually trees establish. Quantification of root depth / distributions and associated near surface material characteristics will yield valuable closure planning information. Key outcomes from the Study are to:

- Collect site specific or analogous site information pertaining to root depth / distributions that will be used to inform the final cover system designs;
- Identify key plant functional groups and material types for each plant functional group; and
- Calibrate a soil-plant-atmosphere (SPA) model using site-specific root depth / distribution and material characteristics information to improve output accuracy.

The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Project site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

1.2 STUDY ORGANIZATION

Reviewer comments suggested that a rooting study should examine existing climax vegetation in locations with similar soils to the proposed cover (and exist in thicknesses at depths more than 0.5 m) to determine the likelihood that rooting depths may exceed 0.5 m. While this is an aspect to be evaluated, more importantly there are key constraints to rooting depth to be considered that can be broadly grouped into physical, chemical, and biological factors (Robinson et al., 2003). Thus, it is not necessarily how deep roots are able to penetrate under ideal conditions, but how deeply can roots be expected to penetrate under conditions proposed for the engineered cover system and how the rooting depth effects net percolation rates. Therefore, a two-phased approach is proposed for the vegetation rooting study.

The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite
- **Task 3**: Vegetate constructed cover system trail area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.

- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Tasks 1 to 6 are aimed to better understand the physical, chemical, and biological constraints to rooting depth and cover system design that can be developed at the Project site. In this way, the uncertainties regarding possible rooting depths are constrained to the cover system design parameters that can be controlled as opposed to having to evaluate the broad range of natural variables that exist in nature.

1.3 STUDY OUTCOMES

The main outcomes of the proposed study include:

- Clarification of the optimal (and minimum) cover thickness capable of supporting plant water requirements for a mature rehabilitated plant community.
- Characterization of an improved plant establishment that will result in higher plant water-use (transpiration).
- Integration of root depth/proportion information in soil-plant-atmosphere (SPA) model improving their predictive accuracy.

2. PROPOSED FIELD METHODS

Proposed field methods to the two-phased approach are described below.

2.1 PHASE 1: NATURAL ANALOGUE SITE INVESTIGATION

2.1.1 Task 1: Literature Review

The comprehensive literature search on vegetation characteristics and forests in the region will be conducted to develop a list of target species to investigate further. In this case, target species (i.e., various trees and shrubs) to study are assumed to be those that fit into end land use vegetation communities but have penetrating root systems that may affect cover system performance.

2.1.2 Task 2: Establish Test Plots

To confirm the appropriate age class of vegetation to be sampled, tree coring and ring counts will be conducted at analogous study sites. The Study sites may include natural areas remaining on or adjacent to the Project site. Due to the possibility that the climax vegetation species may have roots systems that do not have optimal depths, the study will also examine rooting characteristics of various successional forest types that yield more appropriate rooting depths for the proposed cover designs. The rooting depth characteristics have been shown to relate to many factors, so rooting depth may also be constrained by physical properties such as textural contrasts and interfaces. By aging target species at natural analogue sites identified in the literature search, the age of the species in question and root depth can be correlated.

Additional characterization of near surface materials and plant root characteristics at the Project will yield valuable information to further inform closure planning. Assessment of cover trials will be used to optimize cover system design and performance as the current vegetation community is representative of one likely to establish on the cover system post closure.

2.1.3 Task 3: Destructive Sampling

A ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem (Figure 2.1-1a). Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works.

Pits will be dug as close to the stem as practicable (approximately 0.1 m), to a depth based on literature information on the maximal rooting depth of the target species and 0.25 m on either side of the stem (Figure 2.1-1a). Pit walls will then be smoothed using shovels and small water sprayers to remove excess soil and expose roots. Sampling frames divided into 0.05 x 0.05 m grid cells (0.0025 m^2) can be used to count the number of roots in each cell (Figure 2.1-1b). This method will allow for quantification of root depth and distribution, in addition to estimates of cumulative root distributions with soil depth exemplified in Figure 2.1-2.

Information on root distribution is valuable for determining where plants place most of their roots for water extraction, allowing cover designers to implement cover system with adequate growth media thickness to satisfy plant root and moisture requirements. Root depth and distribution information can also be integrated into SPA models to achieve more accurate estimates of cover system performance over time. This information will improve the likelihood of successful rehabilitation and improve the design and performance of cover systems at the Project.

Figure 2.1-1: Creation of pit into a cover system with established vegetation to quantify root depths, distribution, and material textures

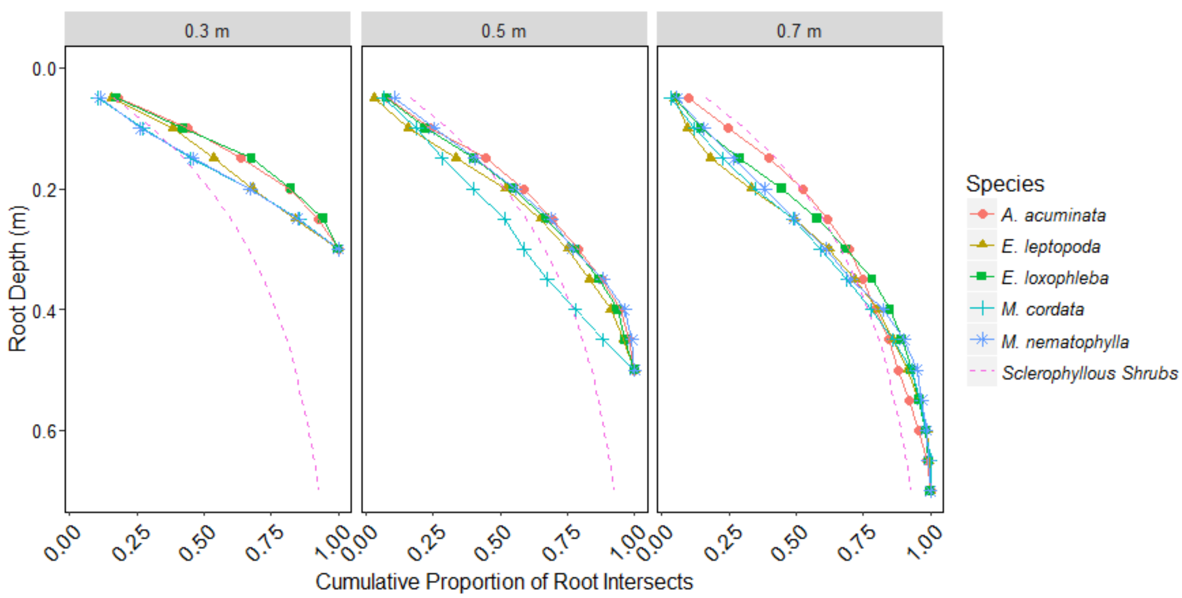

Figure 2.1-2: Example of cumulative proportion of root intersects (root counts) for saplings of five local native species with depth for three cover thicknesses

After root quantification, sampling the soil material from the Study pit wall in active rooting interval will be conducted. The active rooting soil interval likely represents the depth at which most roots extract water; characterizing the active rooting interval will help develop recommendations regarding the cover system growth medium. Soil samples for texture and plant available nutrients will be analyzed. These works can optimize cover system material characterisation in association with plant root characteristics.

2.2 PHASE 2: COVER SYSTEM FIELD TRIAL

2.2.1 Task 1: Field Trial Design

Task 1 is to develop a design for the cover system field trial based on proposed conceptual cover system design and learnings from the natural analogue site investigation to assess selected vegetation treatments.

A store-and-release cover system made up of nominally 0.5 m of cover system material with locally available topsoil and tailings or colluvium will be constructed to cover the landform produced in Task 2 below. The design base case will be of the design specified in the latest closure and reclamation plan for the site as shown in Figure 2.2-1. It may be possible that slight modifications to the cover system and its vegetation performance can be examined as part of field trials.

2.2.2 Task 2: Construct Field Trial Landform and Cover System

Landforms will be constructed from equivalent leached ore or waste rock material produced on site. Modelling and sensitivity analyses conducted (O'Kane, 2014) found very little difference in the performance of the Base Case cover design whether it was covering leached ore or waste rock materials. Landforms will be sized and built with commercial scale equipment that will represent the soil conditions with the expected compaction on closure landforms. Generally, these trials may only need to be on the order of 0.5 ha in area and they will be constructed according to specifications anticipated for closure.

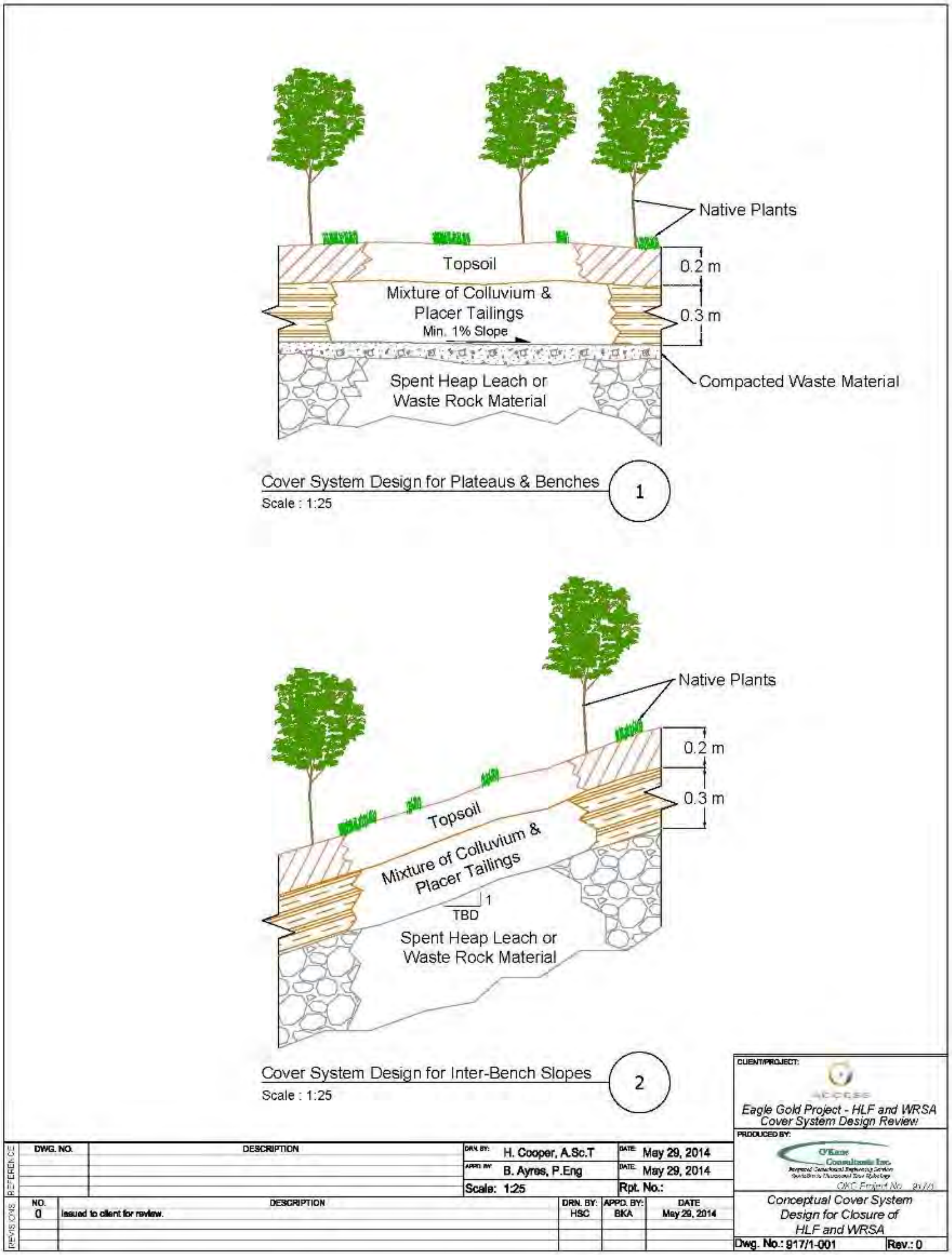

Figure 2.2-1: Conceptual HLF and WRSA Cover Design Drawings

2.2.3 Task 3: Vegetate Cover System Field Trial

Task 3 involves vegetating the constructed cover system trial area in alignment with successional end land uses. Given the end land use, seed mixes will be developed for early successional grasses, and seedlings will be sourced for climax shrubs and trees. The cover system field trial area will be revegetated using standard techniques (Table 2.2-1) with native species and based on updated vegetation information gathered during the natural analogue site investigation. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques and evaluate the degree of success of the closure cover system design.

The field trials will require planting or seeding with desired species chosen as based on results from Phase 1. A short summary of the pros and cons of each re-vegetation technique is provided in Table 2.2-1 and is not intended as an exhaustive list.

Table 2.2-1: The pros (+) and cons (-) of common re-vegetation techniques (Florabank.org.au)

Direct Seeding	Planting	Natural Regeneration
(+) Lower establishment costs	(+) More reliable	(+) Plants are well-adapted to the site
(+) Natural look and more diversely structured	(+) Uniform	(+) Establishes healthiest plants
(+) Establishes healthier plants	(+) Re-vegetation is visible to passers by	(+) Lowest establishment costs
(-) Long establishment times may lead to more maintenance such as weed control.	(+) Uses small quantities of seed	(-) Needs an adjacent or nearby seed source
(-) Ants have been known to take seed	(-) Higher establishment costs	(-) May have to wait a long period for results
(-) Uses lots of seed	(-) Often results in unnatural looking rows	(-) Long establishment times may lead to more maintenance such as weed control.

NOTES:
Symbols of (+) and (-) denote a pros and cons, respectively, associated with each re-vegetation techniques.

If the cover trial is to be vegetated via direct planting, then the density of stems per unit area for a given species should resemble its natural stem density in natural areas. Appropriate planting densities between seedlings are important as water demands increase with plant size as vegetation communities mature. Moreover, planted species often represent those found in the final community stage that often require greater rooting volume, plant available water, and nutrients, thus stressing the importance of planting densities, growth material characteristics, plant available water, and growth medium thickness.

If the cover system is to be seeded, then it will be important to select the seed mix based on the literature review, the targeted end land use and the ability to source the seeds from local provenance. Using seed from the local area will take advantage of subtle adaptations present in plants occurring in the area, thus increasing the likelihood of successful re-vegetation. Seeding rates and seed mixtures for each species should resemble stem densities of their natural analogues on undisturbed sites, and account for typical germination rates for each species present in the mixture. Seeders may be used to spread the seeds on the trial areas. Longer establishment times associated with seeding will likely required increased weed management until seeded plants are well established.

A combination of planting and seedling may be used; however, it is recommended that planting occur first to ensure establishment over a sufficient time followed by seeding. Natural re-vegetation may also occur and be beneficial if not mainly comprised of weeds.

2.2.4 Task 4: Moisture Content Monitoring

Monitoring of the soil water content in the plant root zone will be important in understanding the physical processes contributing to storage or removal of water.

During construction of the cover system it is proposed that an array of automated sensors be deployed in each location where seedling plots are located. Soil matric potential and water content are two parameters that are used to determine the water allocation in the rooting zone; they provide information on how roots are affecting the water balance of the cover system. The sensors will be configured in predetermined depths in the soil profile and connected to a data acquisition system (DAS), whereby measurements will be recorded at high frequency intervals. Generally, the instrumentation proposed here forms the basis of a cover system performance monitoring system that may be used in future stages.

2.2.5 Task 5: Geochemical Characterization

Task 5 will look to assess the geochemical character of the cover system and underlying materials and will identify any constituents that may be susceptible to bioaccumulation as identified through cover system material and waste material sampling programs.

Geochemical sampling during construction of the field trial is proposed in the same locations to where seedlings are to be planted. Samples will be collected of the underlying materials and the cover system materials. Sample collection will be followed by sampling during the destructive sampling to investigate if constituent concentrations in the various cover layers have increased with time. Key areas of geochemical sampling will coincide with target species to be destructively sampled to investigate if water demand by vegetation has assisted in the upward migration of any constituents of concern and if they are bioavailable to the species.

2.2.6 Task 6: Destructive Sampling

Task 6 will involve destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length. As with destructive sampling in the natural analogue site, a ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem. Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works. The methodology will follow the same protocol as in Task 3 of the natural analogue site investigation (Section 2.1.3).

2.2.7 Task 7: Cover System Model Update

The objective of the updated conceptual model will be to incorporate the accumulated monitoring and site investigation data. A review of results of monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data will be used to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist.

The research program has been structured in such a way that areas posing the highest risk and uncertainty to the cover system's performance can be further evaluated. By conducting studies aimed at reducing uncertainty in estimates, numerical modelling can be refined to support field observations. This leads to an update of the conceptual model. Once the level of risk for the cover system performance has been reduced to an acceptable level agreed upon, the conceptual model can be moved forward as a basis for design.

Based on the results of both phases of the study, the cover system model will be updated to include the proposed vegetation strategy for the cover system design. The rooting profile characteristics of the cover system trial site will be compared to an analogue natural site of similar age. At some point during the study, the cover trail can be destructively sampled based on operation feasibility; this may not be until five or more years post-planting. Assuming similarity, the climax community species rooting depths in the analogue sites can then be used to infer the potential for rooting depth on the cover trail into the future.

3. CONCLUSIONS

The proposed two-phased study described herein provides the opportunity to optimize closure planning for the Project. The initial field investigation will increase immediate and short-term knowledge that can be used to improve the design of cover system field trials. Characterization of near-surface materials and plant root characteristics at the Project site will yield valuable information to further Project closure planning and increase the likelihood of successful rehabilitation. The vegetation study outlined here will help refine the anticipated rooting depths on the proposed cover system for specific species from construction through closure. Rooting characteristic information can also be used to identify specific vegetation as likely candidates for the cover system, and what their contribution to increasing AET is likely to be.

APPENDIX C

Alexco Environmental Group – Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

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Technical Memorandum

To: Steve Wilbur, Hugh Coyle, Victoria Gold

From: Jim Harrington, Alexco Environmental Group

Re: Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

1 Introduction and Background

This plan has been developed as part of the closure planning process for the Eagle Gold Project (Project). It is part of the reclamation research identified in the Reclamation and Closure Plan (RCP) to address uncertainties in the heap detoxification process as the heap transitions from leaching into closure. The field-based research is planned to be concurrent with heap leaching operations over a 3-year period, with the primary test taking approximately 100 days followed by quarterly testing of effluents for up to 12 quarters thereafter to evaluate rebound, stability, and seasonal effects.

Water Use Licence QZ14-041, which was granted to the Project in December 2015, requires a phased Reclamation and Research program "to verify the proposed biological detoxification of the heap, including incorporation of data gathered through the operation of the HLF and information from the use of similar technology at heap facilities operated in similar climatic conditions." Further, it also requires "a phased program, similar to that provided for the PTSs, for the proposed in-heap bioreactor treatment system including the assessment of the ability to maintain reducing condition in the long term and the potential for rebound and/or release of metals."

Gold-containing materials leached by cyanide are characterized by cyanide residuals, elevated pH, and some soluble metals and metalloids. These conditions result from the elevated pH due to lime addition during heap placement, cyanide-metals complexation, and oxidation of materials that were previously less exposed to atmospheric conditions. Prior column tests (performed at Kappes Cassidy in 2013-2014 and summarized by TetraTech, 2014) verified that treatment of cyanide residuals in Eagle Gold spent ore, nitrogen-containing CN breakdown products (cyanate, thiocyanate, nitrate/nitrite, and ammonia) can be degraded using microbial degradation. Furthermore, some metals showed significant reduction in concentrations during this treatment process, whether by 1) enhanced sorption as the pH was reduced toward neutral conditions, 2) the removal of the complexing action of cyanide as it was degraded, or 3) via other biological precipitation processes such as formation of mixed valence iron and manganese oxides or biogenic sulphide minerals.

As is indicated in the Reclamation and Closure Plan (RCP; AEG 2014), during late stages of heap operation and heap draindown a biological treatment process will be employed for the Project. The purpose will be to improve heap drainage water quality such that it can be readily treated in a water treatment plant (WTP) or in constructed wetland treatment systems (CWTS).

There are two proposed processes that are complementary and thus are discussed in this Study Plan together. These processes are:

- Biological CN degradation in the vadose and saturated portions of the heap, where sugar-containing-solutions are applied to the heap using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers). Application of the sugar solution within the heap promotes the reaction of sugars and cyanide, which yields less toxic cyanohydrins, and supports the degradation of nitrogenous CN breakdown products that ultimately transforms CN and other N compounds to gaseous N_2.

- Formation of biochemically-created reducing conditions within the saturated portion of the heap, where alcohol-containing solutions are applied to heap materials using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers).

Typically, biological CN degradation is performed with slower solution application rates than that used during active leaching, while targeting a solution quantity to any active application area that is equivalent to a pore volume of the liquid in the vadose zone in that area. Solutions from the gold recovery (in the Adsorption Desorption and Recovery plant) are amended with molasses or other similar sugar source, and pumped back up to the heap. The sugar solution is applied at a rate calculated to degrade both the solution-phase CN and the sorbed CN forms, and is applied slow enough onto the surface of the heap to target the smaller pores within the heap materials, thus enhancing coverage of the solution into zones that could otherwise create rebounds in CN once biological treatment solutions are no longer being applied to the heap. For the Project heap areas, this is estimated to be 12 areas each for approximately 60 days, and the timing of the initial treatment application is targeted to be just after CN addition has stopped, beginning with the oldest areas of the heap and working over the next 2 years progressively toward areas that were last leached.

As the effect of the sugars reaches the in-heap pond, microbes in the pond begin to transform the pond to anaerobic conditions. This effect is tempered by the continued mobilization of nitrate from the vadose zone into the in-heap pond, but because the systems are not well mixed, zones of both denitrification and sulphate reduction will likely form. As CN treatment within the vadose zone progresses to completion, the saturated zone is further driven to more reducing conditions (i.e., more strongly into sulphate-reducing conditions) by the continued application of alcohol. Thus the in-heap treatment process is sequential in timing (sugars targeting CN degradation followed by alcohols enhancing nitrate and sulphate reduction) while migrating in location along the flow path (from vadose zone through to the saturated in-heap pond) prior to discharge from the heap.

2 Operational Data Relevant to Biological Detoxification and Bioreactor Design

There are several areas where heap operational information will be reviewed in the final design of the biological detoxification and bioreactor tests.

2.1 Water Chemistry

While metallurgical column testing provides some understanding of the formation and evolution of constituents that may be present in the full-scale larger heap setting, the smaller-scale testing typically does not fully represent the more complex heterogeneity of the ore body (and hence the resultant stacking of ore in the heap), the length of atmospheric exposure and wetting and drying cycles in the heap leach process, and the localized gradients and variability of pH, cyanide concentration, lime addition rates, etc. Changes in mining plans and other operational decisions can also affect water chemistry, including the extent of evaporative concentration of heap solutions, extent of freshwater makeup and constituents present in the fresh water, the use of sprinklers vs. drip emitters, and the solution application rate which can affect relative oxidation levels in the heap.

When performing the final design of the biological detoxification and bioreactor field tests, water chemistry from the pregnant and barren solutions will be reviewed to ensure that all relevant constituents that may affect reagent requirements have been considered.

2.2 Heap Leaching Performance

As part of the HLF Operations, Maintenance and Surveillance program, for example, gold recovery, leach times (i.e., duration of solution application) for each area of the heap, grades of pregnant solution over time, cyanide use, and pH of the pregnant solution will be monitored. This operational data can be used to assess the potential lateral variability in flow paths which might be relevant for biological detoxification. A review of this operational data would be done during the planning stage for biological detoxification so that solution delivery and potential variability by heap area for duration or concentration of reagents can be evaluated.

3 FIELD TEST STUDY PLAN

3.1 BIOLOGICAL DETOXIFICATION COLUMN AND BIOREACTOR SETUP

During the leaching process over the entire operational period, there will be lifts that will have been leached and then stacked over and re-leached, with the areas deepest in the heap and nearest to the in-heap pond leached the longest. Thus a few years into the heap leach operation, materials will be available that have been well leached and will be representative of the heap at closure. While unsaturated heap materials will be readily available during operations to study the biological detoxification process, the saturated portion of the heap will not be accessible until closure, and consequently heap materials will need to be newly flooded to simulate the in-heap pond area which will become the bioreactor. Thus the field program will create two settings that are similar to the sequential unsaturated and saturated zones in the heap that will be used to treat the water contained in the heap materials. Field columns, small lined areas on the heap, and tanks will be used to set up a flow path that simulates the conditions on site.

The following summarizes essential aspects of the column setup (see attached illustration):

- Select heap materials from the longer leached portion of the heap that have completed their leaching process and have been exposed to atmospheric oxygen for several years. These will be placed into a contained area for biological detoxification testing. While this rehandling will affect the localized material characteristics which affect unsaturated flow of solutions in the heap, this test is studying the chemistry of the process not the unsaturated flow variables of the heap treatment process.

- Two approaches for the vadose-portion of the heap column setup are considered to be appropriate and are acceptable, with some specific advantages and disadvantages for each considered below:

    - A large scale wide diameter column can be constructed, with heights of 10 m or more similar to a lift of stacked heap materials (this setup will be referred to as the “column” approach).

    - A trench can be excavated in the side of the heap, a liner placed, and the heap materials re-placed on the lined area, similar to a field scale lysimeter construction (this setup will be referred to as the “lysimeter” approach.

- Either approach is considered acceptable to study the water chemistry outcomes of the process and yield design parameters and confirmation of the full scale approach.

- Some advantages and disadvantages of the column approach include:

    - All columns suffer from skin effects, i.e., solution flow tends to move vertically until lower permeability materials are encountered, then flow goes laterally until the edge of the column is reached, then flow continues along the surface of the column, and may result in column areas that do not receive representative solution application.

  - Column materials provide restrictions on gas exchange similar to a given soil column that is contained in the heap, allowing for formation of anaerobic conditions within the column more similar to what would be experienced in the bulk heap materials.

- Some advantages and disadvantages of the lysimeter approach include:

  - It may be difficult to apply solutions to the side-heap area that are representative of the vertical column flow path which is the primary flow path in a full scale heap.

  - Side-heap areas are the area where atmospheric exchange is greatest, resulting in a more inefficient use of the reagent.

- The bioreactor setup should be done in such a way as to provide about 14 days of residence time within saturated heap materials. The portion of the test simulating the saturated heap can be done by creating a tank or a lined area that is filled with leached spent heap materials, and providing an invert elevation for the tank or lined area such that the area remains saturated. Options to create this bioreactor can include a small lined area on the side of the heap, a tank placed on the heap area next to the column or lysimeter area, or a second column that each would receive solutions in an upflow configuration. While ideal, it is not necessary that all solutions from the column or heap be applied to the bioreactor. From here on bioreactor setup will be referred to as a “bioreactor tank” even though it may be constructed using liner.

- The bioreactor tank will have an upflow configuration, such that solutions will be added to the bottom of the reactor through a perforated pipe network, and pumped or forced by gravity upward to the overflow area. The heap materials will be entirely saturated such that the all the flow passes through the saturated heap materials, which will become coated by a biofilm of microbes that will ultimately drive the metals treatment process. By providing a shallow layer of standing water over the top, short circuiting to the discharge location will be avoided.

- The solution application process will utilize a similar or slower solution application rate as the heap leaching process itself. For instance, a common range of solution application is 5-20 liters/m^2/hour (Bliewas, USGS 2012 Open-File Report 2012–1085). A solution application rate for biological treatment will typically be half or less than the solution application rate utilized in the actual heap operations. While a design solution application rate has been suggested for the Project based on column test work, the actual solution application rate should be reviewed as it will vary during the life of the project as the heap leach characteristics are determined in the full scale configuration. For this study plan a solution application rate of 5 liters/m^2/hour is assumed.

- Based on the assumed solution application rate, a drip emitters spacing will be utilized so that the material in the heap materials are wetted and maintained wet during the course of the test operation.

- Heap materials will be tested prior to the treatment test for soluble cyanide and nitrogen species using a meteoric water mobility test or hot water rinse. Heap materials will be re-tested after the test operation to compare reduction in solid phase concentrations.

- Heap materials loaded into the bioreactor tank should be tested for metals and sulphate using a meteoric water mobility test or hot water rinse, as well as for hydroxylamine-extractable iron (described in Lovely and Phillips, 1987). Soluble metals, cyanide and nitrogenous species will be measured in the overflow of the bioreactor tank after it is filled, and continue at a frequency equivalent to each calculated pore volume exchange through the rest of the test.

3.2 Column Operation

The following summarizes essential aspects of the column operations:

- Barren solution from the ADR will be filled into a holding tank (approximately 5,000 liters) and replenished periodically. Molasses amendment will be added to and mixed into the barren solution every time it is replenished. The molasses concentration will account for both solid and soluble cyanide and reduced nitrogen species. Low levels of phosphoric acid will be added to the molasses to stimulate microbial growth at a C:P molar ratio of approximately 100:1. (This ratio is based on experience; all heap materials will contribute some phosphate, though its solubility will be initially limited.) The purpose of the P amendment is to stimulate microbial growth, where P limitation can be a factor in the transition from an autotrophic setting (which the heap is during leaching) to a heterotrophic setting (which the heap will be during biological detoxification).

- Drainage from the column or lysimeter will be amended with alcohol (methyl or ethyl alcohols or a mixture of both are acceptable) and directed to the bioreactor. Alcohol amendment concentration will account for soluble oxidized nitrogen species (nitrate, nitrite), soluble metals, sulphate, and a portion of hydroxylamine-extractable iron measured in the heap materials. The objective of the alcohol amendment is to support microbial conversion of the metals into primary metal sulphides via sulphate reduction and metal sulphide precipitation (e.g., FeS, FeAsS, CuS, etc.).

- The overall duration of the solution application will continue for approximately 90 days, then allowed to drain for 10 days at the end for an overall duration of ~100 days. The expectation is that it will take approximately 60 days for the treatment to biologically detoxify the heap materials, and that sulphate reduction will become fully effective in the bioreactor within this same time period, allowing for three samples at the end of the test (i.e., day 70, day 84, and day 98) to show treated effluent concentrations from both the biological detoxification test and from the bioreactor test.

- The solution concentration of molasses in the feed solution will be what is stoichiometrically required to account for equimolar sugars and cyanide and reduced nitrogenous forms in the barren solution and the heap solids, with these compounds including:

    - Total cyanide,
    - WAD cyanide
    - Cyanate,
    - Thiocyanate,

   - Ammonia.

  Note: biological detoxification is accomplished in two phases: the first is a rapid reaction of sugars with free or weakly complexed cyanide (minutes to hours), and the second is a slower reaction that is microbially-catalyzed, where microbes that are naturally present in the ore materials grow and utilize cyanide as a nitrogen source, or detoxify cyanide to render the pore water environment more benign from a microbial perspective. Microbial growth is stimulated by the addition of a carbon source at a typical molar ratio of 0.5:1 sugars to cyanide (i.e., 4:1 C:N ratio). In prior heap detoxification experience, this ratio has been highly variable (i.e., as low as 3:1 and as high as 10:1), and other nitrogen species (nitrate/nitrite or ammonia) can be a bigger control on carbon demand; however, in a test column the WAD and free cyanide are typically the driver of a carbon demand. Total cyanide is assayed to understand if heap drainage could have a secondary CN formation upon exposure to sunlight where FeCN complexes could break down and release free CN.

- The solution concentration of alcohol in the bioreactor feed solution will be what is stoichiometrically required to account for biological reduction of soluble and sorbed species:

   - Nitrate plus nitrite,
   - Divalent cationic metals soluble and sorbed that form primary sulphides: Cd, Cu, Ni, Zn etc.
   - Metalloids that can be incorporated in sulphides: As, Sb
   - Soluble or hydroxylamine-extractible Fe
   - Sulphate that is sufficient to form sulphide and precipitate the above metals
   - Elements that form reduced insoluble (non-sulphide) precipitates: Cr, Se.

- Test operation (i.e., solution and reagent amendment) will continue until stable data for relevant constituents has been achieved for three consecutive data points (four weeks if sampled every 14 days) to determine end points relevant to active WTP design and CWTS design. As currently conceptualized, drainage from the biological detoxification column is expected to be relevant to active water treatment during heap draindown, and drainage from the bioreactor tank is expected to be relevant to the CWTS that would be constructed in the events pond or other areas.

3.3 Post-Test Closure Simulation

At the end of the test, the biological detoxification test will have cover soil placed on the surface using the design that is contemplated for the heap. All flow from the biological detoxification test will be routed through the bioreactor such that the combined biological detoxification and bioreactor processes simulate the heap unsaturated and saturated areas.

Drainage from the bioreactor will then be collected in a buried holding tank and pumped dry quarterly. The volume of the drainage should be measured, and water chemistry assayed for all licence parameters and field parameters (DO, pH, conductivity). No special treatment will be done to ensure flow through the seasons, and it is expected that the columns or tanks may freeze and thaw and the effect of this will be assessed over the subsequent quarterly testing.

While of limited use in predicting cover performance (as this test will simulate only a small area in a setting that reflects only a single aspect that is present in the heap area) this information will show the effect of continued input of meteoric water and any rebound from areas less treated on the chemistry of the combined areas.

4 REFERENCES

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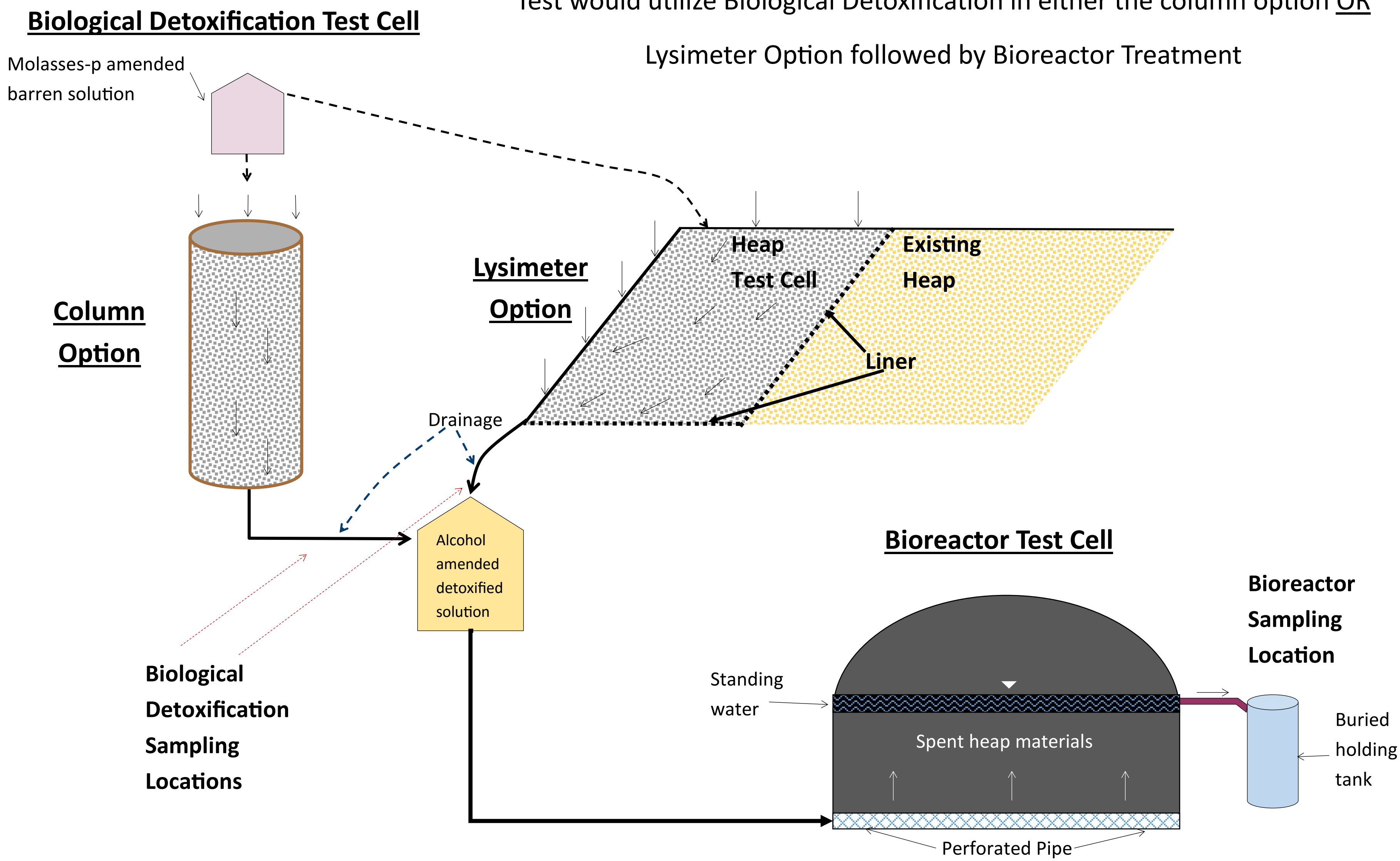
Biological Detoxification and Bioreactor Test Schematic

Test would utilize Biological Detoxification in either the column option OR

Lysimeter Option followed by Bioreactor Treatment



APPENDIX D

Closure Pipe Design Analysis

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Project Memorandum

To:	**File**	**Doc. No.:**	
From:	**Troy Meyer and Derek Hrubes**	**Date:**	**June 29, 2018**
Subject:	**Closure Pipe Design Analysis**		
Project No.:	**0792021**		

1.0 INTRODUCTION

The purpose of this memorandum is to present the methods and results of the closure drain pipe analysis completed for the design of the proposed Heap Leach Facility (HLF) at StrataGold Corporation's (SGC) Eagle Gold Project located in Yukon Territory, Canada. SGC is a directly held, wholly owned subsidiary of Victoria Gold Corp. The HLF design is presented in a report titled "Eagle Gold Project Heap Leach Facility Detailed Design", issued by BGC Engineering and dated January 2018. Select Design Drawings have been provided in Attachment 1 for reference.

2.0 CLOSURE SYSTEM DESIGN

During closure of the HLF, the cyanide in the spent ore will be destructed, the heap will be rinsed and draindown flows will be managed through the existing pumping system. Once draindown flow and water quality are acceptable for the passive treatment system, the liner system below the In-Heap Pond will be punctured by drilling to allow complete drainage of water through a pre-installed outlet system into the closure sump. The closure sump drain system will consist of a linear low-density polyethylene (LLDPE) lined gravel sump with perforated N-12 pipe drain loop directing flow to high-density polyethylene (HDPE) outlet pipes (Drawing 05-04, Detail 31). The closure sump will be placed directly below the leak detection sump to direct residual flows from the leak detection system to the closure outfall (Drawing 05-02, Detail 22).

At closure, the liner system will be punctured by drilling through two 250 mm open casing pipes extending to the In-Heap Pond installed during initial construction (Drawing 05-04, Detail 33). The PLS and LDRS Sump liners will be punctured by a drill string which will be lowered through each casing. A series of steel plates installed during initial construction will guide the drill and stop the drilling head at the appropriate depth within the closure sump. Once the drill string is retrieved, fluid will drain through the punctured liner into the closure sump where it will enter the closure drain loop and drain by gravity to the outlet monitoring vault (Drawing 05-05, Detail 37). Three 150 mm SDR 11 HDPE pipes lead from the closure drain loop at a minimum 2% slope; approximately 40 m downstream from the closure sump at approximately Station 2+72, the three drain pipes merge into one 150 mm SDR 11 HDPE pipe where the grade steepens significantly (Drawing 03-05). This pipe transitions into one 150 mm SDR 17 HDPE pipe at approximately Station 1+80, once there is a sufficient reduction in the buried depth (Drawing 03-05).

The closure drain pipes will be installed such that they connect to the monitoring vault and to allow for water quality and quantity monitoring (Drawing 05-06). An additional closure pipe will be installed to connect from the event pond to approximately Station 0+40 of the design closure pipe alignment, complete with valves to direct flow, as shown in Figure 2-1.

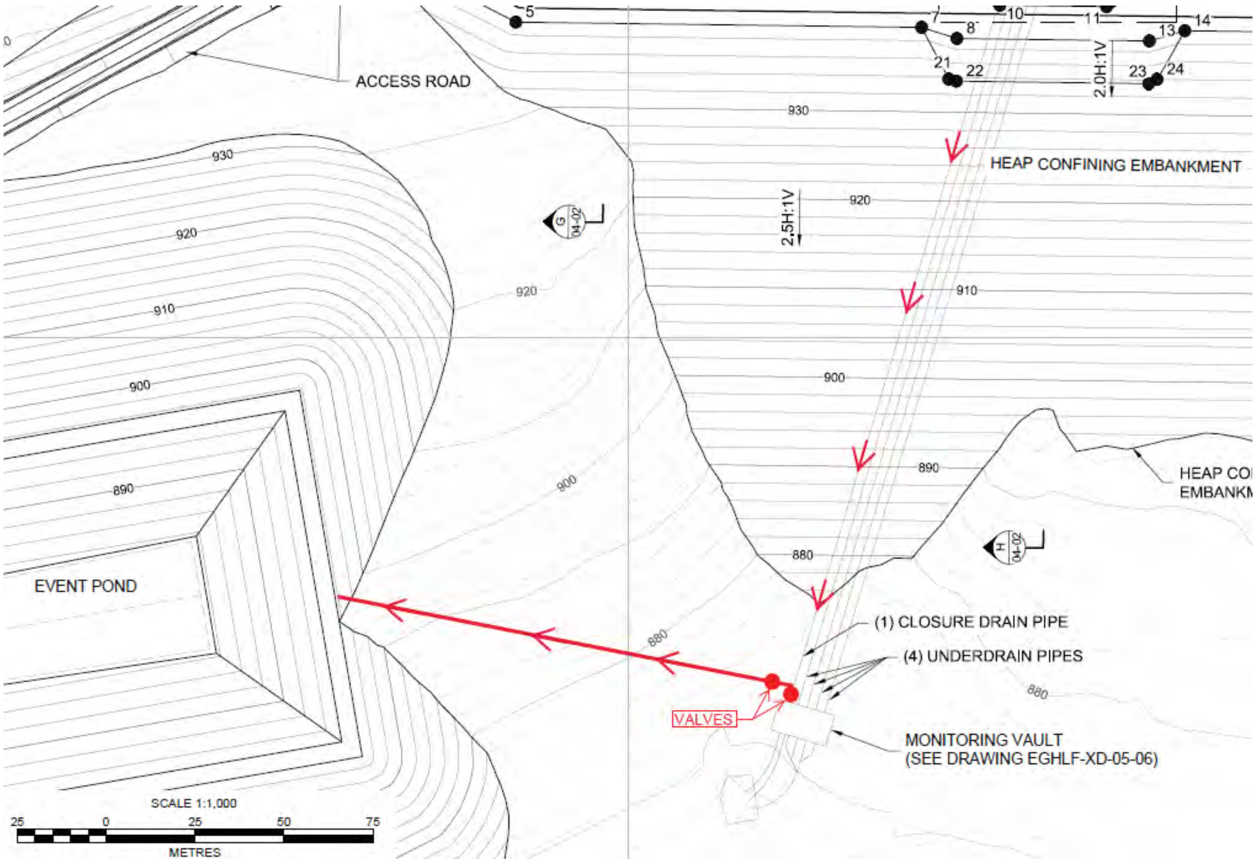

Figure 2-1. Proposed connection pipe alignment

The additional section of closure pipe will be required to flow under confined pressure uphill and this analysis is being performed to verify that there is sufficient elevation (head) difference between the closure sump and the event pond for the pipe system to convey the anticipated design flow at closure and through the post closure period.

3.0 CLOSURE PIPES

Solid wall HDPE pipe is specified for the closure pipes downstream of the closure drain loop. SDR 11 and SDR 17 HDPE pipe are used for the closure system based on the amount of overburden pressure at each section. Pipe sectional properties were obtained from available vendor product data and are presented in Table 3-1.

Table 3-1. Non-perforated solid wall HDPE pipe properties.

Dimension Ratio	Nominal Diameter (mm)	Outside Diameter (mm)	Inside Diameter (mm)	Wall Thickness (mm)	Pressure Rating (psi)	Manning's Roughness Coefficient
11	150	168	136	15.3	160	0.011
17	150	168	147	9.9	100	0.011

The additional section of closure pipe has been modeled as SDR 17, due to the minor amount of overburden pressure anticipated post-installation.

4.0 ANALYSIS METHOD

Hydraulic modeling was performed using Autodesk's Storm and Sanitary Analysis 2018 program, Version 12.0.42.0. The Storm and Sanitary Analysis 2018 program is capable of modeling complex hydrology and hydraulics, through detailed catchment and conveyance system definition. This is accomplished by inputting basins (catchments) and linking these with hydraulic elements (channels, pipes, manholes, ponds, orifices, weirs, etc.). The hydraulic model elements used for this analysis were used to provide results including peak flows, water surface elevations (hydraulic grade lines), and energy grade lines.

Numerous analysis methods are available for use within the Storm and Sanitary Analysis 2018 program. Since one of the pipes does have an uphill slope, where the outlet elevation is higher than the inlet elevation, the system required analysis with hydrodynamic routing.

A flow rate of 10 litres per second (l/s) was modeled to confirm conveyance within the system, based on anticipated maximum closure flow rates provided by SGC.

5.0 ANALYSIS RESULTS

A summary of the results of the hydraulic model for a flow rate of 10 l/s are summarized in Table 5-1 and Table 5-2. A model plan view, detailed output report, and hydraulic profile are provided in Attachment 2.

Table 5-1. Summary of hydraulic link results (10 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	10
2_SDR17	10
3_SDR17	10
4_SDR17 (DIVERSION)	10

Table 5-2. Summary of hydraulic node results (10 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.04	~ 0
STA. 1+81.4	890.80	6.42	9.13
STA. 0+58.2	871.40	24.91	34.43
STA. 0+40	869.80	26.42	**37.58**
EVENT POND	896.00	0.04	~ 0

Routing 10 l/s through the closure pipe system identified that the system could adequately convey this assumed flow, without backing water into the in-heap pond behind the embankment. The maximum head pressure anticipated for a flow rate of 10 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 37.58 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

The potential flow capacity within the closure pipe system increases as the elevation (head) difference between the water levels in the closure sump and the event pond increases. A sensitivity analysis was performed, and it was estimated that water would begin backing up into the in-heap pond once the flow rate exceeds approximately 19 l/s. The piping system is capable of conveying flows in excess of this through an increase in pressure head if the In-Heap Pond impounds water. However, the maximum flow rate is likely dictated by the hydraulic conductivity of the gravel surrounding the closure drain loop, within the closure sump.

A summary of the results of the hydraulic model for a flow rate of 19 l/s are summarized in Table 5-3 and Table 5-4. A detailed output report and hydraulic profile are provided in Attachment 3.

Table 5-3. Summary of hydraulic link results (19 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	19
2_SDR17	19
3_SDR17	19
4_SDR17 (DIVERSION)	19

Table 5-4. Summary of hydraulic node results (19 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.06	~ 0
STA. 1+81.4	890.80	9.67	13.75
STA. 0+58.2	871.40	27.72	39.43
STA. 0+40	869.80	29.04	**41.30**
EVENT POND	896.00	0.05	~ 0

The maximum head pressure anticipated for a flow rate of 19 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 41.30 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

6.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of StrataGold Corporation. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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Yours sincerely,

BGC ENGINEERING INC.
per:

Troy Meyer, P.Eng.
Principal Engineer

Derek Hrubes, P.E.
Civil Engineer

Reviewed by:

Brad Bijold, P.E.
Principal Engineer

Engineers Yukon Permit to Practice
PP092 BGC Engineering Inc.

TM/HW/rm/pg

ATTACHMENT 1
SELECT PHASE 1 FINAL DESIGN DRAWINGS

EGHLF-XD-03-05

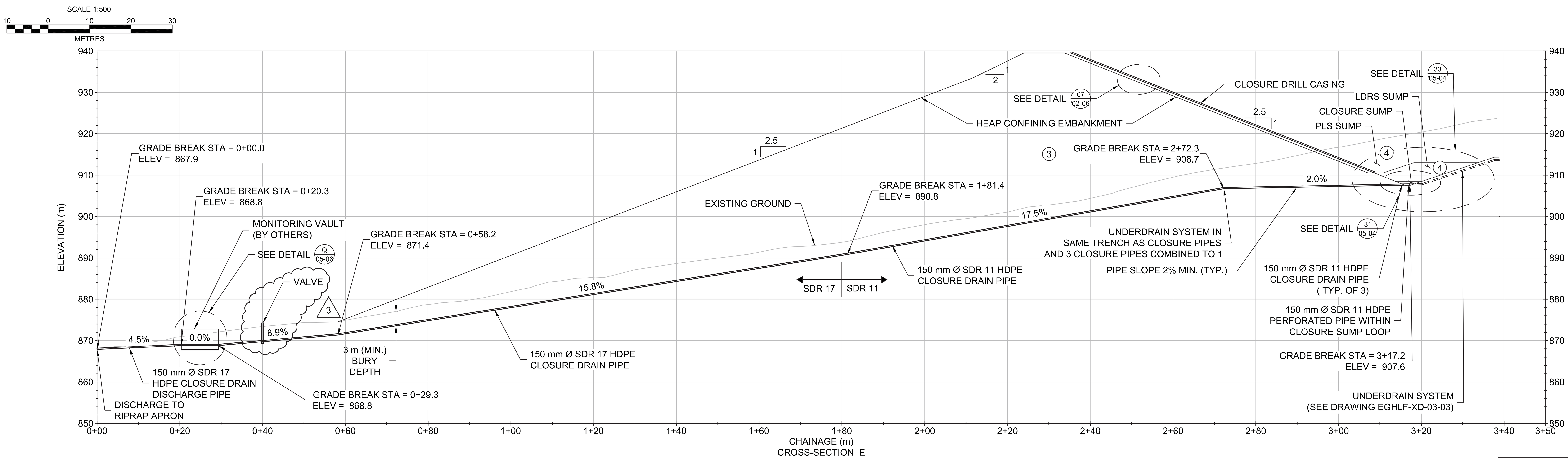
EGHLF-XD-05-02

EGHLF-XD-05-04

EGHLF-XD-05-05

EGHLF-XD-05-06

SCALE 1:500



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THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

ISSUED FOR CONSTRUCTION

LEGEND
- (2) SELECT FILL
- (3) STRUCTURAL FILL
- (4) OVERLINER DRAIN FILL
- (5) SELECT DRAIN FILL

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.

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0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	CLOSURE AND UNDERDRAIN ALIGNMENT AND PROFILE REVISED
2	17	10	12	DAG	TLM	MEH	TLM	REVISED PIPE SDR
3	18	06	27	DAG	TLM	MEH	TLM	ADD VALVE AT STATION 0+40

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 09/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 09/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: CLOSURE PIPING PLAN AND PROFILE

SCALE:	DWG No.:	REV.:
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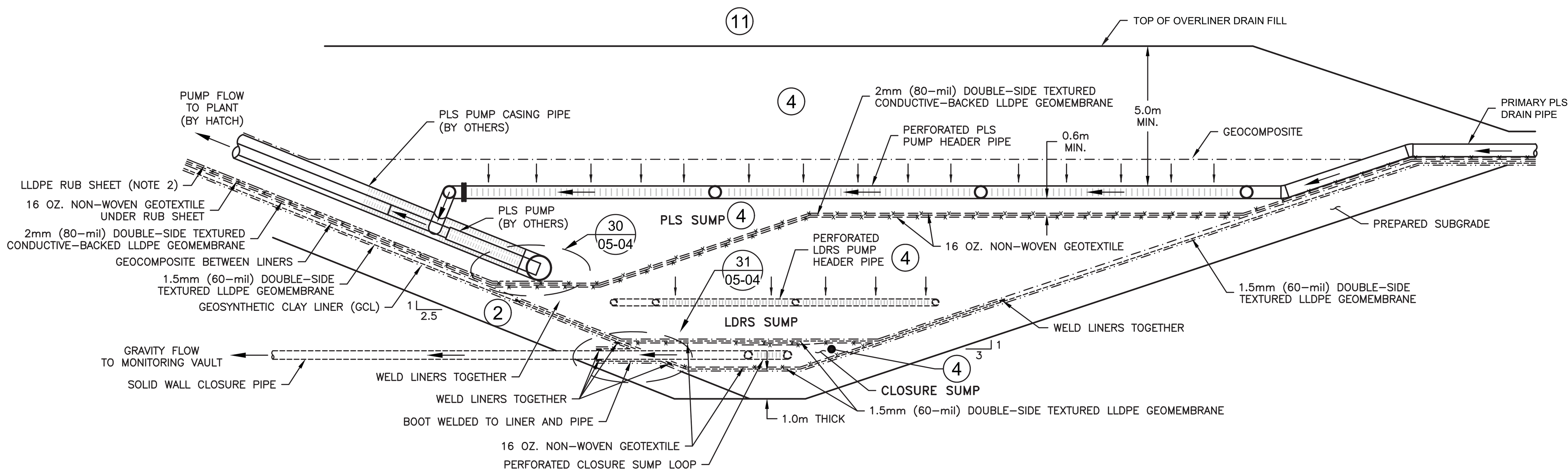
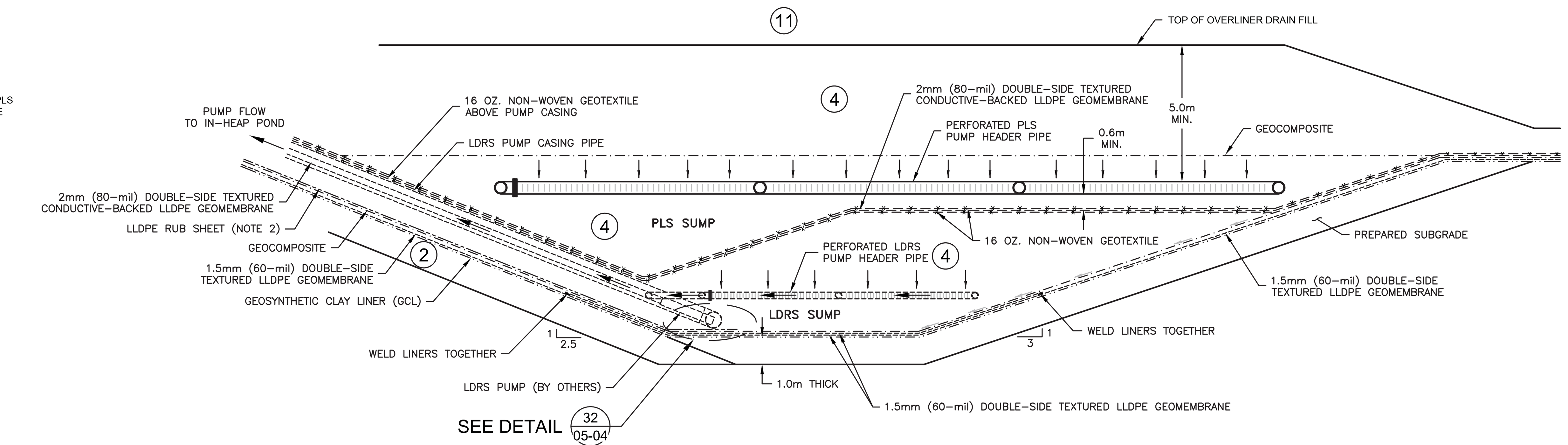


PLS, LDRS & CLOSURE SUMP DETAIL 22/05-01



PLS, LDRS & CLOSURE SUMP DETAIL 23/05-01

PLS, LDRS & CLOSURE SUMP DETAIL 24/05-01

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NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
6. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

LEGEND
- (2) SELECT FILL
- (4) OVERLINER DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

PROFESSIONAL ENGINEER
YUKON TERRITORY
TROY LEE MEYER
03 JAN 18

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PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

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PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: IN-HEAP SUMP DETAILS SHEET 2 OF 2

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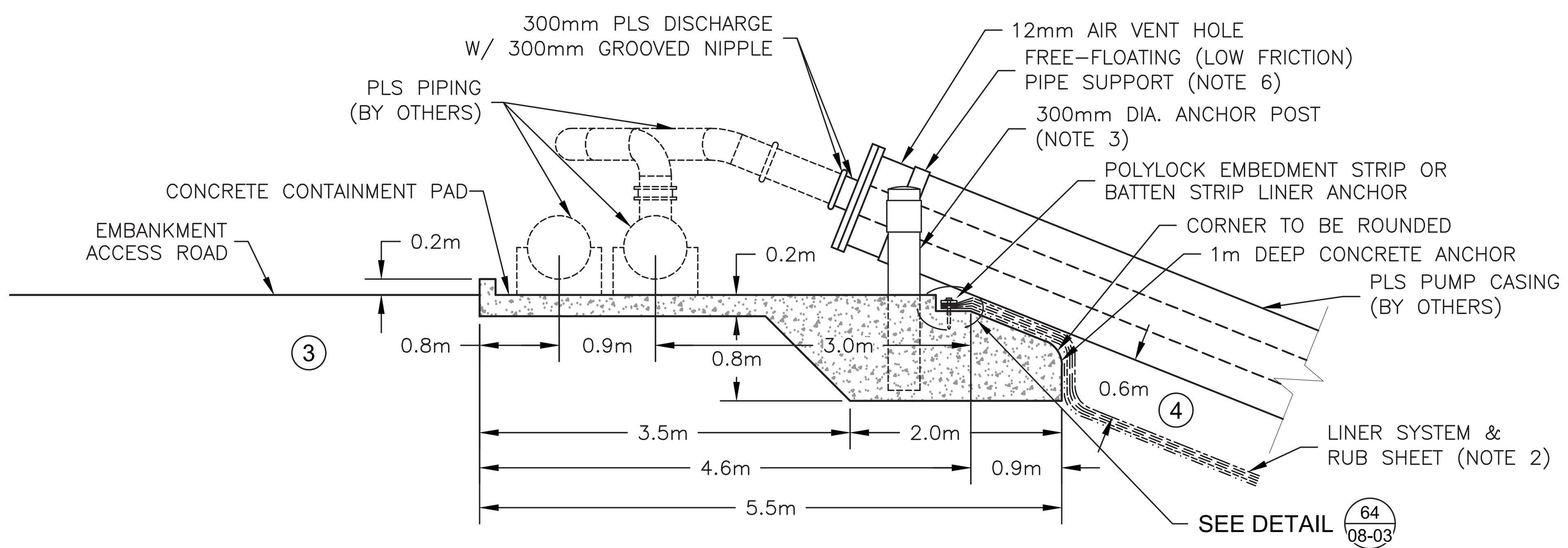

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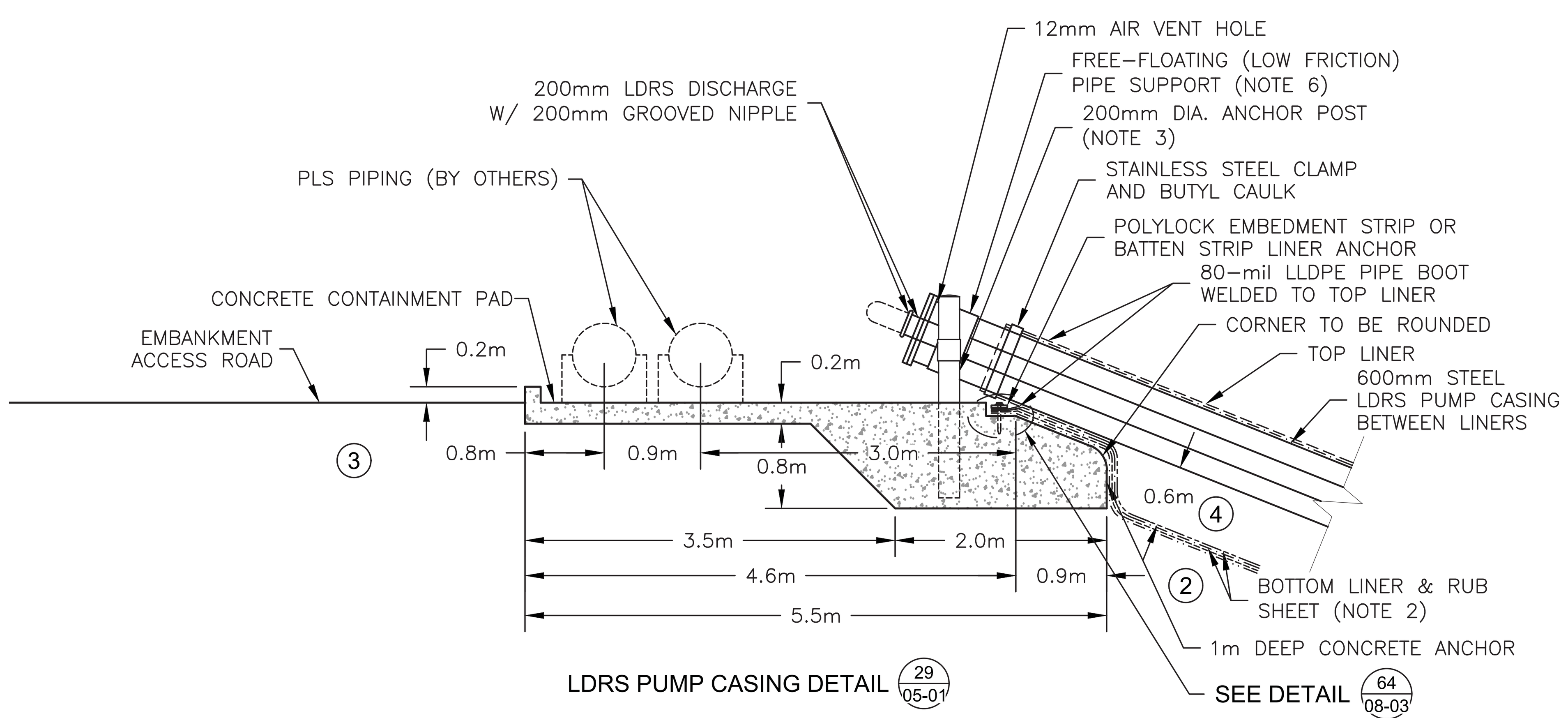
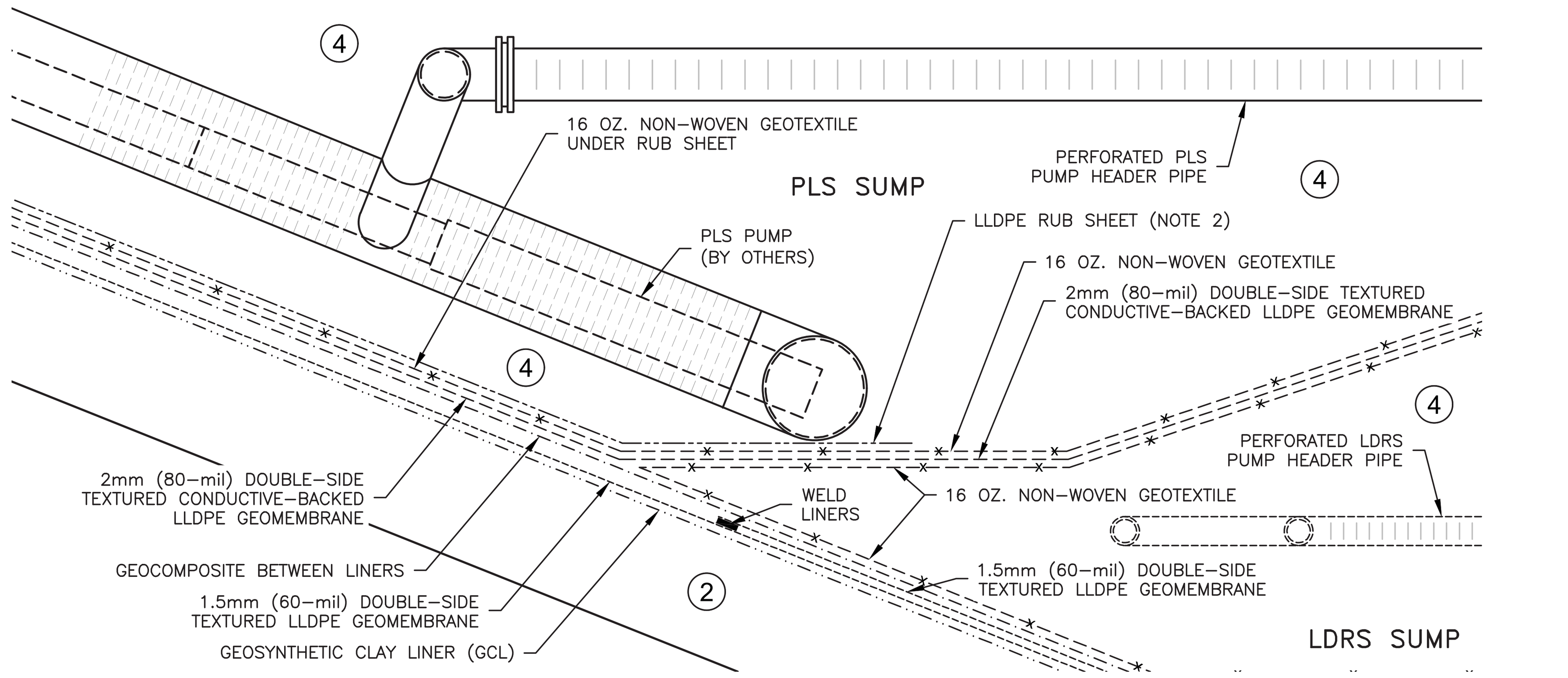
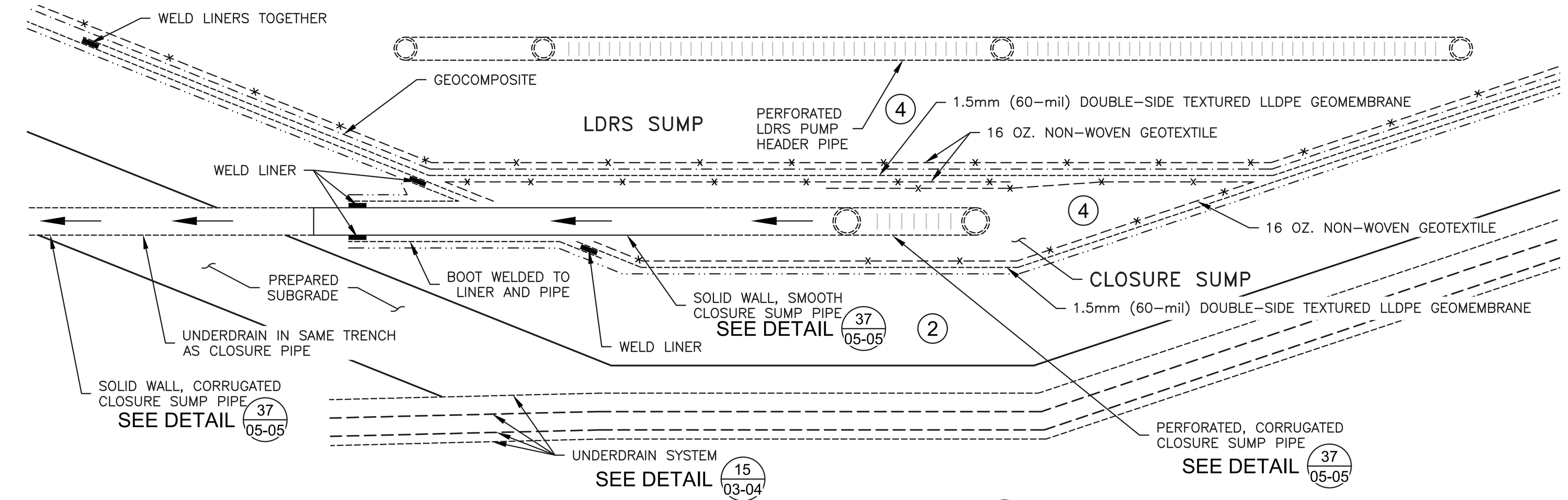


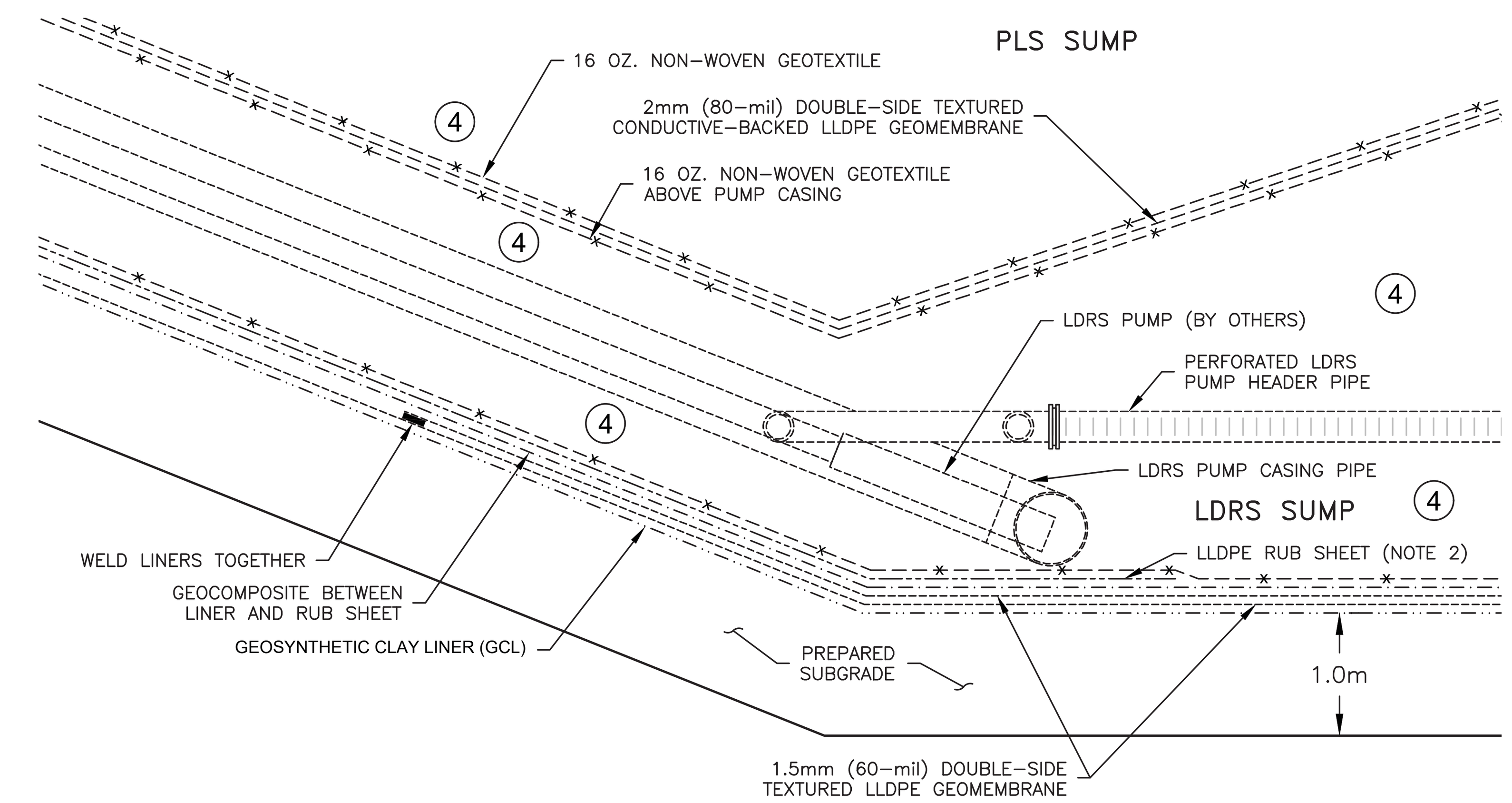
LDRS PUMP CASING DETAIL 29/05-01



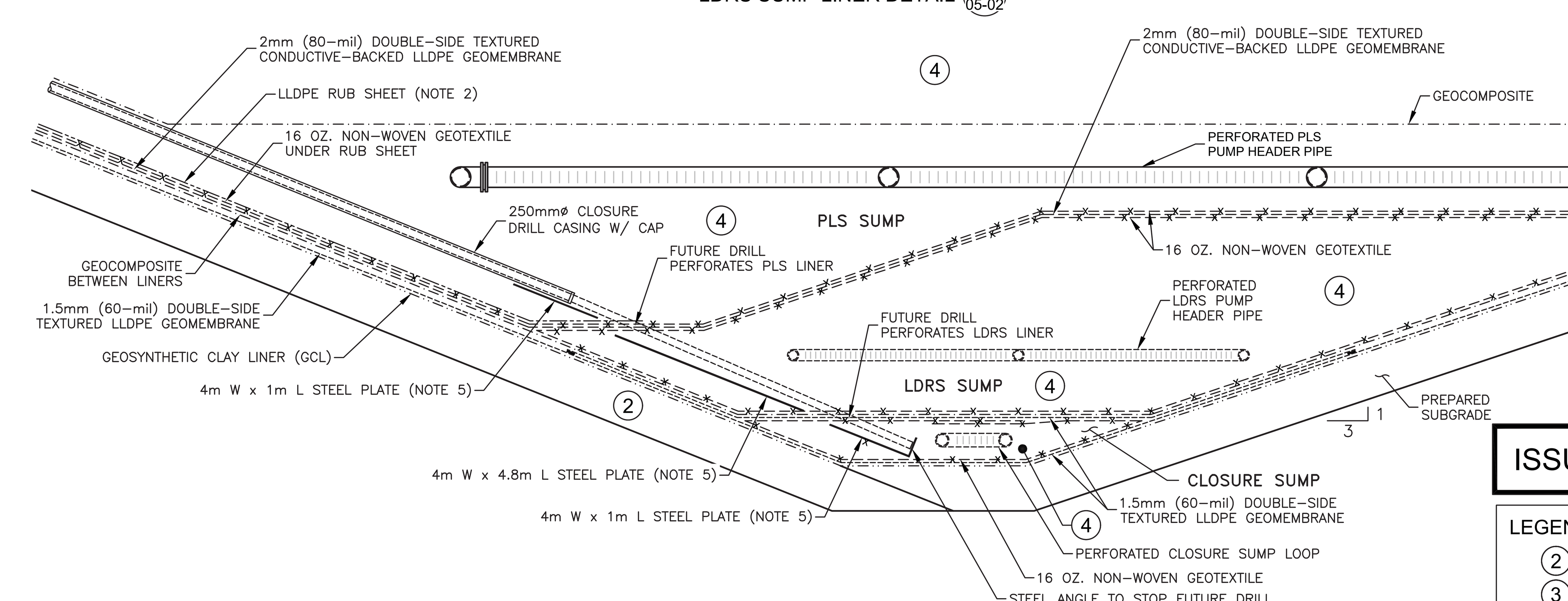
PLS SUMP LINER DETAIL 30/05-02



CLOSURE SUMP LINER DETAIL 31/05-02, 03-05



LDRS SUMP LINER DETAIL 32/05-02



CLOSURE DRILL CASING DETAIL 33/05-03

ISSUED FOR CONSTRUCTION

LEGEND

- (2) SELECT FILL
- (3) STRUCTURAL FILL
- (4) OVERLINER DRAIN FILL
- (5) SELECT DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

NOTES:

1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR 16 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
6. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
7. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH GEOCOMPOSITE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

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PROFESSIONAL ENGINEER — YUKON — TROY LEE MEYER — TERRITORY — 08 JAN 18

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PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

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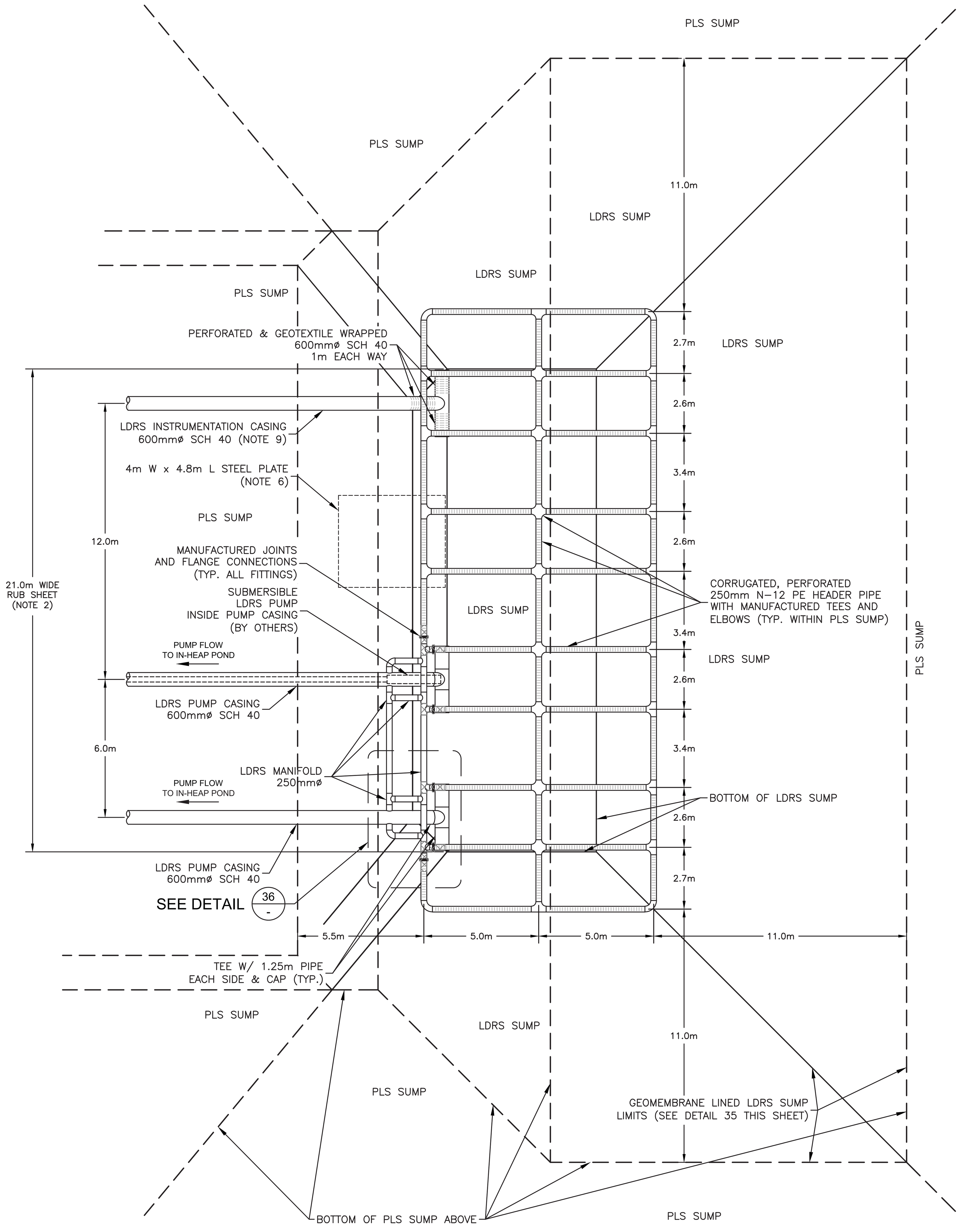
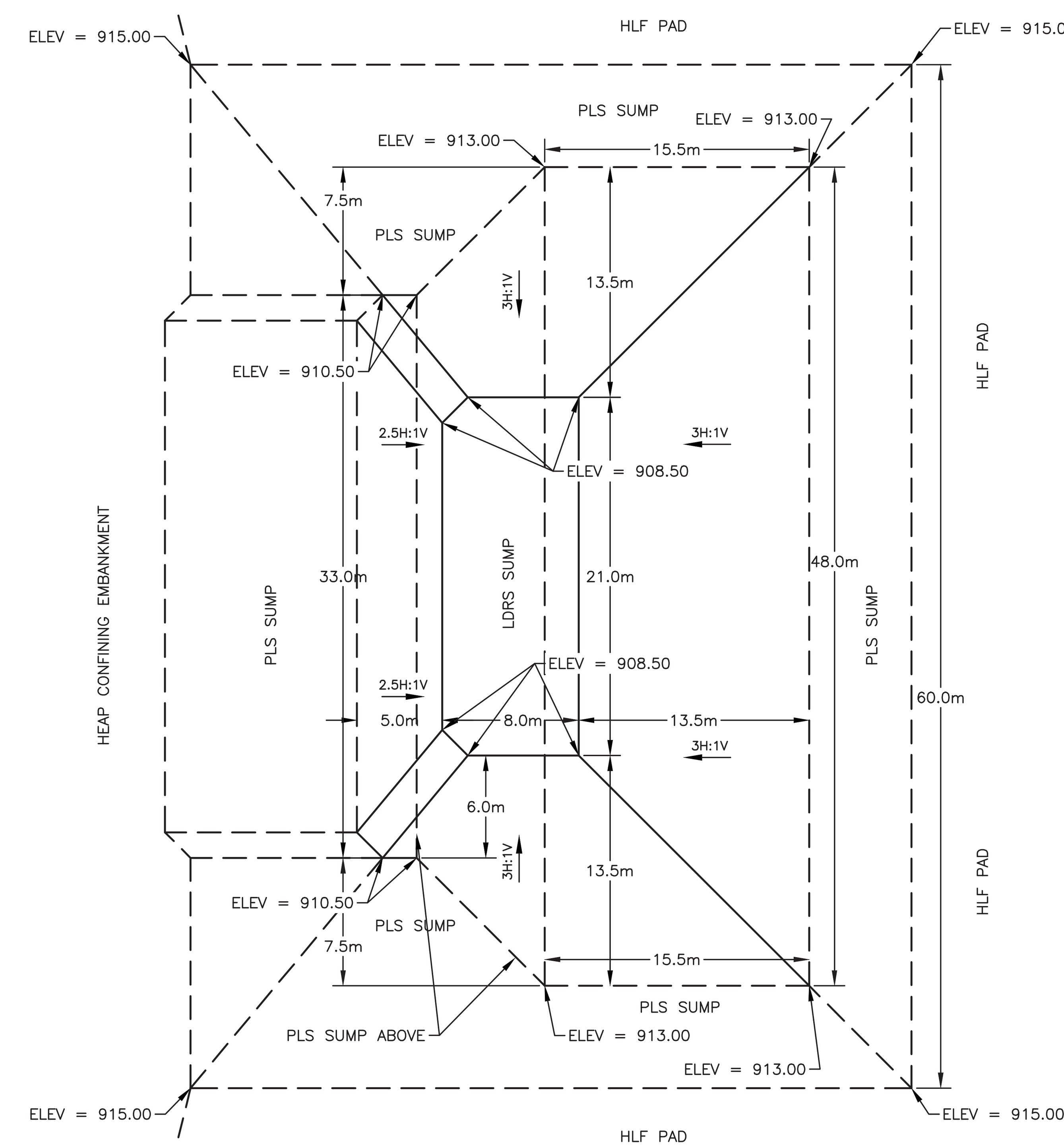


LDRS SUMP AND PIPING PLAN 34/05-01



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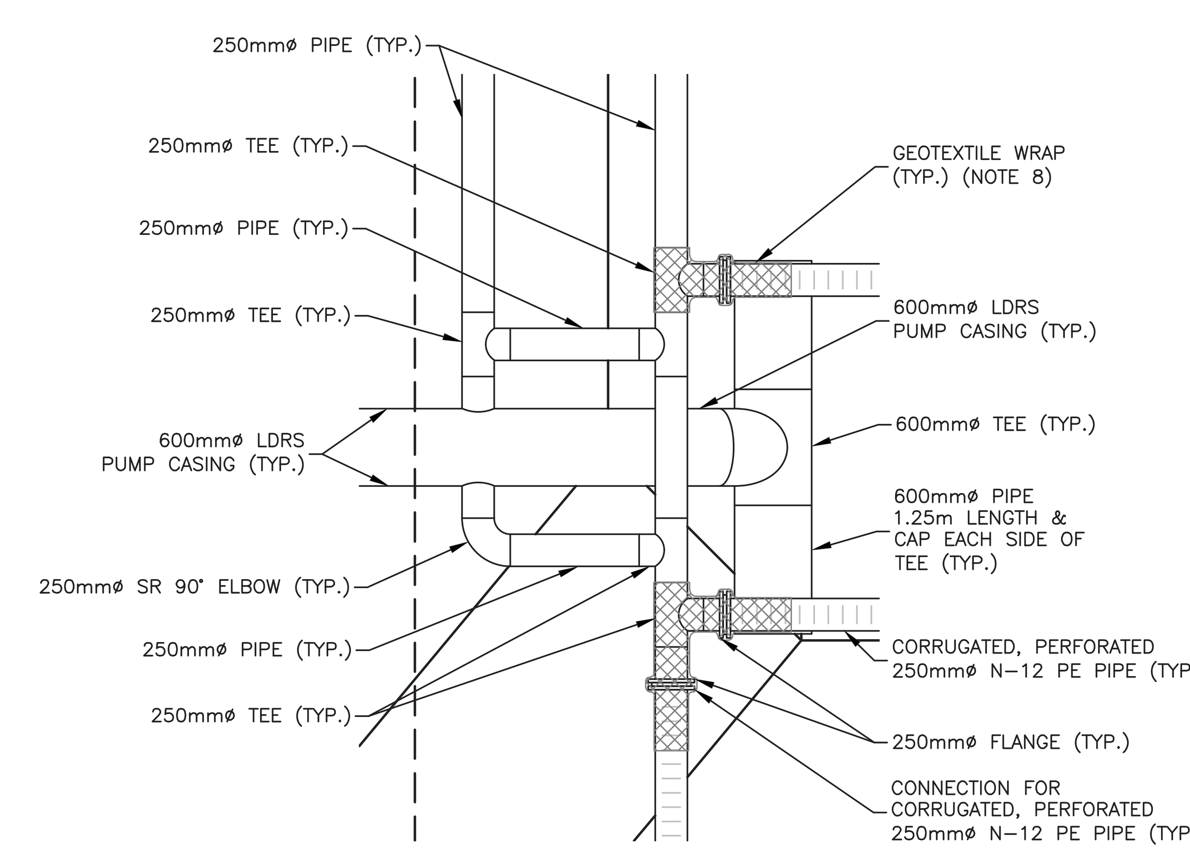

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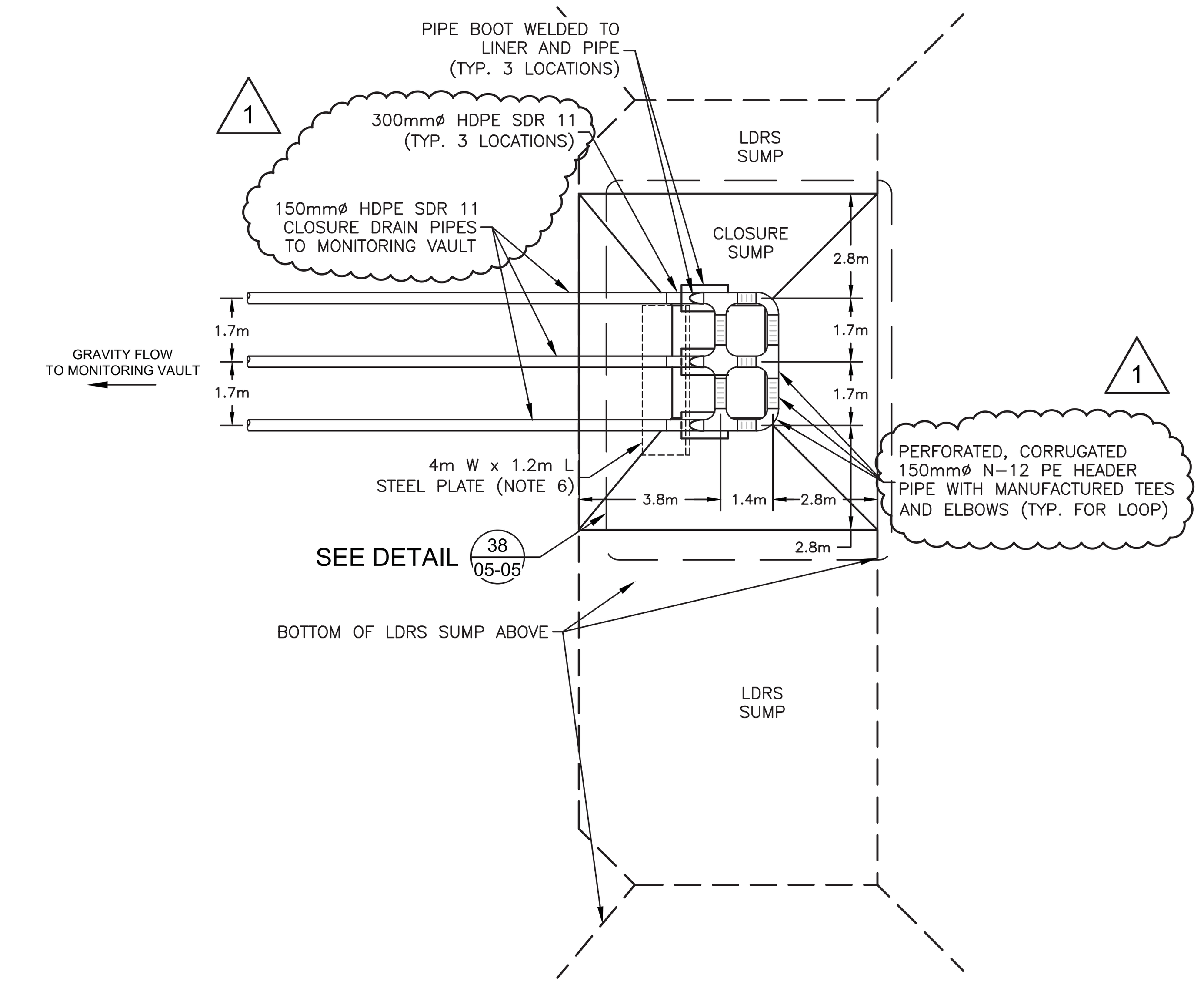
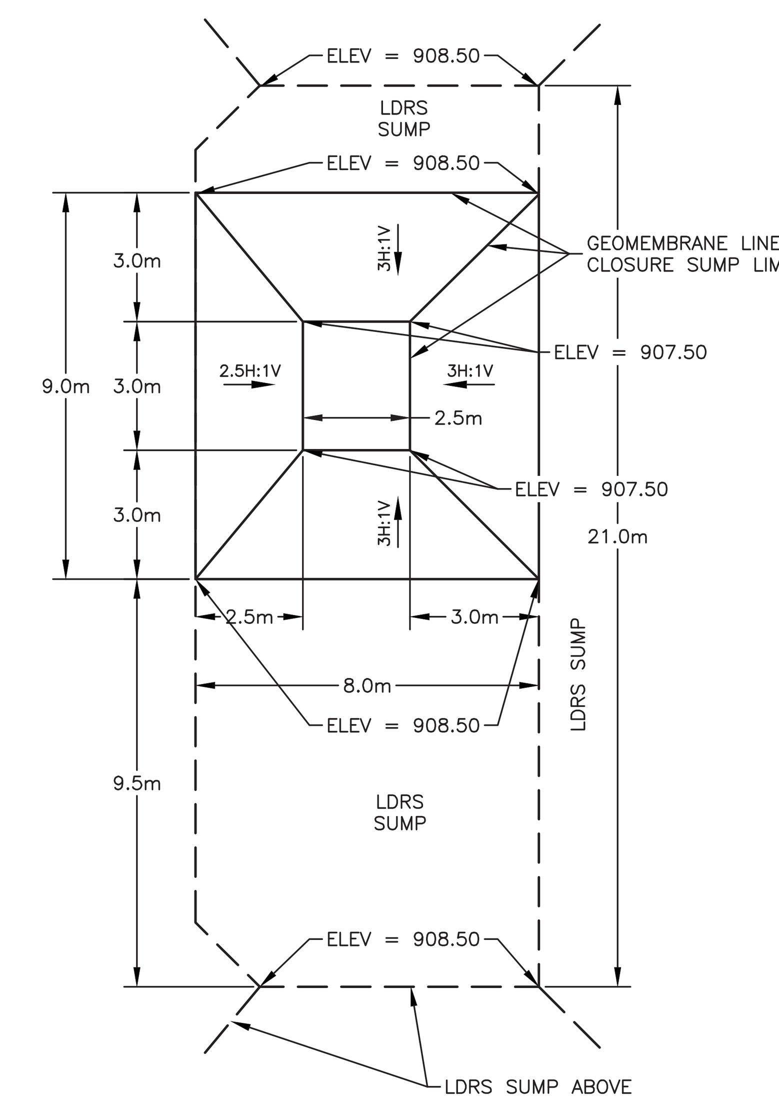


CLOSURE SUMP AND PIPING PLAN 37/05-01, 03-05, 05-04



CLOSURE SUMP GEOMETRY DETAIL 38/-

NOTES:

1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. LDRS RISER PIPE ASSEMBLIES SHALL BE 600mm O.D. FABRICATED USING ASTM 139 HIGH STRENGTH LOW ALLOY STEEL (A606 TYPE 4.) MINIMUM PIPE WALL THICKNESS SHALL BE 17.5mm (SCH 40).
4. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
5. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
6. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR TWO LAYERS OF 12 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
7. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
8. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.
9. THE BOTTOM 2m OF LDRS INSTRUMENTATION CASING SHALL BE SLOTTED. SLOTTING IN THE STEEL PIPE SHALL BE 2mm WIDE BY 75mm LONG (MEASURED PERPENDICULAR TO PIPE FLOW) SPACED 150mm ON CENTER AROUND THE PIPE IN ROWS SPACED 150mm ON CENTER.

ISSUED FOR CONSTRUCTION

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0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	18	06	27	DAG	TLM	MEH	TLM	REVISE DETAIL 37 PIPES

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LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY

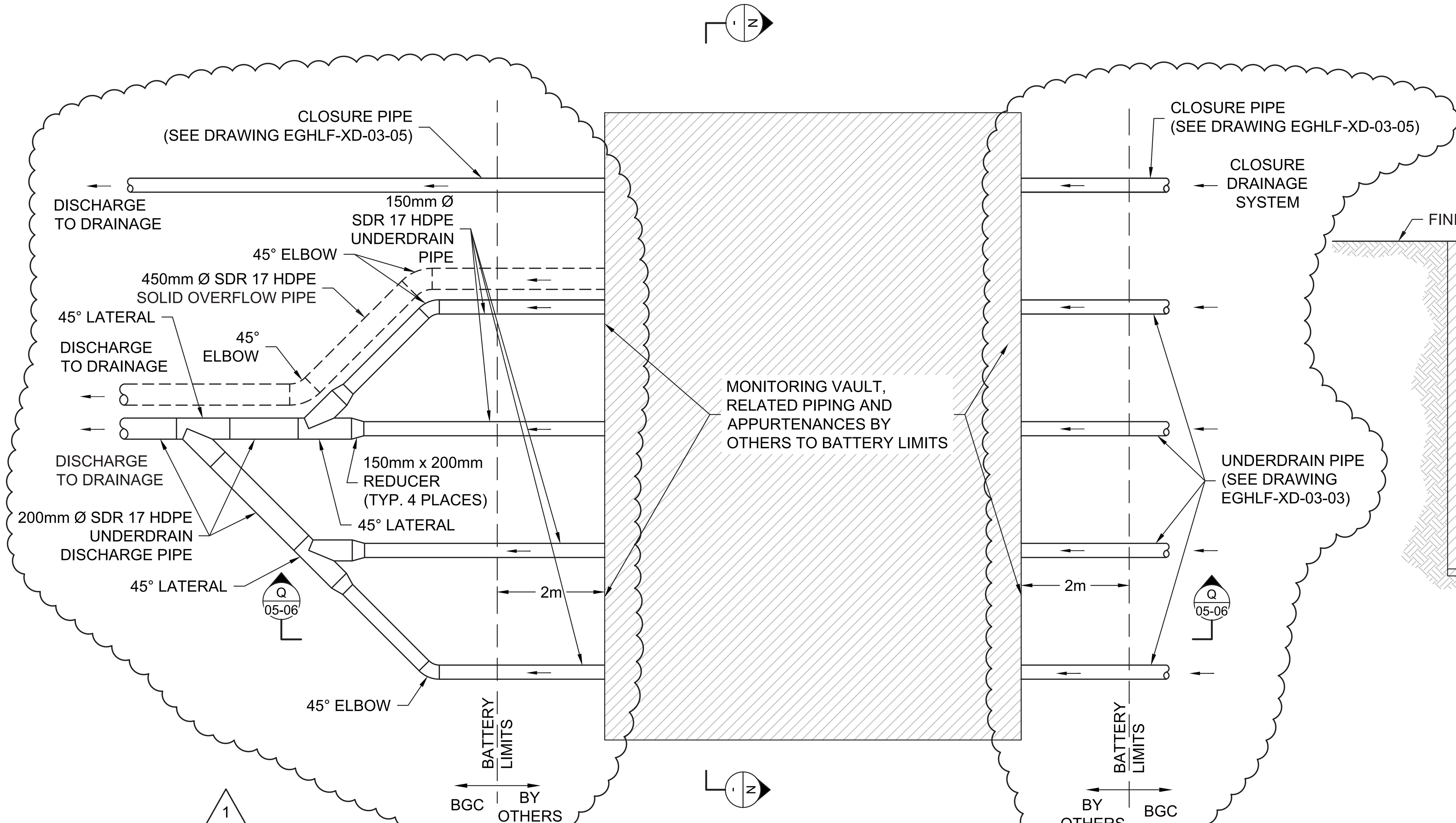
CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

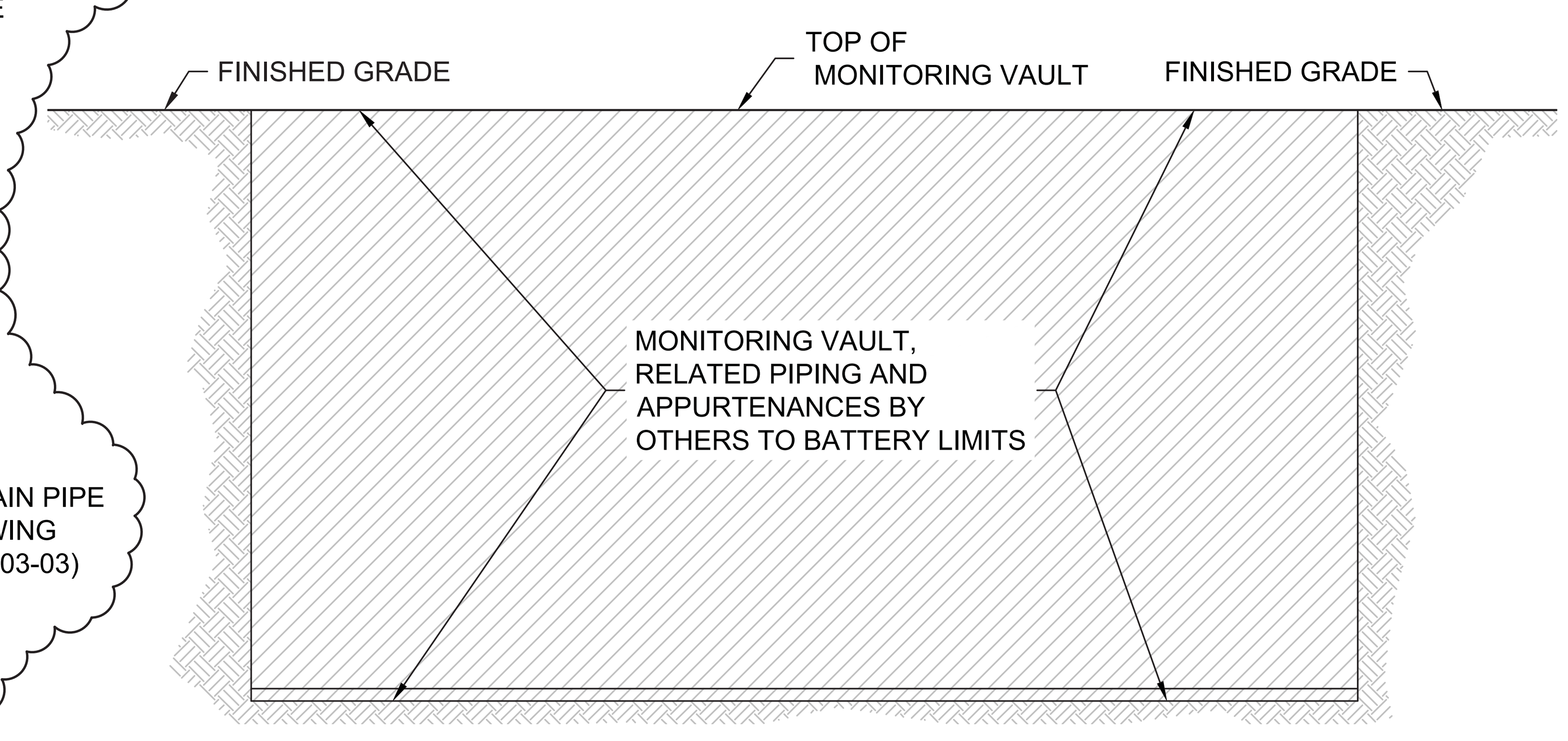
TITLE: LDRS AND CLOSURE SUMP DETAILS

SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-05	1

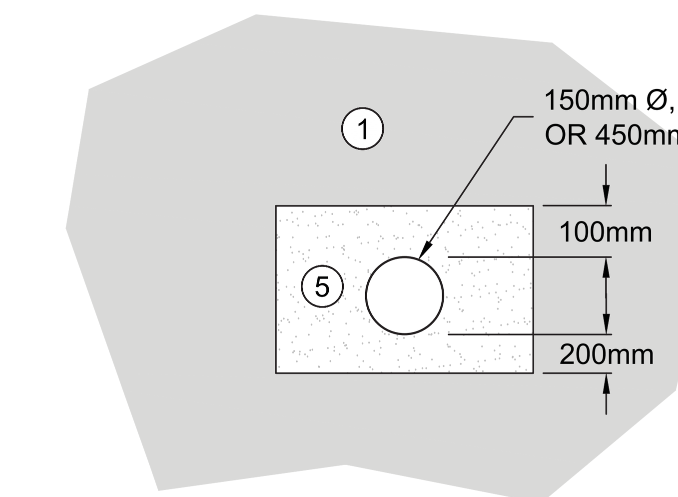
X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-05.dwg Layout: EGHLF-XD-05-05 Plot Date Jun 28 18 Time: 12:09 PM



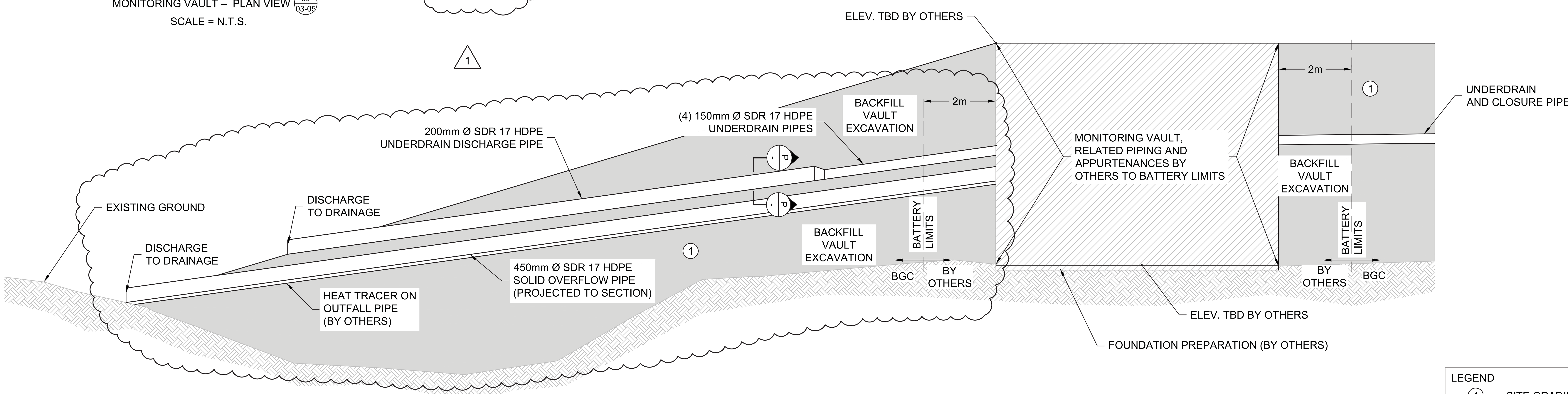
MONITORING VAULT – PLAN VIEW 39/03-05
SCALE = N.T.S.



CLOSURE OUTLET VAULT SECTION N/-
SCALE = N.T.S.



TYPICAL PIPE TRENCH DETAIL P/-
SCALE = N.T.S.



MONITORING VAULT – PROFILE VIEW Q/03-05
SCALE = N.T.S.

LEGEND

1	SITE GRADING FILL
5	SELECT DRAIN FILL

PROFESSIONAL ENGINEER – YUKON TERRITORY – TROY LEE MEYER – 03 JAN 18

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. MONITORING VAULT TO BE DESIGNED BY OTHERS AND SHOWN HERE FOR REFERENCE ONLY. BATTERY LIMITS FOR BGC DESIGN ARE 2 m FROM OUTSIDE OF MONITORING VAULT. DESIGN OUTSIDE TETRA TECH BATTERY LIMITS ARE FOR REFERENCE ONLY..

X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-06.dwg Layout: EGHLF-XD-05-06 Plot Date Jan 2 18 Time: 5:12 PM

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	MONITORING VAULT DETAILS REVISED

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 09/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 09/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

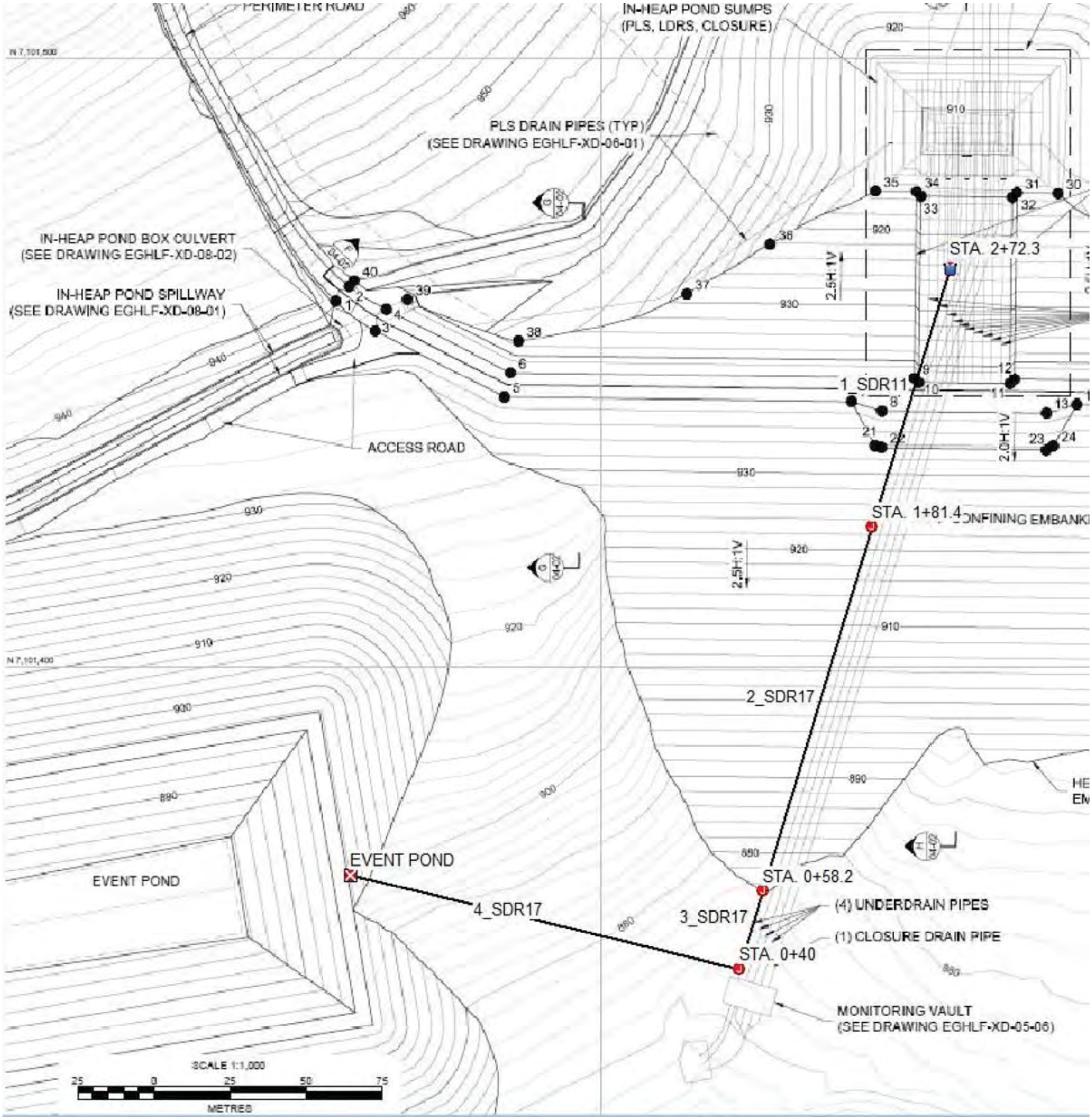
CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

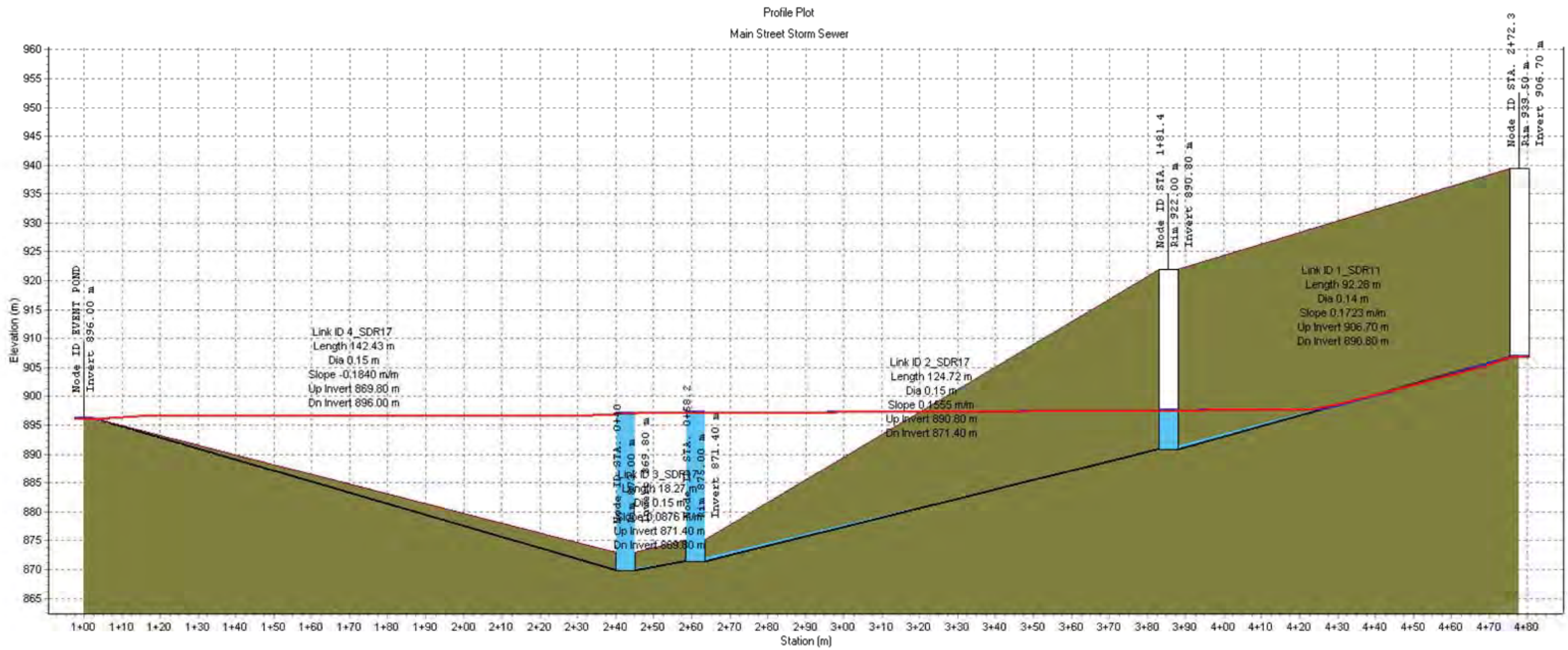
TITLE: MONITORING VAULT DETAILS

SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-06	1

ATTACHMENT 2
HYDRAULIC MODELING RESULTS – 10 LPS FLOW



PERIMETER ROAD
IN-HEAP POND SUMPS
(PLS, LDRS, CLOSURE)
PLS DRAIN PIPES (TYP)
(SEE DRAWING EGHLF-XD-06-01)
IN-HEAP POND BOX CULVERT
(SEE DRAWING EGHLF-XD-08-02)
IN-HEAP POND SPILLWAY
(SEE DRAWING EGHLF-XD-08-01)
ACCESS ROAD
STA. 2+72.3
1_SDR11
STA. 1+81.4
2_SDR17
EVENT POND
EVENT POND
4_SDR17
3_SDR17
STA. 0+58.2
STA. 0+40
(4) UNDERDRAIN PIPES
(1) CLOSURE DRAIN PIPE
MONITORING VAULT
(SEE DRAWING EGHLF-XD-05-06)
2.5H:1V
2.0H:1V
SCALE 1:1,000
METRES



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.04	897.00	897.07	897.50	906.74

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	10.00	10.00	10.00	10.00
Max Vel (m/s):	0.90	1.82	2.46	3.22
Max Depth (m):	0.09	0.15	0.15	0.09

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****
File Name .... Closure Pipe Analysis.SPF

****
Analysis Options
****
Flow Units .... LPS
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****
Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

```
57.53
  2_SDR17          CIRCULAR            0.15         0.15            1         0.02          0.04
67.27
  3_SDR17          CIRCULAR            0.15         0.15            1         0.02          0.04
50.47
  4_SDR17          CIRCULAR            0.15         0.15            1         0.02          0.04
73.15


  **************************        Volume         Volume
  Flow Routing Continuity         hectare-m       Mliters
  **************************       ---------     ---------
  External Inflow ..........          0.086          0.864
  External Outflow .........          0.084          0.837
  Initial Stored Volume ....          0.000          0.000
  Final Stored Volume ......          0.001          0.008
  Continuity Error (%) .....          0.020


  ******************
  Node Depth Summary
  ******************

  ------------------------------------------------------------------------------------------
  Node             Average   Maximum   Maximum   Time of Max     Total     Total  Retention
  ID                 Depth     Depth       HGL    Occurrence   Flooded      Time       Time
                  Attained  Attained  Attained                  Volume   Flooded
                         m         m         m   days  hh:mm     ha-mm   minutes   hh:mm:ss
  ------------------------------------------------------------------------------------------
  STA. 0+40          26.42     27.20    897.00      0  07:17         0         0    0:00:00
  STA. 0+58.2        24.91     25.67    897.07      0  06:47         0         0    0:00:00
  STA. 1+81.4         6.42      6.70    897.50      0  21:11         0         0    0:00:00
  EVENT POND          0.04      0.04    896.04      0  06:18         0         0    0:00:00
  STA. 2+72.3         0.04      0.04    906.74      0  00:23         0         0    0:00:00


  *****************
  Node Flow Summary
  *****************

  -------------------------------------------------------------------------------------
  Node                 Element     Maximum      Peak      Time of  Maximum Time of Peak
  ID                      Type     Lateral    Inflow  Peak Inflow  Flooding     Flooding
                                    Inflow             Occurrence  Overflow   Occurrence
                                       LPS       LPS  days  hh:mm       LPS  days  hh:mm
  -------------------------------------------------------------------------------------
  STA. 0+40             JUNCTION      0.00     10.00     0  07:03      0.00
  STA. 0+58.2           JUNCTION      0.00     10.00     0  18:43      0.00
  STA. 1+81.4           JUNCTION      0.00     10.00     0  00:24      0.00
  EVENT POND            OUTFALL       0.00     10.00     0  06:18      0.00
  STA. 2+72.3           STORAGE      10.00     10.00     0  00:00      0.00


  ********************
  Storage Node Summary
  ********************


---------------------------------------------------------------------------------------------------------
----------------------------
  Storage Node ID        Maximum     Maximum    Time of Max    Average   Average       Maximum
Maximum  Time of Max.        Total
                          Ponded      Ponded         Ponded     Ponded    Ponded  Storage Node
Exfiltration  Exfiltration  Exfiltrated
                          Volume      Volume         Volume     Volume    Volume       Outflow
Rate          Rate        Volume
                         1000 m³         (%)     days hh:mm    1000 m³       (%)           LPS
cmm      hh:mm:ss      1000 m³

---------------------------------------------------------------------------------------------------------
----------------------------
```

STA. 2+72.3 0.003 0 0 00:23 0.003 0 10.00
0.00 0:00:00 0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
EVENT POND	95.52	9.99	10.00
System	95.52	9.99	10.00

****
Link Flow Summary
****

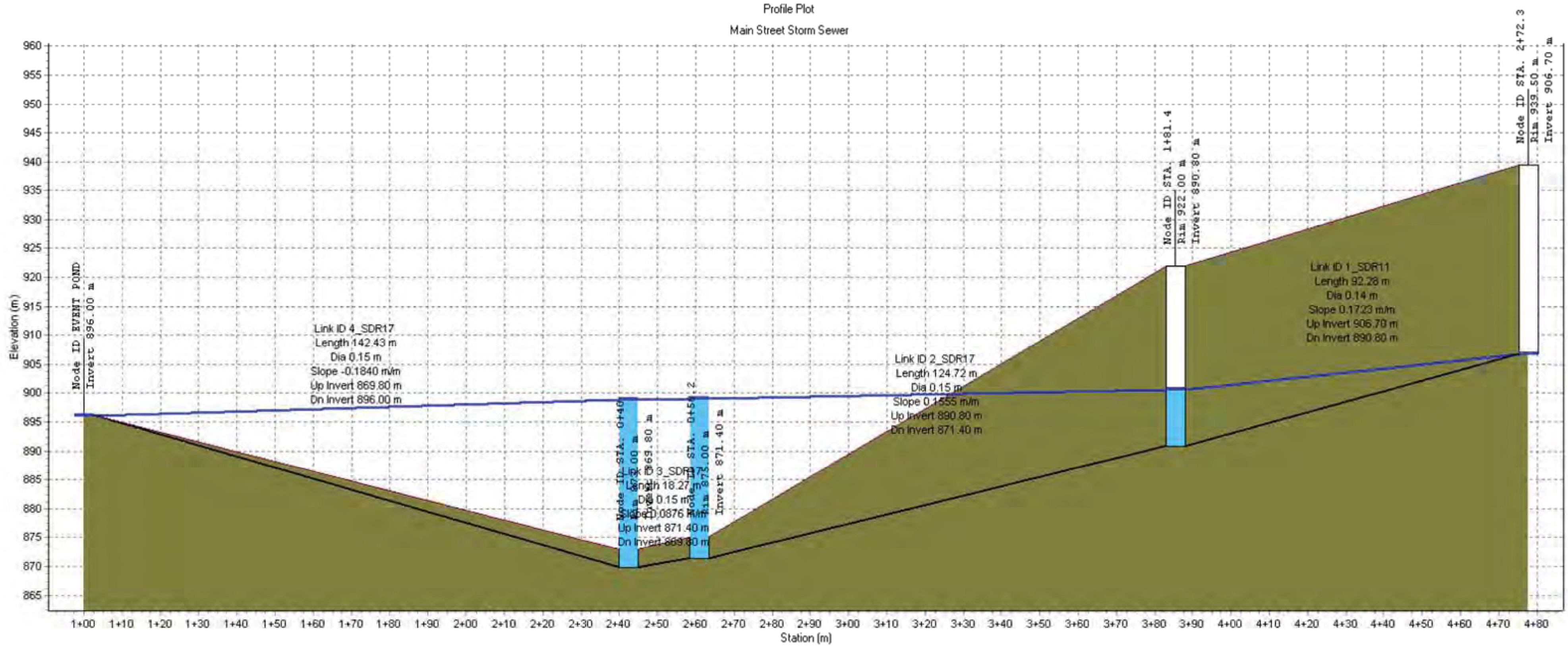
Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
1_SDR11	CONDUIT	0 00:24	3.22	1.00	10.00	57.53	0.17	0.64	0	Calculated
2_SDR17	CONDUIT	0 18:43	2.46	1.00	10.00	67.27	0.15	1.00	1408	SURCHARGED
3_SDR17	CONDUIT	0 07:03	1.82	1.00	10.00	50.47	0.20	1.00	1430	SURCHARGED
4_SDR17	CONDUIT	0 06:18	0.90	1.00	10.00	73.15	0.14	0.62	0	Calculated

****
Highest Flow Instability Indexes
****
All links are stable.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage node invert elevation.
Assumed initial water surface elevation equal to invert elevation.

Analysis began on: Mon Jun 25 08:56:24 2018
Analysis ended on: Mon Jun 25 08:56:25 2018
Total elapsed time: 00:00:01

ATTACHMENT 3
HYDRAULIC MODELING RESULTS – 19 LPS FLOW



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.05	898.84	899.12	900.66	906.76

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	19.00	19.00	19.00	19.00
Max Vel (m/s):	1.56	2.21	2.89	4.15
Max Depth (m):	0.10	0.15	0.15	0.10

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****

File Name .... Closure Pipe Analysis_Sensitivity Analysis.SPF

****
Analysis Options
****

Flow Units .... LPS
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****

Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

57.53

2_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	67.27
3_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	50.47
4_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	73.15

****
Flow Routing Continuity
****

	Volume hectare-m	Volume Mliters
External Inflow	0.164	1.642
External Outflow	0.162	1.620
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.010
Continuity Error (%)	0.007	

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
STA. 0+40	28.61	29.04	898.84	0	13:40	0	0	0:00:00
STA. 0+58.2	27.29	27.72	899.12	0	10:04	0	0	0:00:00
STA. 1+81.4	9.67	9.86	900.66	0	16:19	0	0	0:00:00
EVENT POND	0.05	0.05	896.05	0	05:39	0	0	0:00:00
STA. 2+72.3	0.06	0.06	906.76	0	15:58	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	hh:mm
STA. 0+40	JUNCTION	0.00	19.00	0	08:53	0.00		
STA. 0+58.2	JUNCTION	0.00	30.96	0	00:06	0.00		
STA. 1+81.4	JUNCTION	0.00	19.00	0	04:32	0.00		
EVENT POND	OUTFALL	0.00	19.00	0	05:39	0.00		
STA. 2+72.3	STORAGE	19.00	19.00	0	00:00	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³

STA. 2+72.3	0.005	0	0	15:58	0.005	0	19.00	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
EVENT POND	98.06	18.97	19.00
System	98.06	18.97	19.00

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
1_SDR11	CONDUIT	0 04:32	4.15	1.00	19.00	57.53	0.33	0.72	0	Calculated
2_SDR17	CONDUIT	0 04:38	2.89	1.00	19.00	67.27	0.28	1.00	1426	SURCHARGED
3_SDR17	CONDUIT	0 08:53	2.21	1.00	19.00	50.47	0.38	1.00	1434	SURCHARGED
4_SDR17	CONDUIT	0 05:39	1.56	1.00	19.00	73.15	0.26	0.67	0	Calculated

****
Highest Flow Instability Indexes
****
All links are stable.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage node invert elevation.
Assumed initial water surface elevation equal to invert elevation.

Analysis began on: Fri Jun 29 07:05:30 2018
Analysis ended on: Fri Jun 29 07:05:31 2018
Total elapsed time: 00:00:01

APPENDIX E

O'Kane Consultants Inc. - Eagle Gold Project - Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas

O'Kane Consultants Inc.
Integrated Geotechnical Engineering Services
Specialists in Unsaturated Zone Hydrology

April 28, 2014

Jim Harrington
Access Consulting Group
#3 Calcite Business Centre, 151 Industrial Road
Whitehorse, YK Y1A 2V3

Mr. Harrington:

Re: Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas

O'Kane Consultants Inc. (OKC) was retained by Alexco Environmental Group (AEG) in February 2014 to aid in furthering the development of cover system designs for closure of the proposed heap leach facility (HLF) and waste rock storage areas (WRSAs) at Victoria Gold's Eagle Gold Project (EGP) in the Yukon. The currently planned end land-use for the reclaimed HLF and WRSAs is natural habitat (wilderness). Aside from being geotechnically and geomorphically stable and providing a medium for sustainable growth of native plants, a key design objective for the HLF / WRSA closure cover system is to reduce long-term net percolation rates to the greatest extent possible using locally available materials for cover system construction. Passive treatment systems will be designed and implemented to handle resultant environmental loadings from the HLF and WRSAs post-closure. This letter report documents the work completed by OKC for this project.

<u>Project Objectives and Work Scope:</u>

The overall objective of this project was to aid in further development of cover system designs using locally available materials for closure of the proposed HLF and WRSAs at the EGP site. The currently proposed closure cover system design, referred to as the 'base case' cover system design, is a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. The specific objectives of this project were to further assess the anticipated hydrological performance of the base case cover system design and provide recommendations to improve its predicated long-term performance from a net percolation reduction perspective.

The following tasks were completed to address the above project objectives:

- Project orientation including review of pertinent background information and compilation of key inputs for soil-plant-atmosphere (SPA) numerical modelling;
- Development of a conceptual model of hydrological performance of the base case cover system design;
- Base case and sensitivity analysis numerical simulations of cover system performance using the SPA model VADOSE/W[1]; and

[1] Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Development of recommendations for future studies to reduce uncertainties in the current cover system design and identify potential opportunities for improvements in cover system performance using locally available materials.

SPA numerical modelling was completed with the following outcomes in mind:

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

Conceptual Model of Hydrological Performance:

A conceptual model of hydrological performance of closure cover systems for the EGP site was developed prior to the start of SPA numerical modelling. This required consideration of the following water balance fluxes:

- precipitation (Ppt),
- potential evapotranspiration (PET),
- actual evapotranspiration (AET),
- runoff (RO),
- sublimation (Sub), and
- net percolation (NP).

The average precipitation for the EGP site is estimated to be 492 mm/yr with a range from 262 mm/yr to 694 mm/yr, based on the 80-year historic climate database developed for this project (see Attachment A for further details). The average annual estimate is similar to that developed by KP[2].

Given the relatively high latitude of the EGP site, slope aspect and angle highly influences the amount of solar energy and resultant PET applied to various areas of the site (MEND, 2012)[3]. Hence, for an exposed plateau (i.e. a flat area with no slope influences) or east- or west-facing slope, average annual PET is estimated to be 372 mm/yr with an annual range from 196 mm/yr to 1,413 mm/yr. However, PET is estimated to be 60% less on north-facing aspects and 50% more on south-facing aspects; resulting in average annual PET rates for these two aspects of 149 mm/yr and 558 mm/yr, respectively.

[2] KP (Knight Piesold Ltd.). 2013. *Victoria Gold Corp. Eagle Gold Project – Hydrometeorology Report. VA101-290/6-8*. Prepared for Victoria Gold Corp., August 30.
[3] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

In general, the ratio of annual AET to precipitation ranges from 40 to 60% for study areas similar to the EGP site (Kane and Yang, 2004)[4]. This results in a typical AET:PET ratio of 50 to 70%. However, it must be noted that results for north or south aspects may be outside of the general ranges. Also note that forest canopy interception, which is not calculated by the VADOSE/W model, is included as part of the AET results in this report by using the estimation method described in Attachment A.

Runoff to precipitation ratio for northern sites typically has an increasing trend with increasing latitude (Kane and Yang, 2004). A runoff rate of 5 to 20% of precipitation is expected for the EGP site given the latitude at which the site is located combined with the locally available materials for the base cover system design and the range of vegetation conditions.

Sublimation and redistribution of snow constitutes a significant portion of the water balance in several seasonally snow-covered areas of the Canadian North such as the EGP site (Pomeroy *et al.*, 1995)[5]. Snow interception and sublimation are important hydrological processes that occur as a result of complex mass and energy exchanges. Sublimation of snow intercepted in the vegetation canopy can be as high as 25 to 45% of annual snowfall (Pomeroy and Gray, 1995)[6]. Comparing the EGP site to other northern sites at a similar latitude, a sublimation rate of 25 to 35% of annual snowfall is expected (Kane and Yang, 2004). This corresponds to a sublimation rate of approximately 10 to 15% of total annual precipitation.

NP is a vital component of the water balance for northern climates. Previous modelling completed by KP (2013) determined that the long-term NP rate for the current or base case cover system design would be between 18 and 32% of annual precipitation. NP is functionally halted during the winter months due to frozen ground conditions. In general, the majority of NP at the EGP site occurs during spring melt. Through the summer months, NP rates are lower due to the store and release function of a vegetated soil profile. NP rates generally increase in the fall due to lower PET rates.

A typical annual water balance for the site estimated using VADOSE/W is shown in Figure 1, and demonstrates that the VADOSE/W model estimates conform to the conceptual model.

[4] Kane, D. and Yang, D. 2004. Northern Research Basins Water Balance. International Association of Hydrological Sciences. Oxfordshire, United Kingdom.

[5] Pomeroy, J., Hedstrom, N., and Parvianinen., J. 1995. *The Snow Mass Balance of Wolf Creek, Yukon: Effects of Snow Sublimation and Redistribution*. National Hydrology Research Center. Environment Canada: Saskatoon.

[6] Pomeroy, J.W. and Gray, D.M. 1995. *Snow Accumulation, Relocation and Management*. NHRI Science Report No. 7. Environment Canada: Saskatoon. 144 pp. (Available from NWRI, Saskatoon)

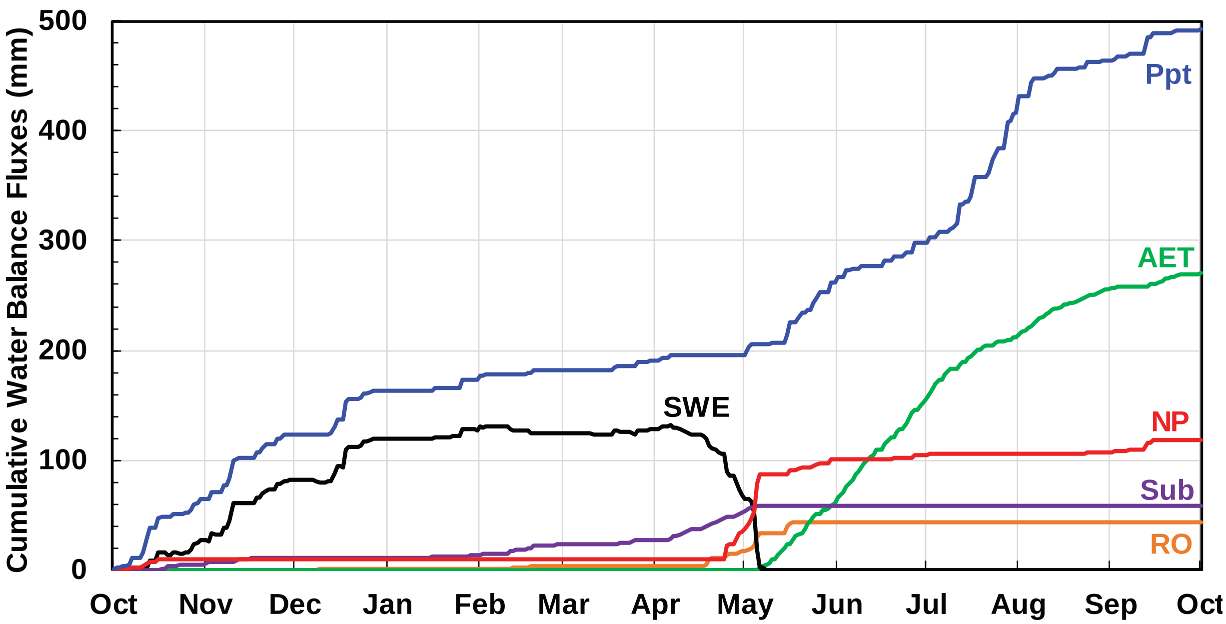


Figure 1 Typical annual water balance fluxes for the EGP site for an east/west bench during an average precipitation year.

Preliminary Estimates of Long-Term Cover System Performance:

The currently proposed closure cover system design, referred to as the 'base' cover system design, consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Tables 1 and 2 provide preliminary estimates of average annual long-term water balances (i.e. post-closure and once climax forest vegetation has established). A description of the model inputs used for the simulations is provided in Attachment A. All modelling completed for this project used the computer modelling program VADOSE/W Version 8.12.3.7901[7].

As shown in the sensitivity analysis section of this report, little can be done to improve performance of the current cover system design based on current knowledge of waste materials and candidate cover materials. Also, the current estimates for east-, west-, and north-facing slopes have AET:PET ratios at or above the typical maximum of 70% stated for the conceptual model. Hence, minimal potential exists for reducing NP rates via increasing AET, which means the store-and-release component of the cover system design cannot be improved upon with any design changes. The only other method to reduce NP is to increase lateral flow (i.e. runoff or interflow) by including a low permeability layer (saturated hydraulic conductivity (k_{sat}) less than $1x10^{-7}$ cm/s), but such a layer cannot be constructed from site materials; this would require the import of sodium bentonite for admixing to local sandy materials or the use of a geomembrane product.

[7] Geo-Slope International Ltd. 2013. GeoStudio 2012. Version 8.12.3.7901. Online. www.geo-slope.com.

Table 1
Average annual water balance fluxes predicted for base case cover system design on WRSAs
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	55% (271)	53% (261)	27% (133)	26% (128)	59% (290)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	24% (118)	21% (103)	52% (256)	47% (231)	20% (98)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 2
Average annual water balance fluxes predicted for base case cover system design on HLF
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	56% (276)	54% (266)	26% (128)	25% (123)	60% (295)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	23% (113)	20% (98)	53% (261)	48% (236)	19% (93)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

It must be emphasized that the values provided in Tables 1 and 2 are averages, but that the components of the water balance will vary greatly from year-to-year, and (as shown in Figure 1) during any given year. As shown in Figures 2 and 3, annual NP at the EGP site can range anywhere from 0 to 500 mm for a given year depending on climate, slope angle and aspect, underlying material, and antecedent moisture conditions. Figures 2 and 3 also provide an estimate of the probability of a given NP rate being exceeded during any given year. For example, there is a 20% probability (i.e. 1-in-5 years) that annual NP rate through a cover system overlying waste rock on a south-facing slope aspect will be greater than 140 mm/yr. Equations for the trendlines in Figures 2 and 3 are provided in the footnotes.

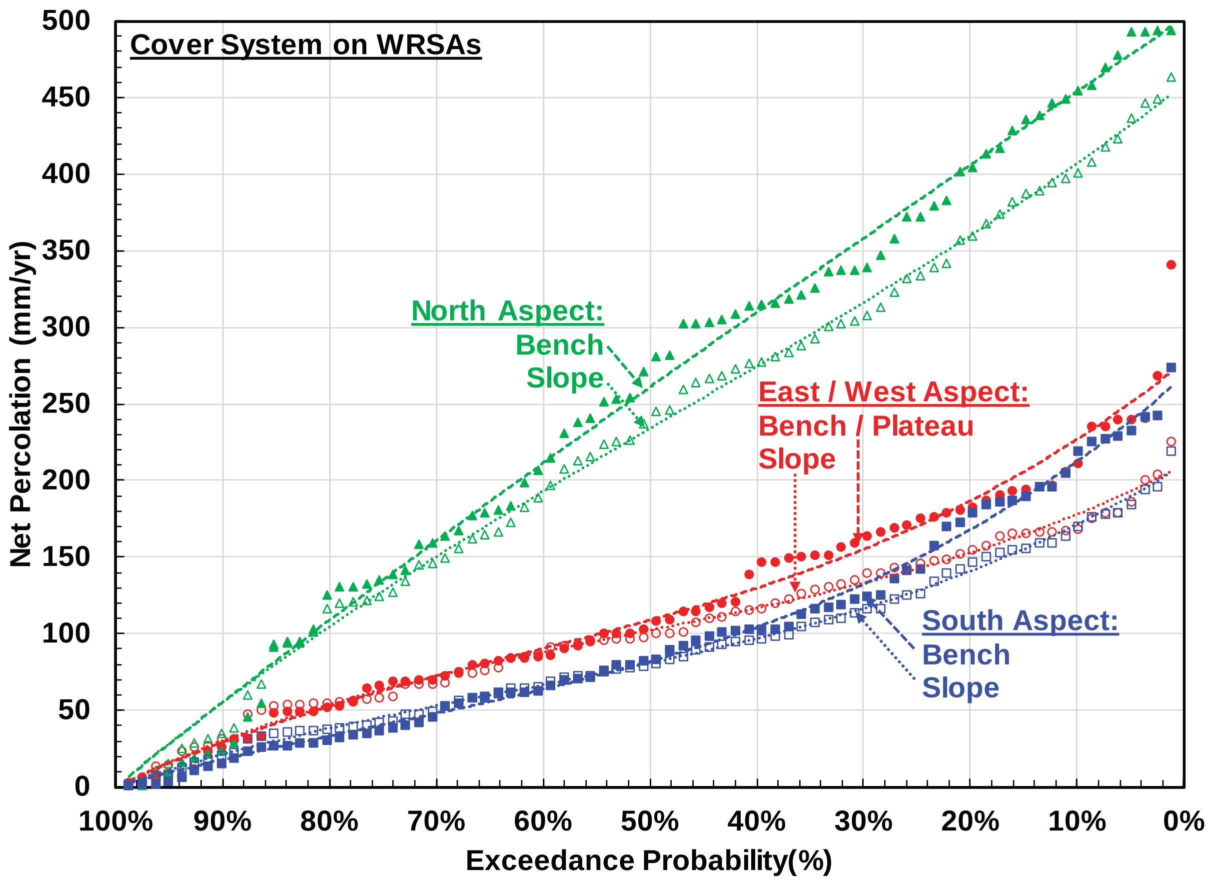


Figure 2 Exceedance probability for annual net percolation though the base case cover system design on WRSAs[8].

[8] Equations for trendlines fitted to data in Figure 2 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):

NP (WRSA North Aspect – Bench) = $40.0041311586974(1\text{-}x)^3 - 99.5768877417431(1\text{-}x)^2 + 561.738884175022(1\text{-}x)$

NP (WRSA North Aspect – Slope) = $206.353645699448(1\text{-}x)^3 - 327.934585562733(1\text{-}x)^2 + 580.167973306423(1\text{-}x)$

NP (WRSA East / West Aspect – Bench/Plateau) = $334.907229739852(1\text{-}x)^3 - 383.091823084556(1\text{-}x)^2 + 325.661910099225(1\text{-}x)$

NP (WRSA East / West Aspect – Slope) = $280.502595140468(1\text{-}x)^3 - 409.768319621682(1\text{-}x)^2 + 339.373074364743(1\text{-}x)$

NP (WRSA North Aspect – Bench) = $272.348822876258(1\text{-}x)^3 - 199.583918676042(1\text{-}x)^2 + 195.342583203572(1\text{-}x)$

NP (WRSA North Aspect – Slope) = $242.715256690288(1\text{-}x)^3 - 267.520494862459(1\text{-}x)^2 + 234.753215517809(1\text{-}x)$

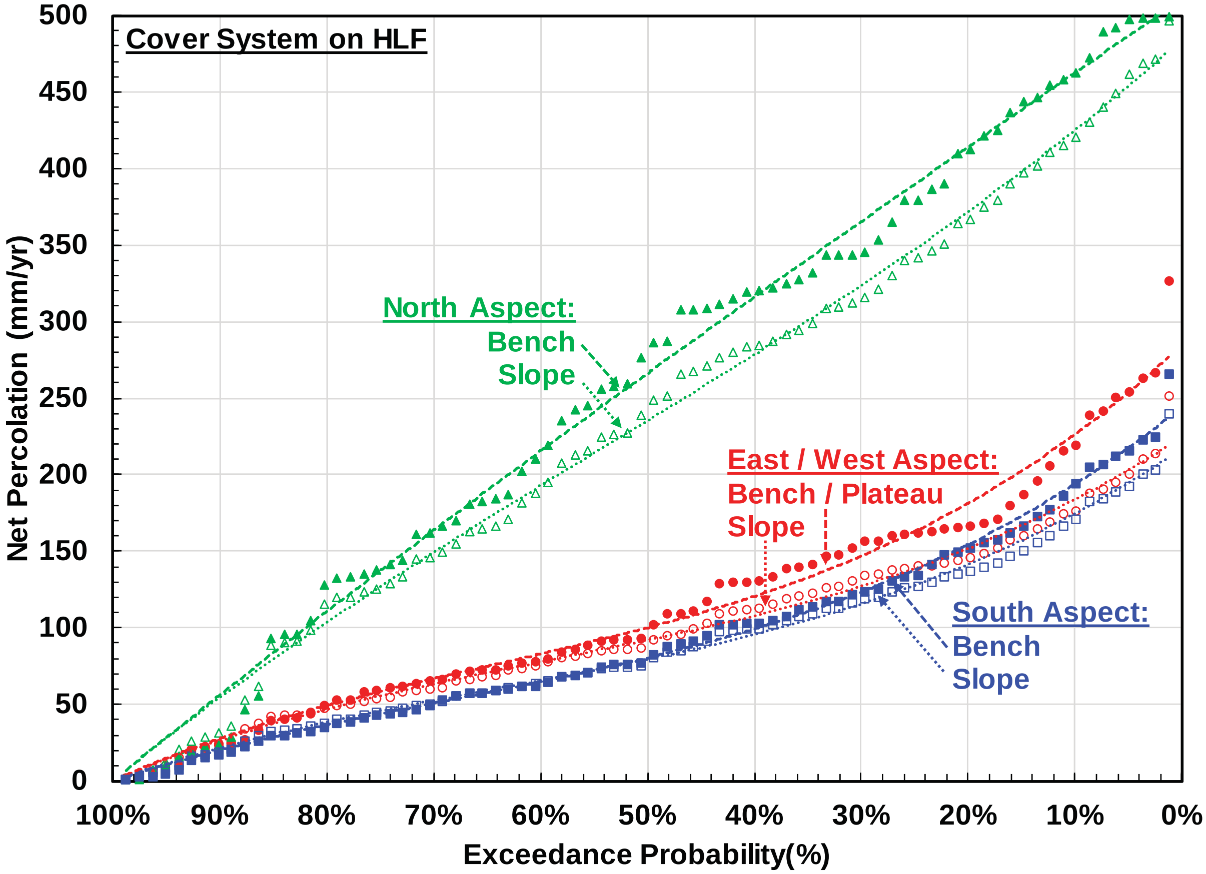


Figure 3 Exceedance probability for annual net percolation though the base case cover system design on HLF[9].

The model results presented prior to this point are estimates of long-term cover system performance, i.e. post-closure once a climax forest vegetation has established on the cover system. Water balance fluxes will vary greatly at different pre- and post-closure stages of the EGP operation. Tables 3 and 4 provide predicted water balance fluxes for different pre- and post-closure stages of the WRSAs and HLF, respectively. The first stage is a pre-closure scenario when the closure cover system is not in place; the NP rate on WRSAs for this case is estimated to be 49% of annual precipitation. The NP rate is estimated to drop to 36% on WRSAs when the cover system is initially constructed, but before vegetation establishment. Once vegetation is established, the NP rate further drops to 28% and 24% of annual precipitation for a grasses & shrubs and climax forest vegetation scenario, respectively. Table 4 shows a similar trend for predicted NP rates for the base case cover system design on the HLF.

[9] Equations for trendlines fitted to data in Figure 3 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):

NP (HLF North Aspect – Bench) = $31.272632650886(1-x)^3 - 89.742473682767(1-x)^2 + 569.412107857963(1-x)$

NP (HLF North Aspect – Slope) = $230.751591012202(1-x)^3 - 318.847922658053(1-x)^2 + 572.512360031695(1-x)$

NP (HLF East / West Aspect – Bench/Plateau) = $401.880632485379(1-x)^3 - 433.796816800299(1-x)^2 + 316.593775515019(1-x)$

NP (HLF East / West Aspect – Slope) = $310.161269957891(1-x)^3 - 383.422721152048(1-x)^2 + 298.154325857064(1-x)$

NP (HLF North Aspect – Bench) = $297.902638452382(1-x)^3 - 279.853973662612(1-x)^2 + 226.194792839713(1-x)$

NP (HLF North Aspect – Slope) = $282.980662582457(1-x)^3 - 307.881636956547(1-x)^2 + 242.043952583721(1-x)$

Table 3
Average annual water balance fluxes predicted for WRSA base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	34%	44%	50%	55%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	49%	34%	28%	24%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 4
Average annual water balance fluxes predicted for HLF base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	37%	42%	51%	56%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	46%	36%	28%	23%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Analysis of Alternate Cover System Designs and Sensitivity to System Variations:

In total, 43 long-term simulations were completed to determine the sensitivity of the base cover system design due to variations in materials, climate, and/or vegetation. The simulations were also completed to determine what (if any) improvements can be made to the base case cover system design. All the scenarios were initially completed without vegetation present so that changes in performance could be directly correlated to changes in materials or climate. Vegetation was then included to further evaluate select scenarios. Finally, the base case results presented in the previous section showed little difference in performance between the WRSAs and HLF simulations. Hence, all sensitivity scenarios were simulated with a cover system overlying waste rock unless otherwise noted. Tornado plots of net percolation predictions for the WRSAs and HLF scenarios simulated are provided in Figures 4 and 5, respectively, followed by detailed analyses.

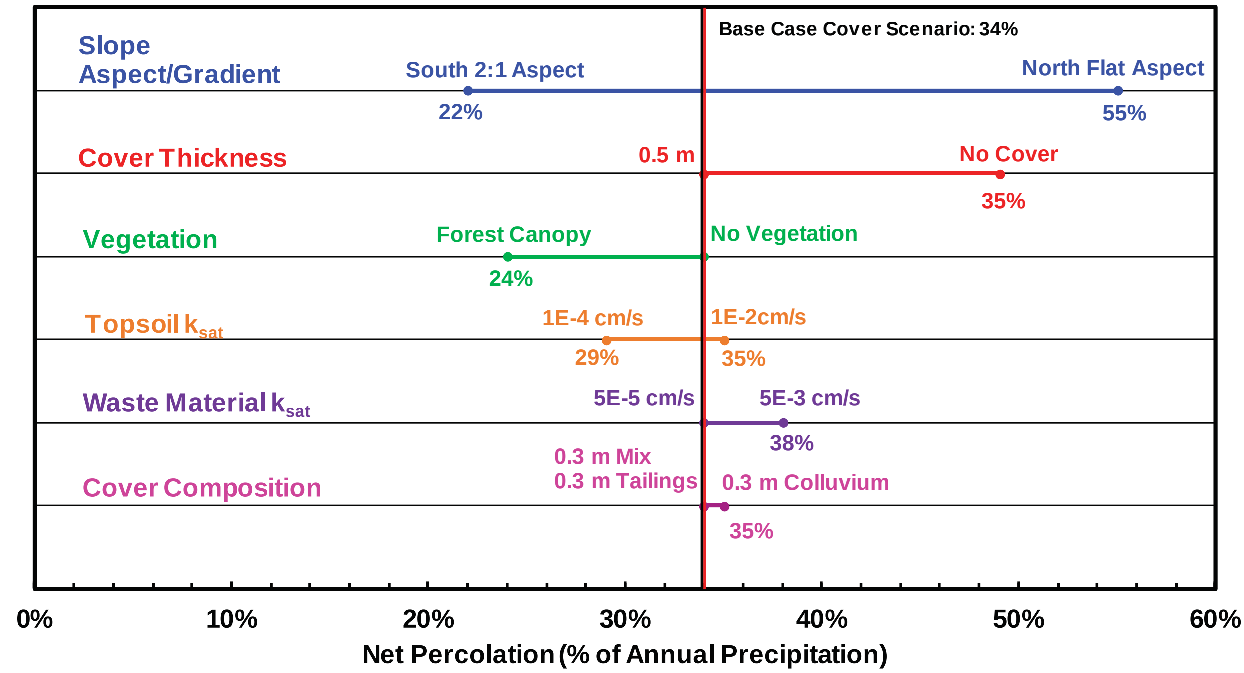


Figure 4 Tornado plot for WRSA cover system net percolation predictions.

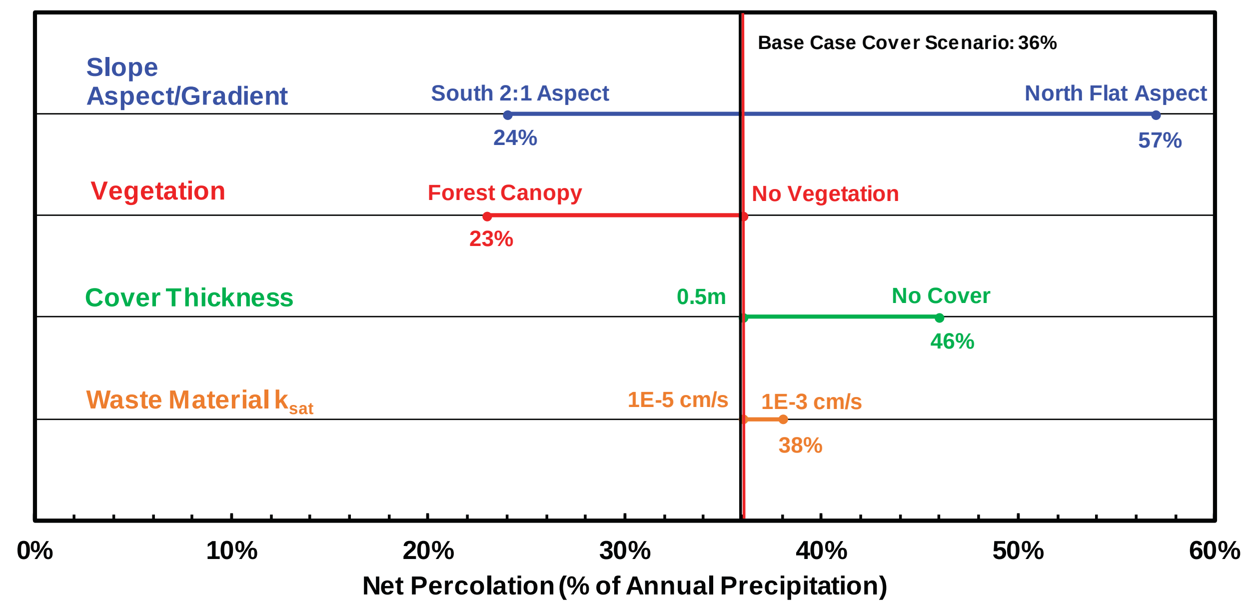


Figure 5 Tornado plot for HLF cover system net percolation predictions.

Slope aspect and gradient have the largest effect on NP rates estimated for both WRSAs and HLF. The added solar radiation on south facing slopes results in a higher AET rate, further drying out the cover in the summer months. In contrast, the north-facing aspect has substantially less solar radiation available to evaporate or transpire water stored in the cover profile. This increases the observed NP rate. A 2:1 slope gradient will result in a larger volume of runoff during the spring melt and high intensity rainfall events.

Table 5 shows predicted average annual NP rates for eight cover system scenarios with varied layer thickness and composition. The majority of the cover thickness and composition scenarios were completed for the WRSAs only. The HLF only compared the uncovered waste material to the base cover system. For the WRSAs, three thicknesses of the tailings-colluvium mix were evaluated to determine if additional storage capacity would improve cover system performance. The materials that comprise the cover system were also varied to determine the effect of different compositions.

Table 5
Average annual NP rates predicted for varying cover thickness and composition scenarios (values in percent of annual precipitation).

Layer 1		***Layer 2***		***Layer 3***		***Net Percolation***
Material	***Thickness (m)***	***Material***	***Thickness (m)***	***Material***	***Thickness (m)***	
TPSL	0.2	MIX	0.3	-	-	34%
TPSL	0.2	MIX	0.5	-	-	35%
TPSL	0.2	MIX	0.7	-	-	35%
TPSL	0.2	TLS	0.3	-	-	34%
TPSL	0.2	CLVM	0.3	-	-	35%
TPSL	0.2	TILL	0.3	-	-	35%
TPSL	0.2	TLS	0.1	CLVM	0.2	35%
TPSL	0.2	CLVM	0.2	TLS	0.1	35%

*TPSL: topsoil; MIX: tailings-colluvium mix; TLS: tailings; CLVM: colluvium; TILL: till; WR: waste rock.

Virtually no difference exists in predicted NP rates resulting from the use of different materials on-site. Cover system scenarios that used only colluvium or tailings (rather than the 2:1 mix) produced nearly identical NP rates as the 2:1 colluvium-tailings mixture. Layered cover systems of the two materials also produced similar NP rates. Based on these results, there is no advantage, from a NP perspective, to mixing the tailings and colluvium into a single cover system material based on the estimated hydraulic properties of the two material types.

Without vegetation to remove water from depth, thickening the cover system provides no reduction in the NP rate, and actually results in an increase in NP. NP rates do not decrease because the energy available for evaporation is low, which creates relatively low hydraulic gradients for removing water from the cover system. Hence, evaporation alone can only remove water stored nearer the surface. The model estimates a slight increase in NP with increased cover thickness because the underlying waste rock is a textural discontinuity, which creates a capillary barrier inhibiting NP and keeping water closer to the surface. When the depth of the capillary barrier is increased by increasing the thickness of the cover system, the percolating water is able to get to depth more easily, which increases NP.

As shown in the previous section, the presence of vegetation is vital to hydrological performance of the cover system. The NP rate is reduced by 10% or more for both the WRSAs and HLF when a forest canopy is present. A large part of the improvement from the forested cover system scenario comes from the improvement of AET via canopy interception. The forest canopy intercepts precipitation on the foliage, which reduces the amount of water that infiltrates into the cover system. This intercepted water is then evaporated or sublimated from a location more exposed to solar radiation and wind compared to surface.

Vegetation requires water to be readily available for root uptake for establishment and survival. When a material dries below a point at which plants are unable to remove water, the material is said to be at its permanent wilting point (PWP). The PWP is generally defined to occur at a suction of 1,500 kPa. At the other end of the range is the field capacity (FC) of the soil. FC is defined as the water content held in the soil after excess water has drained away and the rate of downward movement has decreased. FC is generally stated to occur at a suction of 33 kPa for finer soils and 10 kPa for coarser materials. FC and PWP define the upper and lower limits, respectively, that a growth material is able to supply water for root uptake. Hence, the difference between FC and PWP defines a soil's AWHC (i.e. AWHC = FC – PWP).

Figure 6 shows the estimated amount of water stored within the base case cover system design during the 80-year simulation period for three scenarios: base cover system on WRSA; base cover system on HLF; and, a cover system consisting of 0.2 m of topsoil overlying 0.3 m of till (referred to in Figure 6 as till cover system) overlying WRSA. Till was chosen for the third simulation as it has the highest AWHC of all the potential cover materials considered in this study. The cover system water volume for all three scenarios is estimated to almost always stay within or above the AWHC range. There are only seven periods when the cover system water volumes drop near or below the PWP line. These are periods when vegetation would be at risk; but it must be noted that the model inputs were set to permit forest vegetation to be capable of removing water up to a suction of 2,500 kPa (based on research of tree species), and that VADOSE/W does not account for all plant survival mechanisms (e.g. dormancy). Hence, the model estimates that the current cover system design adequately meets the water requirements for vegetation.

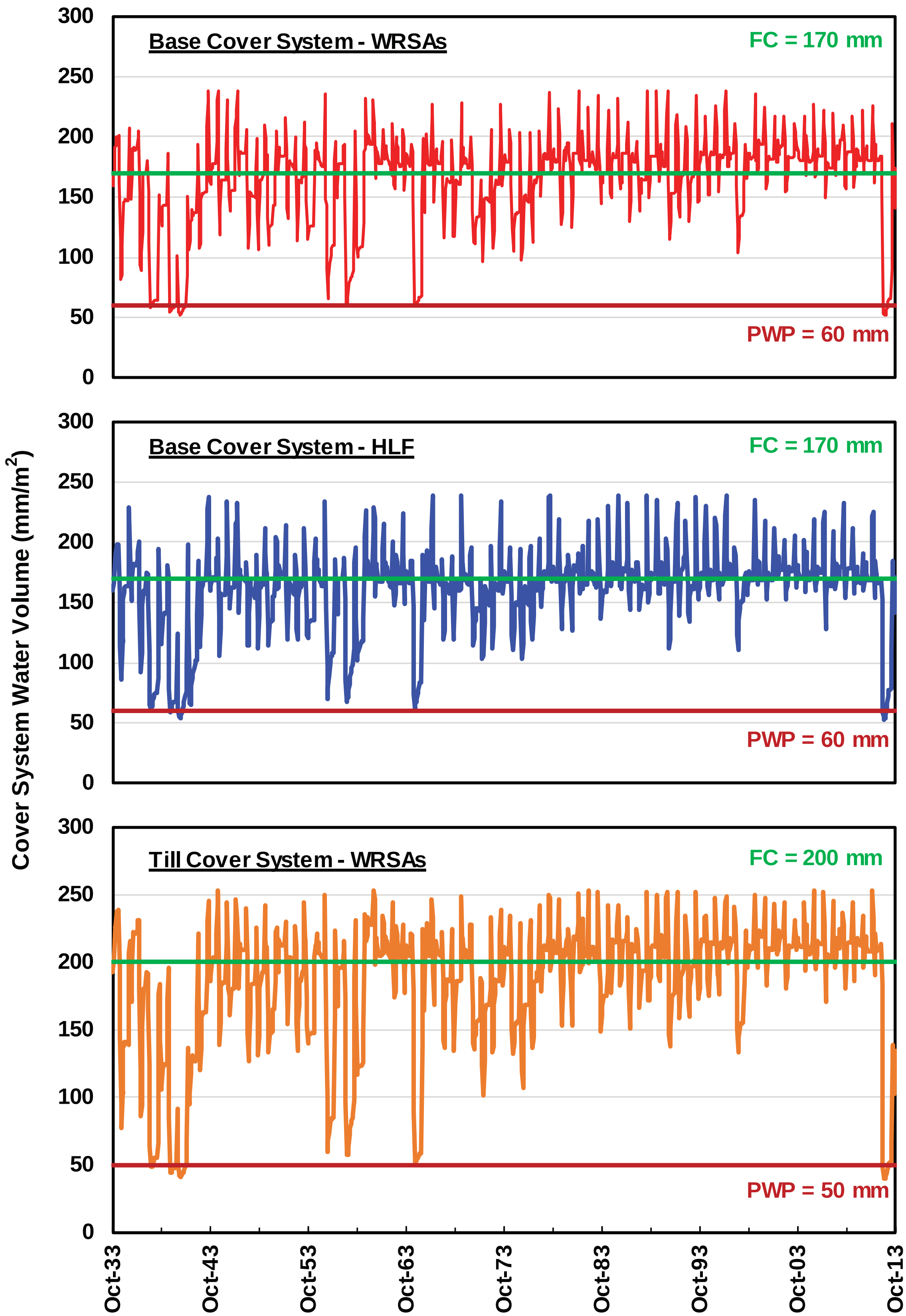


Figure 6 Cover system water volumes estimated during 80-year simulations for three scenarios (from top to bottom): base cover system on WRSAs and HLF and till cover system on WRSAs.

The material properties of the cover system materials were also varied. In general, scenarios that lowered the k_{sat} of various materials resulted in slightly lower NP rates, while increasing the k_{sat} slightly increased NP rates. Table 6 shows predicted average annual water balance fluxes for six cover system scenarios that varied the material properties of the cover system materials.

Table 6
Average annual water balance fluxes predicted for the varied material properties scenarios (values in percent of annual precipitation).

Waste Material	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Heap Leach***	***Heap Leach***
Modification	**Waste Rock k_{sat} increased by 10x**	**Waste Rock k_{sat} decreased by 10x**	**Topsoil k_{sat} increased by 10x**	**Topsoil k_{sat} decreased by 10x**	**Heap Leach k_{sat} increased by 10x**	**Heap Leach k_{sat} decreased by 10x**
Runoff	10%	10%	8%	15%	10%	10%
AE	43%	44%	45%	44%	40%	42%
Sublimation	12%	12%	12%	12%	12%	12%
Net Percolation	35%	34%	35%	29%	38%	36%

The k_{sat} of the topsoil proved to be an influential property during the sensitivity analysis. By increasing or decreasing the k_{sat} of the topsoil by one order of magnitude, the average NP rate varied from 35% to 29% of annual precipitation, respectively. It is essential that thorough testing be completed to verify the hydraulic properties of local topsoil material because its k_{sat} is showing to have the largest influence on predicted NP rates. Decreasing the waste material k_{sat} also had an effect on the observed NP rate; however, increasing the k_{sat} of the waste material had little effect on the NP rate. The effect of varying the k_{sat} of the tailings-colluvium material was also analyzed; however, no difference in the water balance was observed when the material's k_{sat} was varied by one order of magnitude.

One sensitivity that was not included in the above tornado plot is climate change. Climate change predictions for Mayo, YT predict an increase in monthly air temperature and precipitation[10]. The 100-yr average temperature increase is predicted to be between 3 and 6°C, whereas annual precipitation is estimated to increase by 15 to 35%. This increase would have a substantial effect on hydrological cover system performance at the EGP site. Hence, simulations were completed with no ground freezing effects simulated and with the historic climate database adjusted to mid-range climate change estimates (i.e. temperature increase of 4°C and precipitation increase of 25%). Table 7 provides the average water balances for these scenarios (note that the results are stated as a percent of average annual historic precipitation (492 mm/yr) but the climate change scenario has an average annual precipitation rate of 615 mm/yr).

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[10] Scenarios Network for Alaska & Arctic Planning. 2013. *Community Charts: Mayo, YT*. Version 1.219. Online. www.snap.uaf.edy.com

Table 7
Average annual water balance fluxes predicted for the base case and climate change scenarios (values in percent of annual historic precipitation with mm/yr in brackets).

Scenario	Runoff	AE	Sublimation	Net Percolation
Base Case	10% (49)	44% (215)	12% (59)	34% (169)
No Ground Freezing	0% (4)	42% (205)	12% (55)	46% (228)
Climate Change	4% (21)	51% (251)	7% (34)	63% (311)

The majority of runoff from the base case scenario is generated during the spring melt. The frozen ground encourages runoff because the water cannot easily infiltrate due to ice blocking soil pores. When the cover is not able to freeze to a suitable depth due to increased air temperature, spring melt waters are able to infiltrate rather than runoff. The increased infiltration rate contributes to a rise in NP. These scenarios illustrate the advantage of a frozen cover at the EGP site and the risk of its loss due to climate change. The deep frost penetration allows the cover system to limit NP despite the coarser textured locally available material. If the climate change prevents the cover system from freezing to a suitable depth, geosynthetic products would have to be used to limit NP.

Future Studies Recommended to Further WRSA / HLF Closure Cover System Design:

The 2014 EGP modelling program completed by OKC relied on estimated material properties. In order to increase the confidence in the predicted water balance components (especially NP), further study of the EGP site and locally available materials should be completed. Studies recommended by OKC are as follows:

- Material characterization program potential cover materials and waste materials (when they become available), including:
  - hydraulic conductivity,
  - moisture retention, and
  - geochemical properties;
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Closure:

Thank you for the opportunity to assist AEG with closure planning at Victoria Gold's Eagle Gold Project. Please do not hesitate to contact the undersigned should you have any questions.

Sincerely,

Brian Ayres, M.Sc., P.Eng.
Senior Geotechnical Engineer

cc: Scott Keesey and Leia Fougere – Access Consulting Group
Robert Shurniak and Kent Schapansky – O'Kane Consultants Inc.

Attachment A: Key Inputs for 2014 VADOSE/W Modelling Program

ATTACHMENT A

Key Inputs for 2014 VADOSE/W Modelling Program for EGP HLF / WRSA Closure Cover Design Assessment

Preliminary Cover System Modelling Inputs

Before SPA numerical modelling was undertaken the model inputs needed to be clearly defined. These inputs can be placed into five categories: geometry; material properties; initial conditions; upper boundary conditions; and lower and side boundary conditions. A brief description of these model inputs is presented in the following sections. SPA modelling was completed using the software VADOSE/W.

Geometry (Cover System Profile Designs):

The 'base' cover system design consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Variations to this design were simulated as part of the sensitivity analysis as described in the main body of the report.

Material Properties:

Seven materials were defined for the OKC modelling program: waste rock, colluvium, heap leach, placer tailings, topsoil, till, and a tailings-colluvium mix. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC[11][12][13][14]. These PSDs were the basis for the estimates of all material properties for all but one of the materials; no PSD data was available for the topsoil material. Topsoil material properties were developed by comparing a variety of topsoil materials from the OKC material database from similar sites to images of topsoil from EGP. The estimated porosity, saturated hydraulic conductivity (k_{sat}), as well as the percent sand and fines for each of the materials is given in Table A-1.

Table A-1
Summary of basic material properties for SPA modelling.

Material Type	Porosity (m^3/m^3)	k_{sat} (cm/s)	Particle Size Distributions (Minimum – Maximum (Average))		
			% Coarse (>4.75 mm)	% Sand (4.75–0.075 mm)	% Fines (<0.075 mm)
Waste rock	0.30	$5.0X10^{-4}$	34 – 60 (44)	22 – 43 (30)	16 – 44 (26)
Colluvium	0.33	$5.0X10^{-5}$	12 – 60 (40)	18 – 53 (36)	4 – 45 (24)
Heap Leach	0.31	$1.0X10^{-4}$	15 – 50 (33)	20 – 63 (35)	16 – 58 (42)
Tailings	0.26	$5.0X10^{-4}$	25 – 75 (49)	19 – 61 (39)	5 – 19 (12)
Topsoil	0.59	$1.1X10^{-3}$			
Till	0.45	$1.0X10^{-4}$	0 – 33 (11)	5 – 40 (22)	40 – 95 (67)
Tailings-Colluvium Mix (1:2)	0.40	$5.0X10^{-4}$	6 – 68 (34)	27 – 71 (48)	4 – 45 (18)

[11] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March
[12] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November
[13] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January
[14] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

In order to complete the proposed SPA modelling, additional properties or functions needed to be estimated. The required properties or functions for each material in the modelling program are as follows:

- moisture retention curve (MRC - suction versus volumetric water content);
- hydraulic conductivity function (k-function - suction versus hydraulic conductivity);
- thermal conductivity function (volumetric water content versus thermal conductivity); and
- volumetric specific heat function (volumetric water content versus volumetric specific heat).

The MRC, or soil-water characteristic curve, is a continuous function relating energy and the state of water, and hence describes the water content of a material as a function of soil suction, or negative pore-water pressure. The MRC for each of the materials used during the OKC modelling program are shown in Figure A-1.

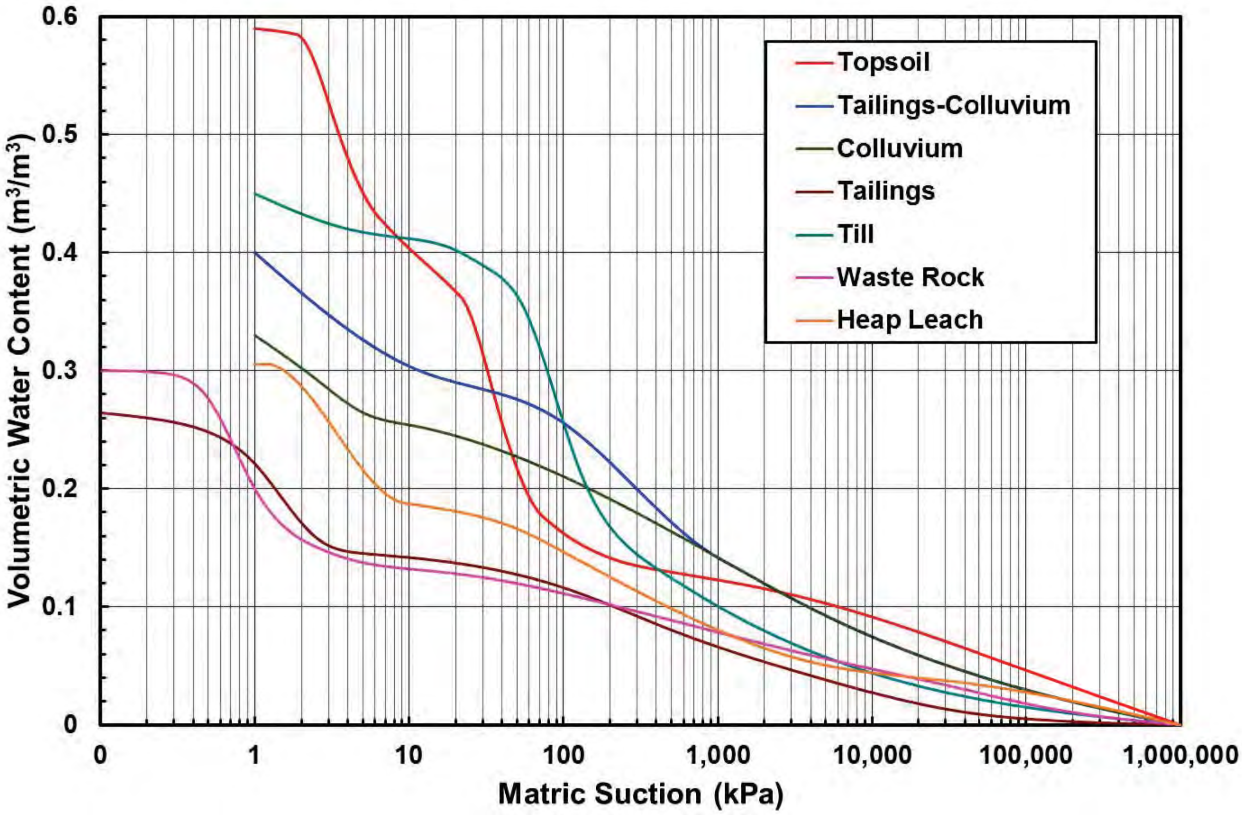

Figure A-1 Moisture retentions curves for all materials used during the OKC modelling program.

Hydraulic conductivity is a measure of the ability of a material to transmit water, and is a maximum for saturated materials. The k-function for each material was estimated from its MRC and k_{sat} using the Fredlund *et al.* method[15]. The k-function for each of the materials used during the OKC modelling program are shown in Figure A-2.

15 Fredlund, D.G., Xing, A., and Huang, S. 1994. Predicting the permeability function for unsaturated soils using the soil-water characteristic curve. Canadian Geotechnical Journal, Vol. 31, pp. 533-546.

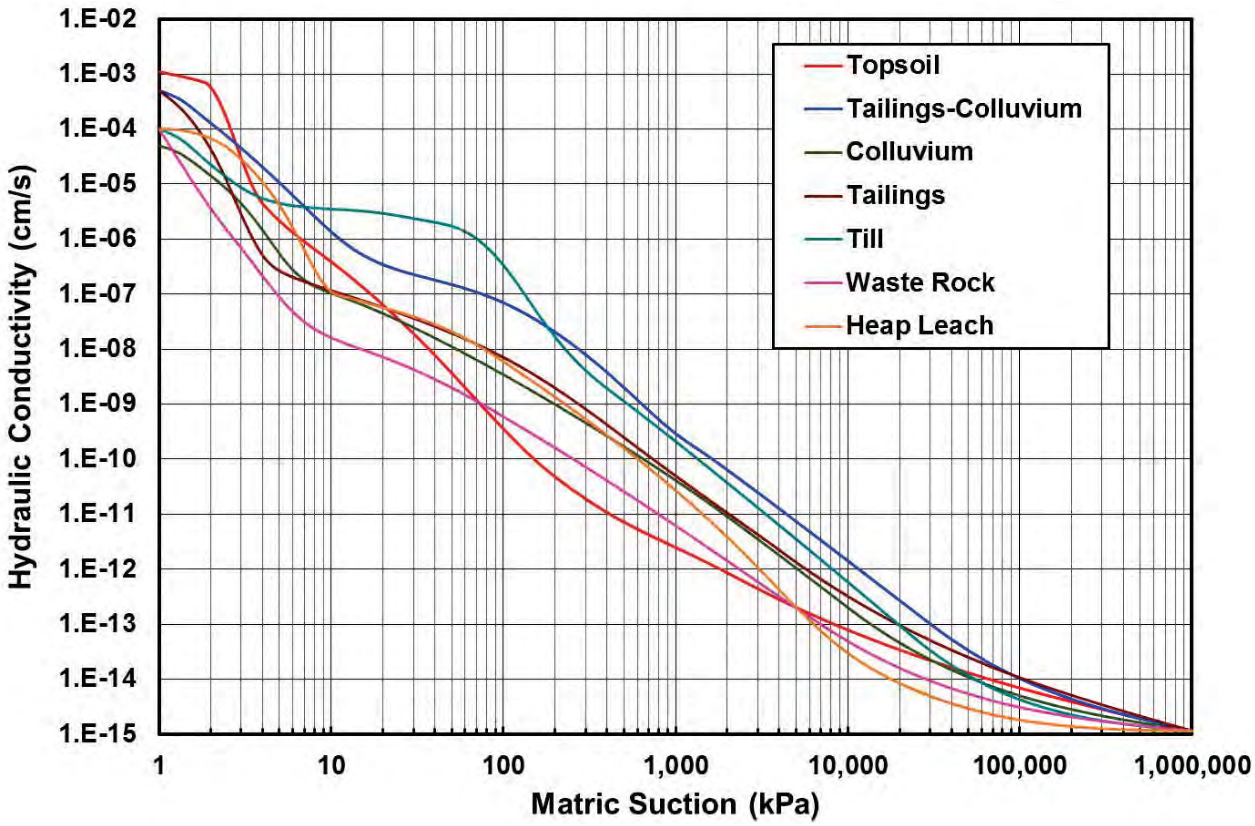

Figure A-2 Hydraulic conductivity function for all materials used during the OKC modelling program.

Thermal conductivity characterizes the ability of a soil medium to transmit heat by conduction. It is defined as the quantity of heat that will flow through a unit area of a soil medium of unit thickness in unit time under a unit temperature gradient. The thermal conductivity functions for all the materials were estimated by VADOSE/W using the Johansen method[16].

The heat capacity of a material is defined as the quantity of heat required to raise the temperature of the material by a unit degree. A volumetric specific heat function describes the relationship between volumetric water content and volumetric specific heat. The volumetric specific heat functions for all the materials were estimated by VADOSE/W using the deVries method[17].

[16] Johansen, O. 1975. *Thermal Conductivity of Soils*. Ph.D. Thesis, (CRREL Draft Translation 637, 1977), Trondheim, Norway.
[17] de Vries, D.A. 1963. *Thermal properties of soils*. Physics of Plant Environment, W.R. Van Wihk (ed.), North Holland Pub. Co., pp. 382.

Upper Boundary Conditions:

The upper boundary conditions required for the VADOSE/W model can be divided into two parts: climate and vegetation. Details regarding the model inputs developed for each are described below.

Climate:

Due to the lack of a long-term data record available for the EGP site, a synthetic climate database was required to proceed with the proposed modelling program. This database consisted of adapting data from several locations. The climate of the EGP site is characterized by long, dry winters and short, warm, wet summers. Local conditions vary due to the variation of elevations found throughout the site.

The elevation of the HLF ranges from approximately 875 to 1,175 masl, and the WRSA's range from approximately 950 to 1,400 masl. This means there is the potential for significantly different climatic conditions at varying elevations on the landforms. For the purposes of OKC's initial cover design modelling, a reference elevation of 1,175 masl was used to develop the base synthetic climate database. All parameters of the synthetic climate database were corrected to this elevation.

The climate data for the OKC modelling program consist of the synthesis of data from three weather stations. Data from two of the stations were provided by AEG. These are the Potato Hills and Camp stations located at the EGP site. These two stations have excellent data quality, but have only operated for a short period. The third station, located at Mayo, Yukon Territory (approximately 85 km south of EGP), is operated by Environment Canada and has long-term data ranging from 1925-2012. Table A-2 summarizes data available for each station. The "Missing Records" column in Table A-2 only lists dates of large sections of missing data. Information from the Hydrometeorology Report prepared by Knight Piésold was also considered while constructing the synthetic climate database[18].

[18] Knight Piésold. 2013, *Hydrometeorology Report*. Prepared for Victoria Gold Corp., August.

Table A-2
Summary of data used for climate database development.

Potato Hills Station: N 64°02' W 135°44' elevation 1420 masl		
Parameter	**Period of Record**	**Missing Records**
Daily Rainfall (mm)	August 14, 2007 – December 31, 2011	-
Daily Maximum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Minimum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Maximum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Minimum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Average Wind Speed (m/s)	August 14, 2007 – December 31, 2011	-
Daily Average Net Radiation (W/m^2)	August 14, 2007 – December 31, 2011	-
Camp Station: N 64°01' W 135°51' elevation 782 masl		
Parameter	**Period of Record***	**Missing Records**
Daily Rainfall (mm)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Average Wind Speed (m/s)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Mayo Airport Station: N 63°37' W 135°52' elevation 504 masl		
Daily Precipitation (mm)	June 1, 1925 – December 31, 2012	March 1, 1946 – March 31, 1946 April 1, 1989 – April 30, 1989 January 1, 1995 – February 28, 1995 April 1, 1995 – December 31, 1995
Daily Maximum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Maximum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Average Wind Speed (m/s)	January 2, 1934 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977

One important parameter that was not available for the Camp or Mayo Airport station is net radiation (NR). This is a vital input for VADOSE modelling to predict potential evapotranspiration (PET) and resultant actual evapotranspiration (AET). For these two stations, NR was calculated using an analytical spreadsheet. This calculation uses the daily maximum and minimum temperature and relative humidity (RH) together with the latitude and elevation of the site to determine the estimated NR. The spreadsheet was first calibrated comparing the measured NR at the Potato Hills station and the calculated NR. The calibration data were then used to predict NR for both the Camp and Mayo Airport Stations.

Climate data obtained from the three stations was thoroughly reviewed with any questionable or incomplete data removed from the record. An equation was developed from the data set for each parameter at each station to provide average conditions for any given day of the year. The equations were obtained by fitting trendlines through daily average graphs for each climate input. Missing data from each station was filled using these average values. The datasets were then compared and adjusted to be representative of the assumed elevation.

The adjusted Mayo Airport data was used as the template for the synthetic climate database. Due to the sparse data available before 1933, the database was reduced to the period between 1933 and 2013, resulting in an 80-year synthetic climate database. Several large gaps in the adjusted Mayo Airport data were filled using either the adjusted data from other stations, or the developed average year. A summary of the average monthly values from the synthetic climate database is provided in Table A-3. The mean annual precipitation for the 80-year climate database is 492 mm, which is similar to the mean annual precipitation noted by Knight Piésold [19].

Table A-3
Monthly average climate for the long-term synthetic climate database.

Month	Average Temperature		Average RH	Monthly Precipitation	Average Daily Wind Speed	Average Net Radiation
	Daily High	Daily Low				
	°C	°C	%	mm	m/s	MJ/m^2
January	-15.7	-23.7	65	34	1.6	-1.2
February	-10.6	-20.4	63	29	1.8	0.3
March	-7.5	-18.3	58	26	2.3	4.6
April	1.8	-7.9	55	24	2.3	10.4
May	9.5	-1.0	37	37	2.2	14.3
June	15.2	3.8	49	52	1.8	17.2
July	16.0	4.8	55	65	1.8	16.1
August	14.1	2.8	62	60	1.8	12.1
September	9.2	-2.4	66	49	1.6	5.3
October	-3.6	-10.0	73	42	1.6	1.2
November	-12.7	-19.5	73	38	1.6	-0.6
December	-15.7	-23.3	71	36	1.0	-1.3

[19] *Op. Cit.*

Vegetation:

VADOSE/W incorporates vegetation affects using a nodal vegetative uptake source term that is combined with a surface energy term based on canopy cover[20]. The amount of actual nodal root uptake depends also on root depth and density, and water stress (negative pore water pressure).

Lack of available plant water and/or high evaporative demands will cause most plants to biologically react by closing stoma, reducing transpiration, and reducing metabolic reactions[21]. Under continued and increasing stress the plant will reach its wilting point. The wilting point results in leaf drop and tissue death. In VADOSE/W the user must implement a plant moisture limiting function, which determines the percentage decrease in the plants' ability to draw water as the negative pore-water pressure increases in unsaturated ground.

The leaf area index (LAI) is used by VADOSE/W to reduce the amount of net radiation intercepting the soil surface, which in turn reduces the computed actual evaporation. In other words, LAI controls how the energy at the surface is partitioned between that available for direct evaporation from the soil and that which is available to the plants in their attempt to transpire water. VADOSE/W uses Equation 1 to determine how much energy is intercepted by the plant canopy:

$$I = -0.21 + 0.7 \times LAI^{1/2} \quad [1]$$

where:

I = percent of net radiation intercepted by the plant canopy, and

LAI = leaf area index.

Hence, the model estimates that the canopy intercepts all energy if LAI is greater than 3.0 (i.e. all energy is applied to transpiration) and does not intercept any energy if LAI is less than 0.1 (i.e. all energy is used for evaporation).

If the soil is saturated, the full amount of energy will be applied to the roots according to the root depth and root distribution functions. In VADOSE/W, two root distribution functions are available: triangular and rectangular. A triangular distribution will potentially draw more water near the surface, whereas a rectangular distribution will potentially draw the same amount of water over the full root depth. If the soil is partially saturated, then the actual transpiration value is further reduced according to the plant moisture limiting function entered by the user.

Three vegetation sequences were chosen that represent different timeframes of the reclamation process: bare ground, grasses and shrubs, and mature forest. Each sequence has a significantly different influence on cover system performance. The bare ground sequence also serves as a baseline for comparing cover systems' performance once vegetation has established.

[20] Tratch, D. 1996. *Moisture uptake within the root zone*. M.Sc. Thesis, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

[21] Saxton, K.E. 1982. *Mathematical modelling of evapotranspiration on agricultural watersheds*. *In* Modeling Components of the Hydrologic Cycle. Singh, H. (ed.), May 18 - 21, 1981. pp. 183-203.

The grasses and shrubs sequence consists of the application of a rectangular rooting depth of 0.3 m as specified by Access Consulting Group[22]. The plant limiting moisture function for this sequence is shown in Figure A-3.

The final vegetation sequence consists of the application of a mature forest to the modelled sites. The mature forest models were simulated with a triangular rooting depth of 0.5 m. The plant limiting moisture function of this sequence is shown in Figure A-3. A canopy interception (CI) rate of up to 1 mm per rainfall event is assumed when simulating the mature forest. This accounts for rainfall that it collected on the forest canopy, and evaporates before ever reaching the cover system. When applying the canopy interception, a proportional amount of net radiation is also removed during rainfall days to account for the energy required to evaporate the intercepted rainfall.

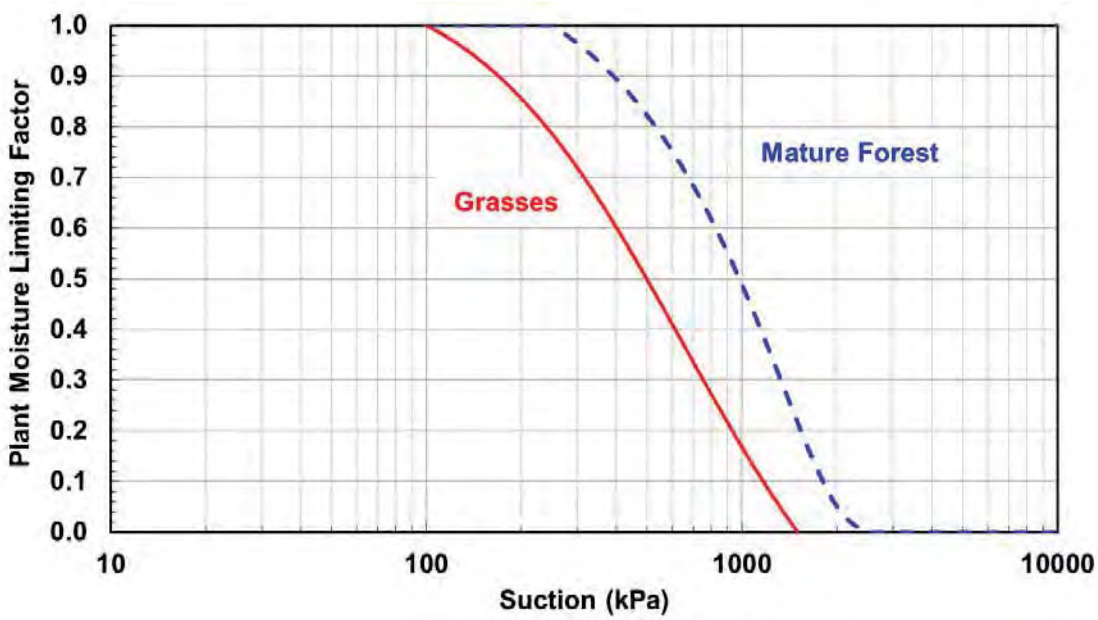

Figure A-3 Plant limiting moisture function for the grasses and mature forest vegetation sequences.

Lower and Side Boundary Conditions:

The lower boundary of each SPA model was simulated as a unit hydraulic gradient at the base of the waste material. This boundary condition simulates the water table to be well below the base of the cover system. A unit hydraulic gradient boundary condition assumes that at the lower boundary the soil suction (and, as a result, water content and hydraulic conductivity) are constant with depth. When this is the case, the total head equals the gravitational head causing a unit hydraulic gradient. In other words, a unit hydraulic gradient represents a location in the modelled profile where water movement is controlled mainly by gravity.

The sides of the 1D models was simulated as no flow boundaries for all simulations.

[22] Access Consulting Group. 2013. *Memorandum: 2012 Dry Stack Tailings Facility Cover Trial*. Prepared for Victoria Gold Corp., March.

APPENDIX F

O'Kane Consultants Inc. – Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

O'Kane Consultants
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Our ref: 917/03
September 30, 2016

Steve Wilbur
Senior Scientist
Victoria Gold Corp

By email: swilbur@vitgoldcorp.com

Mr. Wilbur:

Re: Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

O'Kane Consultants (OKC) was retained by Alexco Environmental Group (AEG) to provide updates to the Eagle Gold Project Reclamation and Closure Plan (RCP). The scope of OKC's work was to provide updates to the RCP based on the Type A Water Use Licence QZ14-041 Clause 178(d): *Research Program for Closure Cover System Designs* and Clause 178(e): *Vegetation Rooting Study*. The required updates were also reiterated in the Quartz Mining License QML-0011 in Schedule C, Part 2, Clause 4.1 (a). The following report provides a brief summary of background information that the conceptual plans were based on, followed by the proposed research program descriptions.

Summary of Previous Work:

OKC worked with AEG in 2014 to further assess the development of cover system designs for closure for the proposed heap leach facility (HLF) and waste rock storage areas (WRSAs) at VG's Eagle Gold Project (EGP) in the Yukon[1]. The closure cover system design was assessed to align with closure design objectives which included being geotechnically and geomorphically stable, providing a medium for sustainable growth of native plants, and reduce long-term net percolation rates to meet closure objectives using locally available materials. Specific project objectives were to further assess the anticipated hydrological performance of the base case cover system design and to provide recommendations to improve its predicated long-term performance from a net percolation reduction perspective. The 'base case' cover system design assessed was a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium.

The assessment was completed through development of a conceptual model for the performance of the base case cover system followed by conducting sensitivity analysis (numerical simulations) of cover system performance using the soil-plant-atmosphere (SPA) model VADOSE/W[2] with available site-specific inputs. The SPA numerical modelling was completed to determine:

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1 O'Kane Consultants Inc. 2014. Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas. OKC Rpt 917-1-01. April.

2 Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a ‘false’ drought condition for the anticipated climax vegetation cover.

Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

- Hydraulic properties of candidate cover system materials;
- Hydraulic properties of HLF and WRSA waste materials;
- Slope aspect (i.e. solar radiation input and snowpack accumulation / melt); and
- Slope gradient.

To increase the confidence in the predicted water balance components, specifically net percolation, OKC (2014) provided the following recommendations for further studies:

- Material characterization program of potential cover materials and waste materials (when they become available);
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Clause Specific Updates for RCP:

Clause 178(d): Research Program for Closure Cover System Designs

The overall objective of this research program is to build confidence in the initial long-term cover system design performance analyses in terms of net percolation and to inform eventual large-scale closure cover system construction. Four tasks for the research plan include:

1. Complete background and results review of any recent monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data to inform and update the conceptual model of cover system performance;

2. Develop a material characterization plan for candidate cover system and HLF and WRSA materials;

3. Enhanced meteorological monitoring; and

4. Design cover system field trials to facilitate the collection and development of a database of moisture and thermal responses (field performance monitoring data).

Tasks 1, 2, and 3 will be completed to update the current long-term cover system performance using numerical models to inform the field trial designs of Task 4.

Task 1: Update Conceptual Model of Closure Cover System Design Performance

The objective of the updated conceptual model will be to incorporate recent available monitoring and site investigation data to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist. In addition, the conceptual model will provide a basis to compare field trial monitoring results as they are obtained. This will be an iterative process where the conceptual model will continue to be updated and refined as new information is received.

Task 2a: Material Characterization Program for Candidate Cover System Materials

The objective of the material characterization program is to:

- quantify certain hydraulic properties that will control the performance of the closure cover systems,

- assess material availability and volume,

- determine soil fertility for candidate top soil material, and

- evaluate erosion characteristics.

A key component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (k_{sat}) showed to have the largest influence on predicted net percolation rates in the 2014 numerical assessment. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC for the

2014 assessment[3456] and OKC used the PSD data to develop hydraulic properties of cover and waste materials for the 2014 assessment. PSD data was not available for the topsoil material and properties were developed by comparing topsoil materials from similar sites in an extensive material database developed by OKC. To achieve the overall objective of the material characterization program a sampling and borrow source availability program is proposed. The sampling program will be conducted during excavation during facility construction phase or during a test pit program to collect samples and log profiles of viable sources of the following candidate cover system materials:

- Topsoil,
- Colluvium, and
- Placer tailings.

The sample location plan will be developed following review of previous material investigations. Previous borrow material investigations and a site reconnaissance would be used to identify areas for further investigation and test pit specifications and execution details. The test pits or excavations would be logged for material layer depths, color, initial texture analysis, water table depth, rooting depth. A digital photographic record will be developed for each test pit and the specific location will be documented using a GPS device. Each potential borrow area will be surveyed for aerial extent by walking the area using survey grade GPS equipment to determine the volume of material available in the area.

Between 7 and 10 samples of each material type be collected and submitted for basic geotechnical testing including water content, particle size distribution (PSD) analyses and Atterberg limits. The exact number of samples collected would depend on the heterogeneity of the materials encountered during the program. Following a review of the PSD test results, a select number of duplicate samples would be submitted for compaction testing and hydraulic characterization including saturated permeability and moisture retention testing. The results of this testwork would allow refinement of the currently estimated hydraulic properties for cover materials simulated in the 2014 VADOSE/W modelling program, and subsequent increase in the confidence of current estimates of long-term cover system performance.

Representative samples of potential cover materials will be submitted for chemical characterization testing. Soil fertility examination for agronomy assessment, including but not limited to, analyses for sodium adsorption ratio (SAR), cation exchange capacity (CEC), pH and EC, organic carbon, exchangeable K, Ca, Mg, macronutrients, and micronutrients will be performed. Erodibility assessment of the topsoil or surface material would include aspects of the chemical and geotechnical assessment as well as the Emerson crumb test. The results of this testwork will aid in determining fertilizer requirements for revegetation of the cover systems, and may show that a particular borrow source, such as placer tailings, is chemically unsuitable to support growth of native plants. In addition, materials susceptible to erosion and not suitable for reclamation of side slopes would be identified.

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[3] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March

[4] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

[5] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January

[6] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

Task 2b: Material Characterization Program for HLF and WRSA Waste Materials:

Representative samples of spent heap leach and waste rock material will be collected once available, and submitted for geotechnical characterization. Analyses include PSD, water content, standard Proctor compaction, saturated permeability, and moisture retention. The mine waste characterization program will also help to determine the technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA to help with future detailed cover system design development.

Spent heap leach and waste rock materials may have a propensity to break down when exposed to the atmosphere and when mechanical energy is applied. A pilot-scale field compaction trial should be conducted to determine the extent to which the waste material can be compacted, thereby reducing its permeability. Large vibratory rollers may be able to reduce the saturated permeability of surface waste material on flatter areas of the HLF and WRSA, such as plateau areas and benches. The intent is to limit net percolation during relatively short-duration seasonal events when the storage capacity of the growth medium layer may be exceeded. Compaction field trials could be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years. The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces.

Task 3: Enhanced Meteorological Monitoring

The objective of the enhanced meteorological monitoring for different slope aspects is to verify climate input parameters used in numerical modelling analysis to gain confidence in site water balance estimations and in the long-term predicted cover system performance. Meteorological monitoring will focus on snow pack sublimation and redistribution of snow, incoming solar energy and wind speed. For northern sites, such as for the EGP site, snow pack constitutes a significant portion of the water balance. Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system. In addition, depending of the prevailing wind direction areas of the HLF / WRSA may be sheltered influencing the evaporative demand.

Currently climate data is being collected at two automated stations in the Project area: the Potato Hill station installed in 2007 and the Camp station installed in 2009. Station details and the climate data that will be collected during this Task are found in the Environmental Monitoring, Surveillance and Adaptive Management Plan[7]. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the Environmental Monitoring, Surveillance and Adaptive Management Plan to provide measurement of incoming solar energy for north, west, and south facing slopes (SGC, 2016).

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in SGC (2016). The snow course surveys will continue to be conducted

[7] Strata Gold Corporation (SGC). 2016. Eagle Gold Project Environmental Monitoring, Surveillance and Adaptive Management Plan, Version 2016-01.

at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in SGC (2016). The surveys will be conducted on a monthly basis during the winter season. The frequency of surveys will increase in late spring and based on climate and temperature patterns to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report as net percolation.

Task 4: Closure Cover System Field Trials for Performance Monitoring

The objective of the closure cover system field trials is increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. The results from the material characterization program and most recent site investigation and monitoring data would be used to update current numerical models of predicted cover system performance to inform the optimum cover system design to be trialed at the EGP site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012)[8]:

1) Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
2) Obtain performance monitoring data for calibration of numerical models, such as VADOSE/W;
3) Develop an understanding of key characteristics and processes that control cover system performance; and
4) Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. The initial modelled assessment of cover system performance showed little difference in performance between the WRSAs and HLF simulations. Information gained in previous tasks will assist in the development of cover trials on different waste material types and on different slope angles. Automated soil monitoring stations consisting of volumetric water content and matric suction sensors will be installed in each cover trial to quantify key surface water and energy balance fluxes. Data will be collected by a datalogger powered by battery and solar panel set up. The two sensor types will be installed in pairs through the cover system profile to capture data to calculate water and energy fluxes at the interfaces of different material types including between the cover system layers and between the cover system and waste. Stations will be installed to capture data on a plateau location and on different slope locations (upper, mid, and lower slope) to determine spatial variability. The number and location of the automated stations will be determined as part of the final design of the cover system monitoring trials informed by the updated conceptual model, the material characterization program, and the expanded site-specific meteorological dataset. The cover system field

[8] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

trial would be revegetated using techniques and species outlined by KP (2012a and 2012b)[9][10] and any updated vegetation monitoring information. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques to evaluate the degree of success of the closure cover system design. The monitoring plan developed for the research program would include monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives. Revegetation studies have been previously conducted to examine site-specific vegetation species and ecosystem characteristics (KP 2012a and 2012b) and will help in developing the re-vegetation component of the detailed research and monitoring plan.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. This will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the initial VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

Clause 178(e): Vegetation Rooting Study

The overall objective of Clause 178E: *Rooting Study* is to evaluate the potential risk for plant root uptake of contaminants of concern (CoCs) from physical, geochemical, and vegetative perspectives. The rooting study will be conducted concurrently with the Closure Cover System Field Trials. The following Tasks will be conducted to achieve this goal:

Task 1: Root Zone Monitoring to understand physical processes contributing to the accumulation or removal of constituents in the rooting zone (i.e. pore-water sampling collection over the duration of the program);

Task 2: Geochemical assessment of cover system and underlying materials to identify any constituents that may be susceptible to bioaccumulation; and

Task 3: Destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length, which would lead to an update of constituents in the cover system and underlying materials.

The following work plan is proposed to address the three Tasks outlined above.

Task 1: Rooting Zone Monitoring in Cover System Field Trial

A manual soil monitoring system would be installed adjacent to an automated soil monitoring system installed during field trials described above to monitor process that allow CoCs to accumulate in the root zone. The location and the number of the manual stations will be determined based on the final design of the cover system monitoring field trials. Deep pressure/vacuum soil water samplers (soil water samplers) would be installed in the cover system to manually monitor and sample pore-water over the duration of the

[9] Knight Piesold Consulting (KP). 2012a. Memorandum to Todd Goodsell. Site visit re-vegetation plan. File No. VA101-290/6-A.01. September 5.

[10] Knight Piesold Consulting (KP). 2012b. Memorandum to Todd Goodsell. Re-vegetation test plots. File No. VA101-290/6-A.01. September 7.

program, providing a basic understanding of soil moisture content and gradient within the cover system that would be verified with the automated system. Additionally, pore-water samples would be analyzed for aqueous chemistry to understand the movement of CoCs within the cover system. The instrumentation installation details will be determined based on the final cover system field trial design; however, the samplers will be installed to capture pore-water through the cover system and particularly near the cover system / waste material contact. Sampling frequency and monitoring plan will be developed to capture high flow periods in the seasonal cycle such as during or immediately following spring melt / cover system profile thaw or intense rainfall events. Pore-water samples collected with the soil water samplers would be submitted for general aqueous chemistry analysis. Samples would be submitted to be tested for measurement of metals (routine and trace) and routine water consisting of pH, EC, total dissolved solids (TDS) and major cations and anions.

Task 2: Geochemical Assessment

In addition to pore-water sample collection, samples of cover system and underlying materials would be collected for geochemical analysis as the field trial is being constructed. General overall geochemical characterization can be included as part of the material characterization program, but discreet samples of the materials used in the field trial should be obtained during construction to provide baseline conditions. Because vegetation will need to be supported by the cover system, basic characterization of the cover system materials and underlying materials will provide an indication of chemical composition related to growth characteristics, inform of potential fertilizer requirements for initial vegetative establishment, and aid in identifying any constituents susceptible to bioaccumulation. Basic chemical characterization would be conducted on samples of cover system layers and waste materials. Initially, samples would be collected and submitted for laboratory chemical characterization of: paste pH and EC, SAR, CEC, calcium carbonate equivalent (CCE) depending on CEC results, and leachate chemistry. The number of samples for each material will be determined as part of the detailed cover system trial work and monitoring plan. Samples will also be collected in conjunction with destructive sampling toward the end of the program to access any changes in soil geochemistry.

Task 3: Destructive Sampling

Destructive sampling would be completed during and near the end of the program to determine spatial vegetation characteristics that include vegetation type, ground cover percentage, vertical root length and density. A vegetation survey, consisting of sample plots randomly located throughout the cover system, would be completed to quantify spatial vegetation characteristics. Percentage of ground cover as well as the proportion of species in each sample plot would be determined using a 0.25 m^2 quadrat.

Following the assessment of ground cover, excavation of a number of plots would be conducted to determine the vertical root length density distribution per mass of soil for the cover system; the excavation may be a portion of the 0.25 m^2 quadrat. Small excavations would be completed using methods such as a backhoe at specified increments. Root presence and density would initially be noted and pictures taken for each increment. Each depth increment would be subsampled for water content and root density; water content subsamples would be tested for moisture content and root density samples would be weighed, stored in plastic bags, and water added to each sample. Upon returning from the field, samples should be soaked overnight in a cooler on ice to minimize root degradation. All roots would be separated from the soil matrix, dried and weighed to determine a root density for each plot. Methodology following Lazorko

(2008)[11] would be used for the root mass survey. The depth of each excavation would be dependent on the presence of roots or until the maximum investigation depth is reached. The number of vegetation and root mass surveys would be determined as part of the overall detailed monitoring plan for the cover system field trials.

Closure:

We thank you for the opportunity to assist Victoria Gold Corp with providing updates for the DCP. Please do not hesitate to contact me at (306) 955-0702 or dchapman@okc-sk.com should you have any questions or comments.

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Jim Harrington, Alexco Environmental Group
Greg Meiers, O'Kane Consultants Inc.

[11] Lazorko, H. M, (2008). Root distribution, activity, and development for boreal species on reclaimed oil sand minesoils in Alberta, Canada (Doctoral dissertation, University of Saskatchewan Saskatoon, Canada).

APPENDIX G

Eagle Gold Mine Base Case Cover System Interim Performance Monitoring Report

Eagle Mine Base Case Cover System Interim Performance Monitoring Report September 2022

September 29, 2022

Victoria GOLD CORP

okane

Integrated Mine Waste Management and Closure Services

Specialists in Geochemistry and Unsaturated Zone Hydrology

Eagle Mine
Base Case Cover System Interim Performance Monitoring Report
September 2022

1048-221-003

September 2022

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Rev. #	Rev. Date	Author	Reviewer	PM Sign-off
0	14-Sept-22	H. Cunningham	M. McKeown	L. Doucette
1	29-Sept-22	H. Cunningham	L.Doucette	L.Doucette

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EXECUTIVE SUMMARY

Okane Consultants Inc. (Okane) was retained by Victoria Gold Corp. (VG) to provide engineering services to design and evaluate performance monitoring systems of a base case cover system (BCCS) for the Platinum Gulch 1370 waste rock storage area (WRSA) at Eagle Gold Mine operation in Yukon, Canada. Two performance monitoring stations were installed by VG in October 2020, on the plateau and south facing slope of the BCCS field trial on the 1370 WRSA. The work summarized herein supports reclamation research described in the Reclamation and Closure Plan (RCP; version 2020-01) and is particularly aimed at evaluating net percolation into the WRSA, which is an important component of the overall site-wide water balance and water quality model (Lorax, 2022). This interim report summarizes performance of the cover system over the first half of the second year of monitoring, from December 1, 2021 to July 31, 2022 (referred to as the interim monitoring period). The 2020/2021 monitoring period (October 24, 2020 to November 30, 2021) is summarized in Okane (2022a).

Meteorological conditions during the interim monitoring period were consistent with trends in climate of the area. Precipitation varied throughout the summer months, with July having high rainfall which exceeded the evapotranspirative processes, and the remaining spring/summer being relatively dry. Volumetric water contents (VWCs) measured at the monitoring stations were generally lower during the interim monitoring period compared to the same time of year in the 2020/2021 monitoring period, indicating greater available storage capacity in the cover system throughout the summer in the interim period.

Based on data collected in the interim monitoring period, data trends suggest that the NP rates for the annual monitoring period will be consistent with the conceptual performance of the base case cover system assumed in the site-wide water balance and water quality model (Lorax, 2022). Water balance model estimates for the second year of monitoring will be conducted when the full year is completed. For 2020/2021 monitoring period, water balance models estimated NP rates of 31% and 37% of effective precipitation for Slope and Plateau locations, respectively. The estimated NP rates are slightly higher than the modelled rates assumed in the site-wide water balance and water quality model. It is expected that NP rates will trend downward as the vegetative cover improves and matures, resulting in lower NP due to more water being pulled from the cover system via evapotranspiration processes. Continued field trial cover system performance monitoring will provide additional data to help characterize cover system performance on a yearly basis and allow various types of climate years to be evaluated.

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1 INTRODUCTION

Victoria Gold Corp. (VG) owns and operates the Eagle Gold Mine on the Dublin Gulch property located in central Yukon Territory, Canada. The mine is currently in operation and has completed the Environmental Assessment process. Version 2020-01 of the Reclamation and Closure Plan (RCP) outlined a series of tasks for a proposed research program in support of ongoing reclamation and closure planning. Relocation of an overburden stockpile to the Platinum Gulch 1370 lift on the waste rock storage area (WRSA) presented an opportunity to advance cover system monitoring in support of progressive reclamation.

Okane Consultants Inc. (Okane) was retained to design and monitor performance monitoring systems for a base case cover system (BCCS) trial constructed from the relocated overburden stockpile. The BCCS, consisting of ~0.5 m of overburden placed on the WRSA lift plateau and slope, provides the opportunity to track the evolution of the cover system in response to site-specific physical, chemical, and biological processes to enhance understanding of key mechanisms that control cover system performance. Cover system performance will primarily be assessed in terms of net percolation (NP) of meteoric waters.

Installation of performance monitoring stations on the plateau and slope of the BCCS trial was completed by VG in fall 2020, with Okane providing remote guidance. This report primarily summarizes meteorological and soil condition data collected through the first half of the second year of monitoring of the BCCS trial, from December 1, 2021 to July 31, 2022, herein referred to as the interim monitoring period. The first monitoring period, from October 24, 2020 to November 30, 2021, is summarized in Okane (2022a) and is hereby referred to as the 2021/2022 monitoring period.

1.1 Project Objectives

The RCP outlines a research program associated with the 1370 m lift on the Platinum Gulch WRSA (i.e., the 1370 WRSA) into reclamation cover system configurations and the processes governing performance. The primary objective of the 1370 WRSA cover system trial is to measure and understand BCCS water dynamics on the lift plateau and slope, such that an informed estimate of NP rates through a variably thick cover system can be developed. Estimated NP[1] rates can then be used to determine whether the assumed BCCS implementation is likely to result in achieving site water quality criteria for closure. Cover system performance is considered in the context of Eagle Gold Mine's water balance and water quality model (WBWQM) (Lorax, 2022).

[1] NP of net precipitation is defined as the difference between total precipitation and total evapotranspiration.

A secondary objective of the research program is to demonstrate that the BCCS design is geotechnically, geomorphologically, and geochemically stable. Thus, as the objectives are realized they can be used to demonstrate that the integrated performance of the system is sufficient to meet closure performance objectives without the need for substantial regrading of the WRSAs.

1.2 Conceptual Model of Performance

The primary aim of the BCCS is to provide controls on NP to limit infiltration into waste material and subsequently limit leaching, by taking advantage of the water store and release properties of the overburden material. Climate will be a primary driver of cover system performance. The Eagle Gold Mine site setting is classified as a Dsb climate regime (Continental Subarctic, with a cold dry summer), according to the Köppen-Geiger classification system. According to the Global Cover System Design Technical Guidance Document (INAP, 2017) a Dsb climate is expected to facilitate an expected range of NP (and variable evapotranspiration and runoff rates), expressed as percentage of annual precipitation, for various cover system alternatives as follows:

- Very low (<5%): Geosynthetic;
- Low (5–10%): Barrier Type – Sand bentonite layer;
- Moderate (10–20%): Enhanced store and release – low hydraulic conductivity layer;
- High (20–50%): Store and release;
- Very High (>50%): Erosion protection – Vegetative cover.

The 1370 WRSA BCCS trial is a simple monolithic layer of overburden and can be expected to perform as a store and release cover system. A cover system of this type would thus be expected to allow from 20% to 50% of average annual precipitation to infiltrate past the base of the cover system (below the zone of effective evapotranspiration). However, the spatial distribution of the NP would not be expected to be consistent over the entirety of the WRSA. For example, slope areas would be expected to have a large runoff component with spring melt, and if slope runoff is not directed off the facility, it could accumulate at a downslope plateau area. The net effect would be for lower infiltration rates on slopes, with the balance accumulating on lift plateaus. Much of the remaining input water would be released via evapotranspiration during the summer months. It is expected that the majority of NP occurs during the freshet season as the soil thaws, and in the fall once evapotranspiration rates slow but before the soil has frozen. Following establishment of the cover system, an NP rate of 25 to 30% of average annual precipitation has been assumed in the Eagle Gold Mine WBWQM (Lorax, 2022).

1.3 Report Organization

The report has been subdivided into the following sections:

- Section 2 – Background;
- Section 3 – Material and Methods;
- Section 4 – Results;
- Section 5 – Discussion;
- Section 6 – Summary; and,
- Section 7 – References.

2 BACKGROUND

The approximate area of the 1370 PG WRSA plateau is 47,500 m^2, and the amount of overburden relocated was 20,777 m^3, which was used to construct the BCCS in September and October 2020. The BCCS consists of ~0.5 m of overburden material placed on a portion of the 1370 WRSA lift plateau and on a section of the adjacent slope (Dwg. 1048-005-020, Appendix A). The cover system design is aligned with the base case configuration in the VG RCP and will inform on the potential of using the configuration for successful reclamation.

The cover system was constructed using standard site procedures. Construction methods included paddock dumping and dozing of the overburden material from the existing stockpile across the plateau of the 1370 WRSA lift to produce the ~0.5 m cover system layer, and nominal tracking and compaction by dozer after placement. Some of the remaining overburden was pushed over the crest and spilled down the south-southeast slope. The method for covering slopes aligns with the proposed final closure method for the mine, as currently waste rock slopes are not intended to be regraded and slope faces will be covered by dozing material over the crest of each bench. The method of application could also be appropriate for the cover systems if some waste rock slopes need to be regraded. The application method does not provide a uniform cover system thickness on the waste rock slopes but will allow for a greater understanding of water partitioning on both benches and slopes for the refinement of cover system model inputs.

Installation of cover system performance monitoring instrumentation on the BCCS trial was completed by VG in October 2020 and is managed jointly by VG and Okane. A material sampling program was conducted before and during cover system construction to characterize the physical and hydraulic properties of the overburden material (Okane, 2022b).

3 MATERIALS AND METHODS

3.1 Performance Monitoring Instrumentation

Profile views of performance monitoring instrumentation installed in the 1370 WRSA BCCS trial are shown on Dwg. 1048-005-002 (Appendix A). A detailed description of the installation of soil water and meteorological monitoring instruments can be found in Okane (2021a). The following is a summary of instrumentation installed:

- One (1) Plateau Soil Monitoring Station consisting of five (5) matric suction and five (5) volumetric water content (VWC) sensors installed throughout the cover system and in the waste surface, along with a net radiometer, snow depth sensor, and tipping bucket rain gauge (TBRG) (Photo B.1, Appendix B);

- One (1) Slope Soil Monitoring Station consisting of five (5) matric suction and five (5) volumetric water content (VWC) sensors installed throughout the cover system and in the waste surface, along with a net radiometer and snow depth sensor (Photo B.2, Appendix B).

Precipitation, wind speed, air temperature, and relative humidity (RH) are measured by the existing meteorological stations on site (Potato Hills and Camp meteorological stations). The primary station used to create the meteorological station data record for this report is Potato Hills. Air temperature and RH recorded at the Camp meteorological station was input to the Potato Hills record for periods of low quality data reported at the Potato Hills station (hereby referred to as the site meteorological station record). Data collected and analyzed for the 2020/2021 monitoring period (October 24, 2020 to November 30, 2021) is summarized in Okane (2022a).

3.2 Monitoring Data Collection

Data capture rates for components of the 1370 WRSA BCCS field trial performance monitoring systems were analyzed over the interim monitoring period (Table 3.1). The average data capture rate for the December 1, 2021 to July 31, 2022 interim monitoring period was 100%. Data capture rates for automated sensors are based on the number of sensors operating compared to the total number of sensors installed, and the data collection efficiency of these sensors [number of data points collected / (number of measurements per day x number of days in the monitoring period)].

Table 3.1: Soil water and meteorological monitoring station data capture rates for the interim monitoring period.

Component	Number of Automated Sensors	Number of Automated Sensors Operating	Data Capture Rate
Site Meteorological Record (Potato Hills and Camp)			
Total precipitation	1	1	100%
Air temperature / RH	1	1	100%
Wind speed / direction	1	1	100%
Plateau Soil Monitoring Station			
Matric suction / temperature	5	5	100%
Water content	5	5	100%
Net radiometer	1	1	100%
Snow depth	1	1	100%
Rainfall	1	1	100%
Slope Soil Monitoring Station			
Matric suction / temperature	5	5	100%
Water content	5	5	100%
Net radiometer	1	1	100%
Snow depth	1	1	100%
Average Data Capture Rate for the Monitoring Period			**100%**

Data issues identified for the monitoring period were as follows:

1. Low quality air temperature and RH measurements recorded at the Potato Hills meteorological station began on July 20, 2022, which may be associated with sensor failure. Air temperature and RH data collected by the Camp meteorological station from July 20 to 31, 2022 were inserted into the Potato Hills station record, to complete the interim site meteorological record.

4 RESULTS

4.1 Meteorological Conditions

Meteorological parameters are measured to obtain site-specific climatic conditions for evaluation of cover system performance. Precipitation, wind speed, air temperature, and RH are measured by the existing meteorological stations on site (Potato Hills and Camp meteorological stations). Due to the similar elevation of the Potato Hills station and the 1370 WRSA BCCS trial, the primary station used to create the meteorological station data record is Potato Hills. The Potato Hills record is supplemented with air temperature and RH data from the Camp meteorological station from July 20 to 31, 2022, when Potato Hills data is missing (hereby referred to as the site meteorological stations record). Net radiation and snow depth are measured at the 1370 WRSA BCCS trial Plateau and Slope cover system monitoring stations, and rainfall is measured at the Plateau monitoring station.

4.1.1 Air Temperature

Air temperatures recorded at the site meteorological stations since the onset of monitoring are presented in Figure 4.1. Air temperature recorded at the site meteorological stations during the interim monitoring period ranged from a low of -34.4°C in January, to a high of 24.9°C recorded in July. Site air temperatures during the interim monitoring period are compared to the 2020/2021 monitoring period (Table 4.1).

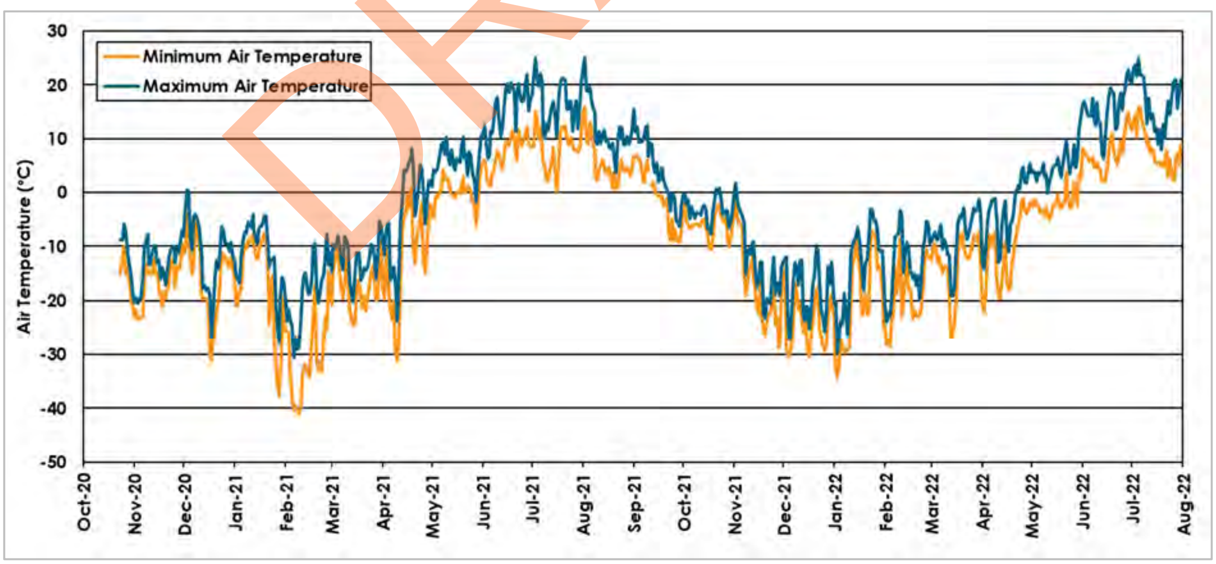

Figure 4.1: Daily minimum and maximum air temperatures recorded at the site meteorological stations since the onset of monitoring.

Table 4.1: Maximum and minimum monthly air temperatures recorded at the site meteorological stations during the interim monitoring period vs. the 2020/2021 monitoring period.

Month	2020/2021		2021/2022 Interim	
	Maximum Air Temp (°C)	Minimum Air Temp (°C)	Maximum Air Temp (°C)	Minimum Air Temp (°C)
December	-	-	-10.4	-30.5
January	0.9	-37.9	-3.1	-34.4
February	-7.7	-41.1	-3.3	-28.6
March	-5.4	-24.7	-1.4	-26.8
April	8.2	-31.1	5.3	-22.1
May	10.6	-6.2	13.9	-5.1
June	21.9	1.3	22.9	1.9
July	28.6	-1.2	24.9	4.7
Average	**9.1**	**-17.1**	**6.1**	**-17.6**

4.1.2 Relative Humidity

Daily maximum and minimum RH recorded at the site meteorological stations was available for the 2020/2021 monitoring period and is presented in Figure 4.2. Daily average RH recorded at the site meteorological stations for the interim monitoring period is presented in Figure 4.3. The maximum recorded average RH in the interim monitoring period was 99.2% and the minimum was 33.6%.

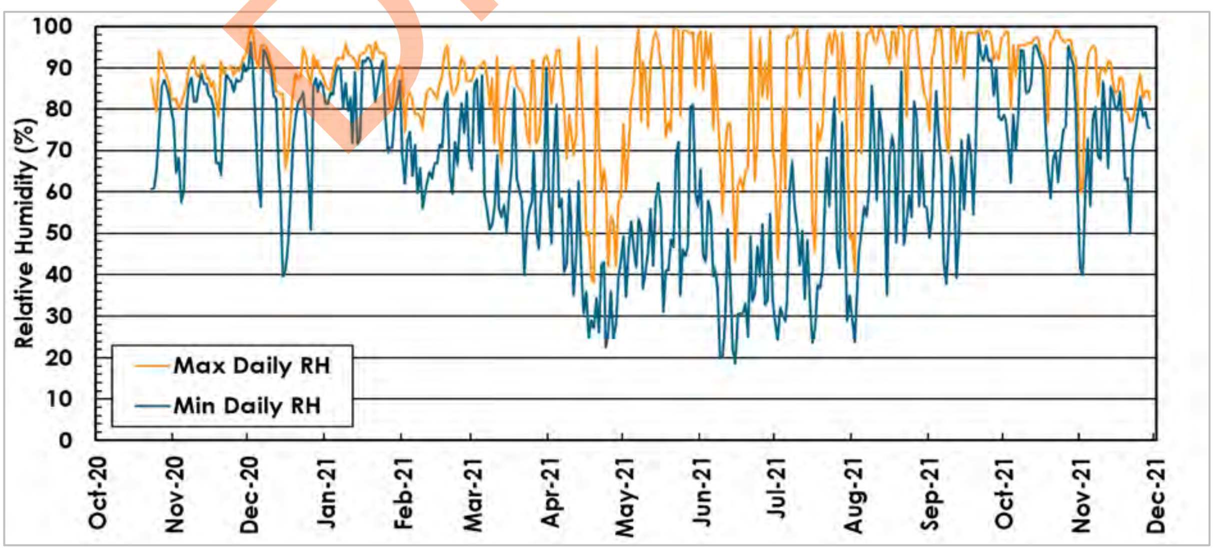

Figure 4.2: Daily minimum and maximum relative humidity recorded at the site meteorological stations during the 2020/2021 monitoring period.

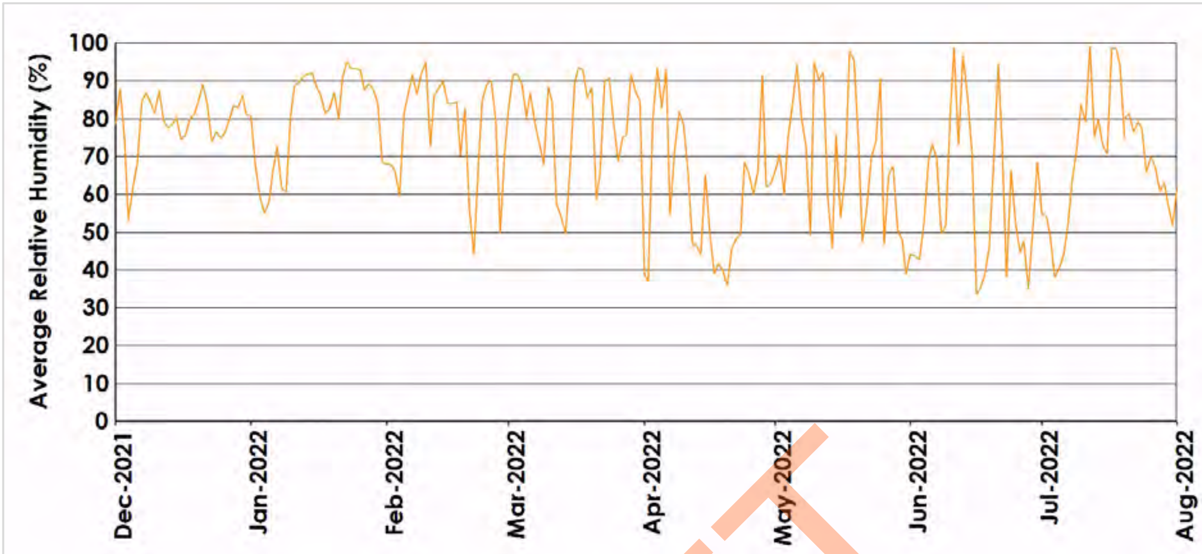

Figure 4.3: Daily average relative humidity recorded at the site meteorological stations during the interim monitoring period.

4.1.3 Wind Speed

The daily average wind speed recorded at the site meteorological stations since the onset of monitoring is presented in Figure 4.4. Average daily wind speed of 2.6 m/s in the interim monitoring period was recorded at the Potato Hills station, with a maximum daily wind speed of 9.6 m/s recorded on January 2, 2022.

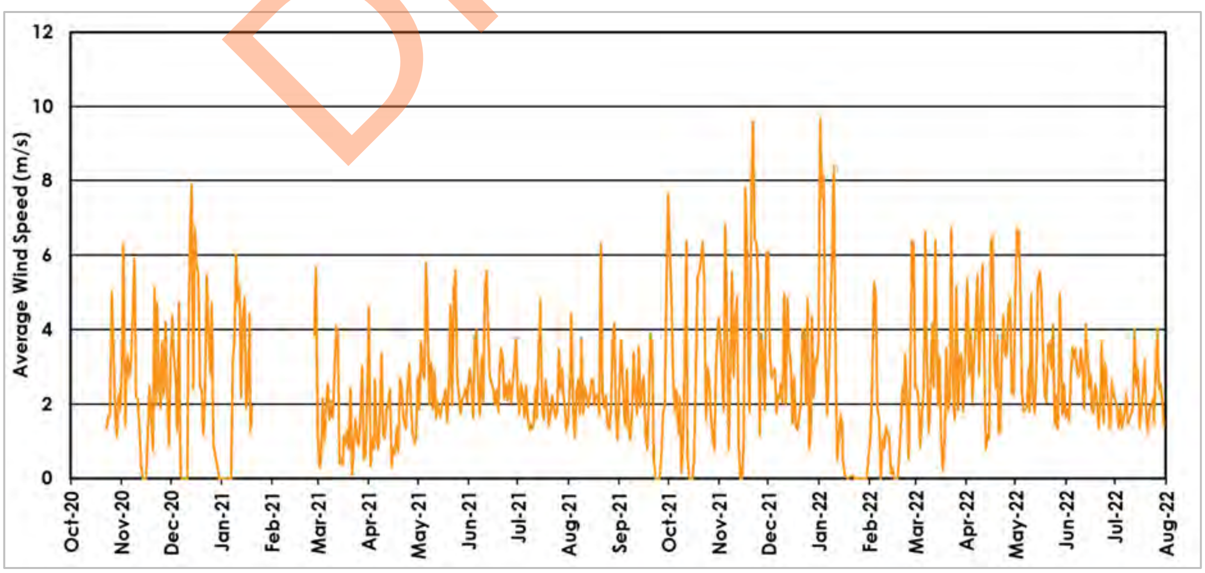

Figure 4.4: Average daily wind speed recorded at the site meteorological stations since the onset of monitoring.

4.1.4 Net Radiation

Net radiation is the primary driver in the calculation used to estimate reference evapotranspiration. Net radiation is continuously monitored at the Plateau and Slope monitoring stations of the 1370 WRSA BCCS trial with NRLite2 net radiometers. The Slope monitoring station is located on the southeast slope of the 1370 WRSA (Dwg. 1048-005-020, Appendix A). Total daily net radiation recorded at the Plateau and Slope stations since the onset of monitoring is presented in Figure 4.5.

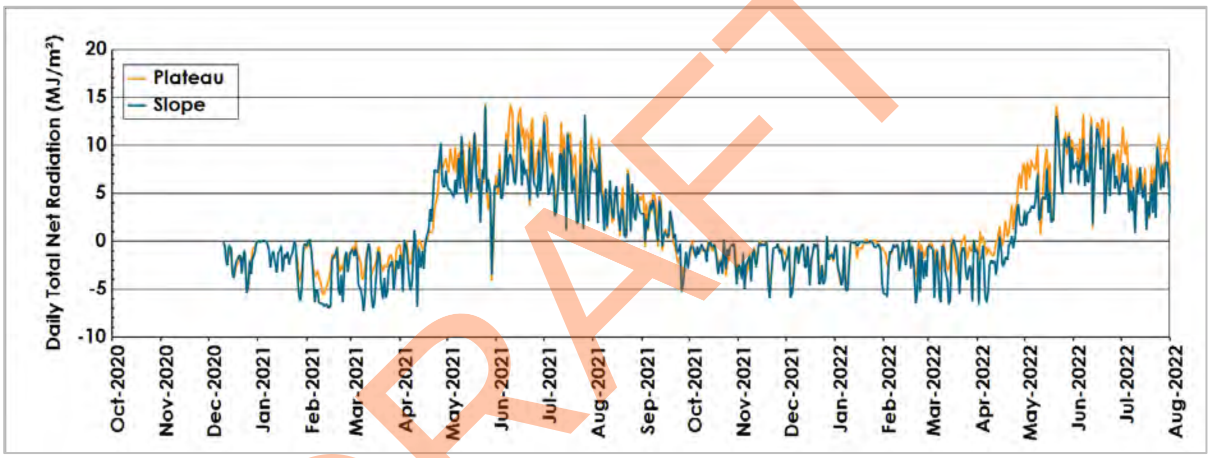

Figure 4.5: Total daily net radiation recorded at the 1370 WRSA BCCS trial Plateau and Slope monitoring stations since the onset of monitoring.

4.1.5 Total Precipitation

Total precipitation is continuously monitored with precipitation weighing gauges at the Potato Hills and Camp meteorological stations and is a sum of rainfall and snow water equivalent. Daily and cumulative precipitation recorded by the site meteorological stations during the 2020/2021 monitoring period is presented in Figure 4.6. Daily and cumulative precipitation recorded by the Potato Hills meteorological station during the interim monitoring period is presented in Figure 4.7, with cumulative precipitation of 222.1 mm.

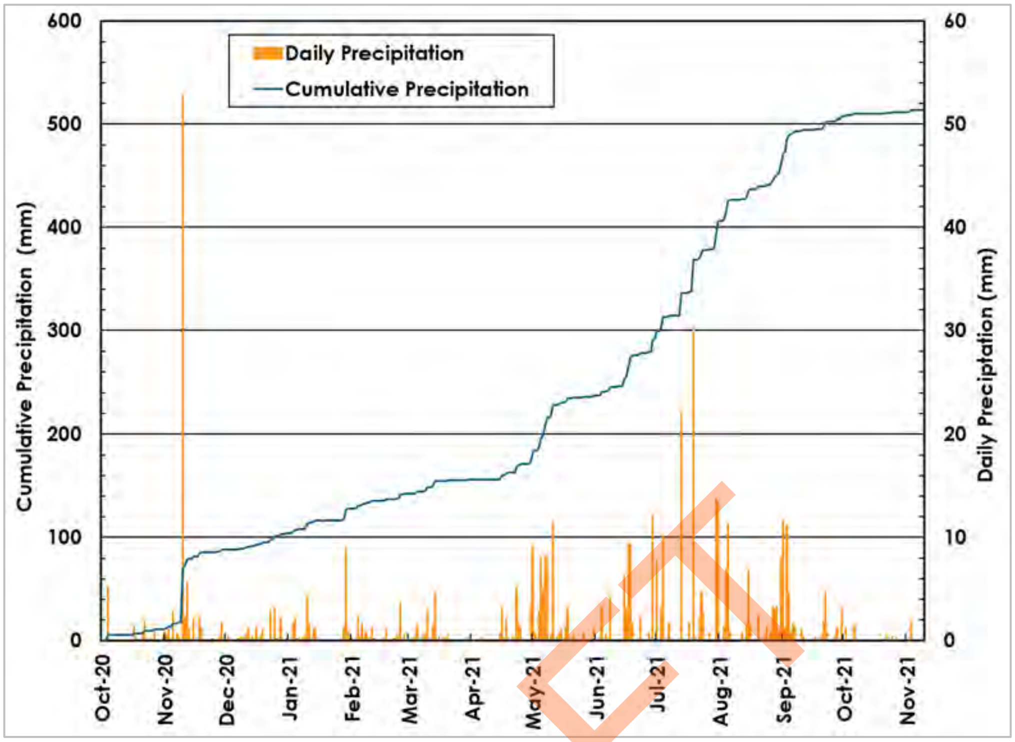

Figure 4.6: Daily and cumulative total precipitation measured at the site meteorological stations during the 2020/2021 monitoring period.

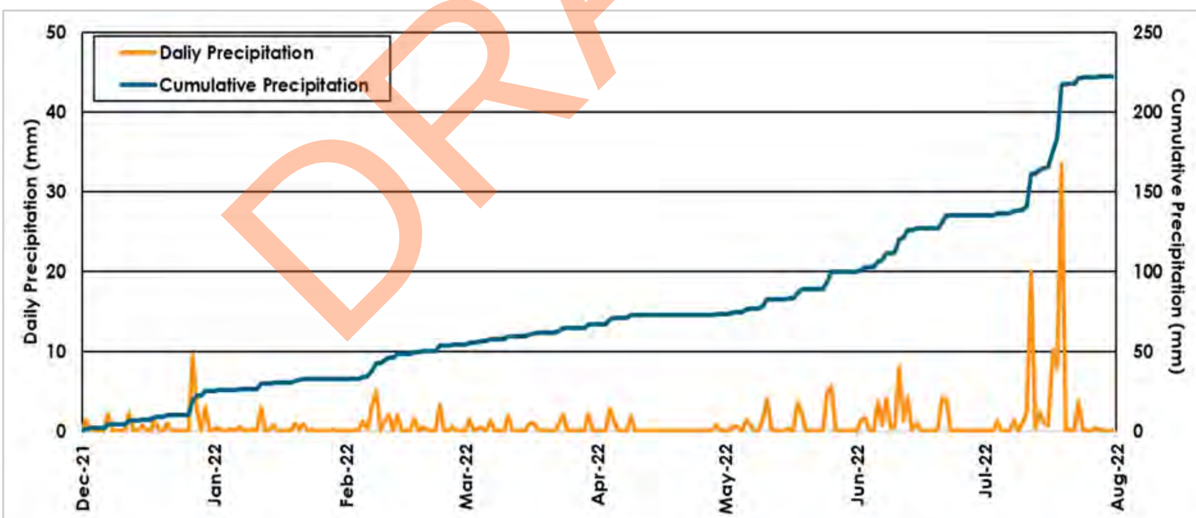

Figure 4.7: Daily and cumulative total precipitation measured at the Potato Hills meteorological station during the interim monitoring period.

4.1.6 Rainfall

Rainfall is continuously monitored on the 1370 WRSA BCCS trial Plateau station with an EML Metric ARG314 TBRG with 0.2 mm resolution. ARG314 rainfall measurements are accurate to

99% up to 120 mm/hr wind speeds. The aerodynamic shape of the TBRG reduces wind loss of rainfall over the orifice, improving accuracy of the measurement. Total monthly rainfall recorded on the 1370 WRSA BCCS trial Plateau and the Potato Hills stations for the interim monitoring period is presented in Table 4.2, along with 2020/2021 monitoring period rainfall recorded during the same months. Daily and cumulative rainfall recorded on the Plateau during the 2020/2021 monitoring period and interim monitoring period is presented in Figure 4.8 and Figure 4.9, respectively. Cumulative rainfall on the Plateau is compared to the site meteorological station 2020/2021 monitoring period record in Figure 4.10 and the Potato Hills meteorological station in the interim monitoring period in Figure 4.11.

Table 4.2: Rainfall recorded on the 1370 WRSA BCCS trial Plateau and Potato Hills meteorological station for the interim monitoring period vs. the 2020/2021 monitoring period.

Month	2020/2021 Total Rainfall (mm)		2021/2022 Interim Total Rainfall (mm)	
	1370 WRSA BCCS Trial	Site Meteorological Stations (Potato Hills and Camp)	1370 WRSA BCCS Trial	Potato Hills Meteorological Station
April	1.0	0.0	0.0	0.0
May	31.8	55.2	8.6	15.1
June	19.4	29.8	40.4	35.8
July	66.4	66.4	67.8	86.8
Total	**118.6**	**151.4**	**116.8**	**137.7**

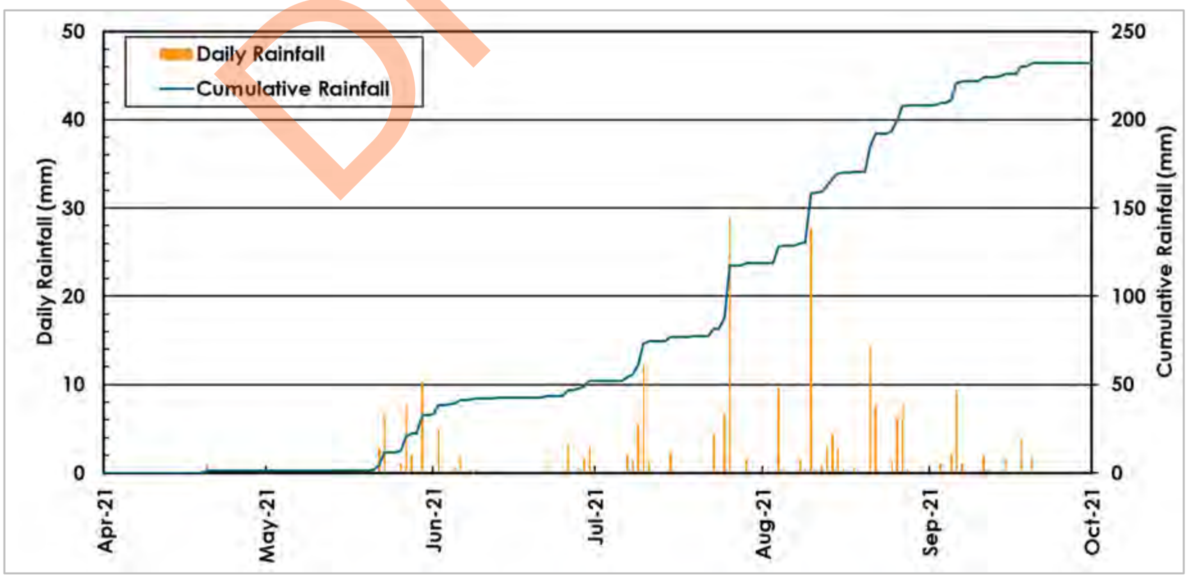

Figure 4.8: Daily and cumulative rainfall measured at the 1370 WRSA BCCS trial Plateau monitoring station during the 2020/2021 monitoring period.

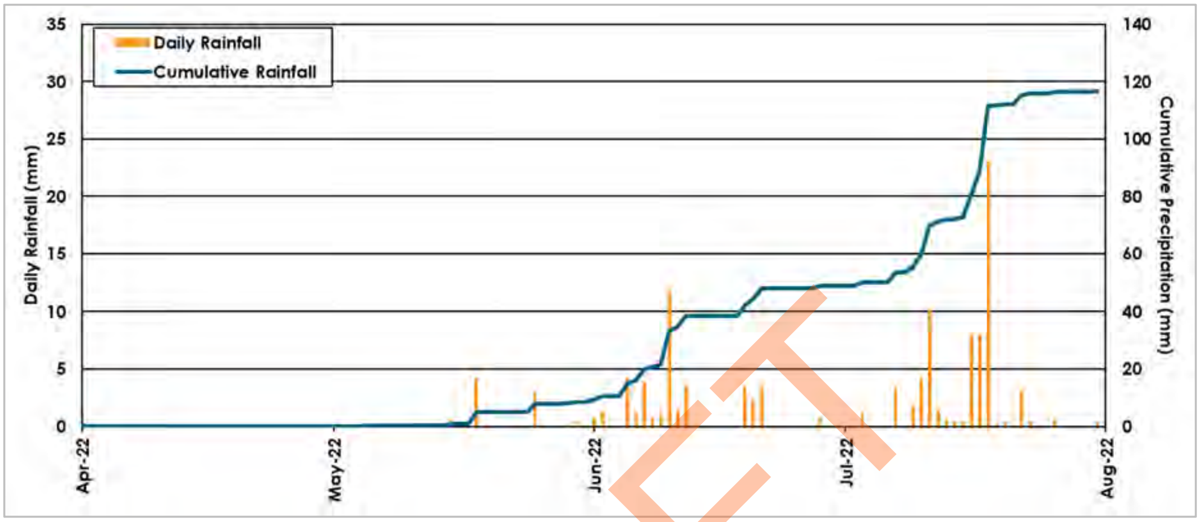

Figure 4.9: Daily and cumulative rainfall measured at the 1370 WRSA BCCS trial Plateau monitoring station during the interim monitoring period.

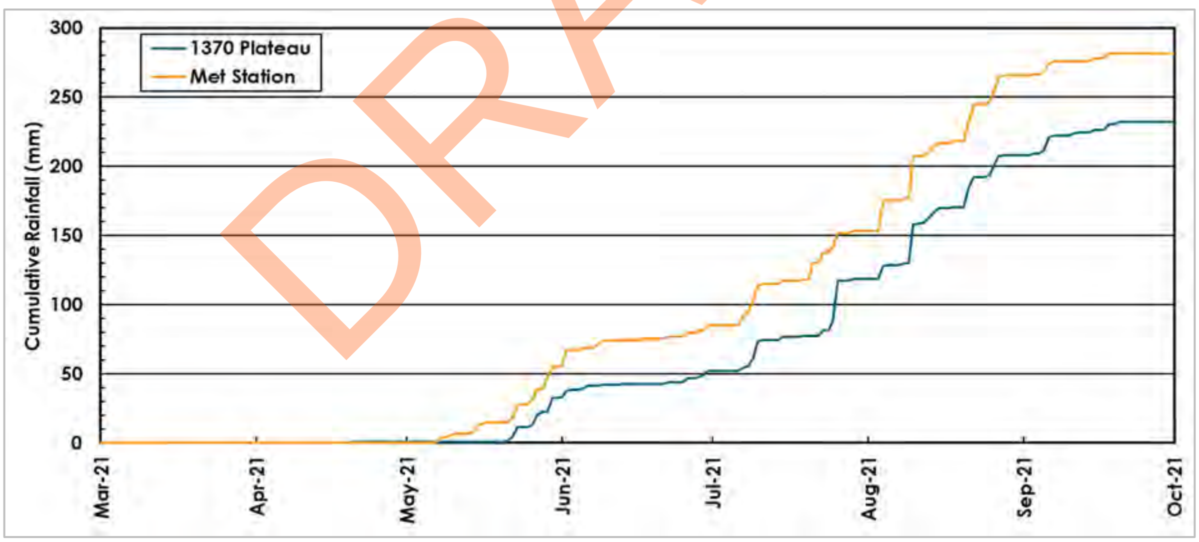

Figure 4.10: Cumulative rainfall recorded at the 1370 WRSA BCCS trial Plateau monitoring station and site meteorological stations during the 2020/2021 monitoring period.

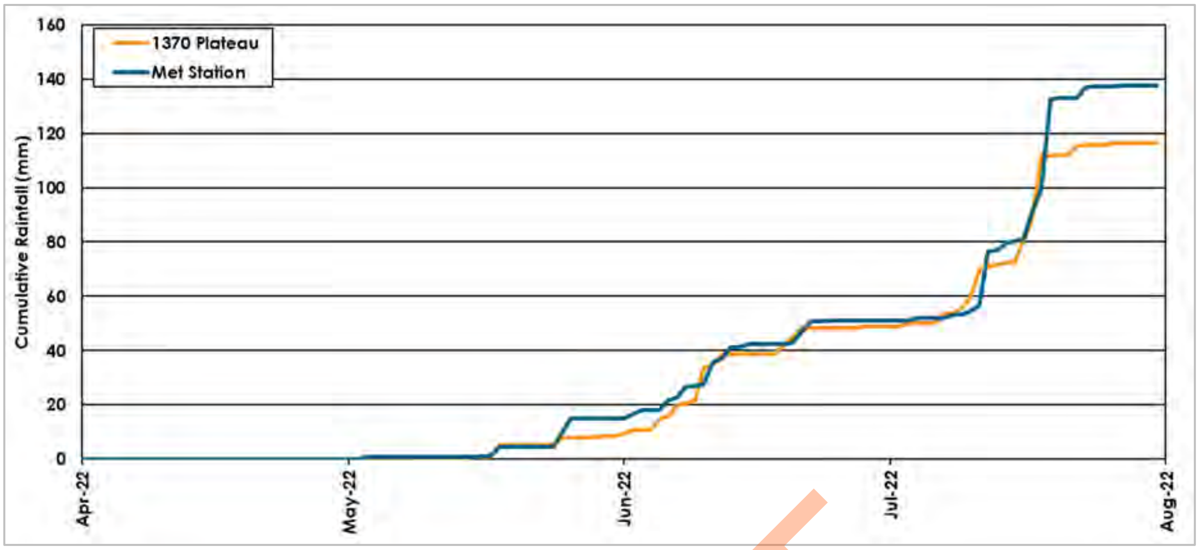

Figure 4.11: Cumulative rainfall recorded at the 1370 WRSA BCCS trial Plateau monitoring station and Potato Hills meteorological station during the interim monitoring period.

4.1.7 Snow Depth

Snow depth is continuously monitored with Campbell Scientific (CS) SR50AT sonic ranging sensors at the 1370 WRSA BCCS trial Plateau and Slope monitoring stations. Measurements are accurate to ±1 cm. Average daily snow depths since the onset of monitoring are presented in Figure 4.12. The snow depth sensor measures the distance to the surface beneath by emitting an ultrasonic pulse in a conical beam and measuring the elapsed time between the emission and return of the pulse. Raw distance data is corrected with an air temperature measurement collected by the SR50AT to account for variations of the speed of sound in air. The corrected snow depth data is then averaged by the sensor and used to calculate a single snow depth value for the conical area below the sensor.

A snow survey was not completed on the cover system trial in the interim monitoring period due to windblown conditions on the 1370 WRSA BCCS plateau. Although the cover trials experienced windblown conditions on the plateau, the snow depth sensor indicated that snow had accumulated below the sensor. The snow depth sensors indicated a maximum snow depth of ~0.33 m and ~0.54 m at the Plateau and Slope station in the interim monitoring period, respectively compared to ~0.32 m and ~0.22 m in the 2020/2021 monitoring period. Snow depth data will be used to estimate snow water equivalent snowmelt timing as part of the water balance analysis in the year end monitoring report and compare to SWE estimated for the 2020/2021 monitoring period water balance.

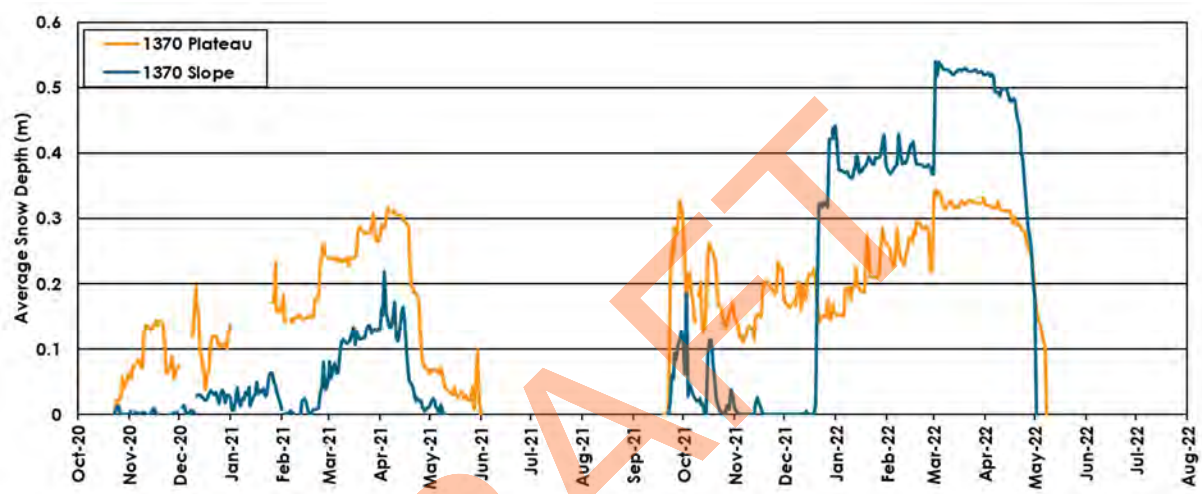

Figure 4.12: Daily average snow depth measured at the 1370 WRSA BCCS trial Plateau and Slope monitoring stations since the onset of monitoring.

4.2 Subsurface Temperature

Subsurface soil temperatures of the cover system trial are recorded at 1370 WRSA BCCS trial Plateau and Slope soil monitoring stations using profiles of Campbell Scientific (CS) Model 229 heat dissipation matric potential sensors. Soil temperature data recorded at the monitoring stations since the onset of monitoring are illustrated in Figure 4.13 and Figure 4.14.

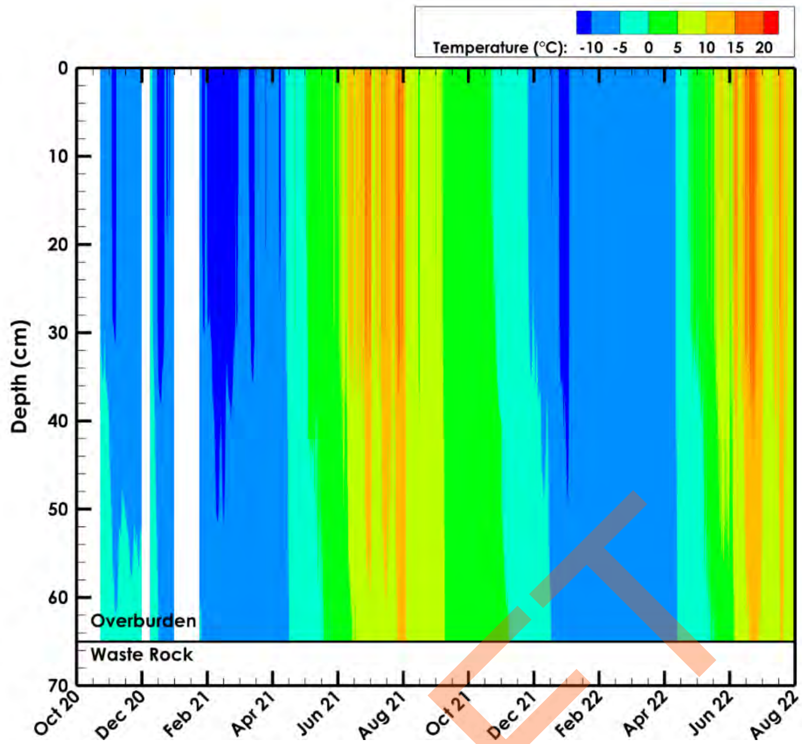

Figure 4.13: Soil temperature measured at the 1370 WRSA BCCS trial Plateau soil monitoring station since the onset of monitoring.

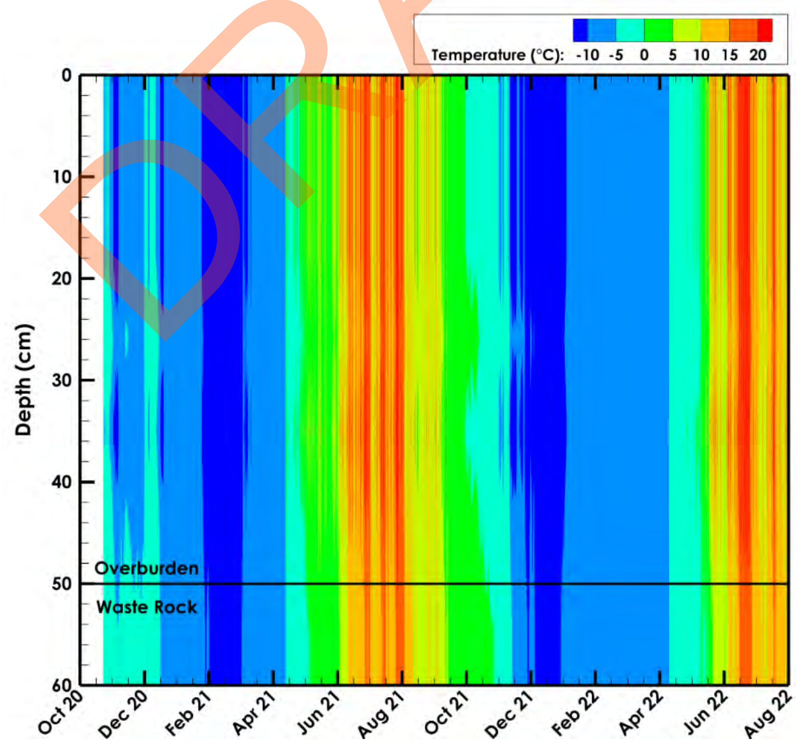

Figure 4.14: Soil temperature measured at the 1370 WRSA BCCS trial Slope soil monitoring station since the onset of monitoring.

4.3 Soil Water Conditions

Subsurface volumetric water content (VWC) of the 1370 WRSA BCCS trial is recorded at Plateau and Slope soil monitoring stations using profiles of CS616 water content reflectometers, with a measurement accuracy of ±2.5%. The CS616 reflectometer measurements are based on dielectric constant, and because the dielectric constant for ice is different than water, VWC data cannot be interpreted during frozen conditions and is removed from datasets. Matric potential is measured with CS229 heat dissipation matric potential sensors installed at the soil monitoring stations with an accuracy of ~1 kPa at matric potentials > -100 kPa.

4.3.1 Volumetric Water Content

Soil VWC data collected at the 1370 WRSA BCCS trial Plateau and Slope monitoring stations since the onset of monitoring are illustrated in Figure 4.15 and Figure 4.16.

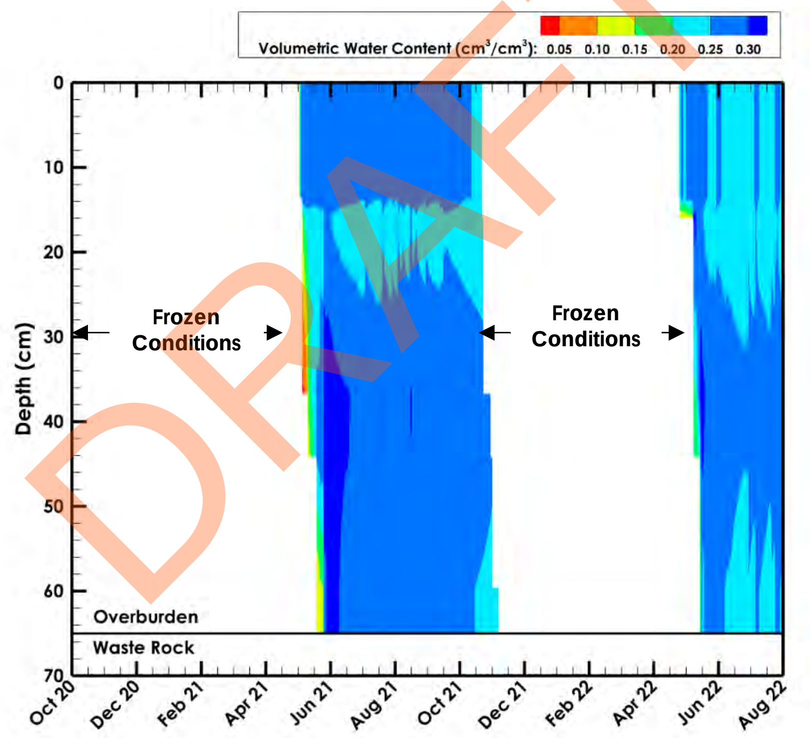

Figure 4.15: Soil VWC measured at the 1370 WRSA BCCS trial Plateau soil monitoring station since the onset of monitoring.

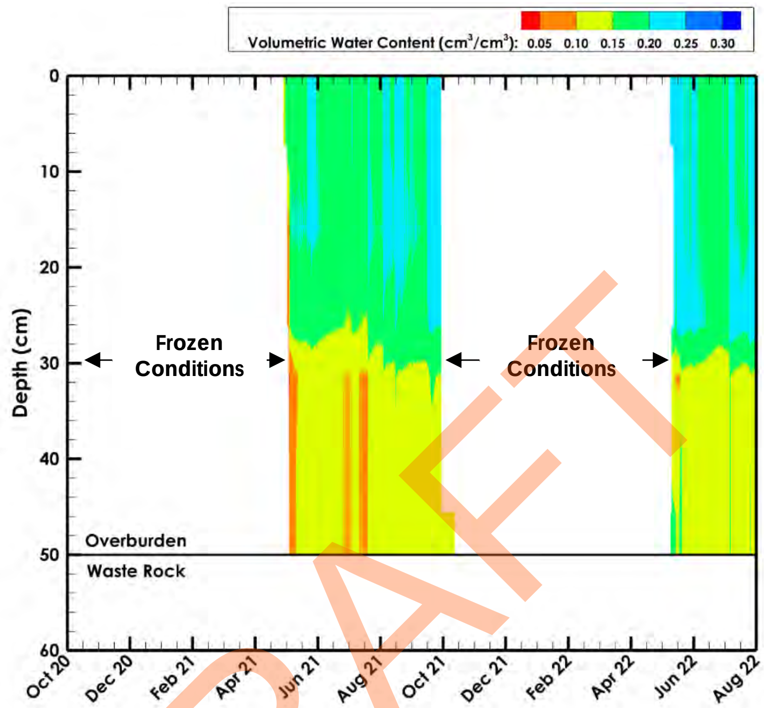

Figure 4.16: Soil VWC measured at the 1370 WRSA BCCS trial Slope soil monitoring station since the onset of monitoring.

4.3.2 Matric Suction

Matric suction is a measure of the energy state in the system. Knowledge of the potential energy of soil water at discrete points within the soil allows determination of how far the water in a soil system is from equilibrium (Hillel, 1998). In the case of unsaturated soils, the magnitude of potential energy as given by matric suction provides an indication of the energy that would be required to remove an additional unit of water at the soil surface. Matric potential data collected at the 1370 WRSA BCCS trial Plateau and Slope monitoring stations since the onset of monitoring are illustrated in Figure 4.17 and Figure 4.18.

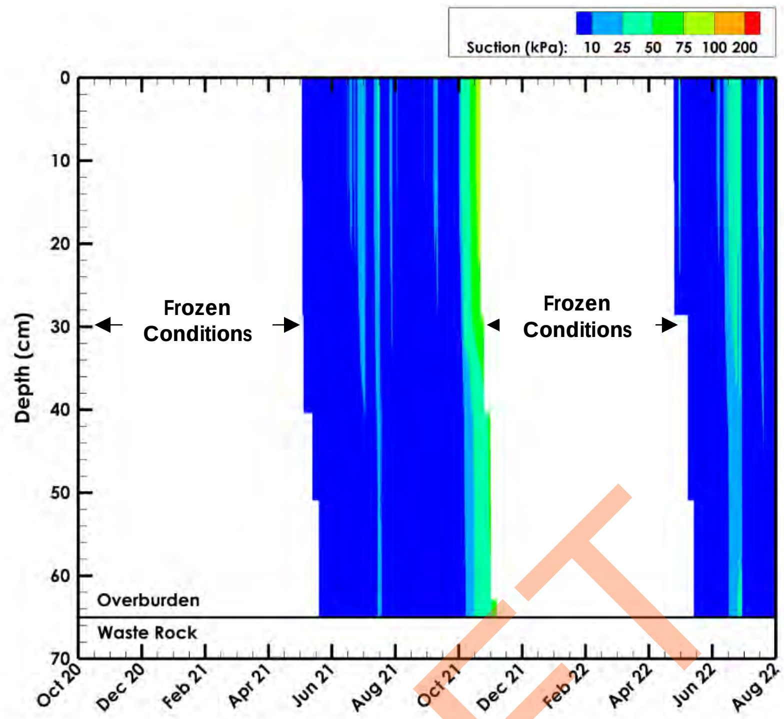

Figure 4.17: Soil matric potential measured at the 1370 WRSA BCCS trial Plateau soil monitoring station since the onset of monitoring.

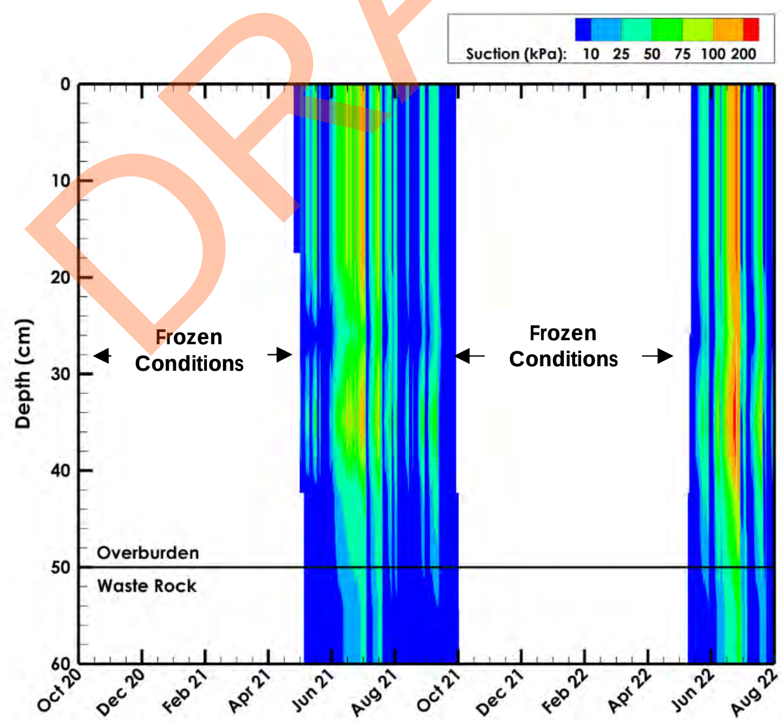

Figure 4.18: Soil matric potential measured at the 1370 WRSA BCCS trial Slope soil monitoring station since the onset of monitoring.

5 DISCUSSION

5.1 Meteorological Conditions

Since monitoring began on the 1370 WRSA BCCS trial, meteorological conditions have been recorded from various monitoring stations and can provide indications of local variability between stations and larger scale climate variability. Meteorological conditions govern the performance of the cover system and the metrics used to evaluate performance, such as subsurface temperatures and water content, reflect local conditions. Generally, trends in meteorological data measured at site follow expected patterns for a northern site, with elevated cover system temperatures during prolonged summer insolation, as well as delayed snowpack melting in late spring.

All snow at the base of the Slope monitoring station had melted by May 1, 2022, while Plateau snowpack had melted by May 7, 2022; both stations then remained snow free up to the end of the interim monitoring period (Figure 4.12). While temperatures remained below zero until late April 2022, snow events in December through March are generally correlated with brief drops in air temperature and corresponding periodic drops in net radiation. The largest snow event on February 28, 2022, corresponded with a minimum temperature of -11.1°C, and a net radiation decrease of ~1 to 3 MJ/m^2, with a snow depth increase of 11.0 cm and 17.0 cm at the Plateau and Slope stations, respectively. In the 2020/2021 period, spring snowfall caused the Plateau snowpack to persist until late May, while the Slope was snow free by early May.

The average minimum air temperature during the interim monitoring period was similar to the same period in the 2020/2021 monitoring period (Table 4.1). However, the average maximum air temperature (6.1°C) in the interim monitoring period was colder than during the same period in 2020/2021 (9.1°C).

Rainfall totals from April to July in the interim monitoring period were similar to the same period in the 2020/2021 monitoring period. The rainfall during the interim monitoring period measured at the 1370 WRSA BCCS trial (116.8 mm) and Potato Hills meteorological station (137.7 mm) differed by approximately 15%. July interim monitoring period rainfall was dominated by two distinct rain events on July 10th to 11^{th,} and July 16th to 18th, 2022 (14.4 mm and 39.0 mm recorded at BCCS trial, respectively) associated with brief RH increases. These meteorological conditions are reflective of a high-pressure area dominating during the month of July, similar to what was observed in the 2020/2021 monitoring period. Monitoring data will be used to characterize the variations in meteorological conditions, which will affect cover system performance by enhancing or subduing the effects of evapotranspiration, soil saturation, and temperature changes in the subsurface.

5.1.1 Reference Evapotranspiration

Reference evapotranspiration (RE) using the Penman-Monteith method is the sum of transpiration of water within vegetation and evaporation of free water from the vegetation surface for a hypothetical crop of 0.12 m height with 70 sm^{-1} surface resistance and an albedo of 0.23 (Allen *et al.* 1998). A reference crop is used for this method to study evaporative demand independent of vegetation type, development, and management, to allow comparison between soil surfaces. Lorax (2022) uses the same method to calculate RE for the Camp meteorological station. The RE calculation in this report uses the site meteorological record air temperature, RH, and wind speed data, combined with net radiation data recorded at the 1370 WRSA BCCS trial, and is therefore more appropriate for the trial location.

During the interim monitoring period, the calculated total cumulative RE was 175.5 and 200.0 mm for the Slope and Plateau respectively, with the highest RE occurring in June (

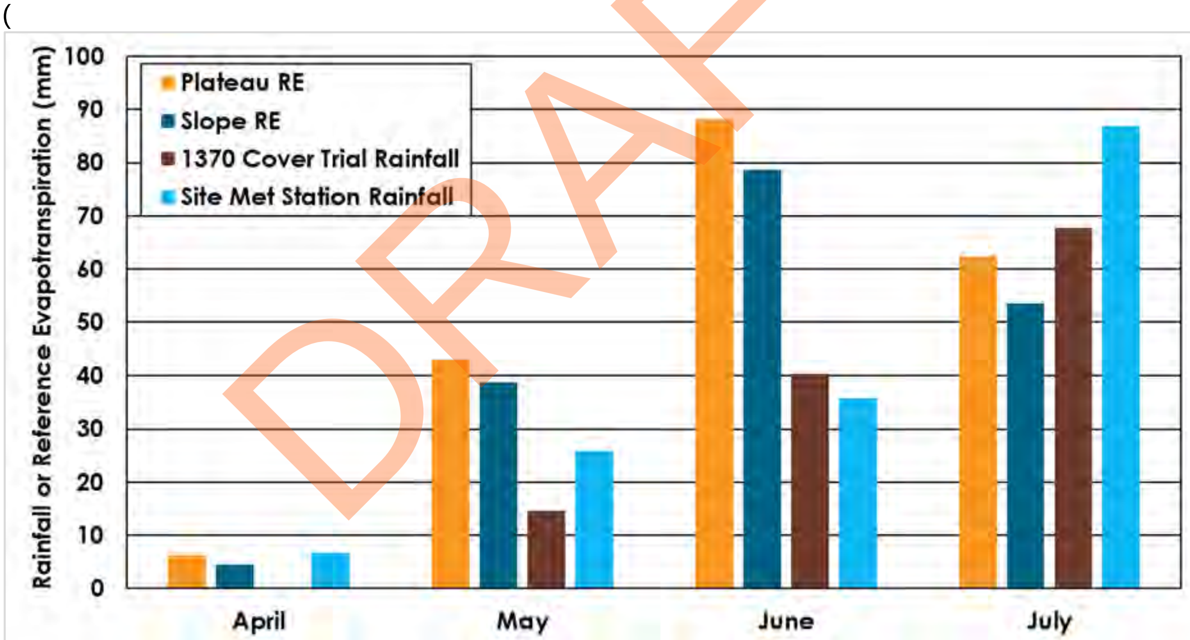

Figure 5.1) when RH was lowest, daily air temperature maximums were highest, and precipitation was low. Rainfall at the 1370 WRSA BCCS trials exceeded the RE only in July which coincides with the lower suctions and higher VWC seen in the Plateau and Slope soil profiles. Calculated RE for the Plateau and Slope monitoring locations in the interim monitoring period were less then 2020/2021 monitoring period for all months (Figure 5.3).

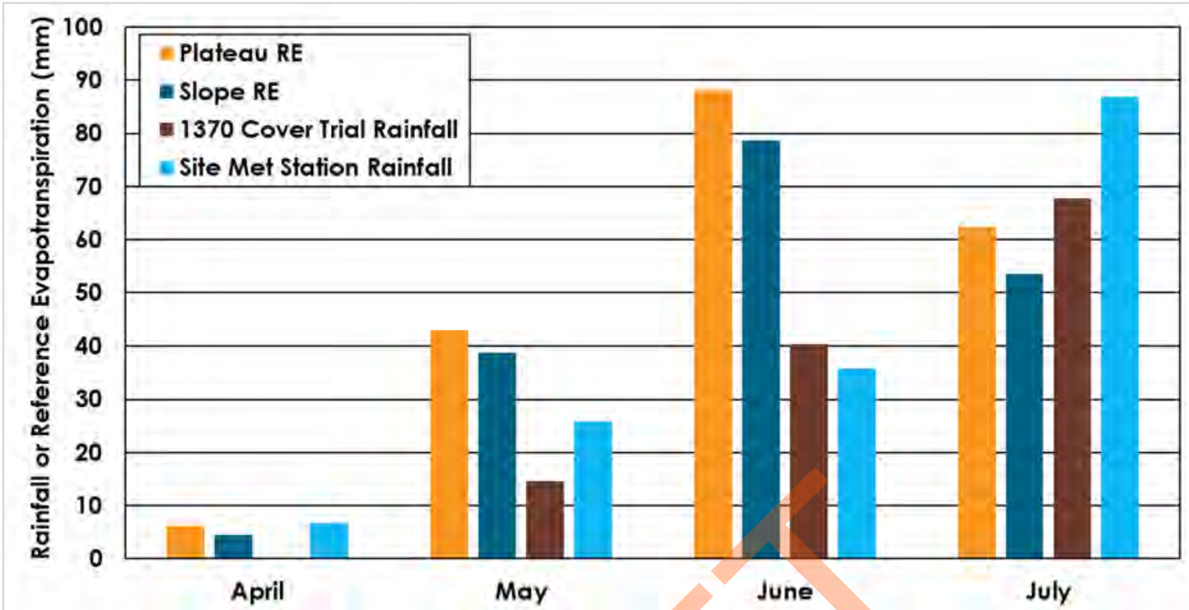

Figure 5.1: **Rainfall and reference evapotranspiration calculated for the 1370 WRSA BCCS trial Plateau and Slope for the interim monitoring period.**

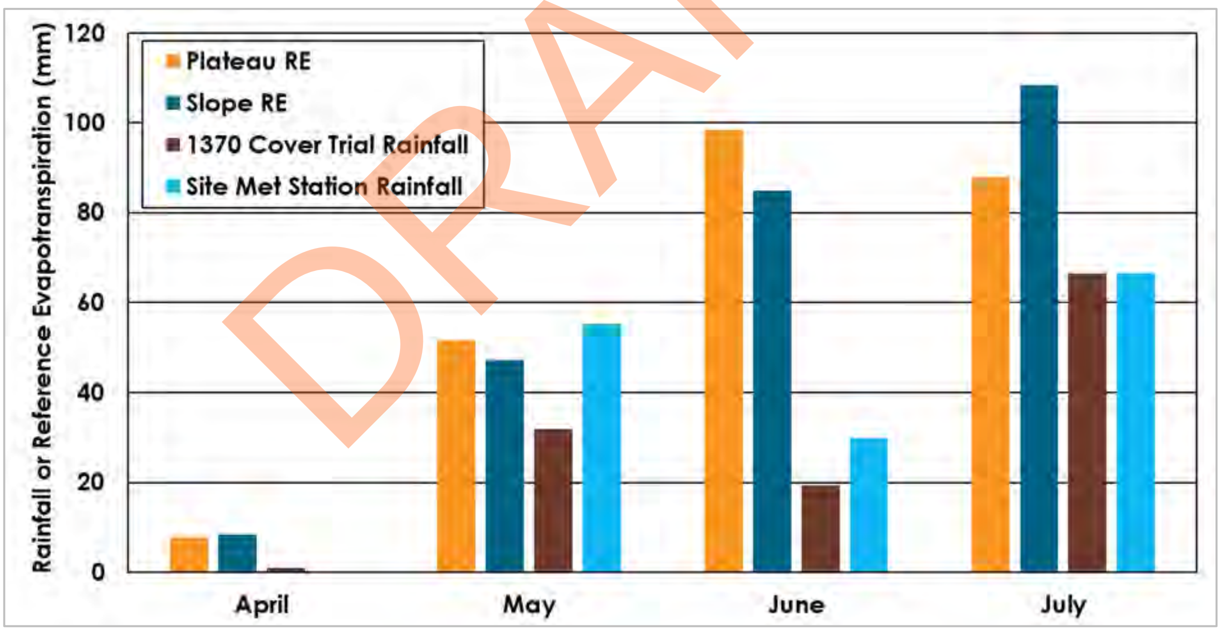

Figure 5.2: **Rainfall and reference evapotranspiration calculated for the 1370 WRSA BCCS trial Plateau and Slope for the 2020/2021 monitoring period.**

5.2 Subsurface Temperature

Cover system soil temperature provides a useful indicator of the energy balance of the system. The partitioning of energy between the cover system and the overlying atmosphere will govern the performance of the system. Partitioning of energy is especially important in northern environments as climate conditions can be considered to achieve closure objectives.

Monitoring of soil temperature is an important indicator variable in cover system energy balances. Surface infiltration and subsurface flow is inhibited in frozen soil (soil temperatures < 0°C). Therefore, water balance calculations incorporate the change in soil temperature with depth which helps characterize the timing of cover system freeze-thaw cycles. The timing of freeze-thaw conditions throughout the entire soil profile is also important for the water balance, as subsurface water flow is possible at depth in the cover system even when infiltration is inhibited by the frozen ground surface (e.g., early winter). In addition, freeze-thaw cycles help shape and condition the cover system, by altering soil density, hydraulic conductivity, and water storage capacity. Subsurface temperature regime and trends are also important to understand growing conditions for cover vegetation once established.

In subarctic, high latitude regions net radiation at the cover system surface determines soil temperatures and can be a primary control on cover system performance; therefore, slope aspect can influence performance of the cover system. The aspect of the instrumented slope on the 1370 WRSA BCCS trial area is in a southeast direction. During spring and fall months where there are limited daylight hours and the sun is lower in the horizon, the Slope station may receive greater amounts of net radiation than the Plateau station or portions of the WRSA with a northern aspect; however, this was not the case during the 2020/2021 and interim monitoring periods.

At the start of the interim monitoring period in December 2021, the Slope station cover system profile was frozen to the waste rock whereas the Plateau station cover system profile didn't fully freeze to the waste rock until late December (Figure 4.13, Figure 4.14). The Plateau cover system profile started freezing from the surface down at the beginning of October 2021 and was completely frozen by late December, while the Slope profile began to freeze in early September 2021 and was completely frozen by early December. The cover systems at the Plateau and Slope are approximately 65 cm and 50 cm thick, respectively, which likely accounts for the relatively rapid freezing and thawing through the profile, as is expected. Ground thaw started early and mid-May for the Plateau and Slope locations during the interim monitoring period, respectively (Figure 4.12).

The Potato Hills station record showed consistent daily maximum air temperatures below freezing in the interim monitoring period, until mid April 2022. Concurrently, net radiation at the Plateau and Slope stations remained primarily negative with some days having slightly positive net radiation values during this period, indicating the loss of energy occurring due to freezing. Positive radiation input began to rise rapidly from May to early July to between 5 and 15 MJ/m^2. Ground thaw at the Slope station started within a week of the above 0°C air temperatures in the spring, while the Plateau station surface thaw began sooner likely due to the thinner snow coverage on the Plateau. Rapid thaw at the stations is facilitated by the infiltration of warmer water from the melting snow above, as well as increased net radiation resulting from rapidly increasing daylight hours and sun angle. During June and July of the interim monitoring period, the Slope station experienced greater soil temperatures throughout the profile than the Plateau station. Trends in soil temperature during the interim monitoring period were similar to the 2020/2021 monitoring period.

5.3 Soil Water Conditions

The VWC at the Plateau monitoring station generally increased with depth during the interim monitoring period spring freshet, indicating downward infiltration of meltwater (Figure 4.15). For the remainder of the interim monitoring period summer, the VWC in the upper ~15 cm and below ~40 cm was consistently between 0.20 and 0.25 cm^3/cm^3, respectively. However, from ~15 to 40 cm there was a layer of slightly higher VWC, which could be a layer with differing texture or density characteristics. These distinct regions of different VWC differ somewhat from the 2020/2021 monitoring period, which may reflect the wetting up and settling of material in the first year following cover system construction. Additional monitoring will help improve the understanding of this process.

Similar to the 2020/2021 monitoring period, the VWC of the Slope monitoring station profile was lower throughout the monitoring period compared to the Plateau station (Figure 4.16). The VWC of the bottom 20 cm of cover system on the slope did not exceed 0.15 cm^3/cm^3 during the interim monitoring period. The lower VWC on the slope in general, and particularly at the base of the cover system can be attributed to greater lateral flow of water on the slope. During spring melt and brief periods in late July of the interim period, the VWC increases to above 0.20 and 0.15 cm^3/cm^3 in the upper 30 cm and lower 20 cm of the profile, respectively. VWC patterns during the interim monitoring period were similar to the 2020/2021 monitoring period.

After interim monitoring period spring melt, the Plateau station primarily recorded matric suctions < 10 kPa and generally remained at this level throughout the entire cover system column with exceptions between late June to early July and end of July when suction increased to between 25 and 50 kPa from the top down (Figure 4.17). The Slope station exhibited similar matric suction at the onset of freshet, but suction quickly increased by late May to above 50 kPa and peaked at greater than 200 kPa in early June (Figure 4.18). The increased suction period was punctuated by July rainfall events that dropped the suction in the entire profile, reflecting percolation of rainfall events. The patterns observed for matric suction data are consistent with those observed in VWC data, and suction data patterns are more prominent and easier to interpret. Matric suction patterns during the interim monitoring period were similar to those observed for the 2020/2021 monitoring period.

Water storage within the cover system profiles was calculated using measured VWC and the thickness of discrete sections of the soil profile centered around each VWC sensor (e.g., a 10 cm interval in the soil profile centered around a sensor measuring a VWC of 0.25 cm^3/cm^3 yields 2.5 cm of water storage). Water storage is an estimation of the volume of water contained within the cover system at a given time and facilitates understanding of changes in the volume of water within the cover system over time. Change in water storage within the cover system is a key performance metric and a water balance parameter and is used to characterize the timing and magnitude of infiltration into the cover system after precipitation events, as well as movement through the cover system.

Similar to the 2020/2021 monitoring period, water storage rapidly increased primarily at the Plateau station during May 2022 spring melt as the ground thawed and some snowmelt water was able to infiltrate the cover system (Figure 5.3). The Slope station generally had a lesser response to snowmelt and rainfall events, likely due to more precipitation translating to runoff rather than infiltration. Following snowmelt at both stations, storage gradually decreased until mid-July 2022 with small storage increases following rainfall events. The general decline in storage from late May to mid-July 2022 corresponds to the RE being greater than rainfall during this time period. Throughout the remainder of the summer, storage increases were seen after rainfall events. The difference in water conditions between Plateau and Slope suggests that different landscape elements exhibit differences in storage, and that runoff rates will vary as a function of landform location. Water storage was comparable or lower during the interim monitoring period compared to the 2020/2021 monitoring period, most likely reflecting the timing and intensity of rainfall events and evapotranspirative processes throughout the summer. This suggest that NP will likely occur gradually throughout the summer months as available storage capacity in the cover changes with larger infiltration events expected to occur following the large rainfall events. As such, it is expected that the NP rate for this monitoring period is on a trajectory to be in a similar range as the first year of monitoring.

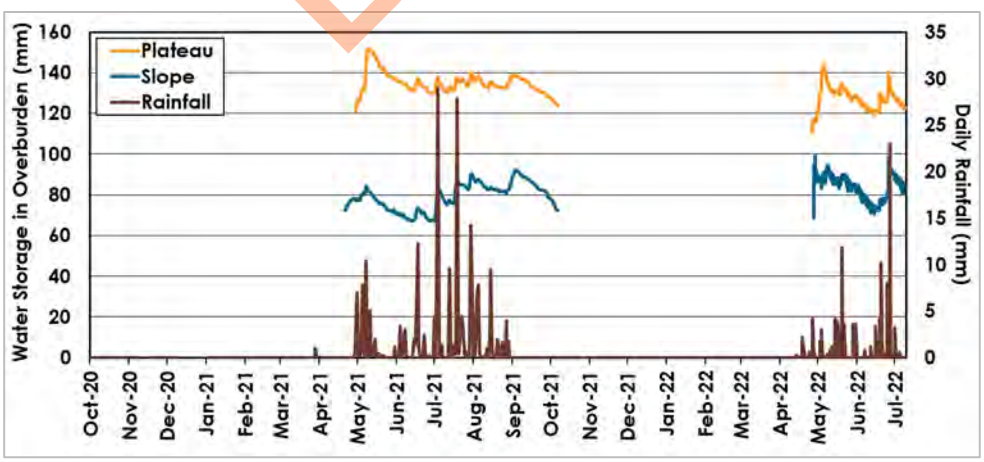

Figure 5.3: Total soil water storage calculated for the cover system trial Plateau and Slope monitoring stations, and daily rainfall recorded since the onset of monitoring.

6 SUMMARY

A high-level data review and interpretation of the 1370 WRSA BCCS at Eagle Mine was completed for the period December 1, 2021 to July 31, 2022 (referred to as the interim monitoring period). The development of water balances will be completed for the annual report when the annual monitoring period is concluded.

The BCCS is a simple monolithic layer of overburden and can be expected to perform as a store and release cover system. Based on INAP (2017), a cover system of this type would be expected to allow rates of NP between 20% to 50% of annual precipitation. However, the spatial distribution of NP would be expected to vary over the entirety of the WRSA.

In the first year of monitoring (October 24, 2020 to November 30, 2021), water balance models estimated NP rates of 31% and 37% of effective precipitation for Slope and Plateau locations, respectively. The rates are close to, but higher than, the modelled rates assumed in the Eagle Mine WBWQM of 25 to 30% (Lorax, 2022). It is expected that NP rates will trend downward as vegetative cover improves and matures, resulting in higher rates of evapotranspiration, and consequently, lower NP. Cover system modelling will help refine the expected range of NP across a range of climatic conditions and vegetative covers.

Meteorological conditions in the interim monitoring period were consistent with climate trends for the area. Calculated RE generally was greater than measured rainfall from April through June 2022; in July 2022, rainfall was greater than RE. The VWC at both monitoring stations were generally lower during the interim monitoring period compared to the 2020/2021 monitoring period, which is an indicator of greater available storage capacity in the cover system.

Continued field trial cover system performance monitoring will provide additional data for characterization cover system performance on a year to year basis and allow various types of climate years to be evaluated.

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APPENDIX H

Detailed Closure Cost Estimate

Summary Table of Estimated Closure Costs

Description of Cost	Current Liability	2-Year Peak Liability	Estimated Cost EOM
Closure Implementation			
T3 General & Administration	$1,549,800	$2,170,183	$3,673,726
T5 Closure Planning	$1,971,840	$1,971,840	$1,971,840
T6 Pit	$55,856	$55,856	$55,856
T7 Heap Leach Pad	$4,545,648	$6,182,991	$8,938,848
T8 Waste Dumps	$4,483,121	$7,529,144	$8,379,570
T9 Surface Facilities	$12,048,857	$12,048,857	$12,048,857
T10 Infrastructure	$401,035	$401,035	$401,035
T11 Waste Disposal and Remediation	$173,135	$173,135	$173,135
T12 Landfills	$143,126	$143,126	$143,126
T13 Roads & Trails	$583,156	$500,120	$475,342
T14 Water Management	$167,970	$219,450	$219,450
T16 Interim Care & Maintenance	$11,332,452	$14,765,544	$14,765,544
Sub-total	$37,455,996	$46,161,282	$51,246,330
Indirect Costs	$5,618,399	$6,924,192	$7,686,949
Contingency Costs	$6,908,197	$8,487,752	$9,297,720
Sub-total for inflation calculation	*$49,982,593*	*$61,573,226*	*$68,230,999*
Cost Inflation year 1	$3,498,782	$1,847,197	
Cost inflation year 2	$1,818,367	$1,585,511	$14,942,208
Cost Inflation years 3+		$2,626,240	
Total Closure Implementation Costs	**$48,391,544**	**$59,144,421**	**$73,875,487**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)			
Onsite Management	$483,483	$848,845	$740,888
Transport Costs	$42,000	$48,854	$40,331
Water Treatment Costs (Phase 6)	-	-	-
Active Treatment (Phase 6)	-	-	-
Capital Costs (included in T9, above)	$0	$0	$0
Capital Replacement Costs	$122,828	$859,018	$1,072,942
Operating Costs	$4,357,806	$4,360,535	$7,949,513
Draindown Pumping (Phase 6)	$1,434,296	$3,589,185	$4,696,907
Passive Treatment (Phase 7-8)	-	-	-
Capital Costs	$136,404	$128,574	$101,198
Operating Costs	$41,911	$73,582	$81,052
Reclamation & Closure Research Phase 6	$37,155	$35,022	$56,809
Monitoring & Reporting	$1,297,543	$1,820,930	$1,638,839
Post Closure Maintenance (Phase 7/8)	$693,961	$830,912	$621,933
Sub-Total	$8,647,386	$12,595,457	$17,000,411
Indirect Costs	$1,297,108	$1,889,319	$2,550,062
Contingency Costs	$1,945,662	$2,833,978	$3,825,093
Total Care, Maintenance and Monitoring Costs	$9,944,494	$14,484,776	$19,550,473
Total Closure Costs	**$58,336,038**	**$73,629,197**	**$93,425,961**
Contingency Amount	**$8,853,859**	**$11,321,730**	**$13,122,813**
Total Closure Costs (Plus Contingency)	**$67,189,898**	**$84,950,927**	**$106,548,773**

Cost Factors	
Indirect Cost Factor	**Contingency Factor**
15%	18.4%
15%	25.0%
15%	15.0%
15%	15.0%
15%	15.0%
15%	15.0%
15%	22.5%
15%	30.0%
15%	30.0%
15%	30.0%
15%	30.0%
15%	22.5%

Cost Factors	
Indirect Cost Factor	**Contingency Factor**
15%	22.5%

Closure Unit Rates

Equipment Rates

Equipment	Unit Rates	Unit	Comment/Source
D9H Dozer	$415.00	hr	Increase based on YG 2022 review
Wheel Loader (939 or equivalent)	$160.00	hr	Yukon Third Party Rental Rate (wet rate)
Haul Truck (Komatsu HD 1500-7 or equivalent)	$305.23	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 11 CAT 785 B Haul Trucks
Track Dozer (570 HP or equivalent)	$215.00	hr	wet rate
Water Truck (52,994 L 550 HP)	$142.50		Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
D6D Dozer	$170.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Haul Truck D250E	$272.50	hr	Increase based on YG 2022 review
Tandem Haul Truck	$150.00	hr	Wet rate
Cat 235 Excavator	$250.00	hr	Increase based on YG 2022 review
Cat 235 Excavator w hammer	$390.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Cat 16H grader	$240.00	hr	Increase based on YG 2022 review
988B Loader	$225.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Tractor Trailer (lowbed)	$195.00	hr	Increase based on YG 2022 review
30 ton Crane	$126.09	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 3 Cranes
Hiab Flatdeck truck	$195.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Cat 950 loader	$150.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Vibratory Roller	$182.50	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Pickup Truck	$21.00	hr	Increase based on YG 2022 review
Mobilize Heavy Equipment - Road Access	$0.15	kmtonne	Updated based on YG third party RECLAIM Model

Personnel Rates

Personnel	Unit Rates	Unit	
Blaster	$48.98	hr	
General Labourer	$39.42	hr	
Trades Labourer	$54.63	hr	
Site Manager	$195.62	hr	
Design Engineer	$162.75	hr	
Environmental Scientist	$116.00	hr	Updated based on YG third party RECLAIM Model; Labour Buildup not utilized
Supervisor	$15,379.88	month	Updated based on YG third party RECLAIM Model
Camp Labourer	$7,450	month	
Site Caretaker	$15,812.16	month	
Environmental Technician	$11,313	month	

Revegetation Rates	Unit Rates	Unit	
Revegetation Seed Mix	$18.38	kg	
Revegetation Seed Mix - 50kg/ha	$919.00	ha	
Fertilizer	$1.16	kg	
Fertilizer - 250kg/ha	$290.00	ha	
Tree Seedlings (1,000 seedlings per ha)	$2,100	ha	
Seed/Fertilizer Application	$1,785	ha	
Erosion Barrier	$3.15	m^2	
Revegetation cost per ha. Including application cost	**$2,994.00**	**ha**	

Passive/Heap In Situ Treatment	Unit Rates	Unit	
Custom Rate: Heap Leach Recirculation Cost--Reagent Delivery		day	
In Situ Treatment Reagent--Reducing Sugars and Nutrients	$795	ton	See Ensero biological detox & https://www.selinawamucii.com/insights/prices/canada/sugar/
In Situ Treatment Reagent--Alcohols and Nutrients	$1,200	ton	
Fertilizer - 250kg/ha		ha	
Wetland plants (4,000 seedlings per ha)	$8,000	ha	
Seed/Fertilizer Application		ha	

Contractor Unit Rates & Camp Costs	Unit Rates	Unit	
Excavation of Soil	$4.50	m^3	
Custom Rate A (Load, haul, place soil cover Heap)	$5.05	m^3	
Custom Rate B (Load, haul, place soil cover Eagle Pup)	$5.84	m^3	
Custom Rate C (Load, haul, place soil cover Platinum Gulch)	$7.40	m^3	
Custom Rate D (Load, haul, place wetland soil in CWTS)	$5.05	m^3	
Custom Rate E (Load, haul, place soil cover IROSA)	$4.27	m^3	
Custom Rate F (Load, haul, place soil cover Open Pit)	$5.05	m^3	
Custom Rate G (Load, haul, place 90 day material)	$5.05	m^3	
Produce rip-rap	$15.75	m^3	
Load, haul and place rip-rap	$15.75	m^3	
Deliver and install geosynthetic membrane on prepared foundation	$21.00	m^2	
Unit Basis (footing burial)	$5.25	each	
GeoWeb - GW30V3	$5.60	m^2	
GeoWeb - GW30V4	$7.10	m^2	
GeoWeb - GW30V6	$10.60	m^2	
Freight run to Whitehorse	$1,500.00	load	
Camp Cost	$82.04	day/person	Rate based on costs for operating a camp of less than 50 people
Site Security Cost	$6,100.00	month	
Power for recirculation pumps	$20,412.00	month	
Power and Heat (Year 2)	$7,500.00	month	
Employee Transport Costs	$7,875.00	month	

Notes:
1) Custom Rates A through G developed specifically for Eagle Project, taking into account such factors as haul distance, grade, machinery req`d, time req'd, etc.
2) Unit rates for GeoWeb materials are provided by a licensed vendor and are considered conservative costs which include delivery and installation.

Labour Buildup

Personnel	Base Rate	Loading Rate	Estimate Hourly Rate	Rotation	Weeks per Year	Days per week	Hours per day	Total Annual Hours	Total Annual Salary	Monthly Rate
Blaster[1]	$32.65	150%	$48.98	3 in -2 out	33	7	12	2772	$135,759	$11,313
General Labourer[1]	$26.28	150%	$39.42	3 in -2 out	33	7	12	2772	$109,272	$9,106
Trades Labourer[1]	$36.42	150%	$54.63	3 in -2 out	33	7	12	2772	$151,434	$12,620
Site Manager	$130.41	150%	$195.62	2 in -2 out	27	7	12	2268	$443,655	$36,971
Design Engineer	$162.75	100%	$162.75	2 in -2 out	27	7	12	2268	$369,117	$30,760
Environmental Scientist	$77.37	150%	$116.06	3 in -2 out	33	7	12	2772	$321,704	$26,809
Project Manager/Supervisor	$54.25	150%	$81.38	2 in -2 out	27	7	12	2268	$184,559	$15,380
Camp Labourer[1]	$26.28	150%	$39.42	2 in -2 out	27	7	12	2268	$89,405	$7,450
Site Caretaker[1]	$28.96	150%	$43.44	1 in -1 out	52	7	12	4368	$189,746	$15,812
Environmental Technician[1]	$32.65	150%	$48.98	3 in -2 out	33	7	12	2772	$135,759	$11,313

Notes:
1 - Base rates: Yukon Government Fair Wage Schedule - Effective Apr 1, 2022
2 - Loading rate includes overtime, CPP, EI, and Worker's Compensation

Custom Load, Haul, Place Rate Estimator

Description	Unit	Quantity: Custom Rate A HLF	Custom Rate B Eagle Pup	Custom Rate C Platinum Gulch	Custom Rate D Wetland CWTS	Custom Rate E IROSA	Custom Rate F Open Pit	Custom Rate H 90 Day	Custom Rate I Rock	Notes and Sources
Excavation - 36T Excavator										
Bucket capacity	cu.m	3.16	3.16	3.16	3.16	3.16	3.16	3.16		CAT Handbook: heaped bucket
Fill factor	%	1.025	1.025	1.025	1.025	1.025	1.025	1.025		CAT Handbook: 'Mix of Sand and Gravel' class median.
Cycle time	s	20.	20.	20.	20.	20.	20.	20.		CAT Handbook: Typical for 336 Excavator = 20 s
Operator skill	%	0.75	0.75	0.75	0.75	0.75	0.75	0.75		Average Operator skill
Machine availability	%	0.92	0.92	0.92	0.92	0.92	0.92	0.92		11 hrs/ 12 hr shift
Excavation Production	cu.m/ hr	402.28	402.28	402.28	402.28	402.28	402.28	402.28		Production driver for work
Bank Factor		0.95	0.95	0.95	0.95	0.95	0.95	0.95		Recommended by GRIT
Min. Placement Factor		1.1	1.1	1.1	1.1	1.1	1.1	1.1		i.e. allowance for over placement to meet Spec Minimum
Excavation Production	cu.m/ hr	347.42	347.42	347.42	347.42	347.42	347.42	347.42		Banked Production
Haul - 30T Rock Truck										
Truck capacity	cu.m	17.5	17.5	17.5	17.5	17.5	17.5	17.5		CAT Handbook
Fill factor	%	1.025	1.025	1.025	1.025	1.025	1.025	1.025		CAT Handbook: 'Mix of Sand and Gravel' class median.
Swings/ load	swings	6.	6.	6.	6.	6.	6.	6.		
Load time	min	2.	2.	2.	2.	2.	2.	2.		Excavator Bucket * Fill Factor/ Truck Capacity/ Cycle Time
Haul distance	km	0.6	1.4	3.1	0.5	0.2	1.2	0.7		Haul distance based on reclamation stockpile proximity to adjacent to facilities along site roads. PG WRSA cover sourced from local stockpile from open pit HLF Cover sources from stockpiles on HLF access and ADR borrow/laydown EP WRSA cover sourced from Stockpile B and local stockpile at conveyor CWTS material sourced from Stockpile D
Average velocity	km/ hr	11.6	19.2	22.4	9	9	18.3	13.5		200 m accelerate + decelerate, mine Site Speeds/ Terrain - Error in Rate E corrected based on 2022 YG review
Haul time + return time	min	6.3	8.8	16.7	6.7	2.7	7.9	6.3		Distance/ Speed
Wait time	min	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
Dump time	min	1.	1.	1.	1.	1.	1.	1.		
Cycle time	min	9.8	12.3	20.2	10.2	6.2	11.4	9.8		Load + travel + dump + return + wait
Machine availability	%	0.92	0.92	0.92	0.92	0.92	0.92	0.92		11 hrs/ 12 hr shift
Haul Production	cu.m/ hr	119.37	95.11	57.91	114.69	188.68	102.62	119.37		
Required Total Trucks		3.4	4.3	7.	3.6	2.2	4.	3.4		
Assigned Trucks		4.	5.	7.	4.	3.	4.	4.		
Spread - Dozer CAT D9										
Estimate production using example curves provided	cu.m/ hr	800.	800.	800.	800.	800.	800.	800.	900.	D9 universal blade @ 45 m average distance for cover D9 universal blade @ 30 m average distance for recontour
Operator skill		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	Average Operator (day operation)
Material type, see table		1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.8	Loose stockpile material Rock, ripped or blasted
Job efficiency		0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	Efficiency Factor to represent Daytime operation.
Hourly productivity	cu.m/ hr	597.6	597.6	597.6	597.6	597.6	597.6	597.6	448.2	
Unit Cost										
Cat 235 Excavator	$/ hr	250.	250.	250.	250.	250.	250.	250.		
Haul Truck D250E	$/ hr	272.5	272.5	272.5	272.5	272.5	272.5	272.5		
D9H Dozer	$/ hr	415.	415.	415.	415.	415.	415.	415.		
Total	$/ cu.m	5.05	5.84	7.4	5.05	4.27	5.05	5.05		

Notes:
1. An altitude factor adjustment is not included for excavation productivity since The CAT Handbook indicates that 100% Flywheel horsepower is available for most equipment at Altitudes between 760 and 1500 m asl.

Estimate of Labour and Duration to Cover Facilities

Description	Unit	Quantity: Resources for HLF	Resources for Eagle Pup	Resources for Platinum Gulch	Resources for Wetland CWTS	Resources for IROSA	Resources for Open Pit	Resources for 90 Day		Notes and Sources
2-Year Peak Liability										
Equipment Operators	ppl	6	7	9	6	5	6	6		
Volume of Material	cu. m.	357,380	333,000	245,445	4,250	11,200	0	48,000		
Number of Hrs to Load, Haul, Place	hrs	1028.67	958.49	706.48	12.23	32.24	0.00	138.16		
Number of Days	days	85.72	79.87	58.87	1.02	2.69	0.00	11.51		
Person-days		514.33	559.12	529.86	6.12	13.43	0.00	69.08		
Max Operators	9									
Person-days (for camp cost)	1691.95	To cover major facilities during the 2-Year Peak Liability you would need about 9 employees over about 7 months during Phase 6.								
Duration of work	239.69									
EOM										
Equipment Operators	ppl	6	7	9	6	5	6	6		
Volume of Material	cu. m.	515,580	414,500	245,445	4,250	11,200	0	48,000		
Number of Hrs to Load, Haul, Place	hrs	1484.03	1193.08	706.48	12.23	32.24	0.00	138.16		
Number of Days	days	123.67	99.42	58.87	1.02	2.69	0.00	11.51		
Person-days		742.01	695.96	529.86	6.12	13.43	0.00	69.08		
Max Operators	9									
Person-days (for camp cost)	2056.47	To cover major facilities during for EOM you would need about 9 employees over about 9 months during Phase 6.								
Duration of work	297.18									
Other		Truck Shop	ADR Plant	Explosives Storage	Crushers					
Equipment Operators	ppl	6	6	5	6					
Volume of Material	cu. m.	12,800	3,780	7,860	26,600					
Number of Hrs to Load, Haul, Place	hrs	36.84	10.88	22.62	76.56					
Number of Days	days	3.07	0.91	1.89	6.38					
Person-days		18.42	5.44	9.43	38.28					
Max Operators	9									
Person-days (for camp cost)	71.57									
Duration of work	12.24									

		Camp			SP Passive Treatm
Equipment Operators	ppl	6			6
Volume of Material	cu. m.	7,900			27,600.
Number of Hrs to Load, Haul, Place	hrs	22.74			79.44
Number of Days	days	2.07			7.22
Person-days		12.40			43.33

		ater Treatment Pla
Equipment Operators	ppl	6
Volume of Material	cu. m.	3,960
Number of Hrs to Load, Haul, Place	hrs	11.40
Number of Days	days	1.04
Person-days		6.22

General and Administration Costs

Item No.	Work Item Description	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
3.1	**Onsite Management**									
	Pickup truck (Phase 6) (2 trucks)	Pickup Truck	hourly	$21.00	7,200	7,200	14,400	$151,200	$151,200	$302,400
	Sundry equipment maintenance (Phase 6)	Unit Cost Basis	annually	$10,000	2	2	4	$20,000	$20,000	$40,000
	Power and heat (Phase 6)	Power and Heat (Year 2)	monthly	$7,500	24	24	48	$180,000	$180,000	$360,000
	General Administrative expenses (Phase 6)	Unit Cost Basis	monthly	$7,500	24	24	48	$180,000	$180,000	$360,000
	Camp Costs (Phase 6)	Camp Cost	person-day	$82.04	5,627	13,189	19,225	$461,671	$1,082,054	$1,577,193
							Sub-Total	**$992,871**	**$1,613,254**	**$2,639,593**
3.2	**Transport Costs**									
	Employee transport costs (Phase 6)	Unit Cost Basis	monthly	$7,875	24	24	48	$189,000	$189,000	$378,000
							Sub-Total	**$189,000**	**$189,000**	**$378,000**
3.3	**Contractor Costs**									
	Contractor Profit & Home Office Overhead	Percentage	%	-	All in contractor equipment rates include profit, insurance					
	Insurance	Percentage	%	-						
	Bonding	Percentage	%	-	Bonding, Taxes, Government Bond Costs, and Property Holding Costs included in "Indirect costs" calculated on Summary table					
	Taxes	Percentage	%	-						
	Government Bond Costs	Unit Cost Basis	monthly	-						
	Property Holding Costs	Unit Cost Basis	monthly	-						
							Sub-Total	**$0**	**$0**	**$0**
3.4	**Mobilization and De-Mobe from Whitehorse**									
		1000	km							
	Excavators x 3	39	kmtonne	$0.15	117,000	117,000	117,000	$17,550	$17,550	$17,550
	Dump trucks x 7	23.5	kmtonne	$0.15	164,500	164,500	164,500	$24,675	$24,675	$24,675
	D9 Dozer x 2	50	kmtonne	$0.15	100,000	100,000	100,000	$15,000	$15,000	$15,000
	Demolition shears x 1	3	kmtonne	$0.15	3,000	3,000	3,000	$450	$450	$450
	Crane x 1	40	kmtonne	$0.15	40,000	40,000	40,000	$6,000	$6,000	$6,000
	Loader x 2	13	kmtonne	$0.15	26,000	26,000	26,000	$3,900	$3,900	$3,900
	Compactor x 1	12	kmtonne	$0.15	12,000	12,000	12,000	$1,800	$1,800	$1,800
	Light duty vehicles x 2	2	kmtonne	$0.15	4,000	4,000	4,000	$600	$600	$600
	Shipping Container - Tools x1	40	kmtonne	$0.15	40,000	40,000	40,000	$6,000	$6,000	$6,000
	Grader x 1	25	kmtonne	$0.15	25,000	25,000	25,000	$3,750	$3,750	$3,750
							Sub-Total	**$79,725**	**$79,725**	**$79,725**
3.5	**Access to Site**									
	Road Maintenance (Phase 6; see breakdown bel	Unit Cost Basis	monthly	$12,009	24	24	48	$288,204	$288,204	$576,408
							Sub-Total	**$288,204**	**$288,204**	**$576,408**
Total Estimated Cost for General and Administration Costs								**$1,549,800**	**$2,170,183**	**$3,673,726**

Notes:

Breakdown of Item 3.1 Onsite Maintenance

ACTIVITY	Description	Quantity
Labour (Phase 6 manpower staying in camp)	Project Manager	1
	Water Management	2
	Caretaker/Security	1
	Catering/Housekeeping	3
	Total Personnel	**7**

Labour Estimates for Camp Costs

Description	Total Hours Current	Total Hours Hours Y2	Total Hours Hours EOM	Total Days Current	Total Days Days Y2	Total Days Days EOM
Total Site Maintenance	61,320	61,320	122,640	5,110	5,110	10,220
Total Active Labour	65,861	73,729	79,933	5,627	6,387	6,948
Total Earthworks for covers					1,691.95	2,056

Breakdown of Item 3.5 Road Maintenance

ACTIVITY	DESCRIPTION / SPECS	UNITS	UNIT PRICE	NO. OF UNITS	COST ESTIMATE
Labour	General Labourer	Rate per hour	$39.42	40	$1,576.80
	Trades Labourer	Rate per hour	$54.63	40	$2,185.20
Equipment	Cat 235 Excavator	Rate per shift	$3,000.00	11	$33,000.00
	Haul Truck D250E	Rate per shift	$3,270.00	2	$6,540.00
	Cat 16H grader	Rate per shift	$2,880.00	35	$100,800.00
TOTAL ESTIMATED COST			**Annual**		**$144,102.00**
			Monthly		**$12,008.50**

Closure Plan Development - Phase 4

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Equipment / Labour	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
3.1	**Closure Specific Studies and Field Trials**									
3.1.1	Update closure plan every two years	Engineering/Design	l.s.	$30,000	1	1	1	$30,000	$30,000	$30,000
3.1.2	Ongoing Revegetation Trials	Engineering/Design	n/a	n/a	Included in costs for implementing the EMSAMP			$0	$0	$0
3.1.3	Engineered Cover Evaluations	Engineering/Design	n/a	n/a	See Breakdown			$526,500	$526,500	$526,500
3.1.4	Rooting Study	Engineering/Design	n/a	n/a	See Breakdown			$110,000	$110,000	$110,000
3.1.5	Passive Treatment Detailed Plan	Engineering/Design	n/a	n/a	See Breakdown			$1,072,340	$1,072,340	$1,072,340
3.1.6	Heap Biological Detoxification and In-heap Bioreactor	Engineering/Design	n/a	n/a	See Breakdown			$43,000	$43,000	$43,000
3.1.7	Groundwater Arsenic Attenuation	Engineering/Design	n/a	n/a	See Breakdown			$40,000	$40,000	$40,000
3.1.8	Site contamination surveys (pre $35K, post $20K)	Engineering/Design	l.s.	$55,000	1	1	1	$55,000	$55,000	$55,000
							Sub-Total	**$1,876,840**	**$1,876,840**	**$1,876,840**
3.2	**Closure Plan Development**	Engineering/Design	l.s.		See Breakdown			$95,000	$95,000	$95,000
							Total Estimated Cost for Closure Plan Development	**$1,971,840**	**$1,971,840**	**$1,971,840**
Notes:										

Breakdown of Item 3.1 Research Program Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.2	**Ongoing Revegetation Trials**	Included in costs for implementing the EMSAMP						$0	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
							Revegetation Trials Total	**$0**	**$0**	**$0**
3.1.3	**Engineered Cover Evaluations**									
3.1.3.1	**Task 1: Conceptual Model**									
	Review and Update of Numerical Model Assessment	Engineering/Design	l.s.	$50,000	1.0	1.0	1	$50,000	$50,000	$50,000
	Runoff and Surface Water Drainage Modelling	Engineering/Design	l.s.	$50,000	1.0	1.0	1	$50,000	$50,000	$50,000
	Landform Erosion Assessment Modelling	Engineering/Design	l.s.	$35,000	1.0	1.0	1	$35,000	$35,000	$35,000
	Field Permeability Testing Program	Engineering/Design	l.s.	$15,000	1.0	1.0	1	$15,000	$15,000	$15,000
	Reporting	Engineering/Design	l.s.	$15,000	1.0	1.0	1	$15,000	$15,000	$15,000
							Sub-Total	**$165,000**	**$165,000**	**$165,000**
3.1.3.2	**Cover System and Heap Materials**									
	Material Characterization Plan Design (Cover and Heap Leach Materials)	Engineering/Design	l.s.	$15,000	1.0	1.0	1	$15,000	$15,000	$15,000
	Field Test Pit Program and Sample Collection	Engineering/Design	l.s.	$50,000	1.0	1.0	1	$50,000	$50,000	$50,000
	Laboratory Testing	Engineering/Design	l.s.	$35,000	1.0	1.0	1	$35,000	$35,000	$35,000
							Sub-Total	**$100,000**	**$100,000**	**$100,000**
3.1.3.3	**Task 4: Enhanced Meteorological Monitoring**									
								-	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
3.1.3.4	**Task 5: Cover System Field Trials**									
	Instrumentation	Engineering/Design	l.s.	$50,000	-	-	-	$0	$0	$0
	Cover System Field Trial Performance Monitoring	Engineering/Design			3	3	3	$211,500	$211,500	$211,500
	Data management			$8,900	3	3	3	$26,700	$26,700	$26,700
	Data interpretation			$32,000	3	3	3	$96,000	$96,000	$96,000

	Monitoring and maintenance visit (quarterly)			$7,400	12	12	12	$88,800	$88,800	$88,800
							Sub-Total	**$211,500**	**$211,500**	**$211,500**
3.1.3.5	**Task 6: Assess Effect of High pH Water Treatment Solids on the Heap Cover**									
		Engineering/Design	l.s.	$50,000	1	1	1	$50,000	$50,000	$50,000
							Sub-Total	**$50,000**	**$50,000**	**$50,000**
							Engineered Cover Evaluations Total	**$526,500**	**$526,500**	**$526,500**
3.1.4	**Rooting Study**									
3.1.4.1	**Phase 1 - Analogous Forest Communities**									
	Review and update Field Program Design	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
	Set up of Test Plots for analogous forest communities	Engineering/Design	l.s.	$35,000	-	-	-	$0	$0	$0
	Destructive sampling of vegetation root system and cover mater	Engineering/Design	l.s.	$35,000	1	1	1	$35,000	$35,000	$35,000
							Sub-Total	**$50,000**	**$50,000**	**$50,000**
3.1.4.2	**Phase 2 - Examination for Mine Engineered Cover Systems**									
	Review and update Field Program Design	Engineering/Design	l.s.	$10,000	1	1	1	$10,000	$10,000	$10,000
	Geochemical Assessment of Cover and Underlying Materials	Engineering/Design	l.s.	Included in material characterization program for Engineered Cover Evaluations				$0	$0	$0
	Destructive sampling of vegetation root system and cover mater	Engineering/Design	l.s.	$35,000	1	1	1	$35,000	$35,000	$35,000
	Project Management and Reporting	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
							Sub-Total	**$60,000**	**$60,000**	**$60,000**
							Rooting Study Total	**$110,000**	**$110,000**	**$110,000**

Breakdown of Item 3.1 Research Program Tasks Continued

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.5	**Passive Treatment Detailed Plan**									
3.1.5.1	**Phase 1: Information Gathering**									
	Continued characterization of water requiring treatment	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Target constituents and performance goals	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Existing wetland characterization (to guide plant selection) and s	Engineering/Design	l.s.	$35,000	-	-	-	$0	$0	$0
							Sub-Total	**$10,000**	**$10,000**	**$10,000**
3.1.5.2	**Phase 2: Indoor Pilot Scale**									
	Design	Engineering/Design	l.s.	$10,000	-	-	-	$0	$0	$0
	Assembly	Engineering/Design	l.s.	$5,000	-	-	-	$0	$0	$0
	Performance Monitoring	Engineering/Design	l.s.	$5,000	5	5	5	$87,400	$87,400	$87,400
	Pofessional fees		l.s.	$32,400	1	1	1	$32,400	$32,400	$32,400
	Space fees, equipment rental, disposal fees, supplies		l.s.	$17,500	1	1	1	$17,500	$17,500	$17,500
	Analytical testing		l.s.	$14,500	1	1	1	$14,500	$14,500	$14,500
	Reporting and data anlysis		l.s.	$23,000	1	1	1	$23,000	$23,000	$23,000
							Sub-Total	**$87,400**	**$87,400**	**$87,400**
3.1.5.3	**Phase 3: On-Site Demonstration Scale**									
	Design	Engineering/Design	l.s.	$10,000	1	1	1	$10,000	$10,000	$10,000
	Construction									
	Excavate Pond	Construction	cu.m	$4.50	70,000	70,000	70,000	$315,000	$315,000	$315,000
	Deliver and install geosynthetic membrane on prepared foundation	Construction	m^2	$21	4,300	4,300	4,300	$90,300	$90,300	$90,300
	Load, haul dump fill, mulch, organics material	Construction	cu.m	$10.60	2,050	2,050	2,050	$21,730	$21,730	$21,730
	Planting Wetland Vegetation	Construction	ha	$8,000	0.43	0.43	0.43	$3,440	$3,440	$3,440
	Performance Monitoring		l.s.	$7,400	5	5	5	$37,000	$37,000	$37,000
							Sub-Total	**$477,470**	**$477,470**	**$477,470**

3.1.5.4	**Phase 4 Full Scale Implementation**	See costs for Passive Water Treatment for the LSDP and Events Pond								
	Design	Engineering/Design	l.s.	$30,000	1	1	1	$30,000	$30,000	$30,000
	Construction									
	Excavate Pond	Construction	cu.m	$4.50	70,000	70,000	70,000	$315,000	$315,000	$315,000
	Deliver and install geosynthetic membrane on prepared foundation	Construction	m^2	$21	4,300	4,300	4,300	$90,300	$90,300	$90,300
	Load, haul dump fill, mulch, organics material	Construction	cu.m	$10.60	2,050	2,050	2,050	$21,730	$21,730	$21,730
	Planting Wetland Vegetation	Construction	ha	$8,000	0.43	0.43	0.43	$3,440	$3,440	$3,440
	Performance Monitoring		l.s.	$7,400	5	5	5	$37,000	$37,000	$37,000
							Sub-Total	**$497,470**	**$497,470**	**$497,470**
							Passive Treatment Detailed Plan Total	**$1,072,340**	**$1,072,340**	**$1,072,340**
3.1.6	**Heap Biological Detoxification**									
	Review of operational parameters of the heap leach facility	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Setup of a sequential test facility adjacent to the heap	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Operation of the columns	Engineering/Design	l.s.	$1,500	12	12	12	$18,000	$18,000	$18,000
	Post-treatment simulation	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
							Sub-Total	**$43,000**	**$43,000**	**$43,000**
							Heap Biological Detoxification Total	**$43,000**	**$43,000**	**$43,000**
3.1.7	**Groundwater Arsenic Attenuation**									
	Geochemical Modelling	Engineering/Design	l.s.	$30,000	1	1	1	$30,000	$30,000	$30,000
	Monitoring of potential As Sources onsite	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	As Evaluation	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
							Sub-Total	**$40,000**	**$40,000**	**$40,000**
							Groundwater Arsenic Attenuation Total	**$40,000**	**$40,000**	**$40,000**
Total Estimated Cost for Research Program Execution								**$636,500**	**$636,500**	**$636,500**
NOTES	The estimates are based on previous OKC programs and are estimated to be +/-30%. The final detailed cost will be based on areas, number of monitoring locations, number of samples, and resulting tests that need to be									
	Costs to conduct monitoring including net radiation, wind speed and direction, snow surveys, maintenance of systems, and data analysis for 5 years of monitoring are included as part of EMSAMP									

Breakdown of Item 3.2 Closure Plan Development Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.2.1	**Reclamation and Closure Planning**									
	Optimization Workshop	Engineering/Design	l.s.	$20,000	1	1	1	$20,000	$20,000	$20,000
	Community and First Nation Engagement	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
	Reclamation Research Plan	Engineering/Design	l.s.	$20,000	1	1	1	$20,000	$20,000	$20,000
3.2.2	**Closure Cost Estimation**	Engineering/Design	l.s.	$18,000	1	1	1	$18,000	$18,000	$18,000
3.2.3	**Report Writing**	Engineering/Design	l.s.	$22,000	1	1	1	$22,000	$22,000	$22,000
Total Estimated Cost for Closure Development								**$95,000**	**$95,000**	**$95,000**

Open Pit, Estimated Closure Costs - Phase 6

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
6.1	**Open Pit**									
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	$39.42	96	96	96	$3,784	$3,784	$3,784
		Trades Labourer	hrs	$54.63	24	24	24	$1,311	$1,311	$1,311
		Support equipment	l.s.	$1,000	1	1	1	$1,000	$1,000	$1,000
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	$250.00	20	20	20	$5,000	$5,000	$5,000
		Haul Truck D250E	hrs	$272.50	20	20	20	$5,450	$5,450	$5,450
	Signage	General Labourer	hrs	$39.42	20	20	20	$788	$788	$788
	Highwall perimeter safety berm/trench (~7km)	Cat 235 Excavator	hrs	$250.00	-	-	-	$0	$0	$0
	Construct inflow spillway from upgradient of pit	Cat 235 Excavator	hrs	$250.00	40	40	40	$10,000	$10,000	$10,000
		Haul Truck D250E	hrs	$272.50	20	20	20	$5,450	$5,450	$5,450
		Produce rip-rap	cu.m	$15.75	200	200	200	$3,150	$3,150	$3,150
		Load, haul and place rip-rap	cu.m	$15.75	200	200	200	$3,150	$3,150	$3,150
	Construct exit channel into Platinum Gulch water conveyance channel	Cat 235 Excavator	hrs	$250.00	20	20	20	$5,000	$5,000	$5,000
		Produce rip-rap	cu.m	$15.75	200	200	200	$3,150	$3,150	$3,150
	Rip-rap shoulder exiting pit-spillway	Load, haul and place rip-rap	cu.m	$15.75	200	200	200	$3,150	$3,150	$3,150
		General Labourer	hrs	$39.42	10	10	10	$394	$394	$394
	Scarify Surface	Cat 16H grader	hrs	$240.00	-	-	-	$0	$0	$0
	Haul and place overburden for revegetation (0.2 m thickness)	Custom Rate F (Load, haul, place soil cover Open Pit)	cu.m	$5.05	-	-	-	$0	$0	$0
	Revegetate	Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		%		10.00%	10.00%	10.00%	$5,078	$5,078	$5,078
							Sub-Total	**$55,856**	**$55,856**	**$55,856**
Total Estimated Cost in Reclaiming Open Pit								**$55,856**	**$55,856**	**$55,856**
Note:										

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Ops	120	120	120	11	11	11
$39.42	General Labour	106	106	106	9	9	9
$54.63	Trades Labour	640	24	24	53	2	2
$54.63	Unit Quantity Labour	470	15	15	39	1	1
$162.75	Design Engineer/Project Ma	31	31	31	3	3	3
	TOTAL	1367	296	296	115	26	26

Heap Leach Facility, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour: Description	Equipment / Labour: Units	Equipment / Labour: Unit Rates	Quantity: Current	Quantity: 2-Year	Quantity: EOM	Cost: Current	Cost: 2-Year	Cost: EOM
7.1	**Heap Reclamation Cover**										
	Roll crest and recontour		D9H Dozer	hrs	$415	299	1,048	3,338	$124,269	$434,942	$1,385,234
	Additional compaction, as req'd		Vibratory Roller	hrs	$183	41	55	80	$7,419	$10,053	$14,600
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	154,890	209,880	304,800	$782,430	$1,060,214	$1,539,704
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	110,840	147,500	210,780	$559,911	$745,100	$1,064,760
	Surficial excavation for snow dump locations		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$415.00		1	1	-	365	365
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	-	2,000	2,000	$0	$10,103	$10,103
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994	52	70	102	$154,580	$209,460	$304,190
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$162,861	$247,024	$431,896
								Sub-Total	**$1,791,471**	**$2,717,260**	**$4,750,853**
7.2	**Heap Passive Treatment CWTS**										
	Develop closure sump piping drainage control		Drilling	lump sum	$20,000	1	1	1	$20,000	$20,000	$20,000
	Construction		Misc.	lump sum	$10,000	1	1	1	$10,000	$10,000	$10,000
	Develop subsurface flow component	~200 m buried pipe	Misc.	lump sum	$30,000	1	1	1	$30,000	$30,000	$30,000
	Fill Pond		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	165,000	165,000	165,000	$833,501	$833,501	$833,501
	Deliver and install geosynthetic membrane on prepared foundation		Construction	m^2	$21	9,000	9,000	9,000	$189,000	$189,000	$189,000
	Load, haul dump fill, mullch, organic materials		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	4,250	4,250	4,250	$21,469	$21,469	$21,469
	Wetland Planting		Wetland plants (4,000 seedlings per ha)	ha	$8,000	0.90	0.90	0.90	$7,200	$7,200	$7,200
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$111,117	$111,117	$111,117
								Sub-Total	**$1,222,287**	**$1,222,287**	**$1,222,287**
7.3	**Heap Passive In Situ Treatment**										
	Nutrients added to heap for cyanide degradation		In Situ Treatment Reagent--Reducing Sugars and Nutrients	ton	$795	553	1,105	1,931	$439,395	$877,722	$1,534,327
	Nutrients added to heap for heap bioreactors		In Situ Treatment Reagent--Alcohols and Nutrients	ton	$1,200	402	402	402	$481,882	$481,882	$481,882
	Management of heap in situ treatment		Environmental Scientist	hrs	$116	1,080	1,080	1,080	$125,280	$125,280	$125,280
	Sonic Drilling for physical testing to confirm detoxification	720 m	Drilling	m	$75	720	720	720	$54,000	$54,000	$54,000
	Material sampling to confirm detoxification		Laboratory sampling	each	$207	36	36	36	$7,452	$7,452	$7,452
	Allowance for establishment of 50,000 m2 of new leach area		24" DR7 piping	m	$160	-	400	400	$0	$64,000	$64,000
			8" DR11 piping	m	$13.95	-	686	686	$0	$9,570	$9,570
			Flanges (24" to 8")	each	$2,808	-	6	6	$0	$16,848	$16,848
			Victaulics	each	$282	-	45	45	$0	$12,690	$12,690
			8" butterfly valves	each	$399	-	4	4	$0	$1,596	$1,596
			High flow drip tubes	m	$0.26	-	50,000	50,000	$0	$13,000	$13,000
			Trades Labourer	hrs	$54.63	-	660	660	$0	$36,056	$36,056
	Rip in lines		D9H Dozer	hrs	$415.00	-	132	132	$0	$54,780	$54,780
	Moving pumps, piping, drip emitter connections, solution application		Site Caretaker	monthly	$15,812	18	18	18	$284,619	$284,619	$284,619
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$139,263	$203,949	$269,610
								Sub-Total	**$1,531,890**	**$2,243,444**	**$2,965,708**
Total Estimated Cost in Reclaiming Heap Leach Facility									**$4,545,648**	**$6,182,991**	**$8,938,848**
NOTE:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours: Current	Total Hours: 2-Year	Total Hours: EOM	Total Days: Current	Total Days: 2-Year	Total Days: EOM
n/a	Equipment Ops	340	1235	3550	31	112	323
$39.42	General Labour	1576	2126	3075	158	213	308
$54.63	Trades Labour	0	660	660	0	55	55
$54.63	Unit Quantity Labour	0	0	0	0	0	0
$116.00	Environmental Scientis	1080	1080	1080	90	90	90
	Caretaker	6480	6480	6480	540	540	540
$162.75	Design Engineer/Proje	2539	3454	4993	212	288	416
	TOTAL	12015	15035	19838	1030	1298	1731

Waste Rock and Overburden Dumps, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
4.1	**Eagle Pup**										
	Roll crest and recontour		D9H Dozer	hrs	$415.00	388	3,405	3,993	$160,819	$1,413,255	$1,656,920
	Additional compaction, as req'd		Vibratory Roller	hrs	$182.50	40	112	140	$7,366	$20,526	$25,550
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.84	71,700	199,800	248,700	$418,432	$1,166,008	$1,451,382
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.84	47,800	133,200	165,800	$278,955	$777,339	$967,588
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	24	67	83	$71,557	$199,400	$248,203
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$93,713	$357,653	$434,964
								Sub-Total	**$1,030,841**	**$3,934,182**	**$4,784,608**
4.2	**Platinum Gulch WRSA**										
	Roll crest and recontour		D9H Dozer	hrs	$415.00	1,879	2,067	2,067	$779,727	$857,700	$857,700
	Additional compaction, as req'd		Vibratory Roller	hrs	$182.50	69	70	70	$12,622	$12,775	$12,775
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch	cu.m.	$7.40	145,500	147,267	147,267	$1,077,367	$1,090,452	$1,090,452
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch	cu.m.	$7.40	97,000	98,178	98,178	$718,244	$726,968	$726,968
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	49	49	49	$145,209	$146,973	$146,973
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$273,317	$283,487	$283,487
								Sub-Total	**$3,006,486**	**$3,118,355**	**$3,118,355**
4.3	**Temporary Ore Stockpiles and Pads**										
	Roll crest and recontour		D9H Dozer	hrs	$415.00	117	117	117	$48,733	$48,733	$48,733
	Additional compaction, as req'd		Vibratory Roller	hrs	$182.50	5	5	5	$942	$942	$942
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate G (Load, haul, place 90 day material)	cu.m.	$5.05	28,800	28,800	28,800	$145,484	$145,484	$145,484
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate G (Load, haul, place 90 day material)	cu.m.	$5.05	19,200	19,200	19,200	$96,989	$96,989	$96,989
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	4	4	4	$10,838	$10,838	$10,838
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$30,299	$30,299	$30,299
								Sub-Total	**$333,285**	**$333,285**	**$333,285**
4.4	**Reclamation Stockpiles**										
	Recontour		D9H Dozer	hrs	$415.00	85	85	85	$35,275	$35,275	$35,275
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	22	22	22	$67,006	$67,006	$67,006
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$10,228	$10,228	$10,228
								Sub-Total	**$112,509**	**$112,509**	**$112,509**
4.5	**Ice Rich Overburden Storage Area**										
	Recontour and scarify surface		D9H Dozer	hrs	$415.00	-	20	20	$0	$8,300	$8,300
			Cat 16H grader	hrs	$240.00	-	10	10	$0	$2,400	$2,400
			Trades Labourer	hrs	$54.63	-	10	10	$0	$546	$546
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	6	6	$0	$16,766	$16,766
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$2,801	$2,801
								Sub-Total	**$0**	**$30,814**	**$30,814**
Total Estimated Cost in Reclaiming Overburden and Waste Rock Dumps									**$4,483,121**	**$7,529,144**	**$8,379,570**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Ops	2583	5892	6507	235	536	592
$39.42	General Labour	2952	4419	4908	295	442	491
$54.63	Trades Labour	0	10	10	0	1	1
$162.75	Design Engineer/Pr	2504	4206	4681	209	350	390
	TOTAL	8040	14527	16105	739	1329	1473

ADR & Ancillary Facilities, Estimated Closure Costs - Phase 6 and 7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
	ADR AND ANCILLARY FACILITIES										
9.1	**Buildings and Structures Demolition**										
	Remove salvageable equipment		General Labourer	hrs	$39.42	1,344	1,344	1,344	$52,980	$52,980	$52,980
			Trades Labourer	hrs	$54.63	504	504	504	$27,534	$27,534	$27,534
			30 ton Crane	hrs	$126.09	84	84	84	$10,592	$10,592	$10,592
	Decontaminate Building-hosing and clean-up		Trades Labourer	hrs	$54.63	168	168	168	$9,178	$9,178	$9,178
	Dismantle Buildings		General Labourer	hrs	$39.42	5,376	5,376	5,376	$211,922	$211,922	$211,922
			Trades Labourer	hrs	$54.63	4,032	4,032	4,032	$220,268	$220,268	$220,268
			Cat 235 Excavator	hrs	$250.00	210	210	210	$52,500	$52,500	$52,500
			30 ton Crane	hrs	$126.09	672	672	672	$84,732	$84,732	$84,732
	Concrete Demolition		Blaster	hrs	$48.98	-	-	-	$0	$0	$0
			Cat 235 Excavator w hammer	hrs	$390.00	252	252	252	$98,280	$98,280	$98,280
			D9H Dozer	hrs	$415.00	168	168	168	$69,720	$69,720	$69,720
	Misc. Supplies & Tools		Misc.	l.s.	$15,000.00	1	1	1	$15,000	$15,000	$15,000
	Scrap haul to solid waste facility		Cat 235 Excavator	hrs	$250.00	168	168	168	$42,000	$42,000	$42,000
			Haul Truck D250E	hrs	$272.50	168	168	168	$45,780	$45,780	$45,780
	Haul and place overburden for revegetation (0.2 m thickness)	1.89	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	3,780	3,780	3,780	$19,095	$19,095	$19,095
	Revegetate	1.89	Revegetation cost per ha. Including application cost	ha	$2,994.00	1.89	1.89	1.89	$5,659	$5,659	$5,659
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$96,524	$96,524	$96,524
								Sub-Total	**$1,061,763**	**$1,061,763**	**$1,061,763**
9.2	**Fuel Storage Area**										
	Cleanout tanks-remove sludge, pressure wash		General Labourer	hrs	$39.42	504	504	504	$19,868	$19,868	$19,868
			Removal to Licensed facility	l.s.	$12,500.00	1	1	1	$12,500	$12,500	$12,500
	Remove bulk fuel storage and piping facilities		General Labourer	hrs	$39.42	756	756	756	$29,802	$29,802	$29,802
			Trades Labourer	hrs	$54.63	336	336	336	$18,356	$18,356	$18,356
			30 ton Crane	hrs	$126.09	84	84	84	$10,592	$10,592	$10,592
			Support Equipment	l.s.	$7,500.00	1	1	1	$7,500	$7,500	$7,500
			Cat 235 Excavator	hrs	$250.00	-	-	-	$0	$0	$0
			General Labourer	hrs	$39.42	-	-	-	$0	$0	$0
			Tractor Trailer (lowbed)	hrs	$195.00	-	-	-	$0	$0	$0
	Fold and Bury Liner		Cat 235 Excavator	hrs	$250.00	48	48	48	$12,000	$12,000	$12,000
			D9H Dozer	hrs	$415.00	24	24	24	$9,960	$9,960	$9,960
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$12,058	$12,058	$12,058
								Sub-Total	**$132,634**	**$132,634**	**$132,634**
9.3	**Reagents Removal and Cleanup**										
	Load and return extra reagents/chemicals		General Labourer	hrs	$39.42	96	96	96	$3,784	$3,784	$3,784
			Support Equipment	l.s.	$2,500.00	1	1	1	$2,500	$2,500	$2,500
			Disposal Cost-bulk materials	l.s.	$5,000.00	1	1	1	$5,000	$5,000	$5,000
			Disposal Cost-lab pacs	pallets	$2,000.00	5	5	5	$10,000	$10,000	$10,000
	Removal of drums, steel, oils, glycol & batteries etc.		Contractor quote	l.s.	$50,900.00	1	1	1	$50,900	$50,900	$50,900
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,218	$7,218	$7,218
								Sub-Total	**$79,403**	**$79,403**	**$79,403**
9.4	**Crusher Area and Screening Area**										
	Test soils for contamination		Environmental Scientist	hrs	$116.00	20	20	20	$2,320	$2,320	$2,320
			Analytical Costs	l.s.	$6,000.00	1	1	1	$6,000	$6,000	$6,000
	Haul any contaminated soils to Land Treatment Facility		Cat 235 Excavator	hrs	$250.00	40	40	40	$10,000	$10,000	$10,000
			Haul Truck D250E	hrs	$272.50	40	40	40	$10,900	$10,900	$10,900
	Haul any ore contaminated soils to heap		Load, haul & place mat'l on heap	cu.m.	$10.00	100	100	100	$1,000	$1,000	$1,000
	Haul and place backfill for stable slopes		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.84	72,000	72,000	72,000	$420,183	$420,183	$420,183
	Haul & place overburden topsoil for revegetation - (0.2 m thickn	1.5	Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.84	3,000	3,000	3,000	$17,508	$17,508	$17,508
	Revegetate	1.5	Revegetation cost per ha. Including application cost	ha	$2,994.00	1.5	1.5	1.5	$4,491	$4,491	$4,491

	Re-contour area and slopes to bury footings and establish drainage		D9H Dozer	hrs	$415.00	60	60	60	$24,900	$24,900	$24,900
	Scarify Surface	13.30	Cat 16H grader	hrs	$240.00	60	60	60	$14,400	$14,400	$14,400
	Haul and place overburden cap (0.5 m thickness)	13.30	Custom Rate F (Load, haul, place soil cover Open Pit)	cu.m.	$5.05	26,600	26,600	26,600	$134,371	$134,371	$134,371
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$64,607	$64,607	$64,607
								Sub-Total	**$710,679**	**$710,679**	**$710,679**
9.5	**Truck Shop Area (s 6.9.7)**										
	Remove salvageable equipment		General Labourer	hrs	$39.42	504	504	504	$19,868	$19,868	$19,868
			Haul Truck D250E	hrs	$272.50	-	-	-	$0	$0	$0
			Trades Labourer	hrs	$54.63	84	84	84	$4,589	$4,589	$4,589
	Dismantle buildings		General Labourer	hrs	$39.42	2,100	2,100	2,100	$82,782	$82,782	$82,782
			30 ton Crane	hrs	$126.09	168	168	168	$21,183	$21,183	$21,183
			Cat 235 Excavator	hrs	$250.00	120	120	120	$30,000	$30,000	$30,000
	Haul building pieces off site - equipment		Tractor Trailer (lowbed)	hrs	$195.00	168	168	168	$32,760	$32,760	$32,760
	Scrap haul to site landfill		Haul Truck D250E	hrs	$272.50	24	24	24	$6,540	$6,540	$6,540
			Cat 235 Excavator	hrs	$250.00	24	24	24	$6,000	$6,000	$6,000
	Excavate & haul contaminated materials to site LTF		Misc.	l.s.	$6,250.00	1	1	1	$6,250	$6,250	$6,250
	Bury footings - haul and place fill, locally sourced		Unit Basis (footing burial)	each	$5.25	300	300	300	$1,575	$1,575	$1,575
	Recontour		D9H Dozer	hrs	$415.00	24	24	24	$9,960	$9,960	$9,960
	Haul and place overburden for revegetation (0.2 m thickness)	6.4	Custom Rate C (Load, haul, place soil cover Platinum Gulch)	cu.m.	$7.40	12,800.00	12,800.00	12,800.00	$94,779	$94,779	$94,779
	Revegetate	6.4	Revegetation cost per ha. Including application cost	ha	$2,994.00	6.40	6.40	6.40	$19,162	$19,162	$19,162
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$33,545	$33,545	$33,545
								Sub-Total	**$368,992**	**$368,992**	**$368,992**
9.6	**Water Treatment Plant**										
	Phase 2-5 Capital Costs - Remaining		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$8,406,793	$8,406,793	$8,406,793
	Phase 6 Capital Costs		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$167,194	$167,194	$167,194
	Phase 6 Pipeline and Containment		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$240,000	$240,000	$240,000
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$881,399	$881,399	$881,399
								Sub-Total	**$9,695,386.13**	**$9,695,386**	**$9,695,386.13**
Total Estimated Cost in Reclaiming ADR and Ancillary Facilities									**$12,048,857**	**$12,048,857**	**$12,048,857**

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators (Addit'l Load Haul Place)		2606	2606	2606	237	237	237
$39.42	General Labour		10680	10680	10680	890	890	890
$54.63	Trades Labour		5124	5124	5124	427	427	427
	General Labour (reveg)		249	249	249	25	25	25
	WTP Construction		14496	14496	14496	1208	1208	1208
$162.75	Design Engineer/Project Management		1329	1329	1329	111	111	111
		TOTAL	34484	34484	34484	2898	2898	2898

Breakdown of Item 9.6 Water Treatment Plant

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 2-5 - Remaining costs									
	SITE CIVIL									
	Tote Stand & Stairway, Clarifier & Oxidation Tank Ladder Ca	ls	Remaining contract price	$ 28,000.00	1	1	1	$ 28,000.00	$ 28,000.00	$ 28,000.00
	HVAC	ls	Remaining contract price	$ 100,000.00	1	1	1	$ 100,000.00	$ 100,000.00	$ 100,000.00
	SITE CIVIL SUBTOTAL		Subtotal					$ 128,000.00	$ 128,000.00	$ 128,000.00
	PROCESS EQUIPMENT									
	Balance of payments to design engineer	ls	Remaining contract price	$ 605,000.00	1	1	1	$ 605,000.00	$ 605,000.00	$ 605,000.00
	Raw water feed pump		Remaining contract price	$ 26,622.00	1	1	1	$ 26,622.00	$ 26,622.00	$ 26,622.00
	Safety Shower System		Remaining contract price	$ 49,364.00	1	1	1	$ 49,364.00	$ 49,364.00	$ 49,364.00
	Fire safety systems		Remaining contract price	$ 190,000.00	1	1	1	$ 190,000.00	$ 190,000.00	$ 190,000.00
	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ 870,986.00	$ 870,986.00	$ 870,986.00
	PIPING									
	Piping Bulks		Remaining contract price	$ 498,291.03	1	1	1	$ 498,291.03	$ 498,291.03	$ 498,291.03
	Manual Valves		Remaining contract price	$ 250,000.00	1	1	1	$ 250,000.00	$ 250,000.00	$ 250,000.00
	Piping Special Items		Remaining contract price	$ 100,000.00	1	1	1	$ 100,000.00	$ 100,000.00	$ 100,000.00
	Overland Bulk Piping & Fittings		Remaining contract price	$ 150,650.36	1	1	1	$ 150,650.36	$ 150,650.36	$ 150,650.36
	PIPING SUBTOTAL		Subtotal					$ 998,941.39	$ 998,941.39	$ 998,941.39
	ELECTRICAL AND INSTRUMENTATION									
	Switchgear		Remaining contract price	$ 20,000.00	1	1	1	$ 20,000.00	$ 20,000.00	$ 20,000.00
	Feeder Cable		Remaining contract price	$ 65,062.05	1	1	1	$ 65,062.05	$ 65,062.05	$ 65,062.05
	Transformers		Remaining contract price	$ 93,350.00	1	1	1	$ 93,350.00	$ 93,350.00	$ 93,350.00
	Motor Control Centres & VFDs		Remaining contract price	$ 549,219.99	1	1	1	$ 549,219.99	$ 549,219.99	$ 549,219.99
	Bulk Electrical Cable		Remaining contract price	$ 315,942.37	1	1	1	$ 315,942.37	$ 315,942.37	$ 315,942.37
	Lighting & Ceiling Fans		Remaining contract price	$ 50,000.00	1	1	1	$ 50,000.00	$ 50,000.00	$ 50,000.00
	HV Testing, Commissioning, and Mobilization		Remaining contract price	$ 43,767.95	1	1	1	$ 43,767.95	$ 43,767.95	$ 43,767.95
	Instrumentation		Remaining contract price	$ 112,500.00	1	1	1	$ 112,500.00	$ 112,500.00	$ 112,500.00
	CONTROL SUBTOTAL		Subtotal					$ 1,249,842.36	$ 1,249,842.36	$ 1,249,842.36
	CONSTRUCTION CONTRACT & SUPPORT CONTRACTS									
	Mechanical Installation		Remaining contract price	$ 1,519,910.70	1	1	1	$ 1,519,910.70	$ 1,519,910.70	$ 1,519,910.70
	WTP - Mechanical Support		Remaining contract price	$ 25,000.00	1	1	1	$ 25,000.00	$ 25,000.00	$ 25,000.00
	E&I Installation		Remaining contract price	$ 2,718,977.75	1	1	1	$ 2,718,977.75	$ 2,718,977.75	$ 2,718,977.75
	Bulk earthworks		Remaining contract price	$ 100,780.00	1	1	1	$ 100,780.00	$ 100,780.00	$ 100,780.00
	Propane Installation		Remaining contract price	$ 204,000.00	1	1	1	$ 204,000.00	$ 204,000.00	$ 204,000.00
	Equipment Rental		Remaining contract price	$ 286,024.20	1	1	1	$ 286,024.20	$ 286,024.20	$ 286,024.20
	Local Rental Solutions Ltd		Remaining contract price	$ 116,292.00	1	1	1	$ 116,292.00	$ 116,292.00	$ 116,292.00
	United Rental		Remaining contract price	$ 143,291.51	1	1	1	$ 143,291.51	$ 143,291.51	$ 143,291.51
	Washcar Rental		Remaining contract price	$ 18,900.00	1	1	1	$ 18,900.00	$ 18,900.00	$ 18,900.00
	Rental Power Distribution		Remaining contract price	$ 25,847.00	1	1	1	$ 25,847.00	$ 25,847.00	$ 25,847.00
	CONSTRUCTION CONTRACT & SUPPORT CONTRACTS SUBTOTAL		Subtotal					$ 5,159,023.16	$ 5,159,023.16	$ 5,159,023.16
				Mine Water Treatment Plant Phase 2-5			Subtotal	$8,406,793	$8,406,793	$8,406,793

Breakdown of Item 9.6 Water Treatment Plant Continued

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 6									
	Construction Contracts									
	Pumping and electical installations		Trades Labourer	$54.63	96	96	96	$ 5,244.48	$ 5,244.48	$ 5,244.48
	CONSTRUCTION CONTRACTS SUBTOTAL		Subtotal					$ 5,244.48	$ 5,244.48	$ 5,244.48
	PROCESS EQUIPMENT									
	Caro's acid inline mixer with cooling jacket	ea		$ 80,000.00	1	1.	1.	$ 80,000.00	$ 80,000.00	$ 80,000.00
	Reagent Feed Pumps from Totes to CIC tank	ea		$ 9,300.00	4	4.	4.	$ 37,200.00	$ 37,200.00	$ 37,200.00

	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ 117,200.00	$ 117,200.00	$ 117,200.00
	PIPING									
	Primary Piping	m		$ 38.00	500	500.	500.	$ 19,000.00	$ 19,000.00	$ 19,000.00
	Secondary Piping	m		$ 27.50	500	500.	500.	$ 13,750.00	$ 13,750.00	$ 13,750.00
	Chem Piping	m		$ 15.00	800	800.	800.	$ 12,000.00	$ 12,000.00	$ 12,000.00
	PIPING SUBTOTAL		Subtotal					$ 44,750.00	$ 44,750.00	$ 44,750.00
						Mine Water Treatment Plant Phase 6	Subtotal	$167,194	$167,194	$167,194
	Phase 6 Pipeline									
	PIPING									
	Feed Pipeline from Destruct Circuit to MWTP - 150mm HD	m		$ 160.00	1,500.	1,500.	1,500.	$ 240,000.00	$ 240,000.00	$ 240,000.00
	PIPING SUBTOTAL		Subtotal					$ 240,000.00	$ 240,000.00	$ 240,000.00
						Phase 6 Pipeline and Containment	Subtotal	$240,000	$240,000	$240,000

Infrastructure, Estimated Closure Costs, Phase 6/7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
10.1	**Mine Camp and Related Infrastructure (including guard house area)**										
	Disconnect Services		Trades Labourer	hrs	$54.63	106	106	106	$5,800	$5,800	$5,800
	Remove salvageable equipment		General Labourer	hrs	$39.42	319	319	319	$12,556	$12,556	$12,556
	Dismantle buildings		General Labourer	hrs	$39.42	637	637	637	$25,113	$25,113	$25,113
			Cat 235 Excavator	hrs	$250.00	80	80	80	$19,908	$19,908	$19,908
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$272.50	27	27	27	$7,233	$7,233	$7,233
			Cat 235 Excavator	hrs	$250.00	27	27	27	$6,636	$6,636	$6,636
	Site Clean-Up		General Labourer	hrs	$39.42	212	212	212	$8,371	$8,371	$8,371
	Decommission water supply wells		Fill with concrete	each	$2,000.00	2.00	2	2	$4,000	$4,000	$4,000
	Haul and place overburden for revegetation (0.2 m thickness)	3.95	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.05	7,900	7,900	7,900	$39,907	$39,907	$39,907
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	3.95	3.95	3.95	$11,826	$11,826	$11,826
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$14,135	$14,135	$14,135
								Sub-Total	**$155,486**	**$155,486**	**$155,486**
10.2	**Explosive / Magazine Storage Facility**										
	Remove salvageable equipment		General Labourer	hrs	$39.42	72	72	72	$2,838	$2,838	$2,838
			Trades Labourer	hrs	$54.63	72	72	72	$3,933	$3,933	$3,933
	Dismantle buildings		General Labourer	hrs	$39.42	48	48	48	$1,892	$1,892	$1,892
			Cat 235 Excavator	hrs	$250.00	24	24	24	$6,000	$6,000	$6,000
	Disconnect Services		Trades Labourer	hrs	$54.63	24	24	24	$1,311	$1,311	$1,311
	Crane services		30 ton Crane	hrs	$126.09	48	48	48	$6,052	$6,052	$6,052
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$272.50	24	24	24	$6,540	$6,540	$6,540
			Cat 235 Excavator	hrs	$250.00	24	24	24	$6,000	$6,000	$6,000
	Haul and place overburden for revegetation (0.2 m thickness)	3.93	Custom Rate E (Load, haul, place soil cover IROSA)	cu.m.	$4.27	7,860	7,860	7,860	$33,540	$33,540	$33,540
	Revegetate	3.93	Revegetation cost per ha. Including application cost	ha	$2,994.00	3.9	3.9	3.9	$11,766	$11,766	$11,766
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,987	$7,987	$7,987
								Sub-Total	**$87,861**	**$87,861**	**$87,861**
10.5	**Electrical Dismantle and Remove**										
		44 km		see T15							
								Sub-Total	**$0**	**$0**	**$0**
10.6	**Conveyor Dismantle and Remove**										
	Remove salvageable equipment		General Labourer	hrs	$39.42	1,344	1,344	1,344	$52,980	$52,980	$52,980
			Trades Labourer	hrs	$54.63	1,008	1,008	1,008	$55,067	$55,067	$55,067
	Crane services		30 ton Crane	hrs	$126.09	280	280	280	$35,305	$35,305	$35,305
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$14,335	$14,335	$14,335
								Sub-Total	**$157,688**	**$157,688**	**$157,688**
Total Estimated Cost in Reclaiming Miscellaneous Sites and Facilities									**$401,035**	**$401,035**	**$401,035**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	509	509	509		46	46
$39.42	General Labour	2632	2632	2632	219	219	219
$54.63	Trades Labour	1210	1210	1210	101	101	101
n/a	General Labour (reveg)	236	236	236	24	24	24
$162.75	Design Engineer/Project Managemen	224	224	224	19	19	19
	TOTAL	4811	4811	4811	362	409	409

Waste Disposal / Remediation, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
11.1	**Solid Waste Disposal**										
	Disposal at the onsite landfill (see individual cost sheets for hauling and T12)					-	-	-	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
11.2	**Hazardous Materials Disposal**										
	Hazmat consolidation, packaging and documentation for disposal			l.s.	$49,807.00	1	1	1	$49,807	$49,807	$49,807
	Off-Site Disposal			l.s.	$2,500.00	10	10	10	$25,000	$25,000	$25,000
								Sub-Total	**$74,807**	**$74,807**	**$74,807**
11.3	**Hydrocarbon Contaminated Soils**										
	Off-Site Disposal			l.s.	$2,500.00	-	-	-	$0	$0	$0
	On-Site Land Treatment Farm (LTF)										
	Prepare and submit closure plan		Misc	l.s.	$2,000.00	1	1	1	$2,000	$2,000	$2,000
	Characterize final soil hydrocarbon concentrations		Misc	l.s.	$4,000.00	1	1	1	$4,000	$4,000	$4,000
	Recontour		D9H Dozer	hrs	$415.00	36	36	36	$14,940	$14,940	$14,940
	Haul and place overburden cover from nearby		Cat 235 Excavator	hrs	$250.00	48	48	48	$12,000	$12,000	$12,000
			Haul Truck D250E	hrs	$272.50	48	48	48	$13,080	$13,080	$13,080
			D9H Dozer	hrs	$415.00	24	24	24	$9,960	$9,960	$9,960
	Final Decommissioning of LTF			l.s.	$17,500	1	1	1	$17,500	$17,500	$17,500
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,348	$7,348	$7,348
								Sub-Total	**$80,828**	**$80,828**	**$80,828**
11.4	**Process Residue Contaminated Soils**										
	Off-Site Disposal			l.s.	$3,500	5	5	5	$17,500	$17,500	$17,500
								Sub-Total	**$17,500**	**$17,500**	**$17,500**
Total Estimated Cost for Waste Disposal / Remediation									**$173,135**	**$173,135**	**$173,135**
Notes:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	156	156	156	14	14	14
$162.75	Design Engineer/Project M	45	45	45	4	4	4
	TOTAL	201	201	201	18	18	18

Landfills, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
12.1	**Expansion of Facility to Accommodate Closure Phase Debris**										
	Expand landfill		Cat 235 Excavator	hr	$250.00	252	252	252	$63,000	$63,000	$63,000
			General Labourer	hr	$39.42	252	252	252	$9,934	$9,934	$9,934
			Vibratory Roller	hr	$182.50	36	36	36	$6,570	$6,570	$6,570
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,950	$7,950	$7,950
								Sub-Total	**$87,454**	**$87,454**	**$87,454**
12.2	**Operation During Closure Phase**										
	Disposal of solid waste at the onsite landfill (see individual cost sheets for hauling solid waste)								$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
12.3	**Final Closure**										
	Prepare detailed closure plan		Misc	l.s.	$2,000.00	1	1	1	$2,000	$2,000	$2,000
	Characterize final waste area		Misc	l.s.	$2,000	1	1	1	$2,000	$2,000	$2,000
	Remove recyclables and special waste materials		Tractor Trailer (lowbed	hrs	$195.00	24	24	24	$4,680	$4,680	$4,680
	Final Compaction & Grading		D9H Dozer	hrs	$415.00	36	36	36	$14,940	$14,940	$14,940
	Haul and cover with adjacent fill and place overburden cap		Cat 235 Excavator	hrs	$250.00	24	24	24	$6,000	$6,000	$6,000
			Haul Truck D250E	hrs	$272.50	24	24	24	$6,540	$6,540	$6,540
	Compaction of cover		D9H Dozer	hrs	$415.00	24	24	24	$9,960	$9,960	$9,960
	Revegetation		Revegetation cost per	ha	$2,994.00	1.5	1.5	1.5	$4,491	$4,491	$4,491
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$5,061	$5,061	$5,061
								Sub-Total	**$55,672**	**$55,672**	**$55,672**
Total Estimated Landfill Costs									**$143,126**	**$143,126**	**$143,126**
Notes:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	420	420	420	38	38	38
$39.42	General Labour	252	252	252	21	21	21
n/a	General Labour (reveg	45	45	45	5	5	5
$162.75	Design Engineer/Proje	80	80	80	7	7	7
	TOTAL	797	797	797	70	70	70

Roads & Trails, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
13.1	**On Site Access and Haul Roads**										
	Recontour crests		Cat 235 Excavator	hrs	$250.00	808	671	630	$202,100	$167,750	$157,500
	Scarify surfaces		Cat 16H grader	hrs	$240.00	210	210	210	$50,400	$50,400	$50,400
	Revegetate		Revegetation cost per ha. Including application c	ha	$2,994.00	81	67	63	$242,035	$200,897	$188,622
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$49,453	$41,905	$39,652
								Sub-Total	**$543,988**	**$460,952**	**$436,174**
13.2	**Culverts**										
	Culvert excavation		Cat 235 Excavator	hrs	$250.00	50	50	50	$12,500	$12,500	$12,500
	Culvert removal		General Labourer	hrs	$39.42	168	168	168	$6,623	$6,623	$6,623
	Recontour slopes and drainage		D9H Dozer	hrs	$415.00	36	36	36	$14,940	$14,940	$14,940
	Stabilize slopes		General Labourer	hrs	$39.42	20	20	20	$788	$788	$788
	Silt Curtains (20m^2 per crossing)		Erosion Barrier	sq. m.	$3.15	140	140	140	$441	$441	$441
	Enviro matting (15m^2 per crossing)		Enviro matting	sq. m.	$3.00	105	105	105	$315	$315	$315
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$3,561	$3,561	$3,561
								Sub-Total	**$39,168**	**$39,168**	**$39,168**
Total Estimated Cost for Closure of Roads & Trails									**$583,156**	**$500,120**	**$475,342**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours Current	Total Hours 2-Year	Total Hours EOM	Total Days Current	Total Days 2-Year	Total Days EOM
n/a	Equipment Operator	1104	967	926	100	88	84
$39.42	General Labour	20	20	20	2	2	2
n/a	General Labour (rev	2425	2013	1890	243	201	189
$162.75	Design Engineer/Pro	326	279	266	27	23	22
	TOTAL	3875	3279	3102	372	314	297

Water Management, Estimated Closure Costs

Item No.	Work Item Description	Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
14.1	**Diversion & Collection Ditches**										
	Raise and/or widen operational 1:10 year ditches			km	$12,500.00	6	6	6	$75,000	$75,000	$75,000
	Removal of Corrugated Steel Half Pipe	2000	Cat 235 Excavator	hr	$250.00	20	20	20	$5,000	$5,000	$5,000
			Tractor trailer for off-site salvage	hr	$180.00	30	30	30	$5,400	$5,400	$5,400
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$8,540	$8,540	$8,540
								Sub-Total	**$93,940**	**$93,940**	**$93,940**
14.2	**Groundwater Wells - Decommissioning**										
	Production Wells			l.s.	$3,600.00	3	4	4	$10,800	$14,400	$14,400
	De-Watering Wells			l.s.	$3,600.00	-	12	12	$0	$43,200	$43,200
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$1,080	$5,760	$5,760
								Sub-Total	**$11,880**	**$63,360**	**$63,360**
14.3	**Pumping**										
	Phase 5										
	Heap Rinsing (See Tab T17b)			$/kw	$ 0.24	6,709,221	6,709,221	11,211,614	$0	$0	$0
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.4	**Construction of New Drainage Channels and Diversions for Closure**										
	Contour ditching (m)		Cat 235 Excavator	hrs	$250.00	100	100	100	$25,000	$25,000	$25,000
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
			Load, haul and place rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$5,650	$5,650	$5,650
								Sub-Total	**$62,150**	**$62,150**	**$62,150**
14.6	**Lower Dublin South Pond**										
	See T 15 - Breakdown of Item 15.3 Passive Treatment Systems - LDSP CW		General Labourer	hr	$39.42	-	-	-	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.7	**Platinum Gulch Pond**										
	See T5 - PGP CWTS full scale build in closure planning			hr	$0.00	-	-	-	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
Total Estimated Cost for Water Management									**$167,970**	**$219,450**	**$219,450**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	150	150	150	14	14	14
$39.42	General Labour	0	0	0	0	0	0
n/a	General Labour (riprap)	27	27	27	2	2	2
$162.75	Design Engineer/Project	94	123	123	8	10	10

TOTAL	270	299	299	24	26	26

Post Closure Care, Maintenance, and Monitoring, Estimated Closure Costs

		Current	2-Year	EOM
Phase 6 =	Heap Drain Down	2	2	4
Phase 7 =	WTP Decommissioning	10	10	15
Phase 8 =	Post Closure Monitoring	2	2	2
	TOTAL YEARS	**14**	**14**	**21**

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Annual Cost (for NPV Calc)	Quantity			Cost			NPV		
						Current	2-Year	EOM	Current	2-Year	EOM	Current	2-Year	EOM
15.1	**Onsite Management**													
	Project Management and Engineering - Included in PME Costs in each Closure Component													
	Pickup truck													
	Phase 7/8	Light truck	monthly	$2,000	$24,000	144	144	204	$288,000	$288,000	$408,000			
	Fuel		monthly	$280	$3,360	144	144	204	$40,320	$40,320	$57,120			
	Heavy equipment maintenance													
	Phase 7/8	Unit Cost Basis	annually	$10,000	$10,000	12	12	17	$120,000	$120,000	$170,000			
	Power and heat													
	Phase 7/8	Unit Cost Basis	monthly	$5,000	$60,000	144	144	204	$720,000	$720,000	$1,020,000			
	General Administrative expenses													
	Phase 7/8	Unit Cost Basis	monthly	$1,500	$18,000	144	144	204	$216,000	$216,000	$306,000			
	Camp Cost													
	Phase 7/8	Unit Cost Basis	person-day	$82.04	$0	-	-	-	$0	$0	$0			
	Subtotal - Phase 7/8 Onsite Management:				**$115,360**				**n/a**	**n/a**	**n/a**	**$483,483**	**$848,845**	**$740,888**
15.2	**Transport Costs**													
	Employee transport costs													
	Phase 7/8	Unit Cost Basis	monthly	$500	$6,000	144	144	204	$72,000	$72,000	$102,000			
	Subtotal - Onsite Management:				**$6,000**				**n/a**	**n/a**	**n/a**	**$42,000**	**$48,854**	**$40,331**
15.3	**Water Treatment Costs**													
	Active Treatment (Phase 6)													
	Capital Costs (See T9)	Misc.	annually	$0.00	$0	1	-	-	$0	$0	$0			
	Capital Replacement Costs					-	-		$0	$0	$0			
	Phase 2-5 WTP, 10-YEAR FREQUENCY	Misc.	10-yrs	*$537,600*	*$537,600*	-	1	1	$0	$537,600	$537,600			
	Phase 2-5 WTP, 4-YEAR FREQUENCY	Misc.	4-years	*$118,987*	*$118,987*	1	2	3	$55,744	$237,974	$356,961			
	Phase 6 A WTP, 4-YEAR FREQUENCY	Misc.	4-years	*$82,500*	*$82,500*	-	-	-	$0	$0	$0			
	Subtotal - Capital Replacement Costs :								**n/a**	**n/a**	**n/a**	**$122,828**	**$859,018**	**$1,072,942**
	Annual Operating Costs													
	Phase 2-5 WTP	Misc.	annually	*$1,490,342*	*$1,490,342*	2.00	2.00	4	$2,589,484	$2,980,684	$5,961,369			
	Phase 6 WTP	Misc.	annually	*$1,308,351*	*$1,308,351*	2.00	2.00	4	$1,999,666	$1,999,666	$5,233,402			
	Subtotal -Annual Operating Costs :								**$0**	**n/a**	**n/a**	**$4,357,806**	**$4,360,535**	**$7,949,513**
	Draindown Pumping (Phase 6)													
	Year 1 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.24	-	Electrical power costs to recirculate heap solution inventory and managed draindown see Tab T17b Draindown			$1,155,868	$2,132,765	$2,660,925	$1,089,517	$1,894,934	$1,974,134
	Year 2 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.24	-				$376,750	$603,694	$1,609,087	$344,779	$520,752	$1,159,008
	Year 3 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.24	-				$0	$0	$694,735	$0	$0	$485,835
	Year 4 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.24					$0	$0	$144,407	$0	$0	$98,044
	In-Heap Pond Pump Capital Replacement	Misc.	4-years	$ 45,430.00			4	4	$0	$181,720	$181,720	$0	$1,173,498	$979,886
	Barren Solution Pump Capital Replacement	Misc.	4-years	$ 284,765.63			4	4	$0	$1,139,063	$1,139,063			
	Subtotal - Draindown Costs :								**n/a**	**n/a**	**n/a**	**$1,434,296**	**$3,589,185**	**$4,696,907**
	Passive Treatment (Phase 7/8)													
	Capital Costs (Occurs in Phase 6)	Misc.	annually	$149,052	$149,052	1	1	1	$149,052.13	$149,052.13	$149,052	$136,404	$128,574	$101,198
	Operating Costs	Misc.	annually	$10,000	$10,000	5	10	15	$50,000	$100,000	$150,000	$41,911	$73,582	$81,052
	Subtotal Passive Treatment Costs:								**n/a**	**n/a**	**n/a**	**$178,315**	**$202,156**	**$182,249**
	Subtotal Water Treatment Costs:								**n/a**	**n/a**	**n/a**	**$6,093,245**	**$9,010,894**	**$13,901,611**
15.4	**Reclamation & Closure Research Plan (Long Term Funding)**													
	Reclamation & Closure Research Plan	Misc.	annually	$20,000	$20,000	2	2	4	$40,000	$40,000	$80,000	$37,155	$35,022	$56,809
	Subtotal Reclamation Research:								**n/a**	n/a	n/a	**$37,155**	**$35,022**	**$56,809**
15.5	**Monitoring & Reporting**													
	Disbursements (non-labour/non-analytical)	Misc.	annually	$0	$0	2	2	2	$0	$0	$0	n/a	$0	$0
	Water Quality Monitoring													
	Phase 6	Misc.	annually	$157,935	$157,935	2	2	4	$315,870	$315,870	$631,740	$257,269	$276,559	$448,605
	Phase 7/8	Misc.	annually	$110,555	$110,555	12	12	17	$1,326,654	$1,326,654	$1,879,427	$569,964	$900,178	$570,676
	Sediment Monitoring:													
	Phase 6	Misc.	annually	$1,272	$1,272	1	1	2	$1,272	$1,272	$2,544	$1,164	$1,097	$1,780
	Phase 7/8	Misc.	annually	$890	$890	6	6	9	$5,342	$5,342	$7,568	$2,351	$3,926	$3,838
	Biological Monitoring (Benthos):													
	Phase 6	Misc.	annually	$1,272	$1,272	1	1	2	$1,272	$1,272	$2,544	$1,164	$1,097	$1,780
	Phase 7/8	Misc.	annually	$890	$890	6	6	9	$5,342	$5,342	$7,568	$2,351	$3,926	$3,838
	Site groundwater monitoring	Misc.												
	Phase 6	Misc.	annually	$41,785	$41,785	2	2	4	$83,570	$83,570	$167,140	$68,066	$73,170	$118,688
	Phase 7/8	Misc.	annually	$29,250	$29,250	12	12	17	$350,994	$350,994	$497,242	$150,796	$238,161	$150,984
	Geotechnical Inspections:													
	Phase 6	Misc.	annually	$15,000	$15,000	2	2	4	$30,000	$30,000	$60,000	$27,866	$26,266	$42,607
	Phase 7/8	Misc.	annually	$15,000	$15,000	12	12	17	$180,000	$180,000	$255,000	$77,333	$91,457	$91,541
	Reclamation Inspections:													
	Phase 6	Misc.	annually	$0	$0	2	2	4	$0	$0	$0	$0	$0	$0
	Phase 7/8	Misc.	annually	$10,000	$10,000	12	12	17	$120,000	$120,000	$170,000	$51,555	$81,424	$61,028
	Monitoring of piezometers, thermistors													
	Phase 6	Misc.	each	$0	$0	2	2	4	$0	$0	$0	$0	$0	$0
	Phase 7/8	Misc.	each	$0	$0	12	12	17	$0	$0	$0	$0	$0	$0
	Annual Inspection + report	Misc.	annually	$12,500	$12,500	14	14	21	$175,000	$175,000	$262,500	$87,665	$123,669	$143,475
	Subtotal:								$2,595,317	n/a	n/a	**$1,297,543**	**$1,820,930**	**$1,638,839**
15.6	**Post Closure Maintenance, Decommissioning and Demobilization**													
	CWTS--Carry out inspection recommendations/maintenance	Misc.	annually	$7,500	$7,500	12	12	17	$90,000	$90,000	$127,500	$38,666	$61,068	$64,782
	Misc. maintenance work related to the site after closure	Misc.	annually	$60,000	$60,000	12	12	17	$720,000	$600,000	$600,000	$251,465	$441,494	$334,220
	Electrical Dismantle and Remove	44 km												
	De-energize, Disassemble structures and dismantle (521 structures)		Trades Labourer	hrs	$54.63	1,042	1,042	1,042	$56,924	$56,924	$56,924			
			General Labourer	hrs	$39.42	1,042	1,042	1,042	$41,076	$41,076	$41,076			
			30 ton Crane	hrs	$126.09	521	521	521	$65,693	$65,693	$65,693			
	Backfill foundation anchor holes		Haul Truck D250E	hrs	$272.50	130	130	130	$35,493	$35,493	$35,493			
			D9H Dozer	hrs	$415.00	48	48	48	$19,920	$19,920	$19,920			
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$272.50	130	130	130	$35,493	$35,493	$35,493			
			Cat 235 Excavator	hrs	$250.00	48	48	48	$12,000	$12,000	$12,000			
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$26,660	$26,660	$26,660			
	Sub-Total Electrical Dismantle and Remove:								**$293,259**	**$293,259**	**$293,259**	$231,501	$188,232	$127,798
	Water Treatment Plant Decommissioning (Phase 7/8)													
	Remove salvageable equipment	General Labourer	hrs	$39.42		672	672	672	$26,490	$26,490	$26,490			
		Haul Truck D250E	hrs	$272.50		-	-	-	$0	$0	$0			
		Trades Labourer	hrs	$54.63		252	252	252	$13,767	$13,767	$13,767			
	Dismantle buildings	General Labourer	hrs	$39.42		960	960	960	$37,843	$37,843	$37,843			
		30 ton Crane	hrs	$126.09		168	168	168	$21,183	$21,183	$21,183			
		Cat 235 Excavator	hrs	$250.00		120	120	120	$30,000	$30,000	$30,000			
	Haul building pieces off site - equipment	Tractor Trailer (lowbed	hrs	$195.00		168	168	168	$32,760	$32,760	$32,760			
	Scrap haul to site landfill	Haul Truck D250E	hrs	$272.50		24	24	24	$6,540	$6,540	$6,540			
		Cat 235 Excavator	hrs	$250.00		24	24	24	$6,000	$6,000	$6,000			
	Excavate & haul contaminated materials to site LTF	Misc.	l.s.	$6,250.00		1	1	1	$6,250	$6,250	$6,250			
	Bury footings - haul and place fill, locally sourced	Unit Basis (footing buri	each	$5.25		300	300	300	$1,575	$1,575	$1,575			
	Recontour	D9H Dozer	hrs	$415.00		24	24	24	$9,960	$9,960	$9,960			
	Haul and place overburden for revegetation (0.2 m thickness)	Custom Rate A (Load,	cu.m.	$5.05		3,960	3,960	3,960	$20,004	$20,004	$20,004			
	Revegetate	Revegetation cost per h	ha	$2,994.00		1.98	1.98	1.98	$5,928	$5,928	$5,928			
	Subtotal Water Treatment Decommissioning Costs:								**$218,300**	**$218,300**	**$218,300**	$172,328	$140,119	$95,132
	Subtotal:								n/a	n/a	n/a	**$693,961**	**$830,912**	**$621,933**
Total Estimated Cost for Post Closure Site Management									**n/a**	**n/a**	**n/a**	**$8,647,386**	**$12,595,457**	**$17,000,411**

Note:

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators		1358	1358	1358	123	123	123
$39.42	General Labour		2674	2674	2674	223	223	223
	Trades Labourer		1294	1294	1294	108	108	108
n/a	General Labour (reveg)		59	69	69	6	7	7
	Water Treatment Operator		804	1922	2184	67	160	182
$162.75	Design Engineer/Project Management		164	164	164	14	14	14

Breakdown of Item 15.3 Water Treatment Costs

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Phase 2-5 Equipment Replacement Costs									
	10-YEAR FREQUENCY									
	MF Membranes	ea		$ 3,200.00	62	168	168	$ 198,400	$ 537,600	$ 537,600
	10-YEAR SUBTOTAL		**Subtotal**					**$ 198,400**	**$ 537,600**	**$ 537,600**
	4-YEAR FREQUENCY									
	Feed Pumps	ea		$ 18,243.50	1	2	2	$ 18,244	$ 36,487	$ 36,487
	Transfer Pumps	ea		$ 7,500.00	2	5	5	$ 15,000	$ 37,500	$ 37,500
	Chemical Pumps	ea		$ 7,500.00	3	6	6	$ 22,500	$ 45,000	$ 45,000
	4-YEAR FREQUENCY SUBTOTAL		**Subtotal**					**$ 55,744**	**$ 118,987**	**$ 118,987**
	Phase 6 Equipment Replacement Costs									
	4-YEAR FREQUENCY									
	Transfer Pumps	ea		$ 7,500.00	5	5	5	$ 37,500	$ 37,500	$ 37,500
	Chemical Pumps	ea		$ 7,500.00	6	6	6	$ 45,000	$ 45,000	$ 45,000
	4-YEAR FREQUENCY SUBTOTAL		**Subtotal**					**$ 82,500**	**$ 82,500**	**$ 82,500**
	Phase 2-5 Annual Operating Costs									
	EQUIPMENT POWER COSTS									
	Transverse 200 Microfilter	Kw/h	3 kW @ 100%	$ 0.24	0.74	2	2	$ 3,911	$ 10,633	$ 10,633
	Feed Pumps	Kw/h	50 Hp (37.285kW) @ 50%	$ 0.24	0.74	2	2	$ 24,304	$ 66,075	$ 66,075
	Process Transfer Pumps	Kw/h	20 Hp (14.914 kW) @ 50%	$ 0.24	3.68	10	10	$ 48,607	$ 132,149	$ 132,149
	Filter Press	Kw/h	15 Hp (11.185) @ 20%	$ 0.24	0.37	1	1	$ 1,458	$ 3,964	$ 3,964
	SUBTOTAL EQUIPMENT POWER		**Subtotal**					**$ 78,280**	**$ 212,821**	**$ 212,821**
	LABOUR COSTS									
	Transverse 200 Microfilter	hrs/yr	Trades Labourer	$54.63	191	520	520	$ 10,449	$ 28,408	$ 28,408
	Filter Press	hrs/yr	Trades Labourer	$54.63	383	1040	1040	$ 20,898	$ 56,815	$ 56,815
	Plate Clarifiers	hrs/yr	Trades Labourer	$54.63	38	104	104	$ 2,090	$ 5,682	$ 5,682
	Chemical Batching	hrs/yr	Trades Labourer	$54.63	38	104	104	$ 2,090	$ 5,682	$ 5,682
	SUBTOTAL LABOUR		**Subtotal**					**$ 35,526**	**$ 96,586**	**$ 96,586**
	CHEMICAL COSTS									
	Process Chemical									
	Ferric Chloride, 39%	kg/y		$2.93	106,500	106,500	106,500	$ 312,045	$ 312,045	$ 312,045
	Sulfuric Acid, 93% Micro C	kg/y		$1.73	81,700	81,700	81,700	$ 141,341	$ 141,341	$ 141,341
	Sodium Hydroxide, 50%	kg/y		$2.14	143,900	143,900	143,900	$ 307,946	$ 307,946	$ 307,946
	Cleaning Chemical									
	Sodium Bisulfite 40%	kg/y		$1.49	20,133	20,133	20,133	$ 29,998	$ 29,998	$ 29,998
	Sodium Hypochlorite, 12.5%	L/y		$1.98	183,033	183,033	183,033	$ 362,405	$ 362,405	$ 362,405
	Citric Acid, Solid	kg/y		$4.00	6,800	6,800	6,800	$ 27,200	$ 27,200	$ 27,200
	SUBTOTAL CHEMICALS		**Subtotal**					**$ 1,180,936**	**$ 1,180,936**	**$ 1,180,936**
	Total Phase 2-5 Annual Operating Costs							**$ 1,294,742**	**$ 1,490,342**	**$ 1,490,342**
	Phase 6 Operating Costs									
	EQUIPMENT POWER COSTS									
	Process Transfer Pumps	Kw/h	10 Hp (7.457 kW) @ 50%	$ 0.24	4	4	10	$ 26,430	$ 26,430	$ 66,075
	SUBTOTAL EQUIPMENT POWER		**Subtotal**					**$ 26,430**	**$ 26,430**	**$ 66,075**
	LABOUR COSTS									
	Chemical Batching	hrs/yr	Trades Labourer	$54.63	154	154	416	$ 8,413	$ 8,413	$ 22,726
	SUBTOTAL LABOUR		**Subtotal**					**$ 8,413**	**$ 8,413**	**$ 22,726**
	CHEMICAL COSTS									
	Process Chemical									
	H_2O_2		tonne	$1,350.00	51	51	64	$ 68,850	$ 68,850	$ 86,400
	H_2SO_4		tonne	$1,730.00	518	518	655	$ 896,140	$ 896,140	$ 1,133,150
	SUBTOTAL LABOUR		**Subtotal**					**$ 964,990**	**$ 964,990**	**$ 1,219,550**
	Total Phase 6 Annual Operating Costs							**$ 999,833**	**$ 999,833**	**$ 1,308,351**

Breakdown of Item 15.3 Passive Treatment Systems

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	LDSP Passive Treatment									
	Construction									
	Construction fill	cu.m	Excavation of Soil	$ 4.50	31000	31000	31000	$ 139,500	$ 139,500	$ 139,500
	Load, haul dump fill, mulch, organics material	cu.m	Custom Rate D (Load, haul, place wetland soil in CWTS)	$ 5.05	1400	1400	1400	$ 7,072	$ 7,072	$ 7,072
	Planting Wetland Vegetation	ha	Wetland plants (4,000 seedlings per ha)	$ 8,000.00	0.31	0.31	0.31	$ 2,480	$ 2,480	$ 2,480
	SUBTOTAL LABOUR		**Subtotal**					**$ 149,052**	**$ 149,052**	**$ 149,052**

Interim Care and Maintenance

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
16.1	**Personnel**									
	On-site Caretaker + 2nd worker = 2 Full-Time									
	Full time (2 people on alternate 7in-7out schedule)	Site caretaker	$15,812.16	$/person-month	24	24	24	$379,492	$379,492	$379,492
	Extra Personnel									
	Electrician (estimate 1 mo/yr total for EOM)	Trades Labourer	$54.63	$/hr	88	176	176	$4,807	$9,615	$9,615
	Mechanic (estimate 1 mo/yr total for EOM)	Trades Labourer	$54.63	$/hr	88	176	176	$4,807	$9,615	$9,615
	Senior Operator/Supervisor (2 people on alternate 7in-7out schedule)	Supervisor	$15,379.88	$/mo	24	24	24	$369,117	$369,117	$369,117
	Camp Costs									
	for above personnel (365+365+15+15+365)	Unit Cost Basis	$82.04	person-days	1,125	1,155	1,155	$92,295	$94,756	$94,756
							Sub-Total - Personnel	**$850,519**	**$862,595**	**$862,595**
16.2	**Equipment**									
	Small Excavator (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Dozer (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Loader (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Pick-Up Truck (1)	Misc.	$2,500	monthly	12	12	12	$30,000	$30,000	$30,000
	Snow Machine & ATV	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
							Sub-Total - Equipment	**$70,000**	**$70,000**	**$70,000**
16.3	**Tasks**									
	Interim water treatment (active)	Misc.	See T15	annually	See Breakdown in T15			$1,294,742	$1,490,342	$1,490,342
	Water Quality monitoring	Misc.	$157,935	annually	1	1	1	$157,935	$157,935	$157,935
	Geotechnical Assessments	Misc.	$15,000	annually	1.00	1	1	$15,000	$15,000	$15,000
	Sediment monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Biological monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Groundwater monitoring	Misc.	$41,785	annually	1	1	1	$41,785	$41,785	$41,785
	Monitoring of piezometers and thermistors	Misc.	$3,000	annually	-	-	-	$0	$0	$0
	Communications & reporting	Misc.	$12,500	annually	1	1	1	$12,500	$12,500	$12,500
							Sub-Total - Tasks	**$1,524,506**	**$1,720,106**	**$1,720,106**
16.4	**Miscellaneous**									
	Misc Supplies	Misc.	$50,000	annually	1	1	1	$50,000	$50,000	$50,000
	MWTP Operating Costs	Misc.	$1,490,342	annually	1	1	1	$1,490,342	$1,490,342	$1,490,342
	Annual Fuel	Misc.	$2.30	$/litre	1,000	1,000	1,000	$2,300	$2,300	$2,300
	Power to maintain HLF water recirculation	$/kw	$ 0.24	annually	7,052,769	13,392,559	13,392,559	$1,678,559	$3,187,429	$3,187,429
							Sub-Total - Miscellaneous	**$3,221,201**	**$4,730,071**	**$4,730,071**
	Annual Cost for ICM							**$5,666,226**	**$7,382,772**	**$7,382,772**
	Number of Years							**2**	**2**	**2**
	Total ICM Cost							**$11,332,452**	**$14,765,544**	**$14,765,544**
Note:										

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Caretaker		8640	8640	8640	720	720	720
$39.42	Electrician		88	176	176	7	15	15
n/a	Mechanic		88	176	176	7	15	15
	Supervisor		8640	8640	8640	720	720	720
	Environmental Scientist		30	30	30	3	3	3

Table of Quantities					
Item Description	**Value Current**	**Value 2- Year Peak**	**Value EOM**	**Units**	**Source/Comment EOM**
Open Pit					
Inflow Spillway Rip-Rap	200.00	200.00	200.00	m^3	
Exit Channel Rip-Rap	200.00	200.00	200	m^3	
Open Pit Area	0	0.0	0	ha	
Overburden for revegetation	0	0	0	m^3	
Heap Leach Facility					
Heap Leach Facility	51.63	69.96	101.60	ha	True area for cover derived from AutoCAD regrading planning
Colluvium for revegetation	154,890	209,880	304,800	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation	103,260	139,920	203,200	m^3	0.2 m thickness over total area
Heap Leach Facility - Embankment Area	3.79	3.79	3.79	ha	
Colluvium for revegetation	0	0	0	m^3	Colluvium required for leached material and waste rock not embankment face
Overburden topsoil for revegetation	7,580	7,580	7,580	m^3	
HLF ore	24,300,000	49,000,000	86,000,000	t	
Passive Treatment CWTS Area	0.90	0.90	0.90	ha	From Ensero 2022 preliminary design
Passive Treatment construction fills	165,000	165,000	165,000	m^3	From Ensero 2022 preliminary design
Substrate fills	4,250	4,250	4,250		From Ensero 2022 preliminary design
In-Heap Pond Storage	59,378	59,378	59,378	m^3	From Ensero 2022 heap biological detox memorandum
Active Leaching Moisture Content (midpoint)	12.91%	12.91%	12.91%	%	
Total contained volume pores (avg case)	3,135,915	6,323,450	11,098,300	m^3	
Total contained volume pore plus pond	3,195,293	6,382,828	11,157,678	m^3	
CN concentration after ICM	50	50	50	mg/L	
Total mass of CN in solution	159,764,650	319,141,400	557,883,900	grams	
Total moles of CN in solution	6,144,794	12,274,669	21,457,073	Moles	
Moles sugar required	3,072,397	6,137,335	10,728,537	Moles	
Mass sugar required	553,031	1,104,720	1,931,137	kg	
Storage Volume (normal operating volume)	23,500	23,500	23,500	m^3	Adjusted based on upper bound volume for normal operating "green" level for the HLF
Storage Volume	23,500,000	23,500,000	23,500,000	liter	
Sulfate Reduction Rate	0.80	0.80	0.80	mM	
	96	96	96	mg/mM	
total sulfate reduction	18,800,000	18,800,000	18,800,000	mM sulfate	
electrons required per mM SO4 reduced	8	8	8	electrons	
total electrons required for SO4 reduction	150,400,000	150,400,000	150,400,000		
methanol	12	12	12	mM electrons	
methanol	12,533,333	12,533,333	12,533,333	mM methanol	
methanol	32.04	32.04	32.04	mg/mM	
	401,568,000	401,568,000	401,568,000	mg methanol	
	17.09	17.09	17.09	mg/L	
	401.568	401.568	401.568	tons methanol	
Nutrients added to heap for cyanide degradatio	553	1,105	1,931	ton	
Nutrients added to heap for heap bioreactors	402	402	402	ton	
Waste Rock and Overburden Dumps					
Eagle Pup Area	23.90	66.60	82.90	ha	True area for cover derived from AutoCAD regrading planning
Eagle Pup Waste Rock	10,100,000	30,000,000	92,942,000	t	
Colluvium for revegetation - Eagle Pup	71,700	199,800	248,700	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Eagle Pu	47,800	133,200	165,800	m^3	0.2 m thickness over total area
Platinum Gulch Area	48.50	49.09	49.09	ha	True area for cover derived from AutoCAD regrading planning
Platinum Gulch Waste Rock	24,700,000	25,000,000	25,000,000	t	
Colluvium for revegetation - Platinum Gulch	145,500	147,267	147,267	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Platinum	97,000	98,178	98,178	m^3	0.2 m thickness over total area
Temporary Ore Stockpiles and Pads Area	3.6	3.6	3.6	ha	Area disturbed outsdie of 90 day cover zone
Pad material removal to Eagle Pup	0	0	0	m^3	Area now considered in cover estimates
90 day stockpile	9.6	9.6	9.6	ha	
90 day stockpile mine plan maximum	1,000,000	1,000,000	1,000,000	t	
Colluvium for revegetation - 90 day	28,800	28,800	28,800	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - 90 day	19,200	19,200	19,200	m^3	0.2 m thickness over total area
Reclamation Stockpiles Area	22.4	22.4	22.4	ha	
Ice Rich Overburden Storage Area	0.0	5.6	5.6	ha	
Process Plant & Ancillary Facilities					
Process Plant Area	1.89	1.89	1.89	ha	Pad area based on aerial survey
Overburden for revegetation	3,780	3,780	3,780	m^3	0.2 m thickness
Crusher and Screening Area	13.3	13.3	13.3	ha	Based on aerial survey
Ore contaminated soils to be hauled to heap	100	100	100	m^3	
Overburden for revegetation	26,600	26,600	26,600	m^3	0.2 m thickness
Truck Shop Area	6.40	6.40	6.40	ha	Based on aerial survey
Overburden for revegetation	12,800	12,800	12,800	m^3	0.2 m thickness

Water Treatment Plant area	1.98	1.98	1.98	ha	
Overburden for revegetation	3,960	3,960	3,960	m^3	0.2 m thickness
Miscellaneous Sites and Facilities					
Mine Camp area	3.95	3.95	3.95	ha	Based on aerial survey
Overburden for revegetation	7,900	7,900	7,900	m^3	0.2 m thickness
Explosive / Magazine Storage Facility area	3.93	3.93	3.93	ha	Based on aerial survey
Overburden for revegetation	7,860	7,860	7,860	m^3	0.2 m thickness
Roads and Trails					
On site access and haul roads	52	63	63	ha	
Construction Trails	29	4	0	ha	
Slope Stabilization					
Silt Curtains (m^2 per crossing)	20	20	20	m^2	
Enviro matting (m^2 per crossing)	15	15	15	m^2	
Number of crossings	7	7	7		
Silt Curtains Total	140	140	140	m^2	
Enviro matting Total	105	105	105	m^2	
Water Management					
New Drainage channels and diversions					
Provision for Rip-Rap	1,000	1,000	1,000	m^3	

Breakdown of Item 14.3 Pumping during Phase 6 Draindown

	Assumption	Value	Unit	
Pregnant Pumps	Maximum power draw per pump	149	kW	
	Maximum capacity per pump	520	m^3/hr	
	Maximum capacity per pump	144	L/s	
Barren Pumps	Power draw per pump based on design flow	254	kW	Based on YWB RFD
	Capacity per pump	520	m^3/hr	
	Maximum capacity per pump	144	L/s	
	Draindown Pumping Factor	100%	%	
	Application Rate (2-Year Peak and EoM)	1,500,000	L/hr	Planned application rates
	Application Rate (2-Year Peak and EoM)	417	L/s	
	Cost per Kw	0.24	$/kw-hr	Cost based on most recent invoices from YEC

Item No.	Work Item Description	Month	Hrs per month	EOM						2-Year Peak (also used for current estimate)					
				Days of Rinse	Pumping Rate (m^3/hr)	Number of Preg Pumps	Number of Barren Pumps	Duration Energy Consumption (kW-hr)	Total Phase 5 Rinsing Power Cost	Days of Rinse	Pumping Rate (m^3/hr)	Number of Preg Pumps	Number of Barren Pumps	Duration Energy Consumption (kW-hr)	Total Phase 5 Rinsing Power Cost
0	*Phase 5 - Recirculation Pumping*														
	Total Duration Required for Rinsing			*402*	*1500*	*3*	*3*	*11,211,614*	*$ 2,668,364.16*	*240*	*1500*	*3*	*3*	*6,709,221*	*$ 1,596,794.53*
				Days of Recirculation	Pumping Rate (m^3/hr)	Number of Preg Pumps	Number of Barren Pumps	Duration Energy Consumption (kW-hr)	Total ICM Power Cost	Days of Recirculation	Pumping Rate (m^3/hr)	Number of Preg Pumps	Number of Barren Pumps	Duration Energy Consumption (kW-hr)	Total ICM Power Cost
	Interim care and maintenance			730	1972	4	4	26,785,118	$ 6,374,858.03	730	1972	4	4	26,785,118	$ 6,374,858.03
				EOM						2-Year Peak					
Item No.	Work Item Description	Month	Hrs per month	Pumping Rate (L/s) during draindown month*	No. of preg pumps req'd for recirculation	No. of barren pumps req'd for recirculation	Maximum Power draw (kW)	Energy Consumption per month (kW-hr)	Monthly Power Cost	Pumping Rate (L/s) during draindown month	No. of preg pumps req'd for recirculation	No. of barren pumps req'd for recirculation	Maximum Power draw (kW)	Energy Consumption per month (kW-hr)	Monthly Power Cost
14.4	**Phase 6 - Draindown Pumping**														
	Year 1	1	744	406	3	3	1209.42	842,944	$ 200,620.72	468	4	4	1612.56	971,115	$ 231,125.25
		2	672	437	4	4	1612.56	818,785	$ 194,870.75	414	3	3	1209.42	775,829	$ 184,647.21
		3	744	395	3	3	1209.42	820,617	$ 195,306.74	404	3	3	1209.42	839,913	$ 199,899.22
		4	720	471	4	4	1612.56	947,337	$ 225,466.28	390	3	3	1209.42	783,803	$ 186,545.20
		5	744	462	4	4	1612.56	958,541	$ 228,132.85	384	3	3	1209.42	796,928	$ 189,668.88
		6	720	472	4	4	1612.56	948,934	$ 225,846.27	338	3	3	1209.42	678,319	$ 161,439.84
		7	744	536	4	4	1612.56	1,112,165	$ 264,695.29	374	3	3	1209.42	776,045	$ 184,698.59
		8	744	499	4	4	1612.56	1,036,881	$ 246,777.63	393	3	3	1209.42	815,108	$ 193,995.70
		9	720	483	4	4	1612.56	970,825	$ 231,056.36	324	3	3	1209.42	651,422	$ 155,038.47
		10	744	478	4	4	1612.56	992,191	$ 236,141.49	333	3	3	1209.42	692,224	$ 164,749.37
		11	720	437	4	4	1612.56	877,901	$ 208,940.48	304	3	3	1209.42	610,881	$ 145,389.56
		12	744	411	3	3	1209.42	853,234	$ 203,069.71	274	2	2	806.28	569,614	$ 135,568.06
								11,180,355	$ 2,660,924.57					8,961,199	$ 2,132,765.36
	Year 2	13	744	354	3	3	1209.42	735,793	$ 175,118.64	239	2	2	806.28	497,316	$ 118,361.19
		14	672	305	3	3	1209.42	572,016	$ 136,139.91	200	2	2	806.28	375,537	$ 89,377.92
		15	744	259	2	2	806.28	537,509	$ 127,927.06	176	2	2	806.28	365,562	$ 87,003.70
		16	720	291	3	3	1209.42	584,052	$ 139,004.41	119	1	1	403.14	238,647	$ 56,797.92
		17	744	354	3	3	1209.42	735,760	$ 175,110.99	78	1	1	403.14	161,778	$ 38,503.13
		18	720	287	2	2	806.28	576,038	$ 137,097.07	76	1	1	403.14	153,287	$ 36,482.31
		19	744	267	2	2	806.28	554,194	$ 131,898.26	59	1	1	403.14	122,070	$ 29,052.75
		20	744	280	2	2	806.28	581,287	$ 138,346.33	77	1	1	403.14	160,118	$ 38,107.98
		21	720	281	2	2	806.28	565,425	$ 134,571.14	75	1	1	403.14	150,873	$ 35,907.88
		22	744	245	2	2	806.28	508,578	$ 121,041.65	61	1	1	403.14	126,651	$ 30,143.02
		23	720	202	2	2	806.28	406,764	$ 96,809.88	54	1	1	403.14	108,424	$ 25,804.92
		24	744	194	2	2	806.28	403,454	$ 96,022.01	29	1	1	403.14	60,391	$ 14,373.08
								6,760,871	$ 1,609,087.34					2,520,655	$ 599,915.79
	Year 3	25	744	172	2	2	806.28	357,405	$ 85,062.47	21	1		149.14	15,877	$ 3,778.68
		26	672	130	1	1	403.14	244,442	$ 58,177.11	14	1		149.14	9,723	$ 2,313.99
		27	744	100	1	1	403.14	207,668	$ 49,425.10	11	1		149.14	8,183	$ 1,947.61
		28	720	112	1	1	403.14	225,818	$ 53,744.69	9	1		149.14	6,687	$ 1,591.48
		29	744	113	1	1	403.14	234,200	$ 55,739.61	8	1		149.14	6,345	$ 1,510.09
		30	720	115	1	1	403.14	230,098	$ 54,763.22	7	1		149.14	5,514	$ 1,312.40
		31	744	135	1	1	403.14	279,826	$ 66,598.49	11	1		149.14	8,702	$ 2,070.98
		32	744	143	1	1	403.14	297,450	$ 70,793.19	10	1		149.14	8,000	$ 1,903.92
		33	720	131	1	1	403.14	262,509	$ 62,477.25	10	1		149.14	7,130	$ 1,696.86
		34	744	102	1	1	403.14	212,401	$ 50,551.50	12	1		149.14	9,582	$ 2,280.63
		35	720	94	1	1	403.14	189,569	$ 45,117.50	13	1		149.14	9,413	$ 2,240.22
		36	744	86	1	1	403.14	177,669	$ 42,285.21	12	1		149.14	8,957	$ 2,131.79
				Year 3 Total				2,919,056	$ 694,735.35					104,112	$ 24,778.66
	Year 4	37	744	49	1	1	403.14	102,279	$ 24,342.35	10	1		149.14	7,985	$ 1,900.45
		38	672	32	1	1	403.14	59,974	$ 14,273.92	9	1		149.14	6,432	$ 1,530.84
		39	744	16	1	1	403.14	34,247	$ 8,150.80	8	1		149.14	6,248	$ 1,486.97
		40	720	23	1	1	403.14	46,524	$ 11,072.64	7	1		149.14	5,258	$ 1,251.45
		41	744	27	1	1	403.14	56,558	$ 13,460.73	6	1		149.14	4,709	$ 1,120.72
		42	720	22	1	1	403.14	43,445	$ 10,339.82	5	1		149.14	3,975	$ 945.97
		43	744	27	1	1	403.14	55,270	$ 13,154.21	10	1		149.14	7,622	$ 1,814.02
		44	744	26	1	1	403.14	54,348	$ 12,934.81	10	1		149.14	7,383	$ 1,757.09
		45	720	22	1	1	403.14	44,375	$ 10,561.27	9	1		149.14	6,694	$ 1,593.17
		46	744	20	1	1	403.14	42,128	$ 10,026.35	12	1		149.14	9,223	$ 2,195.18
		47	720	18	1	1	403.14	36,946	$ 8,793.18	12	1		149.14	9,068	$ 2,158.28
		48	744	15	1	1	403.14	30,660	$ 7,297.04	11	1		149.14	8,698	$ 2,070.10
				Year 4 Total				606,753	$ 144,407.14					83,295	$ 19,824.24
	Year 5	49	744	15	1		149.14	11,304	$ 2,690.45	10	1		149.14	7,836	$ 1,865.06
		50	672	12	1		149.14	8,577	$ 2,041.26	9	1		149.14	6,377	$ 1,517.65
		51	744	12	1		149.14	8,905	$ 2,119.32	8	1		149.14	6,233	$ 1,483.49
		52	720	18	1		149.14	13,686	$ 3,257.26	7	1		149.14	5,263	$ 1,252.50
		53	744	19	1		149.14	14,626	$ 3,481.02	6	1		149.14	4,722	$ 1,123.90
		54	720	16	1		149.14	11,765	$ 2,800.04	5	1		149.14	3,992	$ 950.16
		55	744	20	1		149.14	15,589	$ 3,710.16	10	1		149.14	7,639	$ 1,818.03
		56	744	21	1		149.14	16,239	$ 3,864.96	10	1		149.14	7,392	$ 1,759.34
		57	720	19	1		149.14	13,971	$ 3,325.17	9	1		149.14	6,682	$ 1,590.42
		58	744	17	1		149.14	13,228	$ 3,148.29	12	1		149.14	9,206	$ 2,191.08
		59	720	15	1		149.14	11,037	$ 2,626.79	12	1		149.14	9,070	$ 2,158.67
		60	744	13	1		149.14	10,096	$ 2,402.91	11	1		149.14	8,709	$ 2,072.69
				Year 5 Total				149,024	$ 35,467.64					83,122	$ 19,783.01

NOTES:

At 20L/s recirculation pumping the HLF is considered to be in metastable equilibrium with meteoric inputs and cover of the facility begins (Phase 7/8 begins). At this time site water balance model outflows to the PTS are more representative as the HLF WBM do

APPENDIX I

Victoria Gold Reclamation and Closure Plan Water Balance Support

VICTORIA GOLD CORP
TSX | VGCX

Victoria Gold Reclamation and Closure Plan Water Balance Support

Project #109028

Prepared by:

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Revision	Date	Status	Prepared By	Checked By	Approved By
REV 0	September 30, 2022	Issued Final	B. Fetter	C. Green	C. Green

Table of Contents

1. INTRODUCTION

This report has been prepared by Forte Dynamics, Inc. (Forte) to support Victoria Gold Corp. (VGC) with updating the Reclamation and Closure Plan (RCP) for the Eagle Gold Mine in the Yukon. VGC requested that Forte provide information from the Heap Leach Facility (HLF) Water Balance Model (WBM) to support the RCP update. Forte was requested to provide information related to drain-down of the HLF for the 2-year closure scenario as well as the End-of-Mine (EOM) closure scenario. This includes running of scenarios through the WBM to evaluate ranges in discharge rates and the effect on drain-down duration. As part of this work, Forte was also requested to incorporate Climate Change scenarios, as provided by Lorax to evaluate the effect on drain-down compared to the base case 1000 Meter with no climate change scenarios. This report describes the climate assumptions, discharge rates, provides drain-down results for each scenario, including the 2-year and EOM closure conditions.

For this work, Forte utilized the previously developed HLF WBM , which includes historic measured and projected data for ore placement, solution measurements and management, and other relevant data as it pertains to the HLF. The model results, presented herein, do not represent site-wide water management practices (which is addressed in the site-wide water balance model prepared by Lorax and not discussed here), however they do represent water management practices associated with the HLF. This model incorporates site experience for solution management as well as incorporating actual events and in-heap pond levels for the start of the model (January 1, 2022).

2. INPUTS AND ASSUMPTIONS

This HLF WBM developed by Forte is used for daily operations and uses measured meteorological and site operational data for the period in which such data are available from July 1st, 2019 start date of the simulations to the January 1st, 2022 forecasting date. It is also assumed that no cover is utilized in the modeling for the 2-year closure scenario or the EOM closure scenario.

The HLF WB model used by Forte makes use of a large array of operational, meteorological, ore hydrodynamic properties, and metallurgical input data. During production, ore samples were collected, and then tested over the course of operations to characterize ore properties which have been used in the heap water balance model. The HLF WBM incorporates details surrounding the HLF while providing operations with the ability to utilize more recorded inputs to better understand solution and pond level management.

2.1 Modeling Timeframe

2.1.1 2-Year Closure Scenario

- Operations modelled from:
  - 1/1/2022 – 11/1/2024: Normal Operations (stacking and leaching of HLF)
  - 11/1/2024 – 11/1/2026: Recirculation and Rinsing for 2 years
  - 11/1/2026 – 11/1/2034: Discharge and draindown, closure, solution management (ore rinsing, discharge to treatment)

2.1.2 End-of-Mine Scenario

- Operations modelled from:
  - 1/1/2022 – 2/15/2028: Normal Operations (stacking and leaching of HLF)
  - 2/15/2028 – 1/1/2040: Discharge and draindown, closure, solution management (ore rinsing, discharge to treatment)

2.2 Ore Properties

- **Initial Moisture Content:**
  - 1.5% by weight
- **Residual Moisture Content:**
  - 8.6% by weight, corresponding to a 7.69% by weight for Brooks-Corey Calculations
- **Active Leaching Ore Moisture Content**
  - 14.35% - 11.46% by weight - Calculated within the model, based on application rate (discussed in detail below), ore properties, and changes in density based on loading
- **Bulk Dry Density**
  - 1.9 tonne/m^3
    - Based on additional analysis of ore properties
- **Density Consolidation**
  - Density_Consolidated=Bulk_Density*Overburden_Depth^(Power_Factor), curve fit equation developed from test work with the Power Factor calculated as 0.0195
- **Specific Gravity**
  - 2.65

- **Saturated Hydraulic Conductivity**
  - 0.07268 cm/s (universally scaled down by 1 order of magnitude in model for in-field correction)
- **Saturated Hydraulic Conductivity Consolidation**
  - K_sat_consolidated=Density_Consolidated*Slope+Intercept, linear fit equation developed from test work with Slope=-0.2285 and Intercept=0.4657
- **SCS Curve Number – Loaded HLF**
  - 70 for un-leached ore, 91 for leached ore
- **SCS Curve Number – Un-loaded HLF**
  - 99 for un-loaded HLF area, treated as bare LLDPE liner surface

2.3 Heap Leach Facility Parameters

- **Total Tonnes:**
  - 86Mt, EOM Shown in Figure 1. For the 2 year scenario, only 49Mt are loaded through October 2024.
- **Pad Total Liner Phasing:**
  - Phase 1A - 1/1/2019, 210,000 m^2 Total
  - Phase 1B - 9/24/2020, 460,000 m^2 Total
  - Phase 2a - 8/20/2022, 560,000 m^2 Total
  - Phase 2b - 4/16/2023, 668,000 m^2 Total
  - Phase 3 - 4/3/2025, 983,000 m^2 Total

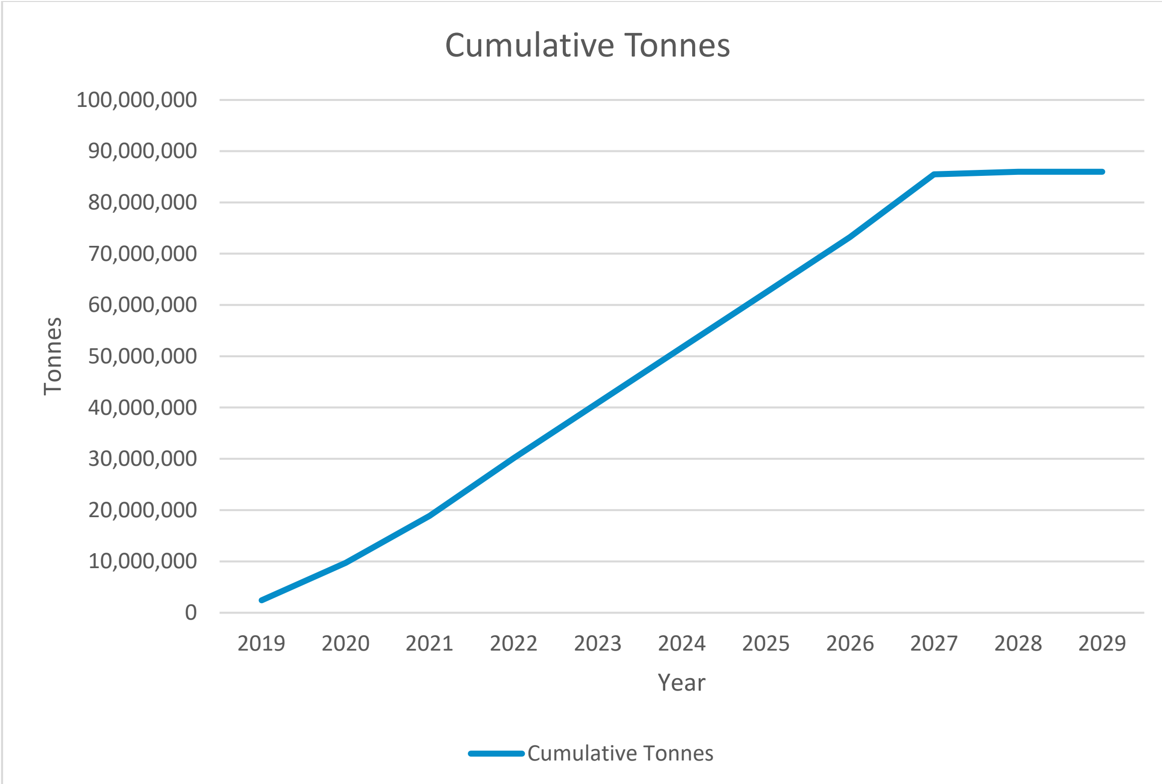

Figure 1 - Mine Plan: EOM Cumulative Tonnes

- **Loading Months:**
  - Forecast stacking (2022-2028) typically occurs April through December each year (9 months of loading), reduced loading in January and March per the mine plan provided by VGC.
    - Historic loading (2019-2021) matches actuals placed to date, which does include some loading during January, February and March.
- **Ultimate Elevation:**
  - 1225m above mean sea level
- **Lift Height:**
  - 10 - 12m
- **Precipitation Soak-up/Initial Abstraction of Precipitation:**
  - SCS Curve Number Excess Moisture Method Used
- **Evaporation Loss from Drip Emitters:**
  - 0.5% only in months with average daily temperatures above 0 Celsius
  - There is no enhanced evaporation considered in the model

2.4 Operational Parameters

- **Initial Leach Cycle:**
  - 45 days
- **Leaching Application Rate (nominal):**

- 7 L/hr/m^2 target for fresh and aged ore
  - Application rate fluctuates based on area under leach and total from plant.
    - This also varies in forecasting based on solution management practices and recirculation when needed.

- **Target Plant Flow Rate:**
  - 1500 m^3/hr, varies through start-up and dependent on total available area for leaching and utilized measured data from site.
  - Additional Discussion: For the simulations performed by Forte, additional specificity of the plant flow rate and its effects on overall solution management is necessary. This includes allowing for fluctuations to this flow rate to manage the In-Heap pond solution level by utilizing recirculation as required.
    - *At the onset of the forecasting date:* During normal operations (following initial ramp-up during development of the HLF), the Target Plant Flow Rate is 1500 m^3/hr limited by the Leaching Application Rate with the Evaporation Loss from Drip Emitters being subtracted off in the applicable months.
    - *Once the mine reaches the end of loading for EOM and 2-Year Scenarios:* After one complete Leach Cycle of the last ore loaded (45 days), the Make-up Water supply is turned off, at which point solution goes through a two year recirculation and rinsing from meteoric contributions phase and then begins to be managed through the discharge of barren solution to treatment, to reduce total volume of solution in the system. More information for the modeling of Make-up Water, Discharge to Treatment, Leach Cycle, In-Heap Pond, and Event Pond can be found in each of those respective sections.

- **Discharge to Treatment Rate:**
  - 2-Year scenarios:
    - Base case 1000 Meter Series:
      - 8 L/s
      - 12 L/s
      - 15 L/s
      - 19 L/s
    - Climate Change Series:
      - 8 L/s
      - 12 L/s
      - 15 L/s
      - 19 L/s
      - 28.5 L/s
  - EOM Scenarios:

- Base case 1000 Meter Series:
  - 8 L/s starting 2/15/2028
  - 12.1 L/s from 2/15/2028 to 1/1/2029, 17.5 L/s after
  - 12.1 L/s from 2/15/2028 to 1/1/2029, 19 L/s after
  - 12.1 L/s from 2/15/2028 to 1/1/2029 24 L/s after
- Climate Change Series:
  - 8 L/s starting 2/15/2028
  - 19 L/s from 2/15/2028 to 1/1/2029, 25.5 L/s after
  - 19 L/s from 2/15/2028 to 1/1/2029, 28.5 L/s after

- **Event Pond Storage:**
  - o 300,577 m^3 maximum, 0.5 m Freeboard Volume of 19,325 m^3
  - o Additional Discussion: For all the modeling simulations performed by Forte, the Event Pond was modeled being the first source of additional make up water required to meet leaching demands. Then, after 2/15/2028, the Event Pond is allowed to fill from meteoric conditions prior to being pumped out and recirculated through the system, eventually returning to the In-Heap Pond. During this same time period the In-Heap Pond level is primarily managed by recirculation and through discharge to treatment. Additionally, the only input to the Event Pond in the model is from In-Heap pond overflow (which does not occur) and direct precipitation.
- **In-Heap Pond Storage Volume:**
  - o 59,378 m^3 (always occupied during operation due to field retention), 57,763 m^3 (maximum available storage volume during operation before overflowing to the Event Pond)
  - o Additional Discussion: For all of the modeling simulations performed by Forte, the In-Heap Pond was drawn from in the following way:
    - As much as possible to maintain the circulation of the targeted flow rate of 1500 m^3/hr, with that flow rate acting as the maximum total withdrawal rate from the In-Heap Pond throughout the entire mine life beginning 1/1/2022.
    - As much as possible to maintain the target for Discharge to Treatment rates with those rates acting as the maximum solution removal rates from the system beginning 2/15/2028.
- **Monitoring Vault Reclaim:**
  - o 165 m^3/day to the Event Pond

2.5 Meteorological Inputs and Parameters

The initial set of Climate Change meteorological data was provided in 2020 by Lorax. For this report, Lorax provided Forte with measured meteorological data for the site and incorporated it into an updated set of 1000 Meter data to generate an updated input file that used historical data from 2019 to 2021 and forecasting data beginning in 2022.

- **Extreme Precipitation Reference Event:**
    - 54 mm (24-hr, 100 yr Event)
- **Precipitation Data used in Modeling:**
    - Two updated, separate composite sets of data provided by Lorax were used by Forte for the updated water balance model.
        - Base Case 1000 Meter Set: The hydrologic 2016 year (Oct 2015 to September 2016) repeated as a typical year from start of 2022 through closure.
        - Climate Change Set: This set has the identical basis as the 1000m set (2016 data repeated for years 2022 through 2099); however, Lorax provided a data set to incorporate the effects of climate change on the weather at the site
        - Refer to Figure 2 through Figure 5

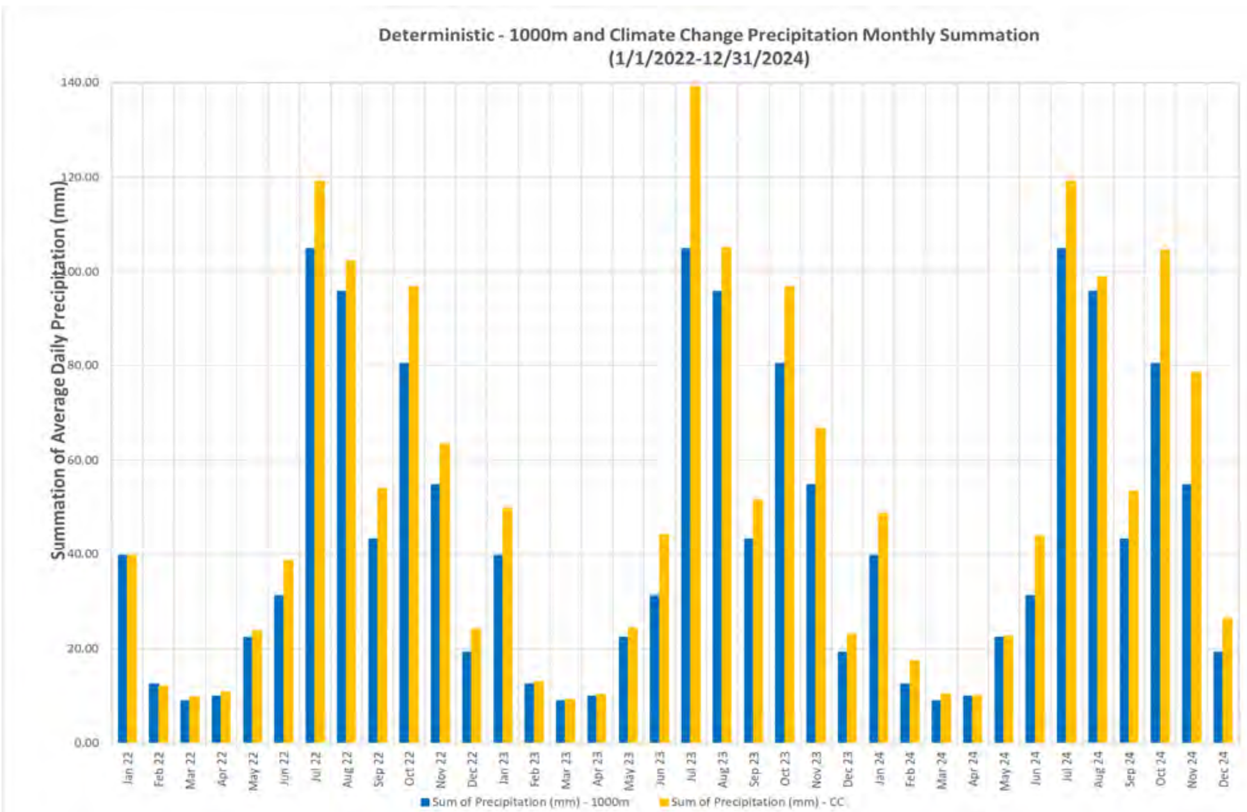

Figure 2 - Precipitation 1/1/2022 - 12/31/2024

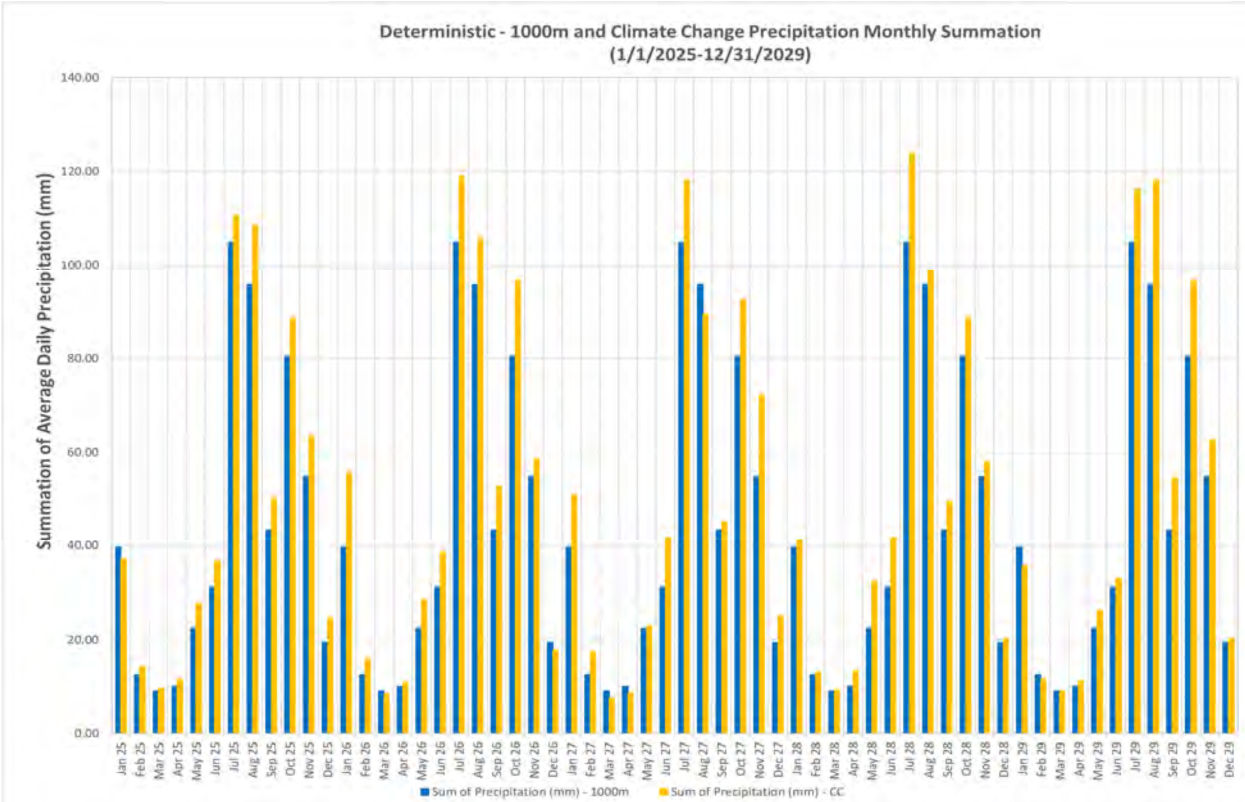

Figure 3 - Precipitation 1/1/2025 - 12/31/2029

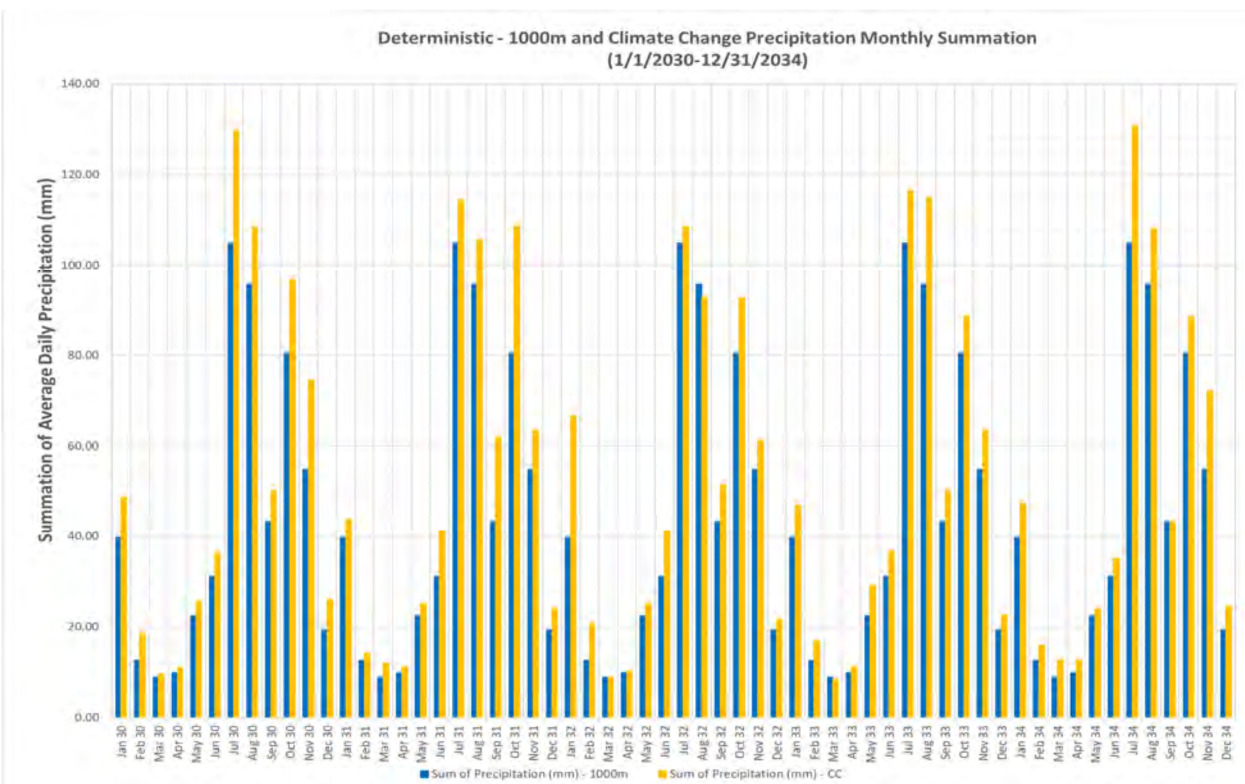

Figure 4 - Precipitation 1/1/2030 - 12/31/2034

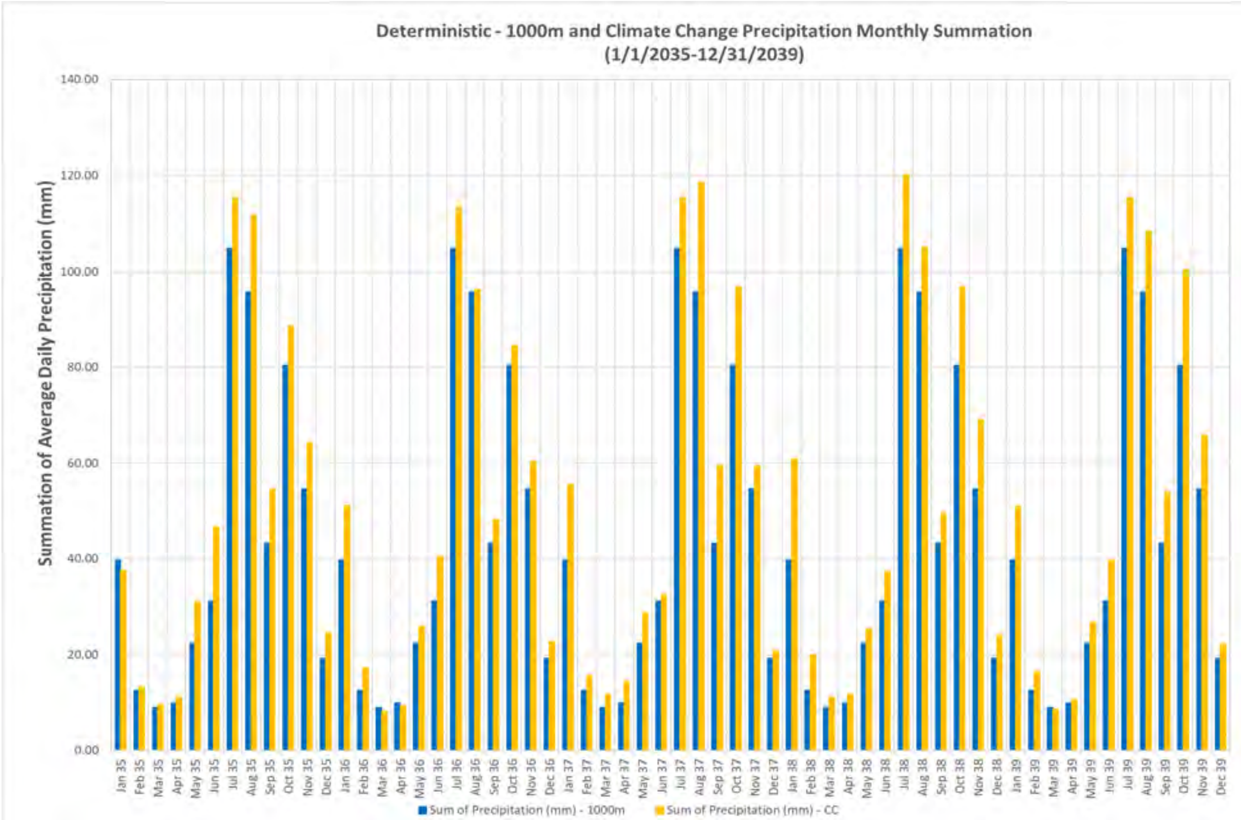

Figure 5 - Precipitation 1/1/2035 - 12/31/2039

- **Potential Evaporation Data used in Modeling:**
  - Two separate composite sets of data provided by Lorax were used by Forte for the water balance model.
    - 1000 Meter Set: The hydrologic 2016 year (October 2015 to September 2016) repeated as a typical year from start of 2022 through closure.
    - Climate Change Set: This set has the identical basis as the 1000m set (2016 data repeated for years 2022 through 2099); however, Lorax provided a data set to incorporate the effects of climate change on the weather at the site.
    - Refer to Figure 6 through Figure 9

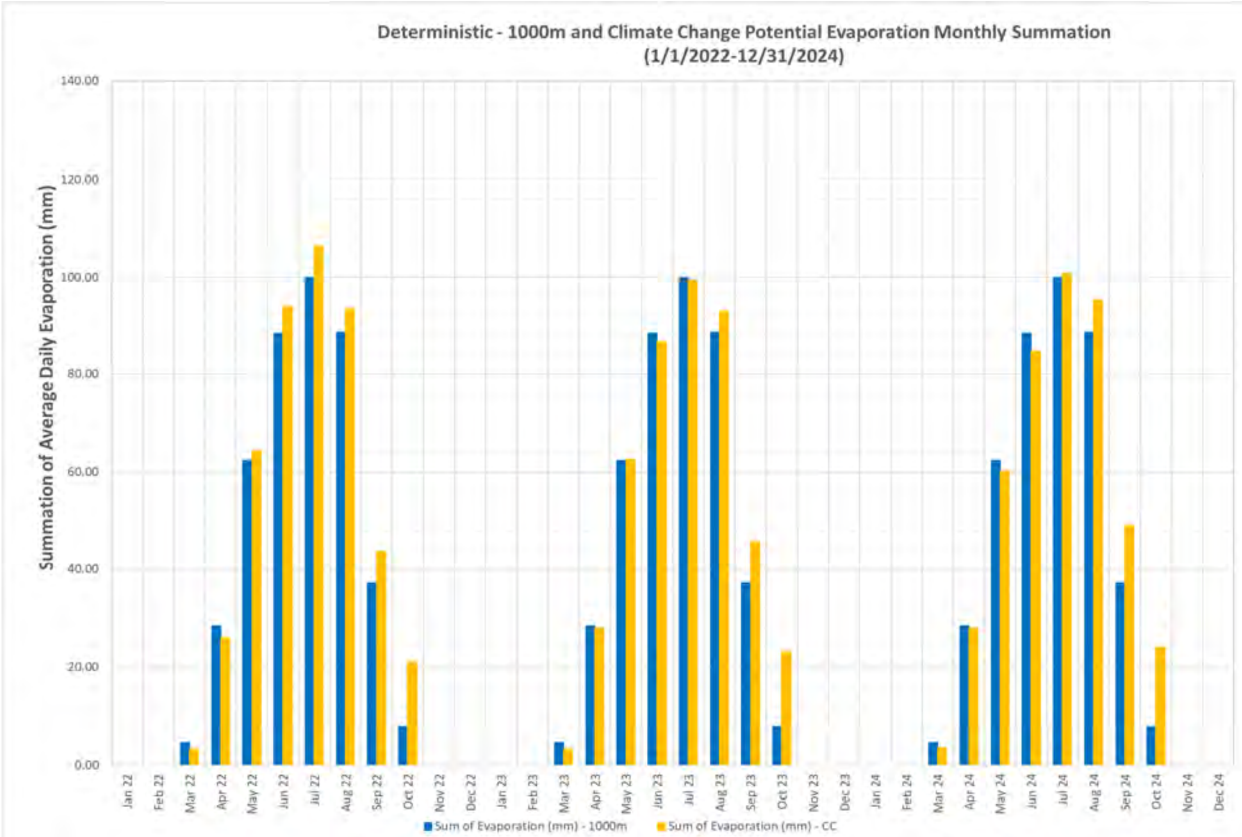

Figure 6 - Evaporation 1/1/2022 - 12/31/2024

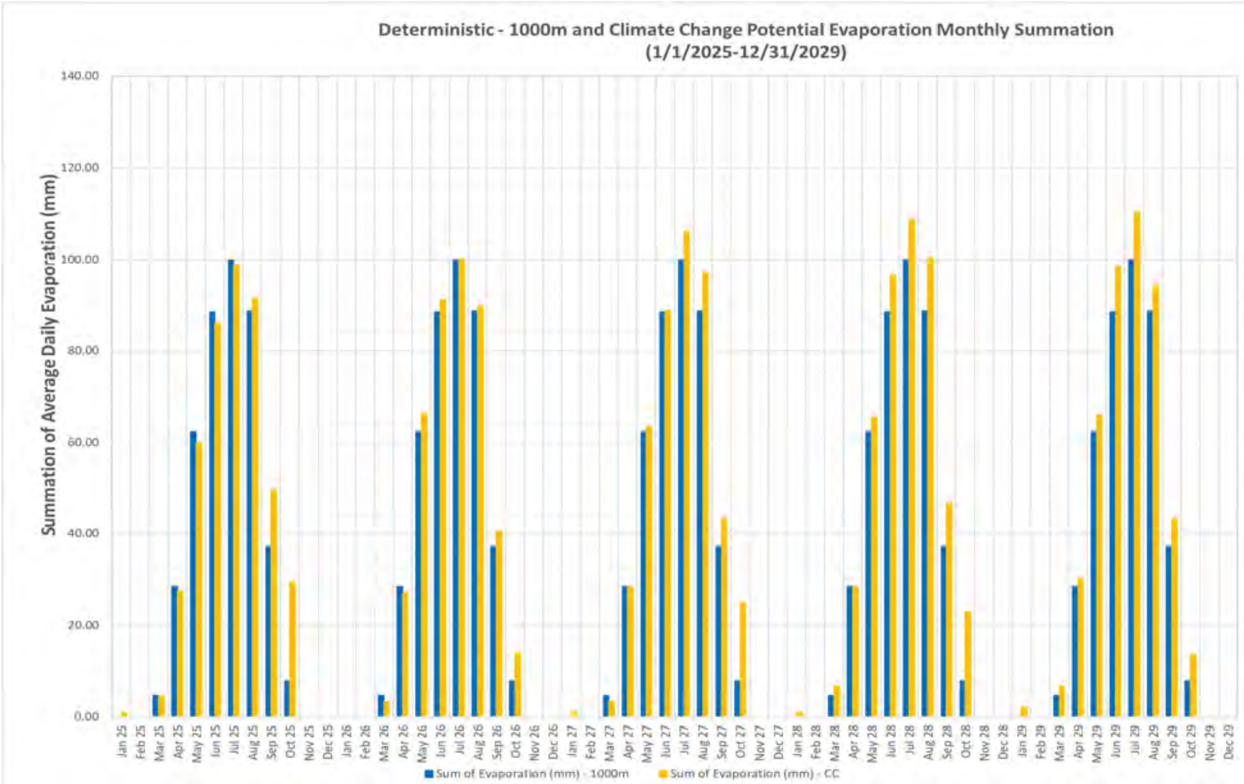

Figure 7 - Evaporation 1/1/2025 - 12/31/2029

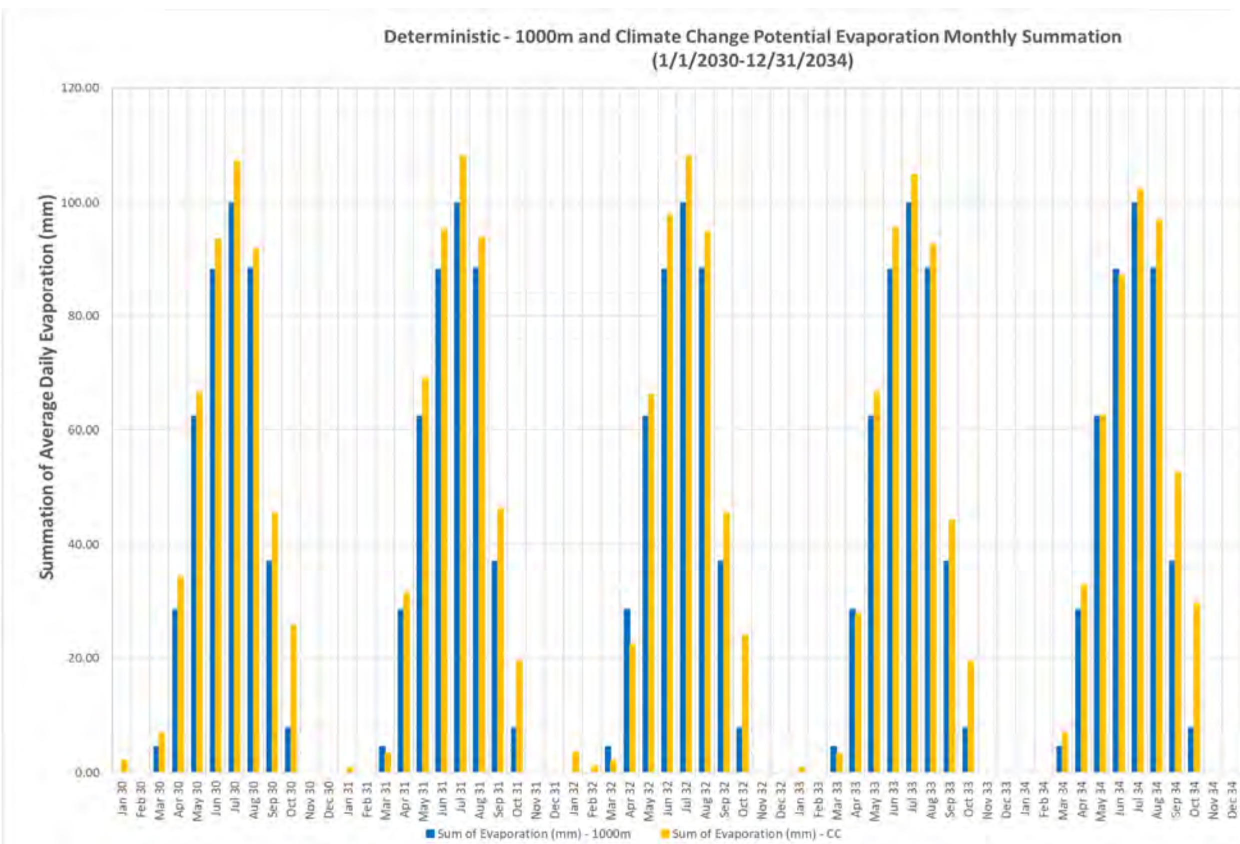

Figure 8 - Evaporation 1/1/2030 - 12/31/2034

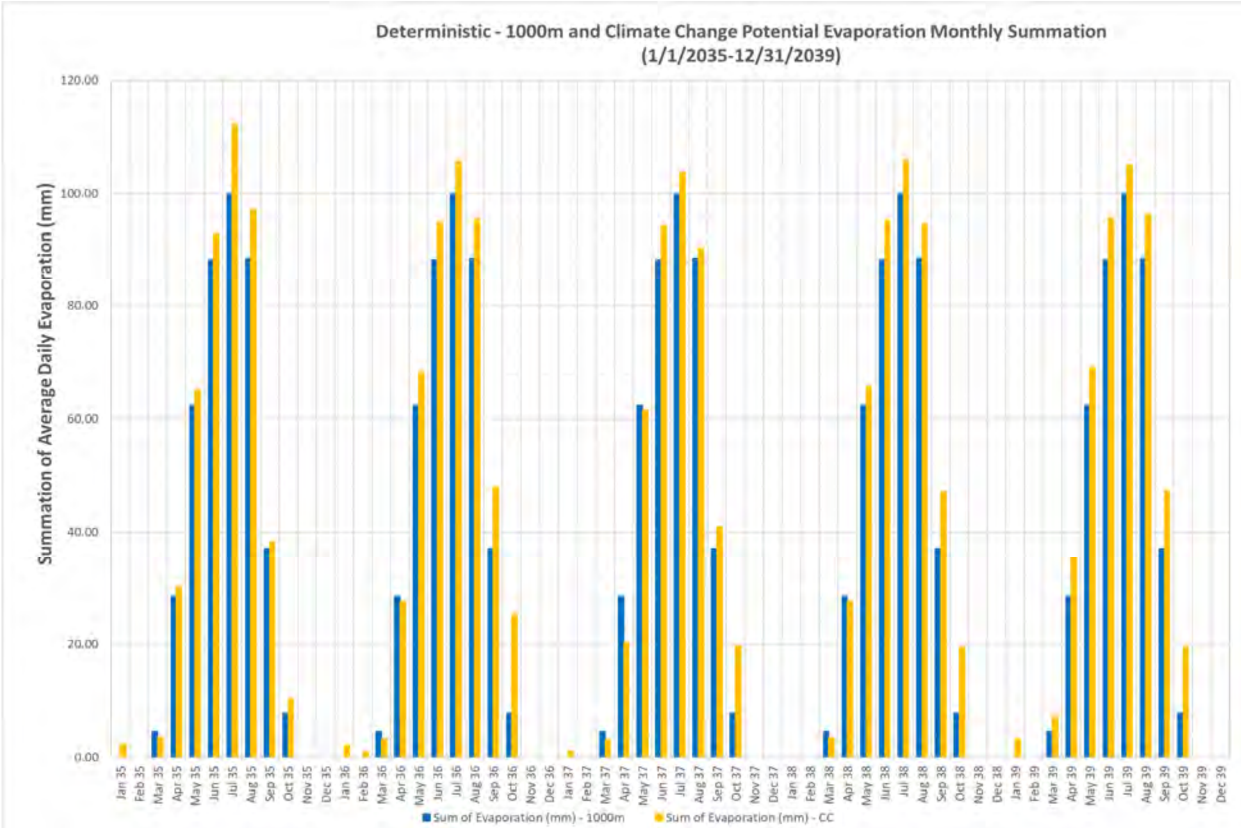

Figure 9 - Evaporation 1/1/2035 - 12/31/2039

- **Temperature Data used in Modeling:**
  - o Two separate composite sets of data provided by Lorax and were used by Forte for the updated water balance model.
    - 1000 Meter Set: hydrologic 2016 year (October 2015 to September 2016) repeated as a typical year from start of 2022 through closure.
    - Climate Change Set: This set has the identical basis as the 1000m set (Site Synthetic through 2021, 2016 data repeated for years 2022 through 2099); however, Lorax provided a data set to incorporate the assumed effects of climate change on the weather at the site.
    - Refer to Figure 10 through Figure 13

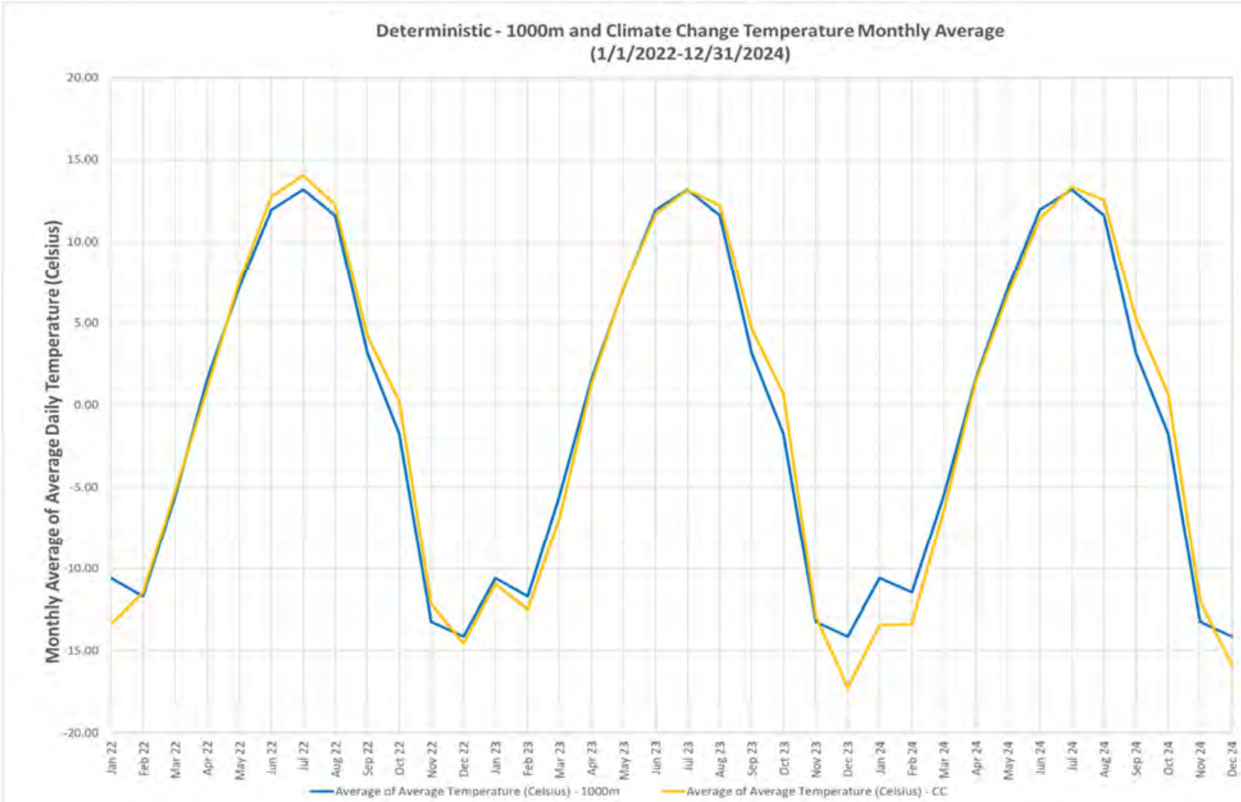

Figure 10 - Temperature 1/1/2022 - 12/31/2024

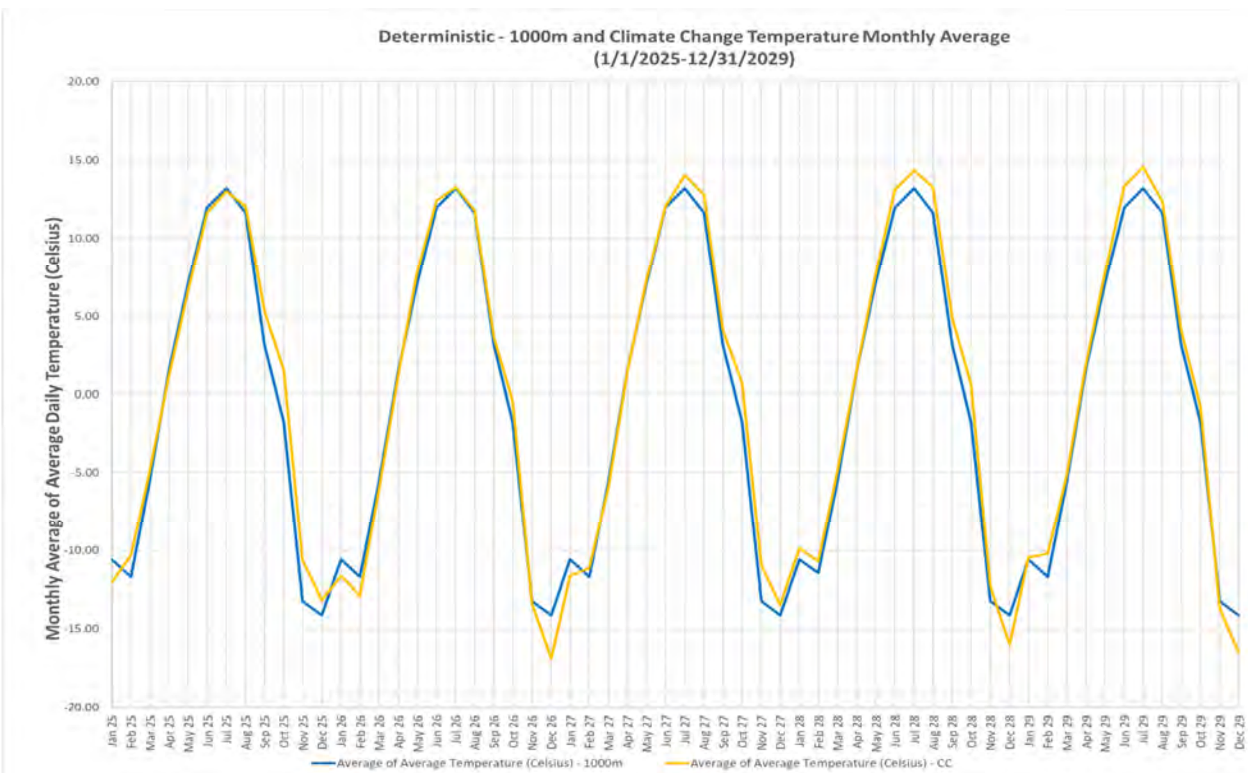

Figure 11 - Temperature 1/1/2025 - 12/31/2029

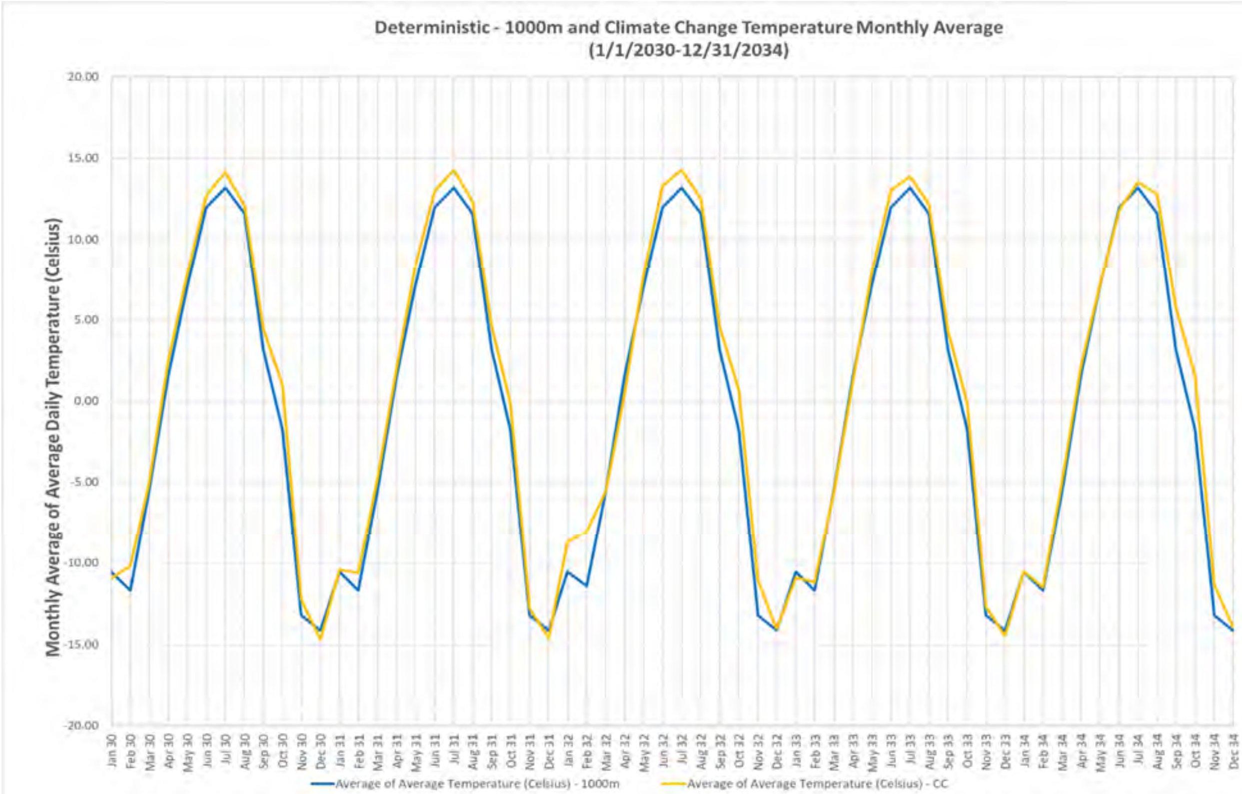

Figure 12 - Temperature 1/1/2030 - 12/31/2034

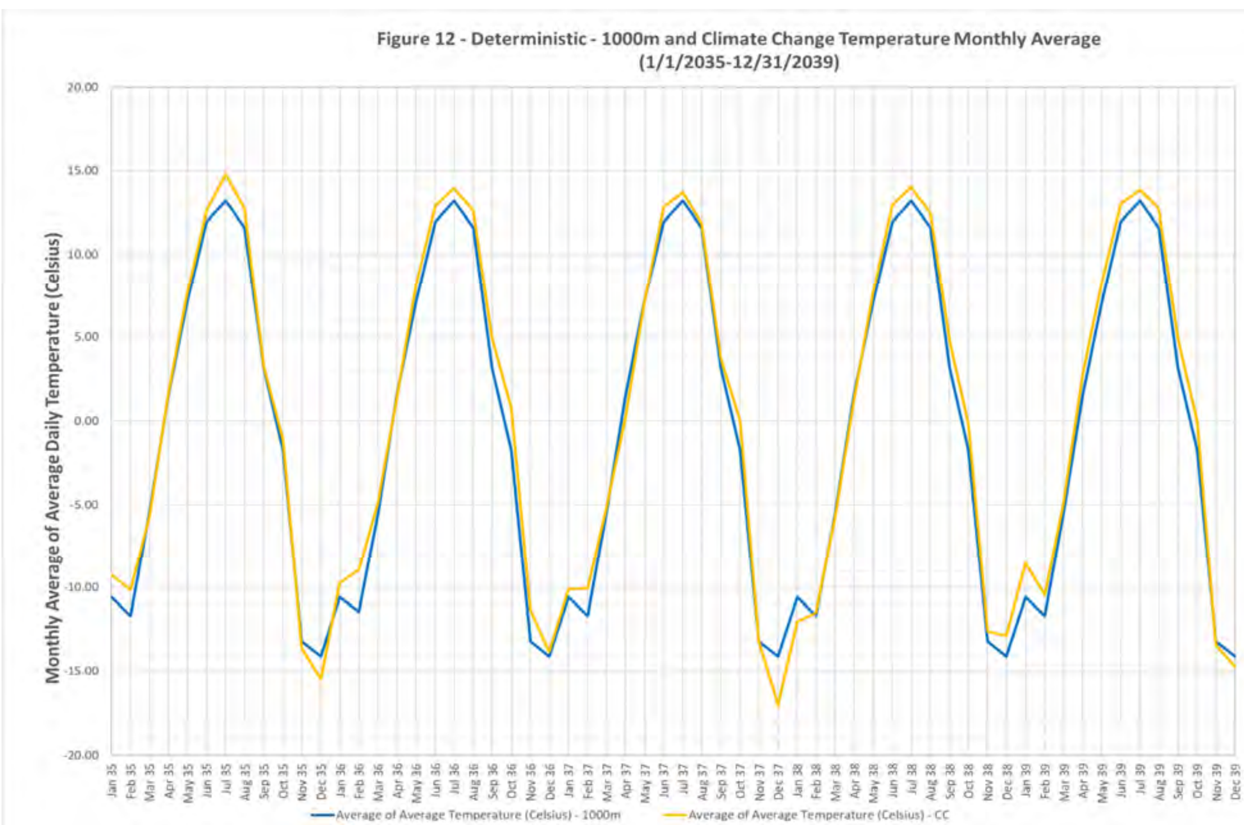

Figure 13 - Temperature 1/1/2035 - 12/31/2039

- **Evapotranspiration Calculated on HLF Only:**
  - Specifically, for the HLF, the Eagle Climate Data was used for the solar radiation, wind speed, and relative humidity necessary (along with temperature data from the 1000m and Climate Change data) for the calculation of evapotranspiration. The evaporation data provided directly in the 1000 meter and Climate Change datasets were used directly for the ponds.
    - Calculations/technique determined by Forte from engineering and HLF modeling experience
- **Sublimation Calculated:**
  - Sublimation is calculated using heat transfer principles and is included implicitly within the Snow 17 (Snow Accumulation and Ablation, Anderson, 2016) submodel used by Forte discussed in greater detail below. The Snow 17 approach yields similar results to the method used by Lorax for the site wide water balance and water quality model, however in Forte's experience this approach more closely matches measured snowpack and provides a better representation of snow accumulation and snow melt for heap leach operations.
    - These data sets provide the necessary inputs for Snow 17 (Snow Accumulation and Ablation, Anderson, 2016)
  - Additional Discussion: Snow 17 uses heat transfer and energy balance methodologies to calculate the energy exchange at the snow-air interface taking into account latent and sensible heat exchange, vapor pressure differential, dew-point temperature.
- **Snowfall, Rain, and Melt:**
  - The division of precipitation between rain and snow and the calculation of Snow Water Equivalent and excess water (rain and melt) are modeled by Forte using the Snow 17 submodel. The Snow 17 submodel takes average daily temperature and precipitation as the critical inputs but also corrects for seasonal solar radiation changes, latitude and altitude in the implicit calculations of melt factor and lapse rate most notably. Snow 17 also makes use of daily heat deficit accounting for determination of the internal condition of the snowpack based on the net heat transfer effects caused by the daily temperature and precipitation at the snow surface. The Snow 17 approach yields similar results to the method used by Lorax for the site wide water balance and water quality model, however in Forte's experience this approach more closely matches measured snowpack and provides a better representation of snow accumulation and snow melt for heap leach operations.

3. RESULTS AND DISCUSSION

Please refer to Figure 14 through Figure 19 for the following discussion of the modeling performed from 1/1/2022 through 11/1/2034 for the 2-year scenarios and the modeling performed from 1/1/2022 through 1/1/2040 for the EOM scenarios.

3.1 Modeling Results

Modeling of the HLF was performed using two sets of Climate/Meteorological data provided to Forte by Lorax as described previously. The key difference between the 1000 Meter (No CC) and Climate Change (CC) data are changes to account for the effect of climate change. For the timeline modeled by Forte, the results were consolidated into Monthly datasets and graphed as such.

3.1.1 Total Flow to Plant and Drainage from Heap

- The Total Flow to Plant (presumed to flow through the plant with negligible changes in volume to be pumped back to the HLF) and Drainage from HLF rates represent the measured and forecasted values of the “barren” solution flow rate pumped to the HLF and the “pregnant” solution reporting back to the In-Heap Pond from the HLF respectively.
- Total Flow to Plant:
    - From about 1/1/2022 to the end of stacking, this rate is primarily a function of the Target Plant Flow Rate of 1500 m^3/hr and this rate is seen to stay near the 1500 m^3/hr target throughout most of this time period. Variations in this rate are attributed to assumed solution management practices imbedded into the model to maintain the desired available storage, prevent the In-Heap pond from overflowing, and meet the simulated Make-Up Water supply, and maintain the Target Plant Flow Rate. Variation in leaching also coincides with the winter months in which the stacking of new ore onto the HLF is decreased. From January through the freshet runoff until about mid-May, there is sufficient volume of solution maintained in the In-Heap Pond for the Total Flow to Plant to consistently meet the target leaching demand at about 1500 m^3/hr. In the event that there is not enough solution to meet the Target Plant Flow Rate requirement, the demand for Make-Up Water is triggered.
    - After stacking is completed, the Total Flow to Plant demand for solution from the In-Heap Pond becomes secondary after the initial leach cycle is completed on the last ore loaded onto the HLF. Solution from the In-Heap Pond is actively pumped out to be discharged to treatment as the top priority and the remaining solution/water is recirculated to the HLF for storage within the ore to maintain the desired available storage.
    - The models were run out for various lengths to show complete draindown, when possible, and to show that the In-Heap Pond reaches sufficiently low levels and that there is no longer a need for continuous recirculation of solution. It is at this point when the Total Flow to Plant falls to zero in perpetuity, and the flow from the pond is directed to the HLF passive treatment system. This is generally considered as a conservative assumption for the model as some solution will be sent to passive treatment during commissioning.

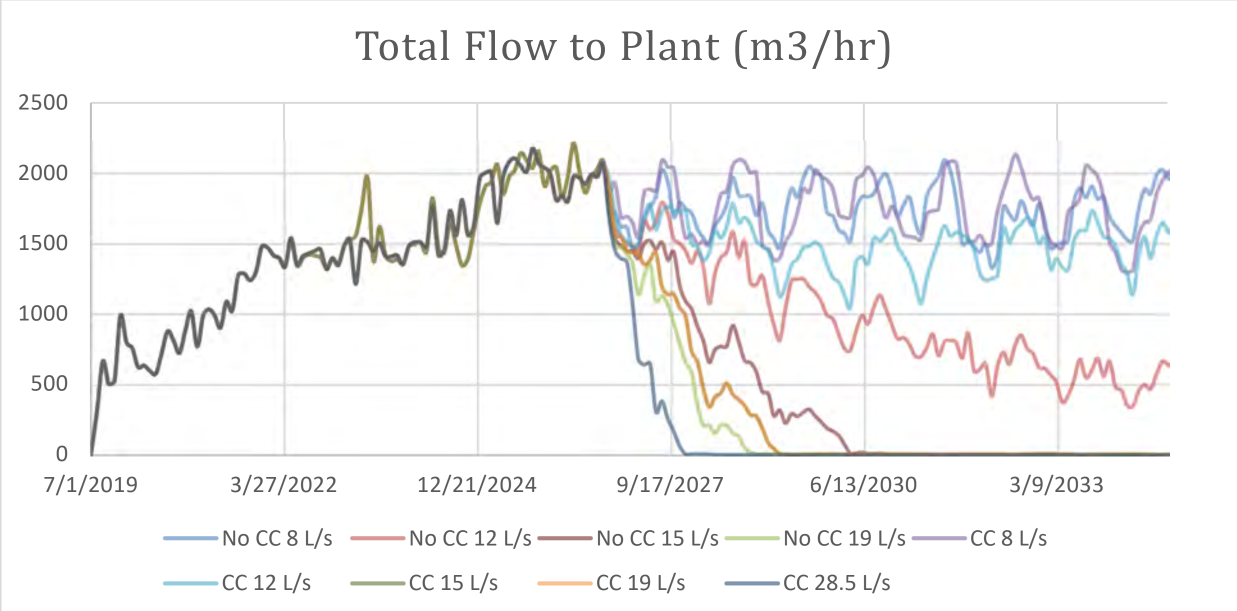

Figure 14 - 2-Year Closure Total Flow to Plant (m3/hr)

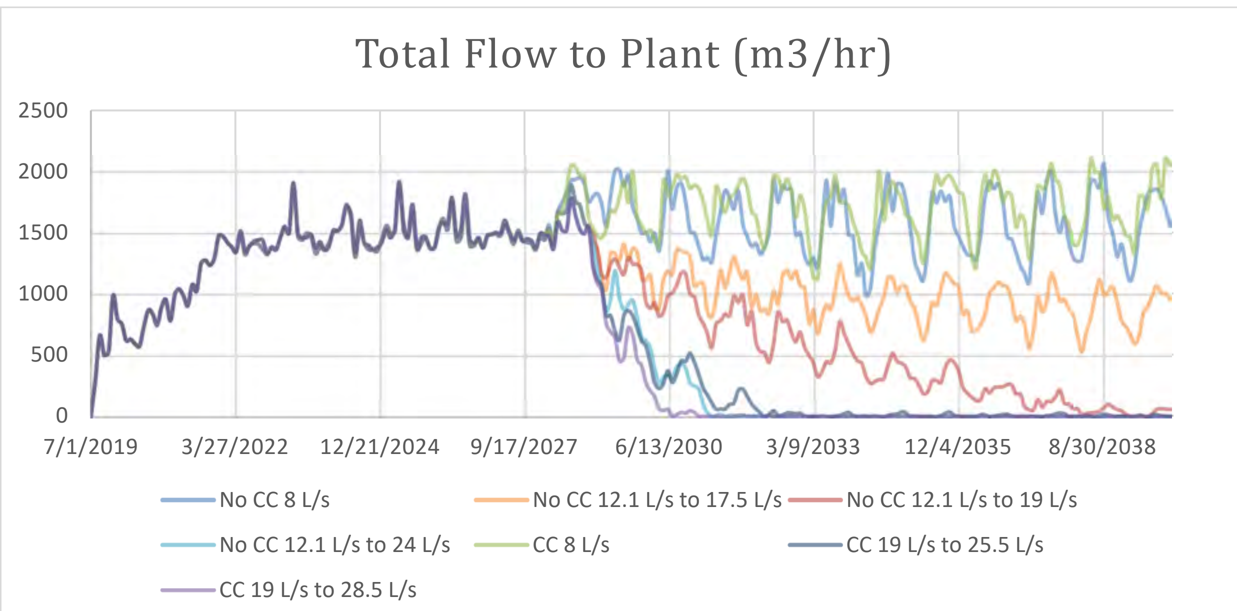

Figure 15 - EOM Closure Total Flow to Plant (m3/hr)

- Drainage from Heap
  - Generally, the Drainage from Heap is a function of the Total Flow to Plant plus Make-Up Water with the addition of meteorological factors. Energy transfer (e.g. sublimation of snow and evapotranspiration) is applied at the surface of the HLF as well as the percentage of precipitation (rain or melt) that infiltrates into the HLF. Note that the portion of this precipitation that does not infiltrate into the HLF reports to the In-Heap Pond by running off the heap or exposed liner then infiltrates into the ore at the lowest surface elevation of the HLF.

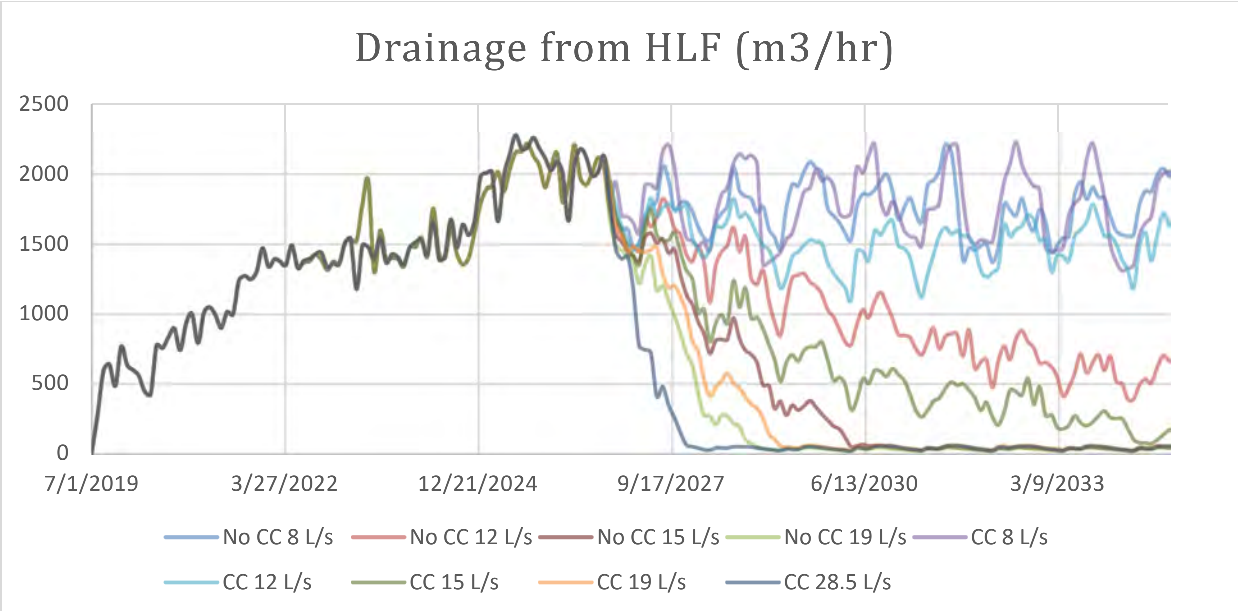

Figure 16 - 2-Year Closure Drainage from HLF (m3/hr)

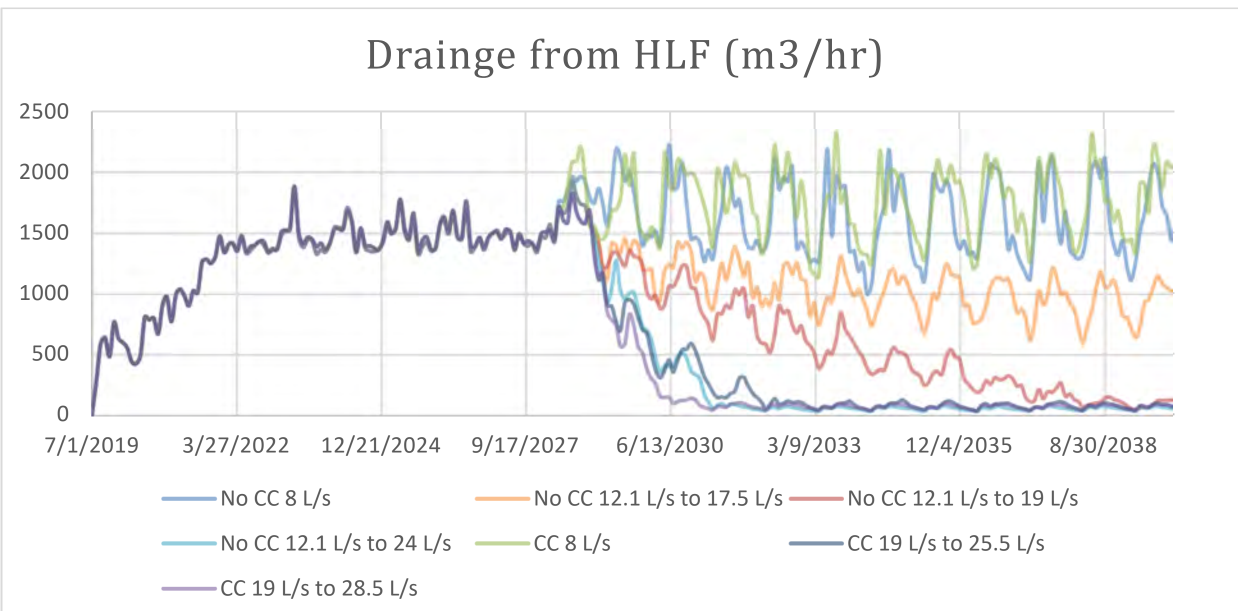

Figure 17 - EOM Closure Drainage from HLF (m3/hr)

3.1.2 Discharge to Treatment Rates

- Discharge to Treatment Rates reduce solution inventory earlier (for the EOM scenarios) from the HLF with the majority of solution continuing to be recirculated through the HLF. This will serve to continue producing gold while gradually reducing solution in the system.

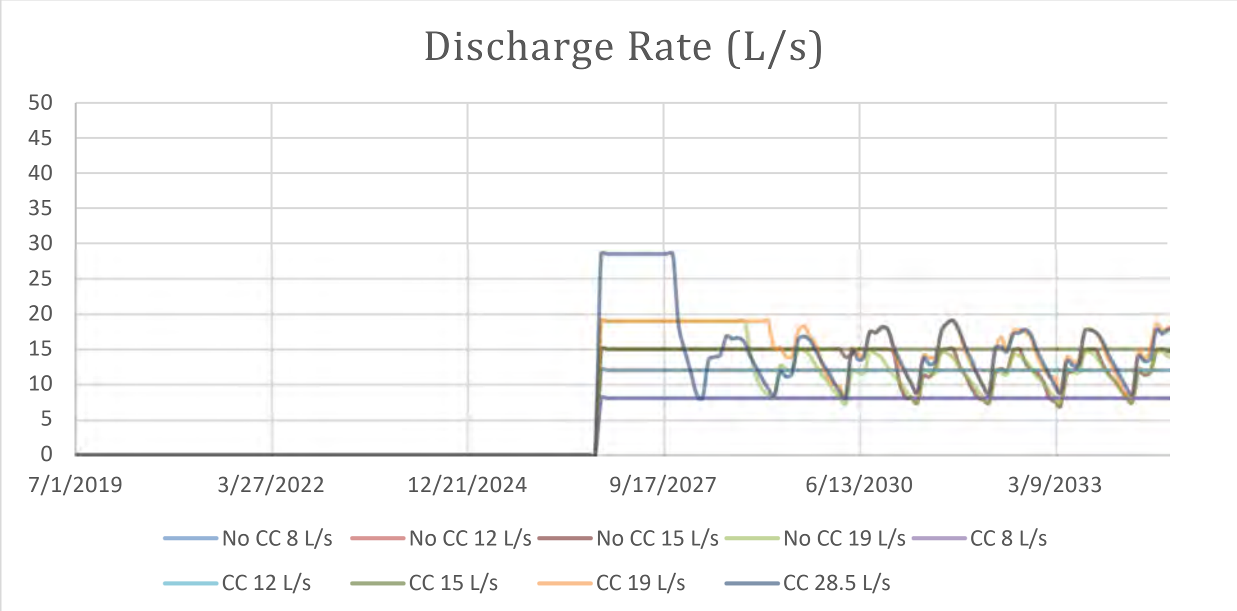

Figure 18 - 2-Year Closure Discharge Rate (L/s)

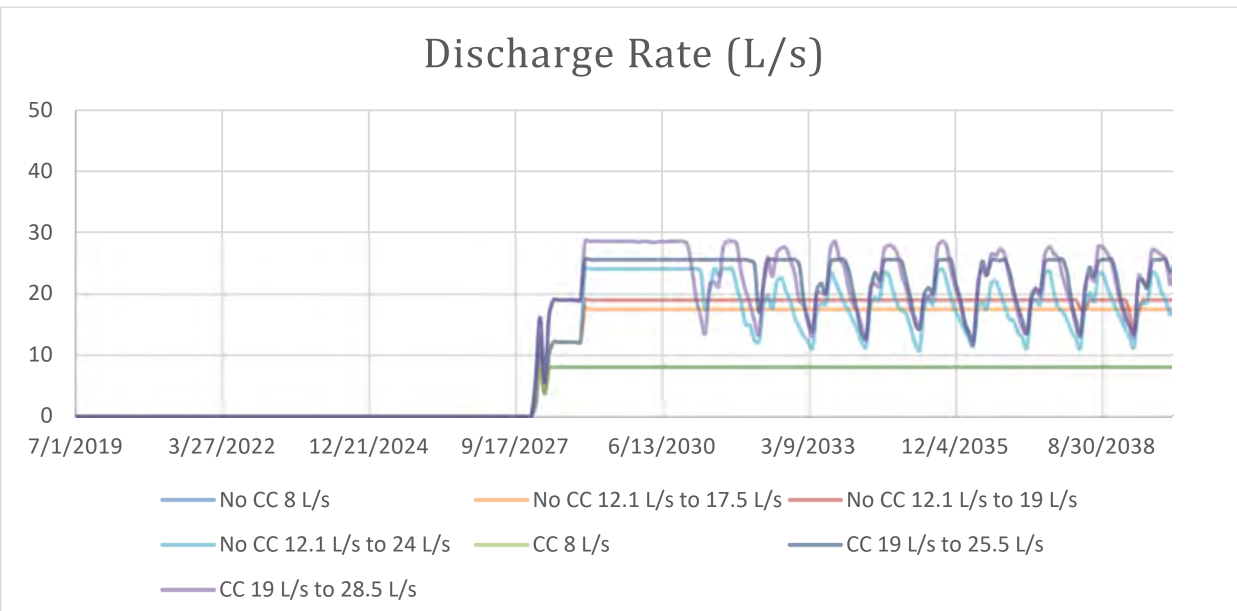

Figure 19 - EOM Closure Discharge Rate (L/s)

3.2 Results Review

From the modeling conducted by Forte, it can be seen that variations in the discharge rate effect the duration of draindown for both the 2-year and EOM closure scenarios. The results presented can be utilized by VGC for inputs to the RCP update.

3.2.1 2-Year Closure Scenario

For the 2-year closure scenario, it is suggested that the 8 L/s discharge rate is insufficient for draindown of the HLF for both the climate change and no climate change scenarios. For the 12 L/s discharge rate, it is suggested that this rate will draindown the HLF for the no climate change scenario, however this rate would not be sufficient for the climate change scenario. The 19 L/s for the climate change and no climate change scenarios was sufficient for draindown and so was the 28.5 L/s for the climate change scenario.

3.2.2 EOM Closure Scenario

Similar to the 2-year closure scenario, it is suggested that the 8 L/s discharge rate is insufficient for draindown of the HLF for both the climate change and no climate change scenarios for the EOM. The 12.1 L/s to 19 L/s for the no climate change and the 19 L/s to the 28.5 L/s for the climate change scenario is sufficient for draindown of the HLF, matching the assumption made in the HLF 2022 annual report. An additional scenario of 12.1 L/s to 24 L/s with no climate change was run to show a different draindown scenario (shorter duration) as well.

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APPENDIX J

Design Rainfall Event Analysis

MEMORANDUM

To:	**Hugh Coyle and Katie Chakhova, Victoria Gold Corp.**	**Date: Sept. 27 2022**
From:	**Scott Jackson, Lorax Environmental Services Ltd.**	**Project #: A610-4**
Subject:	**Design Rainfall Event Analysis**	

1. Introduction

To support ongoing closure planning for the Eagle Gold Mine, Victoria Gold Corp. requested that the design criteria for water management infrastructure be reviewed and updated, as needed, in part to reflect the recent site monitoring data, as well as the potential for future climatic changes to affect rainfall patterns at the Project site. To address these issues, VGC requested Lorax to provide comparisons of:

- Design rainfall estimates presented by Knight Piésold (2013) to the updated values presented in Lorax (2021).
- Design rainfall estimates presented in the *Eagle Gold Project – Construction and Operations Water Management Plan* (StrataGold, 2017) to the site rainfall records collected from 2007 to 2021, specifically the 24-hour event totals for the Camp and Potato Hills climate stations.
- Design peak flow values to the measured peak flow values from the continuous (*i.e.*, 15-minute) streamflow records measured at the Project site hydrometric stations from 2007 to 2021.
- Design rainfall estimates to upscaled values accounting for projected climatic changes at the Project site.

Rainfall and streamflow data from the Project site climate (Table 1-1) and hydrometric (Table 1-2) stations with at least 8-years of record were used for comparison to the original design estimates in the analyses summarized herein. The climate stations span the full elevational range at the Project site, allowing orographic precipitation gradients to be resolved, and the hydrometric station network spans drainage areas over two orders of magnitude (*i.e.*, 1 to 100+ km^2).

Table 1-1:
Climate station locations at the Eagle Gold Project

Station	Elevation (m asl)	UTM E	UTM N	Record Period
Camp Station	782	458,164	7,101,036	2009-present
Potato Hills Station	1,420	463,544	7,100,833	2007-present*

*Due to station malfunction, no climate data collected by the Potato Hills station in 2019.

Table 1-2:
Hydrometric station locations at the Eagle Gold Project with at least eight years of record

Station ID	Station Name	Record Period	Drainage Area (km^2)
W1	Dublin Gulch above Stewart Gulch	2007 – 2021	6.8
W4	Haggart Creek below Dublin Gulch	2007 – 2021	76.9
W5	Haggart Creek above Lynx Creek	2007 – 2021	97.5
W6	Lynx Creek above Haggart Creek	2007 – 2021	100.9
W22	Haggart Creek above Dublin Gulch	2007 – 2021	66.8
W26	Stewart Gulch	2007 – 2021	1.3
W27	Eagle Creek	2007 – 2021	2.7
W29	Haggart Creek below Eagle Creek	2010 – 2015, 2020-2021	86.1

2. Design Estimate Comparison to Measured Data

2.1 Design Rainfall Estimates

The water management infrastructure design process and assumptions for the Project are summarized in StrataGold (2017). Inflow design floods for Ditch A, Ditch B, Ditch C and the Lower Dublin South Pond (LDSP) were modelled using the HEC-HMS and PCSWMM software packages, with the 24-hour rainfall event estimates presented in Knight Piésold (2013) used as the driving climatic inputs. The 24-hour design rainfall values were developed from the Rainfall Frequency Atlas of Canada (Hogg and Carr, 1985), and scaled to higher elevations by a factor of 1.5 (Table 2-1). Since then, the 24-hour design rainfall estimates were revisited and updated in 2021 using more recent regional climate data for the same recurrence intervals (Lorax 2021). A comparison of the Knight Piésold and Lorax rainfall estimates is provided in Table 2-1. In general, the Knight Piesold estimates (using the 1985 source) are 1.3 to 1.4 times higher than the Lorax values (which uses the most up-to-date regional and site data).

Table 2-1:
24-hour Design Rainfall Estimate Comparison for Project elevation (1,125 m).
All values in mm.

Exceedance Probability	Return Period	Knight Piésold (2013)	Lorax (2021)	KP 2013/Lorax 2021
0.1	10-yr	49	38	129%
0.01	100-yr	72	53	136%
0.005	200-yr	78	57	137%
0.001	1000-yr	94	67	140%

2.2 Measured Peak Rainfall Values

An additional nine years of climate data have been collected at the Project site since the 2013 rainfall estimates were first developed. Daily rainfall totals for the record periods used in the updated analysis were converted to 24-hour totals following Herschfield (1961), and monthly maximums were then calculated for the Camp (Table 2-2) and Potato Hills (Table 2-3) locations.

To date, the maximum recorded 24-hour rainfall total is 74.9 mm at the Camp station on July 25, 2021, which is 70% higher than the previous maximum rainfall of 43.9 mm recorded in July 2020 at the Project site. This falls between the 1:100-year and 1:200-year design event as estimated by Knight Piésold (2013), and higher than the 1:1,000-year estimate generated by Lorax (2021). Note that rainfall on the same day was 3.9 mm at the Potato Hills station, indicating that the value measured at the Camp station is either affected by instrumentation error, or the rainfall at the Camp station was very localized. For comparison, the 24-hour totals for the August 10th, 2021, event were 51.3 mm and 34.2 mm at the Camp and Potato Hills stations, respectively, suggesting that these heavy rains were catchment wide.

It is notable that at the Camp station, four of the five maximum monthly rainfall events were recorded in 2021, while the fifth was recorded in June 2020, after the precipitation gauge was updated. Rainfall data from these two years could potentially be impacted by the change in instrumentation.

Streamflow response in the Project catchments was muted for the July 25th event, with peak 15-minute yields of 2 to 15 L/s/km^2 in the smaller catchments (Stewart Gulch (W26), Eagle Creek (W27), and Upper Dublin Gulch (W1)) and larger catchments in Haggart and Lynx Creeks. In contrast, peak yields in the smaller Project catchments were 3 to 13 L/s/km^2 for the August 10th event, and approximately 40 L/s/km^2 in the larger Project area catchments (*i.e.*, > 66 km^2; Figure 2-1). Note that Figure 2-1 shows daily average yields, which will be slightly lower than the peak 15-minute values discussed here. Similarly, the one-day rainfall totals for the August 4th event were 38 mm and 22 mm at the Camp and Potato Hills stations, respectively, and resulted in a similar widespread peak flow response (up to 40 L/s/km^2) as for the August 10th event.

Table 2-2:
Maximum monthly 24-hour rainfall for the Camp station (782 m). All values in mm.

Month	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*	Max
May	NA	9.6	5.6	7.6	6.6	4	3.8	7.6	9.2	10.4	NA	NA	18.1	18.1
Jun	NA	15.2	8.4	6.6	4.6	14	7.2	11	5	11	NA	37.4	8.2	37.4
Jul	NA	8	17.8	22	9.4	11.2	14	21.2	11.6	3.2	NA	43.9	74.9	74.9
Aug	11.2	15.4	14	14	19.8	13.2	16.8	12	3.2	13	NA	24.2	51.3	51.3
Sep	8.6	8.4	8.2	8.8	15.8	8.6	15.4	10.6	15.6	1.4	NA	17	22.8	22.8
Max	11.2	15.4	17.8	22	19.8	14	16.8	21.2	15.6	13	NA	43.9	74.9	74.9

*New all weather Geonor T-200B series precipitation gauge installed in 2020 replaced Campbell Scientific rainfall tipping bucket gauge

Table 2-3:
Maximum monthly 24-hour rainfall for the Potato Hills station (1,420 m). All values in mm.

Month	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020*	2021*	Max
May	NA	14.8	0	7.8	6.2	2.4	7	NA	NA	6.1	5	6.6	NA	NA	10.1	14.8
Jun	NA	16.4	14.4	20.4	13.4	7.2	8	NA	NA	5.4	11.4	6.3	NA	36.1	12.9	36.1
Jul	NA	27.0	5	16.2	17.2	17	3.6	NA	NA	7.3	11	5.4	NA	19.2	13.6	27.0
Aug	14.2	38.2	12.6	20.2	19.8	16.2	6.2	NA	13.1	13.6	7	21.1	NA	15.9	34.2	38.2
Sep	35.8	4	9.2	1.8	12.8	6.8	10	NA	9.5	6.7	14.2	1.2	NA	14.2	13.0	35.8
Max	35.8	38.2	14.4	20.4	19.8	17	10	NA	13.1	13.6	14.2	21.1	NA	36.1	34.2	38.2

*New all weather Geonor T-200B series precipitation gauge installed in 2020 replaced Hobo rainfall tipping bucket gauge

Notably, all of these rainfall events resulted in peak yields that were approximately half those measured during the freshet of 2021, suggesting that the rainfall events were convective and produced by relatively small air masses that were not catchment wide, whereas the freshet runoff is more of a basin-wide snowmelt response to warming temperatures. Thus the pattern observed since 2007 at the Project site appears to be that while high magnitude rainfall events have occurred some of them are highly localized in nature, and do not appear to deliver consistent rainfall depths across the entirety of even the smallest gauged catchments at the Project site (*i.e.*, < 7 km^2). The storms that appear to be catchment wide (August 4 and August 10, 2021) but resulted in relatively low peak unit yields (compared to freshet), likely represent a depleted soil moisture condition relative to the freshet period. Therefore, there is likely significant storage available in the near surface overburden horizons to attenuate large rainfall events during the summer months.

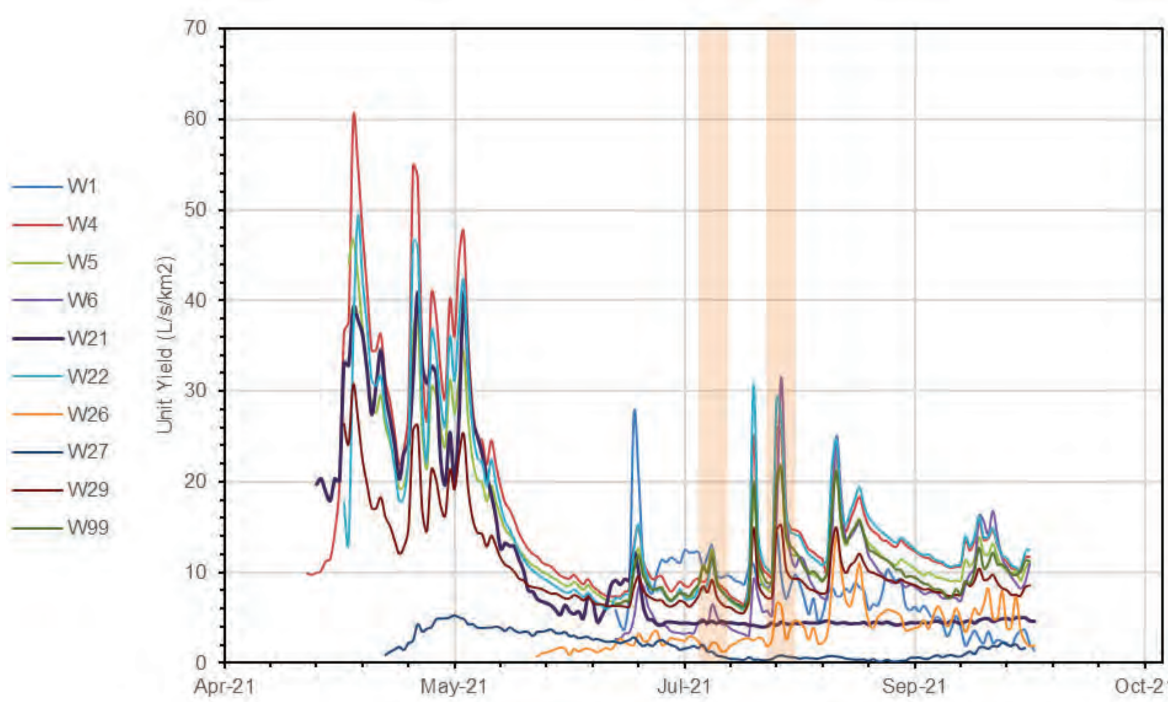


Figure 2-1: Daily unit yield hydrographs for Project site hydrometric stations for 2021. Streamflow responses to the July 25th and August 10th events are highlighted.

2.3 SCS Rainfall Curves

The rainfall-runoff response modelling conducted in support of water management infrastructure design assumed that the 24-hour rainfall events conformed to an SCS (Soil Conservation Service) Type II rainfall distribution (Stratagold, 2017; USDA, 1986). Given the much more extensive site rainfall records now available for analysis, selected high-magnitude 24-hour rainfall events from both site climate stations were compared to the SCS Type I, Ia, II and III rainfall distributions to help evaluate whether the assumption was valid.

In this exercise, measured rainfall events were discretized by hour as a cumulative fraction of the total for comparison against the SCS Type curves, then plotted against time on the x-axis (Figure 2-2 and Figure 2-3). In general terms, the 24-hour rainfall events selected for analysis rarely conform to the Type curves over the full 24-hour period, but when assessed based on the steepest slope of the cumulative fraction (*e.g.*, hour one of the August 16 of the August 2013, hour 12 of the July 10, 2016, and hours 18-20 of the July 17, 2011 events at the Camp station; Figure 2-2), these events appear to most closely match the steep rise in cumulative rainfall totals displayed by either the Type II or Type III curves, and are representative of convective rainfall event signatures. The July 10, 2012 event is a possible exception to this conclusion, as it displays a more uniform rainfall rate. Further, the rainfall event distributions at Potato Hills are display lower slopes in the event distribution curves.

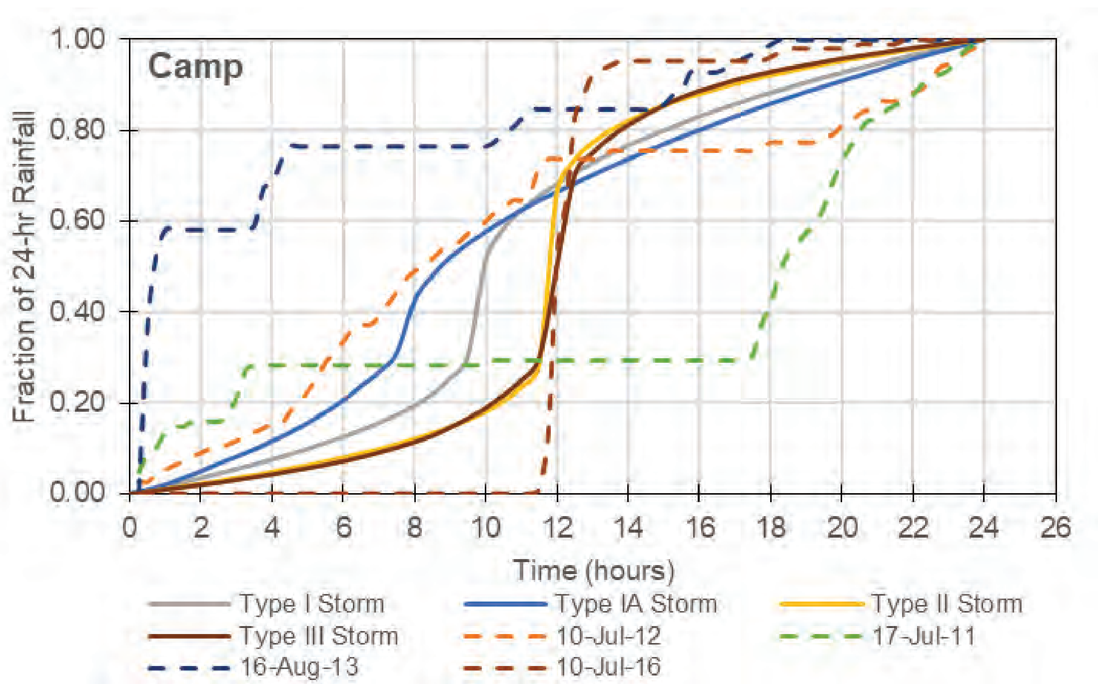


Figure 2-2: Cumulative fraction of 24-hour total rainfall for SCS Storm Types and four representative events from the Camp climate station.

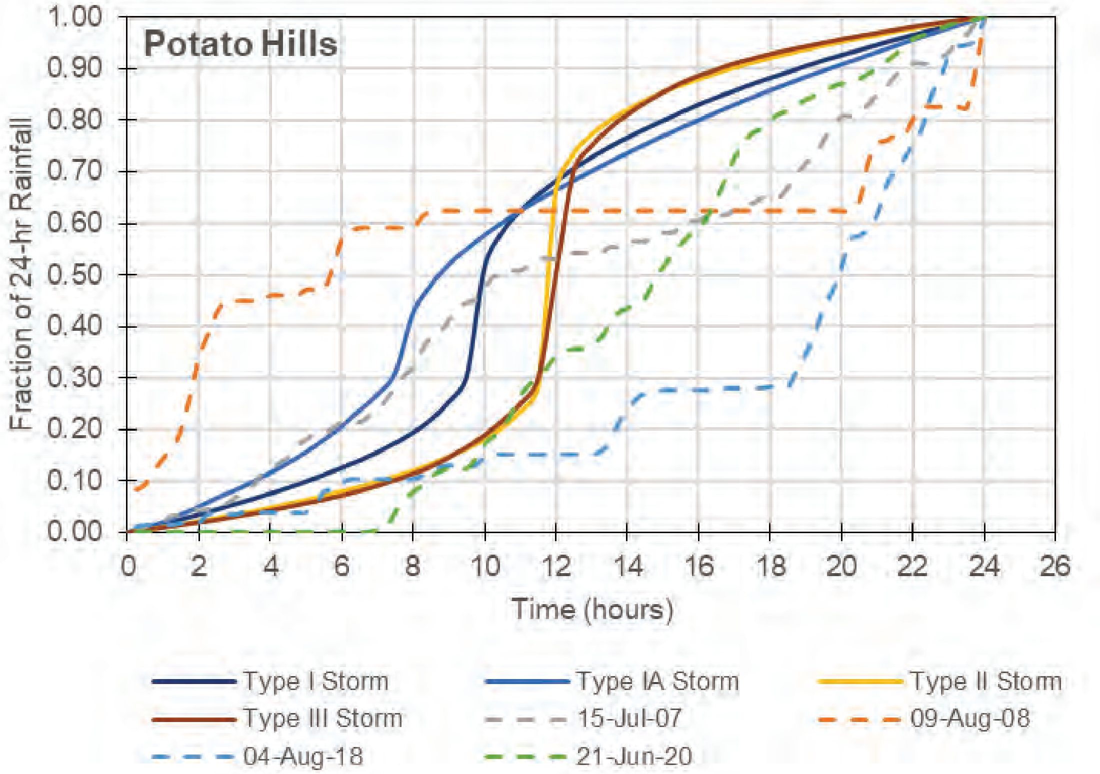


Figure 2-3: Cumulative fraction of 24-hour total rainfall for SCS Storm Types and four representative events from the Potato Hills climate station.

2.4 Modelled and Measured Peak Flows

As part of the Stratagold study, design rainfall values were used as input to catchment models to generate estimates of the design peak flow a given water management structure would need to convey (*i.e.*, ditches and culverts). These design flow estimates were converted to unit yields (discharge per unit area in $L/s/km^2$) and compared to the maximum peak flow values derived from the Project site 15-minute hydrometric records (Table 2-4 and Table 2-5). Note that the measured peak flows also include freshet driven events (which are generally higher), in addition to the rainfall driven events that are the focus of this analysis. Without exception, over 8+ years of record all design peak flow estimates for the 24-hour 1:100-year and 1:200-year events are an order of magnitude higher than the highest recorded peak unit flow at site. The 24-hour 1:10-year design peak flow is noted to be double the highest recorded peak flow at site (Figure 2-4), suggesting that the design peak flows for the ditches and culverts are substantially overestimated, especially when considering that both the Camp and Potato Hills stations have recorded several rainfall events equivalent to or greater than the 1:10-yr 24-hr event of 38 mm for the Project elevation of 1,125 m asl.

Table 2-4:
Peak Design Flows for Ditches and Culverts.

Ditch/Culvert	Design Criteria	Area (km^2)	Design Peak Flow (m^3/s)	Design Peak Flow ($L/s/km^2$)
Ditch A u/s Culvert 8	1:100-yr 24-hr	1.338	5.3	3,961
Ditch A d/s Culvert 8	1:100-yr 24-hr	1.574	6.2	3,939
Ditch B	1:100-yr 24-hr	2.463	8.9	3,613
Ditch C	IDF	4.222	24	5,685
Culvert 1	IDF from Emergency Spillway	4.222	24	5,685
Culvert 2	1:200-yr 24-hr	0.782	4.3	5,499
Culvert 3	1:10-yr 24-hr	0.491	0.3	611
Culvert 4	1:200-yr 24-hr	0.782	4.2	5,371
Culvert 5	1:200-yr 24-hr	0.782	1.2	1,535
Culvert 6	1:200-yr 24-hr	0.782	1	1,279
Culvert 7	1:200-yr 24-hr	0.782	3.1	3,964
Culvert 8	1:100-yr 2-hr	0.716	5.3	7,402
Culvert 9	IDF from Emergency Spillway	NA	24	NA[1]

Notes:
All values derived from Table 6.1-2 and Table 6.1-3 of Stratagold (2017).
[1]Peak unit yields cannot be calculated without a specific drainage area.

Table 2-5:
Measured Peak 15-minute Peak Flows at Project Site Hydrometric Stations.

Station ID	Station Name	Drainage Area (km^2)	Peak Flow ($L/s/km^2$)
W1	Dublin Gulch above Stewart Gulch	6.8	283
W4	Haggart Creek below Dublin Gulch	76.9	125
W5	Haggart Creek above Lynx Creek	97.5	177
W6	Lynx Creek above Haggart Creek	100.9	178
W22	Haggart Creek above Dublin Gulch	66.8	309
W26	Stewart Gulch	1.3	140
W27	Eagle Creek	2.7	124
W29	Haggart Creek below Eagle Creek	86.1	158

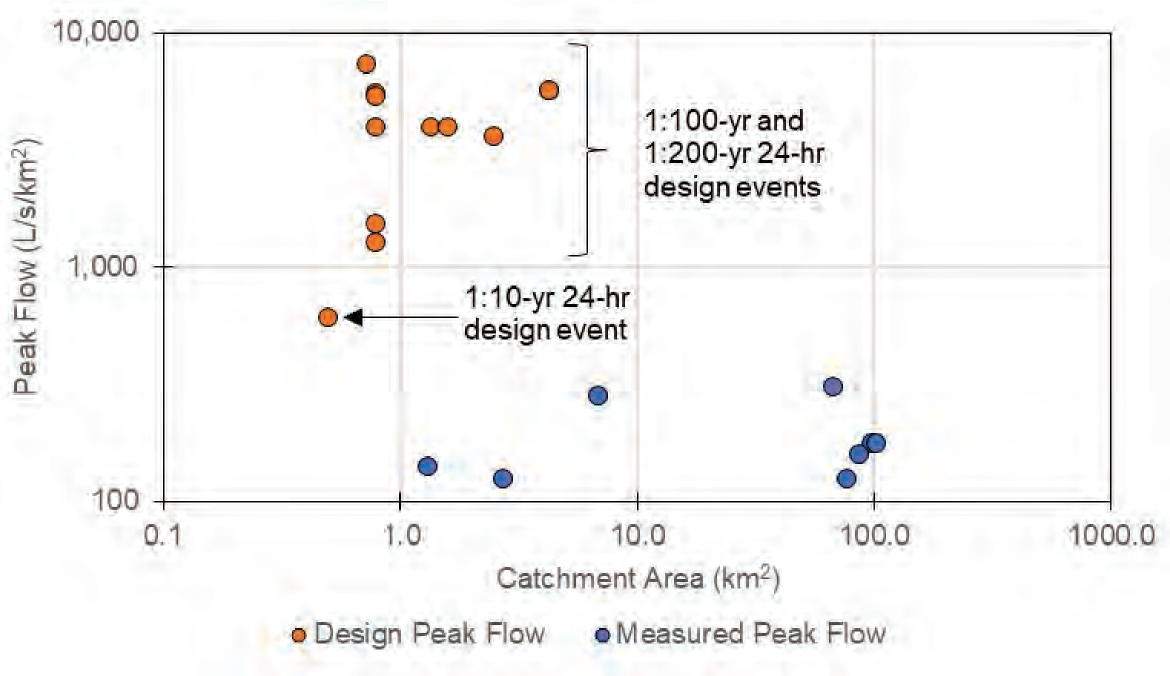


Figure 2-4: Measured and design peak flows as unit yields.

As a final check on the design storm estimates, the 24-hour total inflow volumes to the LDSP were compared to those measured for the July 25 and August 10, 2021 rainfall events discussed in Section 2.2.

Note that the LDSP design inflow floods are (Stratagold, 2017):

- 1:10-year 24-hr: 61,000 m^3
- 1:100-year 24-hr: 125,100 m^3
- 1:200-year 24-hr: 135,100 m^3
- 1:1000-year 24-hr: 196,300 m^3

Table 2-6:
Measured storm inflow totals to the Lower Dublin South Pond.

Storm	Storm Inflow Totals to LDSP (m^3)		
	1-day	2-day	3-day
2021-07-25	9,135	11,703	14,028
2021-08-10	5,628	13,585	14,748

Measured storm inflow totals to the LDSP were summed for the 1-day, 2-day and 3-day periods, to account for potential attenuation of peak flows due to soil storage (Table 2-6). Based on these values, even the 3-day inflows appear to be approximately 25% of the design inflow 1:10-year 24-hour flood.

3. Climate Change Impacts on Design Rainfall Estimates

An assessment was conducted to determine if rainfall estimates used for water management infrastructure design remain applicable and are appropriately conservative under an early closure scenario of sufficient duration and whether projected climate change could substantially impact the magnitude of 24-hour rainfall events. The degree of potential change in short-duration, high-magnitude rainfall was determined using scalars provided in the recently released document *Climate-resilient buildings and core public infrastructure (CRBCPI) 2020: An assessment of the impact of climate change on climatic design data in Canada* (Cannon *et al.*, 2020).

These scalars are provided for a range of potential increases in average annual air temperature, relative to the 1986-2016 historical reference period. These temperature increases are linked to the four Representative Concentration Pathway (RCP) emissions scenarios (*i.e.*, RCP26., RCP4.5, RCP6.0 and RCP8.5) described in (IPCC, 2014). The approximate year at which a specified level temperature increase is reached, according to an ensemble of Earth System Models (CMIP5; Coupled Model Intercomparison Project) running several alternative emissions scenarios, is provided in Table 3-1. A dash indicates that the corresponding global temperature change is not reached before the year 2100 for a given RCP. The CRBCPI scalars provided for the 1-day, 50-year recurrence interval rainfall event were used as the basis for this analysis (see Table 3-2).

Table 3-1:
Projected Air Temperature Increases By RCP Scenario.

<table>
<tr><th>Global ∆T</th><th>RCP8.5</th><th>RCP6.0</th><th>RCP4.5</th><th>RCP2.6</th></tr>
<tr><td>0.5°C</td><td colspan="4">2023</td></tr>
<tr><td>1.0°C</td><td>2035</td><td colspan="2">2046</td><td>—</td></tr>
<tr><td>1.5°C</td><td>2047</td><td colspan="2">2070</td><td>—</td></tr>
<tr><td>2.0°C</td><td>2059</td><td>2087</td><td>—</td><td>—</td></tr>
<tr><td>2.5°C</td><td>2069</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>3.0°C</td><td>2080</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>3.5°C</td><td>2090</td><td>—</td><td>—</td><td>—</td></tr>
</table>

Source: Cannon *et al.*, 2020.

The original design estimates presented in Stratagold (2017) were updated in Lorax (2021), which took into consideration longer duration rainfall records, site monitoring data, and site-specific orographic gradients (Table 3-2). Generally speaking, when the updated design rainfall values (Lorax, 2021) are scaled up to account for the projected range of climate change, the 1:100-year and 1:200-year rainfall events used for water management infrastructure design (Knight Piésold, 2013) are only surpassed under warming of 3.0 to 3.5°C, corresponding to the year 2080 under the RCP8.5 scenario. Only the 1:10-year event is predicted to surpass the original design value under temperature change of 2.5°C, corresponding to the year 2069, also under the RCP8.5 scenario (Table 3-1). Note that none of the scaled rainfall events are expected to surpass the original design estimates under the RCP2.6, RCP4.5 or RCP6.0 scenarios. In summary, only under the RCP8.5 scenario would give deviations above the original rainfall estimates be expected to occur, late in the current century.

Table 3-2:
Design Rainfall Events With Climate Change Scalars

Exceedance Probability	Return Period	Knight Piésold (2013)	Lorax (2021)	Scaled Lorax (2021) Values Relative to 1986-2016 Average Air Temperature						
				0.5°C	1.0°C	1.5°C	2.0°C	2.5°C	3.0°C	3.5°C
Climate Change Precipitation Scalar →				*1.06*	*1.12*	*1.18*	*1.25*	*1.32*	*1.39*	*1.47*
0.1	10-yr	49	38	40	43	45	48	50	53	56
0.01	100-yr	72	53	56	59	63	66	70	74	78
0.005	200-yr	78	57	60	64	67	71	75	79	84
0.001	1000-yr	94	67	71	75	79	84	88	93	98

Notes:
Lorax 2021 values are presented for the Project elevation (1,125 m)
Shaded grey values indicate that the precipitation estimates scaled for climate change exceed the original design event value for only the RCP 8.5 scenario.

4. Summary

The findings of this analysis are summarized below:

- An updated analysis of 24-hour rainfall recurrence interval estimates for the Project site (Lorax 2021) resulted in a reduction of estimated rainfall depths relative to the original design estimates. The updated estimates are based on site data, long-term regional climate records (*i.e.*, 96 years), and updated understanding of orographic scalars at site.
- A 13+ year rainfall record from two Project site climate stations contains six events approximately equal to (within 6%) or greater than the updated 1:10-year 24-hour estimate of 38 mm. To date, the three maximum recorded 24-hour rainfall totals are 43.9 mm (July 2020), 51.3 mm (August 10, 2021) and 74.9 mm (July 25, 2021), all at the Camp station. These are 15%, 35% and 97%, respectively, higher than the estimated design 10-yr rainfall event. The 79.4 mm event is subject to uncertain data quality, and was highly localized, while the 51.3 mm event was more spatially consistent between the two stations, and the third event of 43.9 mm was somewhat localized, as only 19 mm were recorded at the Potato Hills station
    - Neither of the 2021 events, nor the July 2020 event resulted in unusually high peak flows in local tributaries, where resulting peak streamflow yields were approximately

half those measured during freshet of the same year, suggesting that the 2021 extreme rainfalls may be localized (*i.e.*, not basin wide, as is assumed in the peak flow modelling used for water management infrastructure design), and/or that some of the rainfall-runoff response was attenuated by short-term soil storage.

- An hourly analsysis of eight selected high-magnitude rainfall events indicates that while the rainfall distributions don't closely align with any of the published SCS Type curves over a full 24-hour event duration, the slope of the highest intensity rainfall represented by a Type II curve is most representative of the high-magnitude rainfall events measured at the Camp Station but not the Potato Hills Station, suggesting that rainfall intensity patterns are different between the valley bottom and the ridgeline.
- A comparison of modelled peak flows used to inform water management infrastructure design with measured peak 15-minute flows from Project site hydrometric stations indicate that the design flows resulting from a 1:100-year or 1:200-year 24-hour event are an order of magnitude greater than anything measured at site to date, including freshet driven runoff events. The 1:10-year modelled peak flow is double the highest measured peak flow, suggesting that the design peak flows for the ditches and culverts are substantially overestimated, especially when considering that both the Camp and Potato Hills stations have recorded several rainfall events equivalent to or greater than the 1:10-yr 24-hr event of 38 mm.
- The the 3-day total inflow volumes measured during the July 25 and August 10, 2021 high-magnitude rainfall events are one quarter the estimated 1:10-year 24-hour inflow volumes to the LDSP. Comparable measured 1-day inflows are 15% of the estimated 1:10-year 24-hour inflow volume.
- The 1:100-year and 1:200-year rainfall events used for water management infrastructure design are only slightly surpassed under projected warming of 3 to 3.5°C, corresponding to the year 2080 under the conservative RCP8.5 scenario. Only the 1:10-year rainfall event is predicted to surpass the original design value under temperature change of 2.5°C, corresponding to the year 2069, also under the RCP8.5 scenario. In summary, none of the scaled rainfall events are expected to surpass the original design estimates under the RCP2.6, RCP4.5 or RCP6.0 scenarios, and only under the RCP8.5 scenario would deviations above the original rainfall estimates be expected to occur, late in the current century.

5. Closure

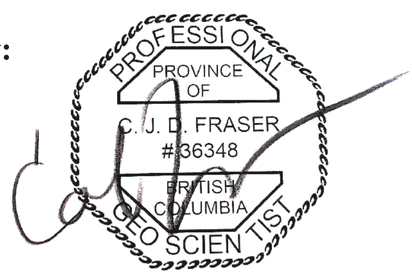
This memorandum has been prepared for the Victoria Gold Corp. by Lorax Environmental Services Ltd. We trust that this memorandum meets your requirements at this time. Please contact the undersigned with any questions or comments.

Yours sincerely,
Lorax Environmental Services

Prepared by:

Scott Jackson, M.Sc., P.Geo.
Senior Hydrologist

Reviewed by:



Colin Fraser, M.Sc., P.Geo.
Senior Hydrologist

Engineers and Geoscientists British Columbia Permit to Practice Number: 1001840

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APPENDIX K

Source Term Evaluation

TECHNICAL MEMORANDUM

To:	**Hugh Coyle, Katie Chakhova (Victoria Gold Corp.)**	**Date: Sep 30, 2022**
From:	**Timo Kirchner & David Flather**	**Project #: A610-4**
Subject:	**Eagle Gold Mine - Geochemical Source Term Evaluation**	

1. Introduction

Victoria Gold Corporation (VGC) owns and operates the Eagle Gold Mine located approximately 45 km north of Mayo, Yukon. As part of the in the Quartz Mining Licence (QML-011) and Water Use Licence (WUL; QZ14-041-1), VGC is currently in the process of updating the existing Reclamation and Closure Plan. One component of this task pertains to the ongoing evaluation of geochemical source terms to ensure their validity in the context of site data with the intent to refine long-term treatment considerations and costing. Since completion of the original WUL application in 2014, Lorax Environmental Services Ltd. (Lorax), has been responsible for the development and annual refinement of geochemical source terms for the Project.

This memorandum provides an overview of the data sources used for the ongoing assessment of the geochemical source term models. The general model approach and major updates are described in Section 2 while data sources used for the ongoing validation of geochemical source terms are presented in Sections 3 and 4.

2. Model Approach and Updates

Geochemical source terms represent contact water chemistry predictions derived for contaminant sources generated by the project and are included in the site-wide surface water quality model. For the Eagle Gold Project, geochemical source terms are developed for following mine facilities:

- Eagle Pup Waste Rock Storage Area (WRSA);
- Platinum Gulch WRSA;
- Pit Walls;
- Heap Leach Facility (HLF);
- Temporary (100-day) Ore Stockpile.

Overarching factors that govern mine contact water quality include mineralogy and geochemistry of the exposed material, grain size distribution, water/rock ratio as well as temperature, amongst others. While these factors will also play a role in the drainage chemistry from the HLF, the operational and draindown seepage chemistry for this facility is expected to also be strongly controlled by gold leaching reagents (NaCN) being added as part of solution application and solution recycling (*e.g.*, Parshley *et al*, 2012).

For the Eagle Gold Project, the prediction of contact water chemistry was conducted via upscaling of loading rates derived from humidity cell tests, followed by the application of scaling factors and the implementation of solubility limits. This approach is described in detail in Lorax (2014). Some changes to the conceptual numerical models were made since the original WUL application submission to capture updated site-specific data and supporting analogue datasets. The most pertinent changes to the source term model in recent years include the following:

- **WRSAs and pit walls:** revision of scaling factors from theoretical literature values (not parameters-specific) to empirical, parameter-specific values based on Platinum Gulch WRSA seepage.
- **HLF:** reduced reliance on 2012 metallurgical column testwork and integrated analogue data with similar geological and process characteristics (Brewery Creek). A Barren Solution source term was introduced using site data for operational treatment considerations.

3. Kinetic Testing

Kinetic geochemical testing is currently ongoing for both waste rock (field barrels) and ore (columns). These tests are critical to quantify the rate of water/rock interactions. The field barrel program is an onsite field-scale test program that originally comprised eight (8) large barrels containing lithological rock samples to assess the leaching characteristics of these materials (SRK, 2014). In 2020, Lorax proposed and guided the de-construction of these barrels and the re-compositing of two (2) mixed-material samples as follows to assess the leaching and attenuation behaviour of waste rock in a blended configuration with a particular focus on arsenic mobility:

- Barrel 1:
  - Top layer: High-arsenic oxide granodiorite.
  - Bottom layer: Mixed metasediment sample.
- Barrel 2: Mixed lithological sample representing typical proportions of WRSA.

Data from these field barrels are compiled annually and reviewed in the context of geochemical source terms. Plots showing the geochemical trends observed over the last five years of testing are provided for selected parameters in Figure 3-1 and Figure 3-2.

Prior to the availability of surface water quality monitoring data from actual WRSA seepages, the field bin data presented an invaluable data source with respect to the calibration of source terms in general and scaling factors in particular for waste rock and pit wall terms. Even after the change of the source term scaling approach to rely more heavily on actual facility-specific water quality monitoring, field barrel data are consulted to ground truth model results and assess the range of contaminant release rates.

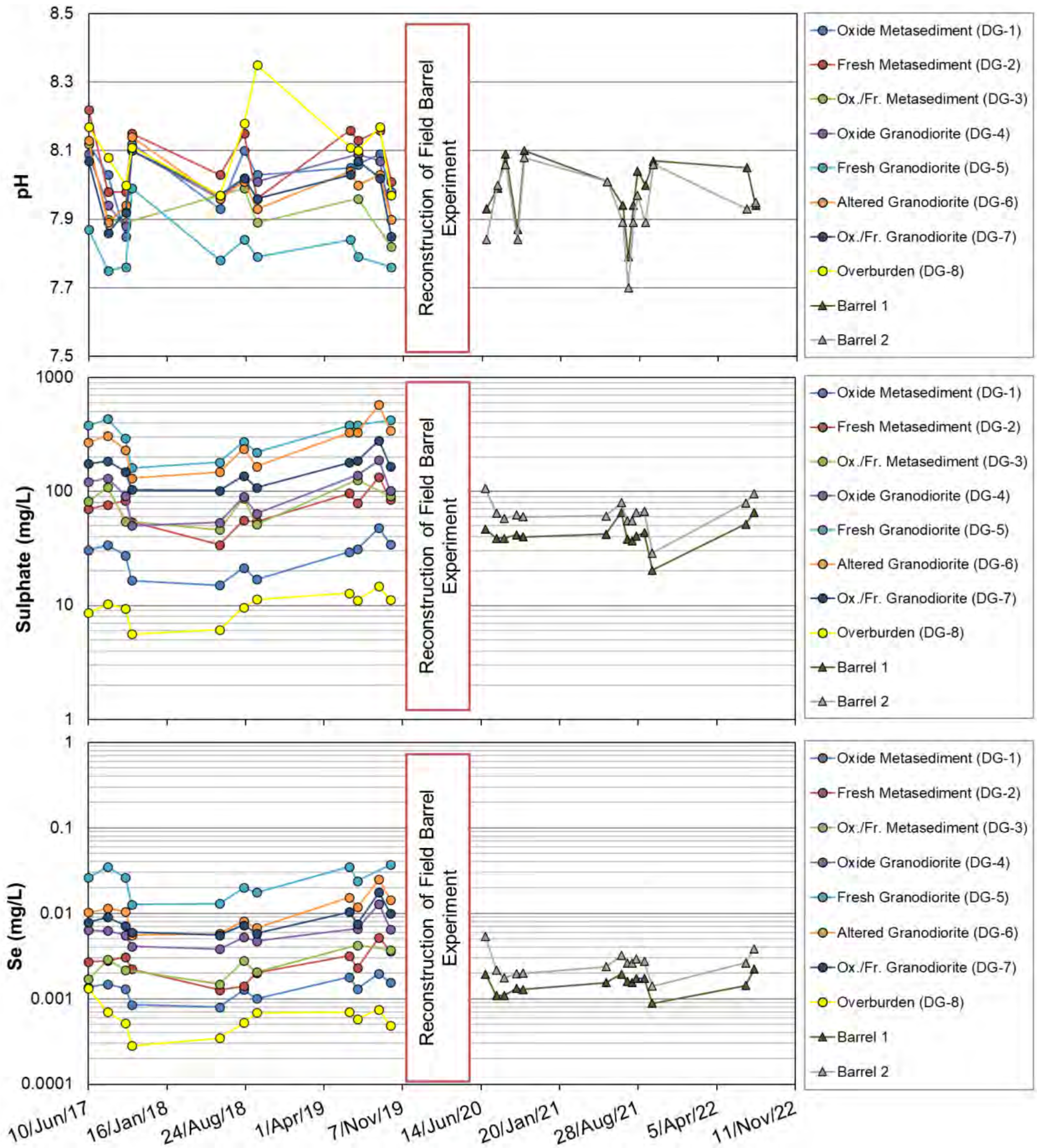

Figure 3-1: Field barrel leachate results for pH, sulphate and selenium prior to and after re-compositing in 2020. For a better resolution of long-term trends, only data since 2017 are shown.

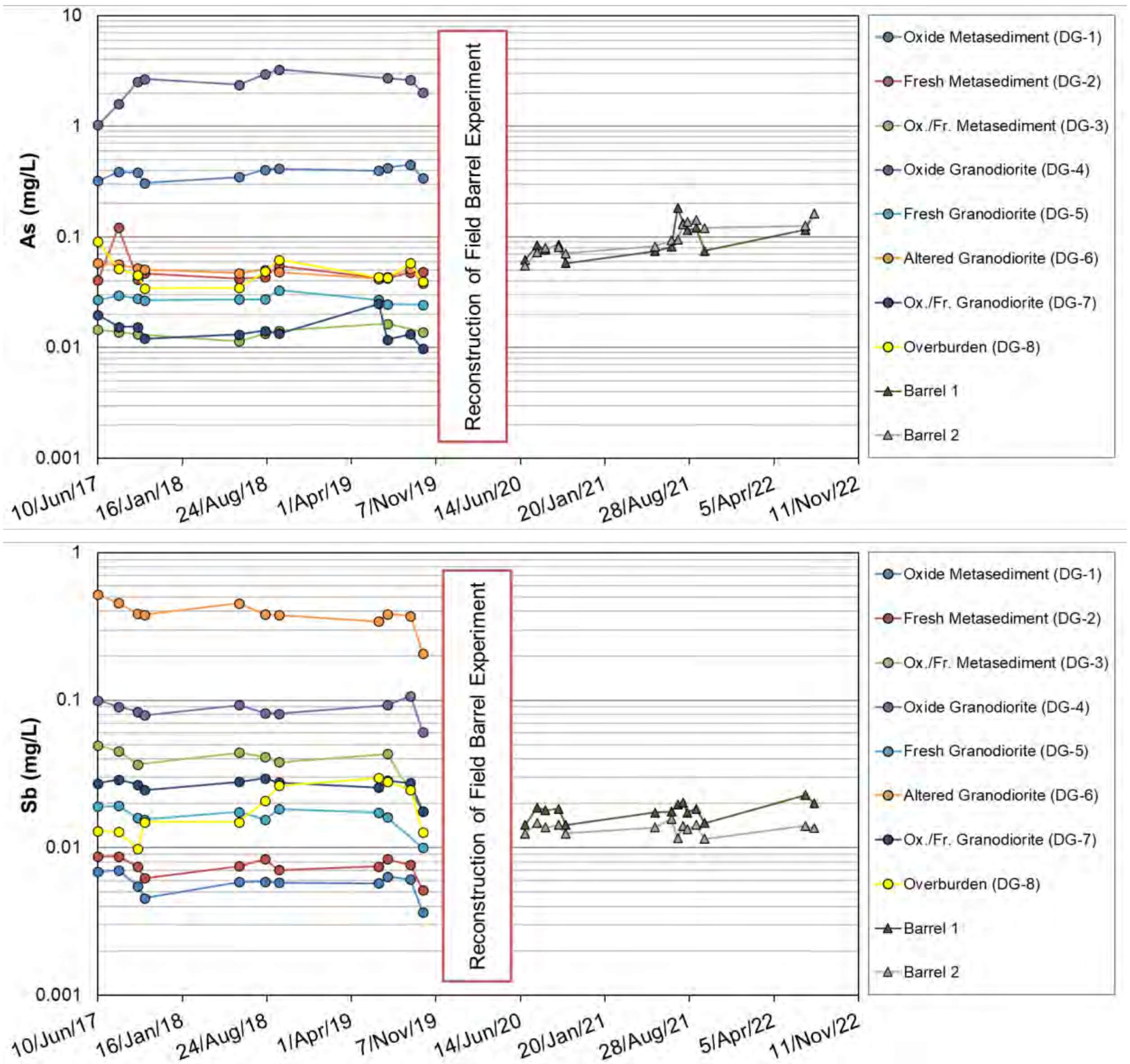

Figure 3-2: **Field barrel leachate results for arsenic and antimony prior to and after re-compositing in 2020. Note that pH has remained circum-neutral for the entire test period. Evidently, As attenuation is occurring in oxide granodiorite (DG-4) drainage as it contacts the underlying metasediment base. An in-depth discussion of As speciation and attenuation mechanisms for these kinetic tests is provided in Lorax (2021). For a better resolution of long-term trends, only data since 2017 are shown.**

In 2021, VGC initiated laboratory ore column testing at Forte Analytical to further evaluate kinetic processes and geochemical signatures associated with gold recovery and cyanide destruction phases from representative ore samples comprising materials from the Eagle deposit as well as mixed ore from the Eagle and Olive deposits. As part of this testwork, viable cyanide destruction processes (ex-situ alkaline chlorination, in-situ biologic, and rinse only) are being investigated. This testwork is not yet complete but will be relied upon, in combination with site analogue data, for future updates of geochemical source terms for draindown and long-term HLF seepage chemistry.

4. Surface Water Quality Monitoring

4.1 WRSAs

VGC conducts an extensive surface water quality monitoring program to assess the effects of mine operations on the downstream environment and support adaptive management programs for the Project. Monitoring stations collecting water considered to be the most representative of WRSA contact water are the Platinum Gulch Seepage (PGS) station and the Eagle Pup Seepage (EPS) station. At the time of preparation of this memorandum, a total of 18 water quality samples from PGS and five (5) samples from EPS were reviewed. Time series plots for the two monitoring stations are shown in Figure 4-1 and Figure 4-2 and compared with the current source term predictions for parameters of interest.

PGS concentrations are generally higher than those measured at EPS for the presented species. This can be explained by the following aspects:

- The Platinum Gulch WRSA was the first facility to be built and as of August 2022 contains a larger tonnage than the Eagle Pup WRSA (27 Mt versus 8 Mt). Therefore, water reporting to the PGS station would have been in contact with a larger rock mass and column.
- The earlier construction start for the Platinum Gulch WRSA (2019 versus 2021) will also have an impact on the hydrology of the facility. Specifically, unsaturated waste media require a period of time for the wetting front to migrate downwards and contact the full height of the WRSA including coarse and fine layers. Before a steady-state hydrological regime has established, chemical load contributions may be dominated by focussed (fast-moving) flow paths which could underestimate long-term, steady state concentrations.
- Non-contact water influencing WRSA seepage between the toe of the facility and the monitoring stations may affect the measured chemistry. More of the catchment reporting to PGS is occupied by waste rock as compared to EPS at this time.

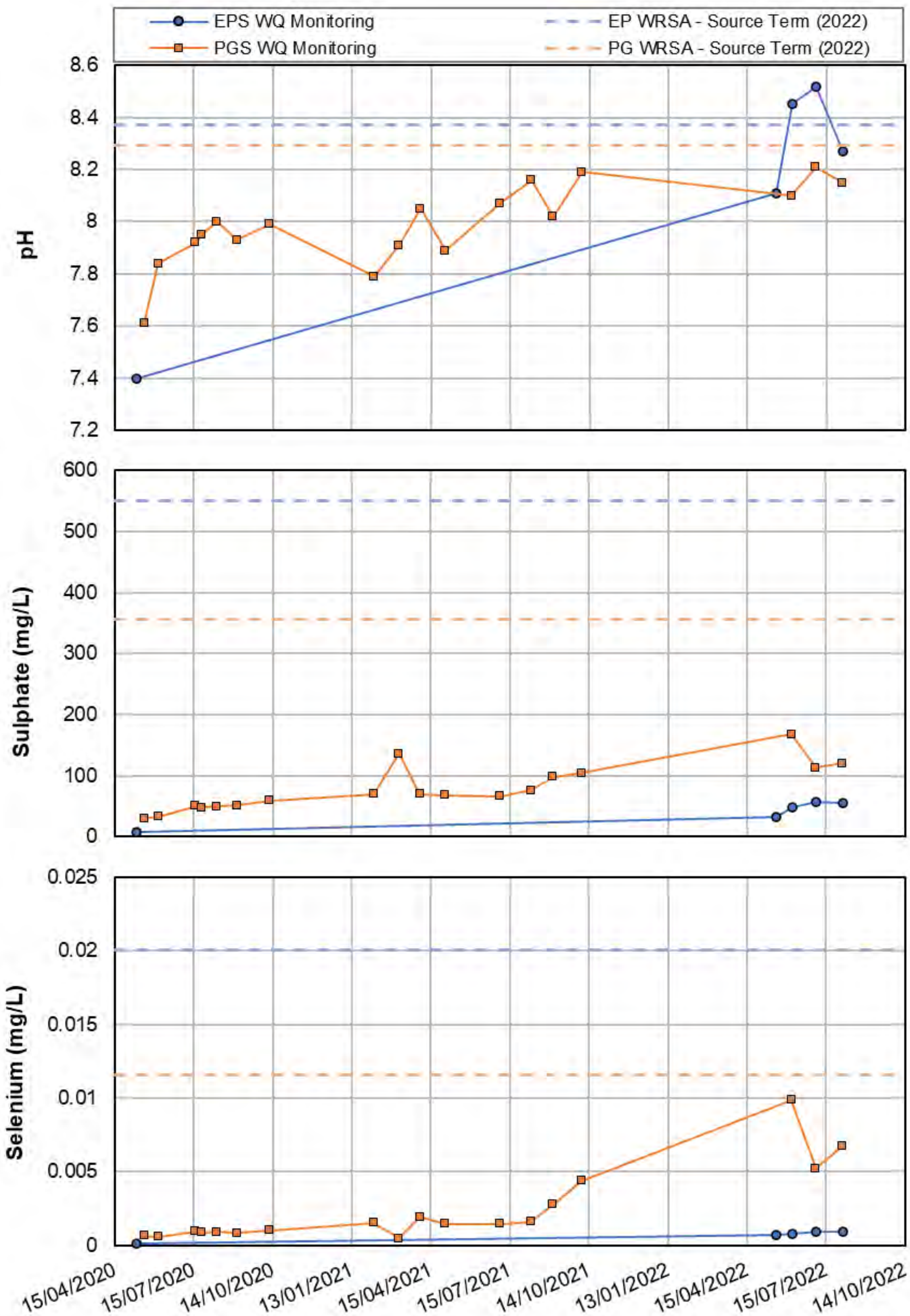

Figure 4-1: Surface water quality trends for pH, sulphate and selenium in stations EPS and PGS compared with the current source term model output for the Eagle Pup and Platinum Gulch WRSAs.

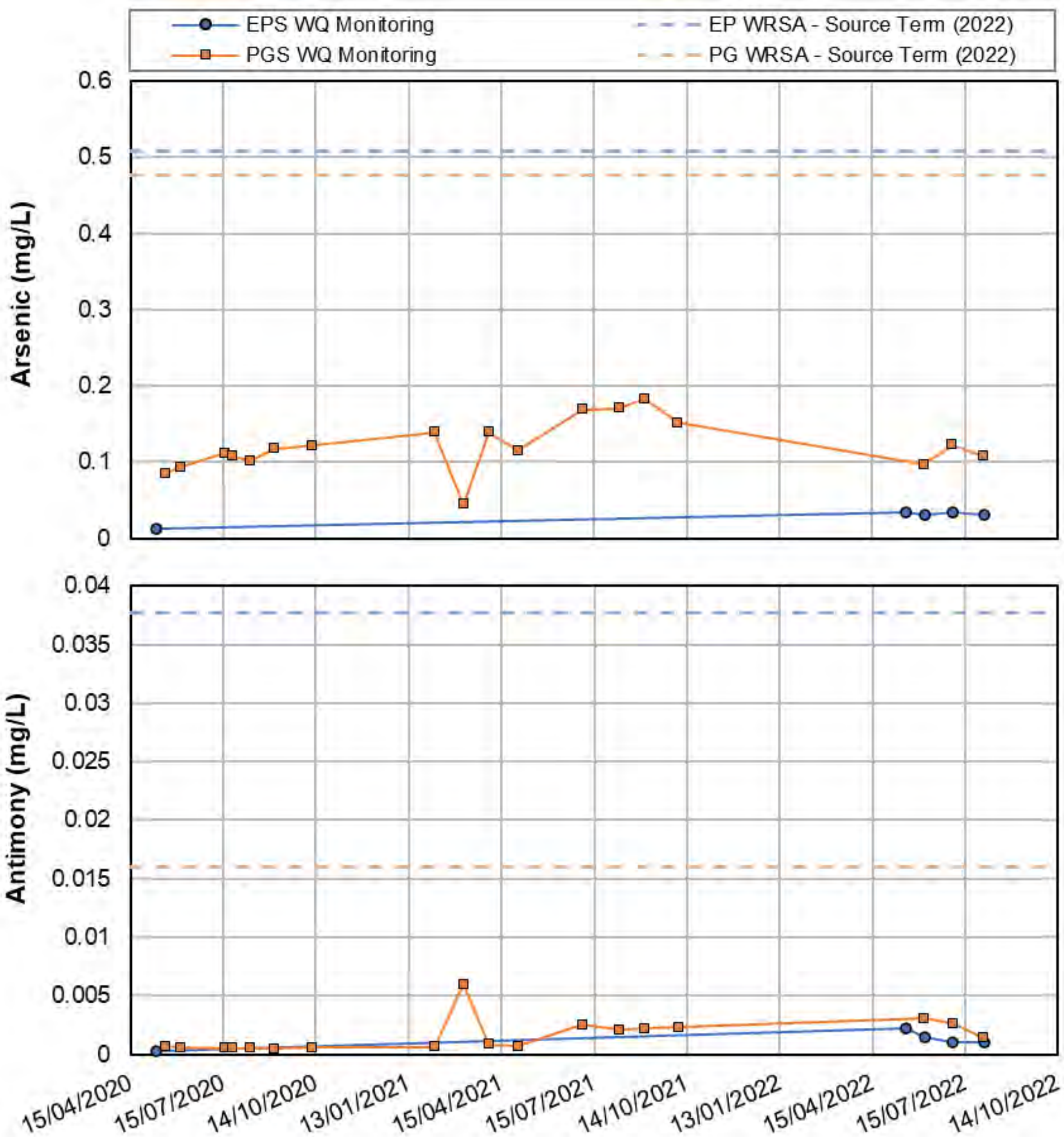

Figure 4-2: Surface water quality trends for arsenic and antimony in stations EPS and PGS compared with the current source term model output for the Eagle Pup and Platinum Gulch WRSAs.

These aspects are expected to result in increasing concentrations at the WRSA toe and downstream monitoring stations over time, especially for the Eagle Pup WRSA. Importantly, the possibility of dilution and the evolving flow regime within the WRSAs was considered in the most recent iteration of geochemical source terms as empirical scaling factors were back-calculated using PGS data until October 2021 (Lorax, 2022). As a result, source terms developed for the primary parameters of concern all currently exceed the measured concentrations at EPS and PGS by varying degrees and can be considered conservative (Figure 4-1and Figure 4-2). Measured concentrations are expected to approach the predictions as WRSAs are built and the influence of waste rock contact water onto the monitoring stations grows. As indicated previously, the source term model is revisited annually and compares predicted seepage chemistry to monitoring data and updates source terms accordingly.

4.2 Pit Walls

Limited water quality monitoring data is currently available for the open pit. The received data comprise water chemistry results from five horizontal drain holes within the open pit collected in August and September 2022. In total, eight samples were reviewed, five of which underwent analysis for an extended suite of water quality parameters including dissolved metals. A statistical overview of these initial results is compared against the 2022 pit wall runoff source terms in Table 4-1. Direct comparisons between groundwater chemistry from the pit drain holes and pit wall source term chemistry should be applied with caution as they technically represent different sources, although they originate from the same area. Over time the proportion of flow from the drain holes would diminish while runoff from the pit walls would increase. The influence of groundwater on the water quality data collected will need to be assessed for future model calibration. Nevertheless, it can be stated that sulphate and Sb predictions fall within the range of the measured values while the Se source term is conservative by an order of magnitude. However, predicted As concentrations currently fall somewhat below the measured median concentration of the limited dataset. Both ongoing field barrel testing and more extensive monitoring of the open pit drain holes will demonstrate whether updates to the pit wall runoff model are warranted in the future.

Table 4-1:
Comparison of Initial Pit Water Quality with Current Source Term Predictions

Data Source	Sulphate	As	Sb	Se
	mg/L	*mg/L*	*mg/L*	*mg/L*
Pit monitoring data				
Min	104	0.0038	0.0015	0.000076
Median	171	0.35	0.014	0.0014
Average	294	0.39	0.043	0.0013
Max	762	1.2	0.18	0.0031
Pit wall source term				
2022 model year	293	0.16	0.020	0.012

4.3 100-Day Ore Stockpile

No water quality monitoring is currently being conducted for seepage from the 100-day Ore Stockpile. Therefore, a comparison with the corresponding source term cannot currently be made. It should be noted that, due to the transient nature of this stockpile and the relatively low flow contribution of this pile to the overall water balance, ore contact water source terms have not been updated since the 2019 WUL Update Report (Lorax, 2020). Since these source term predictions are still based on theoretical scaling factors rather than site monitoring data, they are considered conservative.

4.4 HLF

Limited operational pregnant (n=1) and barren solution (n=4) data are available from 2020 and 2021. These data were used directly for the generation of an operational source term that fed into water treatment considerations by others. Source term modelling accounted for the accumulation of dissolved species as a result of barren solution recycling (Lorax, 2021). Future refinements of draindown and post-closure source terms will rely predominantly on results from the ongoing ore column testwork and site analogue data in consideration of geochemical trends observed during monitoring of operational pregnant and barren solutions.

5. Closure

This technical memorandum was prepared by the Lorax staff below for the exclusive use of Victoria Gold Corporation. Please contact the undersigned should you have any comments or questions with respect to this memorandum.

Respectfully,
Lorax Environmental Services Ltd.

Prepared by: **Reviewed by:**

Timo Kirchner, M.Sc., P.Geo.
Environmental Geoscientist

David Flather, M.Sc.
Principal

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Lorax (2022). Eagle Gold Project 2021 Water Balance and Water Quality Model Update Report (WBM v.7.0.3). Technical report prepared to VGC in March 2022.

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APPENDIX L

Constructed Wetland Treatment System Bench-Scale Trials Interim Update

Memorandum

To: Hugh Coyle and Katie Chakhova; Victoria Gold Corp.

From: Rachel Martz and Andrew Gault; Ensero Solutions

Date: September 30, 2022

Re: CWTS Bench-Scale Trials Interim Memorandum – Final

1 Introduction

Ensero Solutions Canada, Inc. (Ensero) was retained by Victoria Gold Corp. (VGC) to undertake a constructed wetland treatment system (CWTS) bench-scale trial to advance the design of a treatment wetland at VGC's Eagle Mine (the Site). A CWTS is being evaluated as the preferred passive treatment system (PTS) to be implemented at the toe of the Platinum Gulch Waste Rock Storage Area (PG WRSA) for the treatment of primarily arsenic. The CWTS for Platinum Gulch will be used to guide further passive treatment implementation for other locations at the Eagle Mine, such as for seepage from the Eagle Pup Waste Rock Storage Area (EP WRSA), and the Heap Leach Facility (HLF).

This memorandum describes Steps 2 and 3 of the following five step process for developing refinements to the on-site PG CWTS pilot-scale design:

1. Site Fieldwork: including evaluation of CWTS location and the collection of field data including substrate and vegetation (summarized in Ensero, 2022a);
2. Lab scale trial design, design criteria, and inputs, and set-up;
3. Bench-scale trial commissioning (system maturation);
4. Bench-scale trial testing and stagnation phases; and
5. Applying the findings to refine the PG CWTS design for an on-site pilot-scale system.

A desktop study was completed in May and June 2021, followed by site fieldwork in July 2021. The desktop study included a review of information available for the Site to guide the identification of borrow source options for the CWTS and inform on the initial CWTS design (Ensero, 2022a). Using information gathered from the desktop study and through guidance from VGC personnel, potential borrow sources for plants and substrate were identified during the July 2021 site fieldwork and the location of the on-site CWTS for the Platinum Gulch was refined. Samples from the selected substrate borrow sources were sent for analytical testing and plants were harvested from the selected plant borrow sources and brought back to Ensero's pilot facility to establish in a nursery for use in bench-scale trials.

The objective of the CWTS bench-scale trial is to de-risk the implementation of an on-site pilot-scale system by testing multiple designs and inputs at a smaller scale with the intention of using the information to refine the on-site pilot-scale design. The trials will assess the suitability of the substrates and plants sourced from the Site in a CWTS environment and help evaluate the magnitude of potential leaching of constituents. This memorandum describes the trial design and parameters that will be tested during the bench-scale testing to refine the Platinum Gulch on-site CWTS pilot-scale design and provides an update on the work performed to date.

2 BENCH-TRIAL OVERVIEW

2.1 TRIAL DESIGN

The bench-scale trials were constructed at Ensero's Saskatoon temperature-controlled greenhouse facility with setup completed and commissioning phase started on September 2, 2022. The bench-scale trials comprise four series each with two treatment cells (Figure 2-1 and Figure 2-2) with either a rip rap channel (Series 1-3) or a cascade (Series 4) between the cells. Cascades designed as a step cascade or sloped rip rap channel will be evaluated to determine their influence on treatment of arsenic and inform on the design of the cascade to be built in the on-site pilot-scale CWTS. It is thought that a rip rap channel may be a simpler design to implement on site but that a step cascade may provide additional dissolved oxygen as the water flows over the cascade. However, the dissolved oxygen in the Platinum Gulch Seep data provided showed dissolved oxygen consistently above 10 mg/L, so additional oxygenation may not be necessary. A step cascade or a rip rap channel will be utilized on site based on the elevation change in the area of the Platinum Gulch. For the trials, rip rap channels were constructed using corrugated pipe while step cascades were created using pails. A height difference of 61 cm between cells was used when designing the rip rap channels and cascades with cells spaced 122 cm apart within each series. Each channel and step cascade received 2.99 kg of rock from Ditch A. Ditch A rock was approximately 1-7 cm in size and the amount of rock added was weighed prior to addition to ensure that all series received the same amount which will be important when evaluating leaching potential.

Bins were used to create the cells for each series and were filled with the different substrates provided by VGC personnel to a targeted depth of 30 cm. Three different substrates were used in the trials, which were collected from Eagle pup road (described herein as SUB03), lower Haggart Road (described herein as SUB07), and the borrow pit at km 42.5 (described herein as gravel) (Figure 2-3). Substrates selected were based on analytical data as well as availability for use on Site. Gravel provided by VGC included finer particulate, therefore a 0.5-inch sieve was used during setup to remove finer material prior to addition to cells, as this substrate type is intended to inform on the potential benefit of using coarser material as the CWTS substrate (Figure 2-4).

Of the three plant types harvested from site (*Carex aquatilis, Carex utriculata, and Equisetum)*, *Carex aqualitis* established the best within Ensero's greenhouse and was therefore selected for use in the trials. A 10 cm water depth was targeted for the trials and will be evaluated as part of the trial assessment for suitability of plant establishment and ability to maintain aerobic conditions.

The information to be gained from the setup of the different series of trials includes:

- Comparison of substrate types and their risk of leachable metals, and the ability of iron in some substrates to sorb arsenic;
- Need for screening substrate to remove fines;
- Ease of establishment of plants in one substrate versus the other; and
- Difference in arsenic treatment in a rip rap channel versus a step cascade.

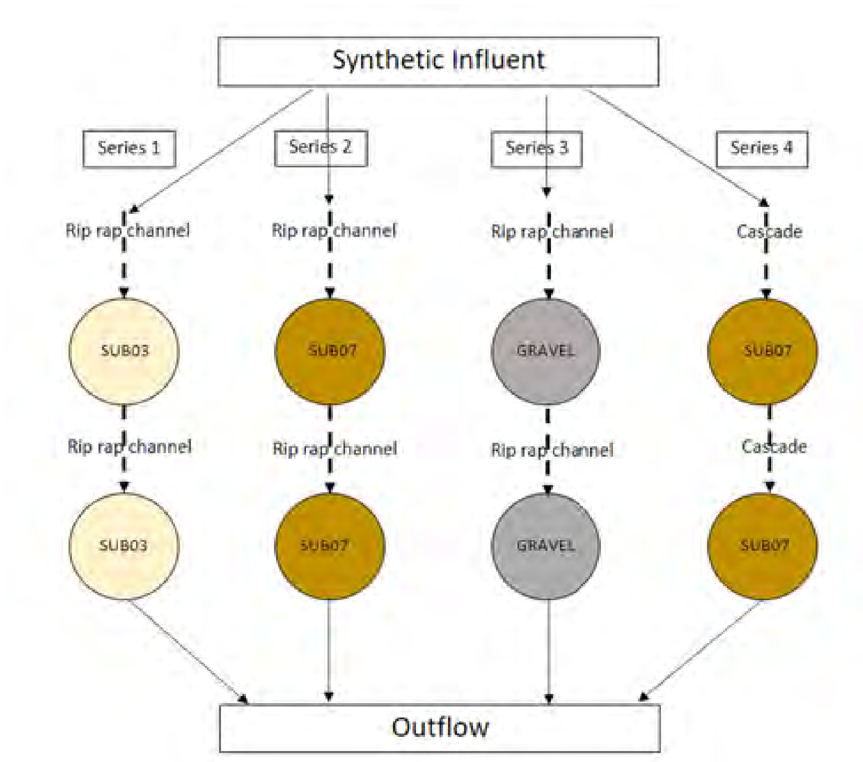


Figure 2-1: Bench-scale CWTS Trial Overview

	
Rip Rap Channel Design (Series 1)	**Step Cascade Design (Series 4)**

Figure 2-2: Rip Rap Channel vs. Step Cascade Design

SUB03 Substrate	SUB07 Substrate	Km 42.5 Substrate (post-sieving)

Figure 2-3: Substrate Addition to Cells

Pre-Sieving	During Sieving

Figure 2-4: Km 42.5 Gravel Substrate

2.2 SYNTHETIC INFLUENT

A synthetic water recipe (Table 2-1) was developed based on the modelled water quality data for the month of May (maximum Platinum Gulch PTS water quality for year 2029) provided by VGC on June 9th 2021. The synthetic water recipe was also based on the use of tap water (i.e., some constituents are higher in tap water than the modelled data) and recent water quality data from the Platinum Gulch Seep (i.e., 2020-2022 data set). The arsenic concentration chosen for the trials was based on the 90th percentile of the dissolved arsenic concentrations from the Platinum Gulch Seep 2020-2022 data set (0.1692 mg/L), to be conservative with higher arsenic concentrations currently observed on Site (compared to the June 9th, 2021, model predicted water quality; 0.087 mg/L) and fluctuations in dissolved arsenic concentrations. However, updated modelled water quality data (75th percentile [P75]) was provided by VCG on September 13th, 2022, which was used to size the conceptual design for the full-scale PG CWTS (Ensero, 2022b). Although the updated P75 modelled data was not used for the bench-scale trials, the main constituent of concern (arsenic) has comparable concentrations to the modelled data (i.e., May 2029 P75 predicted water quality concentration of 0.175 mg/L). Testing higher arsenic concentrations will likely result in less error as it is easier to target higher concentrations in influent and with less error when comparing initial arsenic concentrations to those that may be treated close to detection limit.

Nitrite concentrations in the predicted water chemistry are higher than VGC's effluent quality standards (EQS); therefore, nitrite concentrations in these bench-scale trials will be monitored, as nitrite is expected to oxidize to nitrate under oxidizing conditions and can also be used as nutrient by the plants. Additionally, ammonia can oxidize to nitrate under oxidizing conditions and also be used as a nutrient. While nitrate concentrations in the predicted water chemistry are below the EQS, they are only marginally below the EQS. Although nitrate treatment is not targeted in aerobic CWTS designs, it may be used as a nutrient by the plants in the CWTS and the extent of nitrate removal by plant uptake (and other nitrogen species by plant uptake or oxidation) will be assessed in the bench-scale trials.

The use of tap water versus reverse osmosis water was discussed with VGC personnel and tap water was approved for use in trials as the use of reverse osmosis water was logistically challenging due to the volume required on a weekly basis. By using tap water certain constituents are higher in concentration than the model predicted concentrations. The amount of calcium in the influent recipe is similar to the predicted concentrations but the Platinum Gulch Seep 2020-2022 data show much lower concentrations. Although the calcium concentrations are higher in the tap water, the effect of calcium to affect arsenic sorption is expected to be minimal at these concentrations and circumneutral pH. In addition to calcium, copper was also found to be much higher in the tap water than in the predicted water chemistry. Although higher, it is not anticipated to affect arsenic sorption to the substrate. Additionally, copper concentrations are anticipated to decrease upon influent preparation as PHREEQC simulations of the influent water quality identified the copper hydroxycarbonate mineral malachite as slightly supersaturated. While the copper concentration is higher in the tap water than in the EQS it is important to note that these concentrations are not expected on Site.

Alkalinity in the tap water was found to be 29% higher than the modelled data but can be adjusted using acid addition. Initial PHREEQC runs for the synthetic influent suggest calcite would be supersaturated and will likely precipitate. The alkalinity can be lowered by addition of sulphuric acid to bring the solution to just below calcite saturation. The addition of acid should not have an appreciable effect on the sulphate concentration (within approximately 10% of target).

Table 2-1: Synthetic Water Recipe (Dissolved Concentrations)

Constituents	Synthetic Water Recipe (mg/L)	Constituents	Synthetic Water Recipe (mg/L)
pH	7.76-8.12	**Cobalt**	0.007
Alkalinity	126[1]	**Copper**	0.181[3]
Ammonium (as N)	2.45	**Iron**	0.0736
Chloride	14.6	**Lead**	0.00027
Fluoride	0.638	**Magnesium**	21.4
Nitrate (as N)	19.2	**Manganese**	0.16
Nitrite (as N)	0.44	**Molybdenum**	0.0156
Phosphorus	0.272	**Nickel**	0.00444
Sulphate	314	**Potassium**	32.94
Aluminum	0.0214	**Selenium**	0.0231
Antimony	0.0553	**Silicon**	4.53
Arsenic	0.1692[2]	**Silver**	0.000011
Barium	0.0644	**Sodium**	32.53
Boron	0.0731	**Thallium**	0.000273
Cadmium	0.000055	**Uranium**	0.0673
Calcium	131.39	**Vanadium**	0.0012
Chromium	0.0004	**Zinc**	0.0169

[1] *Tap water concentration is 29% higher than predicted water quality data for PTS 2029 max scenario and will require addition of acid to prevent precipitation.*

[2] *Based on the P90 concentration of the dissolved As Platinum Gulch Seep 2020-2022 data set.*

[3] *Concentration found in tap water; this is not expected on Site. The predicted concentration for PTS 2029 max scenario is 0.00307 mg/L.*

2.3 Bench Trial Testing to Date

To begin commissioning, tap water with additional nutrients began flowing through each series targeting a three-day hydraulic retention time, to maintain aerobic conditions while minimizing water volume requirements on a weekly basis. Nutrients of nitrate, phosphorus, and ammonium (in the form of calcium nitrate tetrahydrate, monopotassium phosphate, and ammonium sulfate) were added to the tap water to promote the establishment and maturation of the *Carex aquatilis.* The targeted nutrient concentrations (of nitrate, phosphorus, and ammonium) used were the same concentrations targeted in the synthetic influent recipe in Table 2-1. Daily monitoring of plant health and flow checks are currently being performed to ensure that plants establish, and flow remains on target to maintain aerobic conditions in the cells. Weekly monitoring of the cells is currently being performed during the commissioning stage using a YSI handheld multiparameter meter to monitor dissolved oxygen concentrations to ensure that aerobic conditions are maintained.

3 NEXT STEPS

Commissioning (i.e., system maturation) is currently ongoing and is planned to continue for approximately 12 weeks. The length of commissioning will depend on plant establishment within the cells with a commissioning criterion of greater than 50% of the initial plant density. Synthetic influent testing is currently ongoing to optimize the procedure to obtain targeted dissolved concentrations for the constituents outlined in Table 2-1. Once the synthetic influent testing is complete, a slow transition of adding synthetic influent to the tap water including the nutrient mixture noted above will commence for all four series. An outline of the commissioning phase and transition to 100% synthetic influent recipe is shown in Table 3-1 below.

Table 3-1: Estimated Commissioning Schedule

Approximate Beginning Date	Water Source	Approximate Duration
September 2, 2022 (Actual start date)	Tap Water + Nutrients	Four weeks
September 30, 2022	50% Tap Water + Nutrients[1] 50% Synthetic Influent	Four weeks
October 28, 2022	100% Synthetic Influent	Four weeks

[1] *Nutrient concentrations will remain consistent through the transition to 100% synthetic influent (Table 2-1) for plant establishment.*

Upon completion of the commissioning stage, the testing stage will commence. The testing stage will occur over a two-month period and it is currently planned to test three different hydraulic retention times (HRT) between 0.5 and 3 days, with three separate testing events per HRT. Water quality monitoring for each cell in the series and influent will include external testing (at ALS laboratories in Saskatoon) for total and dissolved metals, anions (sulphate, fluoride, chloride, nitrate, nitrite), alkalinity, conductivity, pH, hardness, and ammonia, along with internal testing of pH, dissolved oxygen, conductivity, oxidation-reduction potential, and temperature. The frequency of water quality monitoring will be governed by the HRT; however, internal testing will occur at least weekly. Stagnation testing will occur at the end of testing and will be used to evaluate the risk of the system becoming anaerobic during no flow/low flow scenarios and the potential of leaching from the substrate from a change in redox conditions.

The findings of this study will refine the on-site pilot CWTS for Platinum Gulch. Particularly, site-specific reaction rates for the treatment of arsenic will be determined for each trial, which will further refine the sizing estimate of the CWTS as these reaction rates will take into consideration water chemistry applicable to the site as well as potential leaching or sorption to substrates that will be used in the CWTS. Additionally, these trials will confirm suitability of the plant type (*Carex aquatilis*), substrate selection (borrow source, if screening and iron amendment is required), design of the cascade (rip rap channel or step cascade), and water depth (10 cm). Finally, these tests will inform on potential risks of the system turning anaerobic and leaching constituents, which can be further tested in the on-site pilot-scale CWTS.

4 References

Ensero Solutions Inc. (Ensero). (2022a). *Eagle Mine Treatment Wetland Information Review and Site Visit*. March 2022.

Ensero Solutions Inc. (Ensero). (2022b). *Eagle Gold Mine Preliminary CWTS Design.* September 2022.

APPENDIX M

Constructed Wetland Treatment System Design Memorandum

Memorandum

To: Hugh Coyle and Katie Chakhova, Victoria Gold Corp.

From: Jim Harrington and Rachel Martz, Ensero Solutions Canada, Inc.

Date: September 30, 2022

Re: Eagle Gold Mine Preliminary CWTS Design

1 INTRODUCTION

Ensero Solutions Canada, Inc. (Ensero) was retained by Victoria Gold Corp. (VGC) to provide updates and clarification with respect to constructed wetland treatment system (CWTS) design for the Eagle Mine (the Site) in closure. The purpose of this memo is to provide additional information to VGC to advance the design and reduce the level of uncertainty in the CWTS designs in support of an October 2022 revision to the VGC Reclamation and Closure Plan (RCP). VGC's RCP currently includes three CWTSs to be implemented in closure to address seepage from the Platinum Gulch Waste Rock Storage Area (PG WRSA), the Eagle Pup Waste Rock Storage Area (EP WRSA), and the Heap Leach Facility (HLF). The designs of each CWTS were advanced using site-specific geometric and topographic conditions with updated predicted water quality and flows.

This memo provides advanced preliminary sizing, design, and drawings of the three CWTS for closure (Sections 2 and 3).

2 CWTS PHASED APPROACH

To implement a successful CWTS, Ensero is following a phased approach to inform the design of the three CWTSs planned for closure at the Site, and each phase of work will inform the subsequent phases. The Platinum Gulch Passive Treatment System PTS (PG PTS) is the first CWTS that will be built at the Site, which will be the first CWTS to follow this phased approach. The lessons learned during the design and implementation of the PG CWTS will be used to guide CWTS implementation for other locations at the Eagle Mine, specifically at the Eagle Pup Waste Rock Storage Area (EP WRSA), and the Heap Leach Facility (HLF).

The phases for the PG CWTS include:

1. Information gathering (including a desktop study and site visit). Completed (Ensero, 2022a);
2. Bench-scale testing. In progress (Ensero, 2022b);
3. On-site pilot-scale testing;
4. Full-scale implementation; and
5. Use the lessons learned from this approach to guide and inform the approach for other two CWTS planned for closure.

An information review and Site field work was completed by Ensero in 2021 (Ensero 2022a). Based on the field data and samples collected in July 2021 and August 2022, bench-scale trials began in early September 2022. These trials will inform the PG on-site pilot-scale trials to be implemented in 2023, which will ultimately inform the design of the PG full-scale CWTS. One of the main objectives of the bench-scale trials will be to evaluate site-specific reaction rates for the treatment of arsenic, which will help further refine the sizing of the CWTS as these reaction rates will consider water chemistry applicable to the PG WRSA seepage. As discussed in Section 2.1.1 and 3.3.2, proxy removal rates from experience at several other sites with similar constituents are currently being used for the current preliminary sizing and design of CWTSs for the Site. Additionally, the bench-scale trials will inform on the suitability of the plant type being used (*Carex aquatilis*), substrate selection (borrow source), whether screening and iron amendment to the substrate is required, design of associated channels/cascades, and water depth of the CWTS.

2.1.1 PASSIVE WATER TREATMENT IN CWTS

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Eagle Mine. CWTS evaluations are being advanced to fulfill site-specific objectives for passive treatment at the Eagle Mine site for waste rock drainage (PG and EP); due to the more complex chemistry from the heap, a hybrid Passive Treatment System (PTS) comprised of a biochemical reactor (BCR) within the heap, followed by a two-stage anaerobic-aerobic CWTS may be optimal for heap drainage. Thus, the CWTS portion of the Heap PTS design has also been further refined and is described here.

Using predicted closure water quality from each source, each CWTS was sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of constituent removal as the water is treated as it passes through the CWTS, based on treatability of the compound and hydraulic retention time. In Equation 2-1 (below), the zero order RRC has been reconfigured to calculate from t (hydraulic retention time; HRT), allowing the use of C_i

(initial concentration), *Cf* (final, desired concentration), and *k* (removal rate constant) to be used to size the wetlands accordingly.

Equation 2-1: Zero-order Removal Rate Coefficient (RRC) rearranged to solve for HRT

$$t = \frac{Ci - Cf}{k}$$

Removal rate coefficients are based on the treatability of a specific constituent and the HRT of the system, both of which are site-specific based on water chemistry, wetland designs, and characteristics of the system. Removal rate coefficients will be refined through bench-scale and pilot-scale work, which will provide the information for final full-scale sizing. In order to evaluate potential CWTS locations at this stage of the project, a proxy removal rate coefficient was used to size the PG, LDSP, and aerobic HLF CWTS. This proxy removal rate was adopted from a pilot-scale study designed for the treatment of arsenic in an aerobic CWTS at a site in northern Canada, where no additional iron was supplemented to the CWTS, and the water had an iron to arsenic molar ratio of < 1. The CWTS design for which the proxy removal rate was developed used *Typha* species planted into a 50 cm deep substrate (with a porosity of 35%) and water depth of 10 cm. The proxy removal rate coefficient for arsenic used for the preliminary design was 0.13 day^{-1} (zero order reaction). After sorption, the slower process of biomineralization can occur, but this only needs to occur at a rate such that all sorption sites are not used within a given year, as the organic matter from the vegetation that dies off and becomes litter in the CWTS can provide sorption sites for the subsequent year(s). A review of arsenic treatment processes in a CWTS is found in Lizama et al., (2011) and sorption of arsenic in a wetland is dependent on availability and form of iron and organic matter, pH, redox, substrate, and competing species for sorption sites. The annual CWTS sorption capacity of arsenic to organic matter and substrates in aerobic conditions will be assessed through pilot-scale testing.

During the ongoing reclamation research program for the PTS, these design parameters will be further tested and refined, such that the final CWTSs will be sufficiently sized by the time a full-scale system is installed.

3 CWTS DESIGN

Details regarding the methods used for preliminary sizing for the CWTSs to treat seepage from the PG WRSA, EP WRSA, and the HLF are described herein.

3.1 PLATINUM GULCH CWTS

3.1.1 WATER CHEMISTRY

The most recent predicted water quality was provided by Lorax on September 13, 2022 and was used to refine the size of the PG CWTS. The Lorax GoldSim model for 2029, which simulates the PG WRSA seepage, included minimum, median, mean, 75th percentile (P75), and maximum monthly water chemistry and flow, which can be assumed to represent the range in flow and load to the CWTS. Year 2029 was selected for the preliminary sizing of the PG CWTS as it represents a peak year for flow to the PTS, which combines Eagle Pit dewatering and waste rock facility seepage flows. The P75 water quality for May 2029 was used as the design basis as May had the highest arsenic load to the wetland and required the largest wetland size; the predicted flows were adjusted to account for model scale factors and contingency based on calibrated flow data. Thus, the design basis flow assumes the 2303 m³/day in May. When comparing the WUL EQS to the P75 PTS 2029 predicted water chemistry it was noted that nitrite and arsenic frequently exceeded the WUL EQS (Table 3-1). The P75 monthly water chemistry for selected parameters is presented in Table 3-1.

Table 3-1: Design Basis Water Quality and Flow Rate Data for Platinum Gulch (assumes 2029)

Month	75th Percentile		
	Adjusted Flow (m^3/day)	As (mg/L)	NO_2 (mg/L as N)
Jan	11.2	0.052	0.0011
Feb	10.2	**0.054**	0.0018
Mar	61.6	**0.057**	0.012
Apr	1641	**0.092**	**0.17**
May	2303	**0.175**	**0.38**
Jun	728	**0.192**	**0.26**
Jul	1558	**0.130**	**0.18**
Aug	2096	**0.106**	**0.15**
Sep	1922	**0.105**	**0.14**
Oct	1127	**0.065**	0.0457
Nov	477	**0.055**	0.00017
Dec	358	**0.056**	0.00015
WUL EQS	-	0.053	0.12

*Water Use Licence QZ14-041-1 Effluent Quality Standards (WUL EQS): As Total 0.053 mg/L and Nitrite-N 0.12 mg/L; Concentrations above the EQS are indicated with **bold red** text.*

For the treatment of arsenic at the Site an aerobic CWTS design is most suitable with sorption and coprecipitation of arsenic to iron (hydroxy)oxides. Further discussion on the rationale for selecting an aerobic CWTS design can be found in Ensero, 2022a. For the treatment of arsenic in an aerobic CWTS, the molar ratio of iron to arsenic in the water is an important factor to facilitate arsenic removal. A review of the PTS 2029 water chemistry data indicated that the iron to arsenic molar ratio ranged from 0.41-0.91 (in the P75 water chemistry scenario) for the open water season. A similar iron to arsenic molar ratio (0.58) is currently being testing in the bench-scale trials. Higher iron to arsenic molar ratios (up to 10:1) may be needed to achieve low arsenic concentrations; however, arsenic can be treated at lower iron to arsenic ratios. The proxy RRC used for sizing the PG CWTS was based on a pilot-scale trial where the water had an iron to arsenic molar ratio of < 1 and an RRC is currently being refined in the bench-scale trials where the iron to arsenic ration is also <1. Should additional iron be needed for the CWTS, it could be passively incorporated by selecting iron-rich soils found locally. A suitable substrate for the PG CWTS is currently being tested in bench-scale trials (Ensero, 2022b).

It is anticipated that at the predicted concentrations, nitrite will either oxidize to nitrate and/or will be used by the wetland plants as a nutrient source in an aerobic CWTS, and therefore will not require a separate CWTS for treatment. For the purposes of sizing a CWTS, it is assumed that only nitrite and arsenic will need to be treated in the PG CWTS and the CWTS will be primarily designed for the treatment of arsenic through an aerobic design (Section 3.1.2).

3.1.2 Preliminary Design and Size

Preliminary sizing for the PG CWTS was estimated to guide CWTS location evaluation and substrate needs, and is based on best available information to date using the water chemistry and flow rates outlined in Table 3-1, proxy removal rate coefficients (described further below), and assumptions for water depth and substrate depth based on Ensero's experience with similar CWTSs.

The following parameters were used for the sizing and will continue to be refined through the bench- and pilot-scale trials (Table 3-2).

Table 3-2: Preliminary Design Parameters for PG CWTS

Parameter	Design Basis	Source/Rationale
Design	Aerobic	Based on Ensero's experience
Arsenic Concentration	0.1751 mg/L	P75 Predicted water quality by Lorax (May 2029)
Flow Rate	2303 m^3/day	Adjusted P75 Predicted flow rate by Lorax (May 2029)
Treatment Objective	0.053 mg/L	WUL EQS for As
Proxy Removal Rate Coefficient	0.13 day^{-1} (Zero order reaction kinetics)	Pilot-scale study for a proxy site
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended substrate type is currently under investigation in bench-scale trials.
Water Depth for Aerobic CWTS	10 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type is currently under investigation in bench-scale trials.
Treatment Area	0.86 ha	Estimated from month of highest load and wetland size (May)
Approximate amount of construction fill required for CWTS pond creation	140,000 m^3	Estimate calculated by AutoCAD Civil 3D. General fill, readily available from site.
Approximate amount of substrate required for CWTS fill	4,100 m^3	Geometric volume calculation based on CWTS cell dimensions

The preliminary PG CWTS was sized using paired arsenic concentrations and adjusted flow data for May 2029 (Table 3-1) to meet the WUL EQS for arsenic (0.053 mg/L). Using the aerobic proxy removal rate coefficient for arsenic, a 0.86 hectare full-scale wetland may be required to treat the PG water to the WUL EQS target for arsenic. The CWTS size will be further refined and evaluated as the design and testing of the CWTS advances.

3.1.3 PLANTS

Plants are included in a CWTS to aid in treatment of mine-impacted water through contribution in several ways, including providing carbon as food for microbes, accretion, evapotranspiration, structural stability, filtration, hydrology, radial oxygen loss from roots, sorption of constituents, and creation of microbial habitat. CWTS can be designed to create sustainable conditions that will minimize the uptake of constituents into vegetation and decrease bioavailability by promoting direct mineralization of metals and metalloids within the substrate.

A review of the Environmental Baseline Report: Vegetation (Stantec, 2011) identified potential wetland plants such as species of *Carex* that are suitable for use in a CWTS at the Site. During the 2021 Site visit, three plant species were identified as potential candidates for use in a CWTS including *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), and *Equisetum* species (horsetail). The water depth in the CWTS design may be adjusted depending on conditions favorable for the plant type selected and if adjusted, would affect the treatment area of a CWTS. However, it was observed during the 2021 site visit that all of these plant species were growing in areas with approximately 10 cm water depth, which is a water depth that is used for aerobic wetlands and for the sizing described in Section 3.1.2. Further information regarding the location of the borrow source, abundance, harvesting of these plants can be found in Ensero 2022a. In any case, aerobic conditions and plant health will be considered and tested before implementation in a CWTS design.

3.1.4 SUBSTRATE

The PG CWTS is being primarily designed for the treatment of arsenic, therefore the CWTS will require a substrate that promotes the development of aerobic conditions and will not negatively impact the water quality. Further discussion on the considerations for selecting a borrow source can be found in Ensero 2022a. Three borrow sources are currently being tested in bench-scale trials (Ensero, 2022b), however, CWTS sizing here conservatively assumed that there was limited iron provided by the substrate. One of the potential substrate borrow sources for the CWTS is currently being tested in the bench-scale trials and will inform on the relative arsenic treatment between these lower iron substrates with a substrate that contains higher iron content. The substrates were also tested for their potential to generate ARD/ML. The results of the ABA testing indicate that the samples had low potential for acid generation due to their low sulphide sulphur content combined with an adequate amount of neutralization capacity. More information regarding the borrow source selection process, analytical testing performed and results, and location of the borrow source can be found in Ensero 2022a. For the preliminary design, a gravel and sand mixture with a 30% porosity was assumed based on site observation and testing available so far. The depth of the substrate for the PG CWTS design was based on 50 cm of substrate although the bench-scale trials were built with a 30 cm depth. The bench-scale trials were built with a lower substrate depth based on the amount of substrate provided and to fit within the dimensions of the bins.

3.1.5 CONSTRUCTABILITY

A CWTS would be constructed on Site by both digging down into the existing soils and placing compacted fill to create flat bottomed rectangular treatment cells where substrates and plants can be added to create a wetland environment that promotes the treatment of primarily arsenic (Attachment A, Drawing number ECA22YT00233-C-302). With the elevation change across the area, an extended, rip rap covered slope/cascade will be constructed between the cells which will be beneficial for promoting or maintaining aerobic conditions. Substrate material was analyzed prior to being tested in the in-progress bench-scale trials to inform suitability prior to use in the planned on-site pilot-scale system. As the design of the CWTS advances, any additional material used in the CWTS (e.g., rip rap for cascades) will also need to be analysed to determine its suitability for use prior to construction. Further information on test pits results, ease of construction, and areas of permafrost can be found in Ensero 2022a.

Assumptions used for PG CWTS design are:

1. PG WRSA seepage will flow through a rip rap lined channel (upper Ditch A) to convey water to the purposed CWTS. This channel will provide aeration of the water so that the water is oxygenated to support precipitation of arsenic as oxides.

2. Water from upper Ditch A will first flow to a retention basin upstream of the CWTS.

3. The CWTS will be designed to be aerobic to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.

4. The CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design.

5. In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary. The embankments of the wetlands will be a 2.5:1 slope.

6. Flow channels from the retention basin into the CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with rip rap. Bottoms of wetland cells are level, but there must be a height difference between the first and second cells to promote flow and provide aeration of the water.

7. Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.

8. Cells should be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments.

9. The CWTS will be planted with local plants, to the greatest extent possible.

10. The sub-base of the CWTS will require components to protect against thawing of permafrost. This will include (but not limited to) a foundation consisting of compacted gravel with low fines content and a layer of extruded polystyrene insulation.

3.2 Lower Dublin South Pond CWTS

3.2.1 Water Chemistry

The most recent predicted water quality for EP WRSA seepage was provided by Lorax on September 13, 2022 and was used to refine the size of the Lower Dublin South Pond (LDSP) CWTS. The Lorax GoldSim model for 2043, which simulates the Eagle Pup WRSA seepage, included minimum, median, mean, 75th percentile (P75), and maximum monthly water chemistry and flow, which can be assumed to represent the range in flow and load to the CWTS. Year 2043 was selected for the preliminary design basis sizing of the LDSP CWTS as it represents a year of closure PTS flows and loads and likely a few years after the need for active treatment. The P75 water quality for July 2043 was used to further the design basis as July, based on flow and water quality data, required the largest wetland size; the predicted flows were adjusted to account for model scale factors and contingency based on calibrated flow data. Thus, the July design basis flow was 960 m^3/day. When comparing the WUL EQS to the P75 PTS 2043 predicted water chemistry it was noted that nitrite and arsenic consistently exceeded the WUL EQS, and nitrate on occasion exceeded the WUL EQS in the P75 scenario (Table 3-3). The P75 monthly water chemistry for selected parameters is presented in Table 3-3.

Table 3-3: Design Basis Water Quality and Flow Rate Data for LDSP PTS (assumes 2043)

Month	75th Percentile			
	Adjusted Flow (m^3/day)	As (mg/L)	NO_2 (mg/L as N)	NO_3 (mg/L as N)
Jan	22.8	**0.080**	**0.20**	8.6
Feb	18.5	**0.073**	**0.17**	7.7
Mar	96.5	**0.068**	**0.16**	6.9
Apr	1163	**0.071**	**0.17**	7.3
May	1856	**0.077**	**0.22**	9.6
Jun	787	**0.131**	**0.43**	18.8
Jul	960	**0.156**	**0.54**	**23.4**
Aug	1133	**0.136**	**0.46**	**19.9**
Sep	1277	**0.117**	**0.39**	16.8
Oct	569	**0.104**	**0.34**	14.9
Nov	265	**0.089**	**0.28**	12.2
Dec	235	**0.078**	**0.24**	10.4
WUL EQS	-	0.053	0.12	19.5

Water Use Licence QZ14-041-1 Effluent Quality Standards (WUL EQS): As Total 0.053 mg/L, Nitrite-N 0.12 mg/L, Nitrate-N 19.5 mg/L; Concentrations above the EQS are indicated with ***bold red*** *text.*

For the treatment of arsenic at the Site an aerobic CWTS design is most suitable for LDSP CWTS with sorption and coprecipitation of arsenic to iron (hydroxy)oxides for the same rationale as the PG CWTS (Section 3.1.1). A review of the PTS 2043 water chemistry revealed that in the P75 water chemistry scenario the iron to arsenic molar ratio was 1.9-4.8. As noted above, - higher iron to arsenic molar ratios (up to 10:1) may be needed to achieve low arsenic concentrations, however, arsenic can be treated at lower iron to arsenic ratios.

It is anticipated that at the predicted concentrations, nitrite will either oxidize to nitrate and/or will be used by the wetland plants as a nutrient source in an aerobic CWTS, and therefore will not require a separate CWTS for treatment. Similarly, nitrate may also be used as a nutrient by the plants in the CWTS. Nitrate may require a separate CWTS that targets anaerobic (reducing) conditions for removal, in the event that nitrate concentrations are insufficiently treated through plant uptake in the months where nitrate concentrations are slightly above the EQS. The extent of nitrate treatment through plant uptake is currently under investigation in the bench-scale trials. For the purposes of sizing a CWTS, it is assumed that only nitrite and arsenic will need to be treated in the LDSP CWTS and the CWTS will be primarily designed for the treatment of arsenic through an aerobic design (Section 3.1.2). This assumption is justified because nitrate uptake into plants in wetlands is commonly observed and only a limited amount of nitrate removal/reduction is required to achieve the EQS.

3.2.2 Preliminary Design and Size

Preliminary sizing for the LDSP CWTS was further developed to guide CWTS construction and substrate needs, and is based on best available information to date using the water chemistry and flow rates outlined in Table 3-3, proxy removal rate coefficients (described further below), and assumptions for water depth and substrate depth based on Ensero's experience with similar CWTS.

The following parameters were used for the preliminary sizing, which will continue to be refined through the bench- and pilot-scale trials (Table 3-4).

Table 3-4: Preliminary Design Parameters for LDSP CWTS

Parameter	Design Basis	Source/Rationale
Design	Aerobic	Based on Ensero's experience
Arsenic Concentration	0.1565 mg/L	P75 Predicted water quality by Lorax (July 2043)
Flow Rate	960 m^3/day	Adjusted P75 Predicted flow rate by Lorax (July 2043)
Treatment Objective	0.053 mg/L	WUL EQS for As
Proxy Removal Rate Coefficient	0.13 day^{-1} (Zero order reaction kinetics)	Pilot-scale study for a proxy site
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended substrate type is currently under investigation in bench-scale trials.
Water Depth for aerobic CWTS	10 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type is currently under investigation in bench-scale trials.
Treatment Area	0.31 ha	Estimated from month of highest wetland size (July 2043)
Approximate amount of construction fill required for CWTS pond creation	31,000 m^3	Estimate calculated by AutoCAD Civil 3D
Approximate amount of substrate required for CWTS fill	1,400 m^3	Geometric volume calculation based on CWTS cell dimensions

The preliminary LDSP CWTS was sized using paired arsenic concentrations and flow data for July 2043 (Table 3-3) to meet the WUL EQS for arsenic (0.053 mg/L). Using the aerobic proxy removal rate coefficient for arsenic (Section 2.1.1), it is estimated that a 0.31 hectare full-scale wetland may be required to treat the Eagle Pup water to the WUL EQS target for arsenic. The CWTS size will be further refined and evaluated as the design and testing of the CWTS advances. The considered water depth, plants, and substrates (Sections 3.1.3 and 3.1.4) for the preliminary design are similar to the those are currently being testing in bench-scale trials for the PG CWTS.

3.2.3 CONSTRUCTABILITY

A CWTS would be constructed on Site by constructing the CWTS into the current location of the LDSP and backfilling any unused area in the pond with local sediment (Attachment A, Drawing number ECA22YT00233-C-300). The CWTS would be made of flat-bottomed rectangular treatment cells where substrates and plants can be added to create a wetland environment to promote the treatment of primarily arsenic. An elevation change across the area will need to be designed into the CWTS, such that multiple terraced cells may be considered with cascades in between the cells which would be beneficial for promoting or maintaining aerobic conditions. Substrate material will be tested in bench-scale trials and analyzed prior to use in an on-site pilot-scale system.

Assumptions used for LDSP CWTS design are:

1. Eagle Pup WRSA seepage will flow through a rip rap lined channel (Ditch B) to convey water to the purposed CWTS at the LDSP. This channel will provide aeration to precipitate elements as oxides.

2. Water from Ditch B will first flow to a retention basin upstream of the CWTS.

3. The CWTS will be designed to be aerobic to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.

4. The CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design.

5. In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary. The embankments of the wetlands will be a 2.5:1 slope.

6. Flow channels from retention basin into CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with rip rap. Bottoms of wetland cells are level, but there must be a height difference between the retention basin and first cells and between first and second cells to provide aeration of the water.

7. Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.

8. Flow from the retention basin will exit through the spillway channel into Ditch C. The spillway outlet will be cut down to the elevation of the retention basin.

9. Cells should be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments to ensure that water requiring treatment in the CWTS remains in the CWTS flow path.

10. The CWTS will be planted with local plants, to the greatest extent possible.

3.3 HEAP LEACH FACILITY CWTS

3.3.1 WATER CHEMISTRY

The most recent predicted water quality was provided by Lorax on September 13, 2022 and was used to refine the preliminary size of the Heap Leach Facility (HLF) CWTS. The Lorax GoldSim model for 2050, which simulates the HLF water quality in the Events Pond, included minimum, median, mean, 75th percentile (P75), and maximum monthly water chemistry and flow, which can be assumed to represent the range in flow and load to the HLF bioreactor, which is upstream of the HLF CWTS. The HLF CWTS will be built during the time the heap leach is being drained down, and once the HLF CWTS becomes operational a transition away from active water treatment will occur. It is anticipated that the HLF CWTS will be functional before 2050, and year 2050 is simply being used for preliminary HLF CWTS sizing as it is a representative year for the design basis. The P75 water quality for May 2050 was used, as May had the highest antimony, arsenic, cobalt, and selenium concentrations. The P75 flow rates for January to December 2050, were used to determine the flows during open water season (i.e., assuming flow is limited to the CWTS between May and September for all the water collected in the HLF for the year. The inlet pond located ahead of the HLF CWTS will function as an equalization pond to provide water storage when flows are higher (May and June). The stored water would continue to drain out of the inlet/equalization pond when flows are lower (July-September) and provide some control of the flow to the CWTS. Therefore, the flow design basis is based on an equalized flow of 188 m^3/day entering the HLF CWTS from May-September. When comparing the WUL EQS to the P75 PTS 2050 predicted water chemistry it was noted that nitrate, nitrite, arsenic, antimony, cobalt, and selenium frequently exceeded the WUL EQS (Table 3-5). Total suspended solids (TSS) concentrations were on occasion (January and May) slightly higher (15.3 and 22.1 mg/L, respectively) than the WUL EQS of 15 mg/L. The P75 monthly water chemistry for selected parameters is presented in Table 3-5.

Table 3-5: Design Basis Water Quality and Flow Rate Data for HLF PTS (assumes 2050)

Month	75th Percentile						
	Flow (m^3/day)	As (mg/L)	Co (mg/L)	Se (mg/L)	Sb (mg/L)	NO_2 (mg/L as N)	NO_3 (mg/L as N)
Jan	4.96	0.021	0.0021	0.00013	0.0017	0.0010	0.12
Feb	4.96	0.020	0.0020	0.00010	0.0016	0.0020	0.029
Mar	5.75	0.025	0.020	0.0044	0.066	**0.16**	8.75
Apr	75.3	**0.151**	**0.280**	**0.061**	**0.91**	**2.28**	**123**
May	359	**0.333**	**0.712**	**0.156**	**2.34**	**5.85**	**317**
Jun	209	**0.325**	**0.696**	**0.152**	**2.29**	**5.72**	**310**
Jul	74.9	**0.320**	**0.681**	**0.149**	**2.24**	**5.60**	**303**
Aug	74.0	**0.318**	**0.677**	**0.148**	**2.23**	**5.56**	**301**
Sep	84.5	**0.306**	**0.648**	**0.142**	**2.13**	**5.33**	**289**
Oct	39.5	**0.095**	**0.142**	**0.031**	**0.47**	**1.17**	**63.3**
Nov	4.96	0.035	0.00010	0.000095	0.0031	0.0010	0.047
Dec	4.96	0.035	0.00010	0.000095	0.0031	0.0010	0.047
WUL EQS	-	0.053	0.026	0.025	0.13	0.12	19.5

*Water Use Licence QZ14-041-1 Effluent Quality Standards (WUL EQS): As Total 0.053 mg/L, Cobalt Total 0.026 mg/L, Selenium Total 0.025 mg/L, Antimony Total 0.13 mg/L, Nitrite-N 0.12 mg/L, Nitrate-N 19.5 mg/L; Concentrations above the EQS are indicated with **bold red** text.*

It is assumed that the predicted concentrations of nitrate and nitrite will be treated in the upstream anaerobic biochemical reactor that will be created in the in-heap pond from the residual sugars used in the heap treatment and supplemented as appropriate by alcohol injection, thus nitrate and nitrite were not used for the preliminary sizing for the HLF CWTS. TSS is also expected to be filtered by the CWTS and thus was not considered in the design for limited exceedances.

It is assumed that antimony, cobalt, and selenium would require treatment in the HLF CWTS although they are likely to be treated under reducing conditions, it was also assumed that the HLF bioreactor would target denitrification until nitrate and nitrite concentration from the HLF are depleted and the HLF CWTS would target sulphate-reducing conditions to further treat metals and metalloids both during and after the bioreactor is active.

Under reducing conditions, treatment is achieved by transformation of these metals and metalloids to less soluble forms which can be removed from the water through settling and/or filtration. The treatment in the CWTS is designed to stimulate bacteria in the sediments of the CWTS system that naturally occur on the water, rock, roots, and soil in the system through addition of organic carbon. The bacteria oxidize the reduced carbon "food" source (e.g., ethanol, woodchips, decaying plant matter, etc.) and transfer the electrons released to a terminal electron acceptor (TEA). The TEAs are generally used in the order of which is most energetically favorable by bacteria. Therefore, TEA concentrations can be used to determine the amount of reduced carbon that is necessary to reach sulfate-reducing conditions.

Of the major TEAs typically present in mine-impacted waters, dissolved oxygen (DO) is used first, followed by nitrate (NO_3), manganese(IV), iron(III), uranium(VI), and then sulfate (SO_4), creating a "redox ladder" as shown in Figure 3-1. This order of TEA consumption is not absolute and is used to guide treatment design and performance evaluation. The TEA consumption can be influenced by numerous factors including the overall concentrations of reduced and oxidized TEA species, spatial distribution of organic electron donors and TEAs, presence of constituents that may complex TEAs, and the abundance and diversity of TEA-metabolizing microbial populations present. The rate of microbial activity is also typically affected by temperature – in general, colder temperatures have slower activity whereas warmer temperatures accelerate activity.

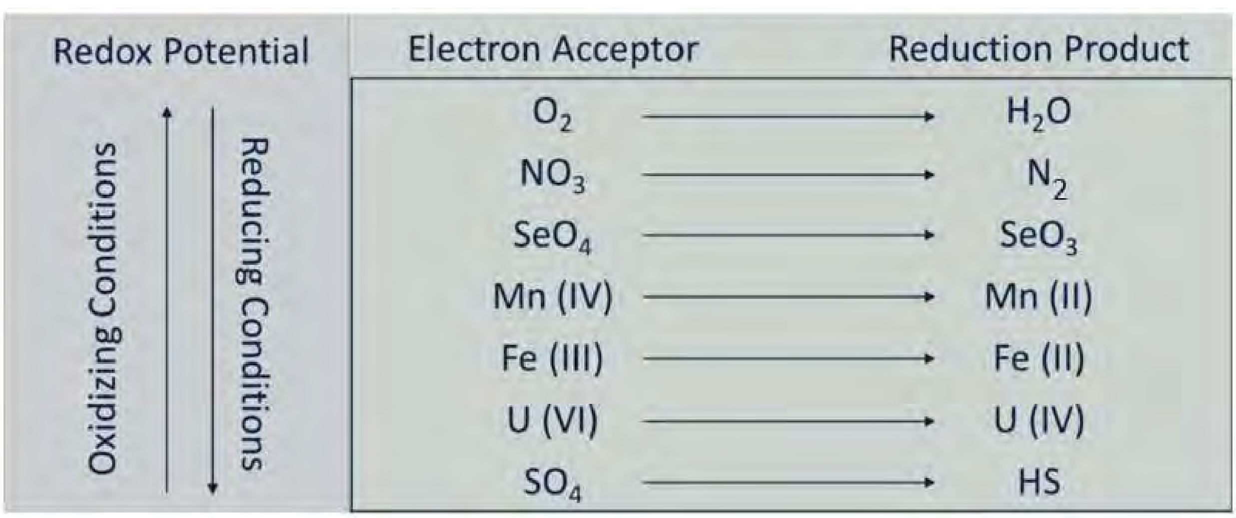


Figure 3-1: Terminal Electron Acceptors

Nitrate and nitrite are reductively treated by microbes in a stepwise fashion to nitrite and then to nitrogen gas in a process called denitrification. Denitrification occurs at low DO concentrations only after the majority of oxygen is consumed.

The targeted selenium treatment pathway is the reduction of selenate (Se(VI)) and selenite (Se(IV)) to insoluble elemental selenium (Se(0)). There are several different types of selenate- and selenite-reducing bacteria that can reduce these soluble forms of selenium to insoluble elemental selenium (e.g., Gonzalez-Gil et al., 2016; Nancharaiah and Lens, 2015; Sharma et al., 2015).

To treat sulphate, chalcophile metals and metalloids (i.e., with an affinity for sulphide), and other sulphide binding elements (such as Co and Sb), microbes transfer electrons from organic carbon supplied to the system to sulphate, creating sulphide in a process called dissimilatory sulphate reduction. The sulphide then binds to dissolved chalcophile elements forming an insoluble sulphide mineral that precipitates from solution. Dissimilatory sulphate reduction occurs at low DO concentrations after the majority of nitrate, selenium, manganese(IV), and iron(III) are reduced. The extent of sulphate treatment through this process is governed by the total concentration of sulphide mineral-forming metals and metalloids that stabilize reduced sulphate as sulphide in its mineralized form.

For the treatment of arsenic at the Site an aerobic CWTS design is most suitable for HLF CWTS with sorption and coprecipitation of arsenic to iron (hydroxy)oxides for the same rationale as the PG CWTS (Section 3.1.1). A review of the HLF PTS 2050 water chemistry indicated that in the P75 water chemistry scenario has on average a 7.0-7.1 iron to arsenic molar ratio. As noted above, in some cases higher iron to arsenic molar ratios (up to 10:1) may be needed to achieve low arsenic concentrations, however, arsenic can be treated at lower iron to arsenic ratios.

For the purposes of sizing a CWTS, it is assumed that only arsenic, antimony, cobalt, and selenium will need to be treated in the HLF CWTS and a CWTS treatment train will be primarily designed for the treatment of antimony, cobalt, and selenium through an anaerobic design followed by treatment of arsenic through an aerobic design (Section 3.1.2 and 3.2.2).

3.3.2 PRELIMINARY DESIGN AND SIZE

Preliminary sizing for the HLF CWTS was estimated to guide CWTS construction and substrate needs, and was based on best available information to date using the water chemistry and flow rates outlined in Table 3-5, proxy removal rate coefficients (described further below), and assumptions for water depth and substrate depth based on Ensero's experience with similar CWTS.

The following parameters were used for the preliminary CWTS sizing and will continue to be refined through the bench- and pilot-scale trials (Table 3-6 and Table 3-7).

Table 3-6: Preliminary Design Parameters for Anaerobic CWTS for HLF CWTS

Parameter	Design Basis	Source/Rationale
Design	Anaerobic	Based on Ensero's experience
Antimony Concentration	2.34 mg/L	P75 Predicted water quality by Lorax (May 2050) where Sb concentration was used for sizing as it is expected to drive sizing.
Flow Rate	188 m^3/day	Estimated controlled flow during open water season using P75 Predicted flow rates by Lorax for 2050
Treatment Objective for Antimony	0.13 mg/L	WUL EQS for Sb as Sb concentration was used for sizing as it is expected to drive sizing.
Proxy Removal Rate Coefficient for Antimony	0.133 day^{-1} (First order reaction kinetics)	Pilot-scale study for a proxy site. Currently estimated as the driver for sizing.
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended substrate type for anaerobic system would need to be sourced and tested. Not currently being tested
Water Depth for Anaerobic CWTS	40 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type for anaerobic system would need to be sourced and tested. Not currently being tested.
Woodchips	10% of substrate volume, locally sourced.	Assumed based on Ensero's experience.
Treatment Area	0.74 ha	Estimated from month of highest load and wetland size (May)
Approximate amount of construction fill required for CWTS pond creation	165,000 m^3	Estimate calculated by AutoCAD Civil 3D for both anaerobic and aerobic cells
Approximate amount of substrate required for CWTS fill	3,500 m^3	Geometric volume calculation based on CWTS cell dimensions

Table 3-7: Preliminary Design Parameters for Aerobic CWTS for HLF CWTS

Parameter	Design Basis	Source/Rationale
Design	Aerobic	Based on Ensero's experience
Arsenic Concentration	0.3331 mg/L	P75 Predicted water quality by Lorax (May 2050)
Flow Rate	188 m^3/day	Controlled flow during open season estimated from P75 Predicted water quality by Lorax
Treatment Objective	0.053 mg/L	WUL EQS for As
Proxy Removal Rate Coefficient	0.13 day^{-1} (Zero order reaction kinetics)	Pilot-scale study for a proxy site
Substrate Depth and Porosity	50 cm of 30% porosity	Assumed based on Ensero's experience. Actual recommended substrate type is currently under investigation in bench-scale trials.
Water Depth for Aerobic CWTS	10 cm	Assumed based on Ensero's experience
Side Slope	2.5:1 slope	Refined from 2020 RCP
Freeboard	30 cm	2020 RCP
Aspect Ratio of Cell	1:3 width to length ratio	Refined from 2020 RCP
Number of Trains	2	Refined from 2020 RCP
Number of Cells	2	Refined from 2020 RCP
Liner	Geosynthetic liner	Refined from 2020 RCP
Plants	Local plants	Actual recommended plant type is currently under investigation in bench-scale trials.
Treatment Area	0.16 ha	Estimated from month of highest As concentration and wetland size (May 2050)
Approximate amount of construction fill required for CWTS pond creation	See Table 3-6	See Table 3-6
Approximate amount of substrate required for CWTS fill	750 m^3	Geometric volume calculation based on CWTS cell dimensions

The anaerobic HLF CWTS was sized using antimony, cobalt, and selenium concentrations and a controlled flow rate of 188 m^3/day (Table 3-3) to meet the WUL EQS for antimony, cobalt, and selenium, respectively (0.13, 0.026, and 0.025 mg/L, respectively). Using anaerobic proxy removal rate coefficients for antimony, cobalt, and selenium, a 0.74 ha full-scale wetland may be required to treat the HLF water to the WUL EQS target, which is driven primarily by treatment of antimony. Cobalt and selenium concentrations are also estimated to be treated to the WUL EQS within this treatment area, with the removal rate for antimony driving the sizing of the CWTS. The antimony removal rate was adopted from a pilot-scale study designed for the treatment of metals and metalloids (including antimony) in an anaerobic CWTS at a site in northern Canada. The proxy removal rate coefficient for antimony used for the preliminary sizing of the HLF CWTS is 0.13 day^{-1} (first order reaction). The CWTS design for which the proxy removal rate was developed used *Carex* species planted into a 30 cm deep substrate (with a porosity of 23%) and water depth of 30 cm. Additionally, toxicity of the high concentrations of antimony to the plants used and sulphate-reducing bacteria is unknown and will be tested in the pilot studies. For the design basis, a substrate depth of 50 cm (with a porosity of 30%) and water depth of 40 cm was assumed and would be tested prior to implementation in a full-scale CWTS. The anaerobic CWTS size will be further refined through pilot-scale testing.

In Equation 3-1 (below), the first order RRC has been reconfigured to calculate from t (hydraulic retention time; HRT), allowing the use of *Ci* (initial concentration), *Cf* (final, desired concentration), and *k* (removal rate constant) to be used to size the wetlands accordingly.

Equation 3-1: First-order Removal Rate Coefficient (RRC) rearranged to solve for HRT

$$t = \frac{-\ln\left(\frac{Cf}{Ci}\right)}{k}$$

Ensero currently does not have removal rate coefficient for cobalt and thus a proxy removal rate coefficient for other chalcophile metals was used to estimate the removal rate of cobalt. Thus, there is some added uncertainty into the removal rate of cobalt, which will require further study.

The aerobic HLF CWTS was conceptually sized using the design basis arsenic concentrations and a controlled flow rate of 188 m^3/day (Table 3-3) to meet the WUL EQS for arsenic (0.053 mg/L). Using the aerobic proxy removal rate coefficient for arsenic (Section 2.1.1), a 0.16 hectare full-scale wetland may be required to treat the HLF water to the WUL EQS target for arsenic. The CWTS size will be further refined and evaluated as the design and testing of the CWTS advances. The considered water depth, plants, and substrates (Sections 3.1.3 and 3.1.4) for the design are similar to the those are currently being testing in bench-scale trials for the PG CWTS.

The preliminary full-scale wetland size is estimated based on concentrations expected to report to the upstream BCR, which is conservative, as an anaerobic BCR pilot-scale performance suggests some treatment of arsenic, antimony, and selenium from 38 to >99% (Janin et al., 2015). However, nitrate and nitrite concentrations were not added to the synthetic influent nor reported in the drainage produced onsite. Thus, treatment of these metalloids in an anerobic BCR is dependent on removal of nitrate and nitrite. With the above assumptions, the total wetland treatment area for a conceptual full-scale wetland is estimated to be 0.9 ha for the combined anaerobic and aerobic CWTS.

3.3.3 CONSTRUCTABILITY

A CWTS would be constructed on Site by constructing the CWTS into the current location of the Events Pond and back-filling any unused area with sediment (Attachment A, Drawing number ECA22YT00233-C-301). The CWTS would be made of flat-bottomed rectangular treatment cells where substrates and plants can be added to create a wetland environment to promote the treatment of primarily antimony, cobalt, and selenium in an anaerobic CWTS followed but treatment of arsenic in an aerobic CWTS. An elevation change across the area is designed into the CWTS. Additionally, for the aerobic CWTS multiple terraced cells may be considered with cascades in between the cells which would be beneficial for promoting or maintaining aerobic conditions. Substrate material and plants will be tested in bench-scale trials and analyzed prior to use in an on-site pilot-scale system.

Assumptions used for HLF CWTS design are:

1. The HLF liner to the closure sump will be perforated through the access piping built into the heap and sump during construction, allowing seepage to flow under pressure from the closure sump to the PTS. Initially, a valving system within the head works of the piping can be used to control the drainage rate to the PTS, or alternatively recycle some portion of the heap drainage by pump back onto the heap surface and eventually via percolation to the In-Heap Pond, which will be dosed with an organic material (such as ethanol). This recirculation of heap drainage into the base of In-Heap Pond will support the operation of the anaerobic bioreactor within the saturated portion of the heap until nitrate and nitrite treatment is no longer required. In addition to denitrification processes, the bioreactor in the In-Heap Pond is expected to substantially reduce metals concentrations during the draindown period when the In-Heap Pond is still active, and before the cover system is fully operational. The in-heap bioreactor may result in effluent sufficiently treated to allow for direct discharge. Nevertheless, in the case that metal concentrations are still above criteria, the HLF PTS will be designed accordingly to meet effluent quality standards. The CWTS will continue to operate after the bioreactor has been decommissioned and treat seepage after the HLF cover is in place.

2. Seepage from the in-heap anaerobic bioreactor will flow through the closure drain system to the CWTS inlet pond. The CWTS inlet pond will function as an equalization pond to provide some flowrate control to the CWTS during the open water season (May to September). The anaerobic effluent will report to a retention basin and subsequently flow into an anaerobic CWTS which is designed to sequester elements (Sb, Co, and Se) into the sediments through coupled biogeochemical reactions and accretion.

3. The anaerobic CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, containing 10% woodchips as organic matter. The above substrate water depth is 40 cm. An additional 30 cm of freeboard is in the design.

4. The anaerobic CWTS will be followed by aerobic CWTS to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.

5. The aerobic CWTS is designed to have two series in parallel, with each series consisting of two cells. The cells will have a 1:3 width to length ratio. The substrate depth is 50 cm, with 30% porosity, while the above substrate water depth is 10 cm. An additional 30 cm of freeboard is in the design.

6. In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary. The embankments of the wetlands will be a 2.5:1 slope.

7. Flow channels from retention basin into CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with rip rap. Bottoms of wetland cells are level. The height difference between the retention basin and the first anaerobic cells and also between first and second anaerobic cells will be minimal to allow flow by gravity but minimize aeration. However, there must be a sufficient height difference between the second anaerobic cells and first aerobic cells and also between first and second aerobic cells to provide aeration of the water.

8. Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.

9. The water from the retention basis will exit through an engineered cut in the events pond embankment and then directed into a designed channel that will convey the treated water to Haggart Creek.

10. Cells should be lined with a geosynthetic liner to prevent leakage to or from surrounding sediments to ensure that water requiring treatment in the CWTS remains in the CWTS flow path.

11. The CWTS will be planted with local plants, to the greatest extent possible.

4 REFERENCES

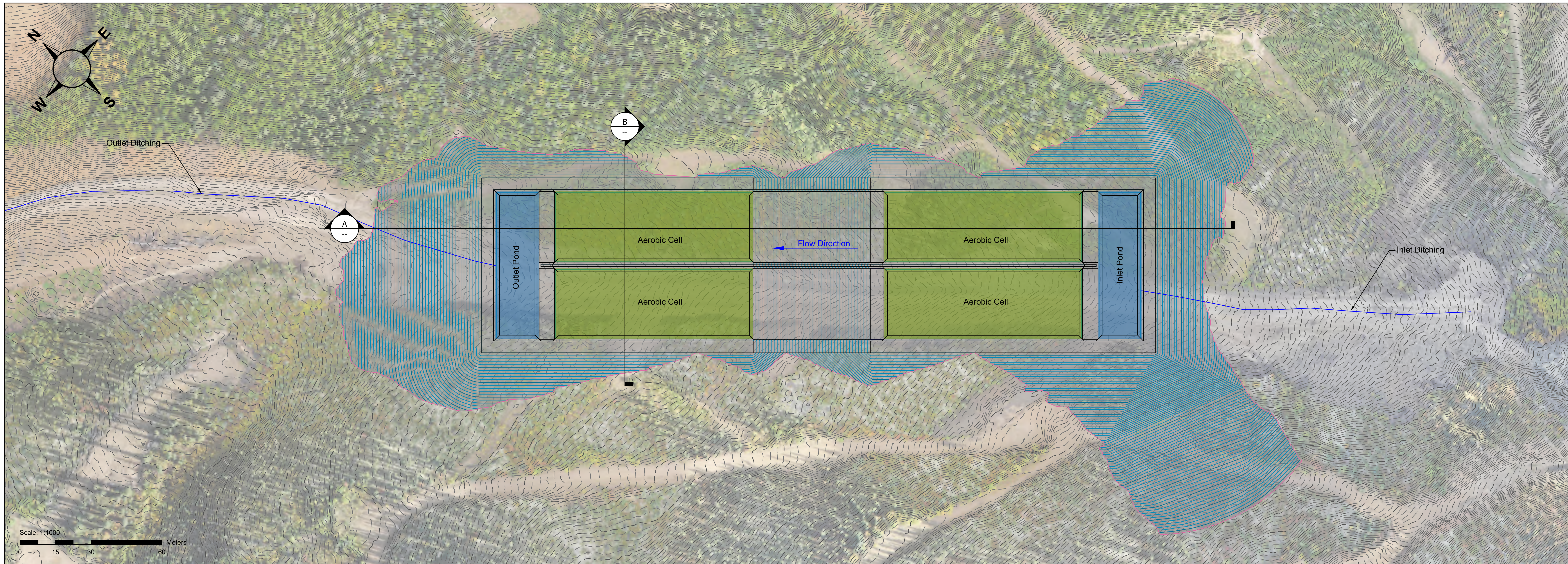
Ensero (2022a). Eagle Mine Treatment Wetland Information Review and Site Visit. March 25, 2022.

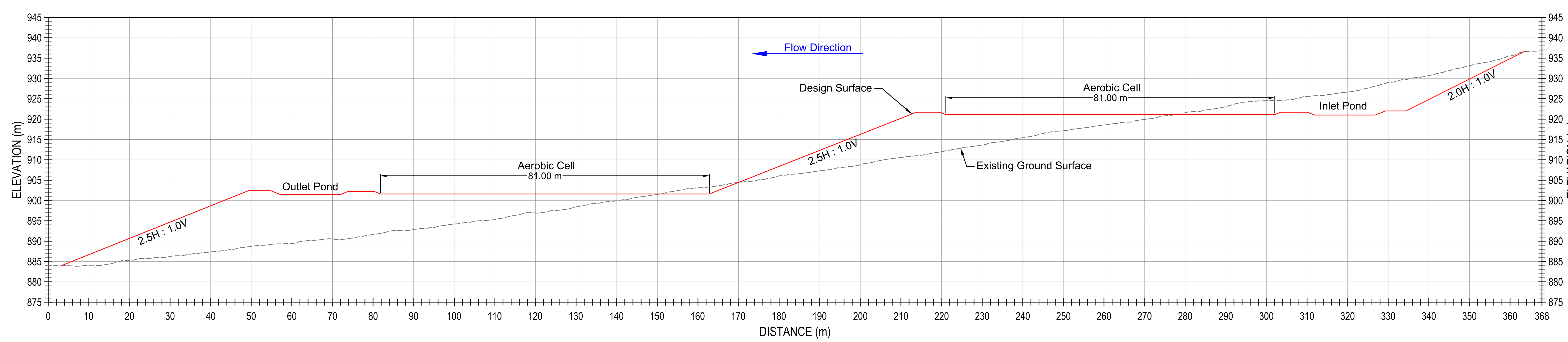
Ensero (2022b). CWTS Bench-Scale Trials Interim Memorandum. September 30, 2022.

Janin A., Ness I., and Wilbur S. (2015). *Arsenic, Antimony and Selenium Removal from Mine Water by Anaerobic Bioreactors at Laboratory Scale*. May 2015.

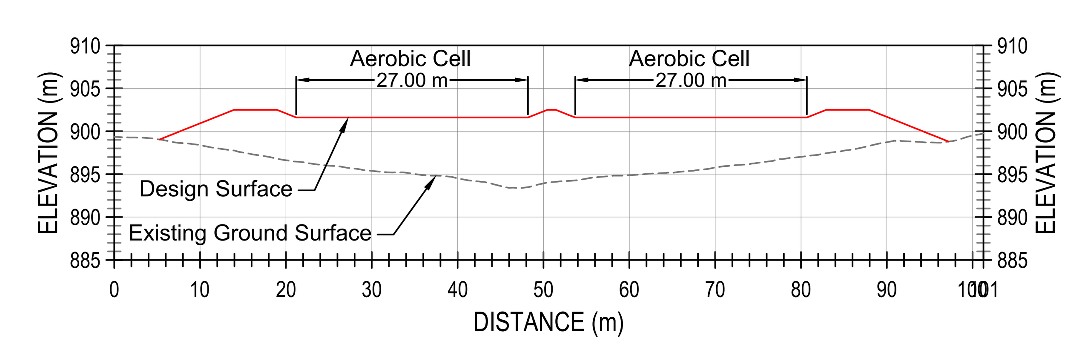
Stantec Consulting Ltd. (2011). *Eagle Gold Project Environmental Baseline Report: Vegetation*. (Document # 1231-10377). Prepared for Victoria Gold Corp.

ATTACHMENT A:
PRELIMINARY CWTS DRAWINGS





Section A



Section B

Quantities

Item	Quantity	units
General Fill (CWTS Sub-Base)	140,000	m^3
Cut	57,000	m^3
Substrate	4,100	m^3
Treatment Area (Aerobic)	0.87	ha

Scale: 1:750

Meters: 0, 12.5, 25, 50

Revision History

Rev.	Description	Date
B	Draft for review	2022-09-28
A	Draft for review	2022-09-21

Engineer's Seal

PRELIMINARY NOT FOR CONSTRUCTION

	Name	Date
Design	K. Boldt	2022-09-28
Drawn	K. Boldt	2022-09-28
Checked	R. Martz	2022-09-28
Approved	J. Harrington	2022-09-28

Project/Drawing Information

Project Name	Eagle Mine - Reclamation and Closure
Project Number	ECA22YT00233
Project Location	Eagle Mine, Yukon Territory

Drawing Name

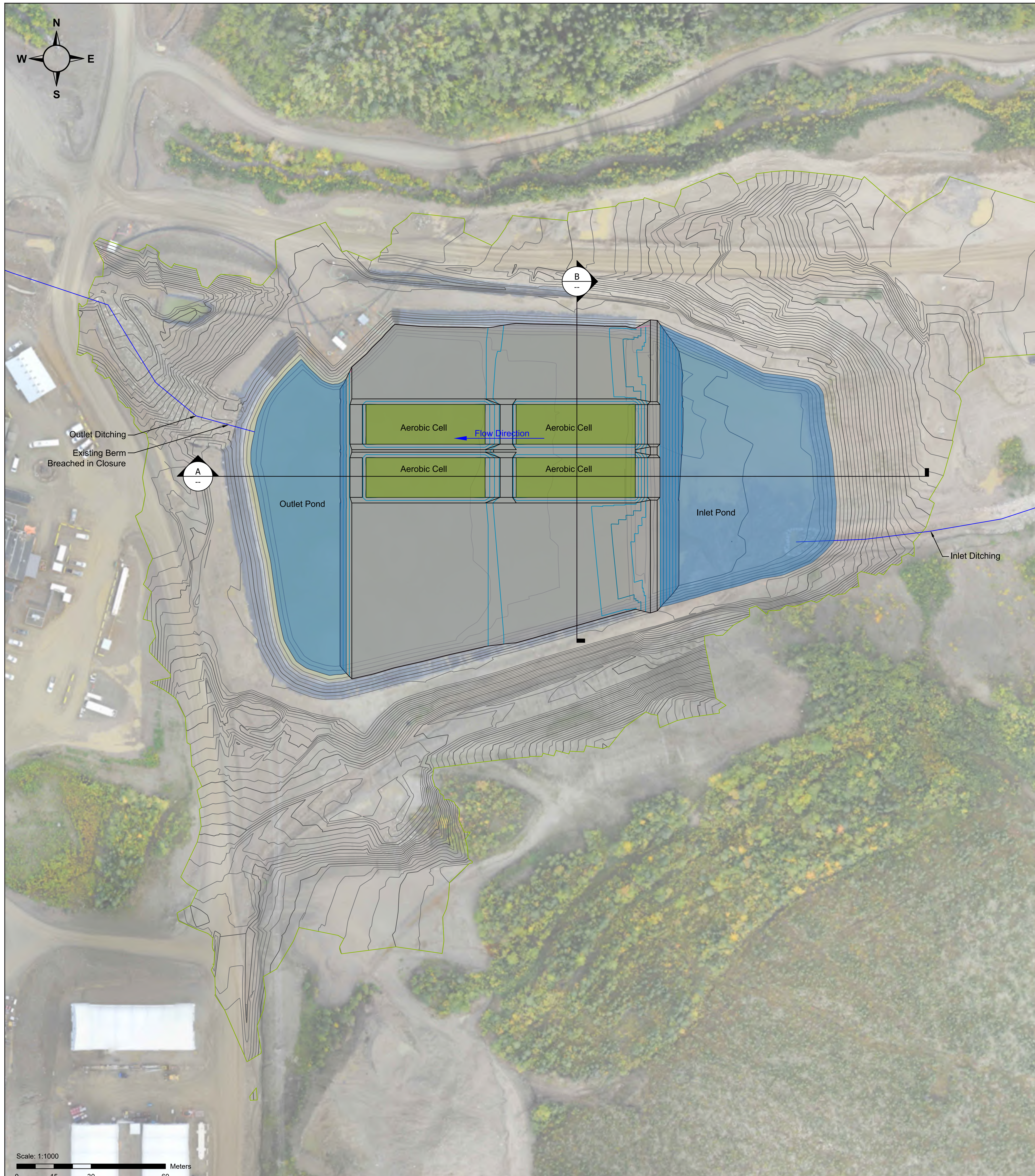
Platinum Gulch
Constructed Wetland Treatment System
Preliminary Design

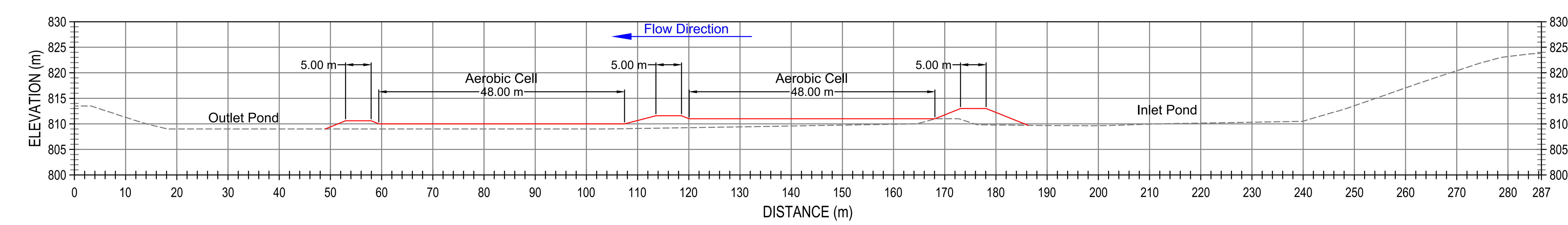
Drawing Number

ECA22YT00233-C-302

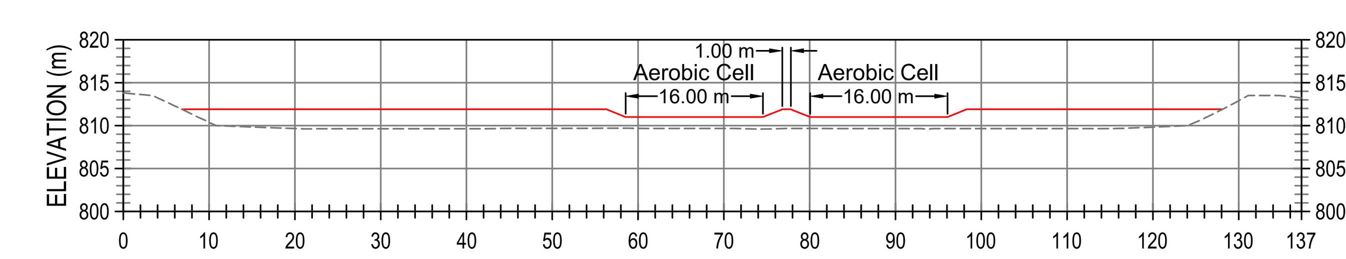
ENSERO solutions
#3 Calcite Business Centre, 151 Industrial Road
Whitehorse, YT Y1A 2V3

Victoria Gold Corp





Section A



Section B

Quantities

Item	Quantity	units
General Fill (CWTS Sub-Base)	31,000	m^3
Substrate	1,400	m^3
Treatment Area (Aerobic)	0.31	ha

Scale: 1:750
0 12.5 25 50 Meters

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Revision History

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Design	K. Boldt	2022-09-28
Drawn	K. Boldt	2022-09-28
Checked	R. Martz	2022-09-28
Approved	J. Harrington	2022-09-28

Project/Drawing Information

Project Name	Eagle Mine Reclamation and Closure
Project Number	ECA22YT00233
Project Location	Eagle Mine, Yukon Territory

Drawing Name

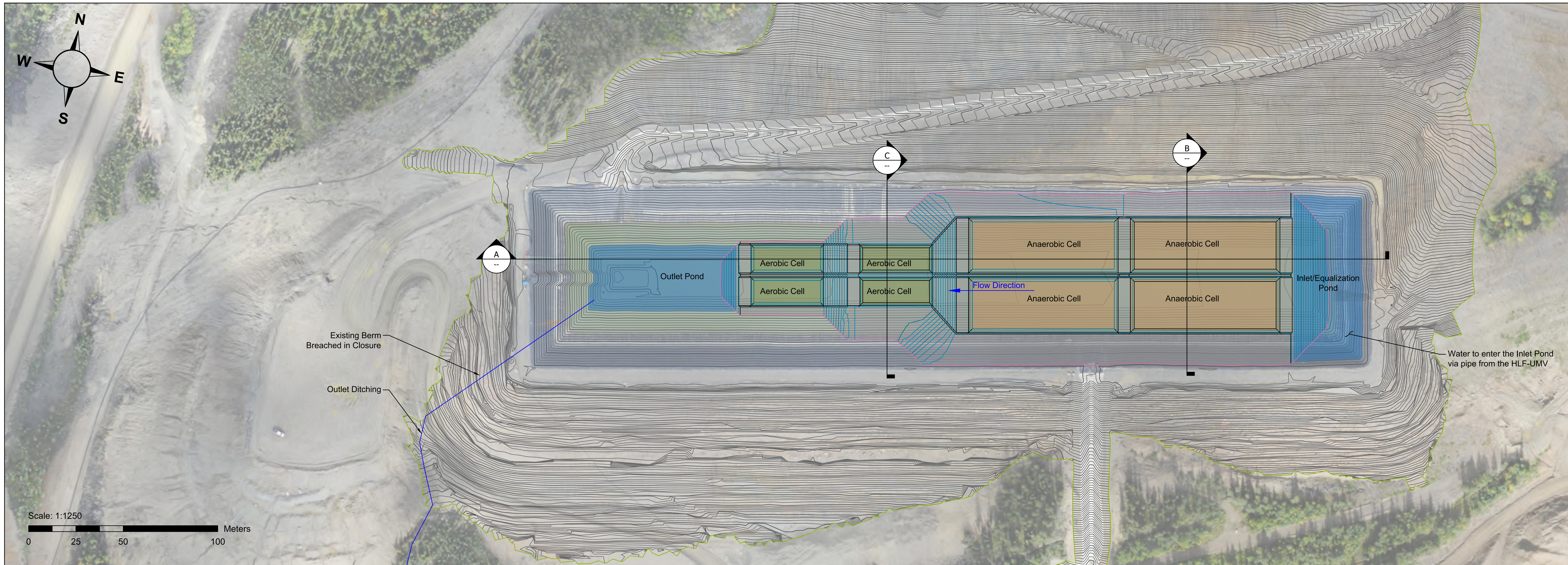
Lower Dublin South Pond
Constructed Wetland Treatment System
Preliminary Design

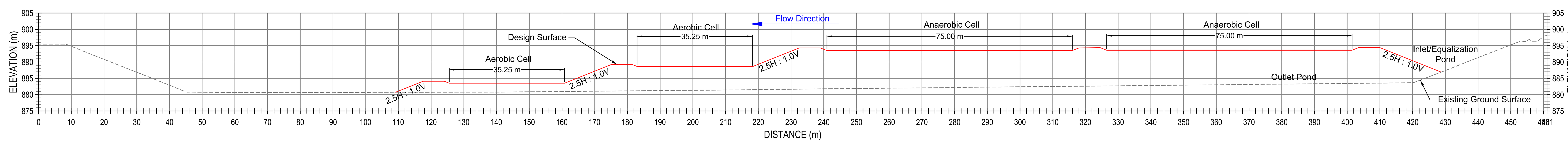
Drawing Number

ECA22YT00233-C-300

ENSERO solutions
410-885 Dunsmuir St
Vancouver, BC V6C 1N5

Victoria Gold Corp





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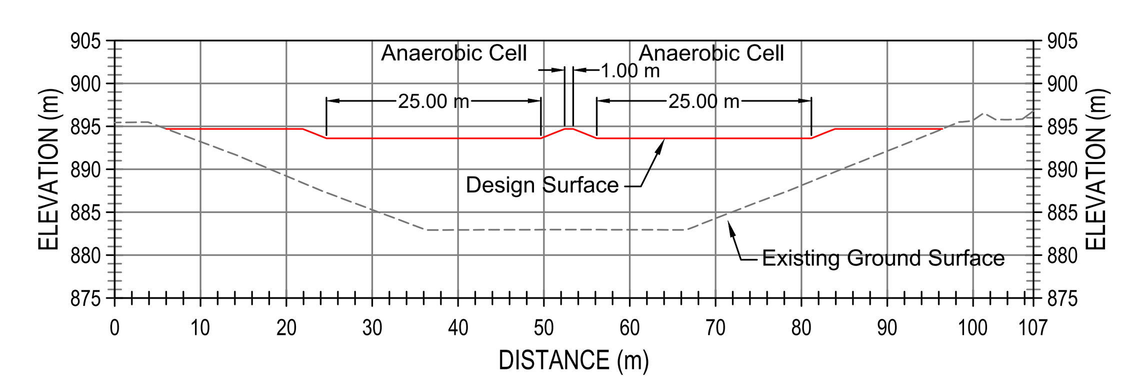

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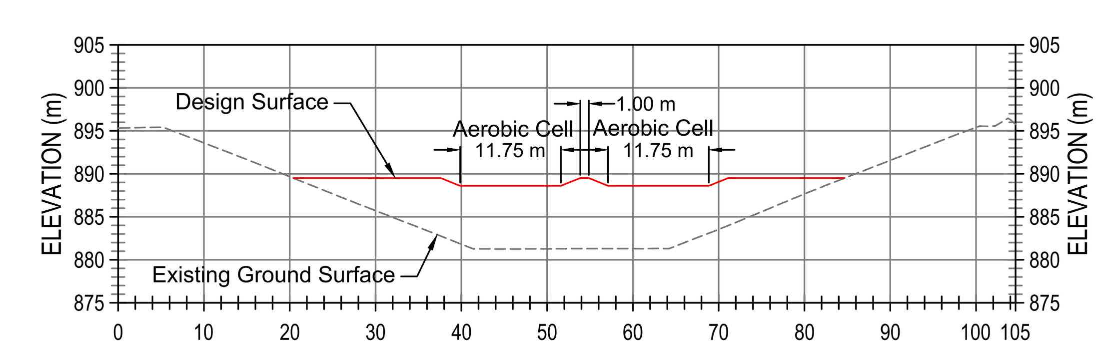

Section C

Quantities

Item	Quantity	units
General Fill (CWTS Sub-Base)	155,000	m^3
Substrate	4,250	m^3
Treatment Area (Anaerobic)	0.75	ha
Treatment Area (Aerobic)	0.16	ha

Scale: 1:750
0 12.5 25 50 Meters

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PRELIMINARY NOT FOR CONSTRUCTION

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Design	K. Boldt	2022-09-28
Drawn	K. Boldt	2022-09-28
Checked	R. Martz	2022-09-28
Approved	J. Harrington	2022-09-28

Project/Drawing Information

Project Name	Eagle Mine - Reclamation and Closure
Project Number	ECA22YT00233
Project Location	Eagle Mine, Yukon Territory

Drawing Name

Heap Leach Pond
Constructed Wetland Treatment System
Preliminary Design

Drawing Number

ECA22YT00233-C-301

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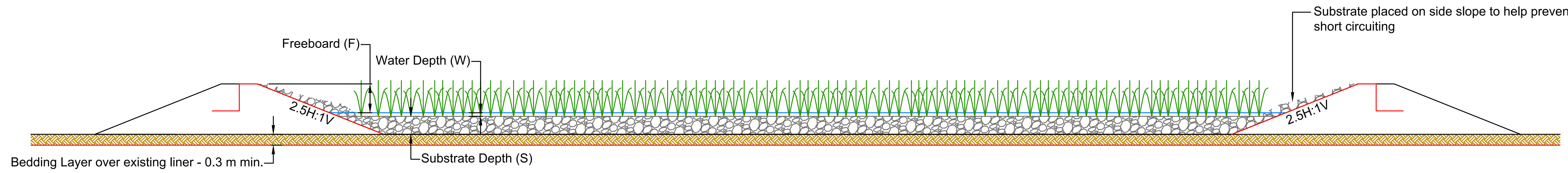
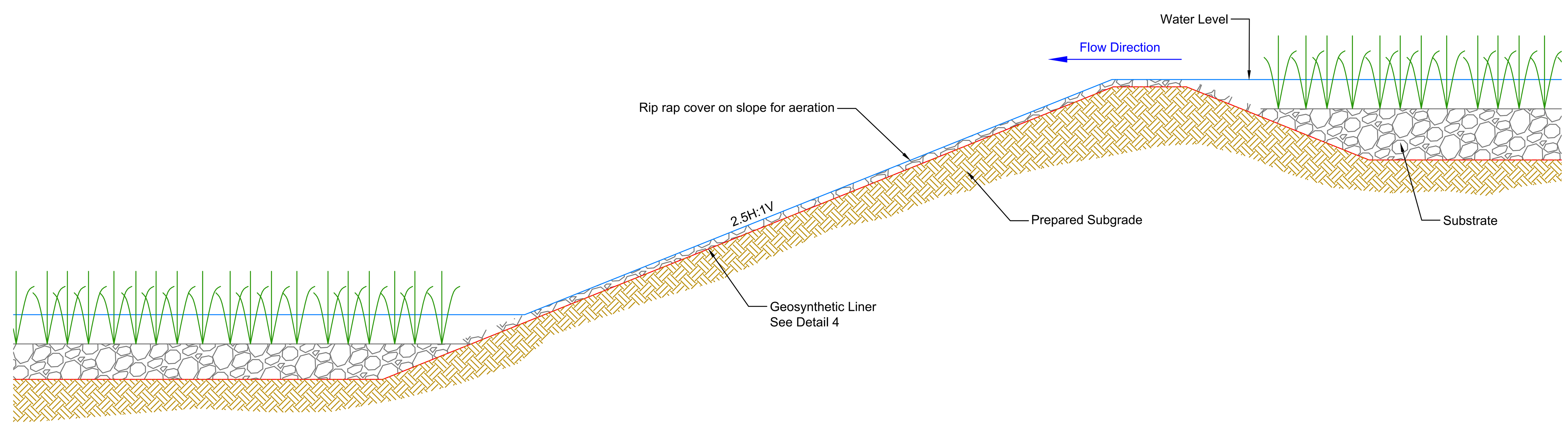
Victoria Gold Corp

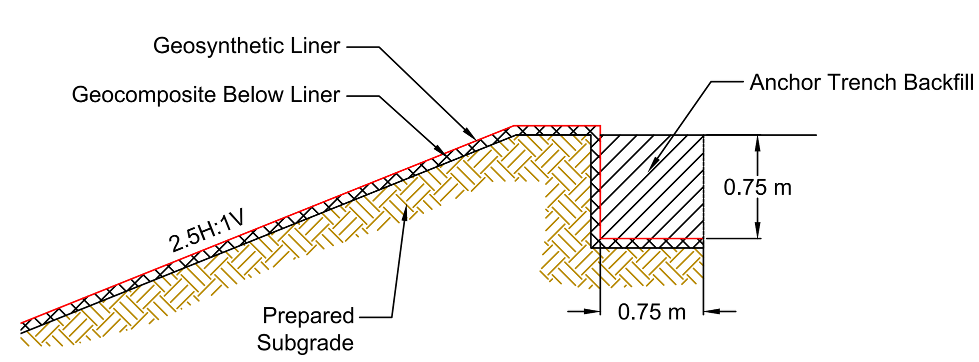


	Anaerobic	Aerobic
Parameter	m	m
F	0.3	0.3
W	0.4	0.1
S	0.5	0.5

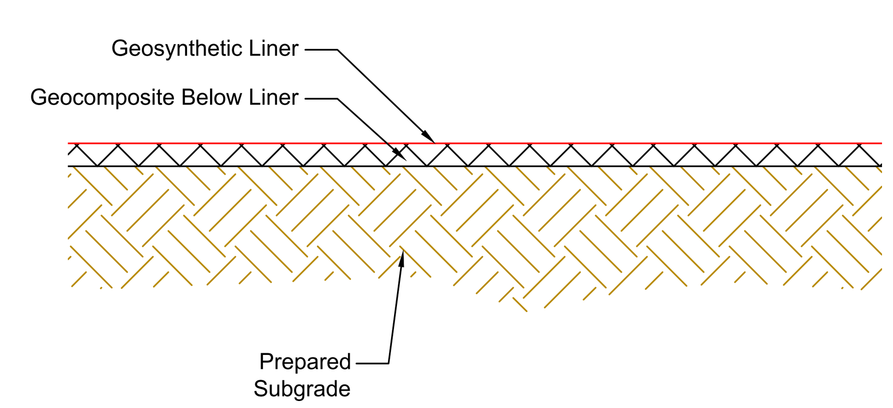
1 CWTS Typical Cross Section
N.T.S



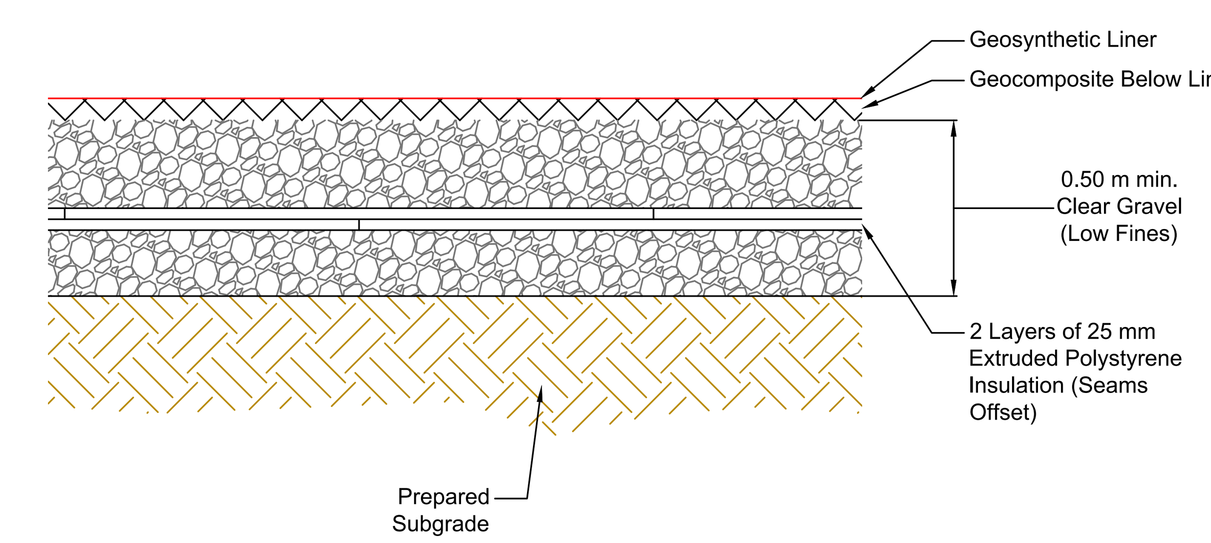
2 CWTS Typical Profile Between Cells
N.T.S



3 CWTS Liner Anchor Detail
N.T.S



4 CWTS Liner Detail
N.T.S



5 Typical Permafrost Protection (Platinum Gulch)
N.T.S

Revision History		
B	Draft for Review	2022-09-28
A	Draft for Review	2022-09-21
Rev.	Description	Date

Engineer's Seal

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Project/Drawing Information	
Project Name	Eagle Mine - Reclamation and Closure
Project Number	ECA22YT00233
Project Location	Eagle Mine, Yukon Territory

Drawing Name

Constructed Wetland Treatment System
Preliminary Design Details

Drawing Number

ECA22YT00233-C-700

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Victoria Gold Corp

APPENDIX N

Heap Detoxification 2022 RCP Updates and Clarifications

Memorandum

To: Hugh Coyle Katie Chakhova, Victoria Gold Corp.

From: Jim Harrington, Ensero Solutions Canada, Inc.

Date: October 1, 2022

Re: 2022 RCP Updates and Clarifications

1 Introduction

Ensero Solutions Canada, Inc. (Ensero) was retained by Victoria Gold Corp. (VGC) to provide updates and clarification with respect to biological detoxification for the Eagle Mine (the Site) in closure. The purpose of this memo is to provide additional information to VGC with respect to the in heap biological detoxification as part of an update for the October 2022 revision to the VGC Reclamation and Closure Plan (RCP). This memo especially presents information about In Heap Biological Detoxification in response to issues that have been raised by the Yukon Water Board (YWB) in their Reasons for Decision (RFD) regarding the Reclamation & Closure Plan (Version 2020-01) Review and Security Determination.

2 Issues Identified in the Reasons For Decision

VGC asked Ensero to respond to several questions or issues raised by the YWB in their RFD. These were specifically:

RFD page 12, Sheet T7 Heap Leach Pad, *Quantity of Sugar*.

- The YWB suggested that a 0.5 g/L sugar concentration should be used for the cost estimate. This memo explains in more detail how the ratio of sugar addition is derived and how it should be utilized for deriving bond costs, and in particular the mass of sugar needed based on the projected heap size as of October 2024 (for the 2-yr cost estimate). In addition, the effect of recycling during the two-year Interim Care and Maintenance period on sugar addition requirements is discussed.

- The YWB asserted that the goal of the original column testing was designed to achieve a much lower cyanide level than evidence suggests that the MWTP was designed to treat. This memo addresses the YWB's claim and discusses the expected target cyanide concentrations after biological detoxification, whether there will be requirements for cyanide treatment after biological in-heap treatment, and how column testing results should be used in planning for full scale treatment.

RFD page 13, Sheet T7 Heap Leach Pad, Confirmatory Drilling.

1. The YWB suggested that the scope of work and density of confirmatory drilling should be equal to what was conducted at the Brewery Creek Mine. This memo discusses the need and likely outcome of a confirmatory drilling program while reviewing what was completed at Brewery Creek and how a program should be considered for the VGC heap.

The following sections first reviews the in-heap detoxification processes, and then with that background, the memo provides responses to the issues raised in the RFD.

3 Responses to Issues Raised in the YWB Reasons For Decision

3.1 In Heap Detoxification

During normal heap operations, any heap leach facility operator will stop adding cyanide to the heap in preparation for the transition to closure. During this time, cyanide concentrations will naturally decrease as already formed gold:CN complexes in the heap are "rinsed" out. This was observed at Brewery Creek, where concentrations of total CN were below 10 mg/L prior to the initiation of in-heap biological detoxification. This has also been observed in VGC column studies, where recirculation of solutions alone without any chemical or biological treatment resulted in 98% reduction over 29 weeks of solution recycling (Forte Analytical, 2022 data; similar findings were observed in TetraTech 2014).

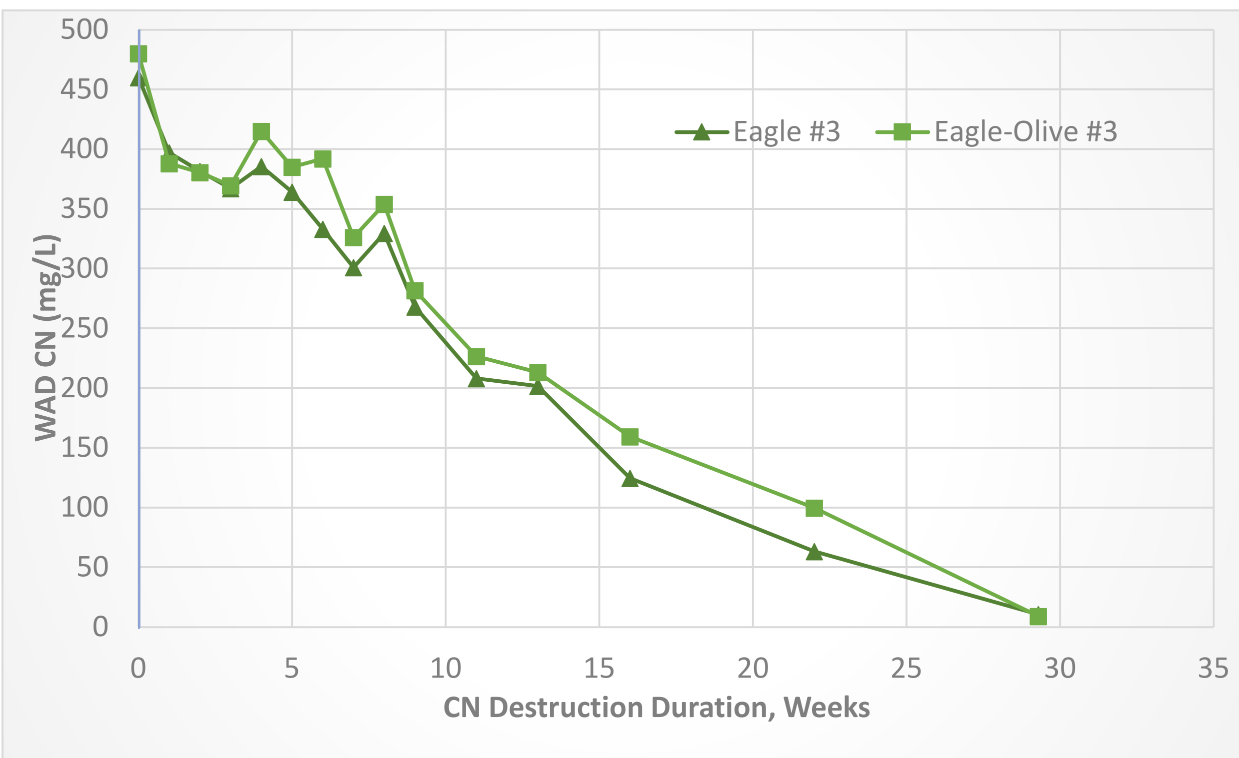

Figure 1. Natural cyanide reduction observed in rinse columns without biological or chemical treatment.

This natural reduction of cyanide during heap recirculation, as the leaching cycle transitions into closure, has also been documented in several published studies, most notably Bowell et al, 2009. They state:

> Cyanide, as Weak Acid Dissociable (WAD) cyanide comprised mainly of divalent metal cation cyanide complexes, occurs at relatively high concentrations in the pregnant pond during leaching operations (10–50 mg/L). Fig. 2 (*not shown here*) shows WAD cyanide concentrations decreasing during the rest period from 12.1 mg/L in March 1999 to less than laboratory detection limits (0.005 mg/L) in August 2000. During recirculation rinsing, WAD cyanide concentrations increase slightly from those observed at the end of the rest period but remain low with the exception of a few measurements just above 2 mg/L.

In the case where there was an unplanned transition to closure, the 2-year time frame associated with Interim Care and Maintenance (IC&M) would provide a longer duration than the planned rinse duration which is more than enough time to allow for naturally reduction of the CN concentrations as shown in the data above. Evidence from these sites and Victoria Gold column studies cited above show that total CN concentrations naturally decrease, whether actively planned or in the case of a period of IC&M. Based on case studies and the column tests, in both cases the starting point for biological detoxification is conservatively estimated to be below 10 mg/L and may be substantially lower. In the case where VGC manages the heap from active leaching transitioned into heap closure, in situ heap detoxification utilizing natural sugars as a treatment reagent would begin when the gold recovery trade-offs show that gold recovery has decreased to the point that further leaching is not economically advantageous. Sugars would then be added to the recirculation solutions over an approximately 1-year period of time on a phased or rotating basis so that sugar-amended solution is recirculated to each area of the heap. These sugars are converted by naturally occurring microbes in the heap, biochemically forming pyruvate from glucose through the universal process of glycolysis as shown in Figure 1. Pyruvate then becomes a treatment reagent that reacts with cyanide and aids in the microbiological utilization of cyanide as a nutrient source.

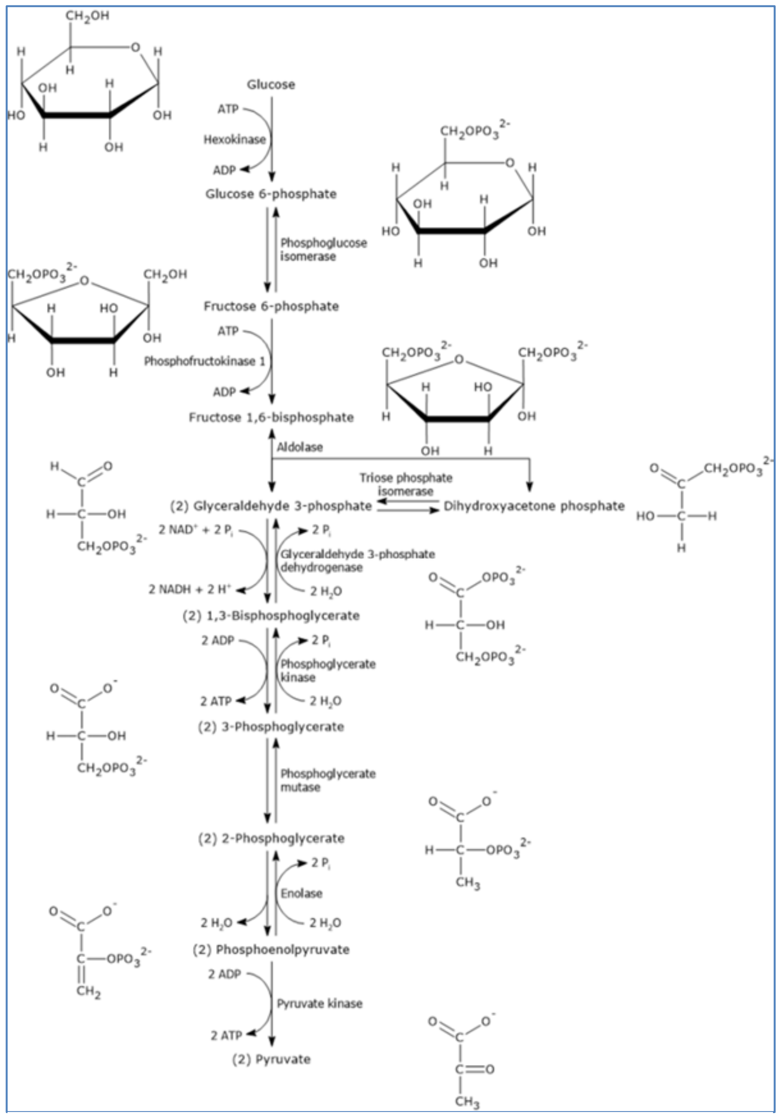

Figure 2. Glycolysis, the microbial process where one mole of glucose is converted to two moles of pyruvate as the first step of in-heap biological treatment.

3.2 Required Quantity of Sugar

In calculating the stoichiometry of required sugar dosing for the Victoria Gold heap as of October 2024, several comments for clarity are needed, as the discussion in the RFD seems to show that previous descriptions of this process have been misinterpreted.

The Board stated that "due to the high degree of uncertainty of how much sugar is required, the Board determines a sugar concentration of 0.5 g/L is appropriate." This concentration is unreasonably high based on the following reasoning. The total quantity of sugars required to support biological degradation of cyanide is a fixed ratio, i.e., 0.5 parts sugar to 1 part cyanide. As described by Kunz, 1998, pyruvate which is produced by the glycolysis process shown in Figure 2 has a reactive carboxylate group that reacts with cyanide. When microorganisms grow with cyanide as a nitrogen source, pyruvate plays an essential role in utilizing CN as a carbon, nitrogen and energy substrate for growth. Pyruvate acts as a "cyanide scavenging agent" to use the term coined by Kunz (1998), appearing in solution as both cyanide and sugars are degraded and consumed. The specific pathway to "scavenge" cyanide is for pyruvate and cyanide to react together and form pyruvate cyanohydrin or 2-cyano-2-hydroxypropanoic acid. This compound is utilized by microbes as a nutrient source (i.e., both as a carbon and nitrogen), and can also be used to create energy by further degrading the pyruvate cyanohydrin to CO_2 and ammonia. It also appears that pyruvate cyanohydrin acts to protect microbial cells from cyanide poisoning and allowing microbes to grow within the heap.

Whether or not pyruvate cyanohydrin is utilized as a nutrient to grow microorganisms within the heap or as an energy source is governed to some extent by the presence of excess sugars. If excess sugars are added, the vast majority of the cyanide ends up as biomass because the cyanohydrin is preferred over glucose as a carbon source for growth. Thus, a carbon:nitrogen ratio of greater than 4:1 is not needed for cyanide detoxification, but provide other water quality benefits in the heap treatment system.

The statement in the RFD (i.e., "VGC's subject matter expert suggested that cyanide destruction would require a range of doses varying from 3:1 to 10:1 which equates to a concentration of sugar ranging from 0.15g/L to 0<5 g/L") suggests that there was a misinterpretation of the following discussion in the RCP which was centered around microbial growth, not cyanide detoxification.

> "Microbial growth is stimulated by the addition of a carbon source at a typical molar ratio of 0.5:1 sugars to cyanide (i.e., 4:1 C:N ratio). In prior heap detoxification experience, this ratio has been highly variable (i.e., as low as 3:1 and as high as 10:1), and other nitrogen species (nitrate/nitrite or ammonia) can be a bigger control on carbon demand." To clarify: the same sugars that are used to support detoxification also stimulate (start the process) of microbial growth, but the further need for a carbon source to support microbial growth for other biological reactions such as denitrification, sulfate reduction etc. in the heap can make the overall ratio of carbon sources added to the heap go up from that 4:1 ratio. The overall heap closure plan includes the heap detoxification (at a ratio of 0.5:1 sugars to cyanide) and also other carbon sources added to pre-treat the water in the in-heap pond prior to the heap solutions discharging from the heap to the passive treatment systems that will be built in the Events Pond.

Thus, the discussion was focused on whether the pyruvate cyanohydrin is utilized exclusively for cyanide detoxification (0.5:1 sugars to cyanide which results in a 4:1 C:N ratio) or whether it is degraded by microbes resulting in the release of other nitrogen species. Notice that in the bond calculation, VGC uses two carbon source calculations, one being for CN degradation and a second one to feed the in-heap bioreactor. In the security estimate worksheet ***T17a Quantities***, there is a Reducing Sugar (or "Nutrient") application rate to the heap for cyanide degradation, and a second carbon source addition quantity for heap bioreactors. This second use of carbon sources can be sugars or alcohols, and for purposes of the prior bond calculation methanol was used (402 tonnes).

Thus, the inclusion of 402 tonnes of methanol creates a total C:N ratio higher than 4:1. This additional carbon source results in not just cyanide detoxification, but some additional removal of nitrogen compounds, reduction of sulphate, and some reduction of metals can also be expected from previous experience. The RCP uses methanol as this carbon source in the formation of the bioreactor, which will further polish any CN not treated in the unsaturated portion of the heap, and also consume nitrates, ammonia, and yield some amount of sulfate reduction. As shown in Table 2-1, this additional carbon source adds enough carbon source to make the overall ratio of C:N in the heap to become just over 5:1.

Table 3-1: October 2024 Heap Detoxification Design Calculations

Parameter	Design Basis	Source/Rationale
Heap Mass	49,000,000 tonnes	Victoria Gold
Heap Surface Area	693,000 m2	Victoria Gold
In-Heap Pond Storage	59,378 m3	Victoria Gold
Treatment Objective	0.03 mg/L	WUL EQS for CN
Active Leaching moisture content (high)	14.35% by weight	Forte Appendix F
Active Leaching moisture content (low)	11.46% by weight	Forte Appendix F
Active Leaching moisture content (midpoint)	12.91% by weight	Calculated
Total Contained Volume heap pore water	6,323,450 tonnes/m3	Calculated from average case
Total Contained Volume (Pore + In-heap pond water)	6,382,828 m3	Calculated
Conservatively assumed total CN concentration	50 mg/L	VC column studies, Brewery Creek experience, Bowell 2009, other Ensero experience in similar heaps
Total mass CN in heap solution	319,141,400 grams	Calculated
Moles total CN	26 grams/mole	Cyanide formula weight
Total moles CN in heap solution	12,274,669 mole CN	Calculated
Reducing sugar (glucose) molecular weight	180 grams/mole	formula weight C6H12O6
Ratio reducing sugar:CN	0.5:1	Glucose yields 2 pyruvate which creates 2 pyruvate cyanohydrins to support microbial CN degradation
Formula pyruvate cyanohydrin	$H_5C_4NO_3$	Kunz et al, 1998 (note pyruvate cyanohydrin has a 4:1 C:N ratio)
Moles sugar required	6,137,335 moles	At 0.5:1 sugar:CN ratio
Mass sugar required	1,104,720 kg	Cyanide detoxification via pyruvate cyanohydrin formation
Mass sugar required	1,104 tonnes	conversion
Cost of sugar	CAD $0.79/kg	https://www.selinawamucii.com/insights/prices/canada/sugar/

Parameter	Design Basis	Source/Rationale
CAD:USD	$0.73	https://www.bankofcanada.ca/rates/exchange/daily-exchange-rates/
Total cost sugar	$877,723	calculated
Methanol	402 tonnes	Documented in T17a (to create in heap bioreactor)
Methanol molecular weight	32 grams/mol	Formula weight CH_3OH
Methanol	12,562,500	calculated
Ratio CN:Methanol	1.02	
Total C:N ratio all heap treatment	5.02 C:N	

3.3 Effect of Recycling During Interim Care & Maintenance

Under an IC&M scenario where the mining company is not actively managing the transition from leaching to closure, for bond calculation purposes the heap treatment timing would be assumed to begin at the end of the 2-year IC&M period. As noted above, at that point total CN concentrations would be expected to be less than 10 mg/L and likely substantially lower. For clarity, there is no requirement for this delay in implementation (i.e., to wait for the IC&M period to fully elapse), but it is economically advantageous to wait to initiate the biological treatment when the natural degradation processes have substantially improved the heap chemistry, and then the in-heap biological treatment process serves to actively degrade cyanide both in the draining porewater and the nonflowing porewater. The biological treatment of the heap will be done with the same pumping loop as water is recirculated to the top of the heap for solution management, with areas designated for treatment receiving the biological nutrient addition on a phased or rotating basis during the second year of the IC&M period so that sugar-amended solution is recirculated to each area of the heap.

3.4 Role of the In-Heap Bioreactor in In-Heap Biological Treatment

The in-heap pond will act to integrate all the flow paths within the heap, creating a final reaction zone for heap detoxification. The additional carbon source added in the in-heap bioreactor will further polish any cyanide not fully removed in the heap pore water. As cyanide concentrations decrease and draindown has been completed the purpose of the in-heap bioreactor will transition from cyanide detoxification to a bioreactor that removes nutrients (nitrate, nitrite, ammonia) and creates sulfate reducing conditions that have been shown to reduce dissolved metals and metalloids (e.g., antimony, arsenic, cobalt and selenium) in previous bioreactor studies, including studies on synthetic VGC heap drainage (Janin et al, 2015).

3.5 HEAP DRILLING PROGRAM FOR CONFIRMATORY SAMPLING

Brewery Creek Mine heap was detoxified using a biological process that is similar to what is proposed for the Victoria Gold heap. The RFD mentions the Brewery Creek heap drilling program and suggests it should be used as a model for what is proposed to be done for VGC.

From Mining and Petroleum Environment and Research Group (MPERG) Report 2009-4:

> "The Brewery Creek Mine heap leach pad was detoxified in 2002-2003 by using a biological reduction process through the introduction of nutrients into the recirculating solution applied to the leach pad. As

part of the Decommissioning and Reclamation Plan (DRP) Viceroy proposed and committed to conducting a solids sampling program on the Brewery Creek heap to verify destruction of free cyanide. The primary objective of the heap solids program was to collect and analyze representative samples and determine the level of free cyanide remaining in the heap. Reactive free cyanide is the driving force for instability in the heap. The destruction of reactive free cyanide remaining in the heap is demonstration of the lack of a driving force for remobilization of reduced metals. In addition to free cyanide, moisture, extractable metals and paste pH were analyzed on composite and individual samples."

It is important to remember that at that time, the biological treatment technology had not been utilized in the Yukon or other northern locations, and knowledge of its effectiveness and whether it would suffer from "bounce back" increases in cyanide concentrations during subsequent rinsing was not yet demonstrated. Thus, back in 2003 the proposed confirmatory drilling work was performed at a higher density of sampling (41 drillholes) than what would be needed today because the proof of concept had not been demonstrated at that time.

From Mine Decommissioning & Reclamation Plan Executive Summary (2003):

> "The detoxified heap was drilled and sampled in September 2003. A total of 41 holes were drilled across the heap on a uniform grid pattern. The leach pad sampling grid was presented in the 2001 Decommissioning and Reclamation Plan, Volume IV, Attachment 6. Both composite and individual samples were collected."

The results of that program documented that the heap effluent and the heap pore water were similar in composition and that the pore water did not present a threat of an untreated source releasing back into the flowing heap drainage. This was important to note because the heap drainage from Brewery Creek was ultimately land applied. Further, the level of monitoring frequency was decreased after the initial drain down as a result of this proof of complete in-heap treatment. These findings suggested that the high density of drillholes was not necessary.

Importantly, the VGC heap closure strategy is not exactly analogous to the Brewery Creek heap. VGC is not proposing to land apply their drain down solutions. VGC is committing to have active treatment for all of the heap solutions for metals, nutrients, etc. and will be capable of cyanide detoxification in the HLF water treatment facility should it be needed. Further, after the active drain-down is completed, the in-heap bioreactor, the two-stage passive treatment system in the Events Pond, and the ongoing monitoring and demonstration of complete treatment is quite different than what was done at Brewery Creek. For these reasons, the paste pH and the metals extraction testing that was done at Brewery Creek should not be required for the Victoria Heap.

With respect to the need for in-heap documentation of successful detoxification, the need to place a heap cover in a timely manner does support the use of some drill sampling of the heap to show that the treatment reactions are complete and that further in-heap treatment is not required. However, a linear extrapolation of the Brewery Creek sampling frequency and intensity is not appropriate for several reasons.

1. Biological heap leach detoxification has been documented to a greater extent than was known at the time of the Brewery Creek Closure:

    a. The level of understanding of in heap treatment mechanisms has continued to improve, while some aspect of "black box" existed at the time of the Brewery Creek treatment.

    b. The understanding of water migration in heaps both for gold extraction and for in-heap treatment has continued to improve.

c. The number of treated heap facilities successfully closed has increased since the days of Brewery Creek. Brewery Creek itself established the viability of this technology in the Northern environments.

d. Victoria Gold has performed column tests that are successful in the heap materials, which further validates that this technology should be successful to detoxify cyanide in the heap.

The heap drainage is itself the most accurate reflection of the pore water. The data from the heap drainage will show an integrated chemistry of all the flowing drainage in the heap. As the heap is treated the pore water measured in the heap should be compared to the heap drainage and if there is consistency in the samples such that the heap pore water is less than or equal to the heap drainage then fundamentally the statistical evaluation is the comparison of the means of the drainage chemistry over the period of time after the heap drainage has become chemically stable with respect to CN concentrations post treatment vs. the mean of the heap materials pore water with respect to CN concentrations post treatment. For this type of test, the when the number of samples exceeds 30 for each type of sample then the population can be compared on the basis of a normal distribution using the t-test. For this test, the sampling locations should be equally distributed across the heap. When the number of samples used to calculate each population mean (heap drainage and heap pore water) is sufficiently large (i.e., >30) then it is reasonable to say that if 30 randomly distributed samples show the same result it is not reasonable to think that more samples will show a different result.

In Maest et al 2005, several distinctions are made that are relevant:

…during the postclosure phase potential water quality impacts are better known and the mine site can be characterized with a higher degree of certainty."

"As the mine matures, the amount and degree of useful characterization information increases substantially, allowing for either confidence in the original source characterizations and water-quality predictions, or the realization that errors in previous characterization and predictive work may require changes in the site conceptual model."

"More homogeneous materials such as tailings would require fewer samples than the more heterogeneous waste rock at any given site. This approach reflects the fact that fundamental error, which results from the compositional heterogeneity of particles, is often the main source of sampling error… If the population is very heterogeneous or the particle size is large, more sample mass is required to minimize the fundamental error associated with sampling… Fewer samples should be required for tailings than for waste rock, wall rock, and other types of heterogeneous material."

"Compositing of samples is only recommended for mined material that is consistent in size and composition, for example, existing tailings material that is known to be from a consistent ore type and a single process."

How this applies to sampling the VGC heap:

a. The heap is and will be relatively homogeneous with respect to texture, grain size distribution and so as noted above would require fewer samples.

b. The heap is and will continue to be well characterized such that zones of known variability will be known and the sampling program can be tailored to make the distribution match the variability of the heap zones.

c. The number of samples should be relevant to not just the volume but the surface area. Because the heap has been leached and treated vertically, the surface area should reflect the variability more than the volume should.

d. Compositing heap samples is appropriate since the material has been crushed to be similar size and composition.

Based on this input, Ensero recommends the following heap sampling framework:

- As the heap is treated, water quality in general and specifically cyanide concentrations in the heap drainage will approach equilibrium as drainage from each treated area reached the in-heap pond.

- A minimum of three months after the last in heap detoxification area has been treated, the heap should have a single core taken to depth on each area of the heap (based on the solution application rate up to 12 zones of sugar application are expected) using a drill method with a high level of core recovery (sonic or split spoon augur drill rig).

- Each hole should have a near surface, a mid heap, and a deep heap composite made (i.e., 36 composites) using three subsamples from each 10 m lift or expected to be on average 6 samples total per two lifts on average for each composite up to 60 meters per hole (i.e., 720 meters maximum drilling, with several of the holes being shorter where fewer lifts are present).

- The composites should be sampled for meteoric water mobility protocol (MWMP) or similar leach tests to simulate rainwater or snowmelt percolation into the heap.

- The leach extraction from each composite should be compared to the heap drainage chemistry with respect to cyanide parameters only. Because all other parameters are being treated in subsequent stages (bioreactor, HLF WTP, anaerobic and aerobic constructed wetlands) metals, nitrogen compounds etc. are not relevant to answer the question of was the heap detoxified successfully.

In summary, this recommended sampling protocol will have 12 locations each yielding 3 composite samples for a total of 36 samples. These 36 samples will be compared to the heap drainage observed around the time of the drilling program for comparison of the mean cyanide concentration in heap pore water vs. the mean cyanide concentration in heap drainage. This sampling framework should provide sufficient data to answer the question of has the heap detoxification program been successful to provide heap drainage that does not require further treatment as documented by the HLF effluent chemistry, and whether the pore water is of similar composition with respect to cyanide as the heap drainage.

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