



EAGLE GOLD PROJECT

RECLAMATION AND CLOSURE PLAN

Version 2016-01

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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
ML	metal leaching
MLU.....	Mining Land Use
MWh/y.....	megawatt hours per year
NSR.....	net smelter return
PLS	pregnant leach solution
Project.....	Eagle Gold Project
PTS	passive treatment system
QMA	<i>Quartz Mining Act</i>
QML	quartz mining licence

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RoW	right of way
RRC	removal rate coefficient
RSA.....	regional study area
SCP	seepage collection pond
SGC	StrataGold Corporation
UTM	Universal Transverse Mercator
VIT.....	Victoria Gold Corp.
WMP	water management plan
WRSA	waste rock storage area
WUL	Water Use Licence
MWTP	mine water treatment plant
YESAA	<i>Yukon Environmental and Socio-economic Assessment Act</i>
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

StrataGold Corporation (SGC), a directly held, wholly owned subsidiary of Victoria Gold Corp. (VGC), has proposed to construct, operate, close and reclaim a gold mine in central Yukon. The Eagle Gold Project ("the Project") is located 85 km from Mayo, Yukon using existing highway and access roads (Figure 1-1). The Project (Figure 1-2) will involve open pit mining at a production rate of approximately 10 million tonnes per year (Mt/y) ore, at an average strip ratio (amount of waste: amount of ore) of 1.45:1.0 and gold extraction using a three stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over a 10 year 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.

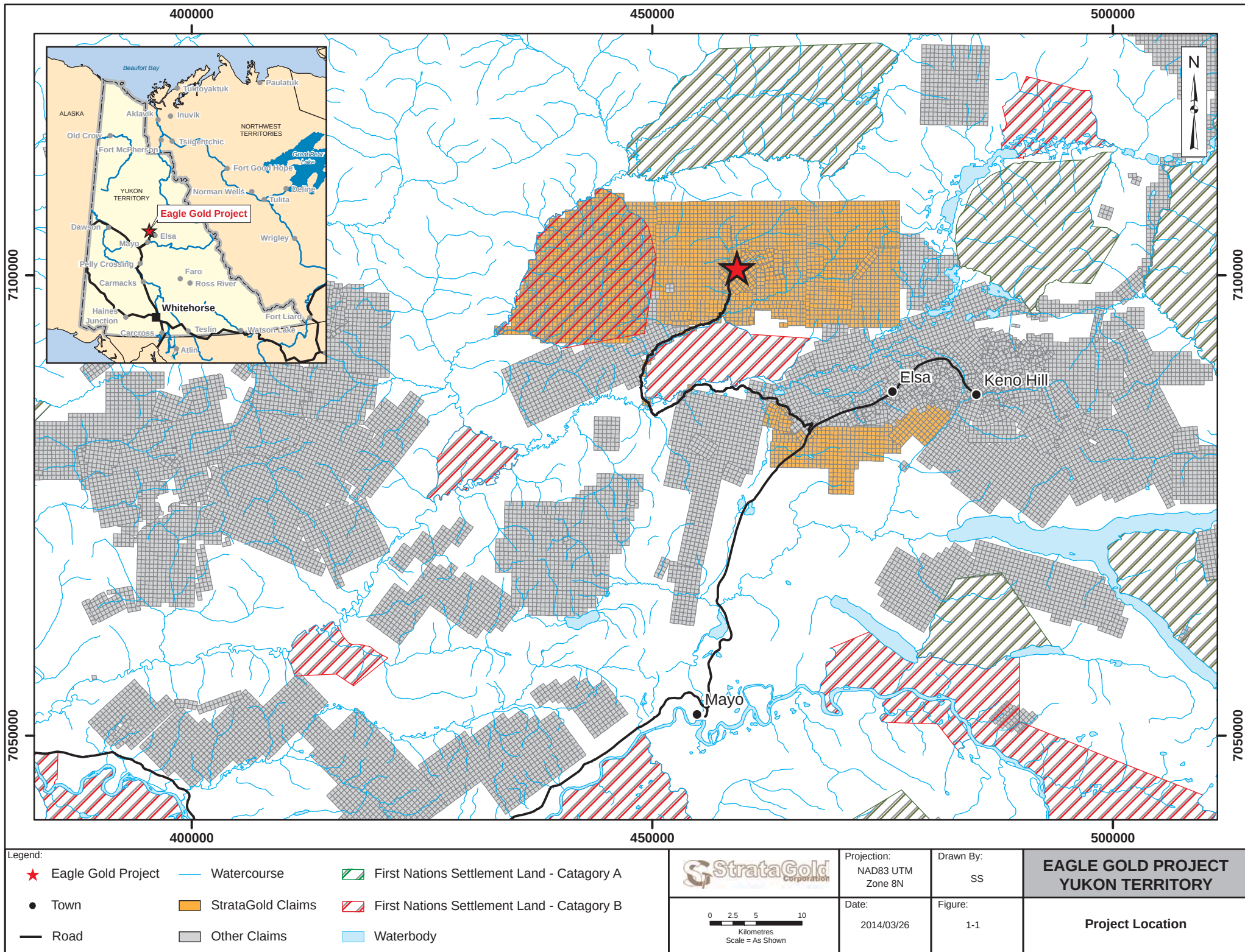
The Project has received regulatory approvals that allow the construction, operation and closure pursuant to the Yukon Waters Act, which covers the administration of Type A and B Water Use Licences (WUL) and the Yukon Quartz Mining Act, which covers the administration of Quartz Mining Licences (QML).

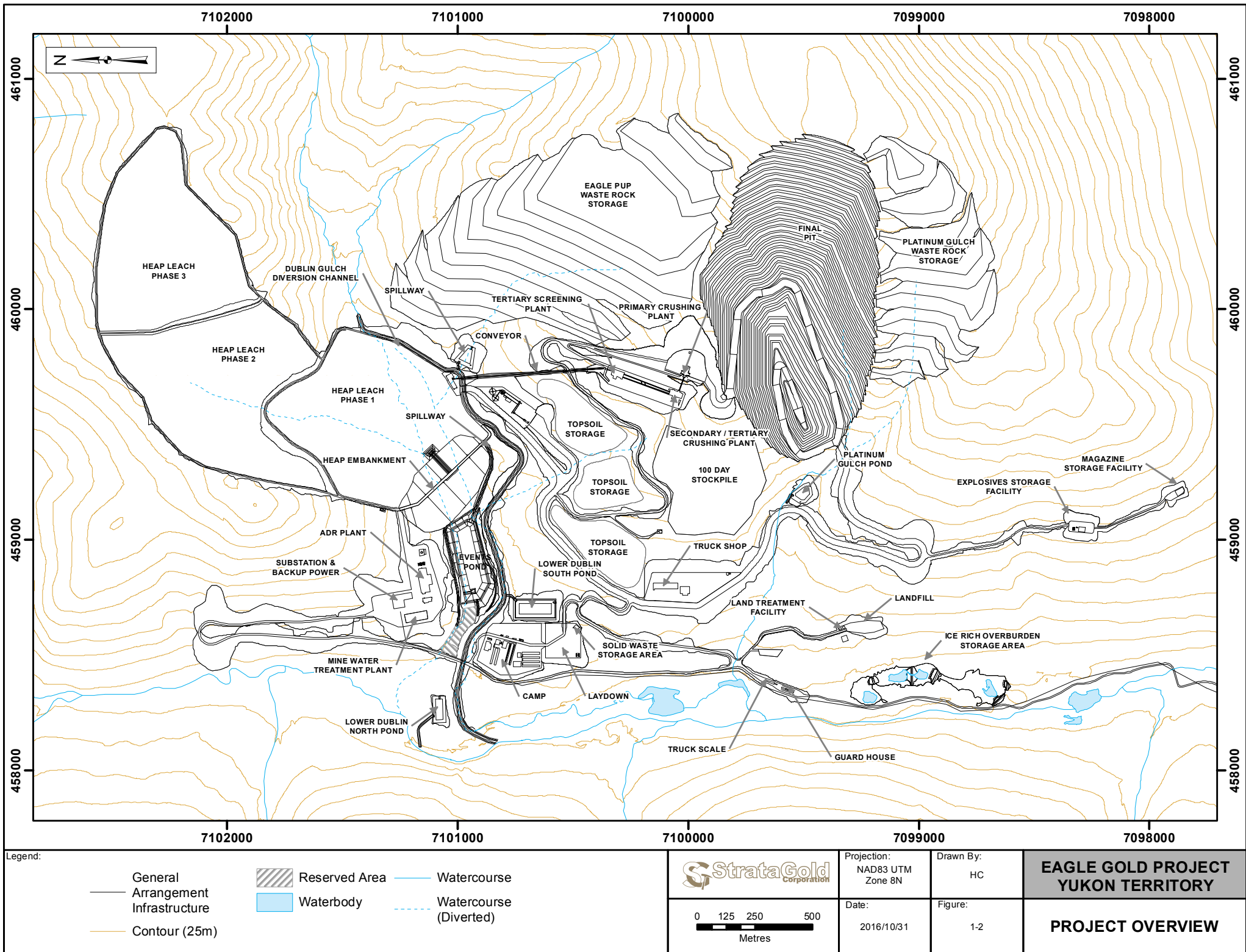
Version 2016-01 of the RCP has been revised based on information provided by the Yukon Water Board (YWB), Yukon Government, the First Nation of Nacho Nyak Dun (FNNND), and other interveners during the regulatory approvals phase of the Project. The revisions to this version of the RCP include:

- General updates to address issues identified and guidance provided during the regulatory process;
- Phased research programs to support final detoxification of the heap leach facility (HLF);
- Phased research programs to support the construction of store and release covers for the HLF and waste rock storage area (WRSAs); and,
- Updates to the security estimates for closure of the Project.

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 and QML-0011 issued for the Project through utilization of the Department of Energy, Mines and Resources (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.





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 conduct until mitigation measures have achieved the closure objectives. The focus of the RCP is to guide the return of the site to appropriate and functional ecosystems, similar to predevelopment conditions, while meeting key end land use objectives. The objectives of the RCP are to address water quality, physical stability (stable landforms), land use, aesthetics, and public health and safety.

Since 2009, VGC has worked with stakeholders (e.g., FNNND, YG) to refine the project, and then develop closure objectives and proposed closure methods for the Project site, and this dialogue is ongoing in the context of further refinements of objectives and reclamation research programs. Section 2.1 below presents a brief outline of the current status of reclamation and research planning for the Project site and Section 10 outlines the ongoing and planned reclamation research for SGC's closure planning.

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 2008). 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.

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. While SGC has received a Type A WUL and a QML, the project has not yet begun construction. Consequently, this plan has been updated to reflect discussions and commitments made during the regulatory processes in 2015 and 2016 and plans for studies required in the licence.

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:

- Soil Covers;
- Revegetation;
- HLF Detoxification;
- Groundwater Attenuation; and
- Passive Water Treatment.

The relative success of these specific closure methods at the Project site compared with expectations derived from evidence documented from other applications and projects in other similar sites will be dependent on a number of site-specific conditions. A reclamation research program has been developed and initiated to provide

proof of concept for these techniques in the Project setting. Major elements of the reclamation and closure research programs are presented in Section 10.

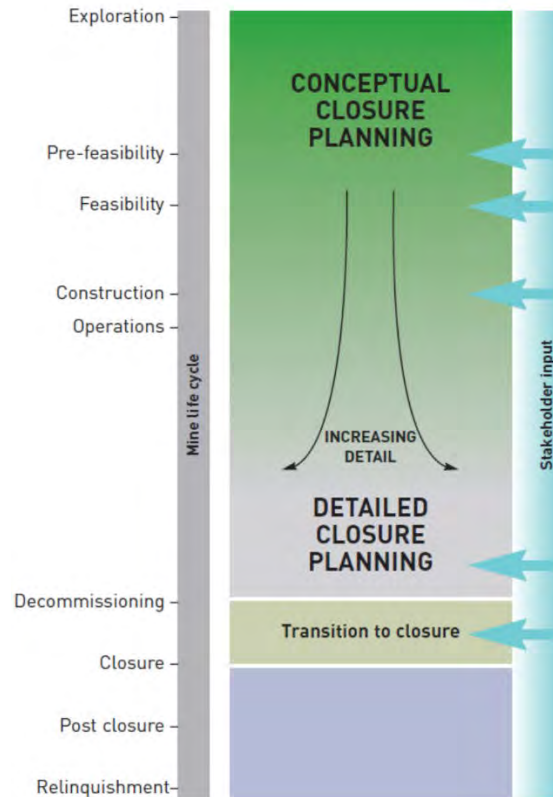


Figure 2-1: Continuum of Closure Planning Relative to Mine Life Cycle

2.2 CLOSURE OBJECTIVES, PRINCIPLES AND REGULATORY GUIDANCE

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 Project, in the context of closure planning that is objectives-based.

Table 2-1 below includes reclamation and closure objectives to be achieved during all stages of reclamation and closure projects in Yukon and their accompanying value. Information from this table has been incorporated into the development of closure objectives in Section 3.

Table 2-1: 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 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.

2.3 FIRST NATION OF NA-CHO NYAK DUN ENGAGEMENT

VGC and its subsidiary SGC have engaged in a wide range of consultation activities and have made early and ongoing consultation with the FNNND a priority to ensure an opportunity for input at all key stages of Project development. A number of workshops on mine closure and reclamation have been conducted along with site visits.

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 0.

2.4 STAKEHOLDER ENGAGEMENT

As mentioned above, VGC has consulted with FNNND and also engaged with the Village of Mayo, local trappers, the Mayo District Renewable Resource Council, Yukon Conservation Society, local outfitters, and placer mine operators. To ensure consistent and frequent communication, VGC has produced twelve newsletters which were sent to the general public with the objective of keeping all informed of Project developments.

Consultation efforts carried out have been well received and well attended. FNNND and the community response to the Project have generally been positive and opportunities for potentially affected parties to raise concerns, and for VGC to respond directly, have been a fundamental component of the consultation program.

On January 21, 2011, the YESAB Executive Committee determined that VGC met the statutory requirement under Section 50(3) of YESAA to consult with the FNNND. VGC has continued to engage in consultation with interested stakeholders subsequent to submission of the Eagle Gold Mine Project Proposal.

2.4.1 Comprehensive Cooperation and Benefits Agreement

VGC and the FNNND signed a comprehensive Cooperation and Benefits Agreement (CBA) on October 17, 2011. The CBA replaced an earlier Exploration Cooperation Agreement and 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 Project.
- Provide business and employment opportunities, related to the Project, 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 Project and the promotion of environmental stewardship.
- Set out financial provisions to enable the FNNND to participate in the opportunities and benefits related to the Project.
- Establish a forum for VGC and the FNNND to discuss matters related to the Project and resolve issues related to implementation of the CBA.

2.4.2 Community Meetings

Various community meetings, workshops and open houses have been held with the FNNND leadership, staff, and citizens as well as the Village of Mayo leadership, residents, and other interested parties. These sessions provided Project updates as well as specific presentations on key aspects of the Project. In general, meetings and workshops have been attended by VGC corporate executives and have included a presentation followed by a formal question and answer session. Participants also had the opportunity to provide written comments on comment cards.

2.4.3 Meetings with FNNND

Meetings with the FNNND Chief and Council, FNNND executive, management, and staff have taken place on a regular basis beginning prior to the submission of the Eagle Gold Mine Project Proposal. In addition to these meetings, representatives from the FNNND have participated in or been invited to participate in ongoing environmental baseline monitoring conducted at Dublin Gulch for the Eagle Gold Project. VGC appreciates the participation and support provided by the FNNND to the baseline data collection that includes climate, hydrology, hydrogeology, and water quality.

2.4.4 Guided Site Tours

As part of the preparation for the submission of the Project Proposal in December 2010, VGC sponsored guided site tours for the FNNND leadership, elders, youth and staff, Village of Mayo, and the Mayo Renewable Resource Council. The purpose of the tours was to gain a better understanding of existing exploration activities at Dublin Gulch, existing conditions of the Project site, and the location of proposed Project facilities and components. While each tour was unique, each provided the tour group with an overview presentation and the opportunity to view the site from a variety of vantage points with description from VGC management of the construction, operation and closure of the Project. After the tours, the group reconvened for questions, answers, and comments.

2.4.5 Meetings with Regulatory Agencies

Engagement with assessors, federal and territorial regulators, and other agencies have been regular, pro-active, and ongoing since the submission of the Eagle Gold Mine Project Proposal. A key objective of VGC's regulatory engagement approach has been to ensure an understanding of assessment and licensing requirements and expectations. Ongoing discussions with YESAB and decision bodies have been conducted to support each stage of the assessment of the Project Proposal.

3 CLOSURE OBJECTIVES AND DESIGN CRITERIA

3.1 RECLAMATION AND CLOSURE OBJECTIVES

An objectives-based approach has been adopted for the development of SGC'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 project components. For each closure objective, proponents propose a set of closure options 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 Eagle Gold Project, 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 SGC project 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 (2008) directly relate to the closure goal and closure principles required for a 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 (YG 2008).

3.1.4 Closure Options and Selected Closure Activity

Closure options are potential activities that proponents could take 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 project 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 achieved 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 project (complete);
- Operational – confirms or refutes accuracy of predictions on project effects that were made during the environmental assessment; 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 initial phase of a project will ensure that measurable targets are relevant to achieving the overarching goals of the closure plan. Monitoring of closure components at the Eagle Project will continue until such a time that closure objectives have been met.

3.1.8 StrataGold Reclamation and Closure Objectives

The goal of the SGC 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 SGC site 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 Tables 3-1 and 3-2.

Detailed site-specific objectives presented in Tables 3-1 and 3-2 are defined by factors that include environmental conditions, site conditions and community expectations. They were developed to address

Section 3: Closure Objectives and Design Criteria

physical stability, chemical stability, health and safety, ecological conditions and sustainability, land use, aesthetics, socio-economic expectations, long-term certainty and financial considerations.

Table 3-1: Summary of Decommissioning and Reclamation Planning for Mine Components

Fundamental Objective ¹	Physical Stability	Health and Safety Physical Stability Chemical Stability	Physical Stability Chemical Stability	Physical Stability Chemical Stability	Health and Safety	Land Use Health and Safety	Health and Safety
Component-Specific Activities	Water Retention and Water Conveyance Structures	Open Pit	Waste Rock Storage Areas and Temporary Stockpiles	Heap Leach Facility	Mine Infrastructure	Roads and Other Access	Temporary Closure Site Conditions
Closure Objectives	Ensure decommissioning of, or upgrades to, water retention and sediment control structures, and appurtenances, in such a way that drainage at, and adjacent to the site, is stable in the long term. Convey flows into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions.	Ensure physical and chemical stability of decommissioned pit in accordance with designs. Able to withstand severe climatic and seismic events. Protect humans and wildlife from topographic hazards associated with pit and pit lake.	Ensure long-term physical stability to minimize erosion, subsidence or slope failure. Able to withstand severe climatic and seismic events. Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria.	Ensure drain-down and cyanide destruction are conducted in controlled manner. Ensure long-term physical stability to minimize erosion, subsidence or slope failure. Able to withstand severe climatic and seismic events. Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria; if required, contingency measures to be implemented.	Remove potential threats to public health and safety. Decommission facilities in a safe manner. Ensure physical stability of any remaining structures.	Remove access to project areas that were not accessible before project initiation. Re-establish access for NND to specific areas (TBD). Re-establish NND access through project site to traditional hunting grounds. Minimize, eliminate or manage invasive species colonization at linear features in closure. Provide for public 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
Closure Measures	Convert ponds to passive treatment systems (Eagle Pup, Platinum Gulch and Lower Dublin South) as needed. Maintain suitable gradients to permit flow and reduce infiltration and erosion. Design facilities to minimize contact of surface flow with mine influenced soils. Dublin Gulch Diversion Channel, initially built for operations, to be armoured at appropriate times/locations for long-term closure. Modifications of flow patterns at site to achieve enhanced stability or accommodate water quality or other objectives.	Safety berm highwalls and control access to pit. Engineer controlled outflow from pit lake.	Engineer graded slopes during operations that have stable configurations and meet closure criteria. Engineer waste covers to reduce infiltration, encourage vegetation growth and minimize erosion. Provide engineered covers in combination with passive treatment systems to yield water quality acceptable for discharge.	Heap drain-down and transition period (additional gold recovery) planned and managed and fully integrated with water management plan. Cyanide destruction using in-situ biological treatment during rinsing stage. Rinsing and recirculation to enhance degradation of cyanide and neutralization of heap solution. Progressively building closure cover (and re-grading as necessary) during rinsing stage. Converting Events Pond to passive treatment system. Complete cover with enhanced engineered improvements to minimize infiltration	Mine site structures not required will be decommissioned and removed (partially or completely). Foundations demolished and buried. Pad areas re-graded as necessary, scarified and re-vegetated	Identify key or essential roads in coordination with NND. Develop a plan to minimize the advance of invasive species. Decommission, scarify and vegetate non-essential roads to provide a means of protection to public safety and encourage development of wildlife habitat	Care and maintenance of facilities. Site water and solution management/treatment as required.

¹ Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon.

Section 3: Closure Objectives and Design Criteria

Fundamental Objective ¹	Physical Stability	Health and Safety Physical Stability Chemical Stability	Physical Stability Chemical Stability	Physical Stability Chemical Stability	Health and Safety	Land Use Health and Safety	Health and Safety
Component-Specific Activities	Water Retention and Water Conveyance Structures	Open Pit	Waste Rock Storage Areas and Temporary Stockpiles	Heap Leach Facility	Mine Infrastructure	Roads and Other Access	Temporary Closure Site Conditions
Closure Criteria/(Objectives)	The design flow at closure for all ditches, channels and other structures on site (storage ponds, spillways, culverts) is selected as the 100-year flood. Calculations are based on the 100-year storm event calculated over a time of concentration specific to each catchment (generally varying between 30 and 60 minutes for the Victoria Gold site). Ditches and channels for water conveyance will have a trapezoidal cross-section. 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. Maximum slopes are not to exceed 10% when possible. For steeper slopes, larger rip rap or energy dissipation structures will need to be put in place to avoid erosion. Culverts and pipes for seepage flows will be sized to accommodate the 1:100 year flood. Culvert minimum diameters are set at 750mm. Pipes will be buried to avoid freezing.	Open pit floor area will be flooded to 925 masl elevation. The open pit disturbance area will be 80 ha. The perimeter and upper benches within the overburden layer will be re-sloped and re-vegetated. Geochemical characterization of rock indicates that they will not be acid generating. Although neutral pH metal leaching of arsenic and antimony has been identified as a potential, in open pit wall run-off, water quality modeling has indicated that direct discharge of pit lake water to Haggart Creek can occur.	At closure the PG WRSA will have side slopes of 2.4H:1V, and maximum thickness of 35m. Valley bottom drainage under the dump at approximately 21° in WRSA footprint. At closure the EP WRSA will have an side slopes of 2.5H:1V, and maximum thickness of 140m. Valley bottom drainage under the dump ranges from 8° to 25°.	There are three stages in the HLF closure process: • residual leaching, • cyanide destruction rinsing, and • draindown The HLF is the last feature to be reclaimed as the cyanide destruction and rinsing processes will take ~2 years, following mining cessation, ore placement and additional time for gold recovery. The construction of an enhanced store-and-release cover will start when cyanide destruction is complete (meets criteria), Seepage will be treated in a passive system constructed down gradient of the facility (converted from the Events Pond). The mine water treatment plant will remain on the Project site for a period of at least 5 years after it was last required to treat effluent discharged from the site when necessary.	Decommissioning and demolition of mine infrastructure will ensure physical stability and remove potential hazards /threats to the public safety and health. 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 of concrete slabs; Bulk earthworks will be completed, foundations broken up and buried in situ; Foundations with rebar will be left in place.	The Haggart Creek Access 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. All unnecessary culverts will be removed and stream channels stabilized.	Operation/Closure criteria apply.

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

Fundamental Objective ²	Health and Safety Physical Stability	Health and Safety Physical Stability Chemical Stability	Physical Stability	Physical Stability Ecological Conditions and Sustainability	Ecological Conditions and Sustainability	Aesthetics	Socio-economic Expectations
Valued Components	Terrain Stability	Soils	Watercourses	Aquatic Resources	Vegetation/Wildlife Habitat	Paleontological, Cultural and Heritage Values	Socio-economic benefits and effects
Closure Objectives	Remaining terrain should present no more significant hazard to people and wildlife by achieving conditions similar to local features. Ensure physical stability such that slopes, excavations and other disturbed lands are in a conditions that will limit the incidence of soil erosion, slumping and other instabilities that are likely to impede re-vegetation of a reclaimed site, pose a threat to public safety, lead to wildlife mortality, or cause excessive sediment loads to enter nearby water bodies. Can withstand severe and climatic seismic events	Minimize exposure to and mobilization of substances that pose a risk to human health and environment through physical and chemical stability of remaining soils	Ensure long-term stability for natural and created watercourses so that erosion and sediment processes are within a natural and acceptable condition	Minimize exposure to and mobilization of substances that pose a risk to aquatic resources through physical and chemical stability. Ensure long-term solutions rely on passive treatment technologies. Provide for functioning aquatic habitats similar to or improved from current conditions.	Ensure long-term physical stability that allows for successful re-vegetation. Encourage natural development of native species and communities. Return temporarily developed land to sustainable wildlife habitats.	Ensure protection of geological values and heritage features associated with mine site.	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 Measures	Re-grading of pads and facilities as necessary. Utilize safety berms where appropriate. Develop an inventory of site pre-disturbance, or a terrain disturbance registry to be populated during life of mine; develop a terrain hazard reduction plan to include registry from which hazard mitigation can be measured against. Develop engineered soil covers that reduce erosion potential, while accounting for precipitation patterns, infiltration capacity, cover depth, cover materials erosion sensitivity, optimal rooting depths of grasses and woody species prescribed for re-vegetation. Consider natural (bioengineered) and synthetic controls where erosion potential may still exist	Conduct site contamination assessment at initiation of closure activities. Develop site remediation plan that could include excavation, landfilling or land treatment, in-situ immobilization or amelioration.	Establish stable hydraulic geometries. Establish native species to enhance bank and floodplain stability. Where appropriate, rehabilitate disturbed watercourses to achieve characteristics similar to pre-disturbance conditions. Compensate for disturbed water courses as required under applicable legislation.	Utilize active water treatment technologies during transition to permanent closure. Progressively develop passive treatment technologies as facilities close, which will provide applicable results to improve designs. Integrate as appropriate various passive treatment technologies (bioreactor, engineered wetlands, in heap treatment) to address challenges with site-specific terrain conditions. Use results from progressive reclamation opportunities to refine and improve the methods for engineering a soil cover that minimizes metal leaching. Compensate for disturbed habitat as required under applicable legislation	Establish self-propagating early seral native plant communities. Encourage opportunities for progressive reclamation over the project life. Preparation and use of soil salvage location to store approximately 1,500,000 m³ of salvaged top soil and organics for reclamation. Develop growth media borrow locations. Develop re-vegetation plans according to prescriptions which include native species. Develop and implement invasive plant species SOPs. Ensure that synthetic liners or other materials that may entrap wildlife are not exposed.	Heritage Impact Assessment and Heritage Conservation Plan. Sites of significant heritage value identified and included in historic sites registry.	

² Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon.

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Fundamental Objective ²	Health and Safety Physical Stability	Health and Safety Physical Stability Chemical Stability	Physical Stability	Physical Stability Ecological Conditions and Sustainability	Ecological Conditions and Sustainability	Aesthetics	Socio-economic Expectations
Valued Components	Terrain Stability	Soils	Watercourses	Aquatic Resources	Vegetation/Wildlife Habitat	Paleontological, Cultural and Heritage Values	Socio-economic benefits and effects
Closure Criteria	Terrain of limited stability (e.g. permafrost, steep slopes, or wetlands) will be given special attention, and protected where possible.	Climate and resulting permafrost (discontinuous) are largest influences on soil development Soil is limited for reclamation suitability primarily by high coarse-fragment content, due to development of soils from weathered bedrock. Average rooting depths are 50 cm, but can reach depths of over 120 cm. Baseline arsenic levels are naturally high in the soil, but do not limit soil reclamation suitability. 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. Soil types within the property that can be used as store and release covers for the HLF and WRSAs include: - Locally sourced compacted colluvium and placer tailings mixture over compacted waste rock or HLF. - A cap will be placed over the colluvium. - The cap will be seeded with species suitable for the aspect that the structure is facing.	Conveyance courses (channels and ditches) will be constructed with trapezoidal channel shape, sized to 1 in 10 year 24 hour storm for lined channels and 1 in 100 year 24 hour storm capacity for ditches. They will be lined with rip rap to minimize erosion and reduce flow velocity.	The mine site supports a self-sustaining biological community that achieves land use objectives. Reclamation and closure activities will protect the aquatic environment from mine-related degradation and restore environments that have been degraded by mine-related activities.	Closure activities will be conducted to promote ecological sustainability of re-vegetated areas to ensure (for example): - Vegetation growth in conveyance channels will minimize channel erosion and provide habitat for aquatic species - Vegetation growth on waste areas (HLF and WRSAs) will be sustainable and provide sufficient evapotranspiration to minimize infiltration into the capped waste deposit.	Closure activities will be conducted to restore the sites to a aesthetic consistent with surrounding areas.	Closure activities will be performed in a manner consistent with Stratagold benefit agreements with FNNND, and where possible utilize local and Yukon businesses in the performance of the work.

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 project 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 final open pit design for the Project to maximize value while minimizing potential risk.

Over the life of the Project, the open pit will be advanced in four major stages, with an ultimate pit size of approximately 1,420 m long and 780 m wide. The minimum elevation of the pit is 847.5 masl and there will be a maximum crest elevation of approximately 1,409 masl, giving the pit a depth of 562 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 925 masl, giving the west highwall a height of approximately 77 m. 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.

During a pre-production period, a total of 4.8 Mt of waste material will be mined and this material will be used to develop haul roads, the HLF embankment and for other construction purposes. Following the pre-production period, ore production will increase to the nominal production rate of 29,500 t/d.

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.

Further detail, including design criteria for the open pit is provided in the *Mine Development, Operations and Material Management Plan*.

3.2.2 Waste Rock Storage Area

Geotechnical design criteria selected for the WRSAs are based on those recommended by the Yukon Water Board (2009), the British Columbia Mine Waste Rock Pile Research Committee (1991), and the technical experts responsible for the design as shown in Table 3-3Error! Not a valid bookmark self-reference..

Table 3-3: Geotechnical Design Criteria

Criteria	Description
Static Factor of Safety – short term (mine operations)	1.3
Static Factor of Safety – long term (post-closure)	1.5
Psuedo-static Factor of Safety – short and long term	1.1

Section 3: Closure Objectives and Design Criteria

Criteria	Description
Design Earthquake Return Period	1-in-475-year event
Overall Slope Angle	2.5H:1V

Based on an evaluation of the potential seismic activity for the project 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.

3.2.3 Heap Leach Facility

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 Project. North American standards for the design of embankment dams were used where applicable, specifically the Canadian Dam Association guidelines. Table 3-4 summarizes the main technical and permitting requirements for the State of Nevada for the key elements of the HLF design.

Table 3-4: 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 1×10^{-6} cm/s or 1×10^{-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 1×10^{-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

Heap Leach Feature	Description
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 CDA are referenced, the latest version of the CDA guidelines (2007) was used for the Project.

Tetra Tech performed a dam breach analysis to determine the hazard classification of the confining embankment in accordance with CDA dam classification guidelines. The results indicate the confining embankment can be classified as a high hazard dam. Results from the dam breach analysis and inundation mapping show that loss of human life or damage to public and commercial facilities are unlikely in the event of a dam breach. However, the dam breach may cause significant damage to fish and wildlife habitat downstream of the embankment considering the potential for release of cyanide solution from upstream of the heap confining embankment. The dam breach analysis report is presented as an appendix to Appendix A in the *Heap Leach and Process Facilities Plan*.

3.2.3.2 Design Criteria

The parameters and criteria are presented in the *Heap Leach and Process Facilities Plan*. The following appendices in Appendix A of the *Heap Leach and Process Facilities Plan* provide rationale for geotechnical design criteria: Appendix C (Site Seismic Hazard Analysis), Appendix J (HLF Stability Analyses), Appendix K (Liquefaction Analysis), and Appendix M (Settlement Analysis), and the Eagle Gold – Geotechnical Design Basis for Mine Site Infrastructure in the Project Proposal (BGC 2011). Ore parameters were taken from Eagle Gold Project Report of Metallurgical Test Work (KCA 2012).

3.2.4 Water Management Facilities

For the purpose of the Water Management Plan, the Project 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. During construction and particularly prior to installation of diversion channels, some of the watershed areas reporting to the sediment control ponds are larger than the areas calculated during operations. Therefore, to ensure that the SCPs are capable of storing runoff during the entire life of the Project, they were sized to store the 10-year 24-hour event from their largest respective contributing area.

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 *Water Management Plan*.

Design storm events are used as input parameters in most rainfall-runoff type storm water models (e.g., HEC-HMS, HydroCAD, TR-55). Design criteria for various design elements are listed in Table 3-5.

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Table 3-5: 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
	Maximum Depth (mm): Type 1 or 2	300
	Minimum Width (mm): Type 2	500
	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
	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
Lined Diversion or 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 (%): Type 3 / Type 4	4.5 / 11
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.75 / 5.0
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

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Infrastructure Element	Design Element	Design Basis Criteria
	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
	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
	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

Please refer to Section 3 of the Project Environment, of *the Eagle Gold Project Type A Water Use Licence Application* for a summary of existing conditions for bio-physical and socio-economic components (e.g., wildlife, water quality, employment and economic opportunities) of the Project.

5 PROJECT DESCRIPTION

Please refer to Section 4 of the *Eagle Gold Project Type A Water Use Licence Application* for a detailed description of the Project.

6 TEMPORARY CLOSURE

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.

Type A WUL QZ14-041 has provided specific criteria/events that are to be considered Temporary Closures for the Project, they are:

1. Prior to Mining, construction activities at the site have started but ceased for two months;
2. After Mining has started but stacking of ore in the HLF has not occurred, and Mining has ceased for a period of two months; or,
3. After loading of ore within the HLF has occurred, no new ore has been placed on the heap for 150 days, no Mining is occurring, and irrigation of the heap for the production of gold has ceased or has occurred for a period of 12 months since the last stacking of ore within the HLF.

This section describes the measures and activities that will be undertaken for the Project 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 sections following 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 Project, 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. 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 ponds and ditches to treatment throughout the temporary closure.

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 SCP 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 operating licenses. 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 by the operating licences.

6.2.2 Chemical Stability

Temporary closure objectives are to achieve chemical stability such that runoff and seepage quality meet water quality criteria, 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 objectives for the WRSAs will ensure short-term chemical stability such that runoff and seepage quality meet water quality criteria.

Chemical stability of the runoff and seepage from the WRSAs will be maintained through the continued implementation of the water management plan. Visual monitoring of seepage and runoff water quality as per licensed monitoring programs, and water treatment if necessary by the MWTP, will be implemented as required.

6.2.2.2 Heap Leach Facility

With regard to chemical stability, the HLF includes the leach pad and process pond. Temporary Closure Objectives for the HLF are to achieve chemical stability such that runoff and seepage quality meet water quality criteria.

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 operational licences.

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. 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.

6.2.2.4 Water Management Facilities (Ponds and Ditches)

Temporary closure objectives for water management facilities are to achieve chemical stability and operation of groundwater and surface water resources.

The site caretaker will also be responsible to monitor for seepage from the WRSAs, ensuring that it is conveyed to and collected in ponds and monitor water quality as required. Drainage from the WRSAs will be collected and treated by the MWTP as required to meet effluent discharge limits.

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 Project will consist of:

- process offices;
- lab;
- shops and warehouse;
- process plant site;
- primary, secondary and tertiary crusher facilities;
- laydown area;
- gatehouse;
- main sub-station;
- 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 *Eagle Gold Project Water Management Plan*. Linkan (2014) summarizes the design and operating approach of the MWTP.

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.

6.2.4 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 land use objectives outside of the area of disturbance.

6.2.5 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.

6.2.6 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.

6.2.7 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.

6.2.8 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 WMP, 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 SGC'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.

6.2.9 Financial Considerations

Minimize outstanding liability and risks while the site is in temporary closure.

6.2.9.1 Entire Site

Financial considerations include:

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- 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.
- 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:
 - o supporting site inspections, security controls, first aid, emergency response and communications
 - o supporting water management and gold recovery, MWTP operations, sample collection and site monitoring
 - o 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
 - o In conjunction with SGC'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 project 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 via ponds and ditches to treatment, as necessary		
Waste Rock Storage Areas and Temporary Ore Storage Area	Physical Stability	Site inspection for stability	Visual inspections 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	Dublin Gulch Diversion Channel and 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	Ongoing for the term of temporary closure
Water Management Facilities (Ponds 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, Equipment and Pads	Physical Stability	Secure buildings and provide maintenance; Conduct any sediment and erosion control measures as needed	Visual inspections	Quarterly and following freshet 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

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
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 project. The water quality treatment and discharge criteria (Table 6-2 and Table 6-3) during temporary closure are phase dependent as they are for regular operations.

Table 6-2: Effluent Water Quality Standards for Temporary Closure - Prior to Mining

Parameter ¹	Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)
pH	6 to 9
As	0.5
Cu	0.3
Pb	0.2
Ni	0.5
Zn	0.5
TSS ²	30.0

NOTE:

1 All Concentrations are total values

2 TSS maximum monthly mean concentration is 15 mg/L

Table 6-3: Effluent Water Quality Standards for Temporary Closure - Mining

Parameter ¹	Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)
pH	6.5 to 8
TSS	15

Parameter¹	<i>Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)</i>
Cl-	250
SO₄	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH₃-N	7.5
CN_{WAD}	0.03
Al (diss)	0.4
Sb	0.13
As	0.053
Cd	0.00125
Cu	0.026
Co	0.026
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

NOTE:

1 All Concentrations are total values

6.4 MONITORING

Monitoring activities for the site will follow the surveillance programs as described in the *Environmental Monitoring and Adaptive Management Plan*. 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, and mine infrastructure
- 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)

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- No regular air monitoring 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
- 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. 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 QZ14-41, the maximum duration provided in the first notice will be one year and further notification will be provided should the temporary closure extend beyond one year. The subsequent notifications will be submitted at least 30 days in advance of the any previously identified end for a temporary closure period.

If a temporary closure period is determined to have commenced based on the conditions provided in clause 163 of QZ14-041 (as shown in Section 6.1), VGC will provide notice to the YWB and EMR within 7 days of the trigger events.

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 the amount of financial security required to be provided and maintained by SGC and to support ongoing reclamation research for final closure of the Project.

7.1 PLATINUM GULCH WASTE ROCK STORAGE AREA

Bottom-up stacking of the Platinum Gulch WRSA to its final configuration will enable progressive reclamation during stacking of the WRSA. Progressive 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 worksite below, remediation will be started toward the end of the Platinum Gulch WRSA 3 year lifespan.

When initiated, reclamation of the 38.9 hectare (benches ~18 ha and side slopes ~20 ha) footprint of Platinum Gulch WRSA will require the construction of an engineered cover. Cover material (Knight Piésold 2013b; Okane 2014) will consist of locally sourced mixtures of colluvium and placer tailings placed to a 0.3 m depth over the waste rock. A 0.2 m cover of previously stockpiled topsoil during WRSA site preparation will cover the engineered mixture. The cap will be re-vegetated with plant species suitable for the west facing aspect of the Platinum Gulch WRSA.

7.2 EAGLE PUP WASTE ROCK STORAGE AREA

The Eagle Pup WRSA will be closed during the first year of closure; however, progressive reclamation may be performed on areas where final contour has been achieved to help reduce dust and 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

Since most or all of the IROSA will be essentially non-active during all of operations, 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.

8 FINAL RECLAMATION AND CLOSURE MEASURES

8.1 CLOSURE SCHEDULE

Due to the longer term process to draindown the HLF, the decommissioning and closure process of the Eagle Gold Project 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 (~Years 1 to 9): Active mining. Complete cover construction on the PG WRSA; replacement of synthetic armouring in the DGDC with construction grade waste rock riprap for long term stability.

Phase 4 (~Year 10): Termination of mining and ore production, but continued irrigation of the ore stack for gold production; managed recirculation of the heap solution inventory; open pit begins to fill; begin building cover on EP WRSA; decommission crushers, some mine roads, temporary ore stockpile, explosives and magazine storage facilities; begin construction of passive treatment system (PTS) for Eagle Pup WRSA seepage.

Phase 5 (~Years 11 to 12): Termination of gold production and beginning of rinsing and cyanide destruction; managed pump-back of heap drain-down solution inventory – no heap discharge to treatment; closure of EP Pond; LDSP (EP) and PG PTSs in place; LDSP (EP) PTS discharge to DGDC when discharge criteria are met; PG PTS discharge to Haggart Creek when discharge criteria are met; open pit still filling; decommission ADR; begin building cover on specific sections of the HLF, if feasible.

Phase 6 (~Years 13 to 19): Controlled drain-down of heap (drain-down solution 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, and other may be infiltrated to create in-heap bioreactor); 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 fills in about eight years – afterwards flow allowed to drain to Haggart Creek (via PTS if necessary); complete building cover on HLF; decommission truck shop and reduce camp size, and decommission remaining access roads.

Phase 7 (~Years 20 to TBD): Decommission MWTP once PTSs have been the only required treatment to reach discharge criteria for a period of five years; all passive treatment systems in place; uncontrolled drain-down of heap – until 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 project 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 Project. 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. SGC 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, SGC 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 project 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. 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.

8.4 MINE RECORDS

As noted in the previous section, all decommissioning and reclamation works will be documented. Active Mining period records showing the extent of mine workings would be retained by SGC. 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 SGC and submitted to government agencies and boards as required.

8.5 ESTIMATED AREAS OF DISTURBANCE AT END OF MINE LIFE

The estimated areas of disturbance and approximate dimensions at the end of the projected mining activities include:

- Open Pit: W: 780 m x L: 1,420 m, D: 562 m along east highwall, 75 m along west highwall, 85 ha.
- Heap Leach Facility: 107.2 ha with approximate dimensions of 520m x 1,980 m, average vertical thickness of heap is 55 m, with a maximum height of 150 m. The heap embankment west of the heap will have a surface area of 5.4 ha. The HLF will have one event pond with the following capacity:
 - o Event Pond below the HLF embankment with approximately 204,000 m³ storage capacity with 1m of freeboard to the pond; and
 - o The pond volume at the spillway invert is approximately 255,000 m³.
- Waste Rock Storage Areas
 - o Platinum Gulch WRSA 13.7 Mt of waste rock with a final footprint of 38 ha.
 - o The Platinum Gulch Pond for seepage and runoff collection will have a total storage capacity of 10,420 m³.
 - o Eagle Pup WRSA 118.7 Mt of waste rock with a final footprint of 94 ha.
 - o The Eagle Pup Pond for seepage and runoff collection will have total storage capacity of 12,300 m³.
- For both WRSAs, overall slope angle of 2.5H:1V with construction in 45m lifts

Table 8-1: Estimated 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 Year 2
Open Pit	82.1	49.5
Heap Leach Facility		
Embankment	10.8	10.8
Phase 1	45.7	45.7
Phase 2	46.8	0
Phase 3	40.8	0

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Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of Year 2
Events Pond	8.5	8.5
Industrial Infrastructure		
Crushing and Conveying Facilities (including temporary facility)	19.5	19.5
Truck Shop and Fuel Storage	9.9	9.9
Laydown and Camp Area	9.5	9.5
Process Facility, Substation and Water Treatment Plant	12.0	12.0
Explosives Facilities	2.5	2.5
Landfill and Land Treatment Facility	1.6	1.6
Waste Rock and Overburden Storage Areas		
Eagle Pup Waste Rock Storage Area	94.0	9
Platinum Gulch Waste Rock Storage Area	38.0	10
Reclamation Stockpiles	18.4	18.4
Ice Rich Overburden Storage Area	5.6	5.6
Water Management Structures		
Lower Dublin North Pond	1.0	1.0
Lower Dublin South Pond	2.7	2.7
Eagle Pup Pond	1.7	1.7
Platinum Gulch Pond	1.2	1.2
Dublin Gulch Diversion Channel	12.4	12.4
Off-Site Infrastructure		
Transmission Line Corridor	16.8	16.8
Miscellaneous Sites and Facilities		
On-Site Access and Haul Roads	51.2	51.2
Borrow Pits	8.0	8.0
Gate House and Truck Scale	1.4	1.4
Temporary Ore Stockpile	16.9	16.9
Total Estimated Area of Disturbance	559	325.8

Based on the earthworks materials take-off estimates, a total of approximately 1.6 Mm³ of excess cut, including topsoil, frozen (ice-rich and non-ice-rich) and non-frozen overburden soils will be stored in the various designated reclamation stockpiles. This is expected to satisfy the overall requirement for closure covers, which is currently estimated at approximately 1.5 Mm³.

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. The effluent

quality objectives development was based on the premise that seepage from the HLF and WRSAs, and overflow from the Pit Lake are the primary sources of mine affected water (Lorax 2014b). Other non-contact water will be conveyed off the mine site into Dublin Gulch Diversion Channel (DGDC) and Haggart Creek Sediment basins and sediment control ponds will be in place until reclamation objectives (e.g., during construction of covers) are achieved and runoff can be discharged directly to receiving waters. Thus the performance of the covers, sediment control structures, the passive treatment systems, and the water conveyance features all work together to achieve the water quality objectives.

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 comingling 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 a PTS 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, a buried pipe and open channel ditch combination will be used to convey water to the LDSP area, where the LDSP will be converted to a PTS as a series of lined facilities.
- Continue to convey Platinum Gulch seepage to the seepage collection pond, which will be converted to a PTS; pit overflow water (when the pit is filled) will be conveyed either to the PTS or directly to the receiving environment (Haggart Creek) when discharge criteria are met.
- Based on source terms characterization and water quality modeling, the Pit Lake is not expected to require any additional treatment other than the natural beneficial processes of direct precipitation on the lake and the physical process of the lake, i.e., settling and ultimately biological processes as the lake becomes active biologically. Thus, the overflow from the Pit Lake will be conveyed in an open and stable channel down 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
 - o On both sides of the heap, runoff from the cover will be conveyed into sediment basins and the LDNP, as needed until the cover is stable and then into the DGDC, and Haggart Creek.
 - o 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 the DGDC.
 - o On the south side 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 overflow from the pit and the treated water from the Platinum Gulch PTS.
- Water collected from disturbed areas including the reclamation and temporary ore stockpile areas.

Discharge from the Pit Lake and the PTS systems will be conveyed in open channels to discharge locations in Haggart Creek or DGDC.

8.6.2 Transition Strategy

During operations, reclamation research will be performed at the full/demonstration scale at the PG WRSA to evaluate and determine operating performance of covers and PTS. Discharge from this feature will be initially sent to the operational water/makeup water in the LDSP until meeting discharge criteria. At closure, with the PTS meeting discharge water quality criteria, this discharge will be routed into the channel established for the runoff from the PG PTS.

When the in-heap cyanide destruction process is completed, the Events Pond will be converted into a PTS, specifically a CWTS. The closure sump will be activated to drain in a controlled manner to the CWTS located in the Events Pond. While the CWTS is coming up to full performance and not yet meeting water quality discharge criteria, a pump will be activated to send the CWTS flow to the MWTP. When the CWTS is meeting discharge criteria consistently for a year, it will be allowed to discharge from the CWTS into a channel to the LDNP, and join with the runoff from the heap and undisturbed areas, and ultimately into Haggart Creek.

During operations, seepage collected in the Eagle Pup seepage collection pond will be pumped to the LDSP and ultimately to the MWTP. During early closure Eagle Pup WRSA seepage will be conveyed in a ditch/piped channel (as described above) and flow via gravity to the LDSP, which will have been converted to a PTS (CWTS). Discharge will continue to be sent to the MWTP until the outflow meets discharge criteria, after which it will be allowed to discharge into the DGDC.

The MWTP will be operational as long as the heap drain-down and the Eagle Pup WRSA seepage requires treatment, and while the CWTSs are becoming active. After the PTS systems are fully operational and meeting discharge criteria, the MWTP will be held on standby for a period of five year, at which time it will be decommissioned along with any other MWTP unnecessary infrastructure – see Section 8.9.

8.6.3 Water Conveyance Network

An extensive water conveyance network will be constructed during operations to safely route water around the main mining components. Details for the water management infrastructures for operations is presented in the *Operations Water Management Plan* (OWMP). The proposed network at closure will incorporate the existing conveyance channels as described in the OWMP (upgrades required in certain locations) complemented with new channels to accommodate the closure objectives.

Five different type cross-sections have been designed for operations and presented in the OWMP to accommodate various gradients and volumes of flow, depending on which ditch or channel is considered.

Type 1 and Type 2: Unlined ditch with triangular (Type 1) or Trapezoidal (Type 2) cross-section for small watersheds limited to channel slopes of 1 to 2%;

Type 3: Lined ditch with riprap with a D_{50} of 150 mm for larger watersheds, with channel slopes between 2 and 5%;

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Type 4: Lined ditch with grouted riprap or shotcrete for slopes between 6 and 15%. 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 is to be used in steep reaches or for spillways.

Details of the various cross-sections are shown in Figure 8-1 and Figure 8-2, as presented in the OWMP.

The various ditches and channels that compose the water conveyance network for operations are described below. Numerous sediment ponds and energy dissipation basins are included in the design to avoid significant erosion and sediment deposition in at-risk locations.

1) Conveyance channels

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

a. Diversion ditches

Diversion ditches will 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 are the design flow and velocity of the water expected in the channel. During construction and operations, the ditches will be sized 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 Type 3 ditches, with the following characteristics, shown in Table 8-2, from the OWMP.

Table 8-2: Diversion Ditch Design Criteria for Operations

Water Management Design Criteria		
Infrastructure Element	Design Element	Design Basis Criteria
Lined Diversion Ditches	Design Storm Event	1 in 10-year, 24-hour
	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

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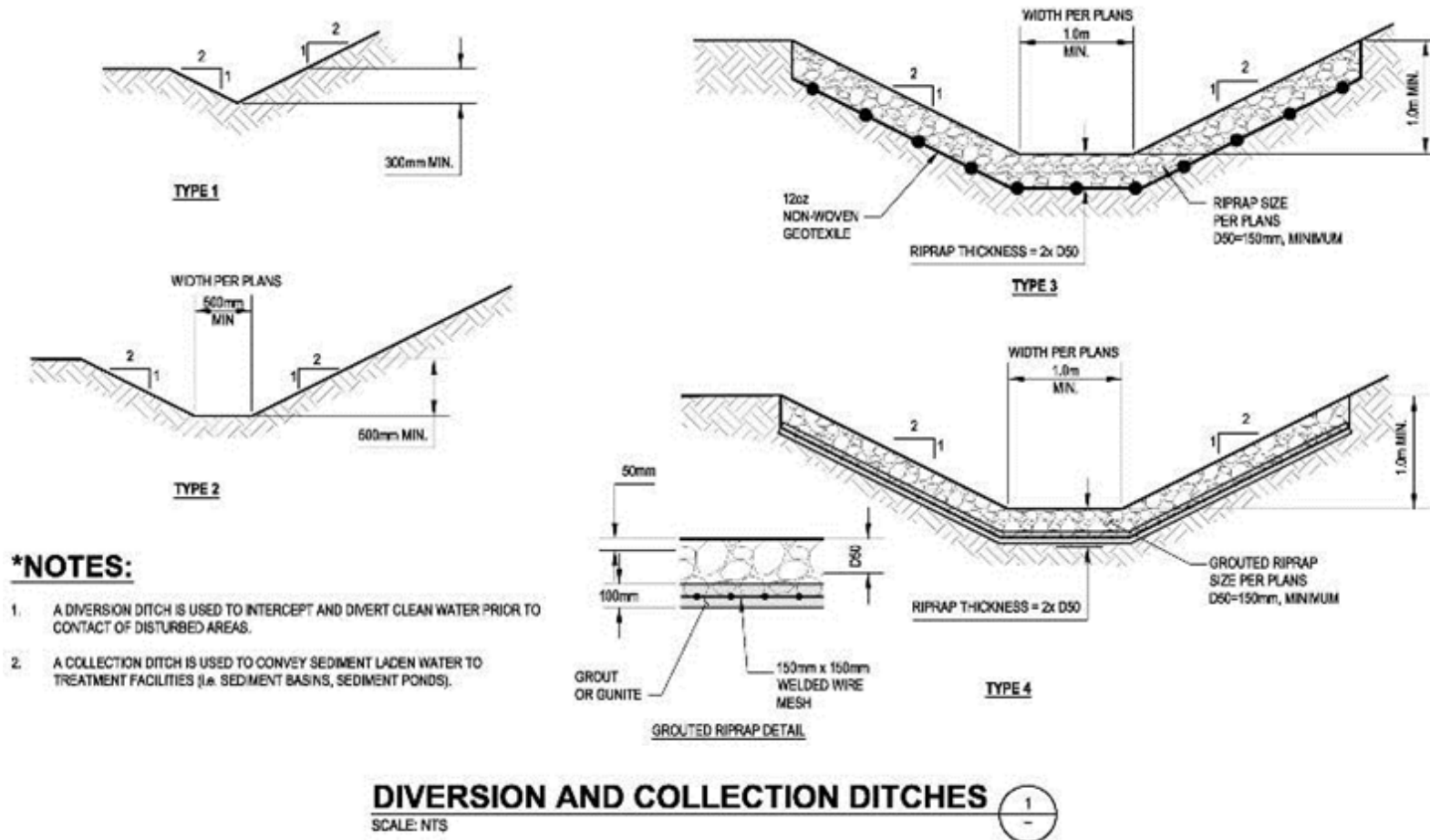


Figure 8-1: Diversion and Collection Ditch Types Used in Operations Surface Water Management

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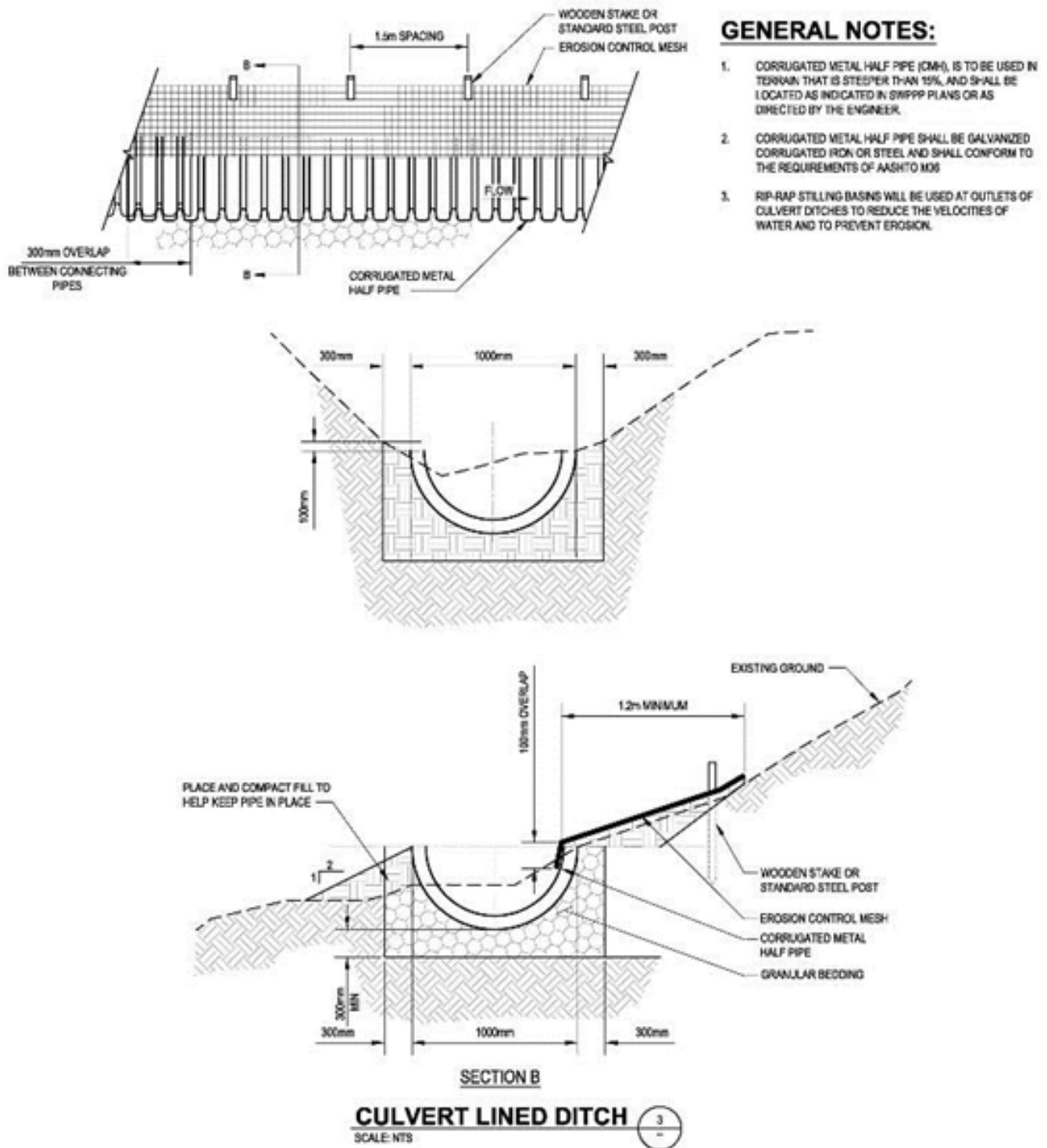


Figure 8-2: Culvert Lined Ditch Designs for Operations Surface water Management

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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 construction areas to collect runoff and convey it to the appropriate sediment control measures. During construction and operations, collection channels will be sized to convey the runoff from a 100-year 24-hour storm event assuming that the entire footprint area has been disturbed and contributes sediment-laden runoff to the seepage collection and recycle ponds. Collection channel design for operations is shown in Figure 8-1. The majority of collection channels that will be required in closure are Type 3 ditches, with the following characteristics, shown in Table 8-3, from the OWMP.

Table 8-3: Collection Channels Design Criteria for Operations

Water Management Design Criteria		
Infrastructure Element	Design Element	Design Basis Criteria
Lined 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 (%): Type 3 / Type 4	4.5 / 11
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.75 / 5.0

c. Culverts

During construction and operations, culverts will be 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. In general, while variations may occur due to site-specific conditions, it is assumed that culverts will be installed at a slope of 2% with an inflow along a smooth headwall. A small energy dissipater or stilling basin will be constructed upstream of each culvert to reduce sedimentation. The culvert will consist of corrugated metal pipe or corrugated polyethylene tubing installed according to the manufacturer's specifications to accommodate the anticipated vehicle loading and to prevent crushing. Standard culvert details can be seen in Figure 8-2, while Table 8-4 shows culvert design criteria.

Table 8-4: Culvert Design Criteria for Operations

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

Water Management Design Criteria		
Infrastructure Element	Design Element	Design Basis Criteria
	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 is based on the structures already in place during operations, with upgrades at closure, complemented with additional structures needed at closure to meet the water management closure objectives. Table 8-5 summarizes the ditches and channels that are required at closure, and if they are new or existing ones that may need to be updated.

Table 8-5: Ditches and Channels Required at Closure

Ditch name	Ditch type	Total Length (m)	Average slope (%)*	Status
C1	contact with cover	2200	20 (40)	Existing
C2	contact with cover	1200	20	Existing
C3	contact with cover	910	15	Existing
C4	contact with cover	1930	5 (25)	New
C5	contact with cover	1660	25	New
NC1	non-contact; disturbed	2030	6	Existing
NC2	non-contact; disturbed	670	4	Existing
S1	seepage	1150	5	Existing - pipe to be added
S2	seepage	650	30	Existing pipe installed during embankment construction
S3	seepage	310	10 (50)	New
S4	seepage	350	15	New
T1	treated	1100	15	New
T2	treated	500	5 (20)	Existing
T3	treated	100	1	New
T4	treated	90	20	New
U2	unimpacted	2500	3	Existing
U3	unimpacted	1350	4	Existing
U4	unimpacted	1200	3	Existing

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Ditch name	Ditch type	Total Length (m)	Average slope (%)*	Status
U5	unimpacted	520	2 (10)	Existing

*Number in parenthesis is the slope of a short but steeper reach

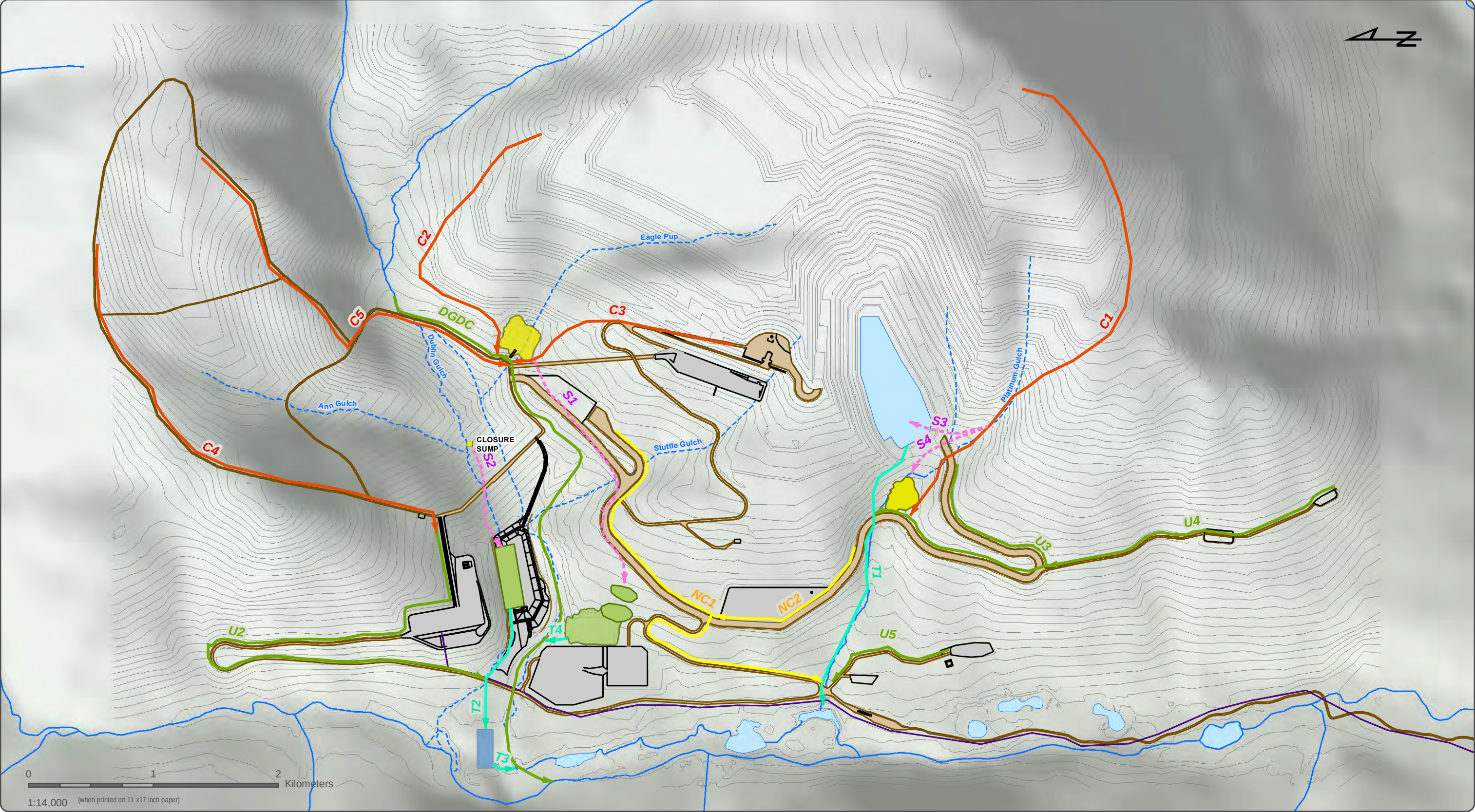
It is expected that approximately 5,000 m of new ditch will be required, and up to 6,000 m of ditches may need to be upgraded to safely convey the 1:100 year flood. All structures will be sized for the 100 year flood based on a 24 hours rainfall event. This is the same methodology that was used for design for operations. Lined diversion ditches and culverts that were sized for the 1:10 year flood will be upgraded for closure. For sediment ponds, calculations will be made using a volume-based approach that considers the hydrograph related to the 1:100 year flood 24 hour rainfall event.

Most of the new ditches that will be built at closure will require cross-sections similar to the Type 3 and Type 4 cross sections that were designed for operations. Some diversion ditches will have higher design flows in closure than during operations, and these ditches will be lined ditches where there are longitudinal slope of more than 2% for all catchment areas. For any new ditches or ditches have expanded purposes due to changes in flow management during closure, Type 3 cross-sections are proposed for slopes between 2 and 5% and Type 4 cross-sections are proposed for slopes between 5 and 15%. For ditches that require expansion or upgrading to accommodate the expanded flow requirements, it is currently expected that these ditches will be raised or widened by 0.5 m 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 is proposed instead of the CHP. The base width of the different ditches and channels will 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 (Type 3 or Type 4 cross-sections) but larger rip rap may be required in steeper reaches.

Additional energy dissipation basins will be required at the toe of steep reaches for the new ditches. At this stage, we estimated that three new basins will be required. Approximate dimensions are to be 5 m by 5 m, with a minimum water depth of 1m. Erosion protection is to be ensured with riprap material with a D_{50} between 300 and 500 mm depending on the ditch considered. Existing sediments ponds and energy dissipations basins will be consolidated if needed and will be upgraded where necessary.

The main component to be added at closure will be pipes to convey seepage flows from the HLF and the WRSAs (Eagle Pup and Platinum Gulch). Normal seepage flows for each component have been calculated to reach maximum values varying between 10 and 25 L/s (Lorax 2014c). Pipes of 150 mm diameter (6 inch) are proposed to convey seepage flows to the PTS. Such pipes have an average capacity of up to 50 L/s under normal operating conditions, thus will be adequate for the flows calculated for closure. It is proposed that the pipes be buried by at least 1 m of material to prevent them from freezing. A minimum slope of at least 5% will be set to ensure adequate flow velocities. For the Eagle Pup pipe, the pipe will be placed within a berm on the edge of the ditch, such that if there is any excess flow during high flow events it would be conveyed within the ditch to the passive treatment system. A typical cross-section of this ditch and pipe combination is presented in Figure 8-4.



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Datum: NAD 83; Map Projection: UTM Zone 8N

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- Collection Point
- Diverted Watercourse
- Watercourse
- seepage
- unimpacted
- contact with cover
- non-contact; disturbed
- treated

- Treatment System/Pond
- Constructed Wetland

Victoria
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EAGLE GOLD PROJECT

FIGURE 8-3

CLOSURE WATER MANAGEMENT NETWORK

JULY 2014

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Profiles for each of the seepage ditch and pipe combination were developed to determine the slopes that will be encountered. There is no limitation in slope that the pipe can withstand, while for the ditch portion, a design will have to be finalized at closure to account for the updated predictions of additional seepage flows. Longitudinal profiles for all four seepage ditch and pipe combos (S1 to S4) are presented below. They were extracted from the end of mine life topography using ArcGIS tools.

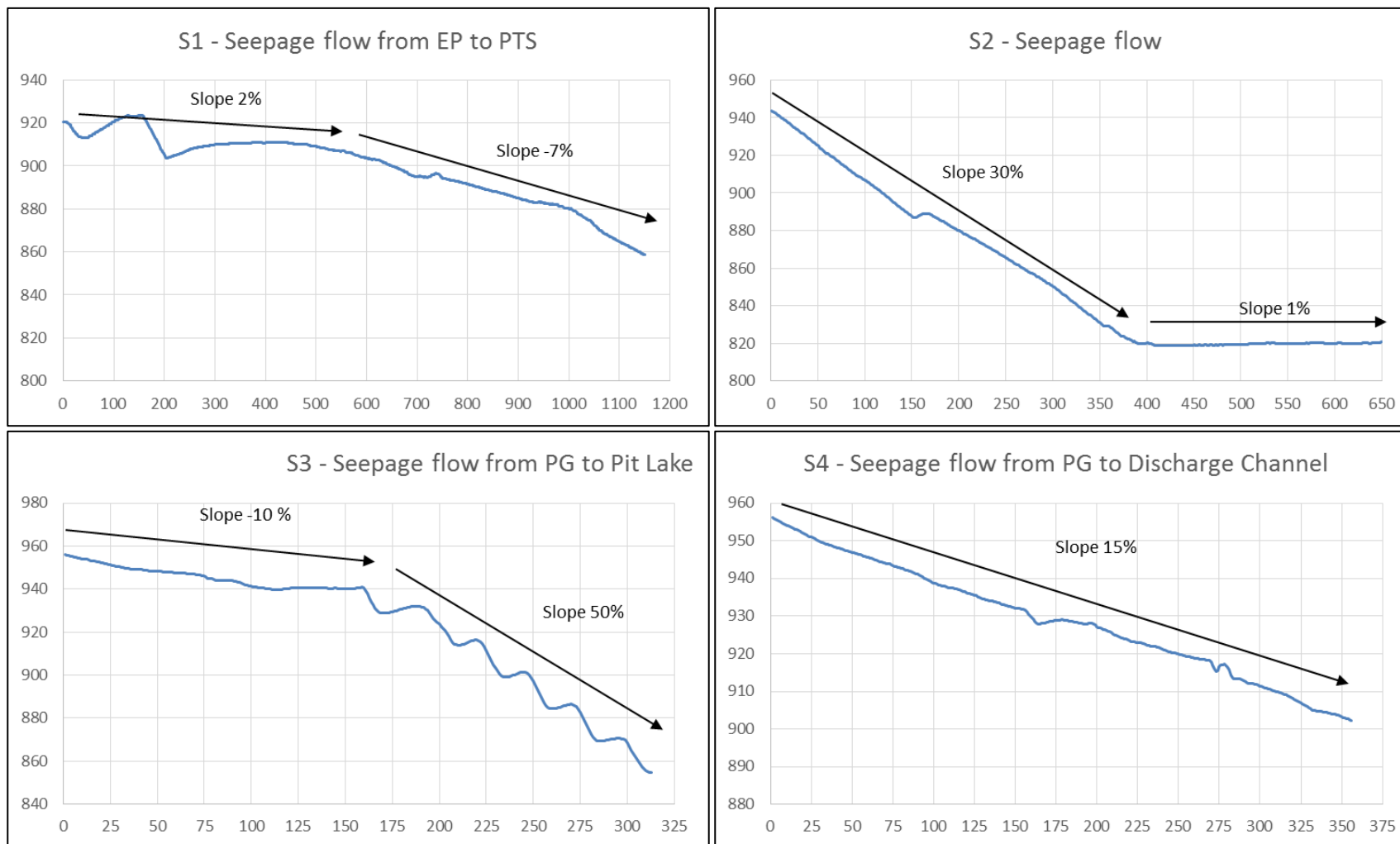


Figure 8-5: Seepage Flow Ditch and Pipe Combos Longitudinal Profiles

8.7 OPEN PIT

8.7.1 Closure Objectives and Criteria

Closure objectives for the Open Pit are to secure the pit to protect human health and safety, and to manage water flow from the pit into Haggart Creek in accordance with water quality guidelines and water management design criteria.

8.7.2 Closure Measures

Upon cessation of mining, the pit pumps and pipe column 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. After approximately eight years, outflow from the pit will flow through 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 10 pit inflows pumped to PG Pond and ultimately to LDSP
- Years 10 to 18 open pit is filling and no discharge occurs
- After Year 18 open pit discharges directly and untreated to Haggart Creek (i.e., no PTS is required for pit discharge).

8.8 HEAP LEACH FACILITY

8.8.1 Closure Objectives and Criteria

Closure objectives for the HLF include:

- conducting drain-down and cyanide destruction activities in a controlled manner to achieve and maintain chemical stability of heap effluent;
- performing grading 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 initial design so that the HLF is able to withstand severe climatic and seismic events;
- achieving long-term chemical stability such that runoff and seepage quality meet water quality criteria; and
- implementing appropriate contingency measures as required.

Table 8-6 provides the water quality criteria for discharge as specified in QZ14-041.

Table 8-6: Heap Leach Facility Effluent Quality Standards

Parameter¹	<i>Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)</i>
pH	6.5 to 8
TSS	15
Cl-	250
SO₄	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH₃-N	7.5
CN_{WAD}	0.03
Al (diss)	0.4
Sb	0.13
As	0.053
Cd	0.00125
Cu	0.026
Co	0.026
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

¹ All Concentrations are total values

Comparison of 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 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 feature to be reclaimed as the cyanide destruction and rinsing processes will take approximately two years, following the cessation of active mining and placement of ore. The construction of a hybrid (enhanced store-and-release) cover system will commence once WAD cyanide concentrations meets 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. There are essentially three stages in the closure process:

- residual leaching,
- cyanide destruction and rinsing, and
- draindown.

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 for purposes of cost estimation, 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.

8.8.2.2 Cyanide Destruction and 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 cyanide destruction and rinsing stage. This stage refers to the destruction of cyanide within the solution, such that it is no longer acutely toxic from the toxicity of cyanide, and the term “rinsing” refers to the continued application of solutions that are low in cyanide concentration to the heap to flush out areas with higher concentrations. During this time there will continue to be recovery of gold-bearing solutions collected in the bottom of the heap.

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 solutions to the heap. However, the solutions added to the top of the heap will no longer have cyanide present in them, because the biochemical treatment of the heap solutions will remove 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 residual cyanide in the barren solution, as well as cyanide in the pores of the heap. Thus the treatment is achieved both in barren pond 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). 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. This experience and experience elsewhere forms 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. Thus the only equipment required to detoxify the heap 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 m³ 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. This approach is consistent with the treatment of the Brewery Creek mine, as well as several other heap leach facilities that have been treated using a biological treatment process that rely upon reducing sugars (Harrington and Levy 1999; Harrington 2002; Brewery Creek Mine Decommissioning and Reclamation Plan, 2002).

8.8.2.3 Formation of In Heap Pond Bioreactor

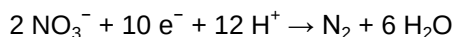
When the cyanide concentrations have decreased in the In-Heap Pond such that the heap outflow to the ADR is consistently below the required free cyanide concentrations, the treatment strategy will shift to a strategy that will stabilize and further improve the water quality from within the heap for water quality constituents beyond cyanide. As described in Lorax (2014b), after cyanide has been degraded the heap drain down water will still be elevated in nitrate, metals and metalloids (As, Pb, Hg, Se and Sb), 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 byproducts (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). As soon as the cyanide concentrations have decreased to less than the required free cyanide concentrations, heap drain-down will begin.

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 are described below for each constituent potentially requiring treatment:

8.8.2.3.1 Nitrate

The predicted source concentration prior to treatment for nitrate is 250 mg/L (Lorax, 2014b). 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.



Microbes that perform denitrification are found nearly universally (ubiquitous) in soils and rocks. The Tetra Tech (2014) cyanide destruction column studies report on Eagle project 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).

8.8.2.3.2 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).

8.8.2.4 Drain-down

The heap drain-down and transition period (during which there will still be additional gold recovery) will be planned and managed to fully integrate with the site water management plan. The overall solution inventory will be decreased by processing water through the mine water treatment plant (MWTP) and/or the heap PTS for discharge. Depending on the flow rates achieved through the MWTP, the PTS, and the effectiveness of the cover system that is being built on the heap, the actively treated drain-down period will vary, but is expected to be a minimum of five years and as much as ten years of active treatment in the MWTP. During this time the following activities will occur:

The transition to heap drain-down will occur with the perforation of the sump and activation of the closure sump. The transition from cyanide destruction to draindown will include the following steps:

- Discharge of water from the closure sump to the MWTP at a controlled rate consistent with the capacity of the MWTP to treat and discharge the water (20 lps; Linkan 2014).
- Discharge of some water from the closure sump to a contingency passive treatment system/CWTS to be built in the Events Pond location.
- When either
 - o The heap is sufficiently drained and is discharging below QZ14-041 discharge criteria, or
 - o The passive treatment system is treating all of the remaining flow at the design capacity and achieving discharge criteria
 - o Then the MWTP can be turned off and decommissioned in accordance with license terms.

During the draindown period, the solutions that are recirculated back up into the heap will have organic carbon sources amended into them. This draindown in situ treatment period will 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 above. This will allow for the heap drainage to continue to improve ultimately to 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. It is expected that at the end of the recirculation and draindown period that the heap solutions can

either be directly discharged in accordance with the site discharge criteria, or that the PTS will be able to polish it using primarily aerobic processes, as described below.

8.8.2.5 HLF Passive Water Treatment

As described above, the main constituent that will not be completely treated prior to discharge from the heap is arsenic, which is conservatively estimated to be reduced in the heap but still remain at 0.5 mg/L. As described above, several in situ heap treatment sites have had arsenic concentrations after treatment of 0.3 mg/L. Thus the passive treatment system is primarily being designed to remove arsenic, and because of its similar removal processes, antimony is also expected to be further reduced by passage through the CWTS.

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Eagle Gold Project. Preliminary studies and planning suggested that Constructed Wetland Treatment Systems (CWTS) would best fulfill the site-specific objectives for passive treatment at the Eagle Gold site, based on the information available at the time; however, a hybrid Passive Treatment System (PTS) comprised of a biochemical reactor (BCR), permeable reactive barrier (PRB), or zero valent iron (ZVI), followed by a CWTS may be optimal. Thus, the PTS design has been further refined, and is described here.

Based on predicted water qualities and quantities, there are slight variations in the proposed PTSs for the HLF and WRSA water sources. Using the predicted closure water quality, all CWTSs were sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of water treatment, based on treatability of the compound and hydraulic retention time. In Equation 1 (below), the first order RRC has been reconfigured to calculate from t (hydraulic retention time; HRT), allowing the use of C_i (initial concentration), C_f (final, desired concentration), and k (removal rate constant) to be used to size the wetlands accordingly. Although it is recognized that the treatment rate of a range of element concentrations varies in a CWTS, the predicted inflow and desired outflow concentrations for this system are in a range that allow a first order RRC to be loosely applied. During the reclamation research program for the PTS, this will be further refined and confirmed, so that the final CWTSs will be shown to be sufficiently sized.

The RRCs used to size the wetlands for this project were developed using two different scenarios. The first scenario for RRC calculation is based on a pilot-scale CWTS with similar arsenic concentrations as those predicted for the Eagle Gold Project. This water has undetectable iron concentrations, and a water temperature of approximately +20°C to 25°C. This RRC was then adjusted based on the principals of Arrhenius' equation, dividing the rate by half to adjust for each 10 degrees of temperature decrease. This is a conservative estimate, since the CWTS is designed such that aeration and sorption will be the initial form of treatment, and this type of CWTS is therefore less influenced by temperature than other types of CWTS (such as those designed for municipal water and sewage, which are treating for high biological oxygen demand). 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 will provide sorption sites for the subsequent year(s). A review of these processes is found in Lizama et al, (2011).

A second scenario for RRC calculation was also applied, based on another pilot-scale study performed by Contango for a PTS in the Northwest Territories that has similar arsenic concentrations as is predicted for the HLF and WRSA seepage. In this pilot scale system iron was present which enhances treatment by providing

another removal process that is iron-coprecipitation based, in addition to the sorption by detritus and biomineralization. Iron-coprecipitation is also a well-known phenomenon in wetlands (Lizama, 2011). In this pilot system, when operating with water temperatures between +0.5°C and +4°C, the removal rate was triple that of the system that did not have iron in it that was operating at +20°C, despite other water parameters being the same. The size of CWTS required under both scenarios is presented in Tables 8-7 and 8-8.

In an accreting CWTS, it is the removal rate that is key for determining size, while aspects such as total loading are secondary. The logic for this rationale is that loading can only be of concern after it is confirmed that it is thermodynamically possible to remove the compound from the water and load into the sediment. As both the RRC and loading generally follow a function that is exponentially decreasing (sometimes even logarithmically decreasing), it must be realized that building the system larger than appropriate can be detrimental to the system rather than beneficial due to thermodynamic minimums and concentration of compounds through evaporation. In other words, a larger CWTS of the same design as a smaller one will not necessarily produce better water quality.

Secondary to determining size based on RRC's, the sizing must be confirmed based on overall loading of compounds into the sediments of the CWTS, while accounting for accretion. All CWTSs have had loading rates to sediments calculated accounting for accretion, and in all cases the predicted average sediment concentrations of the CWTS are within the range of existing baseline concentrations previously measured on site (Appendix F– Soil metal data in Stantec 2011c).

Equation 1. Removal Rate Coefficient (RRC) calculation rearranged to solve for HRT

$$k = \frac{-\ln(C_f/C_i)}{t}$$

$$t = \frac{-\ln(C_f/C_i)}{k}$$

Although both iron and manganese can carry out precipitation reactions with arsenic, the predicted concentrations of both manganese and iron in the HLF and WRSA drainage are insufficient by themselves to solely treat the predicted concentrations of arsenic. It is anticipated that with iron addition, concentrations as low as 0.015 mg/L can be achieved, but long-term operational maintenance by the addition of iron will be minimized by the use of iron rich materials in wetland construction. When wetland treatment is based on biological processes only, concentrations closer to the EQS are predicted. Further evaluation of this process will be performed in the piloting phase to determine whether adding iron within the conveyance channels both upstream and between the cells of the CWTS will improve the treatment capacity, or if it may be mixed directly into the CWTS substrates. Sources of iron and manganese that will be included in the CWTS include the soils used for plant growth media, rock used in riprap within the seepage collection ponds and seepage conveyance channels, and during the initial phase of CWTS, iron could also be added in liquid form to enhance the initial removal rates while plant growth is occurring. All CWTSs have been sized to meet the initially proposed EQSs without the assumption of added iron, but predicted outflow concentrations have been provided for both scenarios with and without added iron.

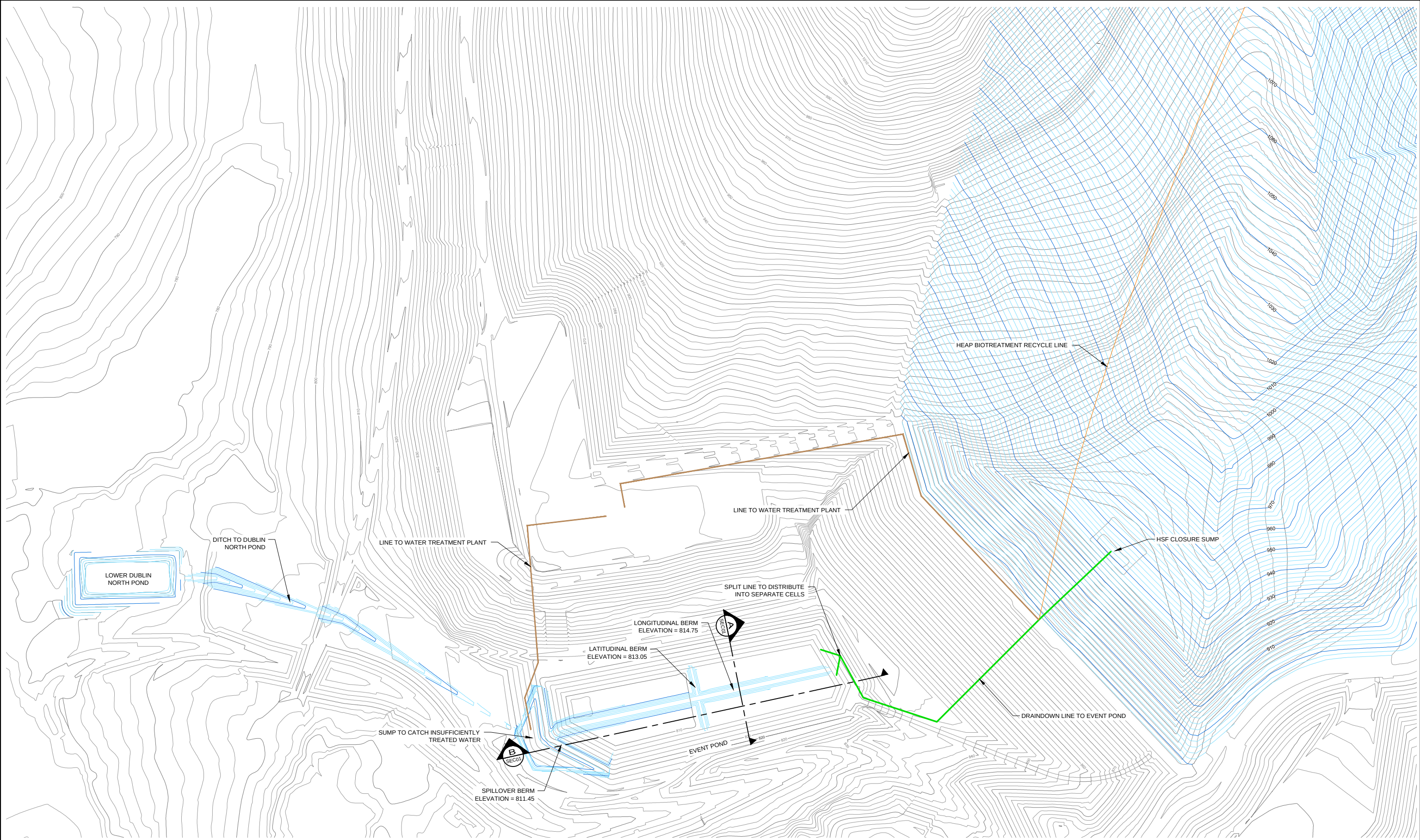
Section 8: Final Reclamation and Closure Measures

Based on water quality and site-specific considerations, the HLF PTS has been conceptualized as a four-step treatment train conceptually shown in Figures 8-6 and 8-7.

1. The HLF liner to the sump will be perforated through the access piping built into the heap and sump during construction, allowing seepage to flow via gravity at a controlled rate from the sump to the PTS. A valving system within the head works of the piping can then 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 HLF 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 zone will support the operation of the anaerobic bioreactor within the saturated portion of the heap. For the HLF, the bioreactor in the In-Heap Pond will be responsible for carrying out the majority of water treatment, especially during the draindown period and before the cover system is fully operational.
2. The seepage will leave the anaerobic bioreactor in the In-Heap Pond and discharge through a rip-rap lined cascade to re-aerate and precipitate elements as oxides. A preference will be given to rip-rap rock that contains iron or manganese oxides to help facilitate the formation of Fe and Mn surface coatings on the rip-rap that will enhance removal of As, Sb and Se.
3. The seepage will enter the area of the Events Pond, which will now be repurposed into a series of CWTS cells. The CWTS will bring water that has been largely treated by the bioreactor down to concentrations acceptable for discharge. The CWTS is designed to mineralize and sequester elements into the sediments in a benign manner through sorption, coupled biogeochemical reactions and accretion.
4. The treated 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 discharge into the LDNP and ultimately Haggart Creek.

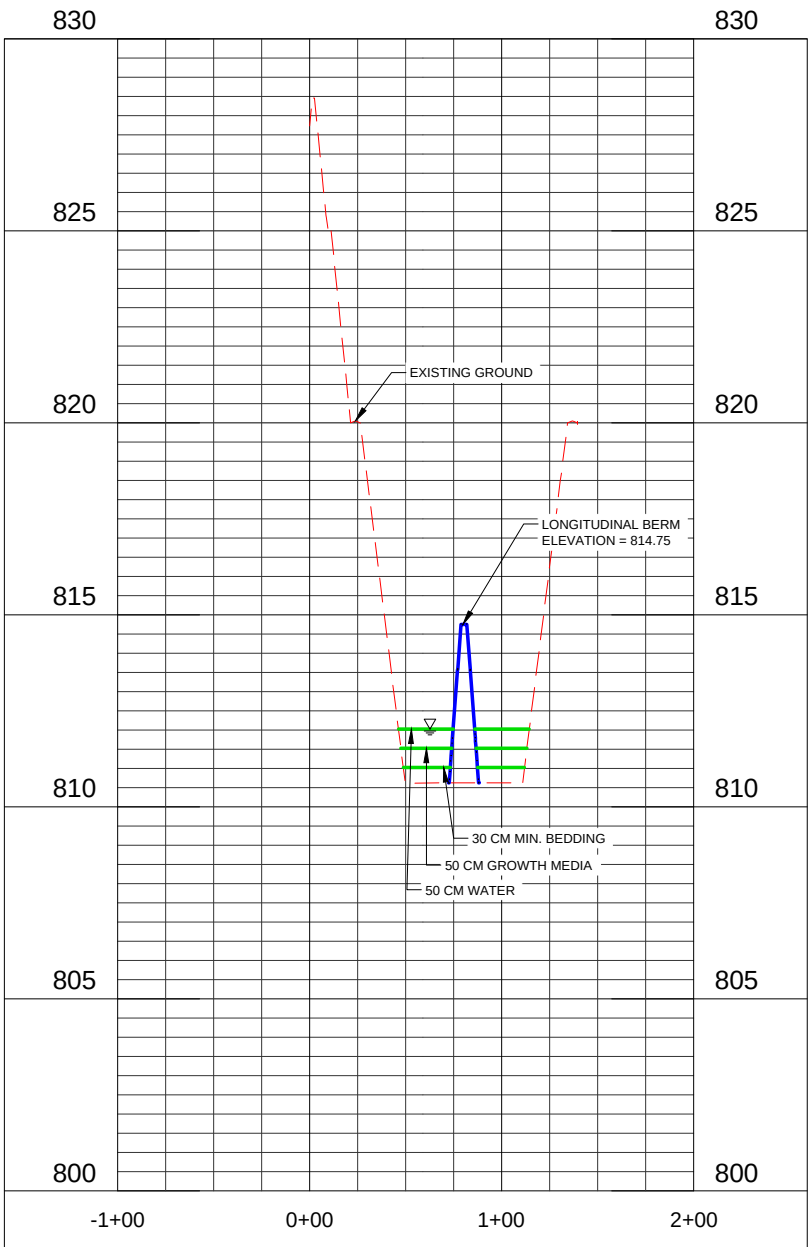
The first two stages of the PTS are closure aspects that have been designed into the operational phases of the facility (sump and Events Pond). For the purposes of this RCP, the CWTS has been sized in two ways, the first way is based on an assumption of complete treatment in the CWTS with the operation of bioreactor not continued, while the second way assumes that the predicted sizing accounts for the expected performance of the bioreactor. The reduction of constituents in bioreactors is based on prior experience at other heap leach facilities (Harrington, 2002), but also synthetic water tests have been performed at Yukon College, where alcohol-fed sulfate-reducing columns decreased arsenic concentrations to less than 0.1 mg/L and selenium concentrations were decreased from 0.3 mg/L to less than 0.01 mg/L.

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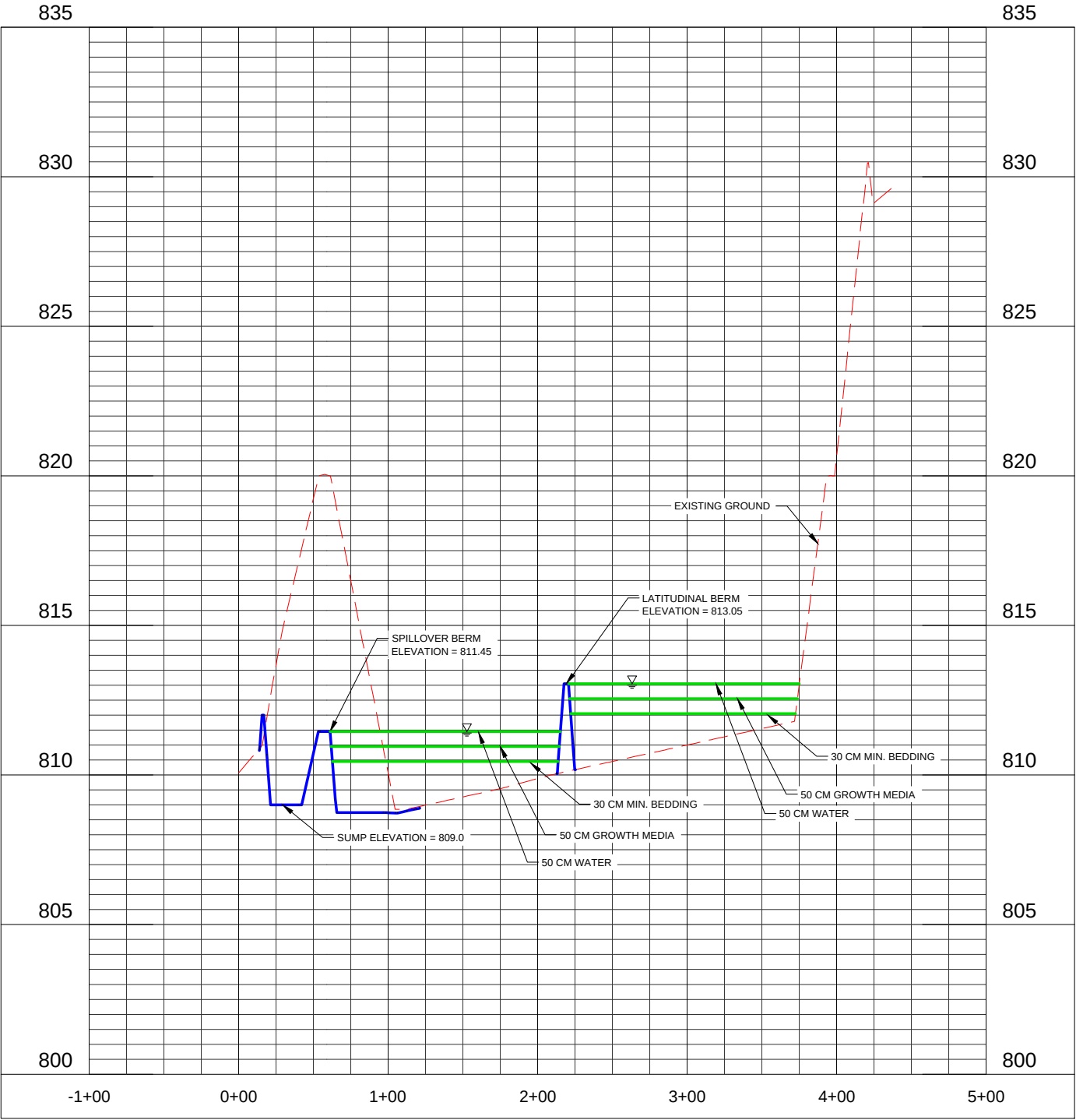


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Section 8: Final Reclamation and Closure Measures

Conceptual design criteria for HLF CWTS component of PTS include:

- Cells will be between a 1:3 to 1:4 width to length ratio
- There will be a minimum of two replicated systems in parallel; each system will have one entry and one exit point
- Each system will have multiple cells in a series to achieve the needed HRT
- 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
- Each aerobic cell will be able to accommodate 45cm of soil, a 30cm water depth, and an additional 30cm freeboard. Each anaerobic cell will be built in the same way, but capable of accommodating 100cm water depth.
- There will be a retention/equalization basin prior to flow into the PTS and a collection basin at the outflow.
- 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 riprap
- The embankments of the wetlands will be a 2:1 - 3:1 slope.
- Bottoms of wetland cells are level, but there must be a height difference between the first and second cells to provide aeration of the water.
- Cells will be constructed with approximately 45 cm of soil, composed of a sand/gravel mixture for aerobic cells and possibly amended with iron bearing material. If anaerobic cells are deemed appropriate, finer soils may be needed, and amended with organic materials from site (such as wood chips).
- Cells should be lined with locally derived fine-grained materials to minimize leakage to or from surrounding sediments
- The CWTS will be planted with local plants, for which a nursery may be needed to propagate sufficient quantities.

Table 8-7: Sizing of HLF CWTS to Meet Year-Round PTS Outflow Goal of 160 µg/L Arsenic (Lorax 2014a)

	Size based on LDSP area
CWTS Hectares	2.4
Average Sediment Concentration (mg/kg) ¹	512

¹Calculated for once water chemistry is stabilized in 2028.

NC - no calculation, distributed through CWTS and conveyance channel.

Table 8-8: Predicted HLF CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Size	Maximum Predicted Source Term in Heap	Bioreactor outflow/CWTS inflow	Maximum CWTS outflow			QZ14-041 EQS for Arsenic
			No Added Iron	With Iron	Added	
2.4 ha	8.6	0.5	0.16	0.015-0.16		0.053

Based on water quality modelling, CWTS assessment and the current EQS for the Project, it is anticipated that with iron addition the arsenic EQS can be achieved using standard passive treatment technologies.

8.8.2.6 Earthworks / Recontouring

Heap Leach material will be placed at the final grade during active use so no final regrading will be required during closure.

8.8.2.7 Final Reclamation Measures for HLF

8.8.2.7.1 Engineered Cover

The HLF is a component of the Project that requires a cover design based on using locally available materials that limits infiltration to the greatest extent possible. 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 volumes which will minimize the total loadings from in-heap leaching processes, and thus limit the required treatment in the heap 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 thick 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 aid in further evaluation of cover system designs for closure of the proposed HLF at the Project site. 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 results from this modelling were considered during the cover system design work supporting the current design.

The currently proposed closure cover system 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. The most recent work further assessed the anticipated hydrological performance of the base-case cover system design and provides recommendations to improve predicated long-term performance from a net percolation reduction perspective. This was accomplished by completing the following work, as detailed in OKC (2014):

- 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 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 determine what, if any, improvements could 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. 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 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 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.

Based on the modelling of the Base Case a profile schematic of the cover that would be placed over the HLF is shown below as Figure 8-8. This conceptual design schematic shows the profile of the cover for the flat areas on the plateaus and benches, as well as the profile for the inter-bench slopes.

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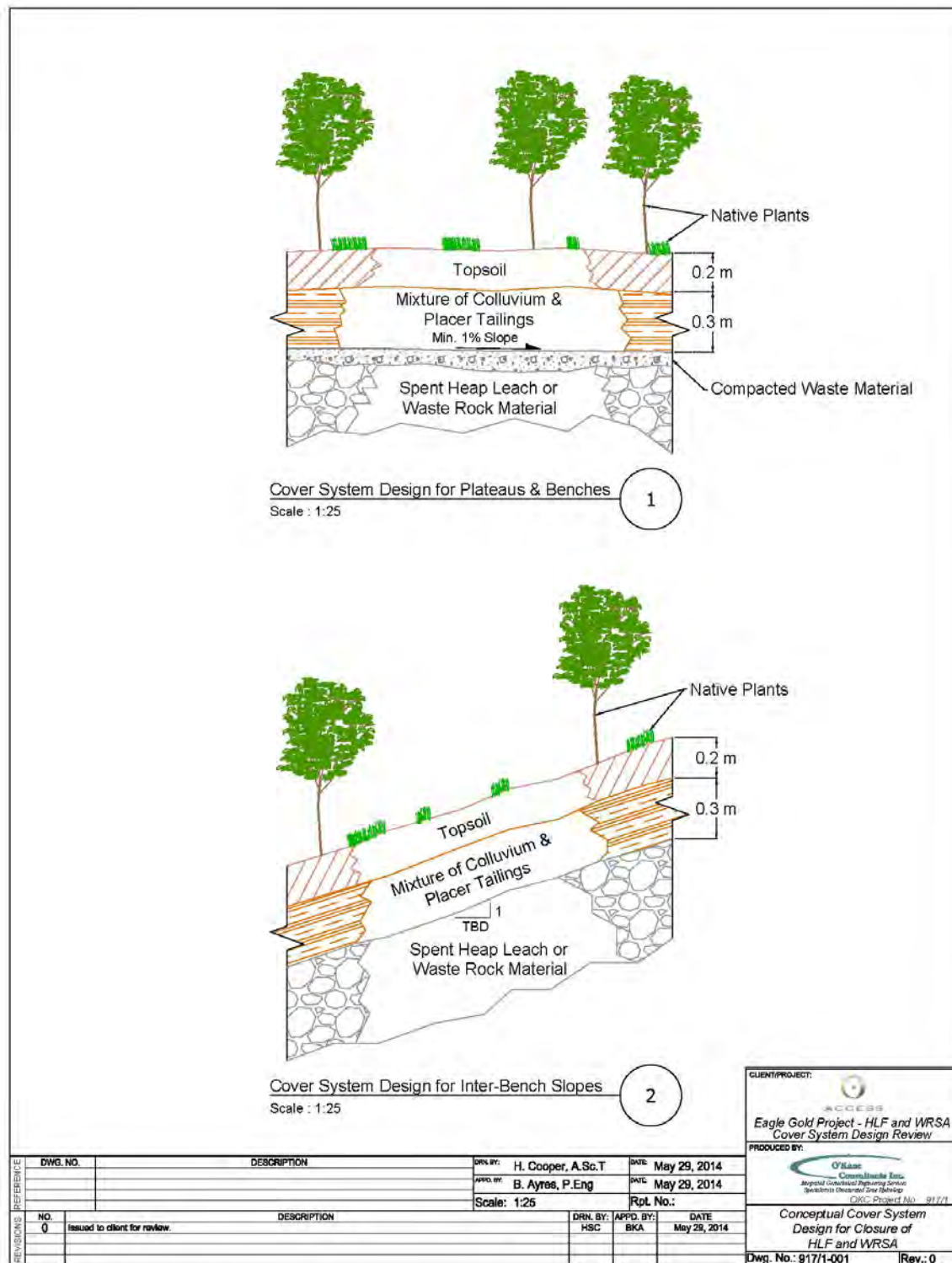


Figure 8-8: Conceptual HLF and WRSA Cover Design Drawings

8.8.2.7.2 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 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 the construction of engineered graded slopes that have stable configurations to meet closure criteria.

Closure measures undertaken to achieve the above objectives will include installation of engineered waste 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

Based on water quality and site-specific considerations, the EP WRSA PTS has been conceptualized as a six-step treatment train.

1. Part of the existing seepage collection system at the EP WRSA will be redone to function as a sedimentation and equalization basin, smoothing out peaks in water chemistry, located higher up the hill right at the toe of the WRSA to allow for gravity drainage to the EP PTS.
2. The new sedimentation/equalization basin also have a section that will contain organics to provide some pre-treatment as a subsurface flow bioreactor.
3. A rip-rap lined channel will then be used to convey water from the new seepage collection pond to the constructed wetland treatment system (CWTS). This channel will provide aeration to precipitate elements as oxides. A preference will be given to riprap rock that contains iron or manganese oxides to help facilitate the formation of Fe and Mn surface coatings on the rip rap that will enhance removal of As, Sb and Se.
4. Water will enter an equalization basin prior to the CWTS. This will again serve for flow equalization, dampen flow velocity from the channel, and provide water retention if maintenance is needed on the CWTS.
5. The CWTS will be replicate cells designed in parallel to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.

6. 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.

The first two stages of the PTS are based on repurposing of elements already necessary to the site during operations (LDSP). For the purposes of this RCP, the CWTS has been sized as though it is a stand-alone PTS, and the bioreactor and aerating conveyance channel are added treatment beyond what has been calculated for the CWTS.

Table 8-9: Sizing of EP CWTS to Meet Year-Round PTS Outflow Goal of 0.15 mg/L Arsenic (Lorax 2014a)

	Without Added Iron
Hectares	2.21
Average Sediment Concentration (mg/kg)	870

NC - no calculation, distributed through CWTS and conveyance channel.

Table 8-10: Predicted EP CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Size	Maximum Predicted Source Term in Heap	Bioreactor outflow/CWTS inflow	Maximum CWTS outflow		QZ14-041 EQS for Arsenic
			No Added Iron	With Added Iron	
2.4 ha	8.6	0.5	0.16	0.015-0.16	0.053

Based on water quality modelling, CWTS assessment and the current EQS for the Project, it is anticipated that with iron addition the arsenic EQS can be achieved using standard passive treatment technologies.

8.9.2.2 Earthworks

The Eagle Pup WRSA will be constructed so that the final landform will be at the design criteria for slopes. However, at closure, some fraction of the WRSA will be re-graded (for purposes of cost estimation, 10%) to tie the sides of the dump into the surface water management features/ditches. The flat areas will be compacted to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, again 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.

8.9.2.3 Cover Construction

A store-and-release cover made up of 0.5 m thick cover constructed with locally available top soil and tailings/colluvium will cover the Eagle Pup WRSA. 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. 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 reclamation research trials 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

The PTS for the PG WRSA was designed to meet discharge criteria during events of average flow and 75th percentile predicted for post-closure conditions. The CWTS design, sizing, and predicted outflow concentrations were developed as described for the HLF PTS, in section 8.8. Based on water quality and site-specific considerations, the PTS for the PG WRSA has been conceptualized as a four-step treatment train.

1. Part of the existing seepage collection pond at the PG WRSA will be repurposed to function as a sedimentation and equalization basin, smoothing out peaks in water chemistry.
2. Flow from the seepage collection pond will then flow through a brief rip-rap lined channel to convey water from the repurposed SCP to the CWTS. This channel will provide aeration to precipitate elements as oxides. A preference will be given to riprap rock that contain iron or manganese oxides to help facilitate the formation of Fe and Mn surface coatings on the rip rap that will enhance removal of As.
3. The CWTS will be designed to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
4. 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.

The first two stages of the PTS are based on repurposing of elements already necessary to the site during operations (PG Pond). For the purposes of this RCP, the CWTS has been sized as though it is a stand-alone PTS, and the bioreactor and aerating conveyance channel are added treatment (redundancy) beyond what has been calculated for the CWTS.

During operations, the PG WRSA seepage will go to the PTS, then be routed to the LDSP as make up water. This PTS that will be functional during operations for treatment of the PG seepage will be part of the reclamation research plan, serving as the on-site demonstration. 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. In long-term closure, the treatment required at the PG WRSA is dependent on water quality, and may involve routing to the pit, or treatment in the PTS. Currently both options are in consideration, and serve as a contingency to one another.

Table 8-11: Sizing of PG CWTS to Meet Year-Round PTS Outflow Goal of 0.150 mg/L Arsenic (Lorax 2014a)

	Without Added Iron
Hectares	0.66
Average Sediment Concentration (mg/kg)	855

NC - no calculation, distributed through CWTS and conveyance channel.

Table 8-12: Predicted PG CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg /L)

Size	Maximum Predicted Source Term in Heap	Bioreactor outflow/CW TS inflow	Maximum CWTS outflow			QZ14-041 EQS for Arsenic
			No Added Iron	With Iron	Added	
2.4 ha	8.6	0.5	0.16	0.015-0.16		0.053

Based on water quality modelling, CWTS assessment and the current EQS for the Project, it is anticipated that with iron addition the arsenic EQS can be achieved using standard passive treatment technologies.

8.10.2.2 Earthworks

The Platinum Gulch WRSA will be constructed so that the final landform will be at the design criteria for slopes. However, at closure, some fraction of the WRSA will be regraded (for purposes of cost estimation, 10%) to tie the sides of the dump into the surface water management features/ditches. The flat areas will be compacted to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, again 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.

8.10.2.3 Cover Construction

A store-and-release cover made up of 0.5 m thick cover constructed with locally available top soil and placer tailings/colluvium will cover the Platinum Gulch WRSA. 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. Modelling and sensitivity analyses conducted (O'Kane 2014; Appendix C) 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 reclamation research trials 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 reclamation research trials 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 will be set on concrete pads and foundation bases to support the ADR plant, recovery plant, admin facility and assay lab. Internal equipment will be 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 8-13: 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 consists 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

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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
- Demolition of steel structures
- Removal/demolition of concrete support and foundation

Table 8-14: Water Treatment Plant Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	Building Type	Size	Equipment	Structural Components	Hazardous Materials
Water Treatment Plant	Pre-engineered steel building	44.2m x 24.4m	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 will consist of two crushing building and a series of conveyance systems connecting the two buildings. The crushing facilities will be 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

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 8-15: 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 19m	Primary crusher Primary apron feeder Secondary feed conveyor	Concrete walls, foundations Steel platforms Rebar	Dust
Secondary crushing building	Pre-engineered steel building	30 m x 21 m	Secondary crusher 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 will be supplied from the Yukon Energy Corporation power grid, via a tap point approximately 25 km southeast of the property. The power line will be supported on wooden poles constructed parallel to the road access and running to the mine site substation and all the facilities. Power will be distributed via two step down substations and to all the process control, instrumentation and communication systems. Closure costs are not included for dismantling and removal of the transmission infrastructure as these assets will be owned by Yukon Energy Corporation.

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 8-16: Power Generation and Transmission Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	Building Type	Size	Equipment	Structural Components	Hazardous Materials
Power line	n/a	45 km	45 km of 69 kV power line Anchors Power line hardware	Wooden poles	
69 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	
25 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	
Overhead power lines	n/a	n/a	25 kV power lines Anchors Power line hardware	Wooden poles	

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 will be completed within an insulated truck shop complete with an overhead crane and support equipment. 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 8-17: 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	126 m x 21 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 will be delivered via trucks to two large storage tanks located near the truck shop, and then pumped to local tanks close to the ADR plant and the primary crushing plant. Propane will be stored local to the camp facilities.

Table 8-18: Fuel Storage Tank Area Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	Building Type	Size	Equipment	Structural Components	Hazardous Materials
Diesel storage	n/a	2 x 750,000 Tanks 2 x 100,000 L Tank	Tanks Pumps	Concrete foundations Concrete containment areas	Diesel sludge
Propane	n/a	3 x 5000 gal Tanks	Tanks Pumps	Concrete foundations Concrete 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 management systems will be implemented to include a series of diversion ditches for both contact and non-contact water with series of ponds and pumps. The associated infrastructure includes mine water treatment plants, cyanide destruction facilities and potable and sewage treatment structures. The 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 (Yukon Government, 2008), 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 of the site in a controlled, stable fashion under a reasonable range of anticipated conditions.

8.13.2 Closure Measures

8.13.2.1 Dublin Gulch Diversion Channel

Initial construction of the Dublin Gulch diversion channel (DGDC) for operations will be re-armoured at appropriate locations so that it is acceptable for long-term closure. The re-armouring of the DGDC will be completed within three years of active mining commencing however, the costs for these activities have been retained in the end of mine closure cost estimate as the activity is beyond the two-year cost estimate and is necessary for closure but has not yet been completed. The closure design for the DGDC will include measures to minimize erosion.

8.13.2.2 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.

8.13.2.3 Lower Dublin South Pond

In preparation for closure, the conversion of the Lower Dublin South pond to a PTS will occur as needed. The majority of the LDSP will be used for construction of a CWTS, and the downgradient end will be used as a final sedimentation and settlement pond for the catchment around the LDSP prior to discharge into the DGDC.

8.13.2.4 Lower Dublin North Pond

In preparation for closure, the conversion of the Lower Dublin North Pond to an equalization basin and a settling pond for water conveyance ditches and the Heap PTS will occur. It is possible that the entire LDNP will be used

as a final sedimentation and settlement pond for the catchment area around the LDNP prior to discharge into Haggart Creek which will be required during the transitional period when covers and reclamation activities are being implemented. The LDNP is substantially larger than what is necessary for use as a settling basin, which will allow the upper end of the LDNP to be used for construction of a CWTS if additional area is needed to achieve water quality criteria. In any case, the height of the pond will be reduced so that it will not be a significant water retaining pond, but rather a pond designed to pass runoff events with sufficient settlement to remove suspended solids.

8.13.2.5 Eagle Pup Pond

In preparation for closure, the Eagle Pup WRSA will have a new small seepage collection pond located higher up-gradient. The collection pond will be divided, with some portion used to provide some flow equalization for the CWTS, and a portion of it is repurposed as a buried bioreactor, as described under the Eagle Pup PTS section. The Eagle Pup Pond will be decommissioned after the collection pond construction area is stable and resistant to erosion.

8.13.2.6 Platinum Gulch Pond

In preparation for closure, the conversion of the Platinum Gulch Pond to a PTS will occur as described under the Platinum Gulch PTS section.

8.13.2.7 Events Pond

In preparation for closure, after cyanide concentrations in the heap discharge meet criteria, the Events Pond will be repurposed for use as a PTS as described under the HLF PTS section.

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 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 preserved (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. 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

Prior to the development of the construction camp, topsoil will be salvaged and stockpiled locally in windrows adjacent to the disturbance site in designated soil stockpile areas or in the reclamation material stockpiles. Species inventory will be conducted and based on results ecosystem units will be recorded to guide future reclamation efforts.

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 sites 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 SGC 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

An onsite landfill 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.

8.18.2 Closure Measures

Landfill areas compacted and capped.

8.19 LAND TREATMENT FACILITY

8.19.1 Closure Objectives and Criteria

An 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 proposed land treatment facility (LTF) will be 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 will be created during the initial construction activities, where overburden materials will be stripped and segregated, and placer materials will be collected and placed.
- In general, three main reclamation materials are anticipated to be used as cover soil or construction materials during closure. The types and estimated materials availability and use are summarized in Knight Piesold (2013a):
 - o Colluvium: ~275,000 m³
 - o Placer Tailings: ~550,000 m³
 - o Topsoil: ~765,000 m³

9 PERFORMANCE UNCERTAINTY AND RISK MANAGEMENT

9.1 FAILURE MODES EFFECTS ANALYSIS (FMEA)

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.

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
- Dublin Gulch Diversion Channel

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:

- o Biological Impacts and Land Use
- o Regulatory Impacts and Closure
- o Public Concern and Image
- o 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

SGC will undertake reclamation and closure research programs prior to decommissioning. The research programs will be initiated to support the closure measures and will be implemented, as appropriate, during temporary closure, after construction, and/or after mining operations have commenced. Currently, several closure and reclamation research programs are planned, including engineered cover designs and test plots, growth media and revegetation trials, passive treatment research and natural groundwater attenuation programs.

10.1 ONGOING REVEGETATION TRIALS

Laberge Environmental Services (2012) conducted vegetation trials at the Peso Mineral Exploration Site, located on claims held by SGC but independent of the project site to test the viability of incorporating biochar and other soil amendments into the Eagle Gold Project. 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 which will be transferable to the Reclamation and Closure Plan as required by the *Quartz Mining and Yukon Waters Acts and Regulations*.

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 have 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. Although some of the soil characteristics at Peso are different from the majority of the Eagle Gold Project site soils, which are less mineralized with neutral to slightly alkaline attributes, the Peso site represents a higher elevation site and will remain undisturbed for the duration of the long term monitoring program.

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

Botanical Name	Common Name
<i>Festuca ovina</i>	Sheep Fescue
<i>Deschampsia caespitosa</i>	Tufted Hairgrass
<i>Poa glauca</i>	Glaucous bluegrass
<i>Agrostis scabra</i>	Tickle Grass

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

Botanical Name	Common Name
<i>Festuca ovina</i>	Sheep Fescue
<i>Deschampsia caespitosa</i>	Tufted Hairgrass
<i>Poa alpine</i>	Alpine bluegrass

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Botanical Name	Common Name
<i>Trisetum spicatum</i>	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.

Monitoring of the plots is ongoing and reporting through to the end of 2015 has shown all seeded plots with no treatments supported no to very sparse, stressed growth. Overall, the plots with the amendments 'biochar and compost' are still providing the most robust and dense growth. Alpine Bluegrass, Tufted Hairgrass, Glaucous Bluegrass, Tickle Grass, Sheep Fescue, Alder and hedysarum have been identified in the plots and several areas exhibiting good overall health.

Three other candidate sites (boreal high, boreal low and riparian) were also identified within the project areas and may be utilized for future revegetation trials.

10.2 ENGINEERED COVERS

The currently planned end land-use for the reclaimed HLF and WRSA at the Project 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 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.

OKC (2014)³ completed an assessment of the anticipated hydrological performance of a base-case cover system design; the base-case 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:

³ 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.

- 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 net percolation and to inform eventual large-scale closure cover system construction. Six 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 characterization of HLF and WRSA waste materials;

Task 4: Conduct enhanced meteorological monitoring on various slope aspects;

Task 5: Conduct closure cover system field trials for performance monitoring; and

Task 6: Assess the effect of high pH water treatment solids on the heap cover

For further discussion on research associated with engineered covers, see Appendix D.

10.2.1 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 (e.g., complete a background and results review of any recent monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation 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

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

The objectives of the material characterization program are 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.

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

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Alberta rated system but needed to be accounted for the Project. 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.

A key component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (ksat) 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 (BGC 2010, BGC 2011, BGC 2012a and BGC 2012b) 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 the facility construction phase or during a test pit program to collect samples and log profiles of locally available viable sources of 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 areal 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.

10.2.3 Task 3 Material Characterization Program for HLF and WRSA Waste Materials

Current estimates of long-term cover system performance for the Project 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 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 will 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, 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 and leachate to passively treat.

10.2.4 Task 4: Enhanced Meteorological Monitoring on Various Slope Aspects

Given the relatively high latitude of the Project site, slope aspect and angle highly influences 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) 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.

The objective of the enhanced hydrological and 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 Project 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. 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 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.

10.2.5 Task 5: 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 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 numerical models, such as VADOSE/W;
- 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.

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 trial would be revegetated using techniques and species outlined by KP (2012a and 2012b) 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 revegetation 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.

10.2.6 Task 6: 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”.

WUL QZ14-041 Clause 178c requires a research program 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

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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. The geochemical testing includes percent solids, ABA, particle size, whole rock assay, and meteoric water mobility testing.

Because the volume of high pH solids is estimated to be low (calculated to be 238 m³/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.

10.3 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.

10.3.1 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 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. A 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.

10.3.2 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.

10.3.3 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 m² 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 m² 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) 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.

10.4 PASSIVE WATER TREATMENT

A passive water treatment system is 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 will be required to optimize and confirm the PTS design and size. Despite being best available estimates for the sizing of the CWTS component of the PTS for closure, these are not site-specific and 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 early point of closure planning, with the understanding that these will be revisited once the PTS designs are 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 Eagle Gold Project. 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

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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 phases of research for the PTS include bench/laboratory/pilot (controlled environment and/or outdoor cold-climate at CSL's dedicated PTS facilities), and demonstration (small-scale, on-site during operations). The purposes of each phase are outlined in Table 10-3.

Table 10-3: CWTS phased development.

Aspects and Parameters Related to Different Constructed Wetland Scales	Pilot (CSL facilities)	Demo (on site)	Full
Test various water chemistries and formulations	+		
Test different sediment makeups	+		
Test different plant efficacies/properties	+		
Environmental parameter control	+		
Develop flow rates and water depths (HRT)	+		
Develop rate coefficients and kinetics	+		
Intensive monitoring	+	+	
Determine parameters for proper sizing	+	+	
Measure removal extent	+	+	+
Evaluate cold weather performance	+*	+	+
Compare demo/full scale data to pilot data (e.g., rate coefficients)		+	+
Confirm removal rates/extents		+	+

*if performed outdoors.

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: Updating Information for Final Design

1. Continued characterization of water requiring treatment; comparing initial predictions with actual performance and reviewing if the initial plan needs adjustment
2. Confirmation of targeted constituents and performance goals
3. Characterization of existing wetlands systems in site vicinity to guide plant selection and water management approaches
4. Site assessment for implementation of CWTS

Section 10: Reclamation and Closure Research Programs

In Phase 1, the following list of information will be gathered from site operations monitoring programs and used for the design basis of the PTS. Additionally, potential borrow sites for hydrosols and wetland plants will be identified. Plants may be collected from site for use in Phase 2, if appropriate.

- Intrinsic Factors
 - o Concentration and identity of constituents that will require a decrease in concentration
 - o Flow rates
 - o Fluctuations in concentrations and flow rates
 - o Cation/anion balance
 - o Conductivity
 - o Alkalinity
 - o Hardness
 - o pH
 - o Concentration of Sulfate
 - o Concentration of Iron and Manganese
 - o Nutrient availability (N,P,K and micronutrients such as Cu, Se)
- Extrinsic Factors
 - o Receiving system limits (water quality objectives, mixing zones)
 - o Soils
 - o Geology
 - o Topography
 - o Constructability
 - o Sources of organic material
 - o Depth to groundwater (hydrogeologic regime: recharge or discharge area)
 - o Vertical and/or lateral proximity to permafrost
 - o Duration of operation required
 - o Wildlife deterrence
- Climatic
 - o Geographic location (lat/long)
 - o Aspect (i.e., north- or south-facing)
 - o Seasonal distribution of Rainfall

- o Character of Storm events
- o Snowfall
- o Freshet (break-up) character
- o Freeze-up character
- o Growing season
- o Temperatures (max, min, mean)
- o Growing-degree days
- o Evaporation and evapotranspiration
- Putative evidence of system functionality at site
 - o Information gathered on existing wetland systems near the site
 - Types of native plant species
 - Redox in natural wetlands
 - Soil chemistry (total organic content, nutrient levels, etc.)
 - o Identify mechanisms in existing wetlands near the site to sequester constituents that will require a decrease in concentration
 - E.g., oxic or anoxic As removal pathways
 - o Accretion rates
 - o Availability and sources of local plants for CWTS planting

10.4.1.2 Phase 2: Indoor Pilot Scale

1. Design of pilot scale PTS (one or more designs may be tested for optimization)
2. Assembly of indoor pilot scale PTS
3. Performance monitoring and stress testing of the indoor pilot scale PTS

In Phase 2, pilot scale systems will be designed and built in a year-round temperature controlled greenhouse. At times, bench or laboratory scale testing is used to aid in the design of the pilot scale PTS. At pilot scale, there are typically two to four treatment cells in a series, two replicates of each system, and 2-4 different system designs tested (a total of 8-32 cells). For this phase, simulated water will be created with chemical characteristics similar to that predicted to occur post closure. These systems will be run for a minimum of 6 months and maximum of 2 years, depending on the extent of optimization and/or stress testing to be performed. A PTS such as a BCR may be used as a pre-treatment step and will be evaluated in line with any other components of the PTS (e.g., a CWTS). During Phase 2, explanatory parameters will be assessed regularly.

10.4.1.3 Phase 3: Outdoor Pilot Scale

Depending on data from Phase 2, it may be possible to skip this phase and proceed directly to on-site demonstration.

1. Assembly of outdoor pilot scale PTS in a cold climate environment (based on information gathered from indoor pilot scale findings)
2. Performance and seasonal monitoring of the outdoor pilot scale PTS

In Phase 3, the best performing systems from Phase 2 will be used for the design basis for outdoor pilot systems. Simulated discharge water will be used. Each treatment cell in the outdoor pilot-size system will contain approximately 500kg of hydrosoil, (total of approximately 2 tonnes per treatment system being tested) and will have 1,200-1,500 litres of simulated discharge water pass through per week. At a minimum, one treatment system will be tested in duplicate. Ideally, these systems will be built using hydrosoil from a borrow site near the Eagle Gold mine. These systems will be located outdoors, at a cold-climate PTS testing facility. These systems will be allowed to run for a minimum of 1.5 years, ideally 2-3 years to properly characterize spring thaw and winter freeze performance. During Phase 3, explanatory parameters will be assessed regularly (as in Phase 2).

10.4.1.4 Phase 4: On-site Demonstration Scale

1. Design of on-site demonstration scale PTS
2. Construction of demonstration scale PTS at the Eagle Gold site
3. Performance monitoring of demonstration scale PTS at site

In Phase 4, the demonstration-scale system will be built on site at the Eagle Gold 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 at the PG WRSA seepage collection area early in operations. The outflow from the demonstration PTS will be sent to the LDSP to be used as make-up water or to the WWTP 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 and 3).

10.4.1.5 Phase 5: Full-Scale Implementation

1. Design of full-scale PTS
2. Construction bids, permitting and initiation
3. Construction

4. Planting and/or maturation
5. Acclimation and initial monitoring
6. Ongoing operation and periodic monitoring of 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

A proposed schedule for implementation of the research program is shown below.

Table 10-4: Passive Treatment Research Program Implementation Schedule

Phase	Start Date	End Date
Phase 1: Information Gathering	September 2012	June 2017
Phase 2: Indoor Pilot Scale	July 2017	December 2018
Phase 3: Outdoor Pilot Scale	Jan 2019	June 2021
Phase 4: On-site Demonstration Scale	2022	2023
Phase 5: Full Scale Implementation	TBD	Into post-closure

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.

Water Use Licence QZ14-041, 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.”

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 in Appendix E.

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 Project 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 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

The reclamation cost estimates provided herein are intended to satisfy clauses 191 to 193 of the Type A WUL QZ14-041 approved by the Yukon Water Board on December 3, 2015. The activities and processes contemplated in the reclamation cost estimates remain unchanged from those presented in the Eagle Gold Project Reclamation and Closure Plan Version 2014-01 dated August 2014 and the activities and procedures to which these cost estimates apply are considered to be approved by QZ14-041 and QML-0011 re-issued on March 24, 2016.

Appendix A presents an estimate of the current site liability based on the exploration programs undertaken by SGC to date. The current liability estimate was provided to SGC by EMR to support the existing bond held for the Project and can be considered as the Year 0 estimate for the Project.

An MS-Excel spreadsheet model has been developed which mirrors the specific cost elements of the Yukon EMR and Water Board guidance document. Appendix B 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 Eagle Mine include the following:

T1 Cost Summary

The summary table pulls in costs calculated in the other costing tables. 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.

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 pumping, site security, 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 it is assumed that exploration disturbance is already bonded for or will be within the footprint of other areas that will be reclaimed elsewhere.

T5 Closure Planning

Lump sum costs for closure planning include an update to the closure plan, detailed design of the passive treatment systems, engineered cover evaluations and site contamination surveys.

T6 Pit

Reclamation tasks for the open pit 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 developed for the feasibility study for producing rip-rap material.

T7 Heap Leach Facility

The primary tasks associated with closure and reclamation of the HLF includes placement of the soil cover over the HLF surface (0.3 m colluvium-tailings mixture, 0.2 m overburden/topsoil) and addition of detoxification reagents. A custom rate has been calculated for haulage and placement of cover material based on costs developed for the feasibility study. The majority of the cost associated with the HLF closure is associated with the reducing sugars and nutrients required for cyanide destruction as well as alcohols and nutrients for the in-heap bioreactor. Unit costs per ton of reagents including freight are based on recent quotations and other project experience. Dosage rates are based on test work and experience at other heap leach detoxification projects.

T8 Waste Rock Storage Areas

The majority of the cost associated with the WRSAs is associated with the haulage and placement of a soil cover over the Eagle Pup and Platinum Gulch WRSA surfaces. A custom rate based on haulage distance, productivity and feasibility costs has been used for the calculation of cover construction. Additional costs for construction and/or improvement ditches between the WRSA drain outlets and the inlets to the PTSs are included based on an estimated number of equipment hours needed for construction of the conceptual design.

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 along with the type of support equipment (crane, excavators, etc.). The estimated hours are based on experience in dismantling an ADR plant at Brewery Creek. It is likely that significant salvage value will be realized in the facilities but the estimated hours assume that only minimal equipment is salvaged. Certainly in Year 2 the ADR plant, crushing plant and other facilities will have significant value as they will be relatively new, and the salvage value would likely exceeding the cost of demolition.

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 a custom rate discussed in Section 13.1.

T11 Waste Disposal and Remediation

The majority of costs associated with this task include 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 take into account 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

The major cost driver for water management is associated with the power needed for HLF pumps to recirculate the heap solution inventory during Phase 6 (i.e., the ~7 year actively managed drawdown period). Electrical power costs are based on the heap drawdown curve derived in Mines Group (2014). The maximum solution pumping power draw is from four 1120 kw motors operating during Phase 6. The electrical power load was factored down each year based on the drawdown curve. The electrical power cost of \$0.11/kw was used to calculate the annual costs. A factor is applied to the connected motor load to account for a reduced power draw since solution will not be primarily pumped to the top of the heap as is the case during operations.

T15 Post Closure Care, Maintenance, and Monitoring – Phase 6, 7, and 8

This table includes costs for onsite management, employee transport, water treatment, long term funding of reclamation and closure research, monitoring and reporting, and site maintenance. The full costs 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.

T16 Interim Care and Maintenance

This table provides an allowance for the site to be managed during an interim 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.

T17 Quantities

This table contains quantities of materials and areas of disturbance, which are used throughout the other tables in the estimate.

NPV Calculations

The NVP 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 2.5%. 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.

13.1 BASIS OF COST ESTIMATE

The basis of the cost estimate for the Project 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. The cost model contains a drop down menu that allows the selection of various pieces of equipment, labour categories and custom rates depending on the specific task. For the basis of the cost estimate, standard equipment types are included that are locally available (i.e. D-9 dozer, CAT 235 excavator). Third party rates have been established using a combination of hourly rates in the feasibility study, published rates for Yukon contractors as well as experience using local contractors.

Custom Haul rates were developed for tasks that involve the transport and placement of significant volumes of material. The rates were developed by Merit Consultants International, a recognized industry leader in project and construction management services who also assisted with the preparation of the feasibility study for the Project, and are based on the mining fleet that will be on site at the start of reclamation. The rates consider haul distances, and grades travelled. The rates are comparable to similarly developed rates from the latest update to the Minto mine closure cost estimation for the hauling and placement of overburden and cover materials.

Equipment and Personnel Rates as well as other Contractor rates and camp costs were adopted from those rates provided by the YWB third party costing review (Attachment A of Reasons for Decision document from QZ14-041) where appropriate. Many of the personnel rates were updated based on the Yukon Government Fair Wage Schedule - Effective Apr 1, 2016, with an applied loading rate to include costs above the base wage such as overtime, Canada Pension Plan, Employment Insurance, and worker's compensation. This is a similar approach to that used in other recent Yukon mining project updates.

Lump Sum Values: Some costs are presented as a lump sum which could be either a one-time expenditure or repeating periodic cost. 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. Lump sum costs in excess of \$50,000 have been specifically called out and explained in Section 13.2.1 and Section 13.3.1 for the Year 2 and EOM closure scenarios, respectively.

Indirect Costs: While an overall indirect cost rate of 15% is typical, in this case, the indirect cost rate included here (5% for EOM) includes only insurance, taxes, and other administrative costs, and most of what is typically included as indirect costs are included elsewhere. A rate of 10% is utilized for the Year 2 estimate to be conservative. In the EOM estimate there are many more administrative costs recognized in particular tasks such as administration of the heap treatment work (both an environmental specialist and a site caretaker). Other indirect costs such as site security, project management and engineering are included separately in the estimate. Contractor profit and overhead is included in the equipment rates. As such, these rates do not need to be accounted for in this line item of indirect cost.

Contingency Costs: Contingency costs have been included at a rate of 15%. This rate is justified based on the detailed understanding of the design requirements and implementation strategies of the proposed mine plan coupled with and the associated high level of detail in the current design. This rate is further supported by direct

experience of the design team with the operation and decommissioning of the Brewery Creek heap leach, which is a reasonable analogue with which to compare the proposed Eagle Gold mine decommissioning plan.

The current iteration of the closure cost estimate reflects feedback from the YWB from both the WUL hearing and as presented in the Reasons for Decision issued in connection with QZ14-041. 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 first two calendar years of the Mine Plan only relate to construction of the Project. The peak liability for these activities is thus realized at the completion of construction at the end of year two. The specific project components that will exist at this point in time are presented in Table 8-1. Table 13-1 provides a cost estimate for the Year 2 site layout.

To support the development of the Year 2 peak liability cost estimate, feedback from the Reasons for Decision issued in connection with QZ14-041 and the associated closure costing review commissioned by the Yukon Water Board (Attachment A of Reasons for Decision document from QZ14-041) have been incorporated. The full updated, detailed costing model is located in Appendix B.

The updated Year 2 Peak Liability Closure Cost Estimate is \$13,471,072. This amount represents a decrease of \$3,659,980 below the financial security specified by EMR in QML-0011. The financial security specified in QML-0011 is intended to include the security required by clause 187 of the Type A Water Use Licence QZ14-041.

The following section highlights the rationale behind the most recent costing update and describes specific modifications that have been proposed for individual costing tables.

13.2.1 Discussion of Year 2 Closure Costing Tables and Notable Adjustments

T1 Summary

The only modification to T1 is related to Indirect Costs which have been reduced from 15% to 10% as described in Section 13.1.

T2 Unit Costs

Certain unit rates and equipment rates have been increased to reflect the updated costing contemplated in the third party review provided as Attachment A of the WUL QZ14-041 Reasons for Decision. Additionally, personnel rates were updated as discussed in Section 13.1 to be based on the Yukon Government Fair Wage Schedule where possible. In general, a 7% engineering fee is estimated for all work tasks on each individual sheet.

T3 General and Administrative

Costs reflect updates to power and heat, site security and camp costs due to increases in unit and equipment rates. Reductions to the quantities for Year 2 as the time required for closure will be significantly reduced.

T5 Closure Planning

\$150,000 added to closure plan development. The lump sum values provided for Closure Specific Studies and Field Trials and Closure Plan Development have been informed by the costs incurred to date in the preparation of the Eagle Gold Project Reclamation and Closure Plan and is consistent with costs experienced by other mining projects in Yukon and other jurisdictions.

T6 Pit

Area of pit (and associated costs) adjusted to reflect actual pit dimensions at Year 2. In Year 2, the area will be scarified and revegetated.

T7 Heap Leach Facilities

No heap treatment costs are included here because no heap materials have been placed. Only costs for cover and passive treatment cell development are required.

T8 Waste Dumps

Areas updated to reflect Year 2 site configuration.

T9 Surface Facilities

Costs have been adjusted to more accurately reflect the ground and equipment conditions in regards to contamination in Year 2 of the Project. Additionally, costs for demolition of the Mine Water Treatment Plant were removed from the Year 2 scenario as the plant will not yet be constructed.

T10 Infrastructure

Allowance for decommissioning of water supply wells as per the third party review provided as Attachment A of the WUL QZ14-041 Reasons for Decision was added.

T11 Waste Disposal & Remediation

No changes.

T12 Landfills

Line item added for revegetation of the landfill.

T13 Road and Trails

Allowance added for labourer to install silt curtains and enviro matting.

T14 Water Management

Reflects some additions from EMR (and WUL RFD) and the elimination of some heap leach components as no ore would have been placed in Year 2. Not all additions from EMR were adopted as the Lower Dublin South Pond and the Platinum Gulch pond will be converted to CWTS in closure. The costs for the construction of CWTS is accounted for elsewhere in the estimate tables.

A notable lump sum amount is included for the raising and/or widening of operational 1:10 year ditches to the sum of \$75,000. This cost allows for materials and equipment time for development of all site ditches to final configurations.

T15 Post Closure Care, Maintenance and Monitoring

The duration of Phase 7 was reduced from 15 years to 5 years for the Year 2 scenario due to the reduction in both size of waste rock facilities and the lack of ore mined. A provision was added for a full suite of monitoring and maintenance at 16 and 31 years after the end of mine (Phase 8).

Water Quality Monitoring costs are developed from an estimate of numbers of stations for sampling and analytical costs included in the licence.

T16 Interim Care and Maintenance

Interim care and maintenance added as per third party review comments

T17 Quantities

This table was added as a source of quantities for all the other worksheets to allow for faster updating in future iterations to assist with the preparations of sensitivity analyses.

13.3 END OF MINE LIFE COST ESTIMATE

The total cost of implementing the Reclamation and Closure Plan as outlined in this document is estimated at \$56,217,181. A summary of the RCP costs for both Year 2 of operations and the end of mine life (EOM) is presented in Table 13-1. This EOM cost estimate includes the full extent of build-out for the open pit, HLF, WRSAs and surface facilities and assumes that no progressive reclamation has been undertaken during the life of the Project. Direct costs for all of the reclamation tasks are based on 2016 dollars and total approximately \$30.478 M for the EOM life cost estimate. Indirect costs are estimated at 5% of the direct costs. Indirect costs for EOM total \$1.524 M. Direct and indirect costs are then inflated 2% over the period of implementation. The EOM cost estimate includes \$3.84 M for inflation. The plan requires 7 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 32, and 47 years after the end of mine (Phase 8). The 7-year duration for implementation is driven by the time required to drain down the heap and establish drainage that can be managed passively. Terrestrial reclamation will be accomplished well before the 7-year timeframe.

Future long-term costs for solution draindown and long-term monitoring and maintenance are calculated on a NPV basis using a discount rate of 2.5%. The NPV of heap detoxification, water treatment and long-term monitoring for the EOM case totals \$13.042 M. A further 15% contingency is added (\$7.333 M) to the direct, indirect and NPV costs to determine the overall total of \$56.217 M.

13.3.1 Discussion of End Of Mine Life Costing Tables and Notable Adjustments

T1 Summary

Previously discussed in Section 13.2.1

T2 Unit Rates

Previously discussed in Section 13.2.1, with the exception that a 5% engineering fee is estimated for all work tasks on each individual sheet instead of 7% which is used in Year 2. This is to recognize the amount of

engineering work that will be available at the end of mine life (as built drawings, test work, and other information required for both operational and regulatory purposes) that won't be available at the end of Year 2.

T3 General and Administrative

EOM quantities were updated to reflect the accounting of Interim Care and Maintenance on a separate table.

T4 Exploration Disturbances

No costs are included for this task as it is assumed that exploration disturbance is already bonded for or will be within the footprint of other areas that will be reclaimed elsewhere.

T5 Closure Planning

The lump sum values provided for Closure Specific Studies, Field Trials and Closure Plan Development have been informed by the costs incurred to date in the preparation of the Eagle Gold Project RCP and are consistent with costs experienced by other mining projects in Yukon and other jurisdictions. At the end of mine life, designs of revegetation systems, waste rock and heap covers, and the in-heap and CWTSS will have been advanced by the reclamation research programs. The \$500,000 allowance is to take the information developed in these programs to final for-construction designs. Note that the Platinum Gulch covers and PTS will have been installed and will have several years of performance data available. In addition, the water treatment plant will have been installed and operated during mine operations. Thus, closure plan development costs are primarily detailed design costs for the in-heap treatment, and CWTSS and covers for the heap and Eagle Pup sites.

T6 Pit

No changes for EOM scenario.

T7 Heap Leach Facility

An allowance was added to this table for sonic drilling and testing of the heap upon closure to confirm detoxification. Additionally, a monthly cost for managing the heap recirculation of treatment solutions, utilizing the drip emitters or sprinklers was included in this table.

Unit rates for In Situ Treatment Reagents were updated to reflect changes in reagent costs since the reagents were priced out in 2014. The costs in 2014 were reflective of higher fuel costs that were outside long term historical norms; the unit prices for both reducing sugars and nutrients and alcohols and nutrients were adjusted to fit the historical trends and current pricing. For example, price of ethanol per gallon has recently ranged between (USD) \$1.43- \$1.69 per gallon while prices in 2014 for a similar time of year ranged between (USD) \$2.02- \$3.15. Similarly, the cost of corn (the feedstock used most often to make reducing sugars) were at recent high levels during 2014, since declining approximately 18% in 2016. Prices for both commodities have returned to levels consistent with their recent 15 year trends, which justifies reducing the price back to be consistent with these long term averages.

T8 Waste Rock Storage Areas

No changes.

T9 Surface Facilities

No changes.

Section 13: Reclamation Cost Estimate

T10 Infrastructure

An allowance was added for the decommissioning of water supply wells.

T11 Waste Disposal and Remediation

No changes.

T12 Landfills

The allowance for revegetation was updated.

T13 Roads and Trails

An allowance for a general labourer was added for slope stabilization activities.

T14 Water Management

Some additions from EMR (and WUL RFD). Not all additions from EMR were adopted, specifically the Lower Dublin South Pond and the Platinum Gulch Pond, which will be converted to CWTS in closure. The costs for the construction of CWTS are accounted for elsewhere in the estimate tables.

T15 Care, Maintenance and Monitoring

A provision was added for a full suite of monitoring and maintenance activities at 32 and 47 years after the end of mine (Phase 8).

Costs for water treatment capital, replacement, and operating costs for active treatment are from Linkan (2014). Water Quality Monitoring costs are developed from an estimate of numbers of stations for sampling and analytical costs included in the licence. Water quality monitoring is expected to decrease in Phases 7/8 to 70% of what is currently included in the licence as stations are discontinued to reflect the implementation of closure and the decommissioning of wells etc.

T16 Interim Care and Maintenance

Interim care and maintenance added as per third party review comments.

T17 Quantities

This table was added as a source of quantities for all the other worksheets to allow for faster updating in future iterations as well as easier sensitivity analysis.

Table 13-1: Summary Table of Estimated Closure Costs

Description of Cost	Estimated Cost Year 2	Estimated Cost EOM
Closure Implementation		
T3 General & Administration	\$689,775	\$3,433,250
T4 Exploration Disturbances		
T5 Closure Planning	\$410,000	\$760,000
T6 Pit	\$59,364	\$51,597
T7 Heap Leach Pad	\$941,595	\$9,666,356

Section 13: Reclamation Cost Estimate

Description of Cost	Estimated Cost Year 2	Estimated Cost EOM
T8 Waste Dumps	\$923,750	\$3,585,622
T9 Surface Facilities	\$1,526,171	\$2,372,477
T10 Infrastructure	\$601,042	\$589,807
T11 Waste Disposal and Remediation	\$103,295	\$114,425
T12 Landfills	\$131,585	\$129,126
T13 Roads & Trails	\$404,874	\$397,307
T14 Water Management	\$700,049	\$5,272,612
T16 Interim Care & Maintenance	\$1,125,048	\$4,105,336
Sub-total	\$7,616,547	\$30,477,914
Indirect Costs (%)	10.0%	5.0%
Indirect Costs	\$761,655	\$1,523,896
Cost Inflation	\$418,910	\$3,840,217
Total Closure Implementation Costs	\$8,797,112	\$35,842,026
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)		
Onsite Management	\$560,000	\$1,506,000
Transport Costs	\$76,125	\$76,125
Water Treatment Costs (Phase 6)		
Active Treatment (Phase 6)		
Capital Costs	\$0	\$3,996,916
Capital Replacement Costs	\$0	\$695,961
Operating Costs	\$0	\$6,659,905
Passive Treatment (Phase 7-8)		
Capital Costs	\$160,000	\$250,000
Capital Replacement Costs	\$7,500	\$22,500
Operating Costs	\$50,000	\$150,000
Reclamation & Closure Research Phase 6	\$75,000	\$75,000
Monitoring & Reporting	\$1,908,112	\$3,599,371
Post Closure Maintenance (Phase 7/8)	\$352,500	\$727,500
Sub-Total	\$3,189,237	\$17,759,278
Sub-Total NPV (2.5% DROR)	\$2,651,694	\$12,421,409
Indirect Costs (%)	10%	5%
Indirect Costs	\$265,169	\$621,070
Total (NPV)	\$2,916,863	\$13,042,479
Total Closure Costs	\$11,713,976	\$48,884,505
Contingency Allowance	15%	15%
Contingency Amount	\$1,757,096	\$7,332,676
Total Closure Costs (Plus Contingency)	\$13,471,072	\$56,217,181

13.4 SENSITIVITY ANALYSIS (WATER TREATMENT)

Comments provided on the Project during the effects assessment pursuant to the YESAA suggested that based on the level of design, changes to the Project footprint during the YESAA process, and uncertainty related to the Project baseline conditions, as they were presented during the YESAA process, that a sensitivity analysis should be undertaken on the closure cost estimate.

The level of design submitted in the applications for both QZ14-041 and QML-0011 advanced significantly since the YESAA submission such that sensitivity analyses for level of design, changes to the Project footprint and baseline conditions have been conducted to account for areas where some level of uncertainty still exists, specifically the effects of climate change. The effects of climate change modelled for the Project, as provided in the Surface Water Balance Model Report, concluded the following:

- *In general, the increase in annual runoff of 11% for the climate change model results in greater overall volumes of water accumulating in the LDSP and HLF over the operating life of the mine.*
- *The total amount of water to be discharged from the LDSP during operations and supplemental gold recovery/rinsing increased from approximately 9.2 Mm³ from the base case model to approximately 9.7 Mm³ as of Year 12 (i.e. a 5% increase in overall volume).*
- *The total draindown water from the heap pumped to treatment increased from 2.99 Mm³ to 3.03 Mm³; only a 1% increase in heap water sent to treatment.*
- *Based on more water accumulation in the HLF, the duration of heap draindown is predicted to be approximately one year longer for the heap to reach a long-term equilibrium with incoming precipitation and draindown under the climate change scenario.*
- *Overall, the modelled changes in water volumes due to potential climate change impacts are well within the range in the base case model due to inherent climatic variability. Therefore, it can be concluded that the water management systems for the project, which are designed according to the results of the base case model, have adequate flexibility to accommodate the future projected changes in climate."*

Additionally, the Reasons for Decision document issued in connection with QZ14-041 made specific reference to two Decision Document conditions which are relevant to security requirements. Specifically, Clause 122(c) highlights the need for a feasible alternative non-passive closure requirement and Clause 123 highlights the need for a sensitivity analysis. The Reasons for Decision document interpreted this to mean that SGC should consider active treatment as the non-passive treatment alternative and conduct a sensitivity analysis to evaluate the cost implications of passive treatment not being adequate to treat mining impacted waters.

To that end, the cost implications of requiring active treatment beyond Year 7 of Phase 6 (due to a delay of establishing the effectiveness of passive treatment) has been evaluated. The scenario considered involved carrying 2/3 the costs of active treatment capital replacement and active treatment operating through all of Phase 7, which ends at 22 years after the EOM. Two-thirds of the active treatment costs is approximately \$700,000, which is appropriate due to the much lower flow rates that the treatment plant will experience after the covers have been established, and recognizing that investment has been made in the in-heap treatment and CWTS systems, which should have at least some effect on water chemistry. The totals NPV of these additional costs are \$513,347 in capital replacement costs, and \$4,912,406 in operating costs.

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APPENDIX A

Cost Estimate: Current Liabilities

Appendix A1
SteveJan Consultants Inc. Reclamation
Cost Estimate for VIT's Proposed
Advanced Exploration Program at the
Dublin Gulch Site

Appendix A2
Victoria Gold Corp., Dublin Gulch -
LQ00303, Security Evaluation, May 4, 2011

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APPENDIX A1

SteveJan Consultants Inc. Reclamation Cost Estimate for VIT's Proposed Advanced Exploration Program at the Dublin Gulch Site

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SteveJan Consultants Inc.
1202-327 Maitland St.
Victoria, BC V9A 7G7
CANADA
Tel/Fax: 250-382-0585
Mobile: 250-850-9002

MEMORANDUM

Date: February 2, 2011

Subject: Reclamation Cost Estimate for Victoria Gold Corp's Proposed Advanced Exploration Program at the Dublin Gulch Site

Background

- The site has had exploration activities dating back 40-50 years through to the present;
- Site exploration activity is currently authorized under Class 3 Operating Plan Approval LQ00090 (original dated July 26, 2002, last amended March 2005), and currently set to expire July 25, 2012;
- Original approval had a number of terms and conditions, a number of which included:
 - o (5) Annual report requirement to indicate reclamation work undertaken and planned for following year, also to include exact location of drill sites (36);
 - o (19) Trenching to not exceed 5000m³ per claim per year or 10000m³ per claim over the duration of the duration of the program;
 - o (20) Machine excavated trenches are to be backfilled, overburden and bedrock first followed by vegetative mat;
 - o (41) Criteria to include when building new trails;
 - o (52) Fuel storage limited to 19 barrels per location. No secondary containment is required if limited to that number;
 - o (53) If fuel in storage exceeds 4000L a secondary containment facility must be constructed;
- Amendment (March 2005) to LQ00090 includes permissions for:
 - o New trails and possibly new access roads on claims;
 - o 270 additional drill holes;
 - o Add 40 km of line cutting with an average width of 2 m and up to 50 clearings per claim;
 - o Add up to 30 new trenches.
- Current Advanced Exploration Program Approval Application process for Class 3 / 4 Quartz MLU Approval, under review by the YESAB Designated Office as project number 2010-0226:
 - o Project Proposal document including QMLU Approval application, dated Oct. 11, 2010 and associated appendices;
 - o Additional information document, dated Dec 14, 2010 based on request from YESAB;
 - o On Dec. 22, 2010 YESAB deemed the proposal adequate. This was accompanied by a Public Notice with a Project Scope, which announced a Jan. 14, 2011 deadline for submission of comments on the project.

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APPENDIX A2

**Victoria Gold Corp., Dublin Gulch -
LQ00303, Security Evaluation, May 4, 2011**

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**Victoria Gold Corp.
Dublin Gulch – LQ00303
Security Evaluation
May 4, 2011**



Background: The Dublin Gulch property has been explored for many years and there are many disturbances on site from this historical work. Throughout the 1980's and 90's a number of exploration and mining companies explored Dublin Gulch including Canada Tungsten Mining Corporation, Queenstake Resources Ltd., First Dynasty Mines Ltd. and later New Millennium Mining. Victoria Gold has been operating under StrataGold's Class 3 MLU approval LQ00252 at the Dublin Gulch property and has now applied for a ten year Class 4 program. To date the claims remain in StrataGold's name.

Government of Yukon requires security on Class 4 operations and to this end we have hired a consultant to prepare a desktop assessment for security. The consultant, Steve Januszewski, did fly the site at an earlier date.

Recommendation: The SteveJan Consultants Inc. assessment can be divided into four parts: camp, roads and trails, trenching and drill sites. The reclamation for trenching and drilling is proposed to be ongoing, so these numbers will not be included at this time. The proponent has made a case that since the camp is modular and situated on tailings that the risk is less than would normally be expected. We have concurred with this assertion. No risk assessment was done for this project, as the company has currently submitted for an executive committee assessment under YESAA for a production licence. The exploration security is deemed to be a short-term and interim measure as it will be partially or totally rolled over to production when that permit is issued.

It is proposed to ask for 100% of the restoration costs for the proposed trails and roads or one hundred and forty-nine thousand dollars (\$149,000.) as per section 2 of the "Reclamation Cost Estimate for Victoria Gold Corp's Proposed Advanced Exploration Program at the Dublin Gulch Site" dated February 2/2011. The breakdown of these costs is attached for the company to review.

Recent Site Work:

- 2006 work-unknown;
- 2007 work-unknown;
- 2008 work - 2008 Post-Season Report shows the work that year included:
 - o 9 trenches (1206 m³)-all have been filled and contoured back into surrounding terrain;
 - o 53 drill sites, each being 500 m², so a total of 26,500 m².
 - o New access road to 1) Mar Tungsten – 3.84 km x 2.5 m width = 9600 m², to Eagle Zone .33km x 2.5 m = 825 m². For a total of 10,425 m²;
 - o No roads were upgraded;
 - o Total of 190 soil samples collected for geochemistry. There was no clearing or other environment impacts associated with the sampling;
 - o Reclamation-rubbish and debris from all 53 drill sites was removed. Sumps were backfilled;
- 2009 work-unknown; and
- 2010 work-unknown

Assumptions

The following assumptions were utilized in the preparation of the attached reclamation cost estimate for the proposed Dublin Gulch exploration program:

- The majority of the material utilized in this cost estimate report is based on information provided in the YESAB On-Line Registry under Project No. 2010-0226. This was supplemented by a brief helicopter flight over the site in September of 2008. The author has not been at the site;
- The cost estimate is considered to be a first-order desk-top undertaking;
- Equipment unit cost rates are based on numbers available from *Third Party Equipment Rental Rates April 1, 2010 – March 31, 2011* by Yukon Highways and Public Works where available. Mayo and Carmacks have contractors and are approximately 60 and 250 km away, respectively. Otherwise, unit costs and rates are based on experience of the author;
- No provision has been included for the possibility of requiring water quality monitoring nor for any acid rock drainage monitoring or mitigation measures at the site, based on information provided in the documents reviewed;
- Progressive reclamation will be undertaken at the site with reclamation of drill sites, trenches and trails once they are no longer required;
- No mob and demob costs have been included for equipment and manpower to undertake the closure tasks outlined in this report;
- A provision of 7% has been added to each of the area costs for project management. This includes design, site supervision, survey control and related costs for undertaking the tasks;
- A contingency of 15% of the final sub-total cost has been added, as is typical in preliminary cost estimates for sites such as this;
- The modular camp buildings are understood to already be on site and only need to be moved to the new location. Therefore only one set of buildings and associated components with a capacity of 100 persons will require decommissioning at the time of project closure.
- The proposed Membrane BioReactor treatment plant is an enclosed unit that is contained within a sea-can which can be easily decommissioned and hauled off-site when no longer required and whose only outside component will be the discharge field for the effluent;

- One water well and pumping system located adjacent to Dublin Gulch will be utilized for camp water. It and several temporary drill water supply pumps will need to be decommissioned at the end of the program;
- There is anticipated to be a minimum of buried components associated with the project and therefore none have been included here;
- It is expected that a quantity of debris from decommissioning the camp and associated buildings will require removal to an off-site landfill, likely in Mayo;
- Various un-used drummed and bagged products (Jet fuel, lubricants, oils, settling aids, etc) will be removed to off-site, most likely to their suppliers, with the only cost being removal to offsite, likely Mayo for pick-up;
- The upgraded access road to the site will be left in its proposed upgraded condition as the road pre-exists the proposed exploration program and the road also provides access to other exploration sites and active placer mine sites;
- Site roads and trails will require some bulldozer/excavator work to re-contour cut banks and fill slopes as well as to re-contour and scarify the road/trail surfaces. Some areas will also require revegetation and may also require additional erosion protection;
- It is understood that no bridges will be required to be constructed along the site roads and trails to undertake the exploration program. Thus no provision has been included for removal of any bridges on the site;
- Only a small number of the nearly 2,000 claims comprising the site will have exploration drill sites and trenches installed;
- Exploration trenches will be backfilled with stockpiled fill and overburden materials and revegetated, where required. This report assumes sufficient fill and overburden materials will have been stockpiled immediately adjacent to the trenches so no haulage of these materials is required (especially from off-site); and
- The areas where cut lines will be required for geo-physics will require no reclamation work.

Basis for Numbers

The following explanations provide information in support of the numbers utilized in the attached cost estimate table:

- Camp Area:
 - The disturbance area of the new camp site and outlying facilities (incl. helicopter pad, office complex, storage sheds, etc) is estimated at 0.6 ha based on information provided. This report assumes an additional disturbance area of 0.4 ha for the previous camp site and associated facilities which will likely remain at the time of program completion as well as other new areas (e.g., maintenance shop). Therefore a total disturbance area of 1.0 ha has been utilized;
- Road s and Trails:
 - An estimated 50% of the proposed new roads and trails on site (i.e., 50% of 100 km) will require scarification to encourage revegetation at the time of project completion;
 - An estimated 25% of the roads and trails on site (i.e., 25% of 100 km) will require revegetation. A 7.5 m width has been used for the disturbed corridor width based on the extra areas (beyond 5m road crest width) associated with a large number of cut banks and fill slopes that will be required to be re-contoured and then re-vegetated to achieve overall slope of 2:1 (or less) of the hillsides on which the trails were constructed;
 - An estimated total of 50 culverts along the 100 km of new site roads and trails will require removal after completion of the exploration program;

- Drill Sites:
 - The exploration program proposal calls on an average of 8 drill sites per claim. And there are close to 2000 claims within the project site. However, only a small percentage of these will likely be drilled. This report assumes that only 5% of the claims will have drill sites. Thus, there could be a total of 800 drill sites utilized. This report estimates 100 of those will remain un-reclaimed at the end of the 10 year exploration program, which will require decommissioning and reclamation. It is also estimated that none of the 800 drill sites will have been revegetated at the time of program closure. This report assumes that 25% of them will require revegetation and that the average area of each drill site will be 1000 m²;
- Trenches:
 - Of the total of 200 proposed trenches through the course of the 10 year exploration program this report estimates ~30 will remain to be backfilled and revegetated at the end of the exploration program. However, it also estimates that only half of all the trenches will have been already revegetated and thus 100 backfilled trenches will also require revegetation (for a total of 130 trenches to be revegetated).

Conclusions and Recommendations

The report provides a first order closure and reclamation cost estimate of \$467,000 for the proposed exploration program at the Dublin Gulch site. It includes a provision of 15%. There has been no provision provided for the pre-existing disturbances at the site due to the significant amount of historical exploration and placer mining undertakings over the years.

A comprehensive ground level site inspection of the entire project area (i.e., historically disturbed areas and areas proposed for the new exploration program) should be undertaken to enable a more accurate closure cost estimation.

<Original signed by>

S. Januszewski, P. Eng
SteveJan Consultants Inc.

Table 1 - Unit Costs

EQUIPMENT RATES		
Bulldozer-small (Cat D6)	\$160	per hr
Bulldozer-medium (Cat D8)	\$270	per hr
Haul Truck-off-road (Cat 740)	\$275	per hr
Haul Truck-on-road (tandem)	\$130	per hr
Excavator-medium (Cat 325)	\$170	per hr
Grader-medium (Cat 14H)	\$250	per hr
Loader-medium (Cat 988B)	\$190	per hr
Loader-small (Cat 950)	\$140	per hr
Tractor Trailer (lowbed)	\$160	per hr
Crane-medium (20 ton capacity)	\$160	per hr
Hiab Flatdeck truck	\$160	per hr
Pickup Truck	\$2,500	per month
Support Equipment	N / A	lump sum

PERSONNEL RATES		
Blaster	\$60	per hr
General Labourer	\$45	per hr
Trades Labourer	\$80	per hr
Site Supervisor	\$95	per hr
Technician	\$75	per hr
Design Engineer	\$130	per hr
Environmental Scientist	\$95	per hr
Project Manager	\$9,700	per month
Camp Labourer	\$4,000	per month
Site Caretaker	\$6,100	per month
Environmental Monitor	\$6,000	per month
Analytical Costs	N / A	Unit cost
Misc.	N / A	lump sum

REVEGETATION RATES		
Revegetation Seed Mix	\$13	per kg
Revegetation Seed Mix - 50kg/ha	\$510	per ha
Fertilizer	\$1	per kg
Fertilizer - 250kg/ha	\$250	per ha
Tree Seedlings	\$1,750	per ha (1,000 seedlings per ha)
Seed/Fertilizer Application	\$1,500	per ha
Erosion Barrier	\$3	sq m
Revegetation cost per ha. Including application cost	\$2,260	per ha

WATER TREATMENT RATES		
Pumping	N / A	cu.m
Reagent Addition	N / A	cu.m
Water treatment	N / A	cu.m
Sludge disposal	N / A	lump sum
Contingency Treatment Measures	N / A	lump sum

CONTRACTOR UNIT RATES & CAMP COST		
Excavation of Soil	\$5	cu.m
Supply and place Geotextile	\$5	sq m
Load, haul and place soil cover	\$5	cu.m
Haul & Place rock cover	\$7	cu.m
Drill, Blast and Screen Rip Rap	\$22	cu.m
Load and Haul Rip Rap	\$10	cu.m
Place Riprap	\$3	cu.m
HDPE Liner incl installation	\$10	sq m
Erosion barriers-installed	\$3	sq m
Freight run to Whitehorse	\$1,500	per load
Camp Cost	\$100	per day per person
Power and Heat	\$5,500	per month
Sundry equipment maintenance	\$5,000	yearly
General Administrative expenses	\$2,000	per month
Employee Transport Costs	\$3,000	per month

Table 2- Reclamation Costs Estimate for Proposed Adv. Exploration Program
Victoria Gold Corp.-Dublin Gulch Site

Item No.	Work Item Description	Equipment / Labour	Units	Quantity	Unit Cost	Cost	Total Cost
1	Camp Area						
	Remove salvageable materials	General Labourer	per hr	8	\$45	\$360	
		Trades Labourer	per hr	4	\$80	\$320	
		988B Loader	per hr	8	\$190	\$1,520	
	Prepare modular trailers & remove from site	General Labourer	per hr	64	\$45	\$2,880	
		Trades Labourer	per hr	32	\$80	\$2,560	
		Bulldozer-medium (Cat D8)	per hr	8	\$270	\$2,160	
	Dismantle other buildings & structures	General Labourer	per hr	40	\$45	\$1,800	
		Trades Labourer	per hr	24	\$80	\$1,920	
		325 Excavator	per hr	8	\$170	\$1,360	
		988B Loader	per hr	8	\$190	\$1,520	
	Decommission MBR treatment plant & discharge field	General Labourer	per hr	16	\$45	\$720	
		Trades Labourer	per hr	8	\$80	\$640	
		Bulldozer-small (Cat D6)	per hr	4	\$160	\$640	
		325 Excavator	per hr	4	\$170	\$680	
		Tractor Trailer (lowbed)	per hr	4	\$160	\$640	
	Decommission water supply wells, pumping systems and storage tanks	General Labourer	per hr	16	\$45	\$720	
		Trades Labourer	per hr	8	\$80	\$640	
		Tractor Trailer (lowbed)	per hr	8	\$160	\$1,280	
		325 Excavator	per hr	4	\$170	\$680	
	Remove non-burnable solid waste to offsite landfill		lump sum	1	\$5,000	\$5,000	
	Remove fuel & propane tanks to off-site	Clean/purge tanks for transport	lump sum	1	\$2,000	\$2,000	
		Trades Labourer	per hr	8	\$80	\$640	
		Tractor Trailer (lowbed)	per hr	16	\$160	\$2,560	
		325 Excavator	per hr	4	\$170	\$680	
			lump sum	1	\$2,000	\$2,000	
	Recontour & scarify area	Bulldozer-small (Cat D6)	per hr	12	\$160	\$1,920	
	Revegetate	Revegetation cost per ha. Including application cost	per ha	1.0	\$2,260	\$2,260	
	Misc. materials & supplies	Misc.	lump sum	1	\$1,000	\$1,000	
	Project Management	7% of Total Cost	%		7.00%	\$2,877	\$41,100
	Sub-Total						\$44,000
2	Roads & Trails						
2.1	Main Access Road (Haggart Crk Rd.)						
	Install earthen barrier to prevent vehicular access to site on main access road	325 Excavator	per hr	4	\$170	\$680	
2.2	Site Roads & Trails (100 km)						
	Scarify road & trail surfaces (50% of above)	Bulldozer-small (Cat D6)	per hr	250	\$160	\$40,000	
	Re-contour banks & slopes for 2:1, as req'd	Bulldozer-small (Cat D6)	per hr	100	\$160	\$16,000	
	Remove culverts & install swales (-50)		each	50	\$500	\$25,000	
	Restoration of ford areas across 5 on-site streams		each	5	\$2,000	\$10,000	
	Erosion barriers/water bars/silt traps		each	5	\$1,000	\$5,000	
	Revegetate 25 km of roads & trails	Revegetation cost per ha. Including application cost	per ha	18.8	\$2,260	\$42,375	
	Project Management	7% of Total Cost	%		7.00%	\$9,734	\$139,055
	Sub-Total						\$149,000
3	Drill Sites						
	Recontour & scarify last 100 drill sites @ 1000 m2 apiece	Bulldozer-small (Cat D6)	per hr	600	\$160	\$96,000	
	Revegetate 200 drill sites	Revegetation cost per ha. Including application cost	per ha	20	\$2,260	\$45,200	
	Project Management	7% of Total Cost	%		7.00%	\$9,884	\$141,200
	Sub-Total						\$151,000
4	Trenches						
	Backfill last 30 trenches	325 Excavator	per hr	150	\$170	\$25,500	
		Bulldozer-small (Cat D6)	per hr	150	\$160	\$24,000	
	Revegetate 130 of 200 trenches	Revegetation cost per ha. Including application cost	per ha	3.9	\$2,260	\$8,814	
	Project Management	7% of Total Cost	%		7.00%	\$4,082	\$58,314
	Sub-Total						\$62,000
5	Miscellaneous Components						
	Environmental monitoring	Not Applicable					
	Mob & Demob	Not Applicable					
	Contractor Overheads	Not Applicable					
	Permitting, insurance, bonds	Not Applicable					
	Project Management	7% of Total Cost	%		7.00%	\$0	\$0
	Sub-Total						\$0
	Final Sub-Total						\$406,000
	Contingency	15% of Final Sub-Total			15.00%		\$61,000
	Exploration Program Reclamation - Total Estimated Cost						\$467,000

APPENDIX B

Detailed Closure Cost Estimate: Year 2 and End of Mine Life

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Summary Table of Estimated Closure Costs

Description of Cost	Estimated Cost Year 2	Estimated Cost EOM
Closure Implementation		
T3 General & Administration	\$689,775	\$3,433,250
T4 Exploration Disturbances		
T5 Closure Planning	\$410,000	\$760,000
T6 Pit	\$59,364	\$51,597
T7 Heap Leach Pad	\$941,595	\$9,666,356
T8 Waste Dumps	\$923,750	\$3,585,622
T9 Surface Facilities	\$1,526,171	\$2,372,477
T10 Infrastructure	\$601,042	\$589,807
T11 Waste Disposal and Remediation	\$103,295	\$114,425
T12 Landfills	\$131,585	\$129,126
T13 Roads & Trails	\$404,874	\$397,307
T14 Water Management	\$700,049	\$5,272,612
T16 Interim Care & Maintenance	\$1,125,048	\$4,105,336
Sub-total	\$7,616,547	\$30,477,914
Indirect Costs (%)	10.0%	5.0%
Indirect Costs	\$761,655	\$1,523,896
Cost Inflation	\$418,910	\$3,840,217
Total Closure Implementation Costs	\$8,797,112	\$35,842,026
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)		
Onsite Management	\$560,000	\$1,506,000
Transport Costs	\$76,125	\$76,125
Water Treatment Costs (Phase 6)		
Active Treatment (Phase 6)		
Capital Costs	\$0	\$3,996,916
Capital Replacement Costs	\$0	\$695,961
Operating Costs	\$0	\$6,659,905
Passive Treatment (Phase 7-8)		
Capital Costs	\$160,000	\$250,000
Capital Replacement Costs	\$7,500	\$22,500
Operating Costs	\$50,000	\$150,000
Reclamation & Closure Research Phase 6	\$75,000	\$75,000
Monitoring & Reporting	\$1,908,112	\$3,599,371
Post Closure Maintenance (Phase 7/8)	\$352,500	\$727,500
Sub-Total	\$3,189,237	\$17,759,278
Sub-Total NPV (2.5% DROR)	\$2,651,694	\$12,421,409
Indirect Costs (%)	10%	5%
Indirect Costs	\$265,169	\$621,070
Total (NPV)	\$2,916,863	\$13,042,479
Total Closure Costs	\$11,713,976	\$48,884,505
Contingency Allowance	15%	15%
Contingency Amount	\$1,757,096	\$7,332,676
Total Closure Costs (Plus Contingency)	\$13,471,072	\$56,217,181

Closure Unit Rates

Equipment Rates			
Equipment	Unit Rates	Unit	Comment/Source
D9H Dozer	\$350	hr	
Wheel Loader (939 or equivalent)	\$345	hr	
Loader (PC3000 or equivalent)			
General Purpose Loader (Cat 416 E or equivalent)			
Haul Truck (Komatsu HD 1500-7 or equivalent)	\$286	hr	
Track Dozer (570 HP or equivalent)	\$215	hr	
Drill Rig (DR 500 or equivalent)			
Grader (Cat 140K or equivalent)			
Water Truck (52,994 L 550 HP)			
D6D Dozer	\$200	hr	
Haul Truck D250E	\$250	hr	
Tandem Haul Truck	\$150	hr	
Cat 235 Excavator	\$250	hr	
Cat 235 Excavator w hammer	\$275	hr	
Cat 16H grader	\$300	hr	As per Cord Hamilton
988B Loader	\$200	hr	
Tractor Trailer (lowbed)	\$180	hr	
30 ton Crane	\$190	hr	
Hiab Flatdeck truck	\$160	hr	
Cat 950 loader	\$155	hr	
Vibratory Roller	\$150	hr	
Pickup Truck	\$2,500	month	As per Cord Hamilton
Personnel Rates			
Personnel	Unit Rates	Unit	
Blaster	\$43.22	hr	Updated based on Yukon Fair Wage Schedule
General Labourer	\$34.79	hr	Updated based on Yukon Fair Wage Schedule
Trades Labourer	\$48.20	hr	Updated based on Yukon Fair Wage Schedule
Site Supervisor	\$59.85	hr	
Design Engineer	\$156.00	hr	
Environmental Scientist	\$116.00	hr	
Project Manager	\$11,204	month	
Camp Labourer	\$6,574	month	Updated based on Yukon Fair Wage Schedule
Site Caretaker	\$8,853	month	Updated based on Yukon Fair Wage Schedule
Environmental Monitor	\$9,983	month	Updated based on Yukon Fair Wage Schedule
Revegetation Rates	Unit Rates	Unit	
Revegetation Seed Mix	\$18.38	kg	As per Cord Hamilton
Revegetation Seed Mix - 50kg/ha	\$919.00	ha	As per Cord Hamilton
Fertilizer	\$1.16	kg	As per Cord Hamilton
Fertilizer - 250kg/ha	\$290.00	ha	As per Cord Hamilton
Tree Seedlings (1,000 seedlings per ha)	\$2,100	ha	As per Cord Hamilton
Seed/Fertilizer Application	\$1,785	ha	As per Cord Hamilton
Erosion Barrier	\$3.15	m ²	As per Cord Hamilton
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	\$1,200	ton	
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)	\$2.62	m ³	Custom rates provided by Merit consultants based on Feasibility Study based on mining fleet that will be on site at start of reclamation
Custom Rate B (Load, haul, place soil cover Eagle Pup)	\$3.62	m ³	
Custom Rate C (Load, haul, place soil cover Platinum Gulch)	\$4.71	m ³	
Custom Rate D (Load, haul, place wetland soil in CWTS)	\$2.62	m ³	
Custom Rate E (Load, haul, place soil cover IROSA)	\$4.71	m ³	
Produce rip-rap	\$15.75	m ³	As per Cord Hamilton
Load, haul and place rip-rap	\$15.75	m ³	As per Cord Hamilton
Deliver and install geosynthetic membrane on prepared foundation	\$21.00	m ²	As per Cord Hamilton
Unit Basis (footing burial)	\$5.25	each	As per Cord Hamilton
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	As per Cord Hamilton
Camp Cost	\$57.75	day/person	As per Cord Hamilton
Site Security Cost	\$6,100.00	month	As per Cord Hamilton
Power for recirculation pumps	\$20,412.00	month	
Power and Heat (Year 2)	\$7,500.00	month	
Employee Transport Costs	\$7,875.00	month	As per Cord Hamilton
Notes:			
1) Custom Rates A through E developed specifically for Eagle Project, taking into account such factors as haul distance, grade, machinery req'd, time reqd, etc.			
2) Unit rates for GeoWeb materials are provided by a licensed vendor and are considered conservative costs which include delivery and installation.			

General and Administration Costs

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM	Comment/Source
3.1	Onsite Management								
	Pickup truck (Phase 6) (2 trucks)	Pickup Truck	monthly	\$2,500	12	-	\$30,000	\$150,000	For EOM two pickup trucks would be purchased
	Pickup truck fuel		monthly	\$1,300		84	incl. above	\$109,200	
	Sundry equipment maintenance (Phase 6)	Unit Cost Basis	annually	\$10,000	1	7	\$5,000	\$70,000	
	Power and heat (Phase 6)	Power and Heat (Year 2)	monthly	\$7,500	6	84	\$45,000	\$630,000	
	General Administrative expenses (Phase 6)	Unit Cost Basis	monthly	\$7,500	6	84	\$45,000	\$630,000	
	Site Security (Phase 6)	Site Security Cost	monthly	\$6,100	6	84	\$36,600	\$512,400	
	Camp Costs (Phase 6)	Camp Cost	man-day	\$57.75	4,813	6,548	\$277,925	\$378,150	
						Sub-Total	\$439,525	\$2,479,750	
3.2	Transport Costs								
	Employee transport costs (Phase 6)	Unit Cost Basis	monthly	\$7,875	6	84	\$47,250	\$661,500	
						Sub-Total	\$47,250	\$661,500	
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	
3.4	Mobilization and Demobilization								
	Heavy Equipment	Unit Cost Basis	per equipment	\$5,000	40	50	\$200,000	\$250,000	
						Sub-Total	\$200,000	\$250,000	
3.5	Access to Site								
	Road Maintenance (Phase 6)	Unit Cost Basis	monthly	\$500	6	84	\$3,000	\$42,000	
						Sub-Total	\$3,000	\$42,000	
Total Estimated Cost for General and Administration Costs							\$689,775	\$3,433,250	
Notes:									

Exploration Disturbances

Assumption is that all exploration disturbance is already bonded for or else will be within the footprint of other areas that will be reclaimed elsewhere

Closure Plan Development - Phase 4

[illegible]

Open Pit, Estimated Closure Costs - Phase 6

[illegible]

Heap Leach Facility, Estimated Closure Costs

[illegible]

Waste Rock and Overburden Dumps - Phase 2 (PG WRSA) and Phase 6

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM	Comments/Source
	WASTE ROCK AND OVERBURDEN DUMPS									
4.1	Eagle Pup (s 8.8)	94.00								
	Roll crest and recontour		D9H Dozer	hrs	\$350.00		-	\$0	\$0	
	Additional compaction, as req'd		Vibratory Roller	hrs	\$150.00	13.32	140	\$1,998	\$21,000	
	Haul & place colluvium for revegetation - (0.3 m thickness)	94.00	Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	\$3.62	26,837	282,000	\$97,148	\$1,020,840	Year 2 quantities based on areas from AutoCAD
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)	94.00	Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	\$3.62	17,891	188,000	\$64,765	\$680,560	Year 2 quantities based on areas from AutoCAD
	Revegetate	94.00	Revegetation cost per ha. Including application cost	ha	\$2,994.00	9	94	\$26,783	\$281,436	Year 2 quantities based on areas from AutoCAD
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$13,349	\$100,192	
							Sub-Total	\$204,043	\$2,104,028	
4.2	Platinum Gulch WRSA (s 8.9)	38.00								
	Roll crest and recontour		D9H Dozer	hrs	\$350.00		-	\$0	\$0	
	Additional compaction, as req'd		Vibratory Roller	hrs	\$150.00	19.28	70	\$2,892	\$10,500	
	Haul & place colluvium for revegetation - (0.3 m thickness)	38.00	Custom Rate C (Load, haul, place soil cover Platinum Gulch)	cu.m.	\$4.71	31,404	114,000	\$147,911	\$536,940	Year 2 quantities based on areas from AutoCAD
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)	38.00	Custom Rate C (Load, haul, place soil cover Platinum Gulch)	cu.m.	\$4.71	20,936	76,000	\$98,608	\$357,960	Year 2 quantities based on areas from AutoCAD
	Revegetate	38.00	Revegetation cost per ha. Including application cost	ha	\$2,994.00	10	38	\$31,341	\$113,772	Year 2 quantities based on areas from AutoCAD
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$19,653	\$50,959	
							Sub-Total	\$300,405	\$1,070,131	
4.3	Temporary Ore Stockpiles and Pads (s 8.10)	16.90								
	Removal of bottom layer of material to Eagle Pup WRSA		Custom Rate B (Load, haul, place soil cover Eagle Pup)		\$3.62	16,900	16,900	\$61,178	\$61,178	
	Recontour		D9H Dozer	hrs	\$350.00	20	20	\$7,000	\$7,000	
	Place 20 cm topsoil cover		Cat 235 Excavator	hrs	\$250.00	30	30	\$7,500	\$7,500	
	Revegetate		Revegetation cost per ha. Including application cost	ha	\$2,994.00	16.90	16.90	\$50,599	\$50,599	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$8,839	\$6,314	
							Sub-Total	\$135,116	\$132,590	
4.4	Reclamation Stockpiles	18.40								
	Recontour		D9H Dozer	hrs	\$350.00	36	36	\$12,600	\$12,600	
	Revegetate		Revegetation cost per ha. Including application cost	ha	\$2,994.00	18.4	18.4	\$55,090	\$55,090	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$4,738	\$3,384	
							Sub-Total	\$72,428	\$71,074	
4.5	Ice Rich Overburden Storage Area	5.60								
	Recontour and scarify surface		D9H Dozer	hrs	\$350.00	20	20	\$7,000	\$7,000	
			Cat 16H grader	hrs	\$300.00	10	10	\$3,000	\$3,000	
	Revegetate		Revegetation cost per ha. Including application cost	ha	\$2,994.00	5.6	5.6	\$16,766	\$16,766	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$1,874	\$1,338	
							Sub-Total	\$28,640	\$28,105	
4.6	Eagle Pup Passive Treatment Ditch									
	Combined pipeline/ditch for Eagle Pup - transport to constructed wetlands		Cat 235 Excavator	hrs	\$250.00	195	195	\$48,688	\$48,688	
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	\$15.75	2,300	2,300	\$36,225	\$36,225	
	Provision for ditching filter material under rip-rap		Load, haul and place rip-rap	cu.m.	\$15.75	2,300	2,300	\$36,225	\$36,225	
	Sedimentation Pond (# of ponds)		Misc.	l.s.	\$50,000	1	1	\$50,000	\$50,000	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$11,980	\$8,557	
							Sub-Total	\$183,117	\$179,694	
Total Estimated Cost in Reclaiming Overburden and Waste Rock Dumps								\$923,750	\$3,585,622	
Note:										

ADR & Ancillary Facilities, Estimated Closure Costs - Phase 6 and 7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM	Comment/Source
ADR AND ANCILLARY FACILITIES										
9.1	Buildings and Structures Demolition									
	Remove salvageable equipment		General Labourer	hrs	\$34.79	1,344	1,344	\$46,751	\$46,751	
			Trades Labourer	hrs	\$48.20	504	504	\$24,290	\$24,290	
			30 ton Crane	hrs	\$190.00	84	84	\$15,960	\$15,960	
	Decontaminate Building-hosing and clean-up		Trades Labourer	hrs	\$48.20	-	168	\$0	\$8,097	
	Dismantle Buildings		General Labourer	hrs	\$34.79	5,376	5,376	\$187,004	\$187,004	
			Trades Labourer	hrs	\$48.20	4,032	4,032	\$194,322	\$194,322	
			Cat 235 Excavator	hrs	\$250.00	210	210	\$52,500	\$52,500	
			30 ton Crane	hrs	\$190.00	672	672	\$127,680	\$127,680	
	Concrete Demolition		Blaster	hrs	\$43.22	-	-	\$0	\$0	
			Cat 235 Excavator w hammer	hrs	\$275.00	252	252	\$69,300	\$69,300	
			D9H Dozer	hrs	\$350.00	168	168	\$58,800	\$58,800	
	Misc. Supplies & Tools		Misc.	l.s.	\$15,000.00	1	1	\$15,000	\$15,000	
	Scrap haul to solid waste facility		Cat 235 Excavator	hrs	\$250.00	168	168	\$42,000	\$42,000	
			Haul Truck D250E	hrs	\$250.00	168	168	\$42,000	\$42,000	
	Haul and place overburden for revegetation (0.2 m thickness)	12	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	\$2.62	24,000	24,000	\$62,880	\$62,880	
	Revegetate	12	Revegetation cost per ha. Including application cost	ha	\$2,994.00	12	12	\$35,928	\$35,928	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$68,209	\$49,126	
Sub-Total								\$1,042,625	\$1,031,638	
9.2	Fuel Storage Area									
	Cleanout tanks-remove sludge, pressure wash		General Labourer	hrs	\$34.79	504	504	\$17,532	\$17,532	
			Removal to Licensed facility	l.s.	\$12,500.00	1	1	\$12,500	\$12,500	
	Remove bulk fuel storage and piping facilities		General Labourer	hrs	\$34.79	756	756	\$26,297	\$26,297	
			Trades Labourer	hrs	\$48.20	336	336	\$16,194	\$16,194	
			30 ton Crane	hrs	\$190.00	84	84	\$15,960	\$15,960	
			Support Equipment	l.s.	\$7,500.00	1	1	\$7,500	\$7,500	
			Cat 235 Excavator	hrs	\$250.00	-	-	\$0	\$0	
			General Labourer	hrs	\$34.79	-	-	\$0	\$0	
			Tractor Trailer (lowbed)	hrs	\$180.00	-	-	\$0	\$0	
	Fold and Bury Liner		Cat 235 Excavator	hrs	\$250.00	48	48	\$12,000	\$12,000	
			D9H Dozer	hrs	\$350.00	24	24	\$8,400	\$8,400	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$8,147	\$5,819	
Sub-Total								\$124,529	\$122,202	
9.3	Reagents Removal and Cleanup									
	Load and return extra reagents/chemicals		General Labourer	hrs	\$34.79	-	96	\$0	\$3,339	
			Support Equipment	l.s.	\$2,500.00	-	1	\$0	\$2,500	
			Disposal Cost-bulk materials	l.s.	\$5,000.00	-	1	\$0	\$5,000	
			Disposal Cost-lab pacs	pallets	\$2,000.00	-	5	\$0	\$10,000	
	Removal of drums, steel, oils, glycol & batteries etc.		Contractor quote	l.s.	\$50,900.00	-	1	\$0	\$50,900	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$0	\$3,587	
Sub-Total								\$0	\$75,326	
9.4	Reclaim Crusher Area and Screening Area (19.5 ha)									
	Test soils for contamination		Environmental Scientist	hrs	\$116.00	-	20	\$0	\$2,320	
			Analytical Costs	l.s.	\$6,000.00	-	1	\$0	\$6,000	
	Haul any contaminated soils to Land Treatment Facility		Cat 235 Excavator	hrs	\$250.00	-	40	\$0	\$10,000	
			Haul Truck D250E	hrs	\$250.00	-	40	\$0	\$10,000	
	Haul any ore contaminated soils to heap		Load, haul & place mat'l on heap	cu.m.	\$10.00	-	100	\$0	\$1,000	
	Re-contour area and slopes to bury footings and establish drainage		D9H Dozer	hrs	\$350.00	60	60	\$21,000	\$21,000	
	Scarify Surface	19.5	Cat 16H grader	hrs	\$300.00	60	-	\$18,000	\$0	
	Haul and place overburden cap (0.5m thickness)	19.5	Unit Rate	cu.m	\$5.50	-	97,500	\$0	\$536,250	Surface is scarified in Year 2
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$2,730	\$29,329	
Sub-Total								\$41,730	\$615,899	
9.5	Truck Shop Area (s 6.9.7)									
	Remove salvageable equipment		General Labourer	hrs	\$34.79	504	504	\$17,532	\$17,532	
			Haul Truck D250E	hrs	\$250.00	-	-	\$0	\$0	
			Trades Labourer	hrs	\$48.20	84	84	\$4,048	\$4,048	
	Dismantle buildings		General Labourer	hrs	\$34.79	2,100	2,100	\$73,049	\$73,049	
			30 ton Crane	hrs	\$190.00	168	168	\$31,920	\$31,920	
			Cat 235 Excavator	hrs	\$250.00	120	120	\$30,000	\$30,000	
	Haul building pieces off site - equipment		Tractor Trailer (lowbed)	hrs	\$180.00	168	168	\$30,240	\$30,240	
	Scrap haul to site landfill		Haul Truck D250E	hrs	\$250.00	24	24	\$6,000	\$6,000	
			Cat 235 Excavator	hrs	\$250.00	24	24	\$6,000	\$6,000	
	Excavate & haul contaminated materials to site LTF		Misc.	l.s.	\$6,250.00	1	1	\$6,250	\$6,250	
	Bury footings - haul and place fill, locally sourced		Unit Basis (footing burial)	each	\$5.25	300	300	\$1,575	\$1,575	
	Recontour		D9H Dozer	hrs	\$350.00	24	24	\$8,400	\$8,400	
	Haul and place overburden for revegetation (0.2 m thickness)	9.9	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	\$2.62	19,800	19,800	\$51,876	\$51,876	
	Revegetate	9.9	Revegetation cost per ha. Including application cost	ha	\$2,994.00	9.9	9.9	\$29,641	\$29,641	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$20,757	\$14,827	
Sub-Total								\$317,287	\$311,357	
9.6	Water Treatment Plant									
	Remove salvageable equipment		General Labourer	hrs	\$34.79	-	672	\$0	\$23,376	
			Haul Truck D250E	hrs	\$250.00	-	-	\$0	\$0	
			Trades Labourer	hrs	\$48.20	-	252	\$0	\$12,145	
	Dismantle buildings		General Labourer	hrs	\$34.79	-	960	\$0	\$33,394	
			30 ton Crane	hrs	\$190.00	-	168	\$0	\$31,920	
			Cat 235 Excavator	hrs	\$250.00	-	120	\$0	\$30,000	
	Haul building pieces off site - equipment		Tractor Trailer (lowbed)	hrs	\$180.00	-	168	\$0	\$30,240	
	Scrap haul to site landfill		Haul Truck D250E	hrs	\$250.00	-	24	\$0	\$6,000	
			Cat 235 Excavator	hrs	\$250.00	-	24	\$0	\$6,000	
	Excavate & haul contaminated materials to site LTF		Misc.	l.s.	\$6,250.00	-	1	\$0	\$6,250	
	Bury footings - haul and place fill, locally sourced		Unit Basis (footing burial)	each	\$5.25	-	300	\$0	\$1,575	
	Recontour		D9H Dozer	hrs	\$350.00	-	24	\$0	\$8,400	
	Haul and place overburden for revegetation (0.2 m thickness)	2	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	\$2.62	-	4,000	\$0	\$10,480	
	Revegetate	2	Revegetation cost per ha. Including application cost	ha	\$2,994.00	-	2	\$0	\$5,988	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$0	\$10,288	
Sub-Total								\$0	\$216,056	
Total Estimated Cost in Reclaiming Mill and Ancillary Facilities								\$1,526,171	\$2,372,477	

Infrastructure, Estimated Closure Costs, Phase 6/7

[illegible]

Waste Disposal / Remediation - Phase #

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM
11.1 Solid Wastes Disposal									
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
								Sub-Total	\$0
11.2 Hazardous Materials Disposal									
	Off-Site Disposal							\$0	\$0
				I.s.	\$2,500	5	10	\$12,500	\$25,000
								\$0	\$0
								\$0	\$0
								Sub-Total	\$12,500
11.3 Hydrocarbon Contaminated Soils									
	Off-Site Disposal								
	On-Site Land Treatment Farm (LTF)								
	Prepare and submit closure plan		Misc	I.s.	\$2,000	1	1	\$2,000	\$2,000
	Characterize final soil hydrocarbon concentrations		Misc	I.s.	\$4,000	1	1	\$4,000	\$4,000
	Recontour		D9H Dozer	hrs	\$350.00	36	36	\$12,600	\$12,600
	Haul and place coverburden cover from nearby		Cat 235 Excavator	hrs	\$250.00	48	48	\$12,000	\$12,000
			Haul Truck D250E	hrs	\$250.00	48	48	\$12,000	\$12,000
			D9H Dozer	hrs	\$350.00	24	24	\$8,400	\$8,400
	Final Decommissioning of LTF			I.s.	\$17,500	1	1	\$17,500	\$17,500
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$4,795	\$3,425
								Sub-Total	\$73,295
11.4 Process Residue Contaminated Soils									
	Off-Site Disposal								
				I.s.	\$3,500	5	5	\$17,500	\$17,500
								Sub-Total	\$17,500
Total Estimated Cost for Waste Disposal / Remediation								\$103,295	\$114,425
Notes:									

Landfills - Phase 6 and 7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM
12.1	Expansion of Facility to Accommodate Closure Phase Debris								
	Expand landfill		Cat 235 Excavator	hr	\$250.00	252	252	\$63,000	\$63,000
			General Labourer	hr	\$34.79	252	252	\$8,766	\$8,766
			Vibratory Roller	hr	\$150.00	36	36	\$5,400	\$5,400
								\$0	\$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$5,402	\$3,858
							Sub-Total	\$82,567	\$81,024
12.2	Operation During Closure Phase								
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
								\$0	\$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$0	\$0
							Sub-Total	\$0	\$0
12.3	Final Closure								
	Prepare detailed closure plan		Misc	l.s.	\$2,000	1	1	\$2,000	\$2,000
	Characterize final waste area		Misc	l.s.	\$2,000	1	1	\$2,000	\$2,000
	Remove recyclables and special waste materials		Tractor Trailer (lowbed)	hrs	\$180.00	24	24	\$4,320	\$4,320
	Final Compaction & Grading		D9H Dozer	hrs	\$350.00	36	36	\$12,600	\$12,600
	Haul and cover with adjacent fill and place overburden cap		Cat 235 Excavator	hrs	\$250.00	24	24	\$6,000	\$6,000
			Haul Truck D250E	hrs	\$250.00	24	24	\$6,000	\$6,000
	Compaction of cover		D9H Dozer	hrs	\$350.00	24	24	\$8,400	\$8,400
	Revegetation		Revegetation cost per ha. Including application c	ha	\$2,994.00	1.5	1.5	\$4,491	\$4,491
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$3,207	\$2,291
							Sub-Total	\$49,018	\$48,102
Total Estimated Landfill Costs								\$131,585	\$129,126

Notes:

Roads & Trails, Estimated Closure Costs - Phase 6-8

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM	
13.1	On Site Access and Haul Roads (s 8.13.3) (51.2		51.2							
	Recontour crests		Cat 235 Excavator	hrs	\$250.00	512	512	\$128,000	\$128,000	
	Scarify surfaces		Cat 16H grader	hrs	\$300.00	210	210	\$63,000	\$63,000	
	Revegeate		Revegetation cost per ha. Including application of	ha	\$2,994.00	51.2	51.2	\$153,293	\$153,293	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$24,100	\$17,215	
Sub-Total								\$368,393	\$361,507	
13.2	Culverts									
	Culvert excavation		Cat 235 Excavator	hrs	\$250.00	50	50	\$12,500	\$12,500	
	Culvert removal		General Labourer	hrs	\$34.79	192	192	\$6,679	\$6,679	
	Recontour slopes and drainage		D9H Dozer	hrs	\$350.00	36	36	\$12,600	\$12,600	
	Stabilize slopes		General Labourer	hrs	\$34.79	20	20	\$696	\$696	
	Silt Curtains (20m ² per crossing)		Erosion Barrier	sq. m.	\$3.15	300	300	\$945	\$945	
	Enviro matting (15m ² per crossing)		Enviro matting	sq. m.	\$3.00	225	225	\$675	\$675	
	Project Management & Engineering		7% of Total Cost	%		7.00%	5.00%	\$2,387	\$1,705	
Sub-Total								\$36,481	\$35,799	
Total Estimated Cost for Closure of Roads & Trails								\$404,874	\$397,307	
Note:										

Water Management, Estimated Closure Costs - Phase 6

Item No.	Work Item Description	Length (m)	Equipment / Labour	Units	Unit Rates	Quantity Year 2	Quantity EOM	Cost Year 2	Cost EOM	Comments/Source
14.1	Diversion & Collection Ditches									
	Raise and/or widen operational 1:10 year ditches			l.s.	\$75,000	1	1	\$75,000	\$75,000	
	Removal of Corrugated Steel Hll Pipe	2000	Cat 235 Excavator	hr	\$250	20	20	\$5,000	\$5,000	
			Tractor trailor for off-site salvage	hr	\$180	30	30	\$5,400	\$5,400	
	Project Management & Engineering		7% of Total Cost	%		7.00%		\$5,978	\$4,270	
							Sub-Total	\$91,378	\$89,670	
14.2	Groundwater Wells - Decommissioning									
	Production Wells			l.s.	\$3,600	4	12	\$14,400	\$43,200	
	De-Watering Wells			l.s.	\$3,600	4	12	\$14,400	\$43,200	
	Project Management & Engineering		7% of Total Cost	%		7.00%		\$2,016	\$4,320	
							Sub-Total	\$30,816	\$90,720	
14.3	Pumping - Phase 6									
						Ave kw Pumps	Ave kw Pumps			
	Year 1 Heap Recycle/Draindown			\$/kw	\$ 0.11	-	2,128	\$0	\$3,033,677	
	Year 2 Heap Recycle/Draindown			\$/kw	\$ 0.11	-	784	\$0	\$745,114	
	Year 3 Heap Recycle/Draindown			\$	0.11	-	448	\$0	\$319,334	
	Year 4 Heap Recycle/Draindown			\$	0.11	-	168	\$0	\$119,750	
	Year 5 Heap Recycle/Draindown			\$	0.11	-	84	\$0	\$79,834	
	Year 6 Heap Recycle/Draindown			\$	0.11	-	67	\$0	\$63,867	
	Year 7 Heap Recycle/Draindown			\$	0.11	-	56	\$0	\$53,222	
	Project Management & Engineering		2.5% of Total Cost	%		2.5%		\$0	\$110,370	
							Sub-Total	\$0	\$4,625,168	
14.4	Construction of New Drainage Channels and Diversions for Closure									
	Contour ditching (m)		Cat 235 Excavator	hrs	\$250.00	100	100	\$25,000	\$25,000	
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	\$15.75	1,000	1,000	\$15,750	\$15,750	
			Load, haul and place rip-rap	cu.m.	\$15.75	1,000	1,000	\$15,750	\$15,750	
	Project Management & Engineering		7% of Total Cost	%		7.00%		\$3,955	\$2,825	
							Sub-Total	\$60,455	\$59,325	
14.5	Lower Dublin North Pond									
	Removal of infrastructure and Liner		General Labourer	hr	\$34.79	10	10	\$348	\$348	
			Cat 235 Excavator	hr	\$250.00	10	10	\$2,500	\$2,500	
	Haul waste to landfill		Tandem Haul Truck	hr	\$150.00	2	2	\$300	\$300	
	Breaching and re-contouring			ha	\$10,700.00	1.05	1.05	\$11,235	\$11,235	
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	\$2.62	2,100	2,100	\$5,502	\$5,502	
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	\$2,994.00	1.05	1.05	\$3,144	\$3,144	
	Project Management & Engineering		7% of Total Cost	%		7.00%		\$1,612	\$1,151	
							Sub-Total	\$24,641	\$24,180	
14.6	Lower Dublin South Pond									
	Removal of infrastructure and Liner		General Labourer	hr	\$34.79	-	-	\$0	\$0	Pond to be used as a PTS in closure
			Cat 235 Excavator	hr	\$250.00	-	-	\$0	\$0	
	Haul waste to landfill		Tandem Haul Truck	hr	\$150.00	-	-	\$0	\$0	
	Breaching and re-contouring			ha	\$10,700.00	-	-	\$0	\$0	
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	\$2.62	-	-	\$0	\$0	
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	\$2,994.00	-	-	\$0	\$0	
	Project Management & Engineering		7% of Total Cost	%		7.00%		\$0	\$0	</

Post Closure Care, Maintenance, and Monitoring - Phase 6.7.8

Item No.	Work Item Description	Equipment / Labour	Units	Quantity (EOM)	Unit Rates	Annual Cost	Cost Year 2	Cost EOM	NPV Year 2	NPV EOM	Comments/Source
15.1	Onsite Management										
	Project Management and Engineering - Included in PME: Costs in each Closure Component. Year 2 CMM 5 years										
	Pickup truck										
	Phase 7/8	Light truck	monthly	180	\$2,000	\$24,000	\$120,000	\$150,000			
	Fuel		monthly	180	\$200		incl. above	\$36,000			
	Heavy equipment maintenance										
	Phase 7/8	Unit Cost Basis	annually	15	\$10,000	\$10,000	\$50,000	\$150,000			
	Power and heat										
	Phase 7/8	Unit Cost Basis	monthly	180	\$5,000	\$60,000	\$300,000	\$900,000			
	General Administrative expenses										
	Phase 7/8	Unit Cost Basis	monthly	180	\$1,500	\$18,000	\$90,000	\$270,000			
	Camp Costs										
	Phase 7/8	Unit Cost Basis	man-day	-	\$55	\$0	\$0	\$0			
	Subtotal - Phase 7/8								\$495,260	\$684,267	
	Subtotal - Phase 7/8 Onsite Management:					\$112,000	\$560,000	\$1,506,000	\$495,260	\$684,267	
15.2	Transport Costs										
	Employee transport costs										
	Phase 7/8	Unit Cost Basis	monthly	180	\$500	\$6,000	\$42,000	\$76,125			
	Subtotal - Phase 7/8:					\$0	\$42,000	\$76,125	\$33,198	\$38,582	
	Subtotal - Onsite Management:					\$0	\$42,000	\$76,125	\$33,198	\$38,582	
15.3	Water Treatment Costs										
	Active Treatment (Phase 6)										
	Capital Costs	Misc.	annually	1	\$3,996,916	\$3,996,916	\$0	\$3,996,916	\$0	\$3,996,916	No Heap in year 2
	Capital Replacement Costs	Misc.	annually	7	\$99,423	\$99,423	\$0	\$695,961	\$0	\$469,389	No Heap in year 2
	Operating Costs	Misc.	annually	7	\$951,415	\$951,415	\$0	\$6,659,905	\$0	\$4,491,751	No Heap in year 2
	Passive Treatment (Phase 7/8)										
	Capital Costs (Occurs in Phase 6)	Misc.	annually	1	\$250,000	\$250,000	\$160,000	\$250,000	\$152,290	\$156,382	
	Capital Replacement Costs	Misc.	annually	15	\$1,500	\$1,500	\$7,500	\$22,500	\$6,633	\$11,617	
	Operating Costs	Misc.	annually	15	\$10,000	\$10,000	\$50,000	\$150,000	\$44,220	\$77,449	
	Subtotal:						\$217,500	\$11,775,282	\$203,143	\$9,203,504	
15.4	Reclamation & Closure Research Plan (Long Term Funding)										
	Reclamation & Closure Research Plan	Misc.	annually	5	\$15,000	\$15,000		\$75,000			
	Subtotal:							\$75,000	\$67,988	\$51,816	
15.5	Monitoring & Reporting										
	Disbursements (non-labour/non-analytical)	Misc.	annually								
	Water Quality Monitoring										
	Phase 6	Misc.	annually	1	\$157,935	\$157,935	\$157,935	\$1,105,545	\$150,325	\$745,631	
	Phase 7/8	Misc.	annually	1	\$110,555	\$110,555	\$1,105,545	\$1,117,390	\$873,844	\$598,900	Monitoring costs reduced by 30% during post closure
	Sediment Monitoring:										
	Phase 6	Misc.	annually	7	\$1,272	\$1,272	\$1,272	\$8,904	\$1,211	\$6,005	
	Phase 7/8	Misc.	annually	15	\$890	\$890	\$8,904	\$10,812	\$7,038	\$5,171	
	Biological Monitoring (Benthos):										
	Phase 6	Misc.	annually	7	\$1,272	\$1,272	\$1,272	\$8,904	\$1,211	\$6,005	
	Phase 7/8	Misc.	annually	15	\$890	\$890	\$8,904	\$10,812	\$7,038	\$5,171	
	Site groundwater monitoring										
	Phase 6	Misc.	annually	7	\$41,785	\$41,785	\$41,785	\$292,495	\$39,772	\$197,272	

Interim Care and Maintenance

Item No.	Work Item Description	Equipment / Labour	Units	Year 2 Quantity	EOM Quantity	Unit Rates	Year 2 Cost	EOM Cost	Comments/Source
16.1	Personnel								
	On-site Caretaker								
	Full time (2 people on alternate 7in-7out schedule, \$6,710 each per month)	Site caretaker	\$/man-month	24	24	\$6,710	\$161,040	\$161,040	
	Extra Personnel								
	Electrician (estimate 1 mo/yr total)	Trades Labourer	\$/hr	88	176	\$91	\$8,008	\$16,016	
	Mechanic (estimate 1 mo/yr total)	Trades Labourer	\$/hr	88	176	\$91	\$8,008	\$16,016	
	Senior Operator/Supervisor (estimate 2mo/yr total)	Unit Cost Basis	\$/hr	176	352	\$110	\$19,360	\$38,720	
	Camp Costs								
	for above personnel (365+30+30+60)	Unit Cost Basis	mandays	425	485	\$57.75	\$24,544	\$28,009	
		</							

Note:

Table of Quantities

Item Description	Value YR2	Value EOM	Units	Source/Comment EOM
Open Pit				
Inflow Spillway Rip-Rap	0	200	m ³	
Exit Channel Rip-Rap	0	200	m ³	
Open Pit Area	12		ha	Year 2 Area from AutoCAD
Overburden for revegetation	23,370		m ³	0.2 m thickness
Heap Leach Facility				
Heap Leach Facility	45.7	107	ha	
Colluvium for revegetation	136,844	321,000	m ³	0.3 m thickness over total area
Overburden topsoil for revegetation	91,229	214,000	m ³	0.2 m thickness over total area
Passive Treatment CWTS Area	2.4	2.4	ha	
Passive Treatment berm	8,000	8,000		400 m x 4 m high x 5 m wide
Bedding and topsoil layers	28,800	28,800		0.8 m topsoil layer plus 0.4 m bedding provision
Nutrients added to heap for cyanide degradation	0	2,327	ton	
Nutrients added to heap for heap bioreactors	0	3,443	ton	
Waste Rock and Overburden Dumps				
Eagle Pup Area	8.9	94	ha	Year 2 Area from AutoCAD
Eagle Pup Waste Rock Volume	3,905,000	26,432,471	m ³	
Colluvium for revegetation - Eagle Pup	26,837	282,000	m ³	0.3 m thickness over total area
Overburden topsoil for revegetation - Eagle Pup	17,891	188,000	m ³	0.2 m thickness over total area
Platinum Gulch Area	10.5	38	ha	Year 2 Area from AutoCAD
Platinum Gulch Waste Rock Volume	900,000	9,100,000	m ³	
Colluvium for revegetation - Platinum Gulch	31,404	114,000	m ³	0.3 m thickness over total area
Overburden topsoil for revegetation - Platinum Gulch	20,936	76,000	m ³	0.2 m thickness over total area
Temporary Ore Stockpiles And Pads Area	16.9	16.9	ha	
Pad material removal to Eagle Pup	16,900	16,900	m ³	0.1 m depth of removal
Reclamation Stockpiles Area	18.4	18.4	ha	
Ice Rich Overburden Storage Area	5.6	5.6	ha	
Eagle Pup Passive Treatment Ditch Rip-Rap	2,300	2,300	m ³	
ADR & Ancillary Facilities				
ADR & Ancillary Facilities Area	12	12	ha	
Overburden for revegetation	24,000	24,000	m ³	0.2 m thickness
Crusher and Screening Area	19.5	19.5	ha	
Ore contaminated soils to be hauled to heap	100	100	m ³	
Overburden cap	97,500	97,500	m ³	0.5 m thickness
Truck Shop Area	9.9	9.9	ha	
Overburden for revegetation	19,800	19,800	m ³	0.2 m thickness
Water Treatment Plant area	2	2	ha	
Overburden for revegetation	4,000	4,000	m ³	0.2 m thickness
Miscellaneous Sites and Facilities				
Mine Camp area	12.5	12.5	ha	
Overburden for revegetation	25,000	25,000	m ³	0.2 m thickness
Explosive / Magazine Storage Facility area	2.5	2.5	ha	
Overburden for revegetation	5,000	5,000	m ³	0.2 m thickness
Roads and Trails				
On site access and haul roads	51.2	51.2	ha	
Slope Stabilization				
Silt Curtains (m ² per crossing)	20	20	m ²	
Enviro matting (m ² per crossing)	15	15	m ²	
Number of crossings	15	15		
Silt Curtains Total	300	300	m ²	
Enviro matting Total	225	225	m ²	
Water Management				
New Drainage channels and diversions				
Provision for Rip-Rap	1,000	1,000	m ³	

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APPENDIX C

O'Kane Consultants Inc. - Eagle Gold Project - Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas

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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.

Project Objectives and Work Scope:

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/W¹; 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 KP².

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 Parviainen, 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)

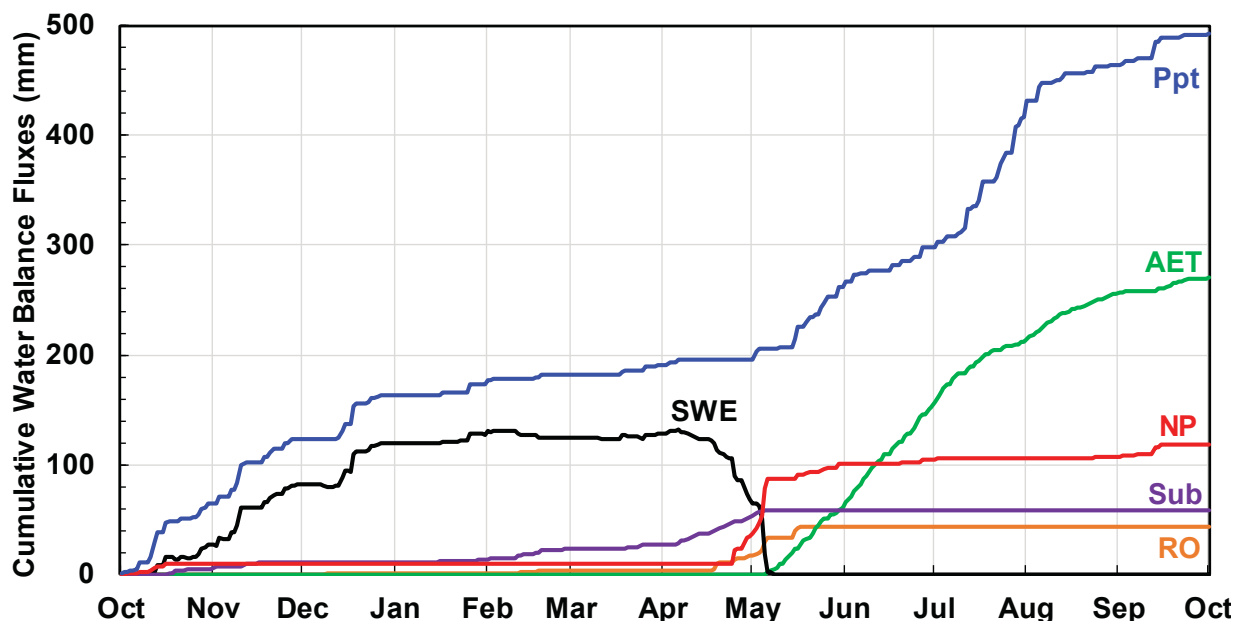


Figure 1 Typical annual water balance fluxes for the EGP site for an east/west bench during an average precipitation year.

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 VADOSEW Version 8.12.3.7901⁷.

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 1×10^{-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.

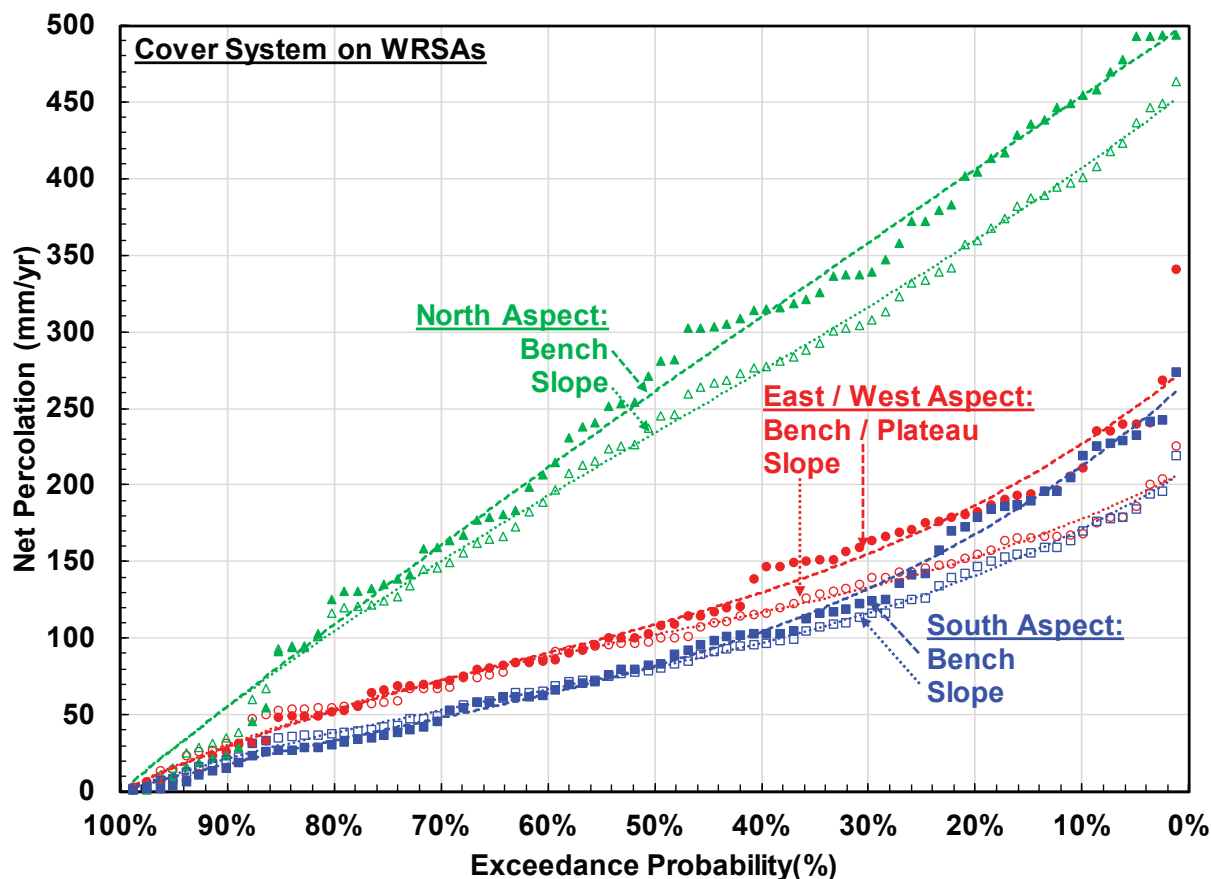


Figure 2 Exceedance probability for annual net percolation through the base case cover system design on WRSAs⁸.

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)):

$$\begin{aligned} \text{NP (WRSA North Aspect – Bench)} &= 40.0041311586974(1-x)^3 - 99.5768877417431(1-x)^2 + 561.738884175022(1-x) \\ \text{NP (WRSA North Aspect – Slope)} &= 206.353645699448(1-x)^3 - 327.934585562733(1-x)^2 + 580.167973306423(1-x) \\ \text{NP (WRSA East / West Aspect – Bench/Plateau)} &= 334.907229739852(1-x)^3 - 383.091823084556(1-x)^2 + 325.661910099225(1-x) \\ \text{NP (WRSA East / West Aspect – Slope)} &= 280.502595140468(1-x)^3 - 409.768319621682(1-x)^2 + 339.373074364743(1-x) \\ \text{NP (WRSA North Aspect – Bench)} &= 272.348822876258(1-x)^3 - 199.583918676042(1-x)^2 + 195.342583203572(1-x) \\ \text{NP (WRSA North Aspect – Slope)} &= 242.715256690288(1-x)^3 - 267.520494862459(1-x)^2 + 234.753215517809(1-x) \end{aligned}$$

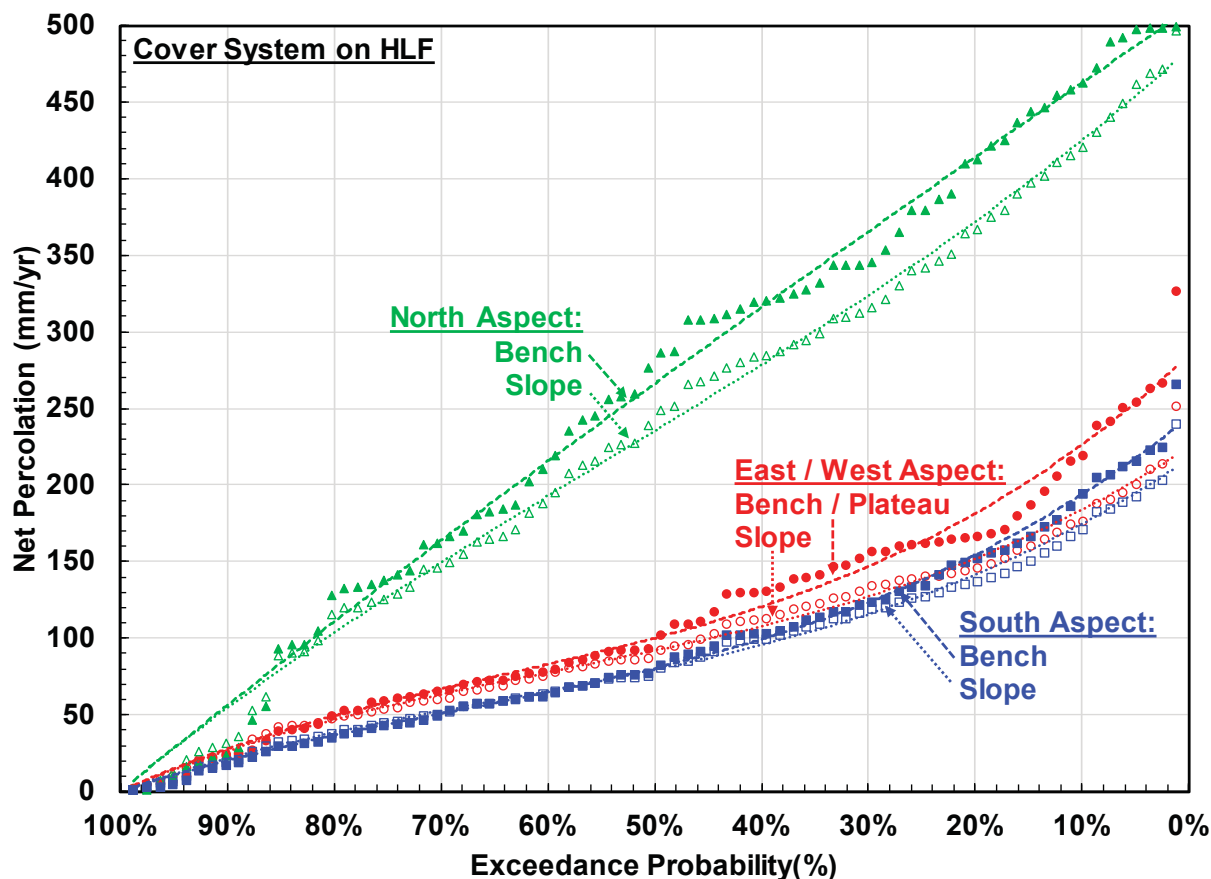


Figure 3 Exceedance probability for annual net percolation through the base case cover system design on HLF⁹.

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)):

$$\begin{aligned} \text{NP (HLF North Aspect – Bench)} &= 31.272632650886(1-x)^3 - 89.742473682767(1-x)^2 + 569.412107857963(1-x) \\ \text{NP (HLF North Aspect – Slope)} &= 230.751591012202(1-x)^3 - 318.847922658053(1-x)^2 + 572.512360031695(1-x) \\ \text{NP (HLF East / West Aspect – Bench/Plateau)} &= 401.880632485379(1-x)^3 - 433.796816800299(1-x)^2 + 316.593775515019(1-x) \\ \text{NP (HLF East / West Aspect – Slope)} &= 310.161269957891(1-x)^3 - 383.422721152048(1-x)^2 + 298.154325857064(1-x) \\ \text{NP (HLF North Aspect – Bench)} &= 297.902638452382(1-x)^3 - 279.853973662612(1-x)^2 + 226.194792839713(1-x) \\ \text{NP (HLF North Aspect – Slope)} &= 282.980662582457(1-x)^3 - 307.881636956547(1-x)^2 + 242.043952583721(1-x) \end{aligned}$$

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.

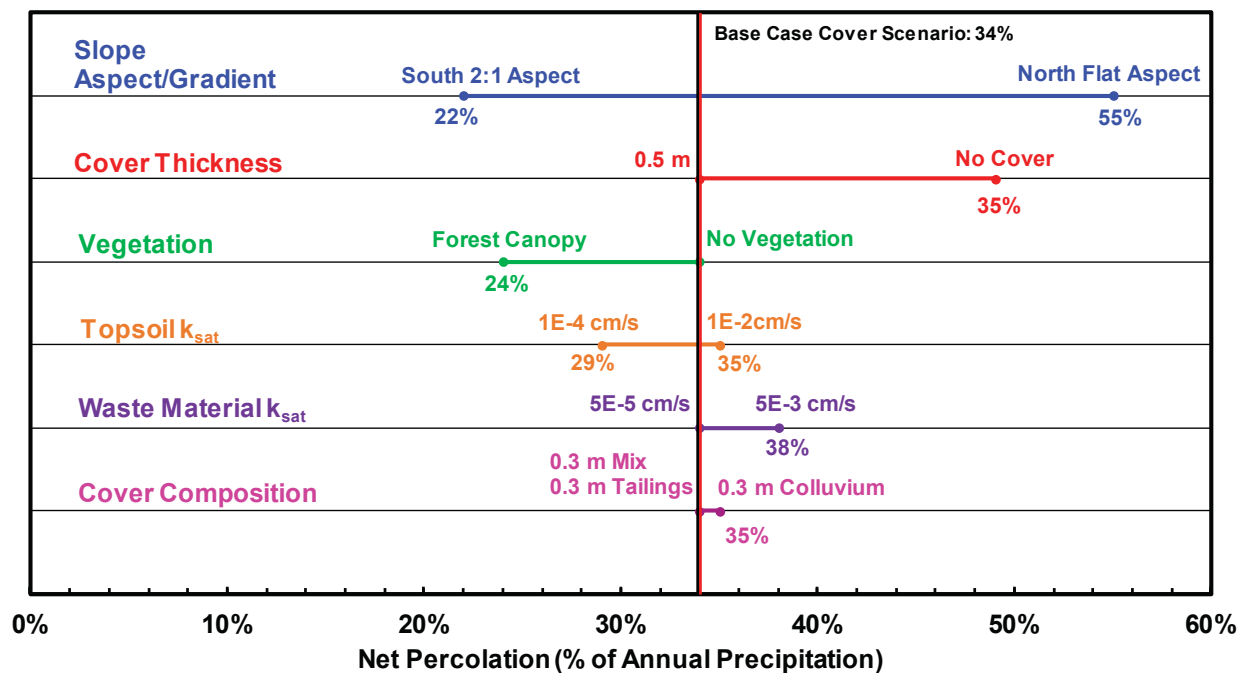


Figure 4 Tornado plot for WRSA cover system net percolation predictions.

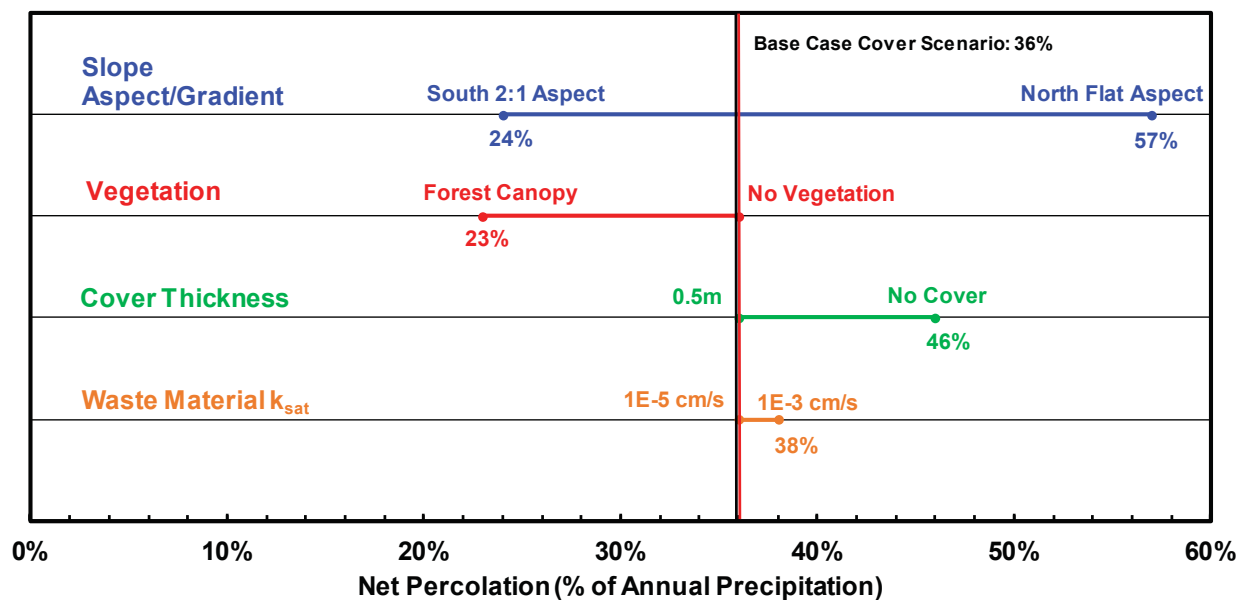


Figure 5 Tornado plot for HLF cover system net percolation predictions.

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).

<i>Layer 1</i>		<i>Layer 2</i>		<i>Layer 3</i>		<i>Net Percolation</i>
<i>Material</i>	<i>Thickness (m)</i>	<i>Material</i>	<i>Thickness (m)</i>	<i>Material</i>	<i>Thickness (m)</i>	
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.

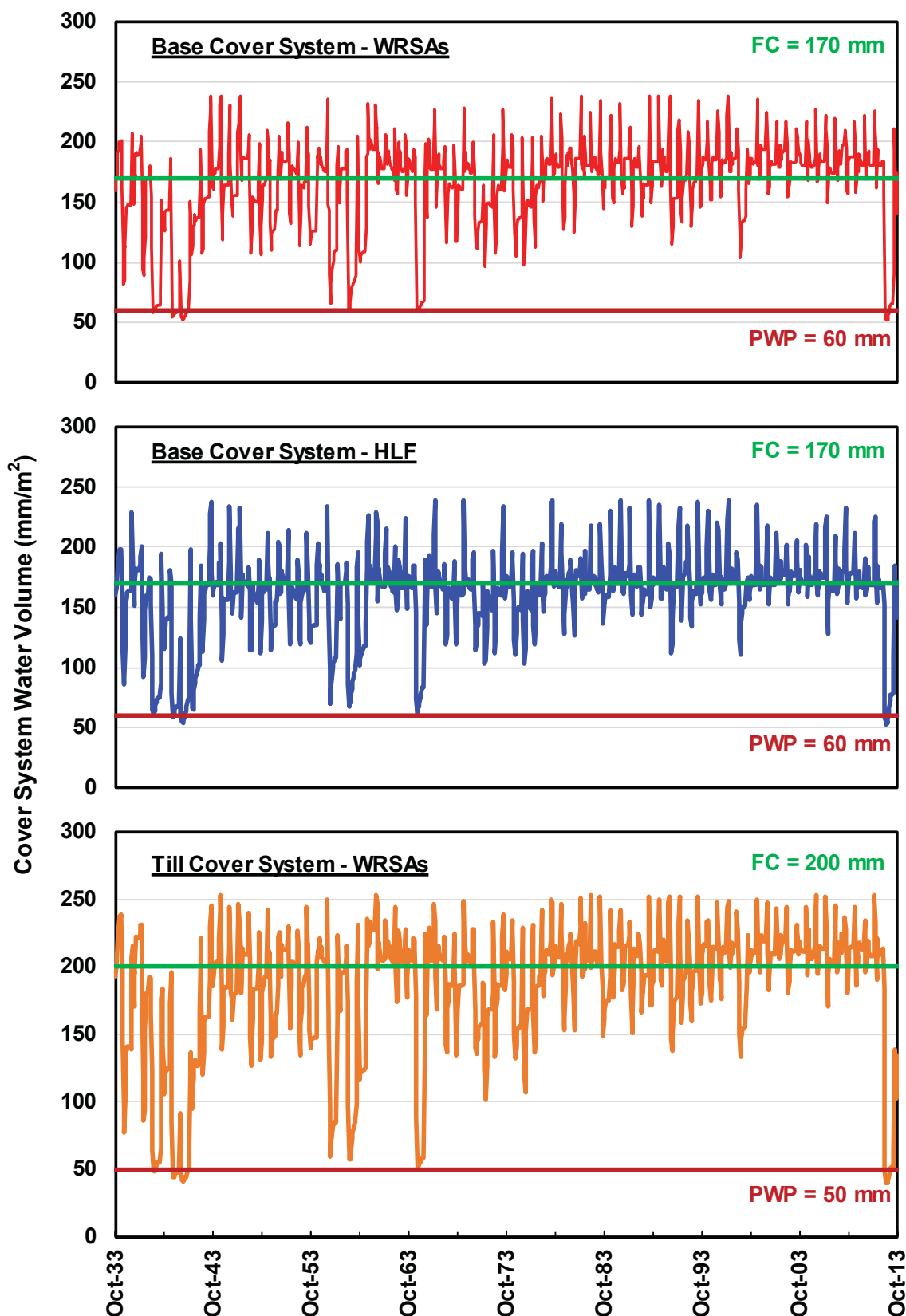


Figure 6 Cover system water volumes estimated during 80-year simulations for three scenarios (from top to bottom): base cover system on WRSAs and HLF and till cover system on WRSAs.

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).

<i>Waste Material</i>	<i>Waste Rock</i>	<i>Waste Rock</i>	<i>Waste Rock</i>	<i>Waste Rock</i>	<i>Heap Leach</i>	<i>Heap Leach</i>
<i>Modification</i>	<i>Waste Rock k_{sat} increased by 10x</i>	<i>Waste Rock k_{sat} decreased by 10x</i>	<i>Topsoil k_{sat} increased by 10x</i>	<i>Topsoil k_{sat} decreased by 10x</i>	<i>Heap Leach k_{sat} increased by 10x</i>	<i>Heap Leach k_{sat} decreased by 10x</i>
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 precipitation¹⁰. 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).

¹⁰ Scenarios Network for Alaska & Arctic Planning. 2013. *Community Charts: Mayo, YT*. Version 1.219. Online. www.snap.uaf.edu.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:
 - o hydraulic conductivity,
 - o moisture retention, and
 - o 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 VADOSEW.

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 OKC¹¹¹²¹³¹⁴. 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.

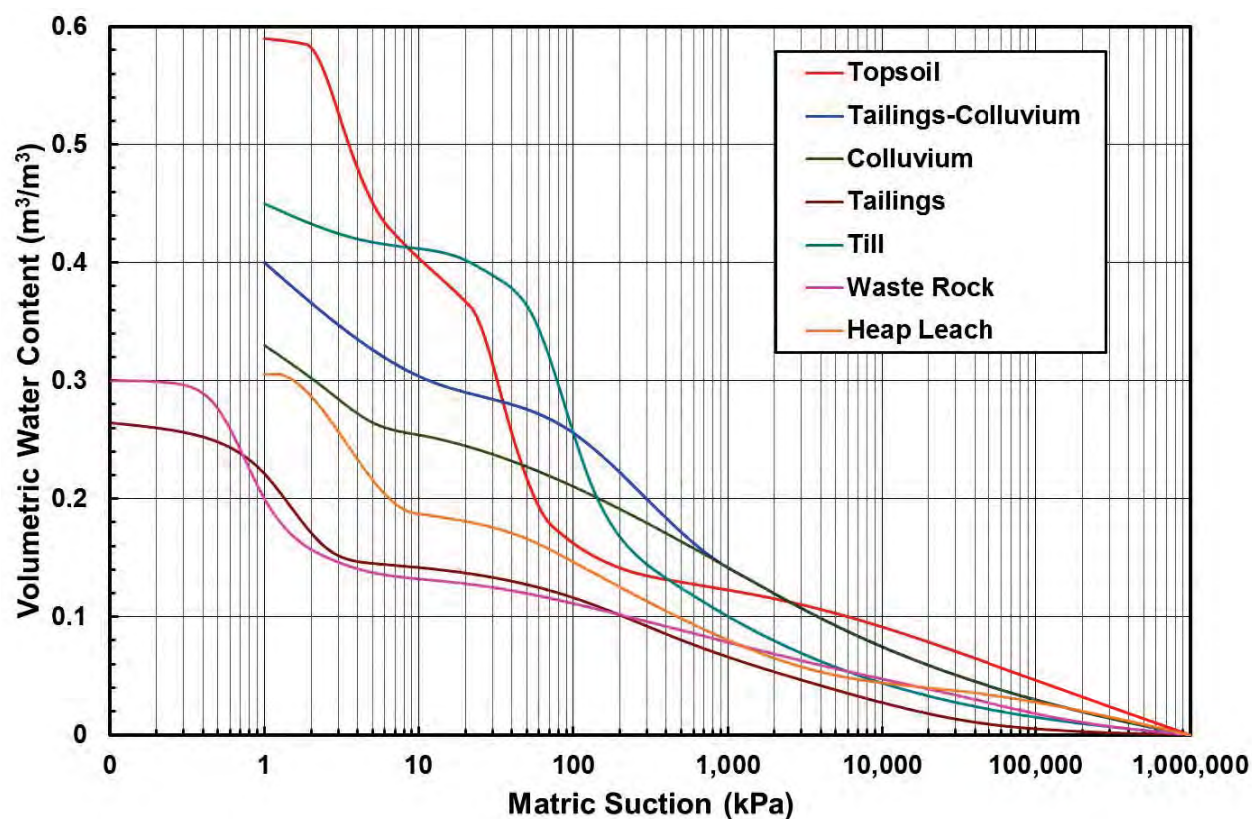


Figure A-1 Moisture retentions curves for all materials used during the OKC modelling program.

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.* method¹⁵. 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.

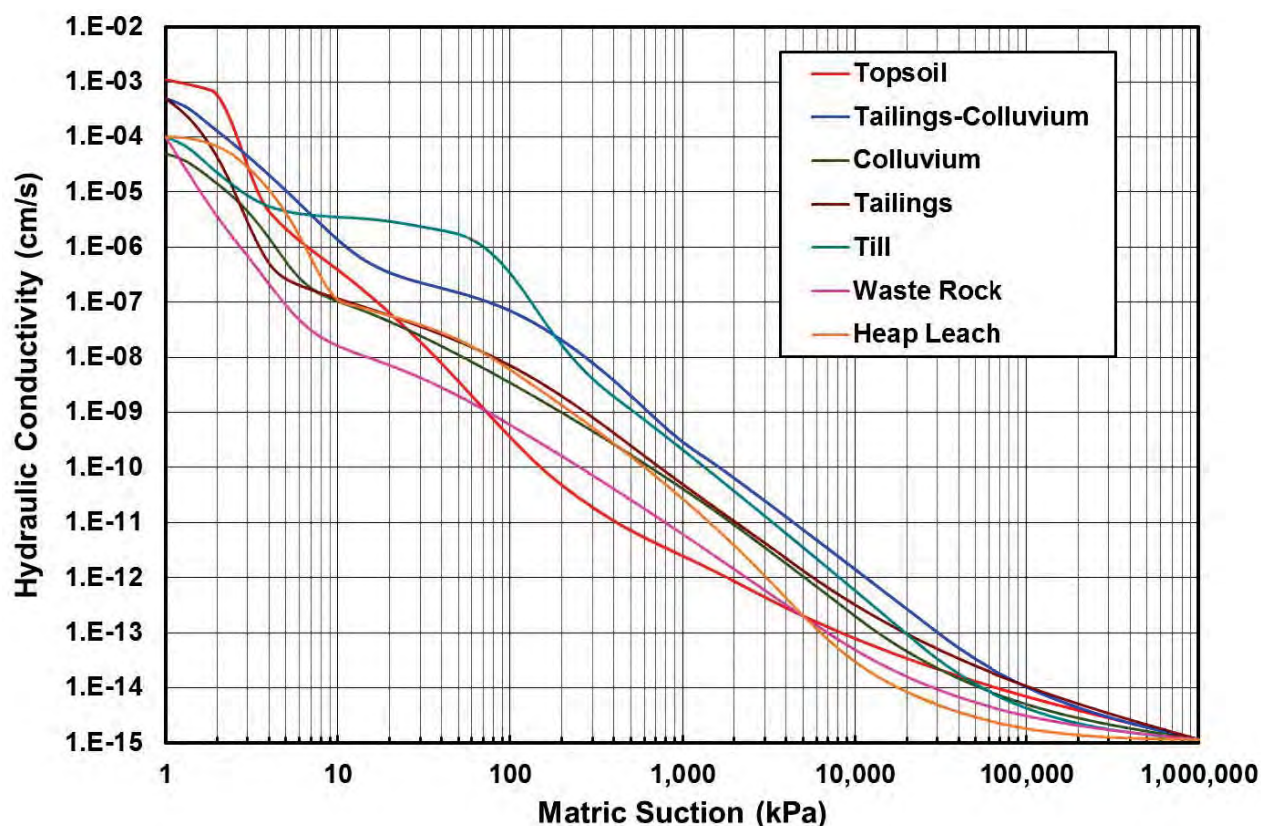


Figure A-2 Hydraulic conductivity function for all materials used during the OKC modelling program.

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 VADOSEW using the Johansen method¹⁶.

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 VADOSEW using the deVries method¹⁷.

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 Wijk (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 database¹⁸.

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				
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 cover²⁰. 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 reactions²¹. 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:

$$I = -0.21 + 0.7 \times \text{LAI}^{1/2} \quad [1]$$

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 Group²². 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.

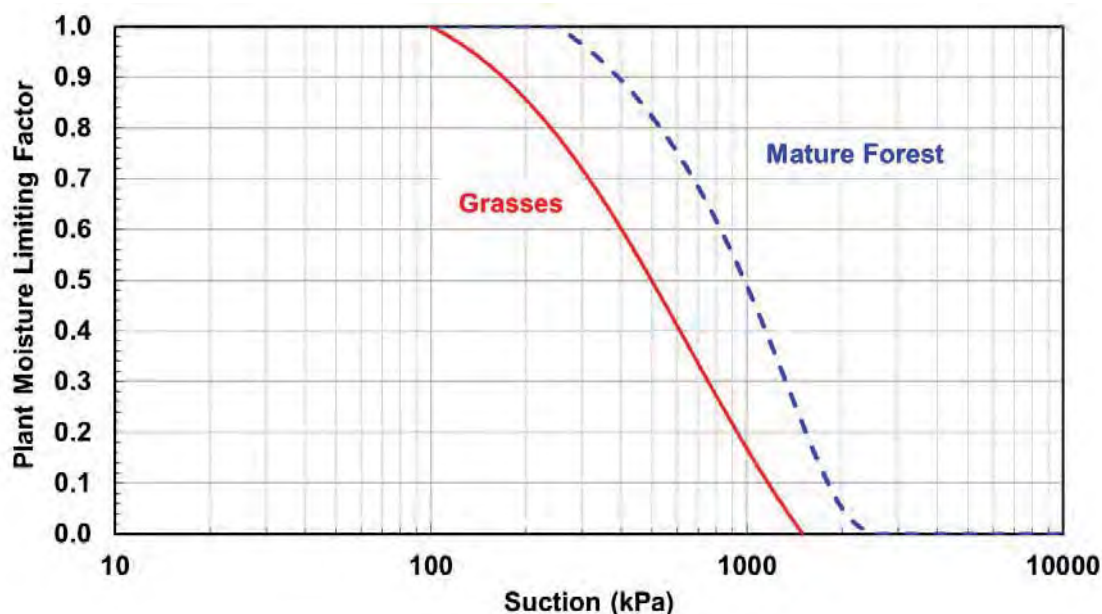


Figure A-3 Plant limiting moisture function for the grasses and mature forest vegetation sequences.

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 D

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

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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 Yukon¹. 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/W² with available site-specific inputs. The SPA numerical modelling was completed to determine:

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 assessment³⁴⁵⁶ 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.

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 Plan⁷. 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)⁹¹⁰ 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

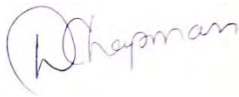
Destructive sampling would be completed during and near the end of the program to determine spatial vegetation characteristics that include vegetation type, ground cover percentage, vertical root length and density. A vegetation survey, consisting of sample plots randomly located throughout the cover 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 m² 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 m² 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.



Denise Chapman, P.Eng.
Senior Geoenvironmental Engineer
dchapman@okc-sk.com

cc: Hugh Coyle, Victoria Gold Corp.
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).

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APPENDIX E

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 N₂.
- 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 replaced 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/m²/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/m²/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

- Bleiwas, D.I., 2012, Estimated water requirements for gold heap-leach operations (ver. 1.1, December 11, 2012): U.S. Geological Survey Open-File Report 2012-1085, 17 p., available only at <http://pubs.usgs.gov/of/2012/1085>.
- Lovely, Derek R.; Phillips, Elizabeth J. 1987. Rapid Assay for Microbially Reducible Ferric Iron in Aquatic Sediments. *Applied and Environmental Microbiology*. v53(7). 1536-1540.
- Tetratech, 2014. Cyanide Destruction Column Studies Report, Eagle Gold Project. March 13, 2014. TetraTech Project No 133-77355-12001.

Biological Detoxification and Bioreactor Test Schematic

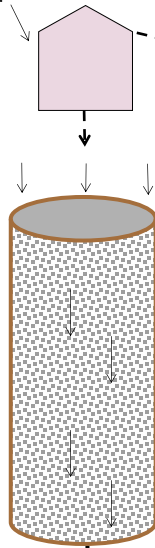
Test would utilize Biological Detoxification in either the column option OR

Lysimeter Option followed by Bioreactor Treatment

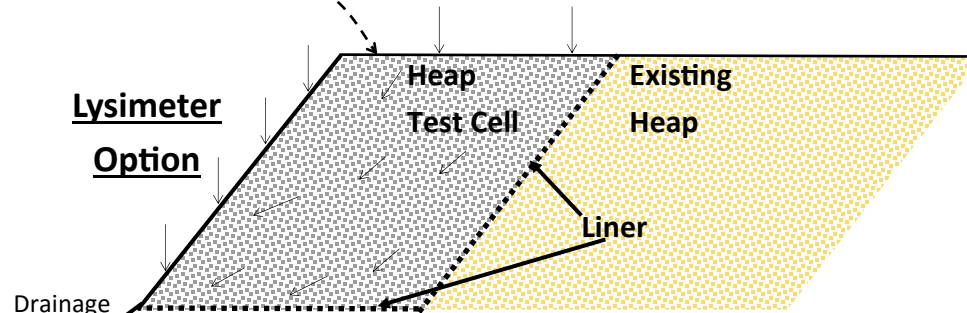
Biological Detoxification Test Cell

Molasses-p amended
barren solution

Column Option



Lysimeter Option

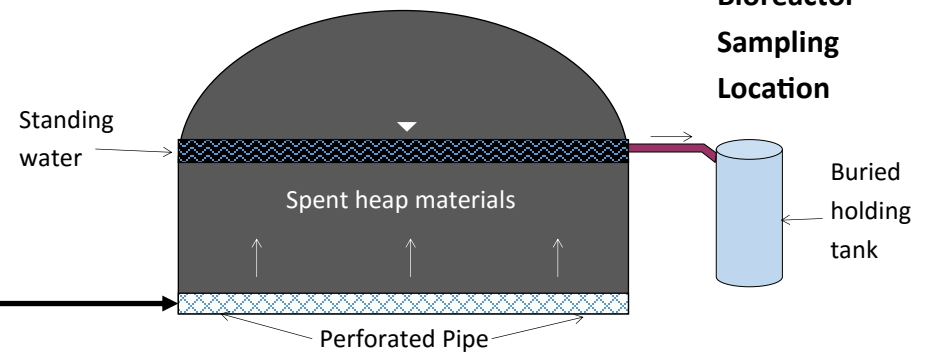


Drainage

Alcohol
amended
detoxified
solution

Biological
Detoxification
Sampling
Locations

Bioreactor Test Cell



Bioreactor
Sampling
Location

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