EAGLE GOLD PROJECT

RECLAMATION AND CLOSURE PLAN

Version 2018-03

SEPTEMBER 2018

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DOCUMENT CONTROL

Submission History

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

Version 2018-03 of the Reclamation and Closure Plan (the Plan) for the Eagle Gold Project has been revised in September 2018 to update Version 2018-02 submitted to the Yukon Water Board in August 2018. The table below is intended to identify modifications to the Plan compared to Version 2016-01, being the last iteration provided to all interested parties, and provide the rationale for such modifications. For greater clarity, Versions 2018-01 and 2018-02 are now considered interim drafts that were submitted to the Yukon Water Board for their consideration during the amendment application process required for QZ14-041.

Version 2018-03 Revisions

Section	Revision/Rationale
1 Introduction	▪ Text revision to provide an update on the development of the Project and the Reclamation and Closure Plan.
2 Reclamation and Closure Planning	▪ Rearrangement of sections for readability.
2.1 Status of Reclamation and Closure Planning	▪ Text revision to acknowledge that construction of the Project has commenced. ▪ Inclusion of a Table of Concordance related to discussions contained within the Reasons for Decision for the Type A Water Use Licence QZ14-041 as requested by reviewers during the previous review process for the RCP.
2.2	▪ Updated section title and text to acknowledge reclamation research completed to date as requested by reviewers during the previous review process for the RCP.

Section	Revision/Rationale
Summary of Reclamation Research Completed to Date	
2.5 Comprehensive Cooperation and Benefits Agreement	▪ Updates to acknowledge the execution of certain construction contracts with Yukon based companies and the FNNND Development Corporation.
Table 3-2 Summary of Decommissioning and Reclamation Planning for Mine Components	▪ Minor revisions to more accurately describe Project facilities.
3.2.1 Open Pit	▪ Minor revisions to more accurately describe Project facilities.
3.2.3.1 Design Basis	▪ Revisions to reference updated design guidance and regulatory expectations.
3.2.3.2 Design Criteria	▪ Updates to referenced material.
3.2.4 Water Management Facilities	▪ Revisions to more accurately describe Project facilities.
4 Existing Environmental Description	▪ Inclusion of cross references to detailed environmental characterization reports as requested by reviewers during the previous review process for the RCP.
5 Project Description	▪ Inclusion of high-level description of the project as requested by reviewers during the previous review process for the RCP.
6.2.1.1 Open Pit	▪ Minor revisions to acknowledge that during early phases of the Project the geometry of the open pit will not allow for the formation of a pit lake.
6.2.2.1 Waste Rock Storage Areas and Temporary Ore Stockpiles	▪ Revisions to provide greater detail on monitoring for the facilities.
6.2.2.2 Heap Leach Facility	▪ Inclusion of discussion on the results of the latest iteration of the HLF water balance model.
6.2.2.3 Mine Infrastructure	▪ Inclusion of commitment to maintain a hazardous material inventory during any period of temporary closure.
6.2.2.5 Mine Water Treatment	▪ Inclusion of new subsection describing mine water treatment capabilities.
6.2.3.4 Mine Water Treatment Plan	▪ Updates to referenced material.

Section	Revision/Rationale
6.2.3.5 Ecological Conditions and Sustainability	▪ Greater detail on mitigation measures considered for any period of temporary closure.
Table 6-1 Summary of Care and Maintenance Activities and Monitoring During Temporary Closure	▪ Revisions to more accurately describe Project facilities.
6.4 Monitoring	▪ Revisions to describe regulatory requirements for inspections.
7.1 Platinum Gulch Waste Rock Storage Area	▪ Additional details regarding the development of the PG WRSA PTS.
8.1 Closure Schedule	▪ Updates to more accurately reflect the Project schedule.
8.3 Supervision and Documentation of Work	▪ Greater detail regarding the documentation of reclamation measures.
8.5 Estimated Areas of Disturbance at End of Mine Lice	▪ Revisions to acknowledge the reduction in facilities sizes/site disturbances.
8.6.1.1 Water Quality Objectives	▪ Inclusion of water quality objectives provided in the EMSAMP and other Project material.
8.6.1.2 Water Conveyance Objectives	▪ Revisions to more accurately describe Project facilities.
8.6.1.3 Transition Strategy	▪ Revisions to more accurately describe Project facilities. ▪ Updates to acknowledge license requirements for MWTP standby period and approval of MWTP decommissioning strategy.
8.6.1.4 Water Conveyance Network	▪ Revisions to more accurately describe Project facilities and water conveyances.
8.8 Heap Leach Facility	▪ Clarification of CN destruction processes. ▪ Updates to referenced material. ▪ Revisions to more accurately describe Project facilities. ▪ Updates to preliminary sizing of CWTS based on additional modelling.
8.9.2.1 8.10.2.1 Passive Water Treatment	▪ Updates to preliminary sizing of PTSs based on additional modelling. ▪ Additional discussion on timing for development of PTSs.

Section	Revision/Rationale
8.12.2.4 Power Generation and Transmission Infrastructure	▪ Removal of statement indicating that reclamation costs and responsibility for the work related to the transmission line was Yukon Energy Corporation's.
8.13 Water Management Structures	▪ Removal of subsection related to the Dublin Gulch diversion channel, the Lower Dublin North Pond, the Eagle Pup Pond and the Platinum Gulch Pond.
10.1 Ongoing Revegetation Trials	▪ Updates to the status of the ongoing trials.
10.2 Engineered Covers	▪ Significant revisions to discussion of cover trials based on ongoing research and planning.
10.3 Vegetation Rooting Study	▪ Significant revisions to discussion of vegetation rooting study based on ongoing research and planning.
10.4.2 Schedule	▪ Updates to schedule based on the current Project status.
13 Reclamation Cost Estimate	▪ Complete revision based on current status of the Project and to more accurately describe Project facilities

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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....*Quartz Mining Act*

QML....quartz mining licence

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 .... *Yukon Environmental and Socio-economic Assessment Act*
YESAB .... Yukon Environmental and Socio-economic Assessment Board
YG .... Yukon Government
yrs .... years
YT .... Yukon Territory
YQMA .... Yukon Quartz Mining Act
YWA .... Yukon Waters Act
YWB .... Yukon Water Board

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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 and gold extraction using a three stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over the mine life.

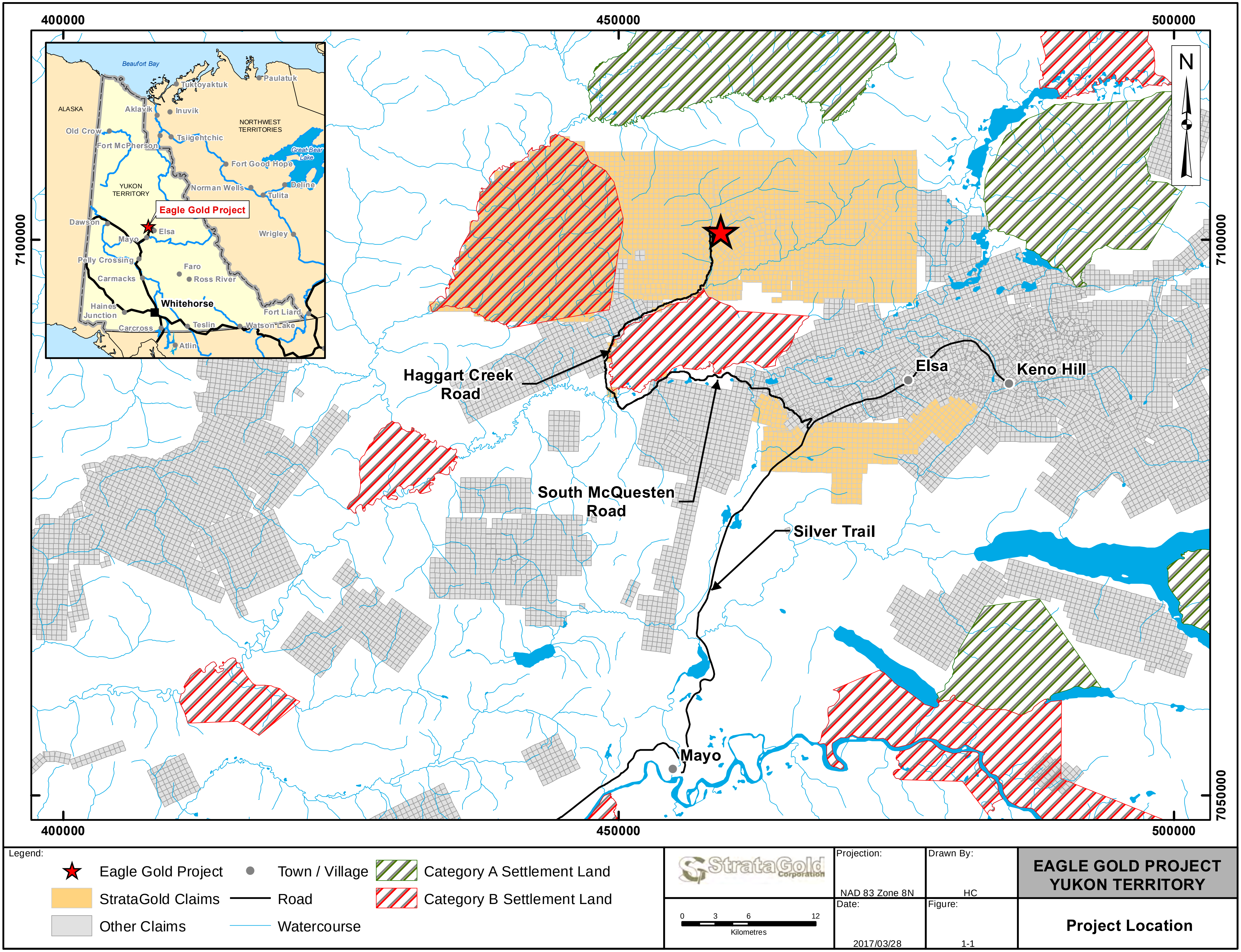
This *Reclamation and Closure Plan* (RCP) addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances from existing development. A program is presented for site management and monitoring both during implementation of closure and after decommissioning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

The 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 Licenses (QML).

Version 2016-01 was submitted to the Yukon Water Board (YWB) and Yukon Government (YG) on November 1, 2016 and is approved under the Quartz Mining License QML-0011. Version 2018-01 was submitted to the YWB on July 3, 2018 as a requirement for the amendment application process. Version 2018-02 of the RCP includes revisions to align the RCP with the optimized Project, the Water Management Plan, and preliminary comments received from the YWB. Version 2018-03 of the RCP is being updated and submitted to YWB and the Department of Energy, Mines and Resources (EMR) in accordance with Clause 171 (b) of QZ14-041 and Clause 7.2 of QML-0011.

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 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.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Fort McPherson
Great Bear Lake
Fort Good Hope
YUKON TERRITORY
Norman Wells
Deline
Tulita
Eagle Gold Project
Dawson
Elsa
Mayo
Wrigley
Pelly Crossing
Faro
Carmacks
Ross River
Haines Junction
Whitehorse
Fort Liard
Teslin
Watson Lake
Carcross
Atlin
Haggart Creek Road
Elsa
Keno Hill
South McQuesten Road
Silver Trail
Mayo
Legend:
Eagle Gold Project
Town / Village
Category A Settlement Land
StrataGold Claims
Road
Category B Settlement Land
Other Claims
Watercourse
StrataGold Corporation
Projection:
NAD 83 Zone 8N
Drawn By:
HC
EAGLE GOLD PROJECT
YUKON TERRITORY
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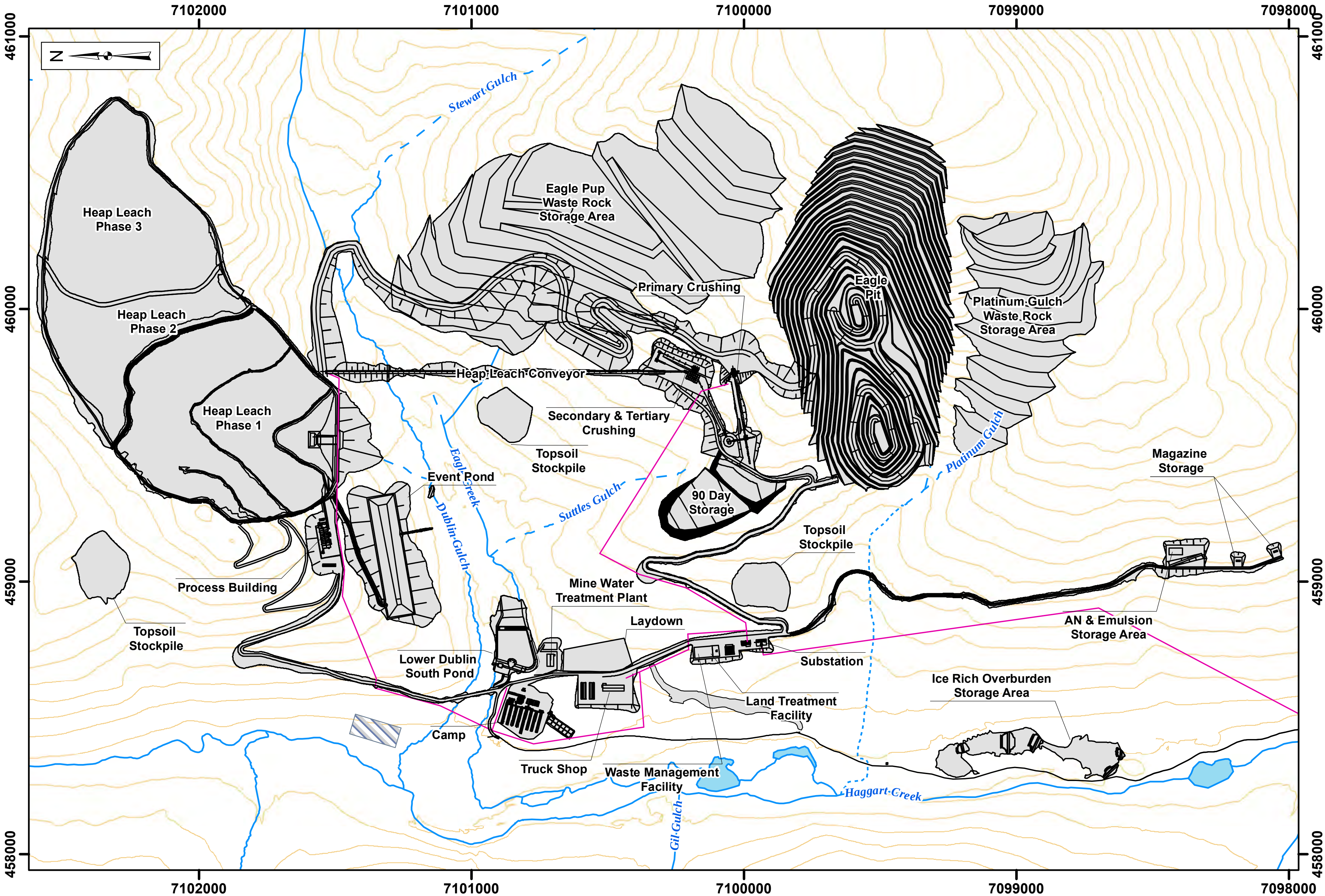
Kilometres
Date:
2017/03/28
Figure:
1-1
Project Location



Legend:

Facility	Perennial	Waterbody
Site Power	Ephemeral	Contour (25m)
Reserved Area	Intermittent	

StrataGold Corporation

0 125 250 500
Metres

Projection:
NAD 83 UTM
Zone 8N

Drawn By:
JK

Date:
2018/08/14

Figure:
1-2

EAGLE GOLD PROJECT
YUKON TERRITORY

Site General Arrangement

2 RECLAMATION AND CLOSURE PLANNING

The overall strategy for the RCP is to provide the proposed approach to decommission mine features, reclaim landforms, and provide a monitoring program to 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.

2.1 STATUS OF RECLAMATION AND CLOSURE PLANNING

Figure 2-1 below illustrates that the closure planning for mining projects is a continuum, and that the details contributing to closure implementation strategy, including level of design, should increase as a mine moves through the mine life cycle. As closure planning increases in detail, the information is integrated into development and operational decision making. SGC has received a Type A WUL and a QML and the project begun the Development Phase in August 2017. Consequently, this plan has been updated to reflect the current status of the Project, discussions and commitments made during the regulatory processes and associated reviews since 2015 and to track the status of plans for studies required in the licence.

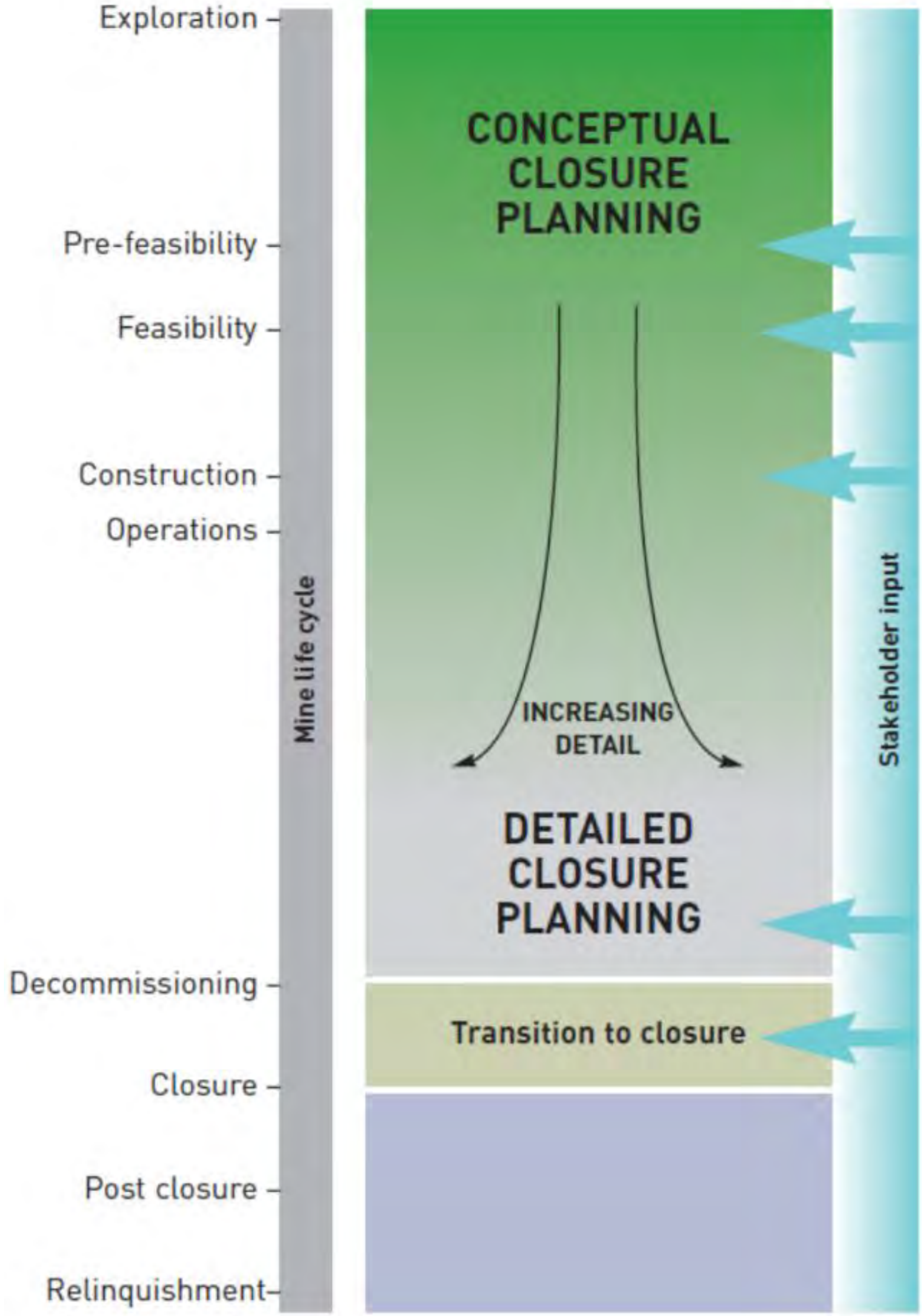


Figure 2-1: Continuum of Closure Planning Relative to Mine Life Cycle

2.1.1 Discussion of Issues Listed in Reasons

The YWB required SGC to include the 19 issues listed in the Reasons for Decision (RFD), whether or not efforts to resolve them have advanced. Accounting of the YWB's identified issues and requirements (from QZ14-041 and its RFD) has been integrated into the RCP, and commentary on advancement or planning related to these items and requirements are detailed in Table 2-1.

Table 2-1: Table of Concordance for QZ14-041 Reasons for Decision Relevant to this Plan

No.	Issue	Status/Where Addressed
1	The issue of use of assimilative capacity of the aquatic receiving environment is a matter that is expected to be addressed during the future development of the plan. SGC and all parties are encouraged to consider how this issue may best be addressed.	**Section 10.4** describes the PTS reclamation research program to refine, optimize and remove uncertainties with regard to achievable water quality chemistries, with the aim of minimizing the consumption of assimilative capacity, and alteration of water quality adjacent to settlement land (at W23). **Status - To commence when effluent generated on site**: Step 1 of the research program is to compare Project water quality predictions with actual performance and will commence when the Operations Phase of the Project commences. Though the specific PTS reclamation research program has not commenced, conceptual PTS sizing based on modelling the Operations Phase effluent quality standards, the optimized Project and expected PTS performance has been undertaken. This ongoing work supports the conclusion that PTS technologies can be employed during the Closure Phase of the Project as a walk away closure solution that minimizes impacts.
2	The further definition of effluent discharge standards for closure is a clear expectation of all parties and SGC should be prepared to advance that issue in future revisions of the RCP.	As described for Item No. 1, above.
3	The issue of the long-term performance of the PTSs [passive treatment systems] with respect to selected water quality objectives and EQS requires further development.	As described for Item No. 1, above.
4	The logistics of rinsing the terraced heap requires further definition to clarify the timing, equipment, and effort that may be required. This should account for constraints on rinsing the sloping portions of the heap only during warmer months.	**Section 10.5** describes heap biological detoxification and in -heap bioreactor research program. **Status - To commence when the HLF is operational on site:** 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.

No.	Issue	Status/Where Addressed
5	Timing of placing cover materials on the heap in coordination with rinsing needs further resolution.	As described for Item No. 4, above.
6	The means of reliably conveying the relatively small volumes of seepage water collected from the EP WRSA down to the relatively distance proposed PTSs located at the LDSP [Lower Dublin South Pond] requires further consideration. The suitability of an unmaintained shallow buried pipeline to convey such seepage during closure is a concern without suitable provisions for long term maintenance of such a system.	The current water management plan for the Project considers the transfer of contact water from the Eagle Pup and Platinum Gulch drainages via a pipe with overflow into an open channel. Observations of the efficacy of this design, and water management concepts utilized for other facilities (e.g., camp water supply), will be examined during the Operations Phase and will inform the design of closure drainage which may incorporate both or either of these concepts.
7	The impact of icing development and subsequent thaw in PTSs that are collecting seepage is a concern that requires further consideration.	**Section 10.4** describes the PTS reclamation research program. Phase 3 involves outdoor pilot scale test at a cold-climate PTS testing facility to characterize spring thaw and winter freeze performance **Status - Not started**.
8	The material balance for cover materials is only modestly positive which may result in the need to obtain additional materials from off-site if less materials are in fact produced or more materials are required. This should be carefully evaluated during early stages of the project.	**Section 8.5** describes the evaluation of materials available for cover. **Section 10.2** describes the research program for closure cover designs, which includes further assessment and refinement of material availability and volume. **Status – Started:** Updating of closure cover system design performance based on refined general arrangement.
9	Refinement of the proposed cover systems will be expected, including further optimization for vegetation growth and confirmation that appropriate properties of the heap ore have been considered for the HLF.	**Section 10.1** describes revegetation trials and **Section 10.2** describes the research program for closure cover designs, during which cover system field trials provide opportunities to investigate vegetation prescriptions and techniques. **Status – Started**
10	The adequacy of the design criteria for closure water conveyance channels is a matter that is not resolved at this time but should be addressed in the near term.	**Section 3.2 Design Criteria** provides information on the design criteria for water management facilities. **Status – Started:** Seasonal climatic variability, longevity, and flow capacity are being examined as part of the design finalization for operations and will be considered in more detail when evaluating specific design criteria to address long-term issues such as maintenance requirements, channel morphology changes, and minimizing the risk of failure.
11	Proposals for only limited re-sloping of the WRSA's and HLF appear suspect and not consistent with	Closure objectives for the WRSAs are: to ensure long-term physical stability to minimize erosion, subsidence or

No.	Issue	Status/Where Addressed
	current expectations for development of suitable closure landforms. For the PG WRSA the re-sloping proposals appear inconsistent with the Requirements for general stability of that waste emplacement.	slope failure; and, 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. Targeted studies of closure landform design option(s) are proposed to balance risk mitigation, manage costs, and identify closure landform options with a high probability of achieving closure objectives. **Status - Not started.**
12	The need to develop and include water conveyance networks on the closed heap and WRSAs is an acknowledged deficiency in current planning.	As described for Item No. 11, above
13	The need to more specifically identify passive treatment designs including the size and location of treatment train components is clear requirement for future revisions of the plan.	As described for Item No. 1, above.
14	The need to refine the water conveyance network near the toe of EP WRSA where presently both contact and non-contact water conveyance channels intersect has been acknowledged by SGC and requires resolution.	As described for Item No. 11, above
15	The issue of collecting seepage from the northern edge of the EP WRSA that is not underlain by a rock drain and lies outside of the existing watershed for Eagle Pup will require further advancement.	**Not applicable:** The EP WRSA is within the existing Eagle Pup watershed.
16	The expected function of the HLF closure drain to attenuate flows suggests either some level of understanding about saturated levels in the heap over the long term or some level of applied external control to establish and maintain a saturated zone in the heap during closure. In either case, more detail is required to understand the expected rate of flow from the heap during closure.	As described for Item No. 4, above.
17	It is unclear whether the functioning of the HLF as a bioreactor is required only during heap drain down or whether it is necessary long term.	As described for Item No. 4, above. Presently, it is assumed that the in-heap bioreactor will only be required during heap drain down.
18	The development of proposals for physical testing of the heap to confirm detoxification remain unresolved.	As described for Item No. 4, above.
19	Elsewhere in these reasons the issue of whether the storage capacity of the in-heap pond has been correctly estimated has been raised. This issue also has implications for closure of the HLF.	**Forte Dynamics (2018b)** describes In-heap pond solution storage capacity and informs HLF closure planning. **Status - Complete.**

2.2 SUMMARY OF RECLAMATION RESEARCH COMPLETED TO DATE

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

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

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 and the status of these programs to date is summarized in Table 2-2.

Table 2-2: Reclamation Research Completed to Date

Research Program	Status
Revegetation	Laberge Environmental Services has been conducting vegetation trials at the Peso Mineral Exploration Site located nearby but independent of the Project site, which continue to be monitored. The objective of the revegetation program is to test the viability of incorporating biochar and other soil amendments into the Project with the goal of refining and improving the reclamation and revegetation plan. In August 2018, soil samples were taken to determine if the soil amendment had added nutrients and other properties to the soil. Additionally, vegetation tissues samples were taken for metals analysis to determine if vegetation is up-taking the elements known to be present in the substrate. Available results from ongoing monitoring of the revegetation trials are presented in Appendix A.
Soil Covers	O'Kane Consultants has updated the research program on engineered covers to align with the optimized Project and included additional detail on execution of the research plan. This information is provided below in Section 10.1.1. Additionally, a Vegetation Rooting Study, as required by Clause 178 (e) of the WUL is summarized in Section 10.3 with additional detail provided in Appendix B.
Passive Water Treatment	Contango Strategies Limited has updated conceptual wetland designs to align with the optimized Project. This information is described in detail in Sections 8.8 through 8.10
HLF Detoxification	The plan for testing besting biological detoxification and in-heap bioreactor for CN and metals is provided in Appendix C.
Groundwater Attenuation	The groundwater arsenic attenuation study is described in Section 10.6

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 First Nation of Na-Cho Nyäk Dun (FNNND) a priority to ensure an opportunity for input at all key stages of Project development.

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

2.4 STAKEHOLDER ENGAGEMENT

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

Consultation efforts carried out have been well received and well attended. The Project optimizations captured by the amendment application are fully supported by the FNNND.

2.5 COMPREHENSIVE COOPERATION AND BENEFITS AGREEMENT

VGC and the FNNND signed a comprehensive Cooperation and Benefits Agreement (CBA) on October 17, 2011. The CBA 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.

The construction activities undertaken to date, and those contemplated to bring the Project into production, have resulted in the execution of over $90 million worth of contracts with Yukon based companies, of which over half have economic connection to the FNNND Development Corporation by either First Nation business or local business.

3 CLOSURE OBJECTIVES AND DESIGN CRITERIA

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

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

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

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

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

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

Value	Reclamation and Closure 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.

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.

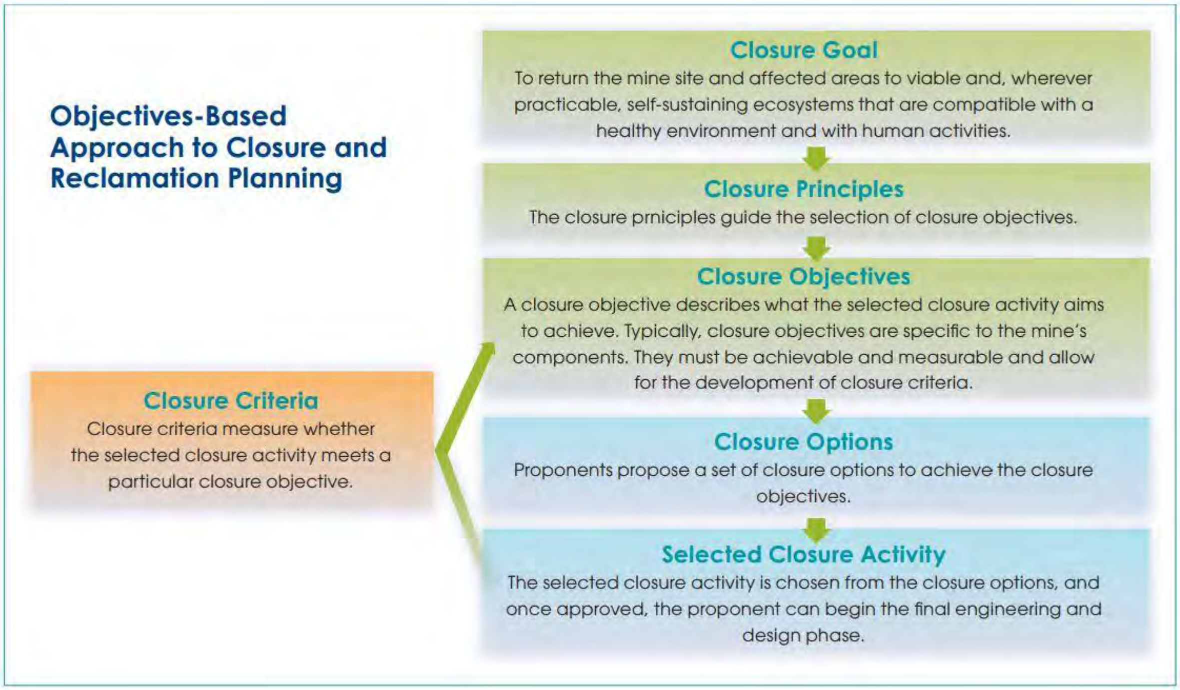


Figure 3-1: Objectives-based Approach to Closure and Reclamation Planning (from MVLWB/AANDC 2013)

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 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 (2013) 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 (Yukon Government 2013).

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 3-2 and 3-3.

Detailed site-specific objectives presented in Tables 3-2 and 3-3 are defined by factors that include environmental conditions, site conditions and community expectations. They were developed to address physical stability, chemical stability, health and safety, ecological conditions and sustainability, land use, aesthetics, socio-economic expectations, long-term certainty and financial considerations.

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

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 climactic 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 (Events Pond and Lower Dublin South) as needed, or construct a passive treatment system (Platinum Gulch) Maintain suitable gradients to permit flow and reduce infiltration and erosion. Design facilities to minimize contact of surface flow with mine influenced soils. 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 draindown 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.

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 Project 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 the level of the west side of the open pit. The open pit disturbance area will be approximately 67 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 2.5H:1V. 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. 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 a 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 3-3: 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 condition 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 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.

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 an aesthetic condition consistent with surrounding areas.	Closure activities will be performed in a manner consistent with the CBA, and where possible utilize local and Yukon businesses in the performance of the work.

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 1,300 m long and 550 m wide. The minimum elevation of the pit is 810 masl and there will be a maximum crest elevation of approximately 1,390 masl, giving the pit a depth of 475 m along the east highwall. Based on the surface topography, the open pit is scalloped-shaped with a lower west highwall. The west highwall crest elevation is approximately 915 masl. To maintain access to the primary crusher, a single ramp will spiral down to the 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 2.1 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 3-4.

Table 3-4: 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
Pseudo-static Factor of Safety – short and long term	1.1

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 (CDA 2014) guidelines. Table 3-5 summarizes the main technical and permitting requirements for the State of Nevada for the key elements of the HLF design.

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

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

3.2.3.1 Design Basis

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

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

Further, specific design guidance is included as follows:

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

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

BGC (2017b) performed a dam breach analysis to provide input into evaluating the HLF embankment hazard classification, per Canadian Dam Association (2013) guidelines. The results confirm that the confining embankment can be classified as a Significant dam (i.e., there is no permanent population or infrastructure at risk in the inundation path, and restoration of fish and wildlife habitat is highly possible). Nevertheless, the WUL for the Project imposes an Extreme dam classification (the most stringent possible) for hydrologic and storage criteria. Thus, the Extreme hydrologic and storage criteria have been used for the HLF design. The WUL does not include a requirement to impose more conservative geotechnical criteria beyond those specified in the CDA guidelines;

nevertheless, geotechnical criteria applied here assume a High hazard dam classification. The dam classifications used here also consider the input from the Application of Dam Safety Guidelines to Mining Dams (CDA 2014) and have been vetted during consideration and consultation between owner and regulators.

3.2.3.2 Design Criteria

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

3.2.4 Water Management Facilities

For the purpose of the Construction and Operations 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.

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 Construction and Operations Water Management Plan.

Design storm events are used as input parameters in most rainfall-runoff type storm water models (e.g., HEC-HMS, PCSWMM, TR-55). Design criteria for various design elements are listed in Table 3-6.

Table 3-6: Water Management Design Criteria

Infrastructure Element	Design Element	Design Basis Criteria
Unlined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Maximum Depth (mm): Type 1 or 2	300
	Minimum Width (mm): Type 2	500
	Minimum Grade (%): Type 1 or 2	1.00
	Maximum Grade (%): Type 1 or 2	1.70
	Maximum Side Slopes: Type 1 or 2	3H:1V
	Maximum Velocity (m/s): Type 1 or 2	1.5
Lined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Design Storm Event (above major infrastructure)	1 in 100-year
	Maximum Depth (mm)	500

Infrastructure Element	Design Element	Design Basis Criteria
	Minimum Grade (%): Type 3 / Type 4	1.00 / 0.50
	Maximum Grade (%): Type 3 / Type 4	4.5 / 15
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.33 / 4.0
Pipes	Design Storm Event	1 in 10-year, 24-hour
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances)	1 in 200-year, 24-hour
	Design Storm Event (downstream of the Lower Dublin South Pond)	1 in 1000-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0
Temporary Sediment Control Ponds and Exfiltration Areas	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 100-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (100-year event)	0.5
Permanent Sediment Control Ponds	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 200-year, 24-hour
	Design Storm Event (overflow spillway – dam)	1 in 1000-year, 24-hour
	Depth Requirements (m):	

Infrastructure Element	Design Element	Design Basis Criteria
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (200-year event)	0.5
	Dewatering (pumping capability)	Full Dewater in 24 hours

4 EXISTING ENVIRONMENT DESCRIPTION

Section 4 presents a summary of existing conditions for bio-physical components including climate, surface water, groundwater, vegetation and wildlife, soil and bedrock and seismicity. Environmental baseline data were collected between 2007 and 2017, and data collection as part of construction monitoring is ongoing.

4.1 CLIMATE

Climate information for the Project is available on the YWB Waterline website registry for QZ14-041 in the Environmental Baseline Report: Climate (Stantec 2010a), Environmental Baseline Report: Climate 2011 Update (Stantec 2012a), Climate Baseline Summary (KP 2013a) and Hydrometeorology Report (KP 2013c) as Exhibits 1.3.1, 1.3.2, 1.3.3 and 1.3.4 respectively and under the YWB Waterline website registry for QZ14-041-1 as Exhibit 1.19.1, 1.19.2 and 1.19.5 (Eagle Gold Climate Baseline Report (Lorax 2016a), Eagle Gold Climate Baseline Report (Lorax 2018a), and (Eagle Gold Hydrometeorology Report (Lorax 2017a)., respectively).

4.2 SURFACE WATER

4.2.1 Hydrology

Hydrology and streamflow conditions at the Project site are described in a number of hydrology related baseline reports. These include the Environmental Baseline Report: Hydrology (Stantec 2010b), Environmental Baseline Data Report: Hydrology 2011 Update (Stantec 2012b) and Hydrology Baseline Data Summary (KP 2013), which are available on the YWB Waterline website registry for QZ14-041 as Exhibits 1.4.1, 1.4.2 and 1.4.3 respectively and under the YWB Waterline website registry for QZ14-041-1 as Exhibit 1.19.3 and 1.19.4 (Eagle Gold Hydrology Baseline Report (Lorax 2016b) and Eagle Gold Hydrology Baseline Report - 2018 Update (Lorax 2018b)).

4.2.2 Water Quality

The Environmental Baseline Report: Water Quality and Aquatic Biota (Stantec 2012d) and Baseline Water Quality Report (Lorax 2013) are available on the YWB Waterline website registry for QZ14-041 as Exhibits 1.4.4 and 1.4.5 respectively and under the YWB Waterline website registry for QZ14-041-1 as Exhibit 1.19.6 (Baseline Water Quality Report 2016 Update (Lorax 2017b)). These reports characterize water quality in receiving environment watercourses that may be affected by the Project, including seasonal variability and identification of contaminants of concern and parameters with concentrations that are naturally elevated as well as parameters that may be appropriate indicators.

4.3 GROUNDWATER

Hydrogeologic baseline characterization studies were conducted from 2009 to 2012 and previous investigations were conducted in 1995 and 1996 (GeoViro 1996 and Knight Piésold 1996a, b, c). This information is available in the Environmental Baseline Report: Hydrogeology (Stantec 2011b), Environmental Baseline Data Report: Hydrogeology 2011-2012 Update (Stantec 2012c), Groundwater Data Report (BGC 2013b), Aquifer Test for Camp Water Supply (Stantec 2010c), Lower Dublin Gulch Valley Aquifer Tests (BGC 2012f), Open Pit Pumping Tests (BGC 2012g), Production Well Completion Report for PW-BGC12-04 (BGC 2013c) and Eagle Gold Project Numerical Hydrogeologic Model (BGC 2014) are available on the YWB Waterline website registry for QZ14-041 as Exhibits 1.4.6, 1.4.7, 1.4.8, 1.4.9, 1.4.10, 1.4.11, 1.4.12.1 to 1.4.12.5, and 1.4.13.1 to 1.4.13.5 respectively and under the YWB Waterline website registry for QZ14-041-1 as Exhibit 1.19.8 for the Eagle Gold Groundwater Quality Characterization Report (Core Geoscience Services 2017).

4.4 VEGETATION AND WILDLIFE

Vegetation and wildlife in the area of the Project are characterized in the Environmental Baseline Report: Vegetation (Stantec 2011c), presented as Exhibit 1.5.3 on the YWB Waterline website registry for QZ14-041, and the Environmental Baseline Report: Terrestrial Wildlife (Stantec 2011d) is presented as Exhibit 1.5.2 on the YWB Waterline website registry for QZ14-041.

4.5 GEOLOGY AND SOILS

An Environmental Baseline Report: Surficial Geology, Terrain and Soils (Stantec 2010e) is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.3.5. Extensive characterization of surficial and bedrock material for geotechnical and geochemical purposes has also been undertaken on the Project site. The Geochemical Characterization Report, Eagle Gold Project (SRK 2014), Geochemical Characterization of Proposed Excavation Areas and Borrow Sources from the Eagle Gold Project (SRK 2013), Site Facilities Geotechnical Investigation Factual Data Report (BGC 2009), 2010 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2011a), 2011 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012a), 2011 Geotechnical Investigation for Mine Site Infrastructure, Foundation Report (BGC 2012b), 2012 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012c), and Estimate of Ice-rich Material (BGC 2012h) are available on the YWB Waterline website registry for QZ14-041 as Exhibits 1.3.12, 1.3.13, 1.3.6, 1.3.7.1 to 1.3.7.6, 1.3.8.1 to 1.3.8.16, 1.3.9, 1.3.10.1 to 1.3.40.4, and 1.3.11 respectively.

4.6 SEISMICITY

A site-specific seismic hazard analysis (TetraTech, 2012) was performed for the Project. This information is available and is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.9.2.1.3.

5 PROJECT DESCRIPTION

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

Construction of the mine will occur over approximately two years pending issuance of required licences and permits.

Economic gold-bearing ore and uneconomic barren waste rock will be removed from the Eagle deposit by conventional drill, blast, shovel and truck mining technology. The footprint of the final open pit will have a surface area of approximately 67 ha and an ultimate pit size of approximately 1,300 m long and 550 m wide. Based on the surface topography, the open pit will be scalloped-shaped with a lower west highwall.

Uneconomic barren waste rock will be deposited in one of two waste rock storage areas (WRSAs) or utilized in the construction of various mine facilities. During the first several years of operations, waste rock will be delivered to both the Platinum Gulch (PG) WRSA and the Eagle Pup (EP) WRSA. For the remainder of the life of the Project, waste rock will be trucked to the EP WRSA. The PG WRSA will contain approximately 21.6 Mt with a footprint of 33 ha, and will be constructed in 45 m lift heights with an ultimate crest elevation of 1,298 masl; the overall height is estimated at approximately 345 m. The EP WRSA will contain approximately 93 Mt of waste rock over the LOM contained within a foot print of 83 ha. It will be constructed in 45 m lift heights with an ultimate crest elevation of approximately 1,250 masl, resulting in an overall height of approximately 315 m. The EP WRSA storage volume includes approximately 15 Mt of low grade material that will be kept segregated and accessible for future processing as feasible.

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

Crushed ore will be delivered and stacked on a lined solution collection pad. Process solution containing cyanide will be applied to the ore to extract gold and collected by the HLF pad leachate collection and recovery system. The HLF pad will consist of a composite liner system in the upper and lower reaches of the facility. The HLF embankment impounds the lower section of the HLF pad, and forms an In-Heap Pond (essentially a saturated zone within the lower extent of the HLF) for primary storage of pregnant solution. Because the In-Heap Pond is saturated ore, there will not be open or exposed surface areas of liquid sodium cyanide solution during normal operations. A lined pond external to the HLF will be constructed for the life of the Project to temporarily store excess process solution during rare upset events, and/or freshet events as needed, and normal precipitation that occurs on the pond. The solution contained in the pond will be recycled back into the heap leach circuit as required.

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

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

Other mine infrastructure will include a camp complex with administration and mine offices, a modular assay laboratory, a mine truck shop and truck scale, a substation, and a guardhouse. Support components will include fuel and explosive storage facilities, a transmission line and an access road into the mine site.

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

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 following sections identify the fundamental and site-specific closure and reclamation objectives that are relevant to mine components and values during a potential temporary closure of the 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 if mining operations have advanced to a depth to allow for it. This level will depend on the pit geometry at the time of temporary closure. After the pit has filled to this level, water will be conveyed via ditches/pipes to treatment throughout the temporary closure as necessary.

6.2.1.2 Waste Rock Storage Areas and Temporary Ore Stockpiles

Temporary closure objectives for the WRSAs include:

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

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

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

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. Periodic visual monitoring of the toes of WRSA's will enable one to search for and identify the emergence of new seeps. Following the identification of a new seep, additional activities (e.g., flow measurements and sample collection), as described in Sections 2.4.3.3 and 6.3.3 of the EMSAMP will also be conducted. Water treatment by the MWTP that is deemed necessary, will be implemented as required.

6.2.2.2 Heap Leach Facility

With regard to chemical stability, the HLF includes the leach pad and in-heap pond. Temporary Closure Objectives for the HLF are to achieve chemical stability such that runoff and seepage quality meet water quality criteria. While water balancing modeling indicates that there is a zero probability of discharge from the HLF during Phase 1, temporary closure of the HLF shall strive to avoid any discharges unless they are necessary to manage excess water volumes within the heap that may develop later in the mine life. Discharges must meet EQS.

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

Water management and leaching from the HLF are concerns during temporary closure. For the period required during any temporary closure, a senior operator will continue to operate HLF pumping, irrigation, solution collection and storage, reagent addition and gold recovery facilities, and maintain the HLF as a zero discharge facility. The site caretaker will assist with maintenance of the HLF pumping, irrigation, solution collection and storage facilities as required during temporary closure.

6.2.2.3 Mine Infrastructure

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

6.2.2.4 Water Management Facilities (Ponds, Pipes and Ditches)

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 the LDSP 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.

6.2.2.5 Mine Water Treatment

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

Cyanide detoxification capability will be available prior to start-up of the HLF operation so that it is readily available to treat excess cyanide contaminated water should the need arise and shall be maintained during temporary closure. The Mine Water Treatment Plant will be commissioned prior to loading ore on Phase 2 of the HLF and once installed, shall be maintained during temporary closure.

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 *Construction and Operations Water Management Plan* submitted in accordance with Clause 134 of QZ14-041 and available on the YWB Waterline website registry for QZ14-041-1 as Exhibit 1.20. Linkan (2014), available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.11.2, 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.

6.2.3.5 Ecological Conditions and Sustainability

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

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

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

6.2.3.6 Land Use

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

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

6.2.3.7 Aesthetics

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

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

6.2.3.8 Socio-economic Expectations

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

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

6.2.3.9 Site Management

Access control, security and site care and maintenance are key to meeting the critical temporary closure objectives of protecting human health and safety and the environment. The Care and Maintenance Program is the program where a reduced workforce will inspect and maintain property assets, restrict access to mine site locations, manage site chemical and explosive storage, continue to implement the site 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.

6.2.4 Financial Considerations

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

6.2.4.1 Entire Site

Financial considerations include:

- Transition to the Care and Maintenance Program which includes essential site repairs, if any, and winterization of seepage collection systems, mobile equipment, buildings and other site infrastructure. This will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to five years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite or readily available through contract services to maintain infrastructure and facilities.
- All hazardous materials will be secured at site including with primary and secondary containments as required to ensure compliance with applicable regulations.
- Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.
- Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite or readily available through contract services should earthworks be required during the temporary closure phase.

- 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 and gold recovery, 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 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 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	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

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
	Leaching and Process Recovery System	Maintain process water management including HLF pumping, HLF irrigation, solution collection and storage, reagent addition and gold recovery facilities	Water quality and systems monitoring	Monthly for the term of temporary closure
Water Management Facilities (Ponds, Pipes and Ditches)	Physical Stability	Excavating sedimentation in ditches and ponds; Snow and aufeis removal as necessary	Visual inspections	Following major rain events and freshet
	Chemical Stability	Maintain groundwater and surface water quality monitoring stations	Water quality and systems monitoring	Weekly to monthly
Mine Water Treatment Plant	Equipment Performance	Secure buildings and maintain equipment for solution recirculation and treatment	Water quality and systems monitoring	Daily
Infrastructure Buildings, 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
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
Cl-	250
SO_4	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH_3-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

Parameter[1]	*Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)*
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* and will ensure that information gathered will enable reporting in accordance with clause 169 of QZ41-014. These may include, but are not limited to the following:

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

Site inspections and monitoring will likely be conducted by vehicle when seasonally possible. Some areas of the site may be inaccessible in winter as snow removal will not be reasonable in some locations. Inspection results will be documented and submitted on a monthly basis as required by QZ14-041. 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 SGC, a notice will be provided to the YWB and EMR at least 60 days in advance of the temporary closure. The notice provided will include the reasons for entering a temporary closure and the anticipated duration. In accordance with QZ14-041, 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), SGC 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, cover placement will be started toward the end of the Platinum Gulch WRSA 3 year lifespan. Beginning in Year 4, and after the PG WRSA cover is completed, a field scale proto PTS will be constructed downstream from the WRSA based on on-going research results during the previous year(s). This PTS will inform part of the reclamation research plan to test treatment methods through seasonal changes, while serving as an on-site demonstration of the potential effectiveness of the design. Over the next few years, and depending on results, design enhancements can be implemented as necessary. See Section 8.10 for more discussion on the PG PTS.

When initiated, reclamation of the 32 ha footprint of Platinum Gulch WRSA will require the construction of an engineered cover. Cover material (Knight Piésold 2013b; O’Kane 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 8): Active mining and mine closure research as described in Section 10. Complete cover construction on the PG WRSA and develop the passive treatment system (PTS) at PG WRSA.

Phase 4 (~Year 9): 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 PTS for Eagle Pup WRSA seepage at the LDSP.

Phase 5 (~Years 10 to 11): 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; LDSP and PG PTSs in place; LDSP PTS discharge to Haggart Creek when discharge criteria are met; PG PTS discharge to Haggart Creek when discharge criteria are met; open pit finished filling; decommission ADR; begin building cover on specific sections of the HLF, if feasible.

Phase 6 (~Years 12 to 15): 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 another may be infiltration 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– 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 site roads.

Phase 7 (~Years 16 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 – when seepage rate meets meteoric input; close substation and most of the camp infrastructure. Begin post closure monitoring and maintenance.

Phase 8 (~Years TBD): Post-closure monitoring and maintenance – all 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.

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

8.4 MINE RECORDS

As noted in the previous section, all 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 maximum estimated areas of disturbance and approximate dimensions (Table 8-1) include:

- Open Pit: W: 550 m x L: 1,300 m, D: 475 m along east highwall, 67 ha.
- Heap Leach Facility: 106 ha (including the heap embankment). The HLF will have one Events Pond with approximately 299,900 m^3 of storage capacity; and
- Waste Rock Storage Areas
    - Platinum Gulch WRSA 21.6 Mt of waste rock with a final footprint of 33 ha.
    - Eagle Pup WRSA 78 Mt of waste rock with a final footprint of 83 ha.
- For both WRSAs, overall slope angle of 2.5H:1V with construction in 45 m 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 2-Year Peak Liability*
Open Pit	67	7.9
Heap Leach Facility		
Embankment	3.8	3.8
Phase 1	48.9	48.9
Phase 2	20.1	0
Phase 3	32.8	0
Events Pond	4.2	4.2
Industrial Infrastructure		
Crushing and Conveying Facilities	11.0	11.0
Truck Shop and Fuel Storage	6.0	6.0
Laydown and Camp Area	3.9	3.9
Process Facility and Water Treatment Plant	3.9	3.9
Explosives Facilities	2.9	2.9
Landfill and Land Treatment Facility, and Substation	3.2	3.2
Waste Rock and Overburden Storage Areas		
Eagle Pup Waste Rock Storage Area	83.0	5.2

Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of 2-Year Peak Liability*
Platinum Gulch Waste Rock Storage Area	32.0	12.3
Reclamation Stockpiles	9.5	5.8
Ice Rich Overburden Storage Area	5.6	3.2
Water Management Structures		
Lower Dublin South Pond	3.9	3.9
Off-Site Infrastructure		
Transmission Line Corridor	16.8	16.8
Miscellaneous Sites and Facilities		
On-Site Access and Haul Roads	51.8	51.8
Borrow Pits	17.2	17.2
Gate House	0.8	0.8
Temporary Ore Stockpile	7.8	7.8
Total Estimated Area of Disturbance	**436.1**	**220.5**

Based on the earthworks materials take-off estimates, a total of approximately 270,000 m^3 of excess cut during construction will be stored in the various designated reclamation stockpiles.
** The end of 2-year peak liability represents the end of Y1 of the mining phase of the Project.*

The Project will involve the movement of large quantities of earth and rock fill in a relatively short construction period and within the assessed footprint. Infrastructure pads will generally be constructed as cut and fill operations when the material requirements can be met.

It is anticipated that there will be an excess of approximately 270,000 m^3 of cut material during the first phase of construction, as shown below. The excess cut material includes approximately 200,000 m^3 of topsoil with colluvium and weathered bedrock forming the remaining portion of cut material. This excess material will be stored in the reclamation stockpiles for use during the closure phase of the Project.

Based on the requirements for closure covers on the WRSAs and the HLF and topsoil replacement on other disturbed areas, approximately 1.2 Mm^3 of cover material will be required for the closure phase of the Project of which approximately 570,000 m^3 is topsoil. It is anticipated that the deficit in topsoil material required for closure (~200,000 m^3) will be sourced from topsoil stripped during the development of the WRSAs. The remaining material required for the closure covers on the HLF and WRSA will be sourced from the approximately 2 Mm^3 of exploitable placer tailings located in the Dublin Gulch and Haggart Creek valleys (BGC 2012b).

8.6 CLOSURE WATER MANAGEMENT PLAN

8.6.1 Closure Objectives

8.6.1.1 Water Quality Objectives

As with the operational strategy for managing water, mine site water quality will be managed to keep, where possible, unaffected water from contacting mine waste, by the use of covers and diversion ditches. 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, 2018). Other contact water will be conveyed off the mine site into the Lower Dublin South Pond, which will be in place until reclamation objectives (e.g., during construction of covers) are achieved, runoff can be discharged directly to receiving waters and the LDSP is converted into a PTS. Thus the performance of the covers, sediment control structures, the PTSs, and the water conveyance features all work together to achieve the water quality objectives.

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

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

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

8.6.1.2 Water Conveyance Objectives

The objectives for the design of the water conveyance features are to convey affected seepage to the PTS sites without coming into contact 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, the effectiveness of a buried pipe and/or open channel ditch will be evaluated during operations to identify what will be used during the closure period 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 PTS pond, constructed subsequent to closure of PG WRSA; pit overflow water (when the pit is filled) will be conveyed to the PG PTS (unless monitoring data indicate it can be discharged directly to Haggart Creek); the PG PTS will then discharge to Haggart Creek.

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

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

Discharge from the PTS systems will be conveyed in open channels to discharge locations in Haggart Creek.

8.6.1.3 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 (EP) will be converted into a PTS, specifically a CWTS. The closure sump will be activated to drain in a controlled manner to the EP CWTS. While the EP CWTS is coming up to full performance prior to meeting water quality discharge criteria, a pump will be activated to send the CWTS flow to the MWTP. When the EP CWTS is meeting discharge criteria consistently for a year, it will be allowed to flow into a channel, and join with the runoff from the heap cover and undisturbed areas, and ultimately into Haggart Creek.

During operations, seepage will be conveyed to the LDSP and ultimately to the MWTP. During early closure Eagle Pup WRSA seepage will be conveyed 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 Haggart Creek.

The MWTP will be operational as long as the heap drain-down and the Open Pit and WRSA seepages require treatment, and while the CWTSs are becoming active. Following at least five consecutive years in permanent closure where the MWTP was not required to treat effluent discharged from the site, SGC will submit to the Board for Review and Approval a plan for the decommissioning of the MWTP, and implement the plan upon approval– see Section 8.9.

8.6.1.4 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 infrastructure for operations is presented in the *Construction and 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.

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

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

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

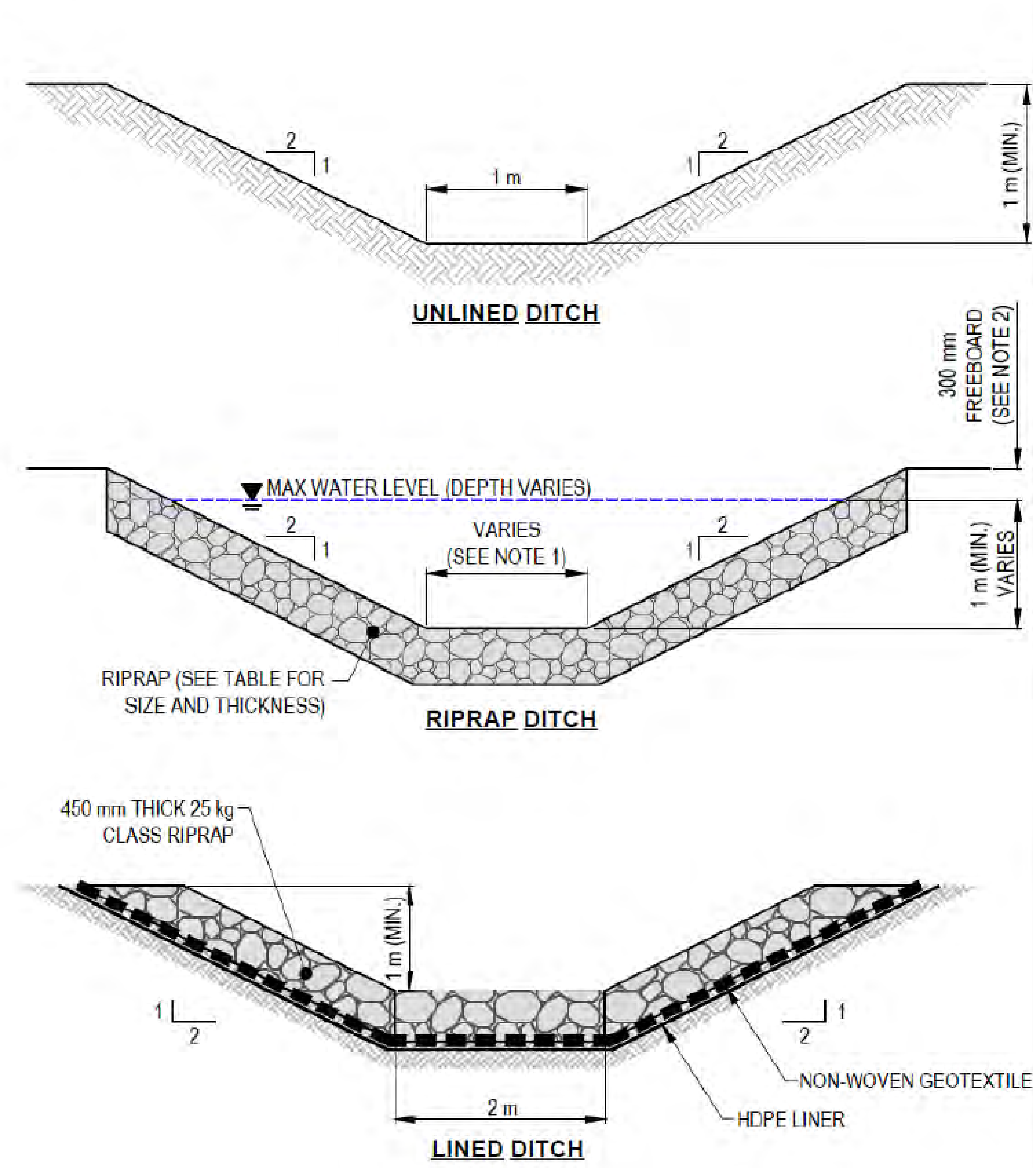


Figure 8-1: Typical Diversion and Collection Ditch Types

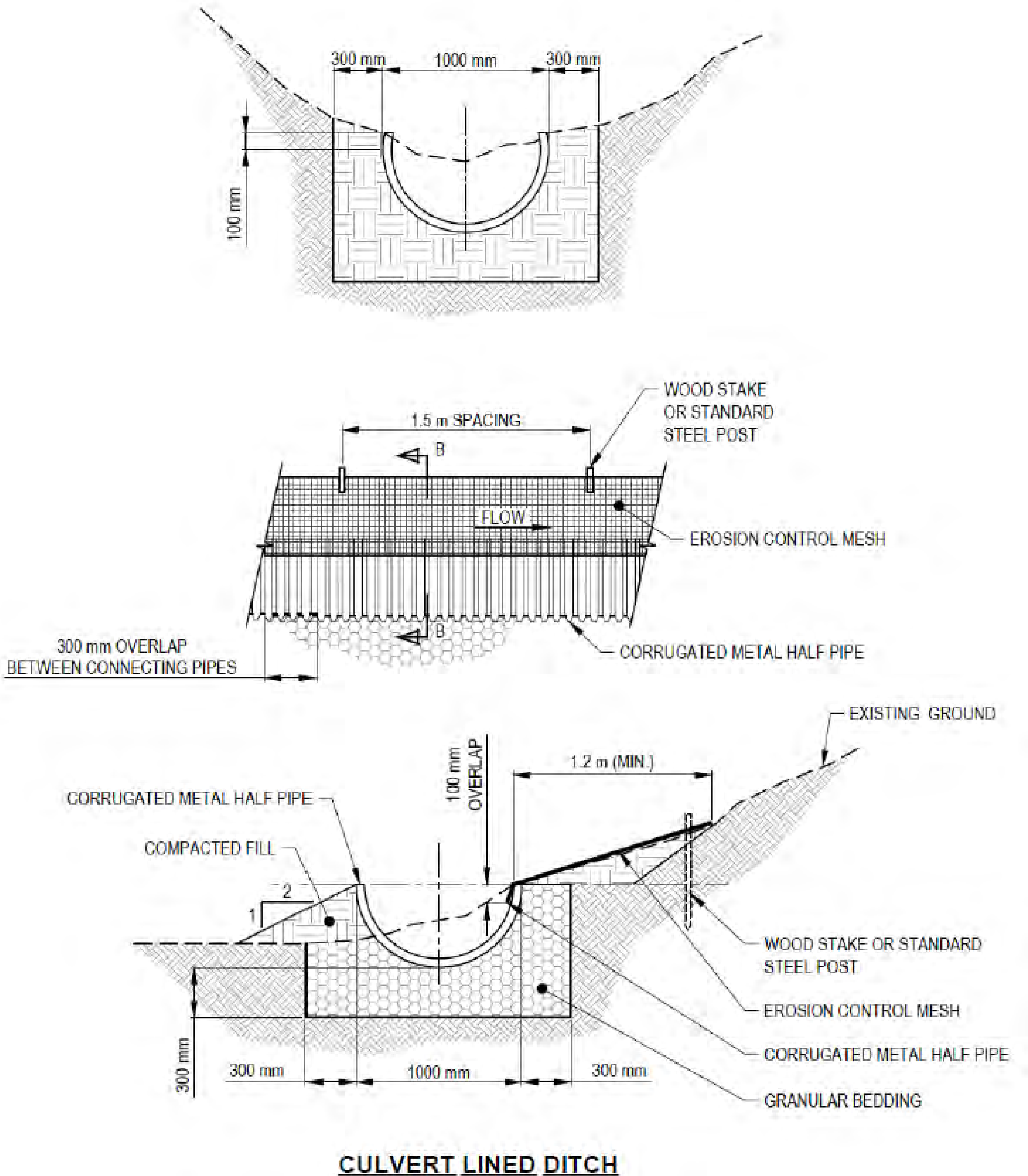


Figure 8-2: Typical Culvert Lined Ditch

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

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 riprap and lined ditches, with the following characteristics, shown in Table 8-4.

Table 8-4: Typical Diversion Ditch Design Criteria

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

b. Collection channels

A collection channel intercepts sediment-laden water runoff from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Collection channels will be used within 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 riprap ditches, with the following characteristics, shown in Table 8-5.

Table 8-5: Collection Channels Design Criteria for Operations

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

c. Culverts

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 8-6 shows culvert design criteria.

Table 8-6: Typical Culvert Design Criteria

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

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

It is expected that new ditches will be required, and operations ditches may need to be upgraded 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. Further, any half pipe culverts installed during construction or operations will be replaced using natural rip-rap and likely involve some slope re-grading (depending on site-specific conditions) to meet physical stability objectives.

Most of the new ditches that will be built at closure will require cross-sections similar to the riprap and lined cross sections that were designed for operations. Some diversion ditches 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 expanded due to changes in flow management during closure, riprap cross-sections are proposed for slopes between 2 and 5% and lined cross-sections are proposed for slopes between 5 and 15%. For ditches that require expansion or upgrading to accommodate the expanded flow requirements, 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.

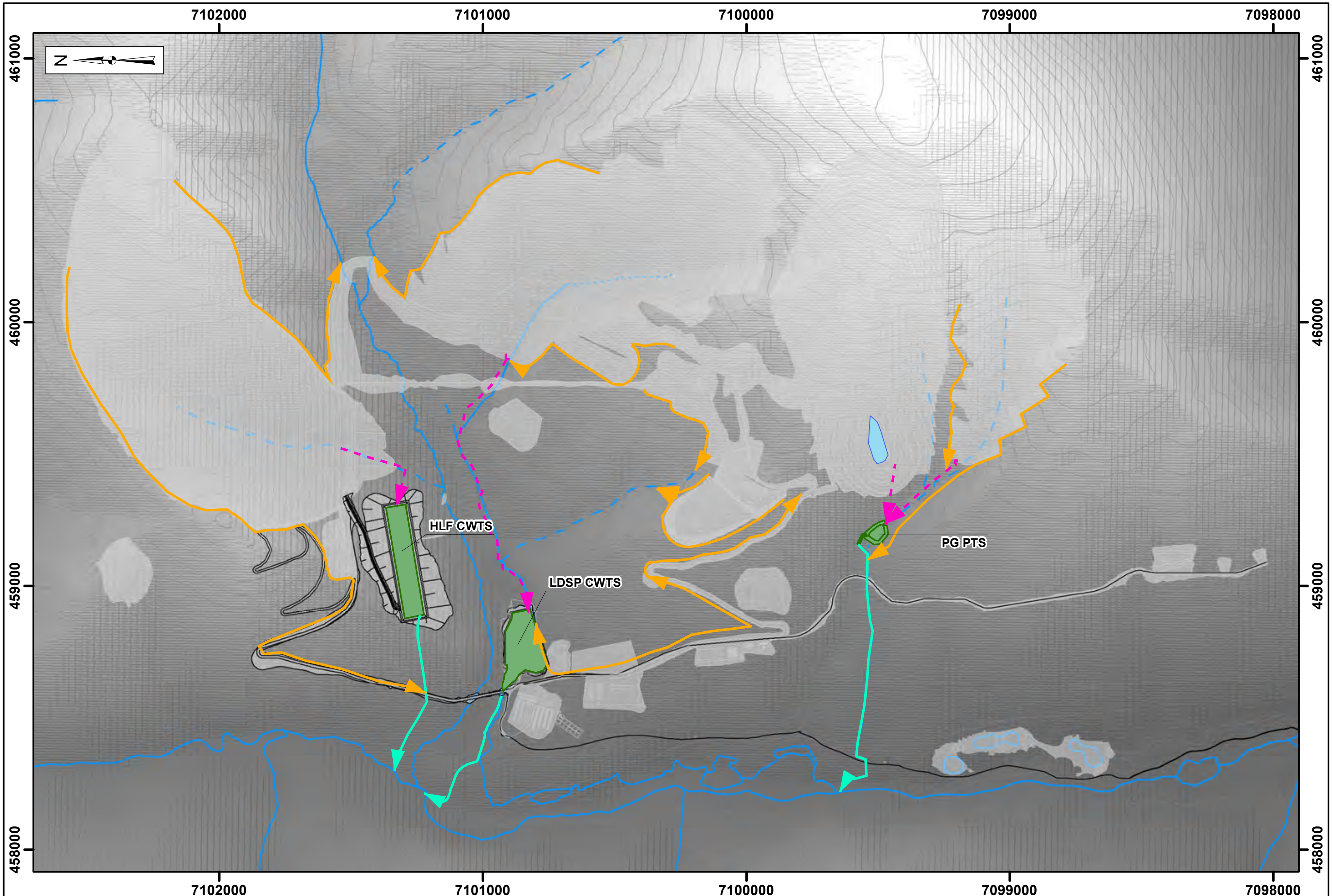
For closure, existing diversion ditches and collection channels will be consolidated and rip rap will be added to ensure integrity of the channel, if required. Riprap with a D_{50} = 150 mm is generally selected but larger rip rap may be required in steeper reaches.

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

A subsurface pipe will convey water the entire way from the HLF sump to the HLF PTS; this will be built during construction and the design and layout are provided in Appendix D. Seepage from the WRSA's will be allowed to drain in the natural creek beds to the PTS's; however, based on experience at Minto Mine, seepage collection from the base of the WRSAs may be enhanced by using rockfill sumps to protect from freezing and the development of aufeis. The lessons learned at Minto and other northern sites will be integrated when developing final designs for seepage collection and conveyance.

The actual depth of burial for closure will be based on empirical information acquired through many years of operating at the site. A minimum slope of at least 5% will be set to ensure adequate flow velocities.

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.



Legend:

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

StrataGold Corporation

0 130 260 520
Metres

Projection: NAD 83 UTM Zone 8N

Drawn By: JK

Date: 2018/08/13

Figure: 8-3

EAGLE GOLD PROJECT
YUKON TERRITORY

Closure Water Management Network

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, and to ensure long-term chemical stability such that discharge meets water quality criteria as specified in QZ14-041.

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 though engineered structures to into the Platinum Gulch conveyance channel.

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

- Years 1 to 9 pit inflows pumped to PG Pond and ultimately to LDSP
- Years 9 to 17 open pit is filling and no discharge occurs

After Year 17 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 8-7 provides the water quality criteria for discharge as specified in QZ14-041.

Table 8-7: Heap Leach Facility Effluent Quality Standards

Parameter[1]	*Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)*
pH	6.5 to 8
TSS	15
Cl-	250
SO_4	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH_3-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 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 with fresh water or with water with a residual cyanide concentration; the objective being to flush out areas with higher concentrations. During this time there may 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 biochemical treatment processes 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, available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.11.6). The heap treatment column test was able to achieve reduction of 16 mg/L WAD cyanide to less than the detection limit (0.025 mg/L) with a sustained application of a mixture of sugars and trace phosphate. 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 m^3 of sugar solution.

Depending on the thickness of the areas on the heap, the particular area where the barren solutions amended with reagents will be added will have solution added by drip emitter onto a specific area of the heap for a period of approximately 60 days. This period of time will allow for the sugars/nutrient mixture to react with cyanide in pore waters in that area and biochemically degrade the cyanide species. Each zone in the heap will have solutions applied to that area such that the sugars/nutrients mixture to break through to the base of the heap. Over the subsequent 'rest period' where solutions are not being applied, the residual pore waters will continue to be biologically treated by the native microbes growing in the heap pores and on the surfaces of the heap materials supported by the sugars and nutrients delivered in the initial solution application period. The solution delivery will be accomplished in phases across the heap, similar to the leaching process, with approximately 12 areas successively treated, for a total period of treatment in the heap of approximately two years. During this time period the flow rates and the areas under solution application will be managed to deliver the solutions at the appropriate strength to the area under solution application until breakthrough of reactive sugars is achieved throughout the leach column, then the area under solution application will be moved to a new area, until the entire heap has received solutions that are amended with the appropriate amount of sugars/nutrients. During this two year period, the costs of treatment includes recirculating solutions (e.g., pumping, moving drip emitters), and the cost of the sugars/nutrient solutions. 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 (2018), 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 (2018). Denitrification is the process where microbes oxidize organic carbon as an electron donor (alcohol is a preferred organic carbon substrate to support denitrification) and reduce nitrate and nitrite to nitrogen gas N_2, which is the gas that comprises approximately 79% of the earth's atmosphere.

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

Microbes that perform denitrification are found nearly universally (ubiquitous) in soils and rocks. The Tetra Tech (2014) cyanide destruction column studies report on 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 to the MWTP at a controlled rate (e.g., 10 L/s) consistent with the capacity of the MWTP to treat and discharge the water).
- Discharge of some water to a contingency passive treatment system/CWTS to be built in the Events Pond location.
- When either
    - The heap is sufficiently drained and is discharging below QZ14-041 discharge criteria, or
    - The passive treatment system is treating all of the remaining flow at the design capacity and achieving discharge criteria
    - 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 and ultimately achieve water quality consistent with that observed in alcohol fed bioreactors. In these conditions, reduction in metal concentrations is also commonly observed as result of the reducing conditions established during microbial metabolic processes, because many metals are less soluble in a reduced state (chromium, copper, selenium, uranium, for instance). Other metals that preferentially sorb to iron or manganese oxides in a more neutral pH range created during the detoxification process will generally decrease, including trace metals such as arsenic and antimony. Metals that form insoluble sulfides will also become substantially treated. 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; 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 Ci (initial concentration), Cf (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 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 (operating at +20°C), despite other water parameters being the same. The size of CWTS required under both scenarios is presented in Table 8-8 and 8-9.

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

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 EQSs without added iron. As a comparison, predicted outflow concentrations have been provided for both scenarios assuming with and without added iron, as there may be some benefit (smaller system, more efficient removal rates) to using iron.

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

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 under pressure 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. In addition to denitrification processes, the bioreactor in the In-Heap Pond is expected to substantially reduce metals concentrations during the draindown period when the In-Heap Pond is still active, and before the cover system is fully operational. The in-heap bioreactor may result in effluent sufficiently treated to allow for direct discharge. Nevertheless, in the case that metal concentrations are still above criteria, the HLF PTS will be designed accordingly to meet effluent quality standards.
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 enter a retention basin that will provide a mixing point for the water moving through parallel replicate systems in the CWTS and serve as a monitoring point for water prior to discharge into 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.

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, to the greatest extent possible.

Table 8-8: Sizing of HLF CWTS Based on Area Available

Parameter	Size based on Events Pond area
CWTS Hectares	3.57 (85% of the Events Pond size)
Wetland Volume (m^3)	10,710
Depth (m)	0.3

Note: The available size of the optimized Events Pond is 4.2 ha. The estimated size of the Events Pond once reconfigured to a CWTS is estimated to be 3.57 ha (85% of the size).

Table 8-9: Predicted HLF CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
3.57 ha	0.5	<EQS	0.53 ha

8.8.2.6 Earthworks / Recontouring

Heap Leach material will be graded as necessary for closure conditions during operations 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 estimating the mean and range of net percolation rates for the Base Case cover system for input to environmental loading and water treatment assessments, and to assess the:

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

In total, 43 long-term simulations were completed to determine the sensitivity of the Base Case due to variations in materials, climate, and/or vegetation. The simulations were also completed to 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 8-4. 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.

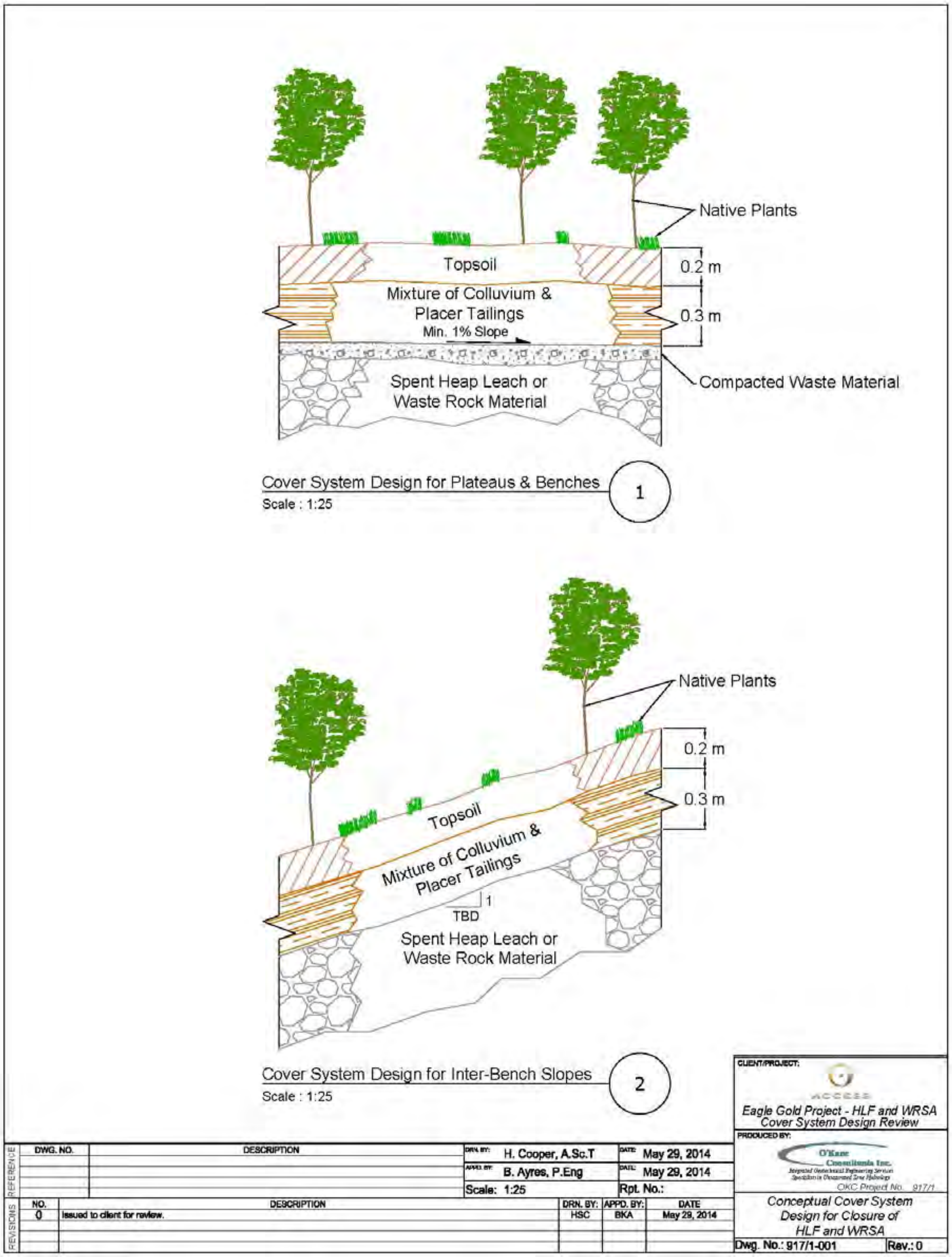


Figure 8-4: Conceptual HLF and WRSA Cover Design Drawings

8.8.2.7.1 HLF Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the HLF. Results from reclamation research trials currently underway 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

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 EP WRSA PTS has been conceptualized as a four-step treatment train.

1. A rip-rap lined channel will be used to convey water from the EP WRSA 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.
2. 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.
3. 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.
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.

LDSP PTS sizing is provided in Tables 8-10 and 8-11, below.

Table 8-10: Sizing of LDSP CWTS Based on Available Area

Parameter	Size Based on LDSP Area
CWTS Hectares	2.3 (85% if the LDSP size)
Wetland Volume (m^3)	6,885
Depth (m)	0.3

Table 8-11: Predicted LDSP CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
2.30 ha	0.1393	<EQS	1.01

Preliminary modelling shows that with the addition of an iron source the wetland size can be reduced by a factor of 6 while also increasing treatment efficacy. This option will be further investigated during additional modellings and during field scale trials.

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 follows.

1. PG WRSA seepage will flow through a rip-rap lined channel to convey water from the purposed built 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.
2. The CWTS will be designed to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
3. 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.

PG PTS sizing is provided in Tables 8-12 and 8-13, below.

During operations, the PG WRSA seepage will be routed to the LDSP for use as make up water. Commencing at the end of Year 3, after final loading of waste rock onto the PG WRSA, the PG WRSA cover will be completed and a field scale proto PTS will be constructed based on on-going research results during the previous year(s). The objective of this PTS is that it will be functional during operations for treatment of the PG seepage and inform part of the reclamation research plan to test treatment methods through seasonal changes, while serving as an on-site demonstration of the effectiveness of the design. Over the next few years, and depending on results, design enhancements can be implemented as necessary. PTS outflow will continue to be routed to the operational LDSP until it can be demonstrated that the system meets discharge criteria. During the initial closure phases, this discharge may be routed to the pit, or may be discharged to Haggart Creek after treatment in the PG PTS. 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.

The timetable described above is tentative, but it serves to describe the general approach. During years 2 and 3 of operations, progressive reclamation (initial cover placement) and research (vegetation trials) will be performed on the PG WRSA. Also, seepage water quality and flow rates collected as part of the EMSAMP will be used to inform lab and pilot studies of the PTS. The final profile and cover of the PG WRSA will be completed in year 4 of operations. It is expected that this additional year or so of seepage monitoring will be needed to finalize a PTS design, which will subsequently be completed downgradient from the PG WRSA by Year 5.

Table 8-12: Sizing of PG CWTS Based on Available Area

Parameter	Size Based on proposed purpose-built PG PTS Area
Hectares	0.66
Wetland Volume (m^3)	1,980
Depth (m)	0.3

Table 8-13: Predicted PG CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg /L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
0.66 ha	<EQS	<EQS	Influent below EQS

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 E) found very little difference in the performance of the Base Case cover design whether it was covering heap or waste rock materials.

8.10.2.4 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from 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 8-14: ADR Facility Infrastructure Demolition Summary

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

8.12.2.2 Mine Water Treatment Plant

The mine water treatment plant 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 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 8-15: 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 8-16: Crushing and Conveyance Infrastructure Demolition Summary

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

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

8.12.2.4 Power Generation and Transmission Infrastructure

A 45 km long power supply line at 69 kV 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.

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

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

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

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 8-18: Truck Shop Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Truck shop and mine dry	Pre-engineered steel building	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 8-19: Fuel Storage Tank Area Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Diesel storage	n/a	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, 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 Sediment and Erosion Control Structures

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

8.13.2.2 Lower Dublin South Pond

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 Haggart Creek.

8.13.2.3 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 was salvaged and stockpiled locally in windrows adjacent to the disturbance site in designated soil stockpile areas to the greatest extent possible. Species inventory has been conducted and will be used 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. Savaged soil that has been stored in designated stockpiles will be hauled by dump trucks and placed at the disturbance sties to be spread by dozer.

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

8.16 EXPLORATION SITES AND TRAILS

The majority of the exploration sites and trails will be removed or encompassed within the planned works. However, any exploration sites and trails required for ongoing exploration activities will remain available for future use. Yukon Government currently holds a bond from 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 (colluvium, placer tailings, topsoil) are anticipated to be used as cover soil or construction materials during closure.

9 PERFORMANCE UNCERTAINTY AND RISK MANAGEMENT

Closure and reclamation plans comprise a series of designs with drawings and specifications that define what will be constructed and coupled with an operating plan that describes how the constructed facilities will operate.

The purpose and intent of the FMEA is to:

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

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

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

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

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

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

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

10 RECLAMATION AND CLOSURE RESEARCH PROGRAMS

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. While the vegetation trials conducted at the Peso mine site have been conducted on waste rock with somewhat different chemistry than that found at the Eagle Site (i.e. Eagle Gold Project soils are less mineralized with neutral to slightly alkaline attributes), there is still much to be gained from the findings, in that the Peso site is only several kilometers away, at a similar elevation and physiography, with the same candidate species and experiencing the same climate conditions. The on-going study will help guide the planned revegetation trials at Eagle when waste rock material becomes available.

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

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

Botanical Name	Common Name
Festuca ovina	Sheep Fescue
Deschampsia caespitosa	Tufted Hairgrass
Poa alpine	Alpine bluegrass
Trisetum spicatum	Spike Trisetum

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

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

Dolomite was added to the waste rock dump plots only.

Monitoring of the plots is ongoing and reporting through to the end of 2017 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.

In August 2018, soil and vegetation samples from the revegetation trial areas were collected for laboratory analysis. The results from this sampling effort is intended to determine the ability for the soil amendments to add nutrients to the soil and the metal uptake rates for vegetation. Results from this program will be provided in annual regulatory reporting in 2019.

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 and is detailed in Section 8.8. An 80-year climate database comprised of daily records using local and regional meteorological data was used to estimate hydrological performance of the base-case cover system

[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.

design as well as variations to the base-case design. Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

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

The overall objective of the research program for closure cover designs is to build confidence in the initial long-term cover system design performance analyses in terms of 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 F.

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

The objective of the updated conceptual model of closure cover performance will be to incorporate monitoring and site investigation data to refine the previous conceptual model of cover system performance. Monitoring and site investigation data will include:

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

The conceptual model has helped to direct the research program and identify key research targets. Continued studies will reduce uncertainty in model assumptions, be used to update the conceptual model and ultimately support cover system field trials (task 5). The conceptual model will be periodically reviewed during updates to the RCP and updated if warranted. Ultimately, the model will improve confidence in cover system performance and provide +a basis for design.

The current model of performance relies strongly on the ET mechanisms of the cover system due to the site-specific climate and material factors. During periods of low evaporative potential such as spring, when water surpluses (freshet) are expected, runoff becomes the dominant control mechanism. To manage NP, cover design components can incorporate components that enhance runoff. The 2014 modelling conducted by O'Kane

Consultants noted that runoff was strongly influenced by slope and cover system grade, and by the presence or absence of frozen ground. The update to the conceptual model will research ways to improve the runoff shedding performance of the cover system to manage NP during freshet. For example, increasing the grade of the benches or utilizing a cover structure that allows for better transmission of interflow of the upper unfrozen zone in the spring to improve runoff conveyance could improve performance. Given that most NP occurs in the short freshet, small improvements in runoff performance during this time of year could lead to significant overall gains in reducing annual NP even if they reduce NP performance to some degree in the following summer period.

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

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

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

The material characterization program conducted during operations on material stockpiled for use during closure will allow refinement of material property inputs to the updated conceptual model of closure cover performance described above. The objectives of the material characterization program are to:

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

To achieve the overall objective of the material characterization program a sampling program is proposed, as follows.

10.2.2.1 Material Availability and volume

Sampling and borrow source availability program is proposed. The sampling program will be conducted during a test pit program to evaluate borrow source availability by collecting samples and log profiles of locally available viable sources of topsoil, colluvium, and placer tailings. Sample locations will be identified based on previous material investigations and site reconnaissance. The test pits or excavations would be logged for material layer depths, color, initial texture analysis, water table depth, and rooting depth (as compared to Vegetation Rooting Study results). 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.

10.2.2.2 Hydraulic Properties

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.

This component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (k_{sat}) of local topsoil material showed to have the largest influence on predicted net percolation rates in the 2014 numerical assessment. A large database of PSDs completed by BGC from a variety of borehole and test pit locations were provided to 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.

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. Soil Fertility

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.

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

The results of material characterization fertility test work will aid in determining fertilizer requirements for revegetation of the cover systems and may show that a particular borrow source is chemically preferable to support growth of native plants.

10.2.2.3 Erosion Characteristics

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

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

10.2.3 Task 3 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.

The sensitivity results of the 2014 numerical modelling report demonstrated that increasing WRSA waste material k_{sat} by 2-orders of magnitude only resulted in a 4% increase in NP, from 34% to 38%. Likewise, increasing HLF waste material k_{sat} by 2-orders of magnitude only resulted in a 2% increase in NP, from 36% to 38%. For both waste types, the model showed limited sensitivity to the hydraulic conductivity properties of ore and waste material. Regardless, characterization of HLF and WRSA wastes will be used to further refine the material assumptions used in the closure cover performance model. Moreover, by increasing the sample size for the various materials, modelers can develop material property envelopes that accurately assess the effect of material variability on predicted results under a larger range of material heterogeneity.

The 2013 Eagle Gold Project Report of Metallurgical Test Work prepared by KCA reported the results from 5 compacted permeability tests on column tailings. Forte Dynamics also reviewed this work and summarized the results in *Hydraulic Conductivity Testing Review* (2018a). Compacted hydraulic conductivity testing (representing 70m of ore height loading) was performed on P80 7mm samples. Hydraulic conductivity results of this testing ranged from 0.0099 to 0.2607 cm/s, with an average of 0.1036 cm/s. While these results represent a deviation from the parameters used in the 2014 O'Kane assessment, given the limited sensitivity of the model to ore and waste hydraulic conductivity, refinements of this parameter will be made once results of compaction field trials are available.

10.2.4 Task 4: Enhanced Meteorological Monitoring on Various Slope Aspects

Given the relatively high latitude of the Project site, slope aspect and angle highly influence the amount of solar energy and resultant potential evapotranspiration (PET) applied to various areas of the site. For an exposed plateau or east- or west-facing slope, OKC (2014) 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, wind speed and incoming solar energy and wind speed. For northern sites, such as Project site, snow pack constitutes a significant portion of the water balance. Characterizing the dominant wind direction during winter is important for informing where snow will tend to accumulate, allowing final closure landforms to be constructed in a way to minimize snow accumulation.

Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. For the initial estimates of PET based on slope aspect, calculated values of extraterrestrial radiation (R_a), solar radiation, in addition to short and long wave radiation was employed according to the FAO's method (FAO, 1998). These calculations provide an estimate of major energy balance components when no direct measurements are available. As with most empirical formulas that are fitted across a range of parameters, there are instances where the calculation begins to lose accuracy. The initial calculation of extraterrestrial radiation is dependent on latitude. Although the calculated R_a values have been shown to be accurate over across all latitudes during non-frozen periods, for the winter months in latitudes greater than 55° (N or S), the equations for R_a have limited validity. Reference can be made to the Smithsonian Tables to assess possible deviations if a correction for a region is available.

It is for this reason that the proposed meteorological monitoring program will incorporate net radiometers, on the varying slope aspects to calibrate the assumptions in the radiation portion of the PET calculations. By gathering a full solar cycle (365 days) of net radiation data, the estimates for PET can be refined to reduce uncertainty in the estimates. Furthermore, the direct measurement of net radiation can be used for future updates to the closure cover performance model as the surface conditions of the cover systems evolve on the WRSA's and HLF. As different types of vegetation establish, the albedo and consequently the partitioning of shortwave to long wave radiation will differ, both having implication for PET.

Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system. 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 is being collected during this Task are found in the EMSAMP. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the EMSAMP to provide measurement of incoming solar energy for north, west, and south facing slopes.

Climate information is analyzed and summarized annually, for parameters including: precipitation, potential evaporation, snow water equivalent (SWE, from snow surveys), and solar radiation that can be compared to the closure cover performance model inputs. Review of climate data analysis by Lorax (2016) shows that precipitation parameters used in the 2014 closure cover performance model remain conservative, as they are based on the 80-year historic climate database and are higher than site-specific precipitation data collected on site. Estimates of PET used in the 2014 O'Kane analyses were nearly identical to PET estimates generated based on Lorax (2016) data analyses.

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in the EMSAMP. The snow course surveys will continue to be conducted at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in the EMSAMP. The surveys will be conducted on a monthly basis during the late winter season. The surveys will aim to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report as net percolation.

O'Kane's estimate of snow water equivalent (135 mm) does not differ significantly from the Lorax (2016) Camp station results, however, it does not include the variability the site experiences in SWE. SWE estimates will refined in the closure cover performance model subsequent to the expansion of snow course surveys to include the HLF.

10.2.5 Task 5: Closure Cover System Field Trials for Performance Monitoring

The objective of the closure cover system field trials is to increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. Cover system field trials track the evolution of the cover systems in response to site-specific processes (physical, chemical, and biological) to enhance understanding of key characteristics and processes that control cover system performance. Cover system field trials also provide the opportunity to assess and compare the performance of multiple cover system design alternatives. Cover system performance will be assessed based on net percolation of meteoric waters to the underlying waste material, the runoff of water and the vegetation rooting characteristics.

The results from the updated cover system performance model will inform the optimum cover system design to be trialed at the site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012):

- Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
- Obtain performance monitoring data for calibration of the VADOSE/W model;
- Develop an understanding of key characteristics and processes that control cover system performance; and
- Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. Cover trials need to be large enough to properly evaluate construction methodologies and equipment that would be used for full-scale construction and performance monitoring. The PG WRSA that will be filled within the first three years of operation, for example, will provide a suitable area for cover system field trials.

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.

Cover system field trials can be used to further investigate variables, and calibrate the closure cover performance model in terms of:

- Cover system layer thickness;
- Cover system textural differences;
- Vegetation and soil amendments;
- Slope grade, length, aspect, and bench configurations; and
- Surface water management structures adhering to geomorphic principals.

The cover system field trials will be constructed with the same, geotechnically stable, landform cover system integration as intended to be used on the full operation scale facilities. Field trials represent an opportunity to examine landform geomorphic evolution (e.g., the potential for settlement, minor slumping and erosion) and use the information to highlight areas of the design to be refined or bolstered prior to implementation on full scale production facilities.

Runoff processes and snowmelt-runoff interactions can be confirmed in the field by using soil matric potential, temperature and water content sensors staggered strategically throughout the cover system profile. In field permeability testing and UAV erosion surveys will also be conducted annually. Runoff collection and monitoring systems can be employed to directly measure the effects of different cover system configurations on runoff. Runoff and erosion monitoring will seek to identify how permeability of the cover trial growth medium will change with time, and how this might influence on runoff and erosion. By better characterizing the in-field conditions of the cover systems water and energy balance, the cover design can be refined to further improve management of snow melt and runoff.

The cover system field trial would be revegetated using techniques and species outlined by KP (2012a and 2012b) and as informed by the Vegetation Rooting Study. Field trials provide an opportunity to investigate vegetation prescriptions and techniques by monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. Information gathered during field trials will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

10.2.6 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 materials and then cover the area with the water treatment solids the same as all other covered areas. Thus, the proposed research is focused on the effect of mixing the high pH solids on the heap as a cover basal layer, and not on the cover layer performance.

During the materials characterization program for cover described in Section 10.2.2, materials testing of heap materials with and without compaction will be performed. When high pH solids are first available, a second set of tests paralleling those described in Section 10.2.2 will be performed: Compaction field trials will be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years.

The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces. This set of tests will be duplicated to include areas mixed with high pH solids. The geotechnical testing that is proposed includes specific gravity, Atterberg limits, gradation (sieve and hydrometer), and consolidation testing (oedometer). The consolidation testing would be used to determine void ratio before and after mixing in the water treatment solids, and would include tests on sludge, heap materials, and a mixture of the two. The sludge and the heap materials would also be characterized to compare their geochemical properties. Geochemical testing on both the spent ore, sludge, and mixed spent ore / sludge will include: paste pH (1:2); rinse pH (1:2); 1 M KCl and 4 M HCl extractions; Total S, Sulfide S, ANC, NAG pH, NAG Acidity to pH 4.5 and 7.0, SPLP testing at pH 3 and pH 7, and whole rock analysis.

Because the volume of high pH solids is estimated to be low (calculated to be 238 m^3/year during phase 6 only), only small portions of the heap will actually receive solids prior to the cover placement. While the solids management plan does state: "Uniformly spread over the entire heap, the caustic sludge generated over Phase 6 would represent a 3 mm thick layer under the HLF cap", this illustrates only that it is a small volume compared to the volume of the heap materials. However, the high pH solids will not be spread uniformly over the surface of the entire heap. For instance, assuming a 10% mixing rate (high pH solids to heap solids), a 70m x 70m by 0.5 m deep zone would accommodate one year of high pH solids production. Thus, the sludge would not be spread over the entire HLF but still spread thin enough so that it could be ripped deep enough into the HLF pad surface so that the rock will maintain grain to grain contact (i.e., sludge just filling part of the void space within the rock), and so that it would have a negligible effect on the geotechnical performance of upper layer of the HLF pad. Based on experience at other sites and from conversations with contractors, conventional equipment (dozer/grader for spreading and ripper/disk) will be used to provide sufficient mixing action. The proposed geotechnical testing will confirm that the performance of this layer has not materially changed.

The plan will include a strategy for implementing the mixing test with sampling under the supervision of a geotechnical engineer such that the mixture achieves the objectives of maintaining grain to grain contact and the sludge fills only part of the void space within the heap leach materials. Close field supervision of the mixing program will help determine optimal field mixing ratios so excessive iterations of the blending operation can be avoided.

The research program will be used to demonstrate the suitability of the mine water treatment solids for use as heap cover material. Information gathered can be analyzed in the site-wide water quality and water balance models for closure to develop a refined picture of water quality management scenarios into closure.

10.3 VEGETATION ROOTING STUDY

The overall objective of Clause 178E: Rooting Study (Appendix B) is to gather information on plant rooting depths and develop optimal requirements for cover thicknesses to encourage maximum evapotranspiration from covers. The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Project site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

A two-phased approach is proposed for the vegetation rooting study. The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite
- **Task 3**: Vegetate constructed cover system trial area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.

- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Additional details on of the Rooting Depth Study tasks are provided in Appendix B.

10.4 PASSIVE WATER TREATMENT

Passive water treatment systems are proposed to treat mine waters upon closure. While the predicted water chemistries and site layout are conducive to passive water treatment, it is recognized that additional research will be required to optimize and confirm each PTS design and size. Despite being best available estimates for the sizing of the CWTS component of the PTS for closure, these 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 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
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	+		

Aspects and Parameters Related to Different Constructed Wetland Scales	Pilot (CSL facilities)	Demo (on site)	Full
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

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 hydrosoils and wetland plants will be identified. Plants may be collected from site for use in Phase 2, if appropriate.

- Intrinsic Factors
  - Concentration and identity of constituents that will require a decrease in concentration
  - Flow rates
  - Fluctuations in concentrations and flow rates
  - Cation/anion balance
  - Conductivity
  - Alkalinity

  - Hardness
  - pH
  - Concentration of Sulfate
  - Concentration of Iron and Manganese
  - Nutrient availability (N,P,K and micronutrients such as Cu, Se)
- Extrinsic Factors
  - Receiving system limits (water quality objectives, mixing zones)
  - Soils
  - Geology
  - Topography
  - Constructability
  - Sources of organic material
  - Depth to groundwater (hydrogeologic regime: recharge or discharge area)
  - Vertical and/or lateral proximity to permafrost
  - Duration of operation required
  - Wildlife deterrence
- Climatic
  - Geographic location (lat/long)
  - Aspect (i.e., north- or south-facing)
  - Seasonal distribution of Rainfall
  - Character of Storm events
  - Snowfall
  - Freshet (break-up) character
  - Freeze-up character
  - Growing season
  - Temperatures (max, min, mean)
  - Growing-degree days
  - Evaporation and evapotranspiration
- Putative evidence of system functionality at site
  - 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.)
  - 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
  - Accretion rates
  - 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 by constructing the PG PTS downgradient of the PG WRSA once the WRSA is closed during 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	Y-1
Phase 2: Indoor Pilot Scale	Y-1	Y-1
Phase 3: Outdoor Pilot Scale	Y1	Y3
Phase 4: On-site Demonstration Scale	Y4	Y5
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.

WUL 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 C.

10.6 GROUNDWATER ARSENIC ATTENUATION STUDY

BGC (2014) prepared and calibrated a multi-purpose groundwater model, which has been used to determine the effects of mine operations on groundwater in the mine area. One purpose of the model was to evaluate the direction that seepage from the WRSAs might go, and the potential effect areas. The report states:

> At the end of mine operations, seepage from the WRSAs and 100 day storage area is not simulated to migrate outside of the facility footprints. However, within the WRSA footprints, seepage may report to the underdrains. Seepage originating from the 100 Day Storage Area could migrate to Suttles Gulch. While results for the end of passive closure are similar, seepage is predicted to also migrate west of the 100 Day Storage Area and the Platinum Gulch WRSA where it could discharge to Haggart Creek.

This conclusion was based strictly on a particle-type analysis ("ModPath") where a particle is modeled to move through groundwater based on hydrodynamic processes, but physical, chemical, or biological reactions that could cause a particular solute, such as arsenic or antimony, to migrate differentially as compared to a model particle, was not considered.

A review of groundwater quality data to current Yukon CSR AW standards identified by Stantec (June, 2012) showed dissolved arsenic exceedances in all 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

This version of the RCP has been updated to address QZ14-041 Clause 171 and Clause 7.2 of QML-0011 which require the submission of an updated Reclamation and Closure Plan on a two-yearly schedule.

Updated Current, 2-Year Peak Liability and End of Mine (EOM) security calculations are provided as Appendix G. Appendix G is a full closure cost estimate, informed by comments through the regulatory processes, the deliberations of the YWB during the amendment application process, and information gathered through construction, which contains the detailed closure cost estimate tables for each of the specific tasks.

The cost model tasks associated with the reclamation and closure of the Project include the following:

T1 Cost Summary

The summary table provides an overview of all costs required for the closure and reclamation of the project and links to the 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. Unit rates are currently based on those recommended in the Reasons for Decision for QZ14-041, to ensure that it meets the expectations of the YWB, updated labour rates based on the Yukon Government Fair Wage Schedule (effective April 1, 2018), estimates based on current site costs, and on the cost to fuel and operate equipment currently owned by SGC.

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 exploration disturbance is bonded for under the Class IV Mining Land Use Approval LQ00303. The security held by Yukon Government pursuant to LQ00303 includes an allowance for the removal of the 100-person camp that was installed to support exploration. The 100-person camp has been amalgamated into the expanded camp required for the construction and operations phase of the Project; however, for the purposes of the current, year 2 and peak liability estimates, the cost for the removal of all camp facilities has been provided.

T5 Closure Planning

Costs for closure planning include an update to the closure plan, and costs to implement the reclamation research program which includes engineered cover evaluations, the rooting study, detailed design of the passive treatment systems and the in-heap bioreactor, and site contamination surveys.

T6 Open Pit

Reclamation tasks for the open pit will include removing pumps, placing boulders in the pit entrance to prevent egress by vehicles and establishing rip-rap water conveyance channels. Equipment hours for these tasks are based on experience and costs realized during Project construction.

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. Rates are currently based on those provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. A custom rate has been calculated for haulage and placement of cover material. 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. Rates are currently based on those provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. A custom rate based on haulage distance, productivity is for the calculation of cover construction.

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.). It is likely that significant salvage value will be realized in the facilities however no value, or credit, for salvage has been included within the security estimates. Capital costs to build the water treatment plant are now included within T9, and are not discounted.

T10 Infrastructure

Infrastructure remaining in addition to the surface facilities primarily consists of modular camp buildings and mobile containers (e.g. the explosives and magazine storage). Costs for removal of these assets are based on labour and equipment hours to disconnect services and haul away. A 0.2 m soil cover is placed over the area and costs for this task are based on unit costs.

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 account for both present and future roads on site, and consider the equipment and labour costs to recontour road crests, scarify the surface and revegetate. Costs for removal of culverts are included along with standard erosion control measures.

T14 Water Management Infrastructure

The major cost driver for water management is associated with upgrading existing ditches for closure and decommissioning groundwater wells. Power needed for HLF pumps to recirculate the heap solution inventory during Phase 5 (i.e., the ~ actively managed recirculation rinsing period) are considered in T16 Interim Care and Maintenance.

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

This table includes costs for onsite management, employee transport, ongoing water treatment operating and capital replacement costs, long term funding of reclamation and closure research, monitoring and reporting, and site maintenance. A breakdown of water treatment operating and capital replacement costs are provided.

This table also includes costs for power associated with pumping water during Phase 6 (i.e., the ~3 year actively managed draindown period). Electrical power costs are based on heap draindown volumes from the Mines Group (2018) HLF water balance model which relies on assumptions developed by Forte Dynamics (2018b) as described for T17b, below. The annual costs and full costs for each of these tasks are presented in this table, along with the Net Present Value (NPV) of the costs as they occur in the future. The NPV costs are calculated in separate tables. NPV is described further below.

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.

This table includes costs for power needed for HLF pumps to recirculate the heap solution inventory during the 2-year Interim Care and Maintenance period. During Interim Care and Maintenance period, the Phase 5 actively managed recirculation rinsing period will be completed. The time required to rinse the heap is 460 days at the EOM, and 90 days at the 2-Year Peak Liability. These durations were calculated by Forte Dynamics and are based on standard best management practice requirement that pads be rinsed with three pore volumes.

T17 Quantities

T17a contains quantities of materials and areas of disturbance for the optimized Project, which are used throughout the other tables in the estimate.

T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on HLF Water Balance Modelling by the Mines Group (2018) for recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6. The maximum solution pumping power draw is from four 149 kw motors operating during Phase 5 and 6. Pumping rates are used to determine the number of pumps that would operate in a given month and the maximum power draw. A factor is applied to the connected motor load to account for a reduced power draw since solution will not be pumped to the top of the heap as is the case during operations. The electrical power cost of $0.14/kw is used to calculate the monthly and annual power costs. During Phase 6 draindown, pumping rates and associated power costs are reduced as water is directed to the MWTP at a conservative rate of 8 L/s for consistency with the Mines Group (2018), until a pumping rate of 20 L/s (the capacity of active/passive treatment) is reached and recirculation of solution will no longer be required.

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 1.5%. 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. For the basis of the current cost estimate, standard equipment types are included that are locally available (i.e. D-9 dozer, CAT 235 excavator). Third party rates are currently based on those provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. SGC has refined some of the established rates to account for fuel, maintenance and operator costs, for equipment that is currently owned by SGC's and has been mobilized to site during construction.

Equipment and Personnel Rates as well as other Contractor rates and camp costs were adopted from the Reasons for Decision for QZ14-041, and are based on Yukon Government Fair Wage Schedule, effective Apr 1, 2018. Custom haul rates are based on site-specific information.

Lump Sum Values: Some costs are presented as a lump sum which could be either a one-time expenditure 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. A review and further breakdown of lump sum costs in excess of $50,000 is provided where necessary.

Indirect Costs: Indirect cost factor rate of 15% includes insurance, taxes, and other administrative costs adopted from the rates provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. A review of the indirect cost factor, based on information gathered through construction will be conducted for future submissions. Site security, project management and engineering are included separately in the estimate.

Contingency Costs: Contingency cost factors are included at rates that range from 15-30% as adopted from the rates provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. Contingency cost factor rates will be reviewed and refined based on detailed engineering, design requirements and implementation strategies in future submissions.

The current iteration of the closure cost estimate reflects YWB-approved equipment and personnel rates, and indirect and contingency cost factors. 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 relate to one year of construction and one year of Project operation. The peak liability for these activities is thus realized at the completion of Year 1 of mining operations. The specific Project components that will exist at this point in time are presented in Table 8-1.

To support the development of the 2-Year peak liability cost estimate, feedback from the Reasons for Decision issued in connection with QZ14-041 and the associated closure costing review commissioned by the YWB have been incorporated. The fully updated, detailed costing model is located in Appendix G.

The updated 2-Year Peak Liability Closure Cost Estimate is $ 21,565,135.

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

Modifications to T1 include retaining an indirect cost factor of 15% and individual contingency rates for each activity based on those provided in the Reasons for Decision for QZ14-041 to ensure that it meets the expectations of the YWB. Based on rate information gathered through construction and operations, SGC will update and refine these rates in future iterations of the RCP. The inflation calculation applied to the direct and indirect costs has been corrected such that inflation is a compounding factor rather than a simple factor, and the discount rate has been reduced to 1.5%. The division of near term and long-term expenditures has been adjusted for consistency. As such, water treatment plant capital costs are now considered an implementation cost, while Phase 6 pumping power costs for recirculating heap solution are considered a long-term cost.

T2 Unit Costs

This table lists the unit rates for equipment, personnel, materials, and other rates, which are used repeatedly throughout the cost estimate. Rates have been adjusted for equipment currently owned by SGC and mobilized to site to reflect the cost for fuel, maintenance and operators for each piece of equipment. Equipment that is not currently owned by SGC has retained the rates based on the YWB's comments in QZ14-041 Reason for Decision. Additionally, personnel rates were updated based on the Yukon Government Fair Wage Schedule effective April 1, 2018. A 7% engineering fee is estimated for work tasks on each individual sheet. These remain unchanged from the most YWB's most recently approved cost estimate for the Project.

T3 General and Administrative

Costs reflect power and heat, site security and camp costs. Reductions to the quantities for the 2-Year peak liability have been made as the time required for closure will be significantly reduced.

T5 Closure Planning

The costs associated with Closure Planning have been increased to reflect the integrated reclamation research program, and lump sum values are broken down for Closure Specific Studies and Field Trials and Closure Plan Development. Costs are informed by the costs incurred to date in the preparation of the Eagle Gold Project Reclamation and Closure Plan and are consistent with costs experienced by other mining projects in Yukon and other jurisdictions. The program contemplated for the 2-Year peak liability estimate includes those research tasks required for closure after one year of operation, and considers the shortened timeframe for conducting research.

T6 Open Pit

Area of pit (and associated costs) were adjusted to reflect optimized Project pit dimensions in Year 1 of operation, at which time, the area will be scarified and revegetated.

T7 Heap Leach Facilities

Areas were updated to reflect the 2-Year peak liability site configuration. The cost estimate scenario at the end of Year 1 includes provisions for active treatment of heap solution within the CN destruct treatment train that is required prior to the use of cyanide on site. Passive treatment would not be used if the Project were to enter a closure period at the end of 1 year of mining operations.

T8 Waste Dumps

Areas updated to reflect optimized Project Year 2 site configuration.

T9 Surface Facilities

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms and undiscounted capital costs for water treatment plant construction have been added.

T10 Infrastructure

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms.

T11 Waste Disposal & Remediation

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms.

T12 Landfills

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms.

T15 Road and Trails

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms.

T14 Water Management Infrastructure

Costs have been adjusted to more accurately reflect the Project layout required for compliance with license terms, including removal of closure costs associated with the Lower Dublin North Pond, the Platinum Gulch Pond, and the Dublin Gulch Diversion Channel which are no longer part of the Project, Costs for conversion of the Lower Dublin South Pond to a PTS are included in T15. The amount included for the raising and/or widening of operational 1:10 year is $75,000 and is based on upgrades to up to 6000 m of ditching. This cost allows for materials and equipment time for development of all site ditches to final configurations.

<u>T15 Post Closure Care, Maintenance and Monitoring</u>

Post Closure Maintenance and Monitoring was updated to more accurately reflect the ongoing costs associated with active water treatment during late closure. Additionally, costs to decommission the water treatment plant and the transmission line are included.

<u>T16 Interim Care and Maintenance</u>

T16 was updated to include costs for power to recirculate solution and ultimately rinse the heap. As described above, Phase 5 rinsing of the heap would occur during the first 90 days of the Interim Care and Maintenance period.

<u>T17 Quantities</u>

T17a was updated to accurately reflect the optimized Project.

As described above, T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on optimized Project HLF Water Balance Modelling by the Mines Group (2018) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

13.3 END OF MINE LIFE COST ESTIMATE

The total cost of implementing the Reclamation and Closure Plan at the end of mine (EOM) life as outlined in this document is $48,050,518. A summary of the RCP costs for both the 2-year peak and EOM liability are presented in Table 13.1. The EOM cost estimate reflects the cost to reclaim the full extent of build-out for the open pit, HLF, WRSAs and surface facilities for the Project (as described in Table 8-1) and assumes that no progressive reclamation has been undertaken during the life of the Project. The reclamation cost estimate provided reflects the optimized Project layout and is based on comments received through licensing processes

Direct implementation costs for all of the reclamation tasks total approximately $24.3M for the EOM life cost estimate. Indirect costs based on the YWB's most recently approved estimate are assumed to be 15% of the direct costs and total $3.6M. Direct and indirect costs are then inflated, using a compounding factor, by 2% over the period of interim care and maintenance and implementation. The EOM cost estimate includes $6.8 M for inflation. The plan requires 3 years (Phase 6) to implement and complete followed by 15 years of late closure/post-closure monitoring and maintenance (Phase 7), as well as monitoring and maintenance at 28, and 43 years after the end of mine (Phase 8). The 3-year duration for implementation is driven by the time required to drain down the heap and establish drainage that can be managed passively.

Future long-term costs for solution draindown, long-term monitoring and maintenance, and post closure decommissioning are calculated on a NPV basis using a discount rate of 1.5%. The NPV of heap detoxification, water treatment operating costs and long-term monitoring for the EOM case totals $7.1 M. A further 15% indirect costs ($1.1 M) and contingency costs are added ($1.1 M) to the direct NPV costs to determine the overall total of $48.1 M.

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

T1 Summary

Previously discussed in Section 13.2.1

The inflation calculation applied to the direct and indirect costs has been corrected such that inflation is a compounding factor rather than a simple factor, and accounts for the time between the cost estimate (2018) and the earliest potential disbursement of the majority of security funds (2029).

T2 Unit Rates

Previously discussed in Section 13.2.1.

T3 General and Administrative

Previously discussed in Section 13.2.1.

T5 Closure Planning

As discussed in Section 13.2.1, the costs associated with Closure Planning have been increased to reflect the integrated reclamation research program, and lump sum values are broken down for Closure Specific Studies and Field Trials and Closure Plan Development. Costs are informed by the costs incurred to date in the preparation of the Eagle Gold Project Reclamation and Closure Plan and are consistent with costs experienced by other mining projects in Yukon and other jurisdictions. The program contemplated for the EOM liability estimate includes the costs for the fully executed research program.

T6 Pit

No changes for EOM scenario.

T7 Heap Leach Facility

Areas were updated to reflect optimized Project for the EOM site configuration. Additionally, the solution application rate and in-heap pond volume are factors in calculating the amount of In Situ Treatment Reagents to detoxify the heap and were updated to reflect optimized Project specifications.

T8 Waste Rock Storage Areas

Areas were updated to reflect optimized Project for the EOM site configuration.

T9 Surface Facilities

Previously discussed in Section 13.2.1.

T10 Infrastructure

Previously discussed in Section 13.2.1.

T11 Waste Disposal and Remediation

Previously discussed in Section 13.2.1.

T12 Landfills

Previously discussed in Section 13.2.1.

T13 Roads and Trails

Previously discussed in Section 13.2.1.

T14 Water Management

Previously discussed in Section 13.2.1.

T15 Post Closure Care, Maintenance and Monitoring

Previously discussed in Section 13.2.1.

T16 Interim Care and Maintenance

As described in Section 13.2.1, T16 was updated to include costs for power to recirculate solution and ultimately rinse the heap. At the EOM, Phase 5 rinsing of the heap would occur during the first 460 days of the Interim Care and Maintenance period.

T17 Quantities

T17a was updated to accurately reflect the optimized Project. T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on optimized Project HLF Water Balance Modelling by the Mines Group (2018) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

Table 13-1: Summary Table of Estimated Closure Costs

Description of Cost		2-Year Peak Liability (End of Y1)	Estimated Cost EOM
Closure Implementation			
T3 General & Administration		$948,276	$1,236,219
T4 Exploration Disturbances		n/a	n/a
T5 Closure Planning		$282,500	$1,040,648
T6 Pit		$35,626	$40,858
T7 Heap Leach Pad		$1,143,932	$3,918,893
T8 Waste Dumps		$590,939	$2,946,392
T9 Surface Facilities		$5,395,711	$11,280,686
T10 Infrastructure		$308,496	$308,496
T11 Waste Disposal and Remediation		$93,803	$106,303
T12 Landfills		$101,706	$101,706
T13 Roads & Trails		$354,432	$354,432
T14 Water Management		$170,502	$232,134
T16 Interim Care & Maintenance		$1,462,887	$2,731,446
Sub-total		$10,888,809	$24,298,212
Indirect Costs		$1,633,321	$3,644,732
Contingency Costs		$1,895,976	$4,075,420
Cost Inflation		$766,455	$6,800,595
Total Closure Implementation Costs		**$13,288,584**	**$34,743,538**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)			
		NPV (1.5% DROR)	
Onsite Management		$489,880	$920,581
Transport Costs		$36,206	$52,616
Water Treatment Costs (Phase 6)		-	-

Description of Cost		2-Year Peak Liability (End of Y1)	Estimated Cost EOM
Active Treatment (Phase 6)		-	-
Capital Costs (included in T9, above)		$0	$0
Capital Replacement Costs		$121,502	$681,665
Operating Costs		$1,501,474	$2,271,395
Draindown Pumping (Phase 6)		$188,584	$335,739
Passive Treatment (Phase 7-8)		-	-
Capital Costs		$122,505	$105,558
Operating Costs		$43,739	$105,149
Reclamation & Closure Research Phase 6		$41,775	$35,996
Monitoring & Reporting		$1,711,152	$1,824,170
Post Closure Maintenance (Phase 7/8)		$651,317	$768,330
Sub-Total		$4,908,134	$7,101,199
Indirect Costs		$736,220	$1,065,180
Contingency Costs		$736,220	$1,065,180
Total Care, Maintenance and Monitoring Costs		$5,644,354	$8,166,379
Total Closure Costs		**$18,932,938**	**$42,909,918**
Contingency Amount		**$2,632,196**	**$5,140,600**
Total Closure Costs (Plus Contingency)		**$21,565,135**	**$48,050,518**

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 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 Phase 6 (due to a delay of establishing the effectiveness of passive treatment) have been evaluated. The scenario considered aligns with previous sensitivity analysis, which involved carrying 2/3 the costs of active treatment capital replacement and active treatment operating through all of Phase 7, which ends at 20 years after the EOM.

Two-thirds of the additional active treatment capital replacement costs over this period is estimated to cost $709,549 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 total NPV of these additional capital replacement costs is about $505,305. The total NPV for active treatment operating costs, including the additional 15 years of operating Phase 2-5 and an additional 5 years of operating Phase 6, totals $3,982,242 in operating costs.

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APPENDIX A

Revegetation Trial Monitoring Results

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Laberge Environmental Services
P.O. Box 21072
Whitehorse, Y.T.
Y1A 6P7
email: laberge@northwestel.net
Office Phone: 867-668-6838
Fax: 867-667-6956

TECHNICAL MEMO

To: Steve Wilbur
Victoria Gold

Date: January 30th, 2018

From: Bonnie Burns
Laberge Environmental Services

Re: **Update on Peso Vegetation Plots**

The fifth annual assessment of the vegetation plots at the Peso mine site was conducted on August 4th, 2017. The details of the assessment have been summarized in Table 1 (Trench sites) and Table 2 (Waste Rock sites).

Figures 1 and 2 demonstrate the estimated vegetative cover for each Plot at the Trench and Waste Rock sites respectively.

Selected photographs are also included with this memo.

Note that details on the methodology and observed results from 2012 to 2014 are included in a previously submitted report (Laberge, 2015). Technical memos outlining the results for the 2015 and 2016 have been submitted to Victoria Gold.

Below are summarized observations and comments on the 2017 assessment:

Trench Site

- The trench plots were seeded with sheep fescue, tufted hairgrass, alpine bluegrass, spike trisetum, hedysarum and alder.
- The seeded plots that received no treatment continued to have minimum to no grass growth/survival. The sparse alder and volunteer plants appeared generally healthy.
- Ticklegrass was not planted at this site but was identified as a volunteer plant on several of the plots. Ticklegrass is a native species throughout the Peso site.
- Non-planted species that were observed growing on some of the trench plots include willows, spruce, Labrador Tea, blueberry and dwarf birch.
- Leaf litter is increasing in several plots.
- There is diverse growth in all of the plots in Block 3.
- Alsike clover, an introduced species to the Yukon, was documented at one of the plots in Block 3 (see Photo #8). Although it is a nitrogen fixer (as is alder), if it appears to be spreading, it will be removed during the next assessment. It was identified in Plot 3-2B in 2016 but was absent in the 2017 assessment. It is suspected that alsike clover originally came in with the compost during the initial seeding.
- Generally the plots treated with compost and biochar exhibited the best growth.

Waste Rock Site

- The waste rock sites were seeded with sheep fescue, tufted hairgrass, glaucous bluegrass, ticklegrass, hedysarum and alder.
- The plots that received no treatment but were seeded at the same rate and with the same species as the others continue to support no growth.
- The alders in Block 1 all appear healthy.

- Alders in Block 2 appeared to have either been browsed and/or subject to defoliation from an insect species (see Photo #13) however they were otherwise robust.
- Non-planted species that were observed growing on some of the waste rock plots include willows, spruce, and dwarf birch.
- Only two plots in Block 3 had live plants.
- The plots containing the healthiest plants with the greatest diversity of growth were generally observed on the plots that had been treated with biochar, compost and dolomite.

Summary

For successful plant growth and survival, some form of amendment is required at the Peso site. The acidic and mineral soils in the area have been very slow to create colonization of the disturbed areas. Peso was last actively mined in 1965. Compost and biochar seems to be sufficient at kick starting the revegetation process.

Grass growth within the plots are gradually decreasing as shrubs take over. Grasses are not the dominant plant type in the area and they were seeded to assist in building up soil conditions and to help retain moisture. Grasses are also seeded in areas to help control erosion although this was not the issue for the Peso study area. As the grasses and shrubs lose their leaves, organic matter builds up, which leads to an increase in soil fertility. The decomposition of alder leaves and plant parts provides available nitrogen.

The Blocks that supported the healthiest and most robust plants were those located closer to the forest margin; Blocks 1 and 3 at the Trench Site and Block 2 at the Waste Rock site. These locations probably provide some protection from the elements and possibly retain greater moisture than the more open sites.

It appears evident at Block 3 on the Waste Rock dump that acid rock drainage (ARD) is seeping in this area (staining on the rock surfaces) and inhibiting growth. Photo #16 shows how the effects of the ARD is corroding the rebar stakes at the plots. The effects of biochar and dolomite used at the plots in Block 3 have essentially been exhausted and now are insufficient to neutralize the soil conditions and allow plant growth. Interestingly, the small willows, alder and dwarf birch observed in Plot 3-4 appeared relatively healthy.

Recommendations

The 2017 assessment provides five years of monitoring at the Peso trail plots. As a final wrap up to this project, it is recommended that in 2018, soil and plant tissue samples are collected and analysed. Soil samples collected in the untreated buffer areas and in the treated plots will give an indication of any changes in pH, metal concentrations and nutrient levels within the 0 to 10 cm depth. Plant tissues (alder leaves and grasses) will be analysed for metal uptake from the plots and compared to those collected from the undisturbed nearby areas. The root depth of plants will also be noted.

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TABLE 1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, AUGUST 4, 2017

BLOCK #1

Plot #	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
1-1A	<1	5 dwarf birch, very small	good	no grass
1-2A	40	Fescue, several mature and producing seed, dominant tufted harigrass, 1 is mature alpine bluegrass ticklegrass spike trisetum, 1 is mature 10 alder , robust growth unidentified small forbs	good	lots of leaf litter and last year's grasses.
1-3	60	Fescue, several mature, dominant alpine bluegrass tickle grass 25 alder - robust unidentifed small forbs	good	all plants appear healthy lots of leaf litter % cover includes leaf litter, See Photo #2
1-1B	1	14 small alder 1 spruce seedling	good	no grasses
1-2B	60	alpine bluegrass, some mature, dominant grass ticklegrass tufted harigrass, 1 is mature 48 alder 1 spruce seedling a few willow seedlings	good	even coverage of plot lots of leaf litter

TABLE 1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, AUGUST 4, 2017

BLOCK #2

Plot #	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-3A	35	unidentified stressed grasses are dominant grass alpine bluegrass, none mature 4 alder, up to 80 cm labrador tea willow seedlings blueberry several dwarf birch moss spruce seedling	grasses - poor others - good	The grasses are stressed but the alders and the volunteer plants are healthy. See Photo #5
2-1A	<5	labrador tea dwarf birch blueberry spruce seedlings small tufts of dead grass from previous years	good	no live grasses all volunteer plants in plot
2-2	50	fescue, several mature alpine bluegrass 1 large alder - 130 cm, also small ones labrador tea blueberry spruce seedling	good	some leaf litter
2-3B	25	unidentified tufts of grasses alpine bluegrass several willow seedlings labrador tea dwarf birch spruce seedling	fair	leaf litter from grasses
2-1B	1	a few blades of unidentified grass dwarf birch willow seedlings labrador tea spruce seedling	grasses - poor others - good	only 1 tuft of spindly grass volunteer shrubs doing well

TABLE 1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, AUGUST 4, 2017

BLOCK #3

Plot #	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
3-2A	65	unhealthy grasses likely fescue - dominant grass alpine bluegrass, immature ticklegrass, mature 1 large alder, 118 cm 3 smaller alder willow labrador tea dwarf birch 1 large tuft of alsike clover moss	poor to good	most plants appear robust and healthy
3-3A	50	tufted hairgrass, mature ticklegrass, mature alpine bluegrass Calamagrotis canadensis, mature fescues, mature 7 alder up to 88 cm dwarf birch willows, labrador tea spruce	good	good biodiversity healthy growth of all plants
3-1	5 - 10	sparse unhealthy fescue 1 ticklegrass dwarf birch labrador tea willow spruce moss	grasses - poor others - good	grasses appear somewhat stressed, volunteer plants appear to be doing well
3-2B	40	struggling fescue alpine bluegrass 9 robust alder up to 80 cm willows, spruce seedlings moss dwarf birch	fair to good	the fescues appear somewhat stressed. alders appear very healthy
3-3B	20	alpine bluegrass fescues 6 alder up to 44 cm dwarf birch willows spruce moss	stressed to healthy	all grasses appear to be stuggling however, the grasses growing near the alder appear more healthy. Alder and volunteer plants appear healthy

TABLE 2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, AUGUST 4, 2017

BLOCK #1

Plot #	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
1-1	0			bare plot
1-2	50	fescue, mature 15 alder up to 61 cm spruce willows	good	a live ant was observed walking thru the plot lots of grass litter
1-3	5	live grasses growing next to alders only alder, 2 plants - healthy small dwarf birch	stressed to good	mostly dead grasses or stressed alders - healthy
1-4	40	Fescue and several in seed alders up to 68 cm willows - healthy and growing spruce, growing (see Photo #12)	good	
1-5	30	ticklegrass, immature grass - likely fescue 4 large alder up to 111 cm small willow seedlings	fair to good	lots of grass litter grassess appear stressed

TABLE 2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, AUGUST 4, 2017

BLOCK #2

Plot #	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-1	0	no sign of any growth		bare plot, moose tracks thru plot
2-2	60	ticklegrass, mature plants immature fescue many alder - too numerous to count 2 spruce seedlings willows	good	coverage mostly on east half
2-3	60	numerous alder 5 paper birch 3 spruce willows	good	grass leaf litter some of the alder appear to have suffered from browsers and/or defoliators (see Photo #13)
2-4	90	tufted hairgrass, several in flower sheep fescue, some mature ticklegrass alder, too many to count, thick growth willows	good	some alder seem to have suffered as in Plot 2-3
2-5	75	unhealthy fescue grasses many alders willows spruce seedlings	fair to good	some alder also seem to have the same fate as Plot 2-3

TABLE 2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, AUGUST 4, 2017

BLOCK #3

Plot #	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
3-1	0	no growth		bare plot
3-2	0	no live growth		only dead plant material from previous years
3-3	0	no growth		bare plot
3-4	5	1 ticklegrass in seed 1 tuft of glaucous bluegrass 2 alder a few willows small dwarf birch small tufts of fescue	fair to good	willows and alder appear healthy most productive plot in block (see Photo #15)
3-5	<5	glaucous bluegrass, mature ticklegrass, mature	fair	

FIGURE 1 Trench Site as Assessed on August 4th, 2017

Treatment Number	Treatment
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite

Trench Block #1

1 Plot #1-1A C = <1%		**3** Plot #1-3 C = 60%		**2** Plot #1-2B C = 60%
	2 Plot #1-2A C = 40%		**1** Plot #1-1B C = 1	

Trench Block #2

	1 Plot # 2-1A C = <5%		**3** Plot # 2-3B C = 25%	
3 Plot # 2-3A C = 35%		**2** Plot # 2-2 C = 50%		**1** Plot # 2-1B C = 1%

Trench Block #3

2 Plot #3-2A C = 65%		**1** Plot #3-1 C = 5 - 10%		**3** Plot #3-3B C = 20%
	3 Plot #3-3A C = 50%		**2** Plot #3-2B C = 40%	

C = Cover

[orange box] → Buffer plots – not seeded or treated.

FIGURE 2 Waste Rock Site as Assessed on August 4th, 2017

Treatment Number	Treatment
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite
4	Seed, biochar, compost, dolomite lime
5	Seed, biochar, compost, leonardite, dolomite lime

Waste Rock Block #1

1 Plot # 1-1 C = 0%		**3** Plot # 1-3 C = 5%		**5** Plot # 1-5 C = 30%
	2 Plot # 1-2 C = 50%		**4** Plot # 1-4 C = 40%	

Waste Rock Block #2

	2 Plot # 2-2 C = 60%		**4** Plot # 2-4 C = 90%	
1 Plot # 2-1 C = 0%		**3** Plot # 2-3 C = 60%		5 Plot # 2-5 C = 75%

Waste Rock Block #3

1 Plot # 3-1 C = 0%		**3** Plot # 3-3 C = 0%		**5** Plot # 3-5 C = <5%
	2 Plot # 3-2 C = 0%		**4** Plot # 3-4 C = 5 %	

C = Cover

[ ] → Buffer plots – not seeded or treated.

Photo #1: Overall view of Block 1 at the Trench site.

Photo #2: Plot 1-3 in Block 1 at the Trench site.

Photo #3: Plot 1-2B in Block 1 at the Trench site.

Photo #4: Overall view of Block 2 at the Trench site.

Photo #5: Plot 2-3A in Block 2 at the Trench site.

Photo #7: Overall view of Block 3 at the Trench site.

Photo #6: Plot 2-2 in Block 2 at the Trench site.

Photo #8: Plot #3-2A in Block 3 of Trench site, alsike clover in foreground.

Photo #9: Plot 3-1 in Block 3 of the Trench site shows small but healthy growth in this untreated plot.

Photo #10: Overall view of Block 1 on the Waste Rock site.

Photo #11: Plot 1-2 in Block 1 at the Waste Rock site.

Photo #13: Overall view of Block 2 on the Waste Rock site. Note moose prints in Plot 2-1.

Photo #12: A thriving healthy spruce plant in Plot 1-4 in Block 1 at the Waste Rock site.

Photo #13: Stripped branches in Plot 2-4 in Block 2 on the Waste Rock. Could be caused by browsers or defoliators.

Photo # 14: Overall view of Block 3 on the Waste Rock site.

Photo #15: Plot #3-4 is the healthiest plot in Block 3 on the Waste Rock site.

Photo #16: Corroded rebar at Block 3 of the Waste Rock site.

APPENDIX B

Vegetation Rooting Study

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EAGLE GOLD PROJECT

PRELIMINARY VEGETATION ROOTING STUDY

Version 2018-01

JUNE 2018

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1. INTRODUCTION

The purpose of the Vegetation Rooting Study ("the Study") is to establish an approximate range of rooting depths for climax vegetation within the proposed cover system for the Eagle Gold Project ("the Project"). Previous cover analysis for the Project assumed an approximate root penetration depth of 0.5 m based on the rooting systems of common tree species in the Yukon (e.g. white spruce, black spruce, and balsam polar). A more detailed assessment of rooting depth is needed to confirm the current cover model assumptions.

1.1 PROJECT OBJECTIVES AND SCOPE

The benefits of vegetation on cover systems are well documented and rely on plant root water uptake to increase evapotranspiration (ET) through plant transpiration, thus limiting deep seepage to underlying mine waste (Benson et al. 2001, Ayres et al. 2004). Plant transpiration relies primarily on plant water availability, which is largely a function of root distribution within the cover profile, in combination with soil texture. Vegetation acts to remove water from the cover system through transpiration and interception. Therefore, through the addition of vegetation, the amount of water that reaches the surface of the cover system (effective precipitation) is immediately reduced as compared to a bare surface condition. As vegetation density increases, so does the root density. Increasing interception, transpiration and runoff will be the primary mechanisms to reduce net percolation into the cover system. Initial vegetation establishment (typically grasses) following cover system construction provides erosion protection. As the cover system ages and conditions allow, shrubs and eventually trees establish. Quantification of root depth / distributions and associated near surface material characteristics will yield valuable closure planning information. Key outcomes from the Study are to:

- Collect site specific or analogous site information pertaining to root depth / distributions that will be used to inform the final cover system designs;
- Identify key plant functional groups and material types for each plant functional group; and
- Calibrate a soil-plant-atmosphere (SPA) model using site-specific root depth / distribution and material characteristics information to improve output accuracy.

The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Project site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

1.2 STUDY ORGANIZATION

Reviewer comments suggested that a rooting study should examine existing climax vegetation in locations with similar soils to the proposed cover (and exist in thicknesses at depths more than 0.5 m) to determine the likelihood that rooting depths may exceed 0.5 m. While this is an aspect to be evaluated, more importantly there are key constraints to rooting depth to be considered that can be broadly grouped into physical, chemical, and biological factors (Robinson et al., 2003). Thus, it is not necessarily how deep roots are able to penetrate under ideal conditions, but how deeply can roots be expected to penetrate under conditions proposed for the engineered cover system and how the rooting depth effects net percolation rates. Therefore, a two-phased approach is proposed for the vegetation rooting study.

The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite
- **Task 3**: Vegetate constructed cover system trail area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.

- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Tasks 1 to 6 are aimed to better understand the physical, chemical, and biological constraints to rooting depth and cover system design that can be developed at the Project site. In this way, the uncertainties regarding possible rooting depths are constrained to the cover system design parameters that can be controlled as opposed to having to evaluate the broad range of natural variables that exist in nature.

1.3 STUDY OUTCOMES

The main outcomes of the proposed study include:

- Clarification of the optimal (and minimum) cover thickness capable of supporting plant water requirements for a mature rehabilitated plant community.
- Characterization of an improved plant establishment that will result in higher plant water-use (transpiration).
- Integration of root depth/proportion information in soil-plant-atmosphere (SPA) model improving their predictive accuracy.

2. PROPOSED FIELD METHODS

Proposed field methods to the two-phased approach are described below.

2.1 PHASE 1: NATURAL ANALOGUE SITE INVESTIGATION

2.1.1 Task 1: Literature Review

The comprehensive literature search on vegetation characteristics and forests in the region will be conducted to develop a list of target species to investigate further. In this case, target species (i.e., various trees and shrubs) to study are assumed to be those that fit into end land use vegetation communities but have penetrating root systems that may affect cover system performance.

2.1.2 Task 2: Establish Test Plots

To confirm the appropriate age class of vegetation to be sampled, tree coring and ring counts will be conducted at analogous study sites. The Study sites may include natural areas remaining on or adjacent to the Project site. Due to the possibility that the climax vegetation species may have roots systems that do not have optimal depths, the study will also examine rooting characteristics of various successional forest types that yield more appropriate rooting depths for the proposed cover designs. The rooting depth characteristics have been shown to relate to many factors, so rooting depth may also be constrained by physical properties such as textural contrasts and interfaces. By aging target species at natural analogue sites identified in the literature search, the age of the species in question and root depth can be correlated.

Additional characterization of near surface materials and plant root characteristics at the Project will yield valuable information to further inform closure planning. Assessment of cover trials will be used to optimize cover system design and performance as the current vegetation community is representative of one likely to establish on the cover system post closure.

2.1.3 Task 3: Destructive Sampling

A ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem (Figure 2.1-1a). Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works.

Pits will be dug as close to the stem as practicable (approximately 0.1 m), to a depth based on literature information on the maximal rooting depth of the target species and 0.25 m on either side of the stem (Figure 2.1-1a). Pit walls will then be smoothed using shovels and small water sprayers to remove excess soil and expose roots. Sampling frames divided into 0.05 x 0.05 m grid cells (0.0025 m^2) can be used to count the number of roots in each cell (Figure 2.1-1b). This method will allow for quantification of root depth and distribution, in addition to estimates of cumulative root distributions with soil depth exemplified in Figure 2.1-2.

Information on root distribution is valuable for determining where plants place most of their roots for water extraction, allowing cover designers to implement cover system with adequate growth media thickness to satisfy plant root and moisture requirements. Root depth and distribution information can also be integrated into SPA models to achieve more accurate estimates of cover system performance over time. This information will improve the likelihood of successful rehabilitation and improve the design and performance of cover systems at the Project.

Figure 2.1-1: Creation of pit into a cover system with established vegetation to quantify root depths, distribution, and material textures

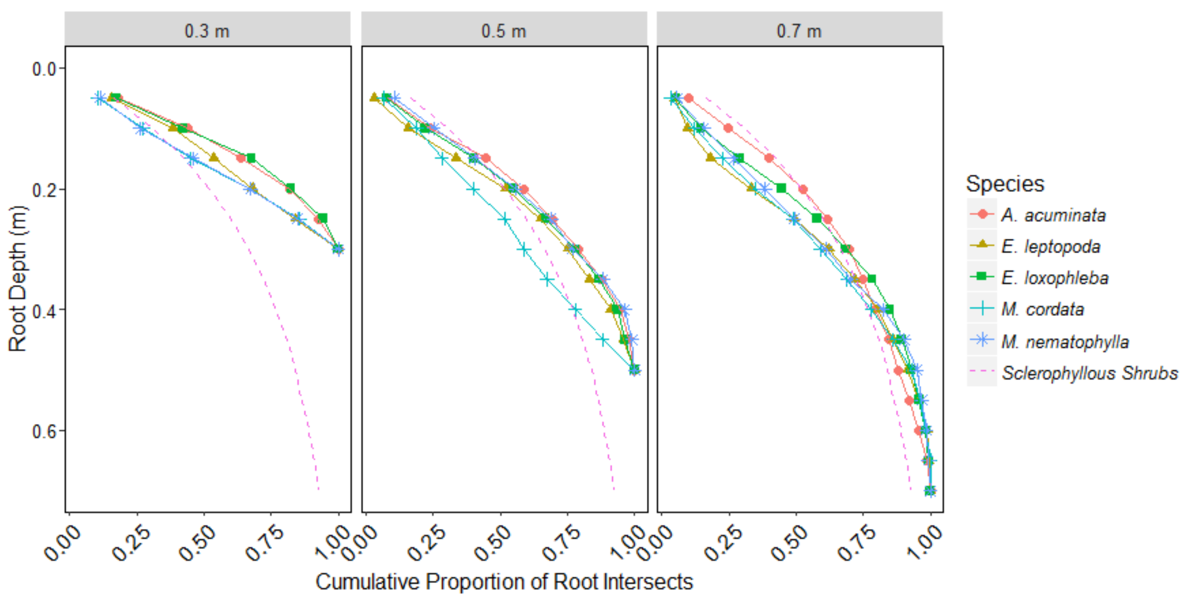

Figure 2.1-2: Example of cumulative proportion of root intersects (root counts) for saplings of five local native species with depth for three cover thicknesses

After root quantification, sampling the soil material from the Study pit wall in active rooting interval will be conducted. The active rooting soil interval likely represents the depth at which most roots extract water; characterizing the active rooting interval will help develop recommendations regarding the cover system growth medium. Soil samples for texture and plant available nutrients will be analyzed. These works can optimize cover system material characterisation in association with plant root characteristics.

2.2 PHASE 2: COVER SYSTEM FIELD TRIAL

2.2.1 Task 1: Field Trial Design

Task 1 is to develop a design for the cover system field trial based on proposed conceptual cover system design and learnings from the natural analogue site investigation to assess selected vegetation treatments.

A store-and-release cover system made up of nominally 0.5 m of cover system material with locally available topsoil and tailings or colluvium will be constructed to cover the landform produced in Task 2 below. The design base case will be of the design specified in the latest closure and reclamation plan for the site as shown in Figure 2.2-1. It may be possible that slight modifications to the cover system and its vegetation performance can be examined as part of field trials.

2.2.2 Task 2: Construct Field Trial Landform and Cover System

Landforms will be constructed from equivalent leached ore or waste rock material produced on site. Modelling and sensitivity analyses conducted (O’Kane, 2014) found very little difference in the performance of the Base Case cover design whether it was covering leached ore or waste rock materials. Landforms will be sized and built with commercial scale equipment that will represent the soil conditions with the expected compaction on closure landforms. Generally, these trials may only need to be on the order of 0.5 ha in area and they will be constructed according to specifications anticipated for closure.

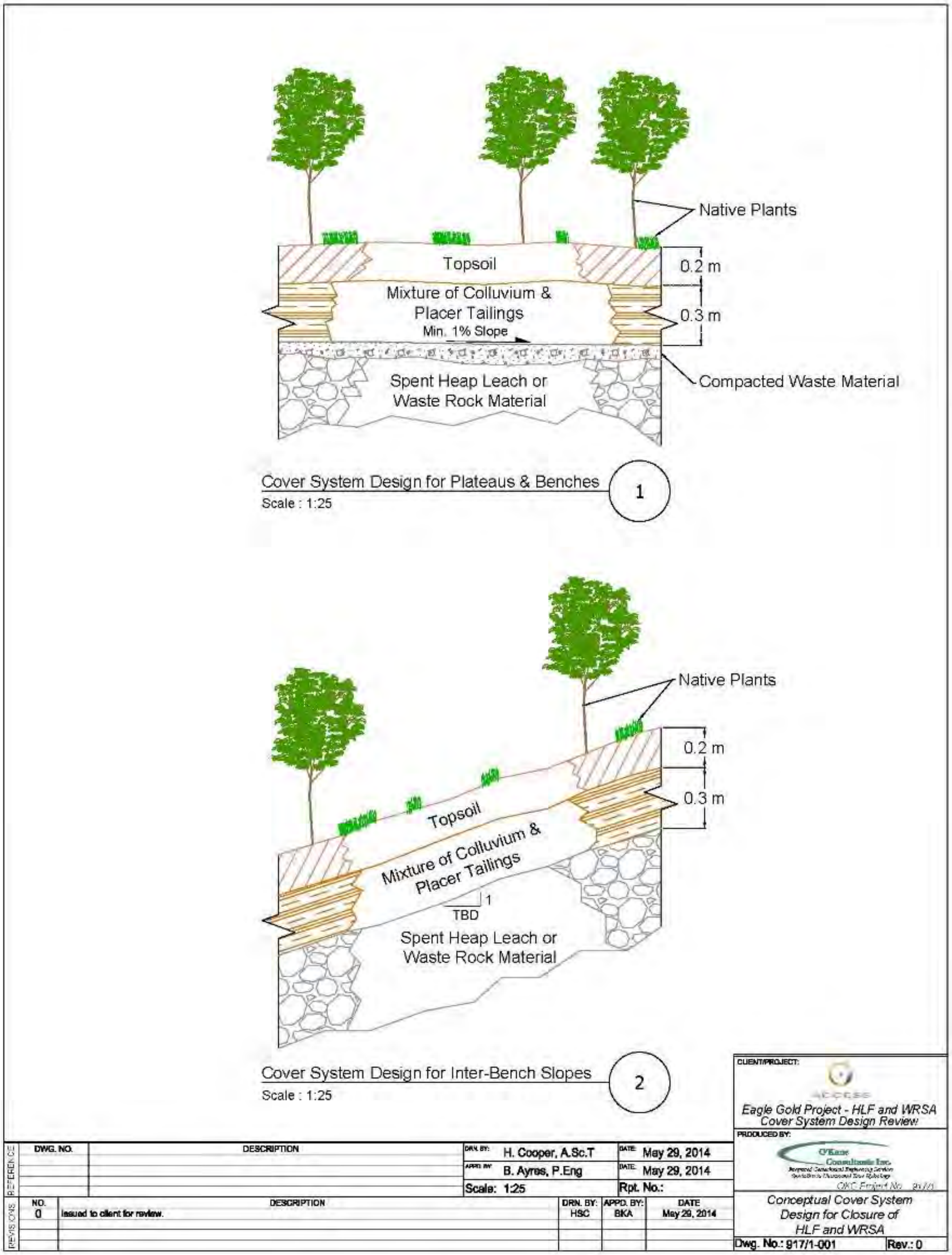

Figure 2.2-1: Conceptual HLF and WRSA Cover Design Drawings

2.2.3 Task 3: Vegetate Cover System Field Trial

Task 3 involves vegetating the constructed cover system trial area in alignment with successional end land uses. Given the end land use, seed mixes will be developed for early successional grasses, and seedlings will be sourced for climax shrubs and trees. The cover system field trial area will be revegetated using standard techniques (Table 2.2-1) with native species and based on updated vegetation information gathered during the natural analogue site investigation. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques and evaluate the degree of success of the closure cover system design.

The field trials will require planting or seeding with desired species chosen as based on results from Phase 1. A short summary of the pros and cons of each re-vegetation technique is provided in Table 2.2-1 and is not intended as an exhaustive list.

Table 2.2-1: The pros (+) and cons (-) of common re-vegetation techniques (Florabank.org.au)

Direct Seeding	Planting	Natural Regeneration
(+) Lower establishment costs	(+) More reliable	(+) Plants are well-adapted to the site
(+) Natural look and more diversely structured	(+) Uniform	(+) Establishes healthiest plants
(+) Establishes healthier plants	(+) Re-vegetation is visible to passers by	(+) Lowest establishment costs
(-) Long establishment times may lead to more maintenance such as weed control.	(+) Uses small quantities of seed	(-) Needs an adjacent or nearby seed source
(-) Ants have been known to take seed	(-) Higher establishment costs	(-) May have to wait a long period for results
(-) Uses lots of seed	(-) Often results in unnatural looking rows	(-) Long establishment times may lead to more maintenance such as weed control.

NOTES:
Symbols of (+) and (-) denote a pros and cons, respectively, associated with each re-vegetation techniques.

If the cover trial is to be vegetated via direct planting, then the density of stems per unit area for a given species should resemble its natural stem density in natural areas. Appropriate planting densities between seedlings are important as water demands increase with plant size as vegetation communities mature. Moreover, planted species often represent those found in the final community stage that often require greater rooting volume, plant available water, and nutrients, thus stressing the importance of planting densities, growth material characteristics, plant available water, and growth medium thickness.

If the cover system is to be seeded, then it will be important to select the seed mix based on the literature review, the targeted end land use and the ability to source the seeds from local provenance. Using seed from the local area will take advantage of subtle adaptations present in plants occurring in the area, thus increasing the likelihood of successful re-vegetation. Seeding rates and seed mixtures for each species should resemble stem densities of their natural analogues on undisturbed sites, and account for typical germination rates for each species present in the mixture. Seeders may be used to spread the seeds on the trial areas. Longer establishment times associated with seeding will likely required increased weed management until seeded plants are well established.

A combination of planting and seedling may be used; however, it is recommended that planting occur first to ensure establishment over a sufficient time followed by seeding. Natural re-vegetation may also occur and be beneficial if not mainly comprised of weeds.

2.2.4 Task 4: Moisture Content Monitoring

Monitoring of the soil water content in the plant root zone will be important in understanding the physical processes contributing to storage or removal of water.

During construction of the cover system it is proposed that an array of automated sensors be deployed in each location where seedling plots are located. Soil matric potential and water content are two parameters that are used to determine the water allocation in the rooting zone; they provide information on how roots are affecting the water balance of the cover system. The sensors will be configured in predetermined depths in the soil profile and connected to a data acquisition system (DAS), whereby measurements will be recorded at high frequency intervals. Generally, the instrumentation proposed here forms the basis of a cover system performance monitoring system that may be used in future stages.

2.2.5 Task 5: Geochemical Characterization

Task 5 will look to assess the geochemical character of the cover system and underlying materials and will identify any constituents that may be susceptible to bioaccumulation as identified through cover system material and waste material sampling programs.

Geochemical sampling during construction of the field trial is proposed in the same locations to where seedlings are to be planted. Samples will be collected of the underlying materials and the cover system materials. Sample collection will be followed by sampling during the destructive sampling to investigate if constituent concentrations in the various cover layers have increased with time. Key areas of geochemical sampling will coincide with target species to be destructively sampled to investigate if water demand by vegetation has assisted in the upward migration of any constituents of concern and if they are bioavailable to the species.

2.2.6 Task 6: Destructive Sampling

Task 6 will involve destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length. As with destructive sampling in the natural analogue site, a ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem. Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works. The methodology will follow the same protocol as in Task 3 of the natural analogue site investigation (Section 2.1.3).

2.2.7 Task 7: Cover System Model Update

The objective of the updated conceptual model will be to incorporate the accumulated monitoring and site investigation data. A review of results of monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data will be used to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist.

The research program has been structured in such a way that areas posing the highest risk and uncertainty to the cover system's performance can be further evaluated. By conducting studies aimed at reducing uncertainty in estimates, numerical modelling can be refined to support field observations. This leads to an update of the conceptual model. Once the level of risk for the cover system performance has been reduced to an acceptable level agreed upon, the conceptual model can be moved forward as a basis for design.

Based on the results of both phases of the study, the cover system model will be updated to include the proposed vegetation strategy for the cover system design. The rooting profile characteristics of the cover system trial site will be compared to an analogue natural site of similar age. At some point during the study, the cover trail can be destructively sampled based on operation feasibility; this may not be until five or more years post-planting. Assuming similarity, the climax community species rooting depths in the analogue sites can then be used to infer the potential for rooting depth on the cover trail into the future.

3. CONCLUSIONS

The proposed two-phased study described herein provides the opportunity to optimize closure planning for the Project. The initial field investigation will increase immediate and short-term knowledge that can be used to improve the design of cover system field trials. Characterization of near-surface materials and plant root characteristics at the Project site will yield valuable information to further Project closure planning and increase the likelihood of successful rehabilitation. The vegetation study outlined here will help refine the anticipated rooting depths on the proposed cover system for specific species from construction through closure. Rooting characteristic information can also be used to identify specific vegetation as likely candidates for the cover system, and what their contribution to increasing AET is likely to be.

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APPENDIX C

Alexco Environmental Group – Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

Suite 1150 – 200 Granville Street
Vancouver, BC V6C 1S4
Phone (604) 633-4888 Fax (604) 633-4887
www.alexcoresource.com

Technical Memorandum

To: Steve Wilbur, Hugh Coyle, Victoria Gold

From: Jim Harrington, Alexco Environmental Group

Re: Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

1 Introduction and Background

This plan has been developed as part of the closure planning process for the Eagle Gold Project (Project). It is part of the reclamation research identified in the Reclamation and Closure Plan (RCP) to address uncertainties in the heap detoxification process as the heap transitions from leaching into closure. The field-based research is planned to be concurrent with heap leaching operations over a 3-year period, with the primary test taking approximately 100 days followed by quarterly testing of effluents for up to 12 quarters thereafter to evaluate rebound, stability, and seasonal effects.

Water Use Licence QZ14-041, which was granted to the Project in December 2015, requires a phased Reclamation and Research program "to verify the proposed biological detoxification of the heap, including incorporation of data gathered through the operation of the HLF and information from the use of similar technology at heap facilities operated in similar climatic conditions." Further, it also requires "a phased program, similar to that provided for the PTSs, for the proposed in-heap bioreactor treatment system including the assessment of the ability to maintain reducing condition in the long term and the potential for rebound and/or release of metals."

Gold-containing materials leached by cyanide are characterized by cyanide residuals, elevated pH, and some soluble metals and metalloids. These conditions result from the elevated pH due to lime addition during heap placement, cyanide-metals complexation, and oxidation of materials that were previously less exposed to atmospheric conditions. Prior column tests (performed at Kappes Cassidy in 2013-2014 and summarized by TetraTech, 2014) verified that treatment of cyanide residuals in Eagle Gold spent ore, nitrogen-containing CN breakdown products (cyanate, thiocyanate, nitrate/nitrite, and ammonia) can be degraded using microbial degradation. Furthermore, some metals showed significant reduction in concentrations during this treatment process, whether by 1) enhanced sorption as the pH was reduced toward neutral conditions, 2) the removal of the complexing action of cyanide as it was degraded, or 3) via other biological precipitation processes such as formation of mixed valence iron and manganese oxides or biogenic sulphide minerals.

As is indicated in the Reclamation and Closure Plan (RCP; AEG 2014), during late stages of heap operation and heap draindown a biological treatment process will be employed for the Project. The purpose will be to improve heap drainage water quality such that it can be readily treated in a water treatment plant (WTP) or in constructed wetland treatment systems (CWTS).

There are two proposed processes that are complementary and thus are discussed in this Study Plan together. These processes are:

- Biological CN degradation in the vadose and saturated portions of the heap, where sugar-containing-solutions are applied to the heap using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers). Application of the sugar solution within the heap promotes the reaction of sugars and cyanide, which yields less toxic cyanohydrins, and supports the degradation of nitrogenous CN breakdown products that ultimately transforms CN and other N compounds to gaseous N_2.

- Formation of biochemically-created reducing conditions within the saturated portion of the heap, where alcohol-containing solutions are applied to heap materials using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers).

Typically, biological CN degradation is performed with slower solution application rates than that used during active leaching, while targeting a solution quantity to any active application area that is equivalent to a pore volume of the liquid in the vadose zone in that area. Solutions from the gold recovery (in the Adsorption Desorption and Recovery plant) are amended with molasses or other similar sugar source, and pumped back up to the heap. The sugar solution is applied at a rate calculated to degrade both the solution-phase CN and the sorbed CN forms, and is applied slow enough onto the surface of the heap to target the smaller pores within the heap materials, thus enhancing coverage of the solution into zones that could otherwise create rebounds in CN once biological treatment solutions are no longer being applied to the heap. For the Project heap areas, this is estimated to be 12 areas each for approximately 60 days, and the timing of the initial treatment application is targeted to be just after CN addition has stopped, beginning with the oldest areas of the heap and working over the next 2 years progressively toward areas that were last leached.

As the effect of the sugars reaches the in-heap pond, microbes in the pond begin to transform the pond to anaerobic conditions. This effect is tempered by the continued mobilization of nitrate from the vadose zone into the in-heap pond, but because the systems are not well mixed, zones of both denitrification and sulphate reduction will likely form. As CN treatment within the vadose zone progresses to completion, the saturated zone is further driven to more reducing conditions (i.e., more strongly into sulphate-reducing conditions) by the continued application of alcohol. Thus the in-heap treatment process is sequential in timing (sugars targeting CN degradation followed by alcohols enhancing nitrate and sulphate reduction) while migrating in location along the flow path (from vadose zone through to the saturated in-heap pond) prior to discharge from the heap.

2 Operational Data Relevant to Biological Detoxification and Bioreactor Design

There are several areas where heap operational information will be reviewed in the final design of the biological detoxification and bioreactor tests.

2.1 Water Chemistry

While metallurgical column testing provides some understanding of the formation and evolution of constituents that may be present in the full-scale larger heap setting, the smaller-scale testing typically does not fully represent the more complex heterogeneity of the ore body (and hence the resultant stacking of ore in the heap), the length of atmospheric exposure and wetting and drying cycles in the heap leach process, and the localized gradients and variability of pH, cyanide concentration, lime addition rates, etc. Changes in mining plans and other operational decisions can also affect water chemistry, including the extent of evaporative concentration of heap solutions, extent of freshwater makeup and constituents present in the fresh water, the use of sprinklers vs. drip emitters, and the solution application rate which can affect relative oxidation levels in the heap.

When performing the final design of the biological detoxification and bioreactor field tests, water chemistry from the pregnant and barren solutions will be reviewed to ensure that all relevant constituents that may affect reagent requirements have been considered.

2.2 Heap Leaching Performance

As part of the HLF Operations, Maintenance and Surveillance program, for example, gold recovery, leach times (i.e., duration of solution application) for each area of the heap, grades of pregnant solution over time, cyanide use, and pH of the pregnant solution will be monitored. This operational data can be used to assess the potential lateral variability in flow paths which might be relevant for biological detoxification. A review of this operational data would be done during the planning stage for biological detoxification so that solution delivery and potential variability by heap area for duration or concentration of reagents can be evaluated.

3 FIELD TEST STUDY PLAN

3.1 BIOLOGICAL DETOXIFICATION COLUMN AND BIOREACTOR SETUP

During the leaching process over the entire operational period, there will be lifts that will have been leached and then stacked over and re-leached, with the areas deepest in the heap and nearest to the in-heap pond leached the longest. Thus a few years into the heap leach operation, materials will be available that have been well leached and will be representative of the heap at closure. While unsaturated heap materials will be readily available during operations to study the biological detoxification process, the saturated portion of the heap will not be accessible until closure, and consequently heap materials will need to be newly flooded to simulate the in-heap pond area which will become the bioreactor. Thus the field program will create two settings that are similar to the sequential unsaturated and saturated zones in the heap that will be used to treat the water contained in the heap materials. Field columns, small lined areas on the heap, and tanks will be used to set up a flow path that simulates the conditions on site.

The following summarizes essential aspects of the column setup (see attached illustration):

- Select heap materials from the longer leached portion of the heap that have completed their leaching process and have been exposed to atmospheric oxygen for several years. These will be placed into a contained area for biological detoxification testing. While this rehandling will affect the localized material characteristics which affect unsaturated flow of solutions in the heap, this test is studying the chemistry of the process not the unsaturated flow variables of the heap treatment process.

- Two approaches for the vadose-portion of the heap column setup are considered to be appropriate and are acceptable, with some specific advantages and disadvantages for each considered below:

    - A large scale wide diameter column can be constructed, with heights of 10 m or more similar to a lift of stacked heap materials (this setup will be referred to as the "column" approach).

    - A trench can be excavated in the side of the heap, a liner placed, and the heap materials re-placed on the lined area, similar to a field scale lysimeter construction (this setup will be referred to as the "lysimeter" approach.

- Either approach is considered acceptable to study the water chemistry outcomes of the process and yield design parameters and confirmation of the full scale approach.

- Some advantages and disadvantages of the column approach include:

    - All columns suffer from skin effects, i.e., solution flow tends to move vertically until lower permeability materials are encountered, then flow goes laterally until the edge of the column is reached, then flow continues along the surface of the column, and may result in column areas that do not receive representative solution application.

- Column materials provide restrictions on gas exchange similar to a given soil column that is contained in the heap, allowing for formation of anaerobic conditions within the column more similar to what would be experienced in the bulk heap materials.

- Some advantages and disadvantages of the lysimeter approach include:
  - It may be difficult to apply solutions to the side-heap area that are representative of the vertical column flow path which is the primary flow path in a full scale heap.
  - Side-heap areas are the area where atmospheric exchange is greatest, resulting in a more inefficient use of the reagent.

- The bioreactor setup should be done in such a way as to provide about 14 days of residence time within saturated heap materials. The portion of the test simulating the saturated heap can be done by creating a tank or a lined area that is filled with leached spent heap materials, and providing an invert elevation for the tank or lined area such that the area remains saturated. Options to create this bioreactor can include a small lined area on the side of the heap, a tank placed on the heap area next to the column or lysimeter area, or a second column that each would receive solutions in an upflow configuration. While ideal, it is not necessary that all solutions from the column or heap be applied to the bioreactor. From here on bioreactor setup will be referred to as a “bioreactor tank” even though it may be constructed using liner.

- The bioreactor tank will have an upflow configuration, such that solutions will be added to the bottom of the reactor through a perforated pipe network, and pumped or forced by gravity upward to the overflow area. The heap materials will be entirely saturated such that the all the flow passes through the saturated heap materials, which will become coated by a biofilm of microbes that will ultimately drive the metals treatment process. By providing a shallow layer of standing water over the top, short circuiting to the discharge location will be avoided.

- The solution application process will utilize a similar or slower solution application rate as the heap leaching process itself. For instance, a common range of solution application is 5-20 liters/m^2/hour (Bliewas, USGS 2012 Open-File Report 2012–1085). A solution application rate for biological treatment will typically be half or less than the solution application rate utilized in the actual heap operations. While a design solution application rate has been suggested for the Project based on column test work, the actual solution application rate should be reviewed as it will vary during the life of the project as the heap leach characteristics are determined in the full scale configuration. For this study plan a solution application rate of 5 liters/m^2/hour is assumed.

- Based on the assumed solution application rate, a drip emitters spacing will be utilized so that the material in the heap materials are wetted and maintained wet during the course of the test operation.

- Heap materials will be tested prior to the treatment test for soluble cyanide and nitrogen species using a meteoric water mobility test or hot water rinse. Heap materials will be re-tested after the test operation to compare reduction in solid phase concentrations.

- Heap materials loaded into the bioreactor tank should be tested for metals and sulphate using a meteoric water mobility test or hot water rinse, as well as for hydroxylamine-extractable iron (described in Lovely and Phillips, 1987). Soluble metals, cyanide and nitrogenous species will be measured in the overflow of the bioreactor tank after it is filled, and continue at a frequency equivalent to each calculated pore volume exchange through the rest of the test.

3.2 COLUMN OPERATION

The following summarizes essential aspects of the column operations:

- Barren solution from the ADR will be filled into a holding tank (approximately 5,000 liters) and replenished periodically. Molasses amendment will be added to and mixed into the barren solution every time it is replenished. The molasses concentration will account for both solid and soluble cyanide and reduced nitrogen species. Low levels of phosphoric acid will be added to the molasses to stimulate microbial growth at a C:P molar ratio of approximately 100:1. (This ratio is based on experience; all heap materials will contribute some phosphate, though its solubility will be initially limited.) The purpose of the P amendment is to stimulate microbial growth, where P limitation can be a factor in the transition from an autotrophic setting (which the heap is during leaching) to a heterotrophic setting (which the heap will be during biological detoxification).

- Drainage from the column or lysimeter will be amended with alcohol (methyl or ethyl alcohols or a mixture of both are acceptable) and directed to the bioreactor. Alcohol amendment concentration will account for soluble oxidized nitrogen species (nitrate, nitrite), soluble metals, sulphate, and a portion of hydroxylamine-extractable iron measured in the heap materials. The objective of the alcohol amendment is to support microbial conversion of the metals into primary metal sulphides via sulphate reduction and metal sulphide precipitation (e.g., FeS, FeAsS, CuS, etc.).

- The overall duration of the solution application will continue for approximately 90 days, then allowed to drain for 10 days at the end for an overall duration of ~100 days. The expectation is that it will take approximately 60 days for the treatment to biologically detoxify the heap materials, and that sulphate reduction will become fully effective in the bioreactor within this same time period, allowing for three samples at the end of the test (i.e., day 70, day 84, and day 98) to show treated effluent concentrations from both the biological detoxification test and from the bioreactor test.

- The solution concentration of molasses in the feed solution will be what is stoichiometrically required to account for equimolar sugars and cyanide and reduced nitrogenous forms in the barren solution and the heap solids, with these compounds including:

    - Total cyanide,
    - WAD cyanide
    - Cyanate,
    - Thiocyanate,

- Ammonia.

Note: biological detoxification is accomplished in two phases: the first is a rapid reaction of sugars with free or weakly complexed cyanide (minutes to hours), and the second is a slower reaction that is microbially-catalyzed, where microbes that are naturally present in the ore materials grow and utilize cyanide as a nitrogen source, or detoxify cyanide to render the pore water environment more benign from a microbial perspective. Microbial growth is stimulated by the addition of a carbon source at a typical molar ratio of 0.5:1 sugars to cyanide (i.e., 4:1 C:N ratio). In prior heap detoxification experience, this ratio has been highly variable (i.e., as low as 3:1 and as high as 10:1), and other nitrogen species (nitrate/nitrite or ammonia) can be a bigger control on carbon demand; however, in a test column the WAD and free cyanide are typically the driver of a carbon demand. Total cyanide is assayed to understand if heap drainage could have a secondary CN formation upon exposure to sunlight where FeCN complexes could break down and release free CN.

- The solution concentration of alcohol in the bioreactor feed solution will be what is stoichiometrically required to account for biological reduction of soluble and sorbed species:
  - Nitrate plus nitrite,
  - Divalent cationic metals soluble and sorbed that form primary sulphides: Cd, Cu, Ni, Zn etc.
  - Metalloids that can be incorporated in sulphides: As, Sb
  - Soluble or hydroxylamine-extractible Fe
  - Sulphate that is sufficient to form sulphide and precipitate the above metals
  - Elements that form reduced insoluble (non-sulphide) precipitates: Cr, Se.
- Test operation (i.e., solution and reagent amendment) will continue until stable data for relevant constituents has been achieved for three consecutive data points (four weeks if sampled every 14 days) to determine end points relevant to active WTP design and CWTS design. As currently conceptualized, drainage from the biological detoxification column is expected to be relevant to active water treatment during heap draindown, and drainage from the bioreactor tank is expected to be relevant to the CWTS that would be constructed in the events pond or other areas.

3.3 Post-Test Closure Simulation

At the end of the test, the biological detoxification test will have cover soil placed on the surface using the design that is contemplated for the heap. All flow from the biological detoxification test will be routed through the bioreactor such that the combined biological detoxification and bioreactor processes simulate the heap unsaturated and saturated areas.

Drainage from the bioreactor will then be collected in a buried holding tank and pumped dry quarterly. The volume of the drainage should be measured, and water chemistry assayed for all licence parameters and field parameters (DO, pH, conductivity). No special treatment will be done to ensure flow through the seasons, and it is expected that the columns or tanks may freeze and thaw and the effect of this will be assessed over the subsequent quarterly testing.

While of limited use in predicting cover performance (as this test will simulate only a small area in a setting that reflects only a single aspect that is present in the heap area) this information will show the effect of continued input of meteoric water and any rebound from areas less treated on the chemistry of the combined areas.

4 References

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*.

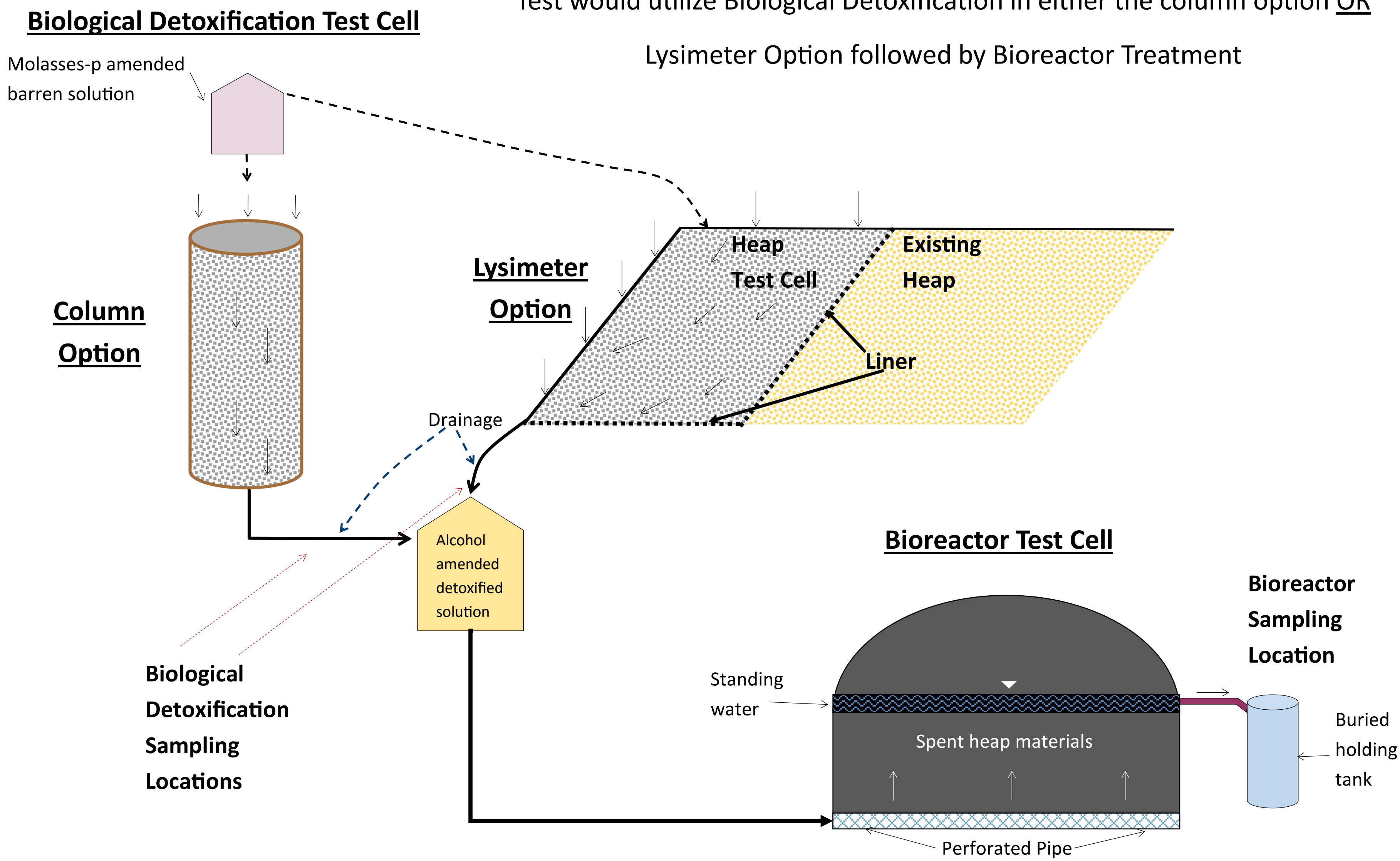
Lovely, Derek R.; Phillips, Elizabeth J. 1987. Rapid Assay for Microbially Reducible Ferric Iron in Aquatic Sediments. Applied and Environmental Microbiology. v53(7). 1536-1540.

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



APPENDIX D

Closure Pipe Design Analysis

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BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
Suite 500 - 980 Howe Street, Vancouver, BC Canada V6Z 0C8
Telephone (604) 684-5900 Fax (604) 684-5909

Project Memorandum

To:	**File**	**Doc. No.:**	
From:	**Troy Meyer and Derek Hrubes**	**Date:**	**June 29, 2018**
Subject:	**Closure Pipe Design Analysis**		
Project No.:	**0792021**		

1.0 INTRODUCTION

The purpose of this memorandum is to present the methods and results of the closure drain pipe analysis completed for the design of the proposed Heap Leach Facility (HLF) at StrataGold Corporation's (SGC) Eagle Gold Project located in Yukon Territory, Canada. SGC is a directly held, wholly owned subsidiary of Victoria Gold Corp. The HLF design is presented in a report titled "Eagle Gold Project Heap Leach Facility Detailed Design", issued by BGC Engineering and dated January 2018. Select Design Drawings have been provided in Attachment 1 for reference.

2.0 CLOSURE SYSTEM DESIGN

During closure of the HLF, the cyanide in the spent ore will be destructed, the heap will be rinsed and draindown flows will be managed through the existing pumping system. Once draindown flow and water quality are acceptable for the passive treatment system, the liner system below the In-Heap Pond will be punctured by drilling to allow complete drainage of water through a pre-installed outlet system into the closure sump. The closure sump drain system will consist of a linear low-density polyethylene (LLDPE) lined gravel sump with perforated N-12 pipe drain loop directing flow to high-density polyethylene (HDPE) outlet pipes (Drawing 05-04, Detail 31). The closure sump will be placed directly below the leak detection sump to direct residual flows from the leak detection system to the closure outfall (Drawing 05-02, Detail 22).

At closure, the liner system will be punctured by drilling through two 250 mm open casing pipes extending to the In-Heap Pond installed during initial construction (Drawing 05-04, Detail 33). The PLS and LDRS Sump liners will be punctured by a drill string which will be lowered through each casing. A series of steel plates installed during initial construction will guide the drill and stop the drilling head at the appropriate depth within the closure sump. Once the drill string is retrieved, fluid will drain through the punctured liner into the closure sump where it will enter the closure drain loop and drain by gravity to the outlet monitoring vault (Drawing 05-05, Detail 37). Three 150 mm SDR 11 HDPE pipes lead from the closure drain loop at a minimum 2% slope; approximately 40 m downstream from the closure sump at approximately Station 2+72, the three drain pipes merge into one 150 mm SDR 11 HDPE pipe where the grade steepens significantly (Drawing 03-05). This pipe transitions into one 150 mm SDR 17 HDPE pipe at approximately Station 1+80, once there is a sufficient reduction in the buried depth (Drawing 03-05).

The closure drain pipes will be installed such that they connect to the monitoring vault and to allow for water quality and quantity monitoring (Drawing 05-06). An additional closure pipe will be installed to connect from the event pond to approximately Station 0+40 of the design closure pipe alignment, complete with valves to direct flow, as shown in Figure 2-1.

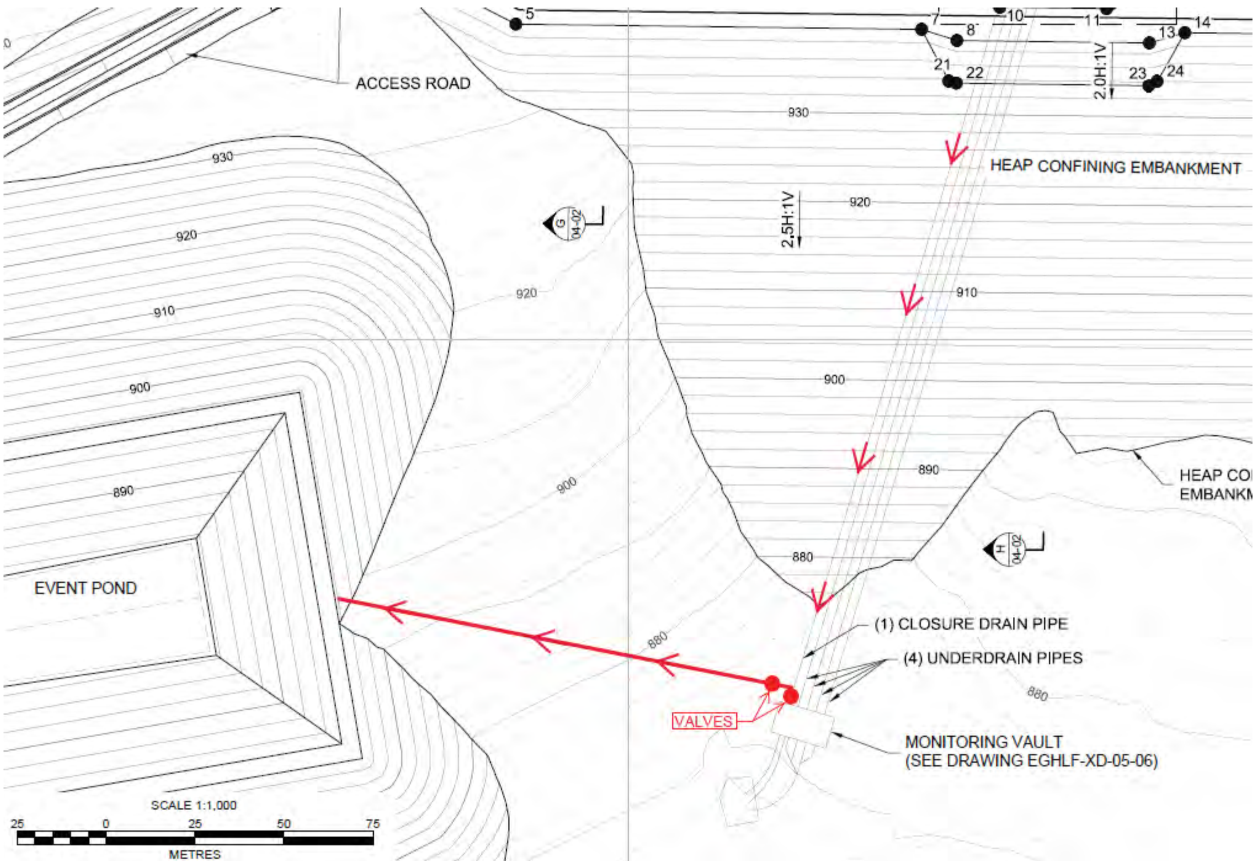

Figure 2-1. Proposed connection pipe alignment

The additional section of closure pipe will be required to flow under confined pressure uphill and this analysis is being performed to verify that there is sufficient elevation (head) difference between the closure sump and the event pond for the pipe system to convey the anticipated design flow at closure and through the post closure period.

3.0 CLOSURE PIPES

Solid wall HDPE pipe is specified for the closure pipes downstream of the closure drain loop. SDR 11 and SDR 17 HDPE pipe are used for the closure system based on the amount of overburden pressure at each section. Pipe sectional properties were obtained from available vendor product data and are presented in Table 3-1.

Table 3-1. Non-perforated solid wall HDPE pipe properties.

Dimension Ratio	Nominal Diameter (mm)	Outside Diameter (mm)	Inside Diameter (mm)	Wall Thickness (mm)	Pressure Rating (psi)	Manning's Roughness Coefficient
11	150	168	136	15.3	160	0.011
17	150	168	147	9.9	100	0.011

The additional section of closure pipe has been modeled as SDR 17, due to the minor amount of overburden pressure anticipated post-installation.

4.0 ANALYSIS METHOD

Hydraulic modeling was performed using Autodesk's Storm and Sanitary Analysis 2018 program, Version 12.0.42.0. The Storm and Sanitary Analysis 2018 program is capable of modeling complex hydrology and hydraulics, through detailed catchment and conveyance system definition. This is accomplished by inputting basins (catchments) and linking these with hydraulic elements (channels, pipes, manholes, ponds, orifices, weirs, etc.). The hydraulic model elements used for this analysis were used to provide results including peak flows, water surface elevations (hydraulic grade lines), and energy grade lines.

Numerous analysis methods are available for use within the Storm and Sanitary Analysis 2018 program. Since one of the pipes does have an uphill slope, where the outlet elevation is higher than the inlet elevation, the system required analysis with hydrodynamic routing.

A flow rate of 10 litres per second (l/s) was modeled to confirm conveyance within the system, based on anticipated maximum closure flow rates provided by SGC.

5.0 ANALYSIS RESULTS

A summary of the results of the hydraulic model for a flow rate of 10 l/s are summarized in Table 5-1 and Table 5-2. A model plan view, detailed output report, and hydraulic profile are provided in Attachment 2.

Table 5-1. Summary of hydraulic link results (10 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	10
2_SDR17	10
3_SDR17	10
4_SDR17 (DIVERSION)	10

Table 5-2. Summary of hydraulic node results (10 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.04	~ 0
STA. 1+81.4	890.80	6.42	9.13
STA. 0+58.2	871.40	24.91	34.43
STA. 0+40	869.80	26.42	**37.58**
EVENT POND	896.00	0.04	~ 0

Routing 10 l/s through the closure pipe system identified that the system could adequately convey this assumed flow, without backing water into the in-heap pond behind the embankment. The maximum head pressure anticipated for a flow rate of 10 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 37.58 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

The potential flow capacity within the closure pipe system increases as the elevation (head) difference between the water levels in the closure sump and the event pond increases. A sensitivity analysis was performed, and it was estimated that water would begin backing up into the in-heap pond once the flow rate exceeds approximately 19 l/s. The piping system is capable of conveying flows in excess of this through an increase in pressure head if the In-Heap Pond impounds water. However, the maximum flow rate is likely dictated by the hydraulic conductivity of the gravel surrounding the closure drain loop, within the closure sump.

A summary of the results of the hydraulic model for a flow rate of 19 l/s are summarized in Table 5-3 and Table 5-4. A detailed output report and hydraulic profile are provided in Attachment 3.

Table 5-3. Summary of hydraulic link results (19 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	19
2_SDR17	19
3_SDR17	19
4_SDR17 (DIVERSION)	19

Table 5-4. Summary of hydraulic node results (19 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.06	~ 0
STA. 1+81.4	890.80	9.67	13.75
STA. 0+58.2	871.40	27.72	39.43
STA. 0+40	869.80	29.04	**41.30**
EVENT POND	896.00	0.05	~ 0

The maximum head pressure anticipated for a flow rate of 19 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 41.30 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

6.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of StrataGold Corporation. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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Yours sincerely,

BGC ENGINEERING INC.
per:

Troy Meyer, P.Eng.
Principal Engineer

Derek Hrubes, P.E.
Civil Engineer

Reviewed by:

Brad Bijold, P.E.
Principal Engineer

Engineers Yukon Permit to Practice
PP092 BGC Engineering Inc.

TM/HW/rm/pg

ATTACHMENT 1
SELECT PHASE 1 FINAL DESIGN DRAWINGS

EGHLF-XD-03-05

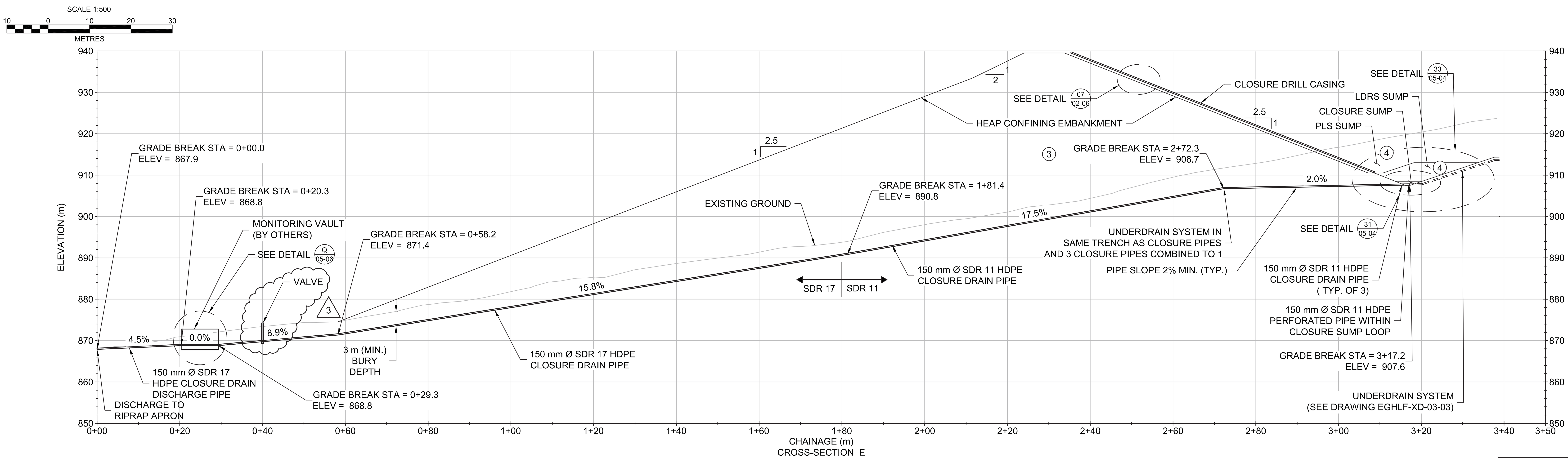
EGHLF-XD-05-02

EGHLF-XD-05-04

EGHLF-XD-05-05

EGHLF-XD-05-06

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.



LEGEND

2	SELECT FILL
3	STRUCTURAL FILL
4	OVERLINER DRAIN FILL
5	SELECT DRAIN FILL

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

ISSUED FOR CONSTRUCTION

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	CLOSURE AND UNDERDRAIN ALIGNMENT AND PROFILE REVISED
2	17	10	12	DAG	TLM	MEH	TLM	REVISED PIPE SDR
3	18	06	27	DAG	TLM	MEH	TLM	ADD VALVE AT STATION 0+40

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 09/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 09/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: CLOSURE PIPING PLAN AND PROFILE

SCALE:	DWG No.:	REV.:
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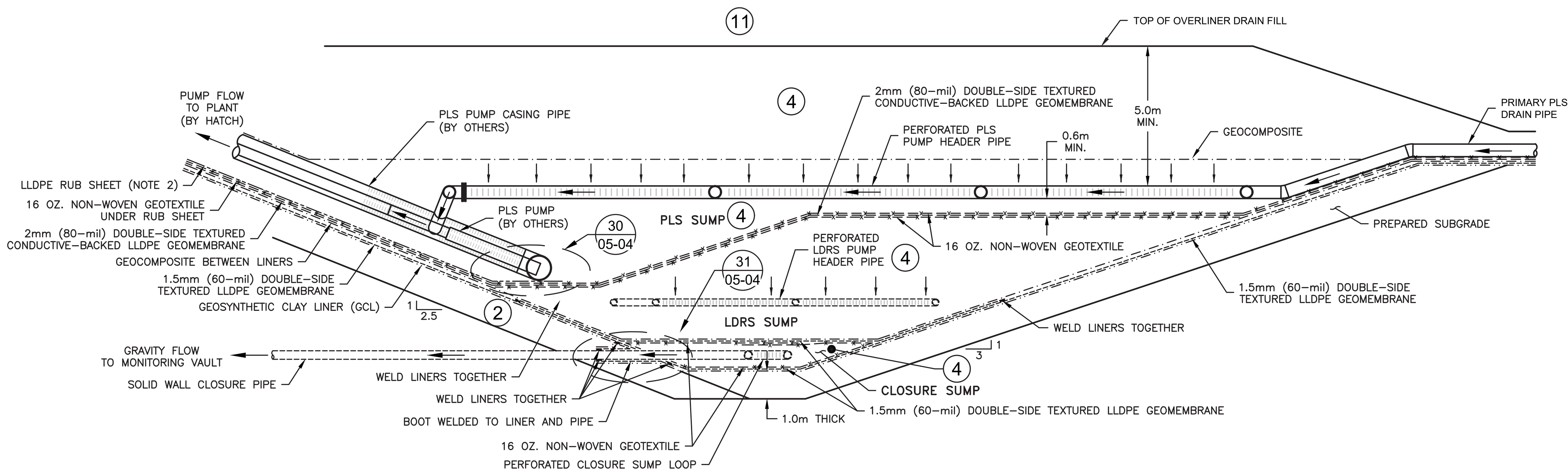
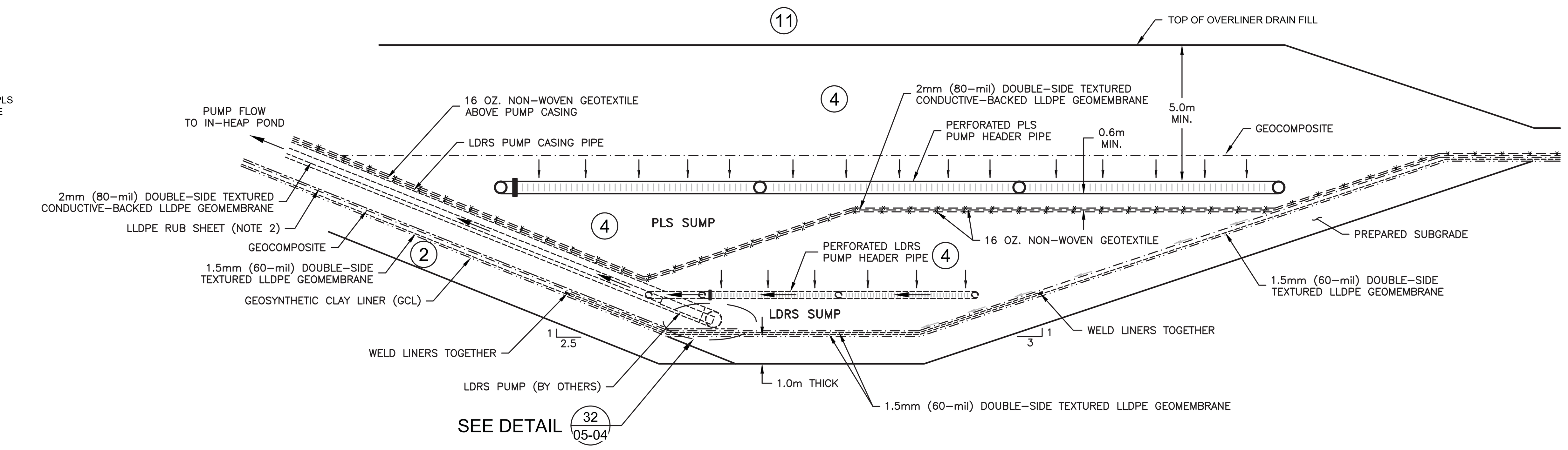


PLS, LDRS & CLOSURE SUMP DETAIL 22/05-01



PLS, LDRS & CLOSURE SUMP DETAIL 23/05-01

PLS, LDRS & CLOSURE SUMP DETAIL 24/05-01

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

LEGEND

- (2) SELECT FILL
- (4) OVERLINER DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

NOTES:

1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
6. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

PROFESSIONAL ENGINEER — YUKON TERRITORY — TROY LEE MEYER — 03 JAN 18

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REVISION INFORMATION

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0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

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CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: IN-HEAP SUMP DETAILS SHEET 2 OF 2

SCALE:	DWG No.:	REV.:
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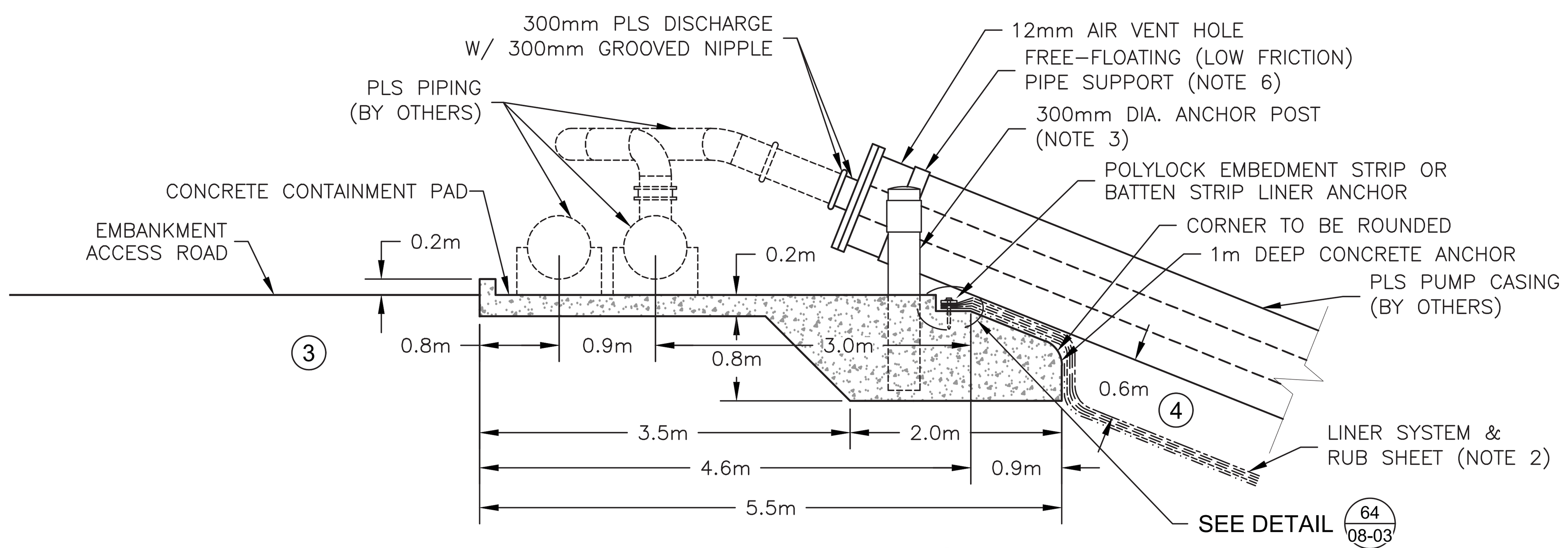

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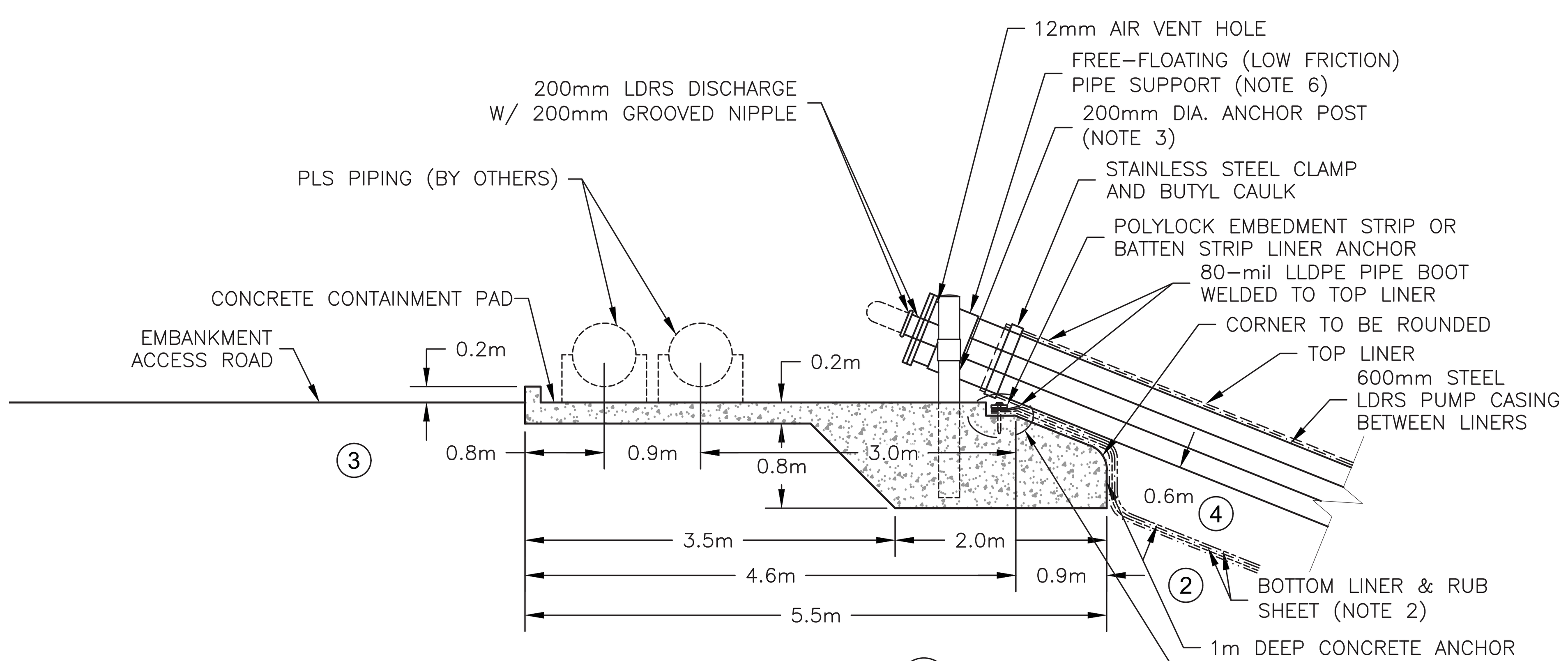

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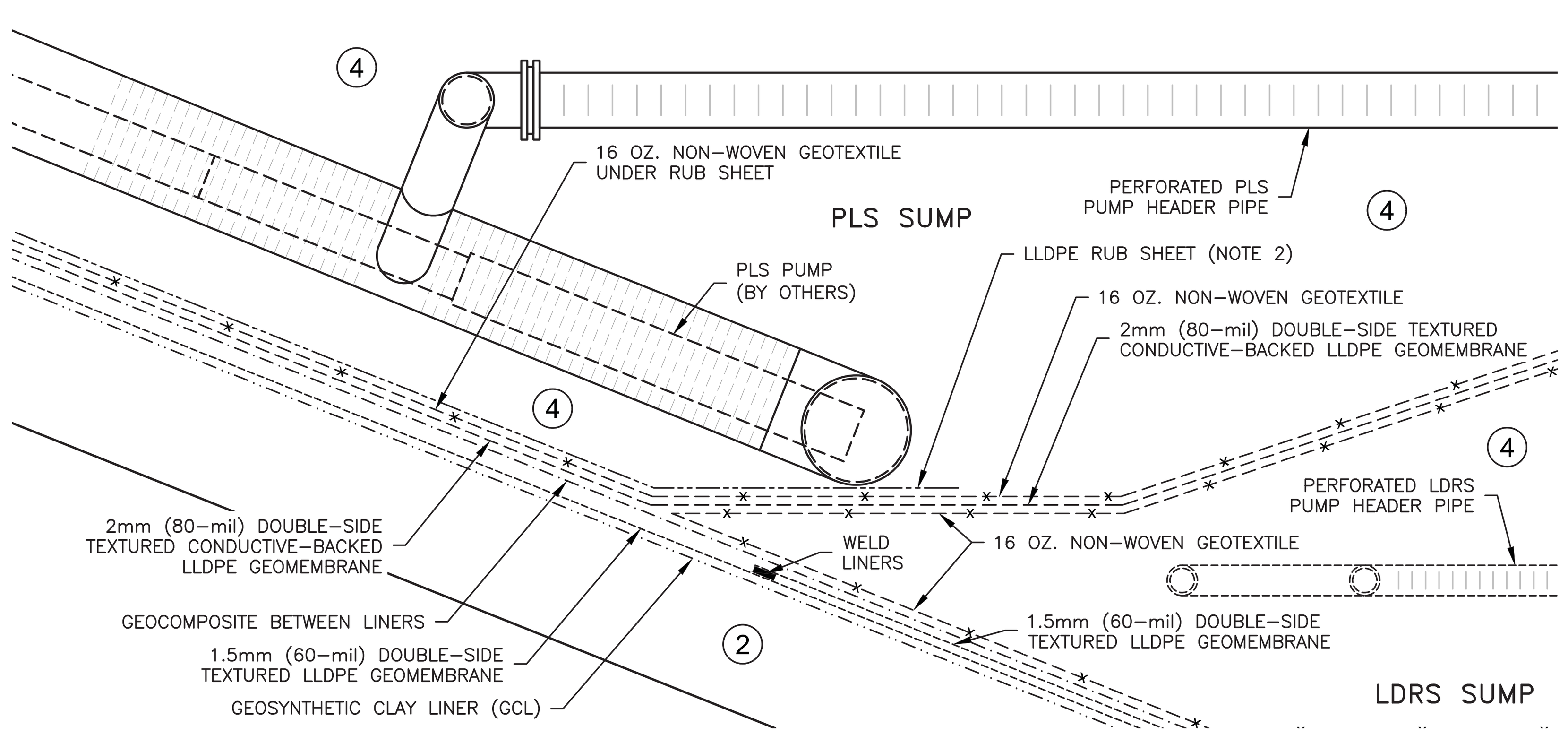

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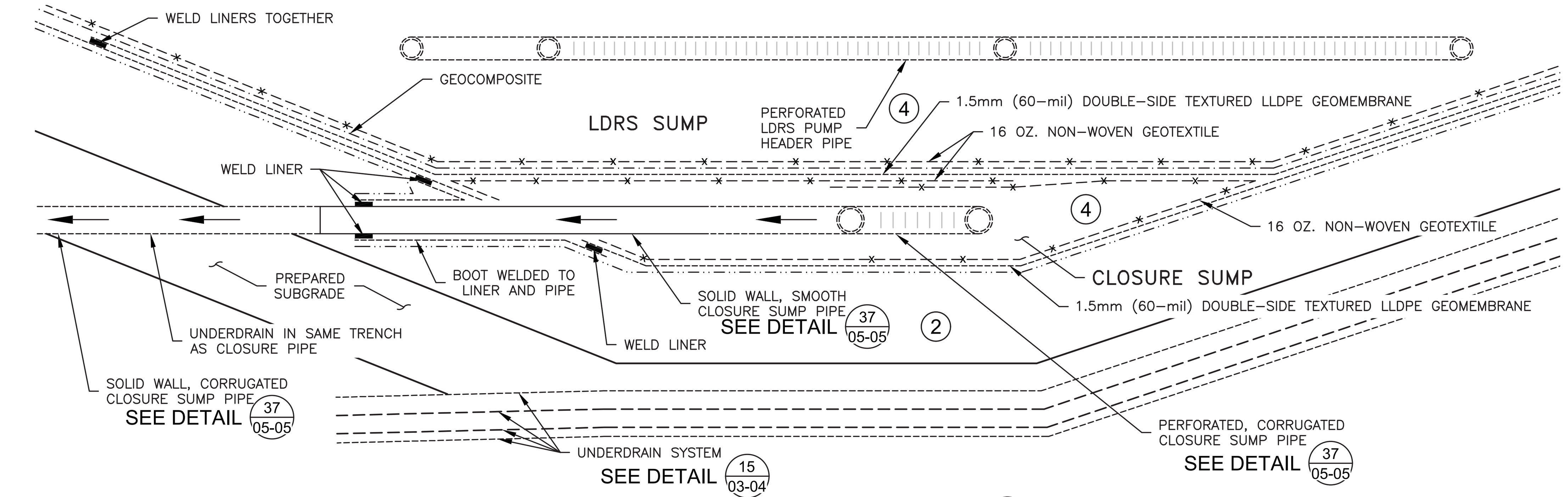
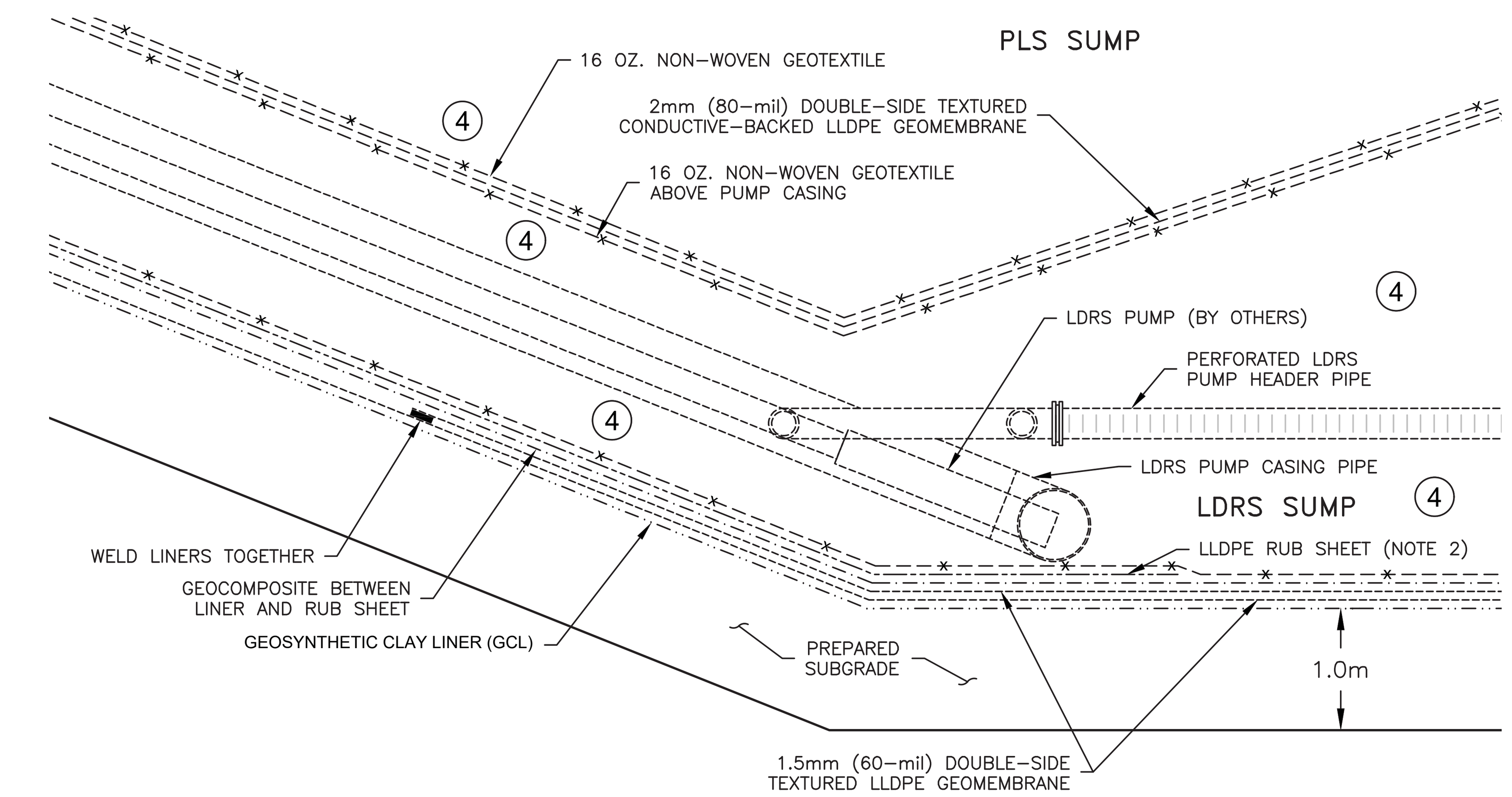
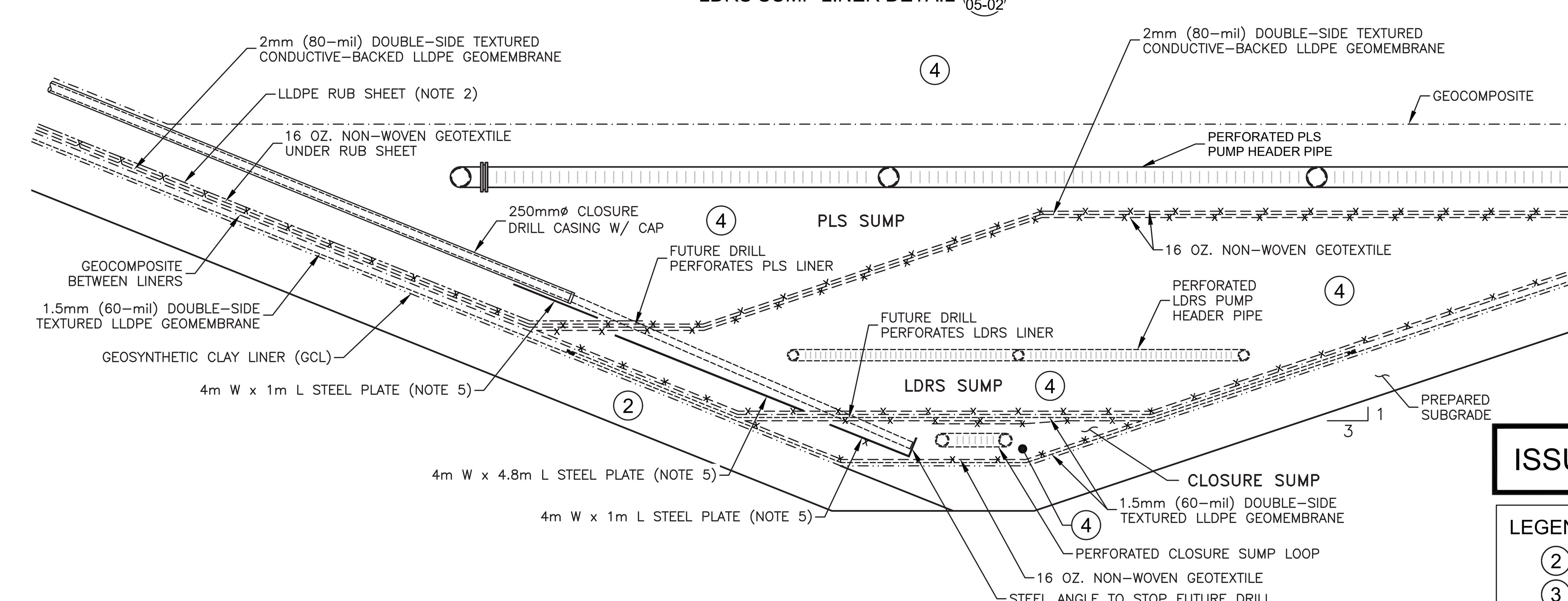


CLOSURE SUMP LINER DETAIL 31 05-02, 03-05



LDRS SUMP LINER DETAIL 32 05-02



CLOSURE DRILL CASING DETAIL 33 05-03

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

ISSUED FOR CONSTRUCTION

LEGEND
- (2) SELECT FILL
- (3) STRUCTURAL FILL
- (4) OVERLINER DRAIN FILL
- (5) SELECT DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR 16 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
6. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
7. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH GEOCOMPOSITE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

PROFESSIONAL ENGINEER — YUKON TERRITORY — TROY LEE MEYER — 08 JAN 18

X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-04.dwg Layout: PLS SUMP DETAILS SHEET 2 OF 2 Plot Date Jan 2 18 Time: 4:55 PM

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

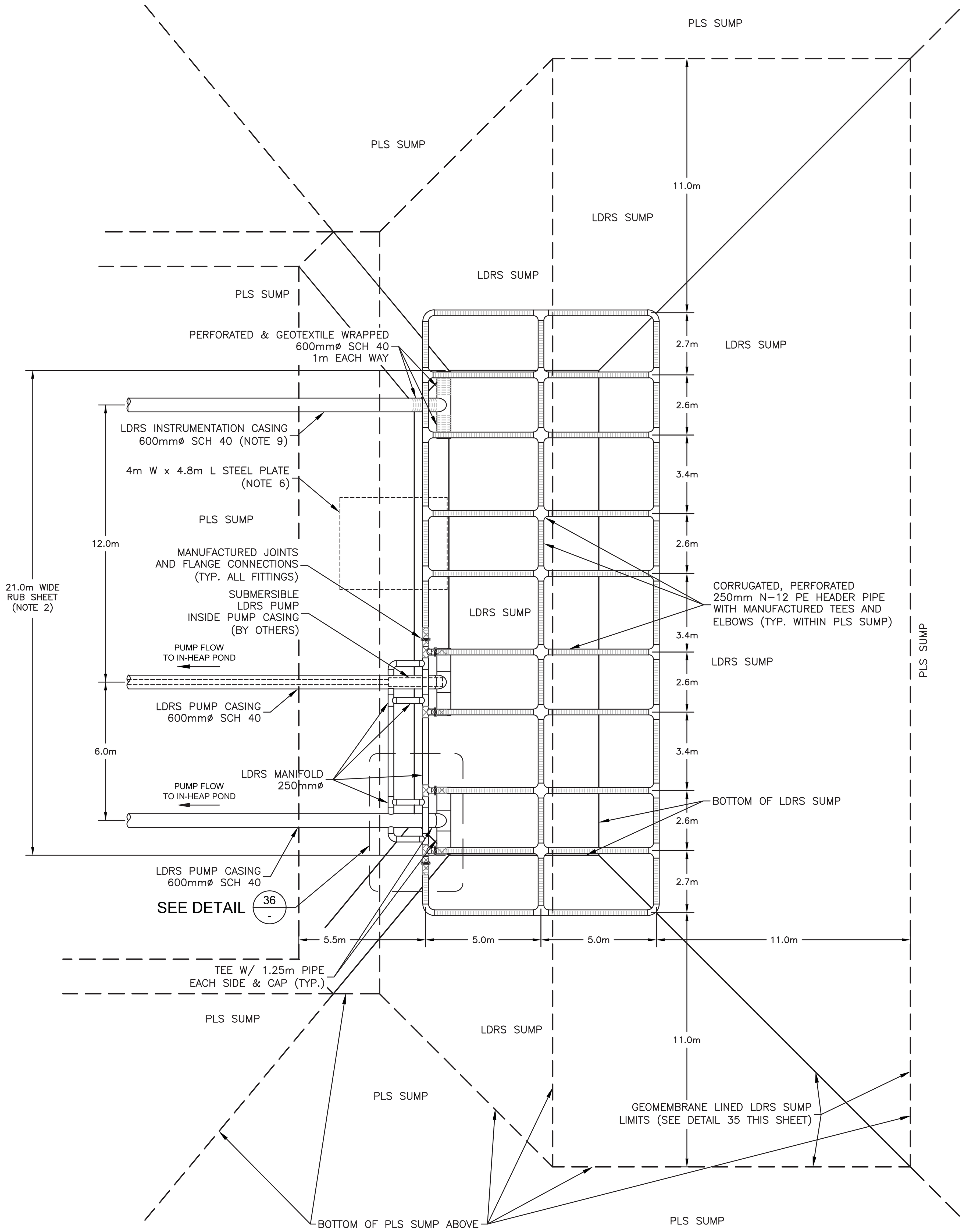
BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY

CLIENT: StrataGold Corporation

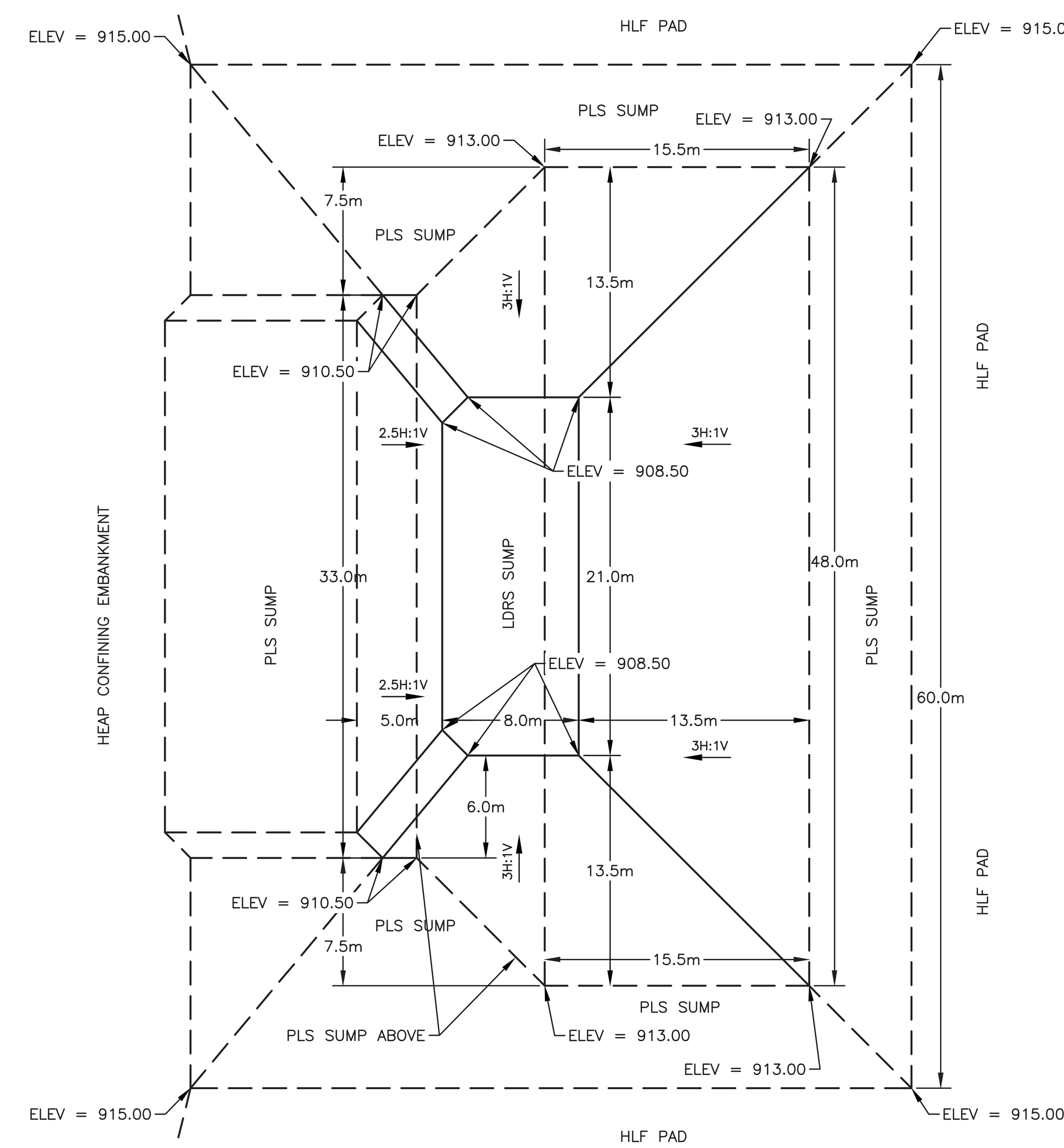
PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: PLS SUMP DETAILS SHEET 2 OF 2

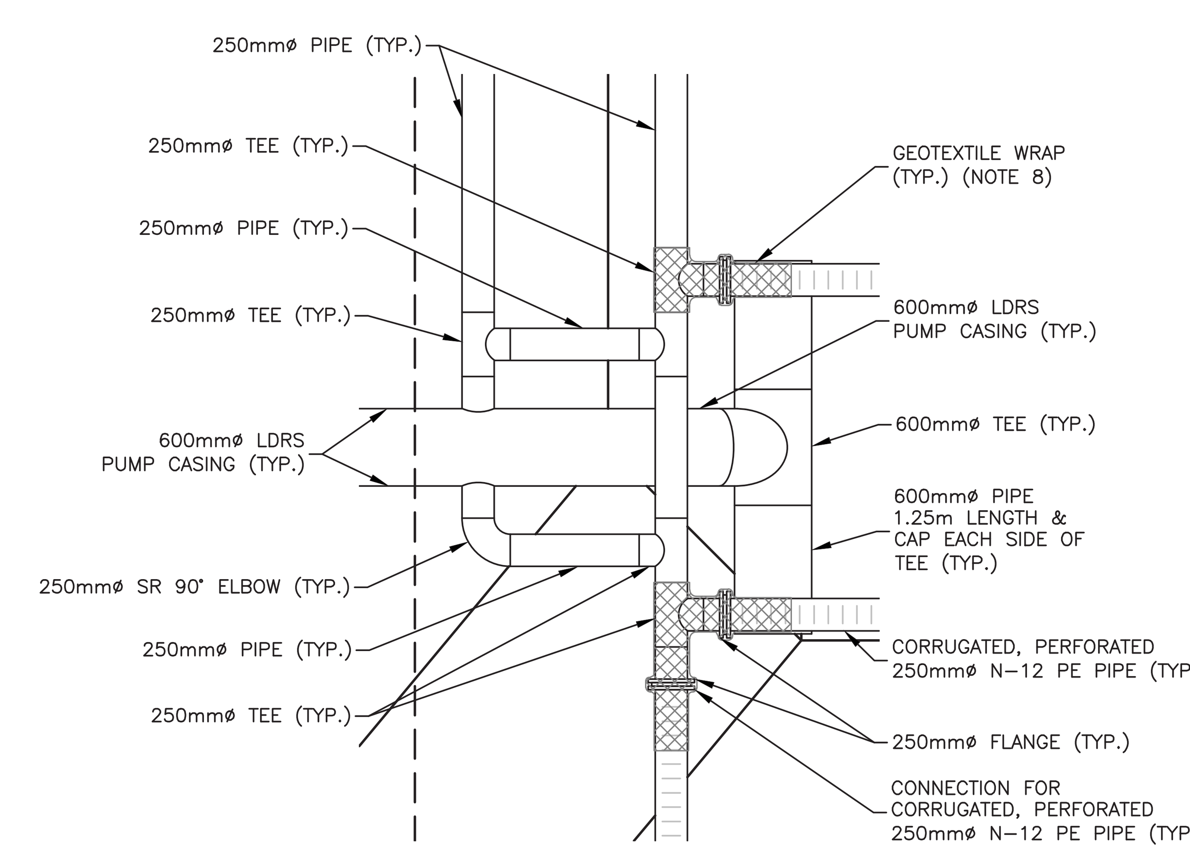
SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-04	0



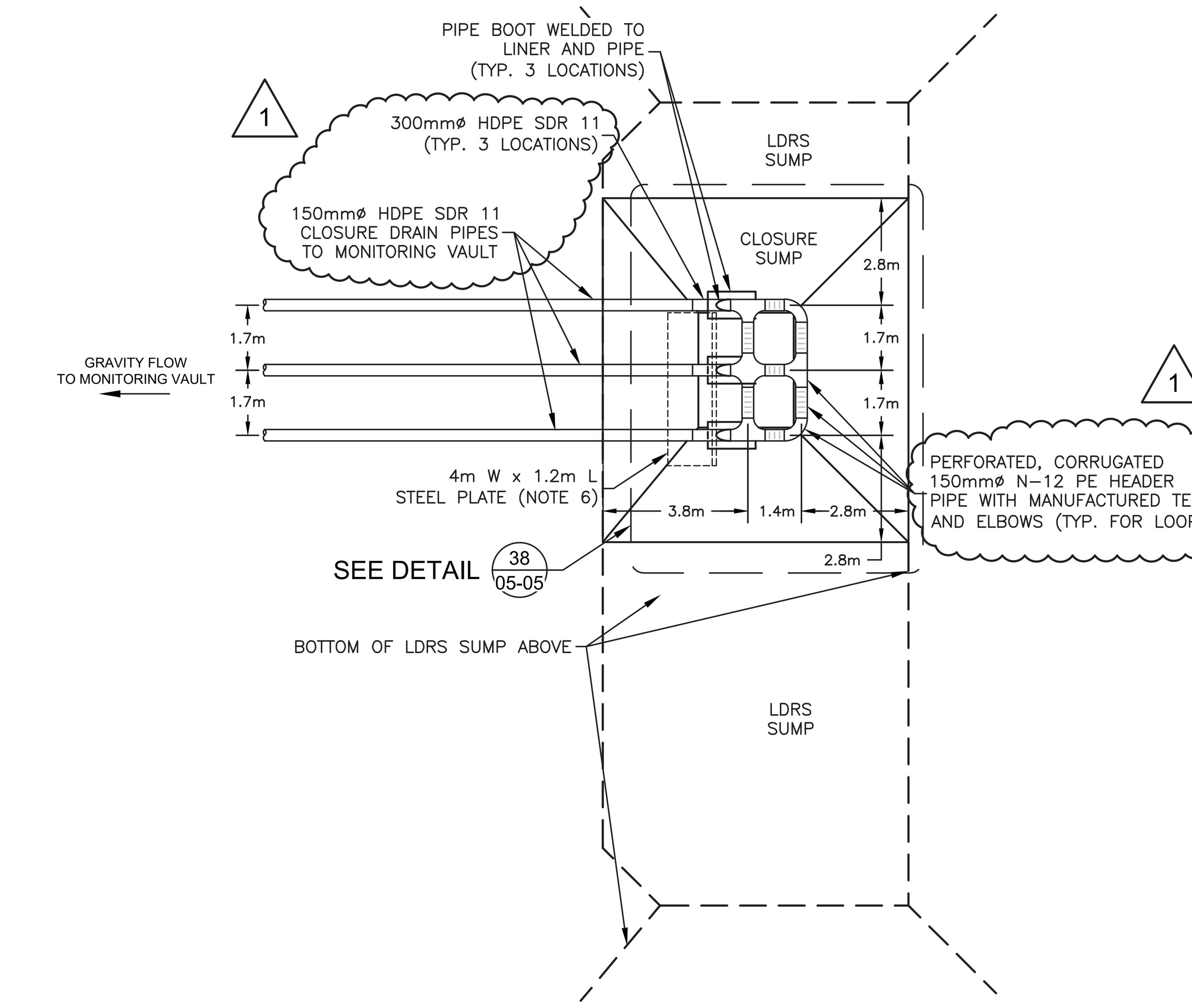
LDRS SUMP AND PIPING PLAN 34 / 05-01



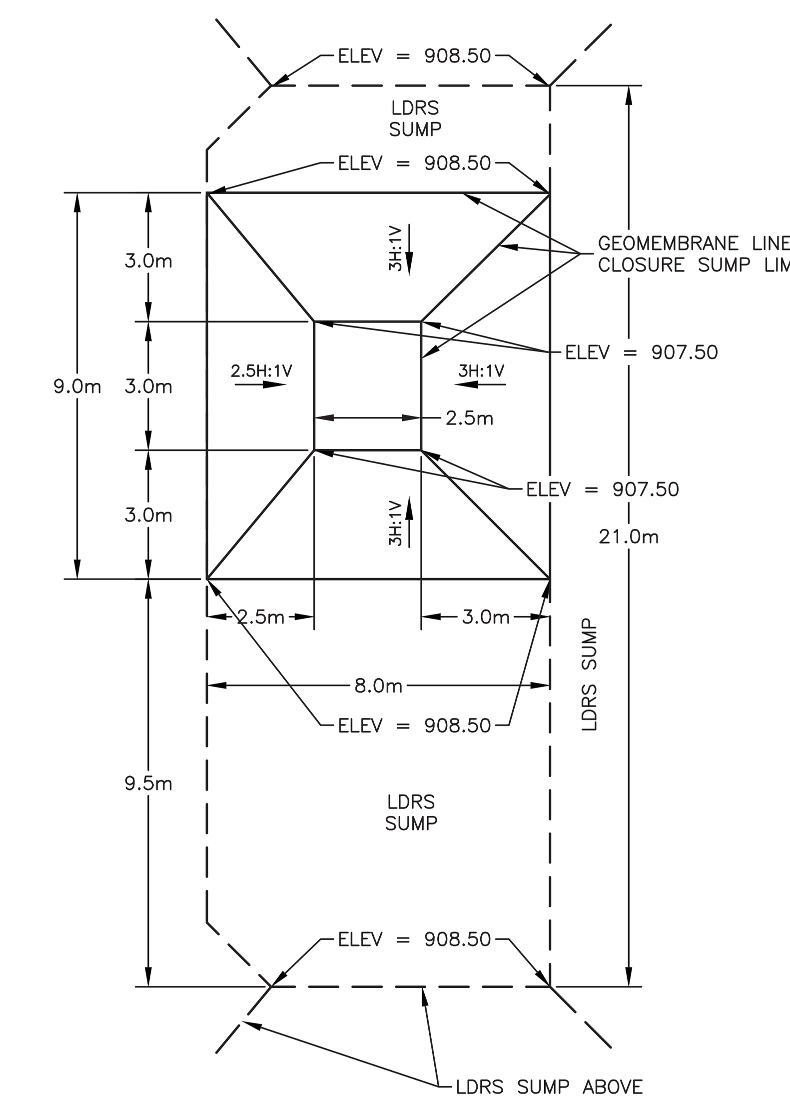
LDRS SUMP GEOMETRY DETAIL 35 / -



LDRS PIPING DETAIL 36 / -



CLOSURE SUMP AND PIPING PLAN 37 / 05-01, 03-05, 05-04



CLOSURE SUMP GEOMETRY DETAIL 38 / -

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. LDRS RISER PIPE ASSEMBLIES SHALL BE 600mm O.D. FABRICATED USING ASTM 139 HIGH STRENGTH LOW ALLOY STEEL (A606 TYPE 4.) MINIMUM PIPE WALL THICKNESS SHALL BE 17.5mm (SCH 40).
4. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
5. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
6. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR TWO LAYERS OF 12 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
7. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
8. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.
9. THE BOTTOM 2m OF LDRS INSTRUMENTATION CASING SHALL BE SLOTTED. SLOTTING IN THE STEEL PIPE SHALL BE 2mm WIDE BY 75mm LONG (MEASURED PERPENDICULAR TO PIPE FLOW) SPACED 150mm ON CENTER AROUND THE PIPE IN ROWS SPACED 150mm ON CENTER.

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	18	06	27	DAG	TLM	MEH	TLM	REVISE DETAIL 37 PIPES

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

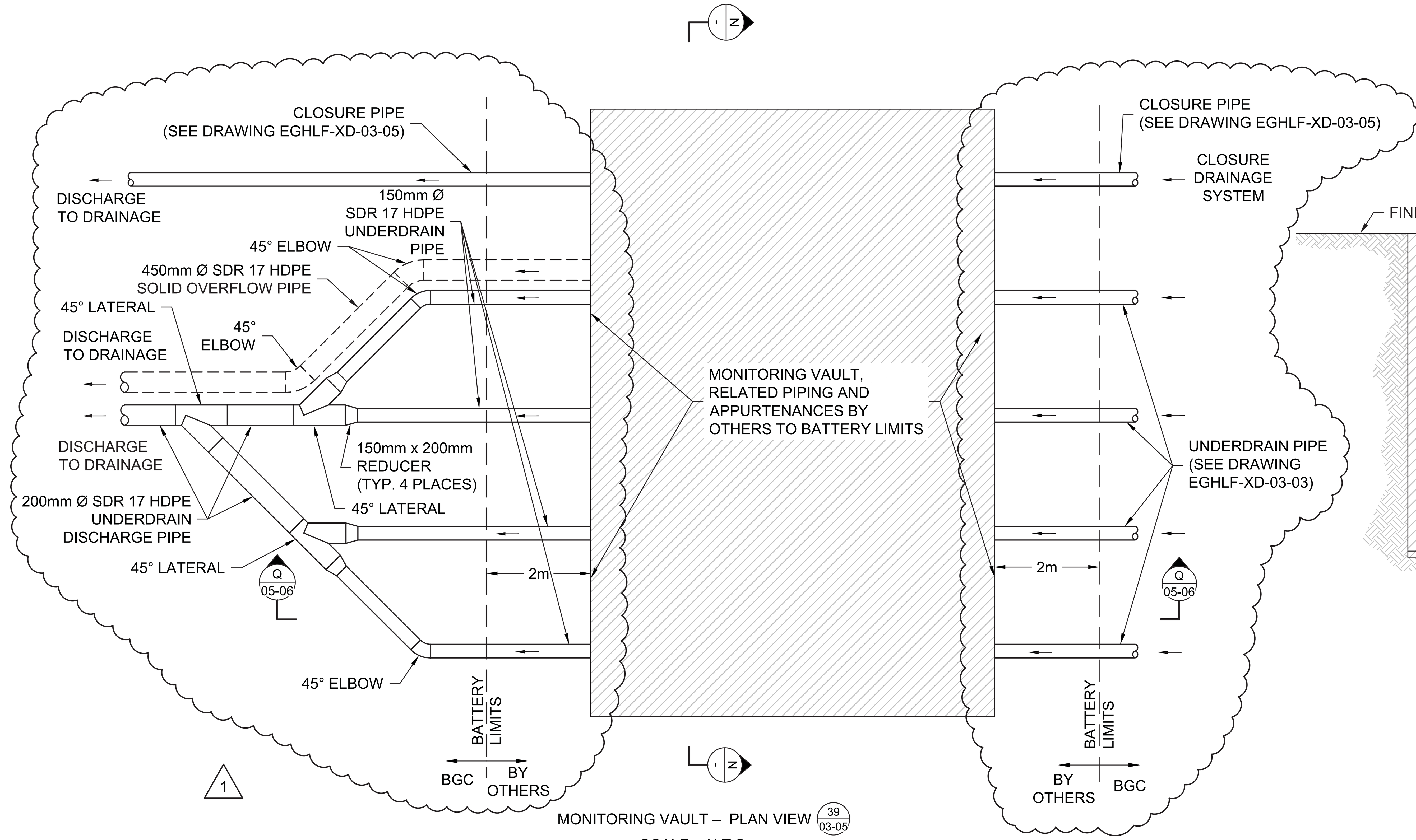
CLIENT:
StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

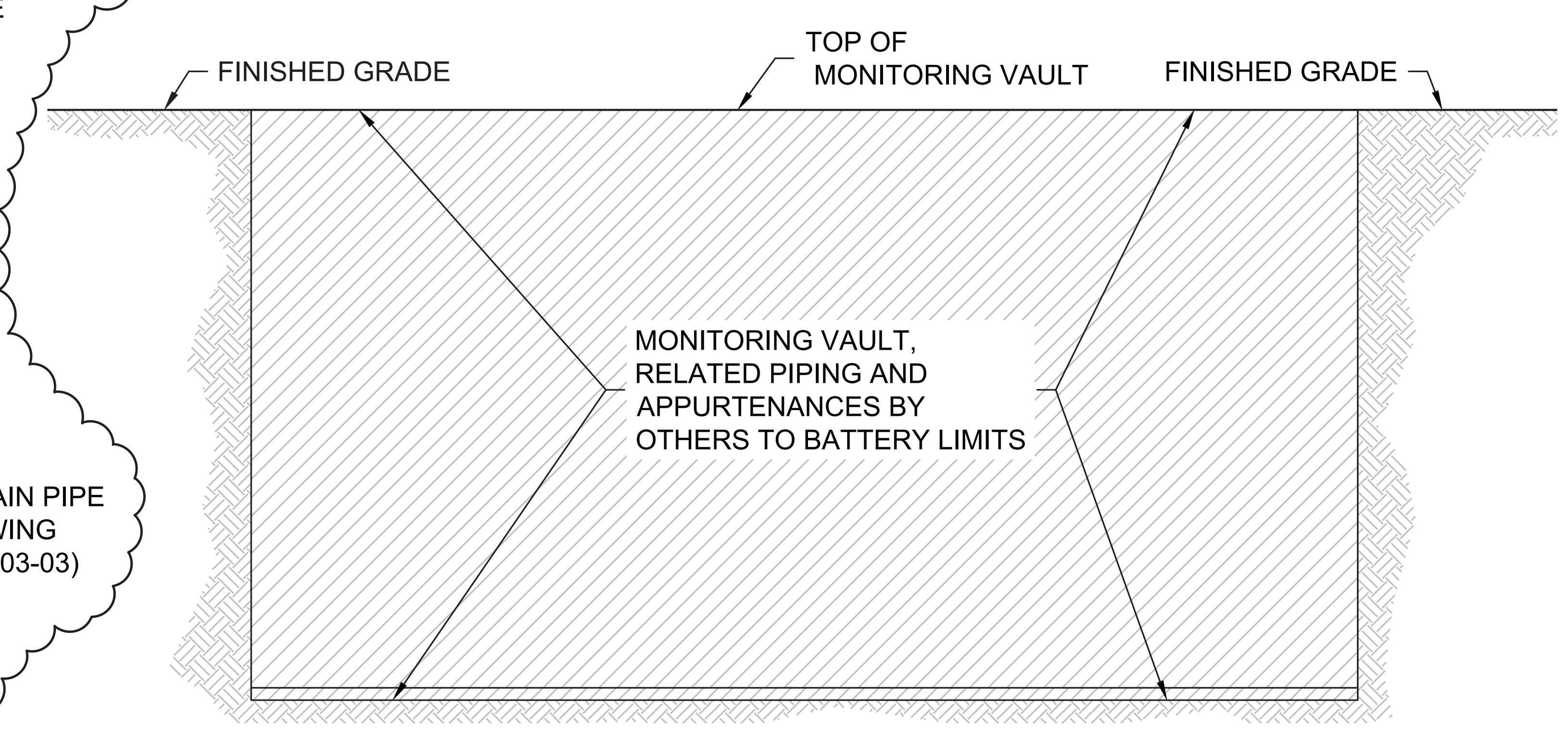
TITLE: LDRS AND CLOSURE SUMP DETAILS

SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-05	1

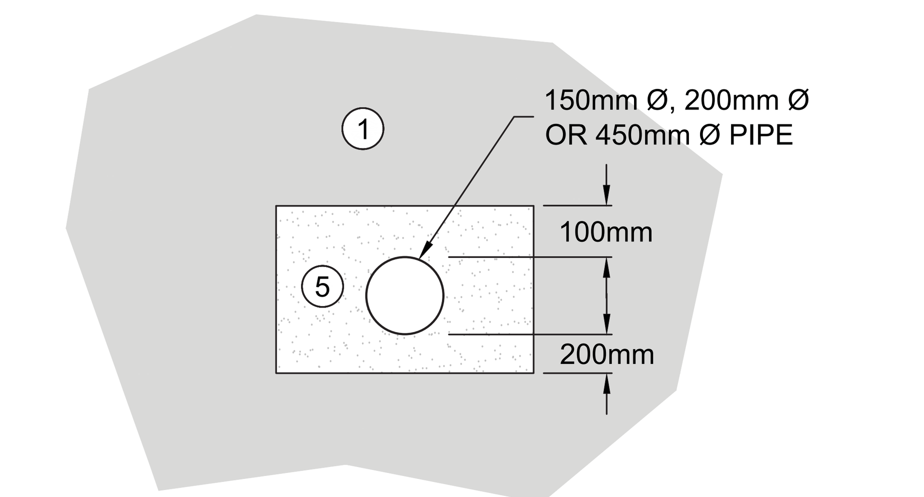
X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-05.dwg Layout: EGHLF-XD-05-05 Plot Date Jun 28 18 Time: 12:09 PM



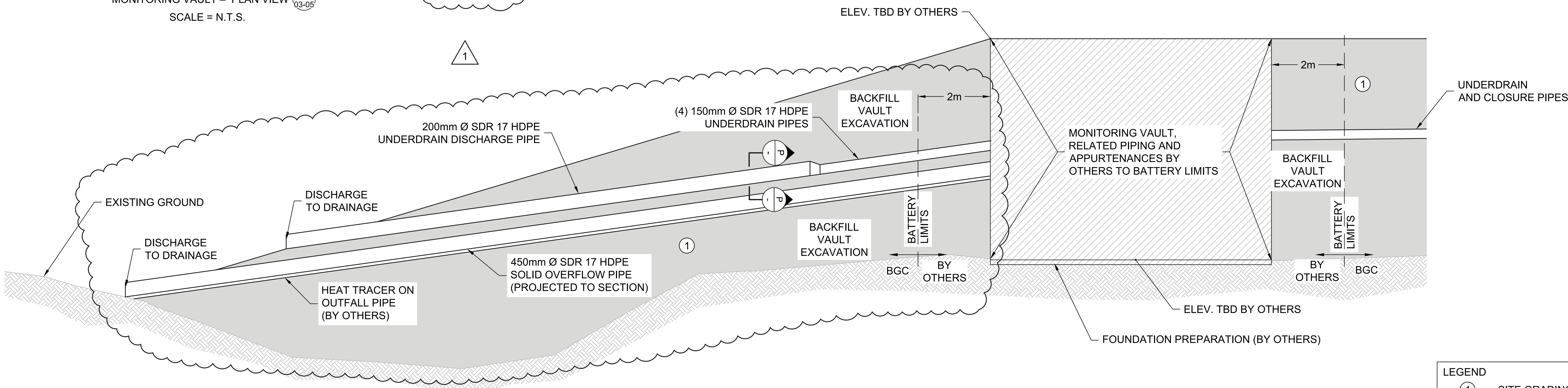
MONITORING VAULT – PLAN VIEW 39/03-05
SCALE = N.T.S.



CLOSURE OUTLET VAULT SECTION N/-
SCALE = N.T.S.



TYPICAL PIPE TRENCH DETAIL P/-
SCALE = N.T.S.



MONITORING VAULT – PROFILE VIEW Q/03-05
SCALE = N.T.S.

LEGEND
(1) SITE GRADING FILL
(5) SELECT DRAIN FILL

PROFESSIONAL ENGINEER — YUKON TERRITORY — TROY LEE MEYER — 03 JAN 18

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. MONITORING VAULT TO BE DESIGNED BY OTHERS AND SHOWN HERE FOR REFERENCE ONLY. BATTERY LIMITS FOR BGC DESIGN ARE 2 m FROM OUTSIDE OF MONITORING VAULT. DESIGN OUTSIDE TETRA TECH BATTERY LIMITS ARE FOR REFERENCE ONLY..

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	MONITORING VAULT DETAILS REVISED

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 09/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 09/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

CLIENT: StrataGold Corporation

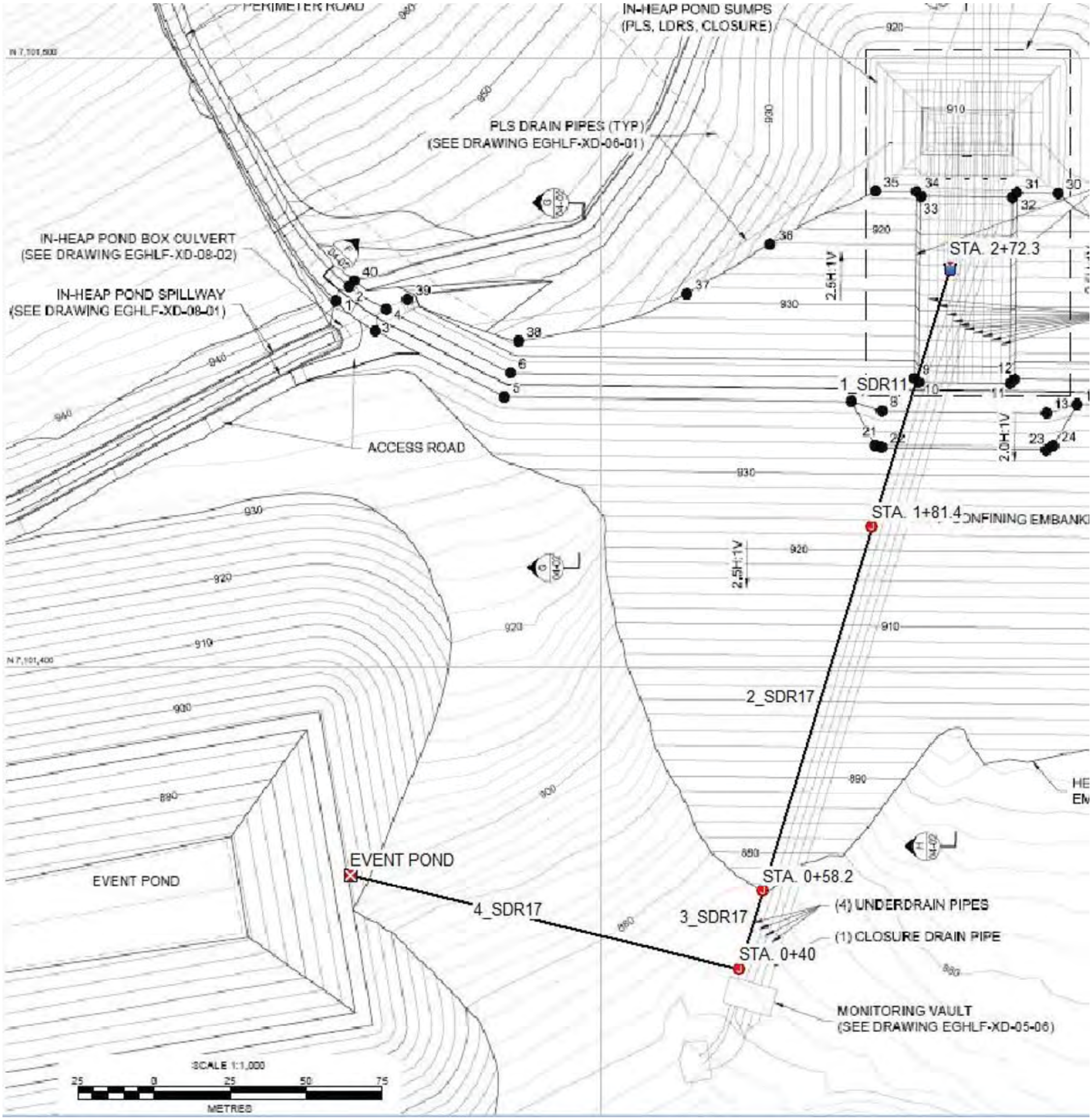
PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

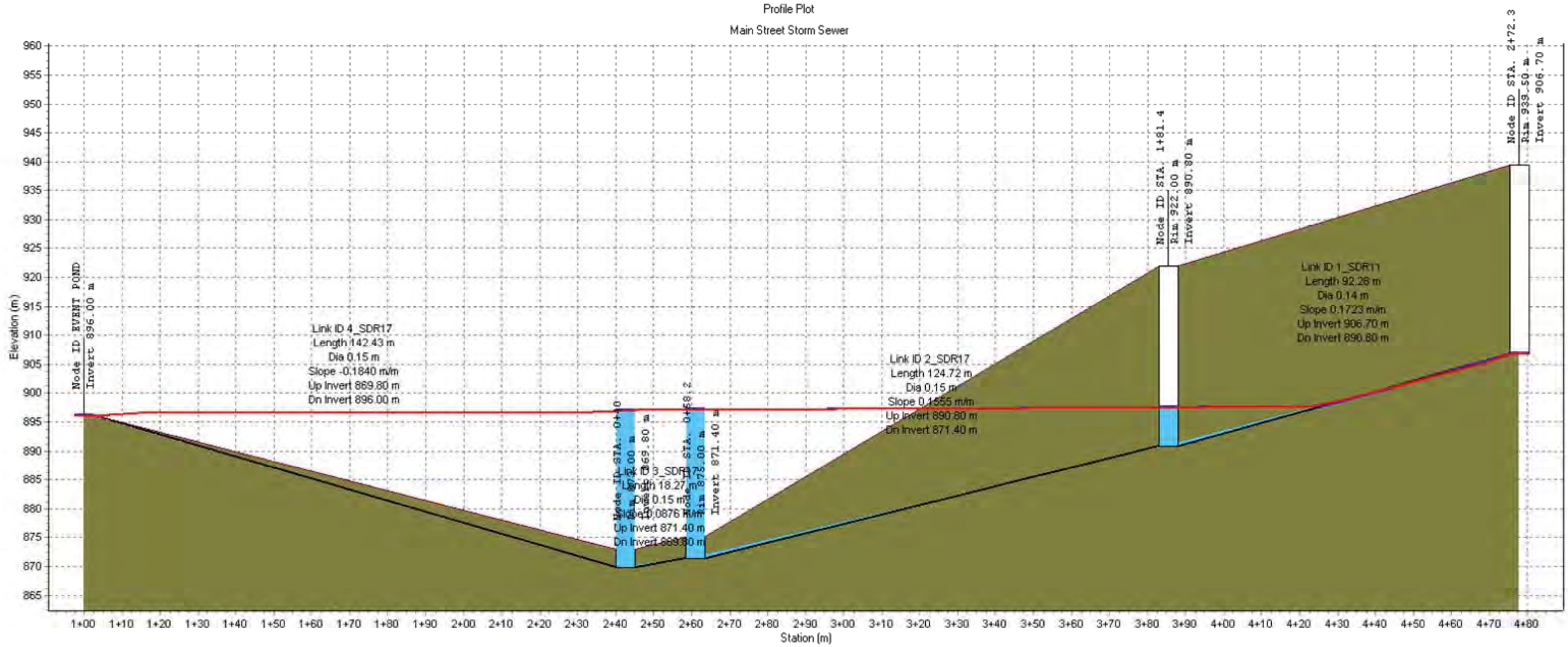
TITLE: MONITORING VAULT DETAILS

SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-06	1

X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-06.dwg Layout: EGHLF-XD-05-06 Plot Date Jan 2 18 Time: 5:12 PM

ATTACHMENT 2
HYDRAULIC MODELING RESULTS – 10 LPS FLOW


PERIMETER ROAD
IN-HEAP POND SUMPS
(PLS, LDRS, CLOSURE)
PLS DRAIN PIPES (TYP)
(SEE DRAWING EGHLF-XD-06-01)
IN-HEAP POND BOX CULVERT
(SEE DRAWING EGHLF-XD-08-02)
IN-HEAP POND SPILLWAY
(SEE DRAWING EGHLF-XD-08-01)
ACCESS ROAD
STA. 2+72.3
1_SDR11
STA. 1+81.4
CONFINING EMBANK
2_SDR17
EVENT POND
EVENT POND
4_SDR17
3_SDR17
STA. 0+58.2
STA. 0+40
(4) UNDERDRAIN PIPES
(1) CLOSURE DRAIN PIPE
MONITORING VAULT
(SEE DRAWING EGHLF-XD-05-06)
2.5H:1V
2.0H:1V
SCALE 1:1,000
METRES



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.04	897.00	897.07	897.50	906.74

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	10.00	10.00	10.00	10.00
Max Vel (m/s):	0.90	1.82	2.46	3.22
Max Depth (m):	0.09	0.15	0.15	0.09

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****
File Name .... Closure Pipe Analysis.SPF

****
Analysis Options
****
Flow Units .... LPS
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****
Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

							57.53
2_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	67.27
3_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	50.47
4_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	73.15

****

Flow Routing Continuity	Volume hectare-m	Volume Mliters
External Inflow	0.086	0.864
External Outflow	0.084	0.837
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.008
Continuity Error (%)	0.020	

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
STA. 0+40	26.42	27.20	897.00	0	07:17	0	0	0:00:00
STA. 0+58.2	24.91	25.67	897.07	0	06:47	0	0	0:00:00
STA. 1+81.4	6.42	6.70	897.50	0	21:11	0	0	0:00:00
EVENT POND	0.04	0.04	896.04	0	06:18	0	0	0:00:00
STA. 2+72.3	0.04	0.04	906.74	0	00:23	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
STA. 0+40	JUNCTION	0.00	10.00	0	07:03	0.00		
STA. 0+58.2	JUNCTION	0.00	10.00	0	18:43	0.00		
STA. 1+81.4	JUNCTION	0.00	10.00	0	00:24	0.00		
EVENT POND	OUTFALL	0.00	10.00	0	06:18	0.00		
STA. 2+72.3	STORAGE	10.00	10.00	0	00:00	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³

STA. 2+72.3	0.003	0	0 00:23	0.003	0	10.00	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
EVENT POND	95.52	9.99	10.00
System	95.52	9.99	10.00

****
Link Flow Summary
****

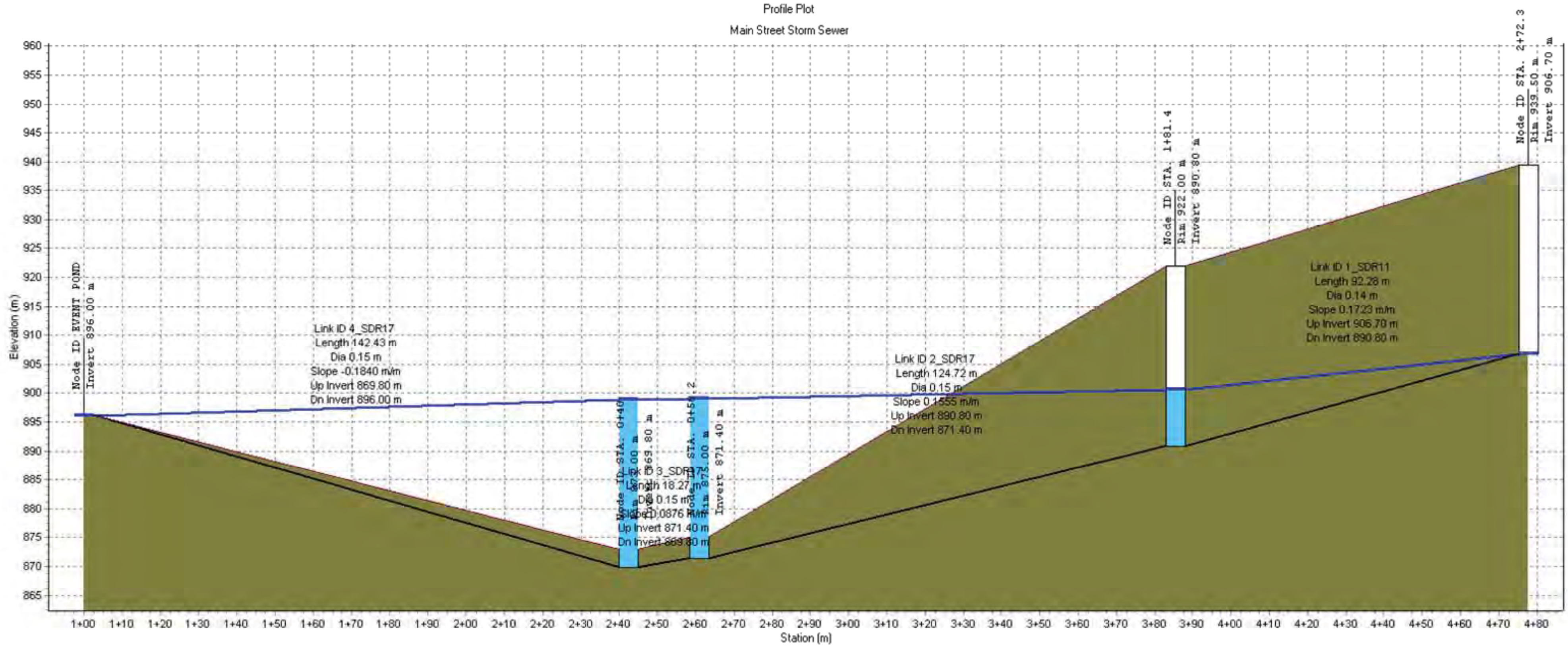
Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
1_SDR11	CONDUIT	0 00:24	3.22	1.00	10.00	57.53	0.17	0.64	0	Calculated
2_SDR17	CONDUIT	0 18:43	2.46	1.00	10.00	67.27	0.15	1.00	1408	SURCHARGED
3_SDR17	CONDUIT	0 07:03	1.82	1.00	10.00	50.47	0.20	1.00	1430	SURCHARGED
4_SDR17	CONDUIT	0 06:18	0.90	1.00	10.00	73.15	0.14	0.62	0	Calculated

****
Highest Flow Instability Indexes
****
All links are stable.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage node invert elevation.
Assumed initial water surface elevation equal to invert elevation.

Analysis began on: Mon Jun 25 08:56:24 2018
Analysis ended on: Mon Jun 25 08:56:25 2018
Total elapsed time: 00:00:01

ATTACHMENT 3
HYDRAULIC MODELING RESULTS – 19 LPS FLOW



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.05	898.84	899.12	900.66	906.76

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	19.00	19.00	19.00	19.00
Max Vel (m/s):	1.56	2.21	2.89	4.15
Max Depth (m):	0.10	0.15	0.15	0.10

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****

File Name .... Closure Pipe Analysis_Sensitivity Analysis.SPF

****
Analysis Options
****

Flow Units .... LPS
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****

Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

57.53

2_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	67.27
3_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	50.47
4_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04	73.15

****
Flow Routing Continuity
****

Flow Routing Continuity	Volume hectare-m	Volume Mliters
External Inflow	0.164	1.642
External Outflow	0.162	1.620
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.010
Continuity Error (%)	0.007	

****
Node Depth Summary
****

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
STA. 0+40	28.61	29.04	898.84	0	13:40	0	0	0:00:00
STA. 0+58.2	27.29	27.72	899.12	0	10:04	0	0	0:00:00
STA. 1+81.4	9.67	9.86	900.66	0	16:19	0	0	0:00:00
EVENT POND	0.05	0.05	896.05	0	05:39	0	0	0:00:00
STA. 2+72.3	0.06	0.06	906.76	0	15:58	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	hh:mm
STA. 0+40	JUNCTION	0.00	19.00	0	08:53	0.00		
STA. 0+58.2	JUNCTION	0.00	30.96	0	00:06	0.00		
STA. 1+81.4	JUNCTION	0.00	19.00	0	04:32	0.00		
EVENT POND	OUTFALL	0.00	19.00	0	05:39	0.00		
STA. 2+72.3	STORAGE	19.00	19.00	0	00:00	0.00		

****
Storage Node Summary
****

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³

STA. 2+72.3	0.005	0	0 15:58	0.005	0	19.00	0.00	0:00:00	0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
EVENT POND	98.06	18.97	19.00
System	98.06	18.97	19.00

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
1_SDR11	CONDUIT	0 04:32	4.15	1.00	19.00	57.53	0.33	0.72	0	Calculated
2_SDR17	CONDUIT	0 04:38	2.89	1.00	19.00	67.27	0.28	1.00	1426	SURCHARGED
3_SDR17	CONDUIT	0 08:53	2.21	1.00	19.00	50.47	0.38	1.00	1434	SURCHARGED
4_SDR17	CONDUIT	0 05:39	1.56	1.00	19.00	73.15	0.26	0.67	0	Calculated

****
Highest Flow Instability Indexes
****

All links are stable.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.

WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.

WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage node invert elevation.
Assumed initial water surface elevation equal to invert elevation.

Analysis began on: Fri Jun 29 07:05:30 2018
Analysis ended on: Fri Jun 29 07:05:31 2018
Total elapsed time: 00:00:01

APPENDIX E

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

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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/W[1]; and

[1] Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Development of recommendations for future studies to reduce uncertainties in the current cover system design and identify potential opportunities for improvements in cover system performance using locally available materials.

SPA numerical modelling was completed with the following outcomes in mind:

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

Conceptual Model of Hydrological Performance:

A conceptual model of hydrological performance of closure cover systems for the EGP site was developed prior to the start of SPA numerical modelling. This required consideration of the following water balance fluxes:

- precipitation (Ppt),
- potential evapotranspiration (PET),
- actual evapotranspiration (AET),
- runoff (RO),
- sublimation (Sub), and
- net percolation (NP).

The average precipitation for the EGP site is estimated to be 492 mm/yr with a range from 262 mm/yr to 694 mm/yr, based on the 80-year historic climate database developed for this project (see Attachment A for further details). The average annual estimate is similar to that developed by KP[2].

Given the relatively high latitude of the EGP site, slope aspect and angle highly influences the amount of solar energy and resultant PET applied to various areas of the site (MEND, 2012)[3]. Hence, for an exposed plateau (i.e. a flat area with no slope influences) or east- or west-facing slope, average annual PET is estimated to be 372 mm/yr with an annual range from 196 mm/yr to 1,413 mm/yr. However, PET is estimated to be 60% less on north-facing aspects and 50% more on south-facing aspects; resulting in average annual PET rates for these two aspects of 149 mm/yr and 558 mm/yr, respectively.

[2] KP (Knight Piesold Ltd.). 2013. *Victoria Gold Corp. Eagle Gold Project – Hydrometeorology Report. VA101-290/6-8*. Prepared for Victoria Gold Corp., August 30.
[3] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

In general, the ratio of annual AET to precipitation ranges from 40 to 60% for study areas similar to the EGP site (Kane and Yang, 2004)[4]. This results in a typical AET:PET ratio of 50 to 70%. However, it must be noted that results for north or south aspects may be outside of the general ranges. Also note that forest canopy interception, which is not calculated by the VADOSE/W model, is included as part of the AET results in this report by using the estimation method described in Attachment A.

Runoff to precipitation ratio for northern sites typically has an increasing trend with increasing latitude (Kane and Yang, 2004). A runoff rate of 5 to 20% of precipitation is expected for the EGP site given the latitude at which the site is located combined with the locally available materials for the base cover system design and the range of vegetation conditions.

Sublimation and redistribution of snow constitutes a significant portion of the water balance in several seasonally snow-covered areas of the Canadian North such as the EGP site (Pomeroy *et al.*, 1995)[5]. Snow interception and sublimation are important hydrological processes that occur as a result of complex mass and energy exchanges. Sublimation of snow intercepted in the vegetation canopy can be as high as 25 to 45% of annual snowfall (Pomeroy and Gray, 1995)[6]. Comparing the EGP site to other northern sites at a similar latitude, a sublimation rate of 25 to 35% of annual snowfall is expected (Kane and Yang, 2004). This corresponds to a sublimation rate of approximately 10 to 15% of total annual precipitation.

NP is a vital component of the water balance for northern climates. Previous modelling completed by KP (2013) determined that the long-term NP rate for the current or base case cover system design would be between 18 and 32% of annual precipitation. NP is functionally halted during the winter months due to frozen ground conditions. In general, the majority of NP at the EGP site occurs during spring melt. Through the summer months, NP rates are lower due to the store and release function of a vegetated soil profile. NP rates generally increase in the fall due to lower PET rates.

A typical annual water balance for the site estimated using VADOSE/W is shown in Figure 1, and demonstrates that the VADOSE/W model estimates conform to the conceptual model.

[4] Kane, D. and Yang, D. 2004. Northern Research Basins Water Balance. International Association of Hydrological Sciences. Oxfordshire, United Kingdom.
[5] Pomeroy, J., Hedstrom, N., and Parvianinen., J. 1995. *The Snow Mass Balance of Wolf Creek, Yukon: Effects of Snow Sublimation and Redistribution*. National Hydrology Research Center. Environment Canada: Saskatoon.
[6] Pomeroy, J.W. and Gray, D.M. 1995. *Snow Accumulation, Relocation and Management*. NHRI Science Report No. 7. Environment Canada: Saskatoon. 144 pp. (Available from NWRI, Saskatoon)

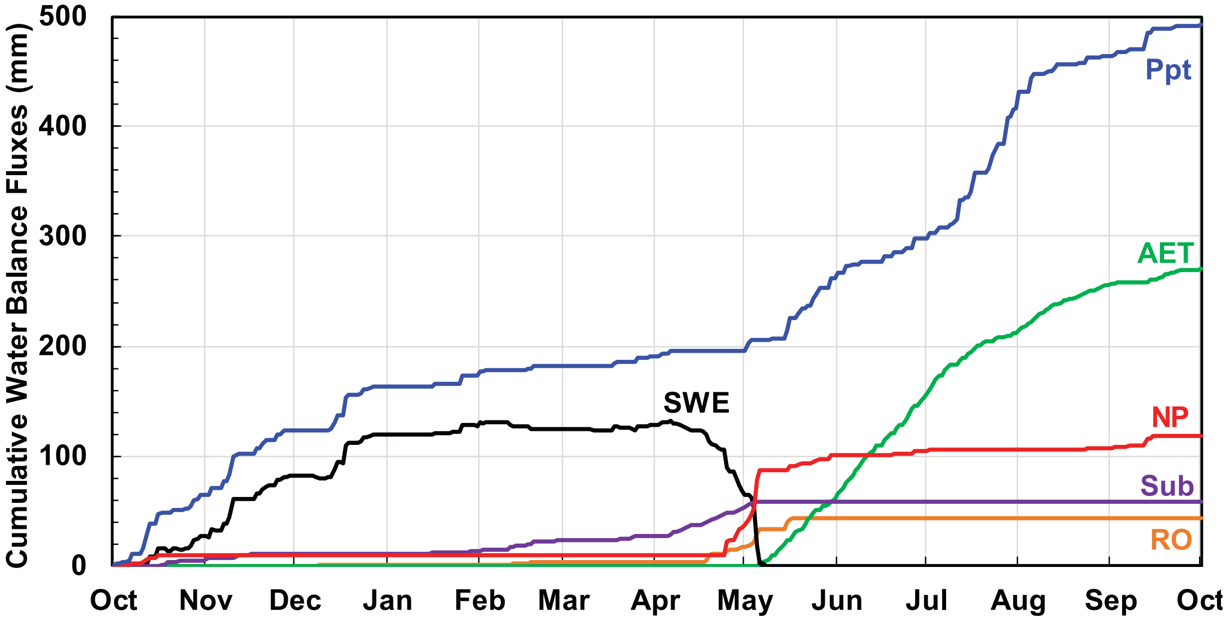

Figure 1 Typical annual water balance fluxes for the EGP site for an east/west bench during an average precipitation year.

__Preliminary Estimates of Long-Term Cover System Performance:__

The currently proposed closure cover system design, referred to as the 'base' cover system design, consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Tables 1 and 2 provide preliminary estimates of average annual long-term water balances (i.e. post-closure and once climax forest vegetation has established). A description of the model inputs used for the simulations is provided in Attachment A. All modelling completed for this project used the computer modelling program VADOSE/W Version 8.12.3.7901[7].

As shown in the sensitivity analysis section of this report, little can be done to improve performance of the current cover system design based on current knowledge of waste materials and candidate cover materials. Also, the current estimates for east-, west-, and north-facing slopes have AET:PET ratios at or above the typical maximum of 70% stated for the conceptual model. Hence, minimal potential exists for reducing NP rates via increasing AET, which means the store-and-release component of the cover system design cannot be improved upon with any design changes. The only other method to reduce NP is to increase lateral flow (i.e. runoff or interflow) by including a low permeability layer (saturated hydraulic conductivity (k_{sat}) less than $1x10^{-7}$ cm/s), but such a layer cannot be constructed from site materials; this would require the import of sodium bentonite for admixing to local sandy materials or the use of a geomembrane product.

[7] Geo-Slope International Ltd. 2013. GeoStudio 2012. Version 8.12.3.7901. Online. www.geo-slope.com.

Table 1
Average annual water balance fluxes predicted for base case cover system design on WRSAs
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	55% (271)	53% (261)	27% (133)	26% (128)	59% (290)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	24% (118)	21% (103)	52% (256)	47% (231)	20% (98)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 2
Average annual water balance fluxes predicted for base case cover system design on HLF
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	56% (276)	54% (266)	26% (128)	25% (123)	60% (295)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	23% (113)	20% (98)	53% (261)	48% (236)	19% (93)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

It must be emphasized that the values provided in Tables 1 and 2 are averages, but that the components of the water balance will vary greatly from year-to-year, and (as shown in Figure 1) during any given year. As shown in Figures 2 and 3, annual NP at the EGP site can range anywhere from 0 to 500 mm for a given year depending on climate, slope angle and aspect, underlying material, and antecedent moisture conditions. Figures 2 and 3 also provide an estimate of the probability of a given NP rate being exceeded during any given year. For example, there is a 20% probability (i.e. 1-in-5 years) that annual NP rate through a cover system overlying waste rock on a south-facing slope aspect will be greater than 140 mm/yr. Equations for the trendlines in Figures 2 and 3 are provided in the footnotes.

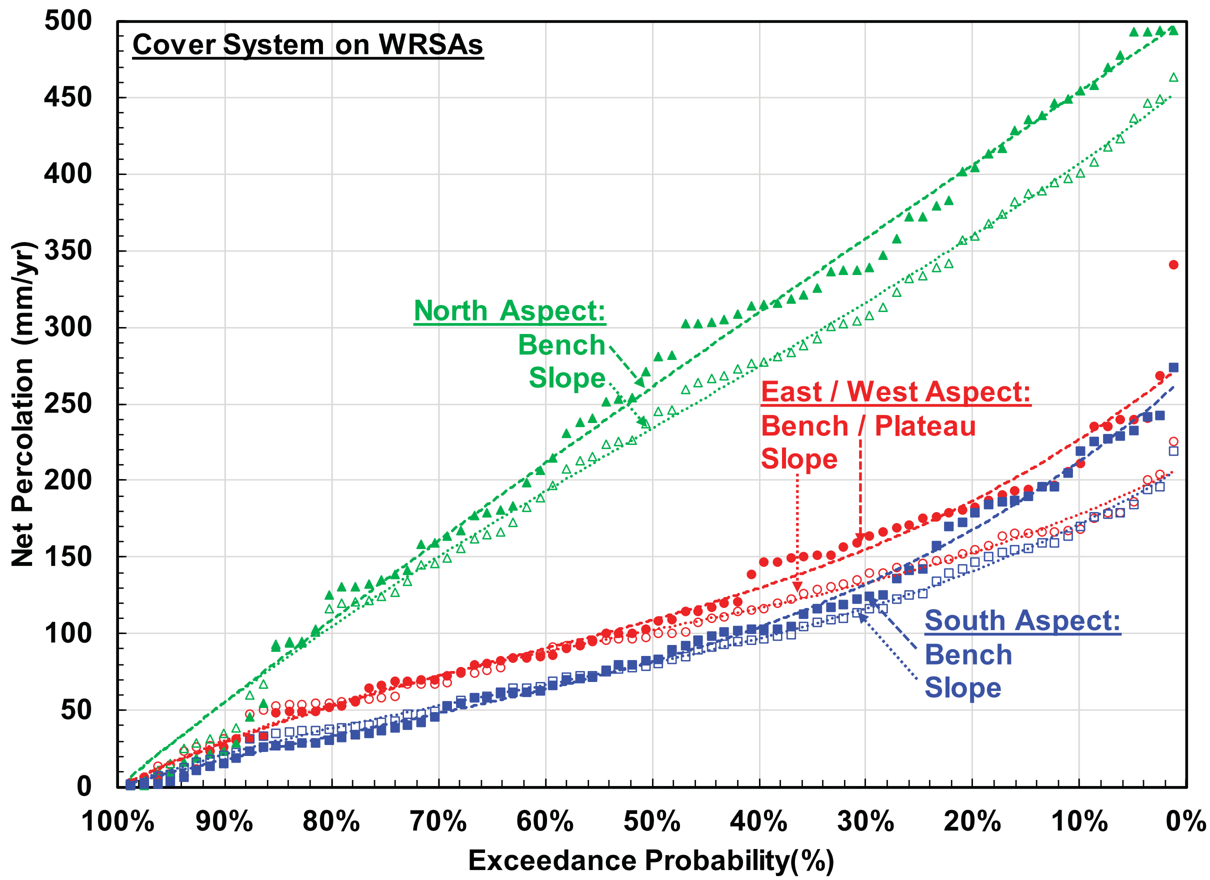

Figure 2 Exceedance probability for annual net percolation though the base case cover system design on WRSAs[8].

[8] Equations for trendlines fitted to data in Figure 2 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):

NP (WRSA North Aspect – Bench) = $40.0041311586974(1-x)^3 - 99.5768877417431(1-x)^2 + 561.738884175022(1-x)$

NP (WRSA North Aspect – Slope) = $206.353645699448(1-x)^3 - 327.934585562733(1-x)^2 + 580.167973306423(1-x)$

NP (WRSA East / West Aspect – Bench/Plateau) = $334.907229739852(1-x)^3 - 383.091823084556(1-x)^2 + 325.661910099225(1-x)$

NP (WRSA East / West Aspect – Slope) = $280.502595140468(1-x)^3 - 409.768319621682(1-x)^2 + 339.373074364743(1-x)$

NP (WRSA North Aspect – Bench) = $272.348822876258(1-x)^3 - 199.583918676042(1-x)^2 + 195.342583203572(1-x)$

NP (WRSA North Aspect – Slope) = $242.715256690288(1-x)^3 - 267.520494862459(1-x)^2 + 234.753215517809(1-x)$

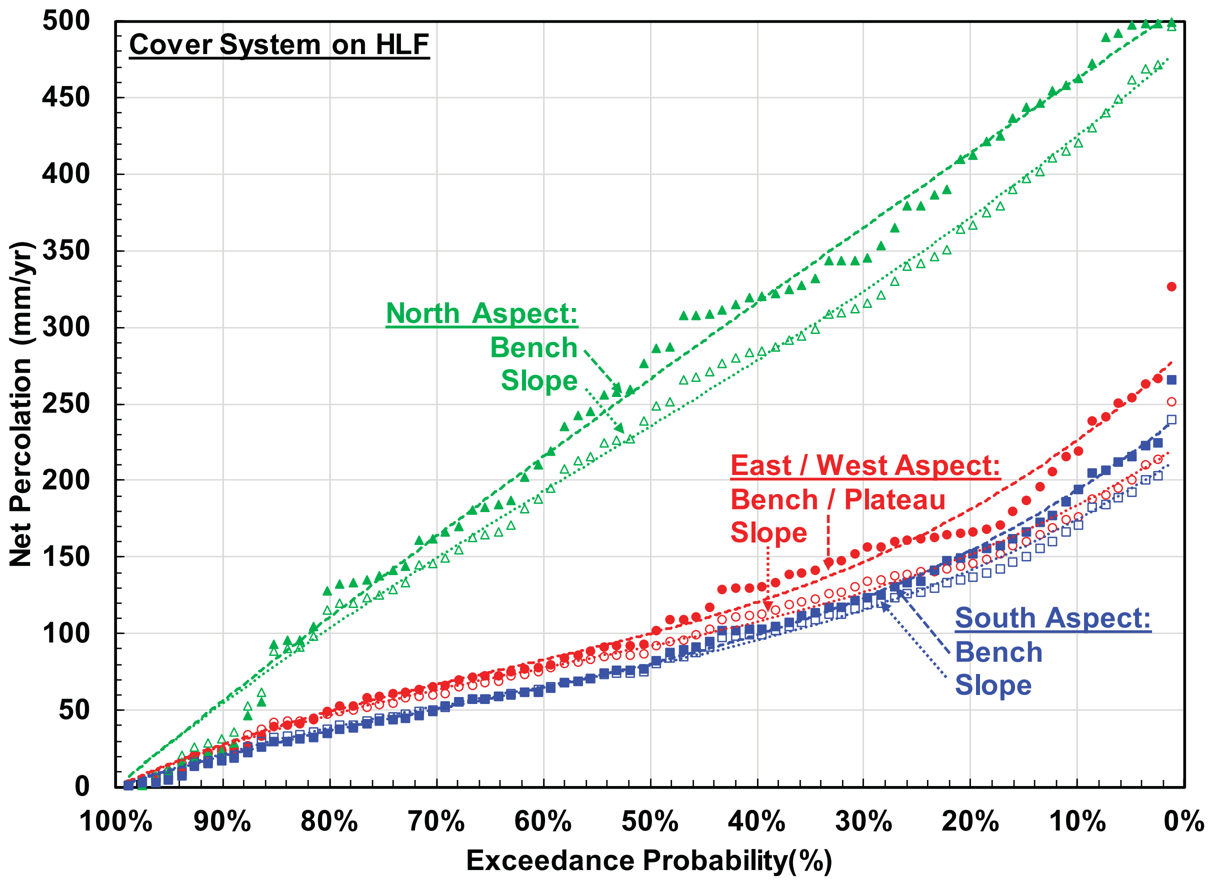

Figure 3 Exceedance probability for annual net percolation though the base case cover system design on HLF[9].

The model results presented prior to this point are estimates of long-term cover system performance, i.e. post-closure once a climax forest vegetation has established on the cover system. Water balance fluxes will vary greatly at different pre- and post-closure stages of the EGP operation. Tables 3 and 4 provide predicted water balance fluxes for different pre- and post-closure stages of the WRSAs and HLF, respectively. The first stage is a pre-closure scenario when the closure cover system is not in place; the NP rate on WRSAs for this case is estimated to be 49% of annual precipitation. The NP rate is estimated to drop to 36% on WRSAs when the cover system is initially constructed, but before vegetation establishment. Once vegetation is established, the NP rate further drops to 28% and 24% of annual precipitation for a grasses & shrubs and climax forest vegetation scenario, respectively. Table 4 shows a similar trend for predicted NP rates for the base case cover system design on the HLF.

[9] Equations for trendlines fitted to data in Figure 3 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):

NP (HLF North Aspect – Bench) = $31.272632650886(1-x)^3 - 89.742473682767(1-x)^2 + 569.412107857963(1-x)$

NP (HLF North Aspect – Slope) = $230.751591012202(1-x)^3 - 318.847922658053(1-x)^2 + 572.512360031695(1-x)$

NP (HLF East / West Aspect – Bench/Plateau) = $401.880632485379(1-x)^3 - 433.796816800299(1-x)^2 + 316.593775515019(1-x)$

NP (HLF East / West Aspect – Slope) = $310.161269957891(1-x)^3 - 383.422721152048(1-x)^2 + 298.154325857064(1-x)$

NP (HLF North Aspect – Bench) = $297.902638452382(1-x)^3 - 279.853973662612(1-x)^2 + 226.194792839713(1-x)$

NP (HLF North Aspect – Slope) = $282.980662582457(1-x)^3 - 307.881636956547(1-x)^2 + 242.043952583721(1-x)$

Table 3
Average annual water balance fluxes predicted for WRSA base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	34%	44%	50%	55%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	49%	34%	28%	24%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 4
Average annual water balance fluxes predicted for HLF base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	37%	42%	51%	56%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	46%	36%	28%	23%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Analysis of Alternate Cover System Designs and Sensitivity to System Variations:

In total, 43 long-term simulations were completed to determine the sensitivity of the base cover system design due to variations in materials, climate, and/or vegetation. The simulations were also completed to determine what (if any) improvements can be made to the base case cover system design. All the scenarios were initially completed without vegetation present so that changes in performance could be directly correlated to changes in materials or climate. Vegetation was then included to further evaluate select scenarios. Finally, the base case results presented in the previous section showed little difference in performance between the WRSAs and HLF simulations. Hence, all sensitivity scenarios were simulated with a cover system overlying waste rock unless otherwise noted. Tornado plots of net percolation predictions for the WRSAs and HLF scenarios simulated are provided in Figures 4 and 5, respectively, followed by detailed analyses.

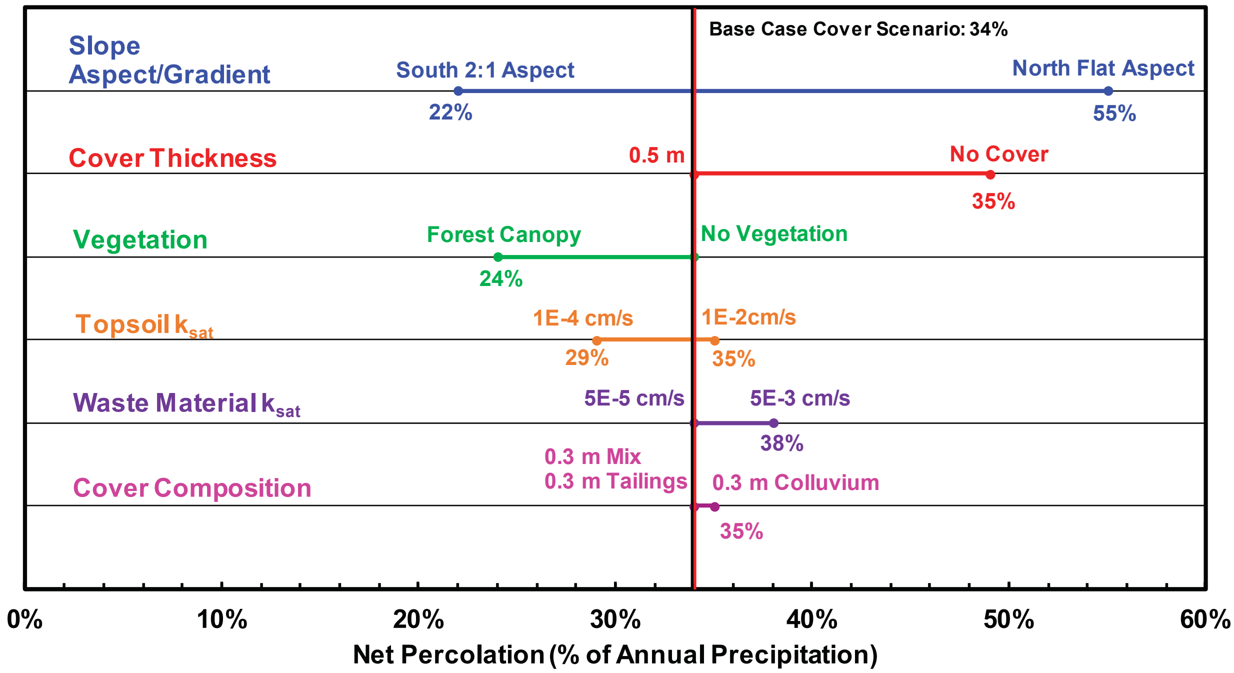

Figure 4 Tornado plot for WRSA cover system net percolation predictions.

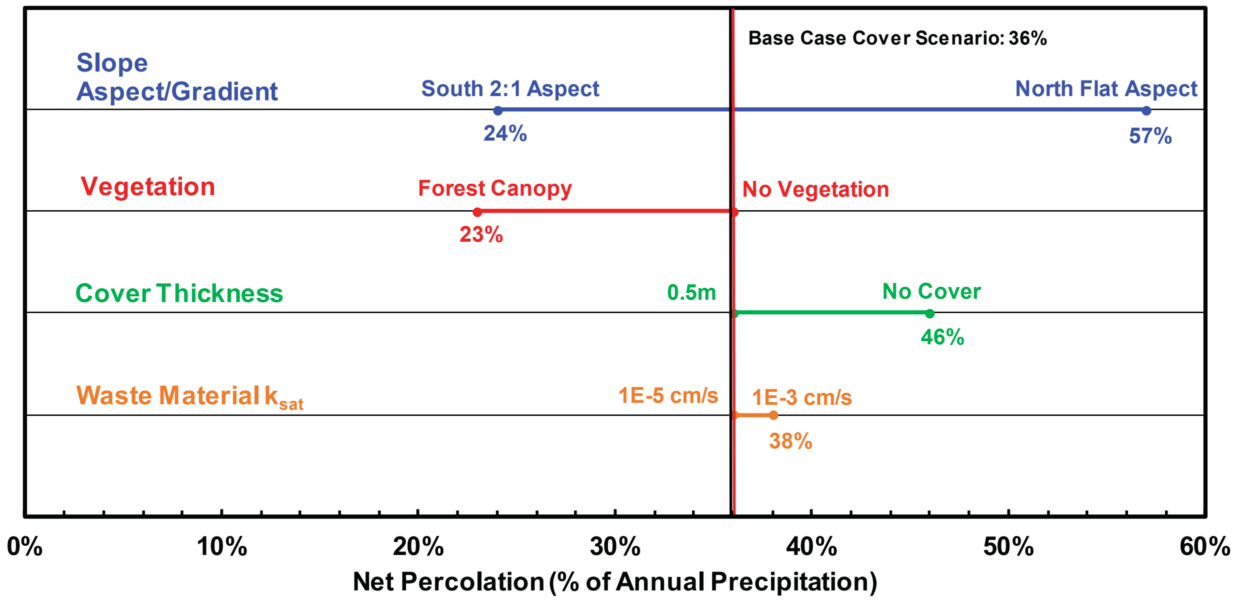

Figure 5 Tornado plot for HLF cover system net percolation predictions.

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

Table 5 shows predicted average annual NP rates for eight cover system scenarios with varied layer thickness and composition. The majority of the cover thickness and composition scenarios were completed for the WRSAs only. The HLF only compared the uncovered waste material to the base cover system. For the WRSAs, three thicknesses of the tailings-colluvium mix were evaluated to determine if additional storage capacity would improve cover system performance. The materials that comprise the cover system were also varied to determine the effect of different compositions.

Table 5
Average annual NP rates predicted for varying cover thickness and composition scenarios (values in percent of annual precipitation).

Layer 1		***Layer 2***		***Layer 3***		***Net Percolation***
Material	***Thickness (m)***	***Material***	***Thickness (m)***	***Material***	***Thickness (m)***	
TPSL	0.2	MIX	0.3	-	-	34%
TPSL	0.2	MIX	0.5	-	-	35%
TPSL	0.2	MIX	0.7	-	-	35%
TPSL	0.2	TLS	0.3	-	-	34%
TPSL	0.2	CLVM	0.3	-	-	35%
TPSL	0.2	TILL	0.3	-	-	35%
TPSL	0.2	TLS	0.1	CLVM	0.2	35%
TPSL	0.2	CLVM	0.2	TLS	0.1	35%

*TPSL: topsoil; MIX: tailings-colluvium mix; TLS: tailings; CLVM: colluvium; TILL: till; WR: waste rock.

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

Without vegetation to remove water from depth, thickening the cover system provides no reduction in the NP rate, and actually results in an increase in NP. NP rates do not decrease because the energy available for evaporation is low, which creates relatively low hydraulic gradients for removing water from the cover system. Hence, evaporation alone can only remove water stored nearer the surface. The model estimates a slight increase in NP with increased cover thickness because the underlying waste rock is a textural discontinuity, which creates a capillary barrier inhibiting NP and keeping water closer to the surface. When the depth of the capillary barrier is increased by increasing the thickness of the cover system, the percolating water is able to get to depth more easily, which increases NP.

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

Vegetation requires water to be readily available for root uptake for establishment and survival. When a material dries below a point at which plants are unable to remove water, the material is said to be at its permanent wilting point (PWP). The PWP is generally defined to occur at a suction of 1,500 kPa. At the other end of the range is the field capacity (FC) of the soil. FC is defined as the water content held in the soil after excess water has drained away and the rate of downward movement has decreased. FC is generally stated to occur at a suction of 33 kPa for finer soils and 10 kPa for coarser materials. FC and PWP define the upper and lower limits, respectively, that a growth material is able to supply water for root uptake. Hence, the difference between FC and PWP defines a soil's AWHC (i.e. AWHC = FC – PWP).

Figure 6 shows the estimated amount of water stored within the base case cover system design during the 80-year simulation period for three scenarios: base cover system on WRSA; base cover system on HLF; and, a cover system consisting of 0.2 m of topsoil overlying 0.3 m of till (referred to in Figure 6 as till cover system) overlying WRSA. Till was chosen for the third simulation as it has the highest AWHC of all the potential cover materials considered in this study. The cover system water volume for all three scenarios is estimated to almost always stay within or above the AWHC range. There are only seven periods when the cover system water volumes drop near or below the PWP line. These are periods when vegetation would be at risk; but it must be noted that the model inputs were set to permit forest vegetation to be capable of removing water up to a suction of 2,500 kPa (based on research of tree species), and that VADOSE/W does not account for all plant survival mechanisms (e.g. dormancy). Hence, the model estimates that the current cover system design adequately meets the water requirements for vegetation.

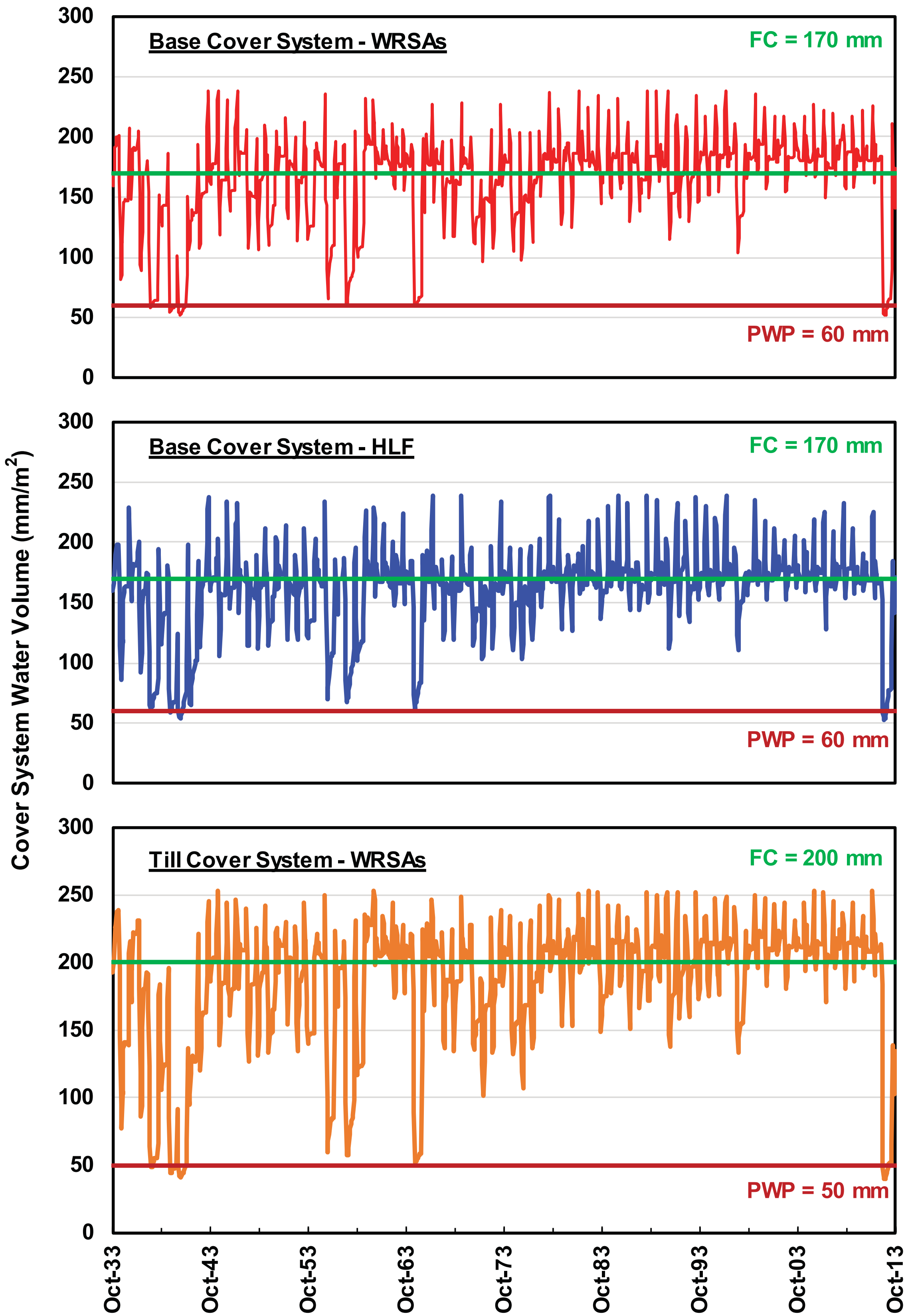

Figure 6 Cover system water volumes estimated during 80-year simulations for three scenarios (from top to bottom): base cover system on WRSAs and HLF and till cover system on WRSAs.

The material properties of the cover system materials were also varied. In general, scenarios that lowered the k_{sat} of various materials resulted in slightly lower NP rates, while increasing the k_{sat} slightly increased NP rates. Table 6 shows predicted average annual water balance fluxes for six cover system scenarios that varied the material properties of the cover system materials.

Table 6
Average annual water balance fluxes predicted for the varied material properties scenarios (values in percent of annual precipitation).

Waste Material	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Heap Leach***	***Heap Leach***
Modification	**Waste Rock k_{sat} increased by 10x**	**Waste Rock k_{sat} decreased by 10x**	**Topsoil k_{sat} increased by 10x**	**Topsoil k_{sat} decreased by 10x**	**Heap Leach k_{sat} increased by 10x**	**Heap Leach k_{sat} decreased by 10x**
Runoff	10%	10%	8%	15%	10%	10%
AE	43%	44%	45%	44%	40%	42%
Sublimation	12%	12%	12%	12%	12%	12%
Net Percolation	35%	34%	35%	29%	38%	36%

The k_{sat} of the topsoil proved to be an influential property during the sensitivity analysis. By increasing or decreasing the k_{sat} of the topsoil by one order of magnitude, the average NP rate varied from 35% to 29% of annual precipitation, respectively. It is essential that thorough testing be completed to verify the hydraulic properties of local topsoil material because its k_{sat} is showing to have the largest influence on predicted NP rates. Decreasing the waste material k_{sat} also had an effect on the observed NP rate; however, increasing the k_{sat} of the waste material had little effect on the NP rate. The effect of varying the k_{sat} of the tailings-colluvium material was also analyzed; however, no difference in the water balance was observed when the material's k_{sat} was varied by one order of magnitude.

One sensitivity that was not included in the above tornado plot is climate change. Climate change predictions for Mayo, YT predict an increase in monthly air temperature and precipitation[10]. The 100-yr average temperature increase is predicted to be between 3 and 6°C, whereas annual precipitation is estimated to increase by 15 to 35%. This increase would have a substantial effect on hydrological cover system performance at the EGP site. Hence, simulations were completed with no ground freezing effects simulated and with the historic climate database adjusted to mid-range climate change estimates (i.e. temperature increase of 4°C and precipitation increase of 25%). Table 7 provides the average water balances for these scenarios (note that the results are stated as a percent of average annual historic precipitation (492 mm/yr) but the climate change scenario has an average annual precipitation rate of 615 mm/yr).

[10] Scenarios Network for Alaska & Arctic Planning. 2013. *Community Charts: Mayo, YT*. Version 1.219. Online. www.snap.uaf.edy.com

Table 7
Average annual water balance fluxes predicted for the base case and climate change scenarios (values in percent of annual historic precipitation with mm/yr in brackets).

Scenario	Runoff	AE	Sublimation	Net Percolation
Base Case	10% (49)	44% (215)	12% (59)	34% (169)
No Ground Freezing	0% (4)	42% (205)	12% (55)	46% (228)
Climate Change	4% (21)	51% (251)	7% (34)	63% (311)

The majority of runoff from the base case scenario is generated during the spring melt. The frozen ground encourages runoff because the water cannot easily infiltrate due to ice blocking soil pores. When the cover is not able to freeze to a suitable depth due to increased air temperature, spring melt waters are able to infiltrate rather than runoff. The increased infiltration rate contributes to a rise in NP. These scenarios illustrate the advantage of a frozen cover at the EGP site and the risk of its loss due to climate change. The deep frost penetration allows the cover system to limit NP despite the coarser textured locally available material. If the climate change prevents the cover system from freezing to a suitable depth, geosynthetic products would have to be used to limit NP.

Future Studies Recommended to Further WRSA / HLF Closure Cover System Design:

The 2014 EGP modelling program completed by OKC relied on estimated material properties. In order to increase the confidence in the predicted water balance components (especially NP), further study of the EGP site and locally available materials should be completed. Studies recommended by OKC are as follows:

- Material characterization program potential cover materials and waste materials (when they become available), including:
    - hydraulic conductivity,
    - moisture retention, and
    - geochemical properties;
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Closure:

Thank you for the opportunity to assist AEG with closure planning at Victoria Gold's Eagle Gold Project. Please do not hesitate to contact the undersigned should you have any questions.

Sincerely,

Brian Ayres, M.Sc., P.Eng.
Senior Geotechnical Engineer

cc: Scott Keesey and Leia Fougere – Access Consulting Group
Robert Shurniak and Kent Schapansky – O'Kane Consultants Inc.

Attachment A: Key Inputs for 2014 VADOSE/W Modelling Program

ATTACHMENT A

Key Inputs for 2014 VADOSE/W Modelling Program for EGP HLF / WRSA Closure Cover Design Assessment

Preliminary Cover System Modelling Inputs

Before SPA numerical modelling was undertaken the model inputs needed to be clearly defined. These inputs can be placed into five categories: geometry; material properties; initial conditions; upper boundary conditions; and lower and side boundary conditions. A brief description of these model inputs is presented in the following sections. SPA modelling was completed using the software VADOSE/W.

Geometry (Cover System Profile Designs):

The 'base' cover system design consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Variations to this design were simulated as part of the sensitivity analysis as described in the main body of the report.

Material Properties:

Seven materials were defined for the OKC modelling program: waste rock, colluvium, heap leach, placer tailings, topsoil, till, and a tailings-colluvium mix. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC[11][12][13][14]. These PSDs were the basis for the estimates of all material properties for all but one of the materials; no PSD data was available for the topsoil material. Topsoil material properties were developed by comparing a variety of topsoil materials from the OKC material database from similar sites to images of topsoil from EGP. The estimated porosity, saturated hydraulic conductivity (k_{sat}), as well as the percent sand and fines for each of the materials is given in Table A-1.

Table A-1
Summary of basic material properties for SPA modelling.

Material Type	Porosity (m^3/m^3)	k_{sat} (cm/s)	Particle Size Distributions (Minimum – Maximum (Average))		
			% Coarse (>4.75 mm)	% Sand (4.75–0.075 mm)	% Fines (<0.075 mm)
Waste rock	0.30	$5.0X10^{-4}$	34 – 60 (44)	22 – 43 (30)	16 – 44 (26)
Colluvium	0.33	$5.0X10^{-5}$	12 – 60 (40)	18 – 53 (36)	4 – 45 (24)
Heap Leach	0.31	$1.0X10^{-4}$	15 – 50 (33)	20 – 63 (35)	16 – 58 (42)
Tailings	0.26	$5.0X10^{-4}$	25 – 75 (49)	19 – 61 (39)	5 – 19 (12)
Topsoil	0.59	$1.1X10^{-3}$			
Till	0.45	$1.0X10^{-4}$	0 – 33 (11)	5 – 40 (22)	40 – 95 (67)
Tailings-Colluvium Mix (1:2)	0.40	$5.0X10^{-4}$	6 – 68 (34)	27 – 71 (48)	4 – 45 (18)

[11] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March
[12] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November
[13] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January
[14] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

In order to complete the proposed SPA modelling, additional properties or functions needed to be estimated. The required properties or functions for each material in the modelling program are as follows:

- moisture retention curve (MRC - suction versus volumetric water content);
- hydraulic conductivity function (k-function - suction versus hydraulic conductivity);
- thermal conductivity function (volumetric water content versus thermal conductivity); and
- volumetric specific heat function (volumetric water content versus volumetric specific heat).

The MRC, or soil-water characteristic curve, is a continuous function relating energy and the state of water, and hence describes the water content of a material as a function of soil suction, or negative pore-water pressure. The MRC for each of the materials used during the OKC modelling program are shown in Figure A-1.

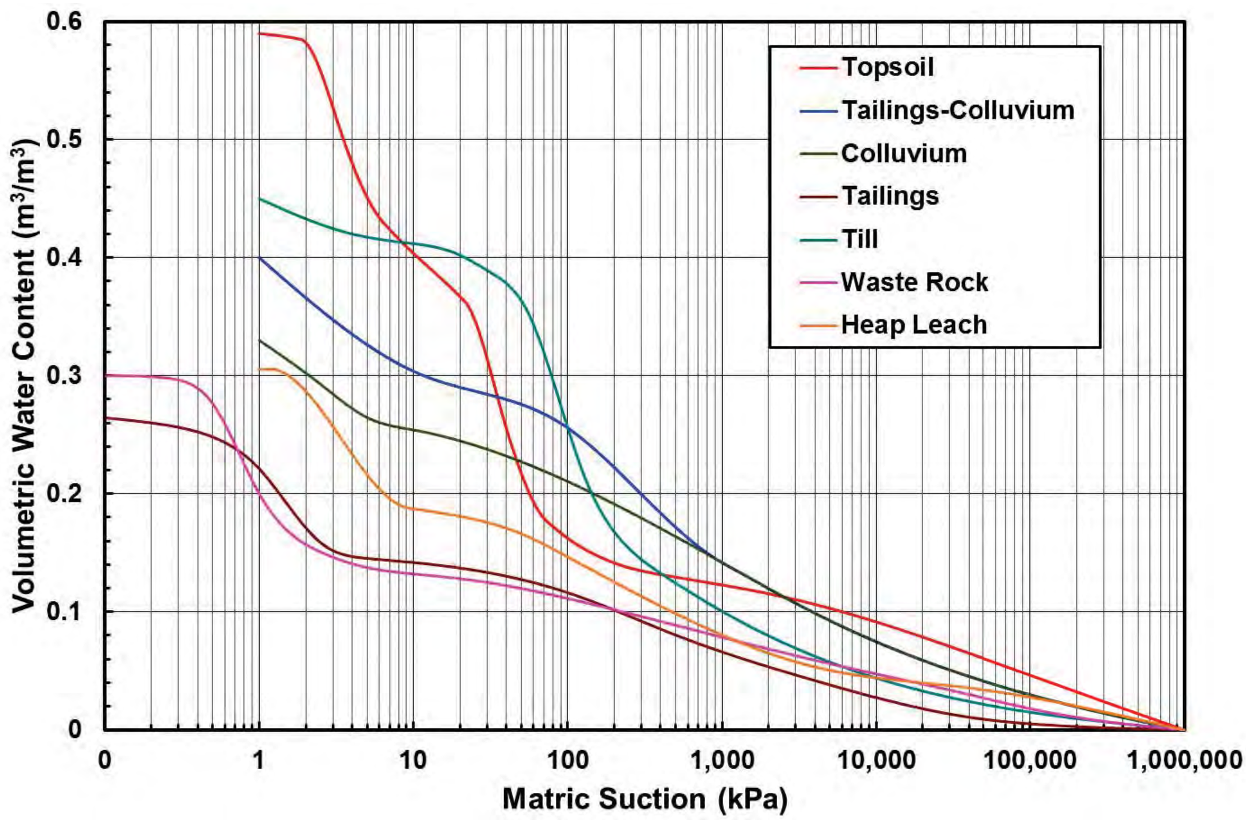

Figure A-1 Moisture retentions curves for all materials used during the OKC modelling program.

Hydraulic conductivity is a measure of the ability of a material to transmit water, and is a maximum for saturated materials. The k-function for each material was estimated from its MRC and k_{sat} using the Fredlund *et al.* method[15]. The k-function for each of the materials used during the OKC modelling program are shown in Figure A-2.

[15] Fredlund, D.G., Xing, A., and Huang, S. 1994. Predicting the permeability function for unsaturated soils using the soil-water characteristic curve. Canadian Geotechnical Journal, Vol. 31, pp. 533-546.

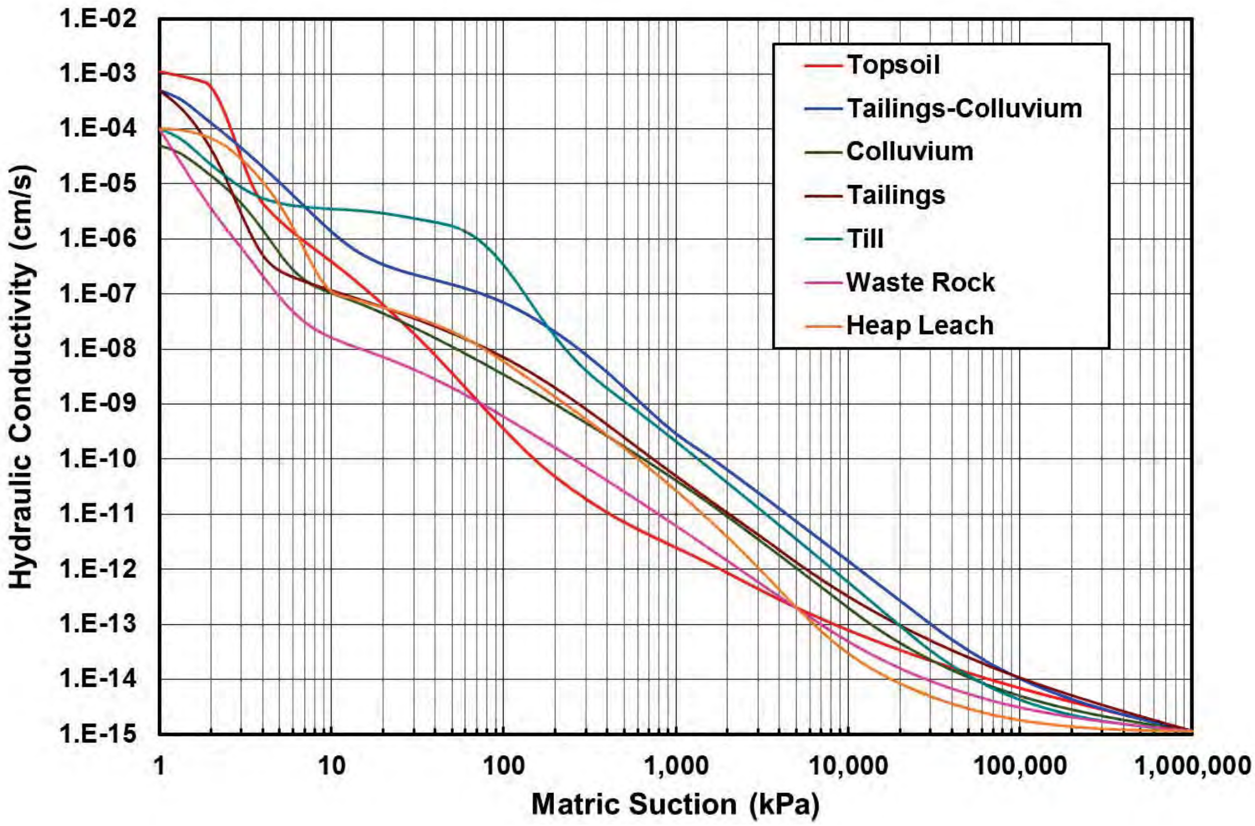

Figure A-2 Hydraulic conductivity function for all materials used during the OKC modelling program.

Thermal conductivity characterizes the ability of a soil medium to transmit heat by conduction. It is defined as the quantity of heat that will flow through a unit area of a soil medium of unit thickness in unit time under a unit temperature gradient. The thermal conductivity functions for all the materials were estimated by VADOSE/W using the Johansen method[16].

The heat capacity of a material is defined as the quantity of heat required to raise the temperature of the material by a unit degree. A volumetric specific heat function describes the relationship between volumetric water content and volumetric specific heat. The volumetric specific heat functions for all the materials were estimated by VADOSE/W using the deVries method[17].

[16] Johansen, O. 1975. *Thermal Conductivity of Soils*. Ph.D. Thesis, (CRREL Draft Translation 637, 1977), Trondheim, Norway.
[17] de Vries, D.A. 1963. *Thermal properties of soils*. Physics of Plant Environment, W.R. Van Wihk (ed.), North Holland Pub. Co., pp. 382.

Upper Boundary Conditions:

The upper boundary conditions required for the VADOSE/W model can be divided into two parts: climate and vegetation. Details regarding the model inputs developed for each are described below.

Climate:

Due to the lack of a long-term data record available for the EGP site, a synthetic climate database was required to proceed with the proposed modelling program. This database consisted of adapting data from several locations. The climate of the EGP site is characterized by long, dry winters and short, warm, wet summers. Local conditions vary due to the variation of elevations found throughout the site.

The elevation of the HLF ranges from approximately 875 to 1,175 masl, and the WRSA's range from approximately 950 to 1,400 masl. This means there is the potential for significantly different climatic conditions at varying elevations on the landforms. For the purposes of OKC's initial cover design modelling, a reference elevation of 1,175 masl was used to develop the base synthetic climate database. All parameters of the synthetic climate database were corrected to this elevation.

The climate data for the OKC modelling program consist of the synthesis of data from three weather stations. Data from two of the stations were provided by AEG. These are the Potato Hills and Camp stations located at the EGP site. These two stations have excellent data quality, but have only operated for a short period. The third station, located at Mayo, Yukon Territory (approximately 85 km south of EGP), is operated by Environment Canada and has long-term data ranging from 1925-2012. Table A-2 summarizes data available for each station. The "Missing Records" column in Table A-2 only lists dates of large sections of missing data. Information from the Hydrometeorology Report prepared by Knight Piésold was also considered while constructing the synthetic climate database[18].

[18] Knight Piésold. 2013, *Hydrometeorology Report*. Prepared for Victoria Gold Corp., August.

Table A-2
Summary of data used for climate database development.

Potato Hills Station: N 64°02' W 135°44' elevation 1420 masl		
Parameter	**Period of Record**	**Missing Records**
Daily Rainfall (mm)	August 14, 2007 – December 31, 2011	-
Daily Maximum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Minimum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Maximum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Minimum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Average Wind Speed (m/s)	August 14, 2007 – December 31, 2011	-
Daily Average Net Radiation (W/m^2)	August 14, 2007 – December 31, 2011	-
Camp Station: N 64°01' W 135°51' elevation 782 masl		
Parameter	**Period of Record***	**Missing Records**
Daily Rainfall (mm)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Average Wind Speed (m/s)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Mayo Airport Station: N 63°37' W 135°52' elevation 504 masl		
Daily Precipitation (mm)	June 1, 1925 – December 31, 2012	March 1, 1946 – March 31, 1946 April 1, 1989 – April 30, 1989 January 1, 1995 – February 28, 1995 April 1, 1995 – December 31, 1995
Daily Maximum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Maximum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Average Wind Speed (m/s)	January 2, 1934 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977

One important parameter that was not available for the Camp or Mayo Airport station is net radiation (NR). This is a vital input for VADOSE modelling to predict potential evapotranspiration (PET) and resultant actual evapotranspiration (AET). For these two stations, NR was calculated using an analytical spreadsheet. This calculation uses the daily maximum and minimum temperature and relative humidity (RH) together with the latitude and elevation of the site to determine the estimated NR. The spreadsheet was first calibrated comparing the measured NR at the Potato Hills station and the calculated NR. The calibration data were then used to predict NR for both the Camp and Mayo Airport Stations.

Climate data obtained from the three stations was thoroughly reviewed with any questionable or incomplete data removed from the record. An equation was developed from the data set for each parameter at each station to provide average conditions for any given day of the year. The equations were obtained by fitting trendlines through daily average graphs for each climate input. Missing data from each station was filled using these average values. The datasets were then compared and adjusted to be representative of the assumed elevation.

The adjusted Mayo Airport data was used as the template for the synthetic climate database. Due to the sparse data available before 1933, the database was reduced to the period between 1933 and 2013, resulting in an 80-year synthetic climate database. Several large gaps in the adjusted Mayo Airport data were filled using either the adjusted data from other stations, or the developed average year. A summary of the average monthly values from the synthetic climate database is provided in Table A-3. The mean annual precipitation for the 80-year climate database is 492 mm, which is similar to the mean annual precipitation noted by Knight Piésold [19].

Table A-3
Monthly average climate for the long-term synthetic climate database.

Month	Average Temperature		Average RH	Monthly Precipitation	Average Daily Wind Speed	Average Net Radiation
	Daily High	Daily Low				
	°C	°C	%	mm	m/s	MJ/m^2
January	-15.7	-23.7	65	34	1.6	-1.2
February	-10.6	-20.4	63	29	1.8	0.3
March	-7.5	-18.3	58	26	2.3	4.6
April	1.8	-7.9	55	24	2.3	10.4
May	9.5	-1.0	37	37	2.2	14.3
June	15.2	3.8	49	52	1.8	17.2
July	16.0	4.8	55	65	1.8	16.1
August	14.1	2.8	62	60	1.8	12.1
September	9.2	-2.4	66	49	1.6	5.3
October	-3.6	-10.0	73	42	1.6	1.2
November	-12.7	-19.5	73	38	1.6	-0.6
December	-15.7	-23.3	71	36	1.0	-1.3

[19] *Op. Cit.*

Vegetation:

VADOSE/W incorporates vegetation affects using a nodal vegetative uptake source term that is combined with a surface energy term based on canopy cover[20]. The amount of actual nodal root uptake depends also on root depth and density, and water stress (negative pore water pressure).

Lack of available plant water and/or high evaporative demands will cause most plants to biologically react by closing stoma, reducing transpiration, and reducing metabolic reactions[21]. Under continued and increasing stress the plant will reach its wilting point. The wilting point results in leaf drop and tissue death. In VADOSE/W the user must implement a plant moisture limiting function, which determines the percentage decrease in the plants' ability to draw water as the negative pore-water pressure increases in unsaturated ground.

The leaf area index (LAI) is used by VADOSE/W to reduce the amount of net radiation intercepting the soil surface, which in turn reduces the computed actual evaporation. In other words, LAI controls how the energy at the surface is partitioned between that available for direct evaporation from the soil and that which is available to the plants in their attempt to transpire water. VADOSE/W uses Equation 1 to determine how much energy is intercepted by the plant canopy:

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

where:

I = percent of net radiation intercepted by the plant canopy, and

LAI = leaf area index.

Hence, the model estimates that the canopy intercepts all energy if LAI is greater than 3.0 (i.e. all energy is applied to transpiration) and does not intercept any energy if LAI is less than 0.1 (i.e. all energy is used for evaporation).

If the soil is saturated, the full amount of energy will be applied to the roots according to the root depth and root distribution functions. In VADOSE/W, two root distribution functions are available: triangular and rectangular. A triangular distribution will potentially draw more water near the surface, whereas a rectangular distribution will potentially draw the same amount of water over the full root depth. If the soil is partially saturated, then the actual transpiration value is further reduced according to the plant moisture limiting function entered by the user.

Three vegetation sequences were chosen that represent different timeframes of the reclamation process: bare ground, grasses and shrubs, and mature forest. Each sequence has a significantly different influence on cover system performance. The bare ground sequence also serves as a baseline for comparing cover systems' performance once vegetation has established.

[20] Tratch, D. 1996. *Moisture uptake within the root zone*. M.Sc. Thesis, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.
[21] Saxton, K.E. 1982. *Mathematical modelling of evapotranspiration on agricultural watersheds*. *In* Modeling Components of the Hydrologic Cycle. Singh, H. (ed.), May 18 - 21, 1981. pp. 183-203.

The grasses and shrubs sequence consists of the application of a rectangular rooting depth of 0.3 m as specified by Access Consulting Group[22]. The plant limiting moisture function for this sequence is shown in Figure A-3.

The final vegetation sequence consists of the application of a mature forest to the modelled sites. The mature forest models were simulated with a triangular rooting depth of 0.5 m. The plant limiting moisture function of this sequence is shown in Figure A-3. A canopy interception (CI) rate of up to 1 mm per rainfall event is assumed when simulating the mature forest. This accounts for rainfall that it collected on the forest canopy, and evaporates before ever reaching the cover system. When applying the canopy interception, a proportional amount of net radiation is also removed during rainfall days to account for the energy required to evaporate the intercepted rainfall.

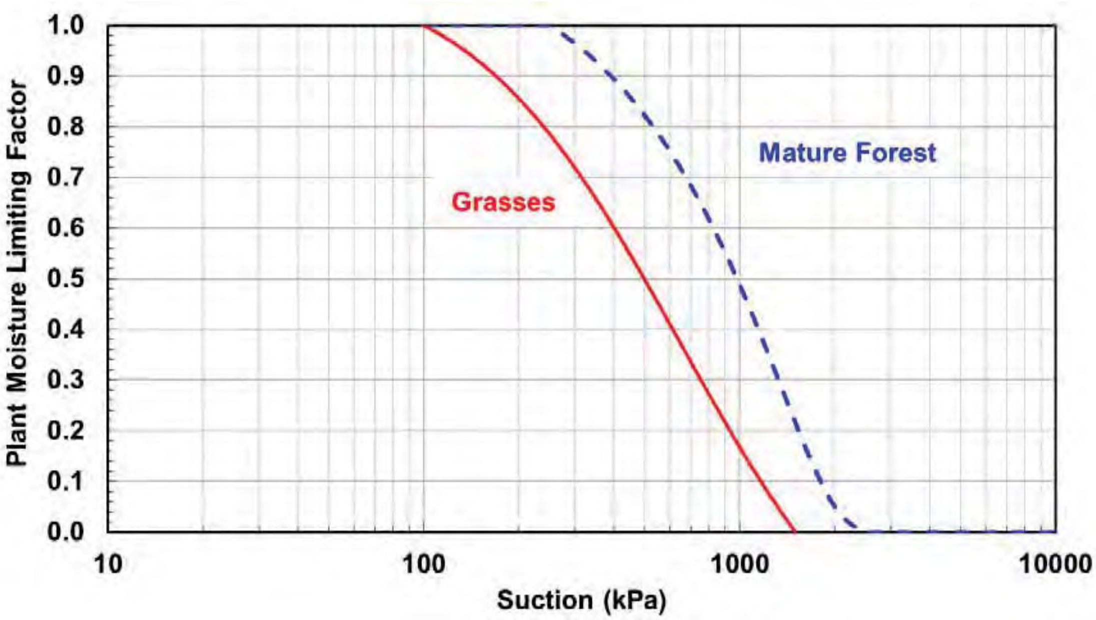

Figure A-3 Plant limiting moisture function for the grasses and mature forest vegetation sequences.

Lower and Side Boundary Conditions:

The lower boundary of each SPA model was simulated as a unit hydraulic gradient at the base of the waste material. This boundary condition simulates the water table to be well below the base of the cover system. A unit hydraulic gradient boundary condition assumes that at the lower boundary the soil suction (and, as a result, water content and hydraulic conductivity) are constant with depth. When this is the case, the total head equals the gravitational head causing a unit hydraulic gradient. In other words, a unit hydraulic gradient represents a location in the modelled profile where water movement is controlled mainly by gravity.

The sides of the 1D models was simulated as no flow boundaries for all simulations.

[22] Access Consulting Group. 2013. *Memorandum: 2012 Dry Stack Tailings Facility Cover Trial*. Prepared for Victoria Gold Corp., March.

APPENDIX F

O'Kane Consultants Inc. – Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

O'Kane Consultants
Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology

O'Kane Consultants Inc.
112 - 112 Research Drive
Saskatoon, SK S7N 3R3
Canada
T: (306) 955 0702 F: (306) 955 1596
www.okc-sk.com

Our ref: 917/03
September 30, 2016

Steve Wilbur
Senior Scientist
Victoria Gold Corp

By email: swilbur@vitgoldcorp.com

Mr. Wilbur:

Re: Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

O'Kane Consultants (OKC) was retained by Alexco Environmental Group (AEG) to provide updates to the Eagle Gold Project Reclamation and Closure Plan (RCP). The scope of OKC's work was to provide updates to the RCP based on the Type A Water Use Licence QZ14-041 Clause 178(d): *Research Program for Closure Cover System Designs* and Clause 178(e): *Vegetation Rooting Study*. The required updates were also reiterated in the Quartz Mining License QML-0011 in Schedule C, Part 2, Clause 4.1 (a). The following report provides a brief summary of background information that the conceptual plans were based on, followed by the proposed research program descriptions.

Summary of Previous Work:

OKC worked with AEG in 2014 to further assess the development of cover system designs for closure for the proposed heap leach facility (HLF) and waste rock storage areas (WRSAs) at VG's Eagle Gold Project (EGP) in the Yukon[1]. The closure cover system design was assessed to align with closure design objectives which included being geotechnically and geomorphically stable, providing a medium for sustainable growth of native plants, and reduce long-term net percolation rates to meet closure objectives using locally available materials. Specific project objectives were to further assess the anticipated hydrological performance of the base case cover system design and to provide recommendations to improve its predicated long-term performance from a net percolation reduction perspective. The 'base case' cover system design assessed was a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium.

The assessment was completed through development of a conceptual model for the performance of the base case cover system followed by conducting sensitivity analysis (numerical simulations) of cover system performance using the soil-plant-atmosphere (SPA) model VADOSE/W[2] with available site-specific inputs. The SPA numerical modelling was completed to determine:

[1] O'Kane Consultants Inc. 2014. Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas. OKC Rpt 917-1-01. April.
[2] Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

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

To increase the confidence in the predicted water balance components, specifically net percolation, OKC (2014) provided the following recommendations for further studies:

- Material characterization program of potential cover materials and waste materials (when they become available);
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Clause Specific Updates for RCP:

Clause 178(d): Research Program for Closure Cover System Designs

The overall objective of this research program is to build confidence in the initial long-term cover system design performance analyses in terms of net percolation and to inform eventual large-scale closure cover system construction. Four tasks for the research plan include:

1. Complete background and results review of any recent monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data to inform and update the conceptual model of cover system performance;

2. Develop a material characterization plan for candidate cover system and HLF and WRSA materials;

3. Enhanced meteorological monitoring; and

4. Design cover system field trials to facilitate the collection and development of a database of moisture and thermal responses (field performance monitoring data).

Tasks 1, 2, and 3 will be completed to update the current long-term cover system performance using numerical models to inform the field trial designs of Task 4.

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

The objective of the updated conceptual model will be to incorporate recent available monitoring and site investigation data to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist. In addition, the conceptual model will provide a basis to compare field trial monitoring results as they are obtained. This will be an iterative process where the conceptual model will continue to be updated and refined as new information is received.

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

The objective of the material characterization program is to:

- quantify certain hydraulic properties that will control the performance of the closure cover systems,

- assess material availability and volume,

- determine soil fertility for candidate top soil material, and

- evaluate erosion characteristics.

A key component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (k_{sat}) showed to have the largest influence on predicted net percolation rates in the 2014 numerical assessment. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC for the

2014 assessment[3456] and OKC used the PSD data to develop hydraulic properties of cover and waste materials for the 2014 assessment. PSD data was not available for the topsoil material and properties were developed by comparing topsoil materials from similar sites in an extensive material database developed by OKC. To achieve the overall objective of the material characterization program a sampling and borrow source availability program is proposed. The sampling program will be conducted during excavation during facility construction phase or during a test pit program to collect samples and log profiles of viable sources of the following candidate cover system materials:

- Topsoil,
- Colluvium, and
- Placer tailings.

The sample location plan will be developed following review of previous material investigations. Previous borrow material investigations and a site reconnaissance would be used to identify areas for further investigation and test pit specifications and execution details. The test pits or excavations would be logged for material layer depths, color, initial texture analysis, water table depth, rooting depth. A digital photographic record will be developed for each test pit and the specific location will be documented using a GPS device. Each potential borrow area will be surveyed for aerial extent by walking the area using survey grade GPS equipment to determine the volume of material available in the area.

Between 7 and 10 samples of each material type be collected and submitted for basic geotechnical testing including water content, particle size distribution (PSD) analyses and Atterberg limits. The exact number of samples collected would depend on the heterogeneity of the materials encountered during the program. Following a review of the PSD test results, a select number of duplicate samples would be submitted for compaction testing and hydraulic characterization including saturated permeability and moisture retention testing. The results of this testwork would allow refinement of the currently estimated hydraulic properties for cover materials simulated in the 2014 VADOSE/W modelling program, and subsequent increase in the confidence of current estimates of long-term cover system performance.

Representative samples of potential cover materials will be submitted for chemical characterization testing. Soil fertility examination for agronomy assessment, including but not limited to, analyses for sodium adsorption ratio (SAR), cation exchange capacity (CEC), pH and EC, organic carbon, exchangeable K, Ca, Mg, macronutrients, and micronutrients will be performed. Erodibility assessment of the topsoil or surface material would include aspects of the chemical and geotechnical assessment as well as the Emerson crumb test. The results of this testwork will aid in determining fertilizer requirements for revegetation of the cover systems, and may show that a particular borrow source, such as placer tailings, is chemically unsuitable to support growth of native plants. In addition, materials susceptible to erosion and not suitable for reclamation of side slopes would be identified.

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[3] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March

[4] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

[5] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January

[6] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

Task 2b: Material Characterization Program for HLF and WRSA Waste Materials:

Representative samples of spent heap leach and waste rock material will be collected once available, and submitted for geotechnical characterization. Analyses include PSD, water content, standard Proctor compaction, saturated permeability, and moisture retention. The mine waste characterization program will also help to determine the technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA to help with future detailed cover system design development.

Spent heap leach and waste rock materials may have a propensity to break down when exposed to the atmosphere and when mechanical energy is applied. A pilot-scale field compaction trial should be conducted to determine the extent to which the waste material can be compacted, thereby reducing its permeability. Large vibratory rollers may be able to reduce the saturated permeability of surface waste material on flatter areas of the HLF and WRSA, such as plateau areas and benches. The intent is to limit net percolation during relatively short-duration seasonal events when the storage capacity of the growth medium layer may be exceeded. Compaction field trials could be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years. The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces.

Task 3: Enhanced Meteorological Monitoring

The objective of the enhanced meteorological monitoring for different slope aspects is to verify climate input parameters used in numerical modelling analysis to gain confidence in site water balance estimations and in the long-term predicted cover system performance. Meteorological monitoring will focus on snow pack sublimation and redistribution of snow, incoming solar energy and wind speed. For northern sites, such as for the EGP site, snow pack constitutes a significant portion of the water balance. Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system. In addition, depending of the prevailing wind direction areas of the HLF / WRSA may be sheltered influencing the evaporative demand.

Currently climate data is being collected at two automated stations in the Project area: the Potato Hill station installed in 2007 and the Camp station installed in 2009. Station details and the climate data that will be collected during this Task are found in the Environmental Monitoring, Surveillance and Adaptive Management Plan[7]. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the Environmental Monitoring, Surveillance and Adaptive Management Plan to provide measurement of incoming solar energy for north, west, and south facing slopes (SGC, 2016).

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in SGC (2016). The snow course surveys will continue to be conducted

[7] Strata Gold Corporation (SGC). 2016. Eagle Gold Project Environmental Monitoring, Surveillance and Adaptive Management Plan, Version 2016-01.

at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in SGC (2016). The surveys will be conducted on a monthly basis during the winter season. The frequency of surveys will increase in late spring and based on climate and temperature patterns to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report as net percolation.

Task 4: Closure Cover System Field Trials for Performance Monitoring

The objective of the closure cover system field trials is increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. The results from the material characterization program and most recent site investigation and monitoring data would be used to update current numerical models of predicted cover system performance to inform the optimum cover system design to be trialed at the EGP site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012)[8]:

1) Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
2) Obtain performance monitoring data for calibration of numerical models, such as VADOSE/W;
3) Develop an understanding of key characteristics and processes that control cover system performance; and
4) Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. The initial modelled assessment of cover system performance showed little difference in performance between the WRSAs and HLF simulations. Information gained in previous tasks will assist in the development of cover trials on different waste material types and on different slope angles. Automated soil monitoring stations consisting of volumetric water content and matric suction sensors will be installed in each cover trial to quantify key surface water and energy balance fluxes. Data will be collected by a datalogger powered by battery and solar panel set up. The two sensor types will be installed in pairs through the cover system profile to capture data to calculate water and energy fluxes at the interfaces of different material types including between the cover system layers and between the cover system and waste. Stations will be installed to capture data on a plateau location and on different slope locations (upper, mid, and lower slope) to determine spatial variability. The number and location of the automated stations will be determined as part of the final design of the cover system monitoring trials informed by the updated conceptual model, the material characterization program, and the expanded site-specific meteorological dataset. The cover system field

[8] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

trial would be revegetated using techniques and species outlined by KP (2012a and 2012b)[9][10] and any updated vegetation monitoring information. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques to evaluate the degree of success of the closure cover system design. The monitoring plan developed for the research program would include monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives. Revegetation studies have been previously conducted to examine site-specific vegetation species and ecosystem characteristics (KP 2012a and 2012b) and will help in developing the re-vegetation component of the detailed research and monitoring plan.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. This will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the initial VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

Clause 178(e): Vegetation Rooting Study

The overall objective of Clause 178E: *Rooting Study* is to evaluate the potential risk for plant root uptake of contaminants of concern (CoCs) from physical, geochemical, and vegetative perspectives. The rooting study will be conducted concurrently with the Closure Cover System Field Trials. The following Tasks will be conducted to achieve this goal:

Task 1: Root Zone Monitoring to understand physical processes contributing to the accumulation or removal of constituents in the rooting zone (i.e. pore-water sampling collection over the duration of the program);

Task 2: Geochemical assessment of cover system and underlying materials to identify any constituents that may be susceptible to bioaccumulation; and

Task 3: Destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length, which would lead to an update of constituents in the cover system and underlying materials.

The following work plan is proposed to address the three Tasks outlined above.

Task 1: Rooting Zone Monitoring in Cover System Field Trial

A manual soil monitoring system would be installed adjacent to an automated soil monitoring system installed during field trials described above to monitor process that allow CoCs to accumulate in the root zone. The location and the number of the manual stations will be determined based on the final design of the cover system monitoring field trials. Deep pressure/vacuum soil water samplers (soil water samplers) would be installed in the cover system to manually monitor and sample pore-water over the duration of the

[9] Knight Piesold Consulting (KP). 2012a. Memorandum to Todd Goodsell. Site visit re-vegetation plan. File No. VA101-290/6-A.01. September 5.

[10] Knight Piesold Consulting (KP). 2012b. Memorandum to Todd Goodsell. Re-vegetation test plots. File No. VA101-290/6-A.01. September 7.

program, providing a basic understanding of soil moisture content and gradient within the cover system that would be verified with the automated system. Additionally, pore-water samples would be analyzed for aqueous chemistry to understand the movement of CoCs within the cover system. The instrumentation installation details will be determined based on the final cover system field trial design; however, the samplers will be installed to capture pore-water through the cover system and particularly near the cover system / waste material contact. Sampling frequency and monitoring plan will be developed to capture high flow periods in the seasonal cycle such as during or immediately following spring melt / cover system profile thaw or intense rainfall events. Pore-water samples collected with the soil water samplers would be submitted for general aqueous chemistry analysis. Samples would be submitted to be tested for measurement of metals (routine and trace) and routine water consisting of pH, EC, total dissolved solids (TDS) and major cations and anions.

Task 2: Geochemical Assessment

In addition to pore-water sample collection, samples of cover system and underlying materials would be collected for geochemical analysis as the field trial is being constructed. General overall geochemical characterization can be included as part of the material characterization program, but discreet samples of the materials used in the field trial should be obtained during construction to provide baseline conditions. Because vegetation will need to be supported by the cover system, basic characterization of the cover system materials and underlying materials will provide an indication of chemical composition related to growth characteristics, inform of potential fertilizer requirements for initial vegetative establishment, and aid in identifying any constituents susceptible to bioaccumulation. Basic chemical characterization would be conducted on samples of cover system layers and waste materials. Initially, samples would be collected and submitted for laboratory chemical characterization of: paste pH and EC, SAR, CEC, calcium carbonate equivalent (CCE) depending on CEC results, and leachate chemistry. The number of samples for each material will be determined as part of the detailed cover system trial work and monitoring plan. Samples will also be collected in conjunction with destructive sampling toward the end of the program to access any changes in soil geochemistry.

Task 3: Destructive Sampling

Destructive sampling would be completed during and near the end of the program to determine spatial vegetation characteristics that include vegetation type, ground cover percentage, vertical root length and density. A vegetation survey, consisting of sample plots randomly located throughout the cover system, would be completed to quantify spatial vegetation characteristics. Percentage of ground cover as well as the proportion of species in each sample plot would be determined using a 0.25 m^2 quadrat.

Following the assessment of ground cover, excavation of a number of plots would be conducted to determine the vertical root length density distribution per mass of soil for the cover system; the excavation may be a portion of the 0.25 m^2 quadrat. Small excavations would be completed using methods such as a backhoe at specified increments. Root presence and density would initially be noted and pictures taken for each increment. Each depth increment would be subsampled for water content and root density; water content subsamples would be tested for moisture content and root density samples would be weighed, stored in plastic bags, and water added to each sample. Upon returning from the field, samples should be soaked overnight in a cooler on ice to minimize root degradation. All roots would be separated from the soil matrix, dried and weighed to determine a root density for each plot. Methodology following Lazorko

(2008)[11] would be used for the root mass survey. The depth of each excavation would be dependent on the presence of roots or until the maximum investigation depth is reached. The number of vegetation and root mass surveys would be determined as part of the overall detailed monitoring plan for the cover system field trials.

Closure:

We thank you for the opportunity to assist Victoria Gold Corp with providing updates for the DCP. Please do not hesitate to contact me at (306) 955-0702 or dchapman@okc-sk.com should you have any questions or comments.

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 G

Detailed Closure Cost Estimate

Summary Table of Estimated Closure Costs

Description of Cost	Current Liability	2-Year Peak Liability (End of Y1)	Estimated Cost EOM
Closure Implementation			
T3 General & Administration	$86,397	$948,276	$1,236,219
T4 Exploration Disturbances	n/a	n/a	n/a
T5 Closure Planning	$110,000	$282,500	$1,040,648
T6 Pit	$0	$35,626	$40,858
T7 Heap Leach Pad	$65,266	$1,143,932	$3,918,893
T8 Waste Dumps	$104,163	$590,939	$2,946,392
T9 Surface Facilities	$1,330,057	$5,395,711	$11,280,686
T10 Infrastructure	$112,184	$308,496	$308,496
T11 Waste Disposal and Remediation	$25,175	$93,803	$106,303
T12 Landfills	$0	$101,706	$101,706
T13 Roads & Trails	$354,432	$354,432	$354,432
T14 Water Management	$170,502	$170,502	$232,134
T16 Interim Care & Maintenance	$606,506	$1,462,887	$2,731,446
Sub-total	$2,964,682	$10,888,809	$24,298,212
Indirect Costs	$444,702	$1,633,321	$3,644,732
Contingency Costs	$511,927	$1,895,976	$4,075,420
Cost Inflation	$137,739	$766,455	$6,800,595
Total Closure Implementation Costs	**$3,547,123**	**$13,288,584**	**$34,743,538**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)			
		NPV (1.5% DROR)	
Onsite Management	$343,200	$489,880	$920,581
Transport Costs	$18,000	$36,206	$52,616
Water Treatment Costs (Phase 6)	-	-	-
Active Treatment (Phase 6)	-	-	-
Capital Costs (included in T9, above)	$0	$0	$0
Capital Replacement Costs	$0	$121,502	$681,665
Operating Costs	$0	$1,501,474	$2,271,395
Draindown Pumping (Phase 6)	$0	$188,584	$335,739
Passive Treatment (Phase 7-8)	-	-	-
Capital Costs	$0	$122,505	$105,558
Operating Costs	$0	$43,739	$105,149
Reclamation & Closure Research Phase 6	$0	$41,775	$35,996
Monitoring & Reporting	$534,583	$1,711,152	$1,824,170
Post Closure Maintenance (Phase 7/8)	$100,245	$651,317	$768,330
Sub-Total	$996,028	$4,908,134	$7,101,199
Indirect Costs	$149,404	$736,220	$1,065,180
Contingency Costs	$149,404	$736,220	$1,065,180
Total Care, Maintenance and Monitoring Costs	$1,145,432	$5,644,354	$8,166,379
Total Closure Costs	**$4,692,556**	**$18,932,938**	**$42,909,918**
Contingency Amount	**$661,331**	**$2,632,196**	**$5,140,600**
Total Closure Costs (Plus Contingency)	**$5,353,887**	**$21,565,135**	**$48,050,518**

Cost Factors	
Indirect Cost Factor	**Contingency Factor**
15%	30%
n/a	n/a
15%	30%
15%	15%
15%	15%
15%	15%
15%	15%
15%	23%
15%	30%
15%	30%
15%	15%
15%	30%
15%	15%

Cost Factors	
Indirect Cost Factor	**Contingency Factor**
15%	15%

Closure Unit Rates

Equipment Rates			
Equipment	**Unit Rates**	**Unit**	**Comment/Source**
D9H Dozer	$350.00	hr	wet rate
Wheel Loader (939 or equivalent)	$179.59	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 2 CAT Loaders
Loader (PC3000 or equivalent)			
General Purpose Loader (Cat 416 E or equivalent)			
Haul Truck (Komatsu HD 1500-7 or equivalent)	$300.75	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 11 CAT 785 B Haul Trucks
Track Dozer (570 HP or equivalent)	$215.00	hr	wet rate
Drill Rig (DR 500 or equivalent)			
Grader (Cat 140K or equivalent)			
Water Truck (52,994 L 550 HP)			
D6D Dozer	$133.38	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 1 CAT D6t Crawler Dozer
Haul Truck D250E	$159.79	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 2 CAT 740 B Haul Trucks
Tandem Haul Truck	$150.00	hr	wet rate
Cat 235 Excavator	$155.40	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 2 CAT excavators
Cat 235 Excavator w hammer	$275.00	hr	wet rate
Cat 16H grader	$141.06	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 1 Motor Grader
988B Loader	$200.00	hr	wet rate
Tractor Trailer (lowbed)	$180.00	hr	wet rate
30 ton Crane	$121.61	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 3 Cranes
Hiab Flatdeck truck	$85.72	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 1 Boom Truck
Cat 950 loader	$105.84	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 2 CAT Loaders
Vibratory Roller	$150.00	hr	wet rate
Pickup Truck	$6.52	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 8 Pickup Trucks
Personnel Rates			
Personnel	**Unit Rates**	**Unit**	
Blaster	$44.96	hr	Updated based on Yukon Fair Wage Schedule
General Labourer	$36.18	hr	Updated based on Yukon Fair Wage Schedule
Trades Labourer	$50.15	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	$6,838	month	Updated based on Yukon Fair Wage Schedule
Site Caretaker	$9,210	month	Updated based on Yukon Fair Wage Schedule
Environmental Monitor	$10,385	month	Updated based on Yukon Fair Wage Schedule
Revegetation Rates	**Unit Rates**	**Unit**	
Revegetation Seed Mix	$18.38	kg	Modified based on Board's comments in Reason for Decision on unit rates.
Revegetation Seed Mix - 50kg/ha	$919.00	ha	Modified based on Board's comments in Reason for Decision on unit rates.
Fertilizer	$1.16	kg	Modified based on Board's comments in Reason for Decision on unit rates.
Fertilizer - 250kg/ha	$290.00	ha	Modified based on Board's comments in Reason for Decision on unit rates.
Tree Seedlings (1,000 seedlings per ha)	$2,100	ha	Modified based on Board's comments in Reason for Decision on unit rates.
Seed/Fertilizer Application	$1,785	ha	Modified based on Board's comments in Reason for Decision on unit rates.
Erosion Barrier	$3.15	m^2	Modified based on Board's comments in Reason for Decision on unit rates.
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	Modified based on Board's comments in Reason for Decision on unit rates.
Load, haul and place rip-rap	$15.75	m^3	Modified based on Board's comments in Reason for Decision on unit rates.
Deliver and install geosynthetic membrane on prepared foundation	$21.00	m^2	Modified based on Board's comments in Reason for Decision on unit rates.
Unit Basis (footing burial)	$5.25	each	Modified based on Board's comments in Reason for Decision on unit rates.
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	Modified based on Board's comments in Reason for Decision on unit rates.
Camp Cost	$57.75	day/person	Modified based on Board's comments in Reason for Decision on unit rates.
Site Security Cost	$6,100.00	month	Modified based on Board's comments in Reason for Decision on unit rates.
Power for recirculation pumps	$20,412.00	month	
Power and Heat (Year 2)	$7,500.00	month	
Employee Transport Costs	$7,875.00	month	Modified based on Board's comments in Reason for Decision on unit rates.

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 req'd, etc.
2) Unit rates for GeoWeb materials are provided by a licensed vendor and are considered conservative costs which include delivery and installation.

General and Administration Costs

Item No.	Work Item Description	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
3.1	**Onsite Management**									
	Pickup truck (Phase 6) (2 trucks)	Pickup Truck	hourly	$6.52	-	8,400	10,800	$0	$54,768	$70,416
	Sundry equipment maintenance (Phase 6)	Unit Cost Basis	annually	$10,000	-	2.3	3	$0	$23,000	$30,000
	Power and heat (Phase 6)	Power and Heat (Year 2)	monthly	$7,500	-	28	36	$0	$207,000	$270,000
	General Administrative expenses (Phase 6)	Unit Cost Basis	monthly	$7,500	-	28	36	$0	$207,000	$270,000
	Camp Costs (Phase 6)	Camp Cost	man-day	$57.75	1,496	2,823	3,847	$86,397	$163,032	$222,139
							Sub-Total	**$86,397**	**$654,800**	**$862,555**
3.2	**Transport Costs**									
	Employee transport costs (Phase 6)	Unit Cost Basis	monthly	$7,875	-	28	36	$0	$217,350	$283,500
							Sub-Total	**$0**	**$217,350**	**$283,500**
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**	**$0**
3.4	**Mobilization and Demobilization**									
	Heavy Equipment	Unit Cost Basis	per equipment	$5,000	-	6	6	$0	$30,000	$30,000
							Sub-Total	**$0**	**$30,000**	**$30,000**
3.5	**Access to Site**									
	Road Maintenance (Phase 6; see breakdown below)	Unit Cost Basis	monthly	$1,671	-	28	36	$0	$46,125	$60,164
							Sub-Total	**$0**	**$46,125**	**$60,164**
Total Estimated Cost for General and Administration Costs								**$86,397**	**$948,276**	**$1,236,219**

Breakdown of Item 3.5 Road Maintenance

ACTIVITY	DESCRIPTION / SPECS	UNITS	UNIT PRICE	NO. OF UNITS	COST ESTIMATE
Labour	General Labourer	Rate per hour	$36.18	40	$1,447.20
	Trades Labourer	Rate per hour	$50.15	40	$2,005.80
Equipment	Excavator 324 (25 ton)	Rate per shift	$1,403.50	3	$4,210.50
	Dump Truck (White Western Star)	Rate per shift	$3,395.53	2	$6,791.06
	Grader 14' (CAT 14G/H/M)	Rate per shift	$1,120.00	5	$5,600.00
TOTAL ESTIMATED COST			**Annual**		**$20,054.56**
			Monthly		**$1,671.21**

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

Item No.	Work Item Description	Equipment / Labour: Equipment / Labour	Equipment / Labour: Units	Equipment / Labour: Unit Rates	Quantity: Current	Quantity: 2-Year	Quantity: EOM	Cost: Current	Cost: 2-Year	Cost: EOM
3.1	**Closure Specific Studies and Field Trials**									
3.1.1	Update closure plan every two years	Engineering/Design	l.s.	$30,000	1	1	1	$30,000	$30,000	$30,000
3.1.2	Ongoing Revegetation Trials	Engineering/Design	n/a	n/a	Included in costs for implementing the EMSAMP			$0	$0	$0
3.1.3	Engineered Cover Evaluations	Engineering/Design	n/a	n/a	See Breakdown			$0	$107,500	$540,000
3.1.4	Rooting Study	Engineering/Design	n/a	n/a	See Breakdown			$0	$0	$145,000
3.1.5	Passive Treatment Detailed Plan	Engineering/Design	n/a	n/a	See Breakdown			$0	$45,000	$172,648
3.1.6	Heap Biological Detoxification and In-heap Bioreactor	Engineering/Design	n/a	n/a	See Breakdown			$0	$0	$43,000
3.1.7	Site contamination surveys (pre $35K, post $20K)	Engineering/Design	l.s.	$55,000	1	1	1	$55,000	$55,000	$55,000
							Sub-Total	**$85,000**	**$237,500**	**$985,648**
3.2	**Closure Plan Development**	Engineering/Design	l.s.		See Breakdown			$25,000	$45,000	$55,000
Total Estimated Cost for Closure Plan Development								**$110,000**	**$282,500**	**$1,040,648**

Breakdown of Item 3.1 Research Program Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.2	**Ongoing Revegetation Trials**	Included in costs for implementing the EMSAMP						$0	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
							Revegetation Trials Total	**$0**	**$0**	**$0**
3.1.3	**Engineered Cover Evaluations**									
3.1.3.1	**Task 1: Conceptual Model**									
	Assessment	Engineering/Design	l.s.	$50,000	-	0.5	1	$0	$25,000	$50,000
	Runoff and Surface Water Drainage Modelling	Engineering/Design	l.s.	$50,000	-	0.5	1	$0	$25,000	$50,000
	Landform Erosion Assessment Modelling	Engineering/Design	l.s.	$35,000	-	0.5	1	$0	$17,500	$35,000
	Field Permeability Testing Program	Engineering/Design	l.s.	$15,000	-	0.5	1	$0	$7,500	$15,000
	Reporting	Engineering/Design	l.s.	$15,000	-	0.5	1	$0	$7,500	$15,000
							Sub-Total	**$0**	**$82,500**	**$165,000**
3.1.3.2	**Task 2 and 3: Material Characterization Plan for Candidate Cover System and Heap Materials**									
	Material Characterization Plan Design (Cover and Heap Leach Materials)	Engineering/Design	l.s.	$15,000	-	0.5	1	$0	$7,500	$15,000
	Field Test Pit Program and Sample Collection	Engineering/Design	l.s.	$50,000	-		1	$0	$0	$50,000
	Laboratory Testing	Engineering/Design	l.s.	$35,000	-	0.5	1	$0	$17,500	$35,000
							Sub-Total	**$0**	**$25,000**	**$100,000**
3.1.3.3	**Task 4: Enhanced Meteorological Monitoring**							-	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
3.1.3.4	**Task 5: Cover System Field Trials**									
	Instrumentation	Engineering/Design	l.s.	$50,000	-	-	2	$0	$0	$100,000
	Cover System Field Trial Performance Monitoring	Engineering/Design	l.s.	$25,000	-	-	5	$0	$0	$125,000
							Sub-Total		**$0**	**$225,000**
3.1.3.5	**Task 6: Assess Effect of High pH Water Treatment Solids on the H**	Engineering/Design	l.s.	$50,000	-	-	1	$0	$0	$50,000
							Sub-Total	**$0**	**$0**	**$50,000**
							Engineered Cover Evaluations Total	**$0**	**$107,500**	**$540,000**
3.1.4	**Rooting Study**									
3.1.4.1	**Phase 1 - Analagous Forest Communities**									
	Review and Field Program Design	Engineering/Design	l.s.	$15,000	-	-	1	$0	$0	$15,000
	Set up of Test Plots for analgous forest communities	Engineering/Design	l.s.	$35,000	-	-	1	$0	$0	$35,000
	Destructive sampling of vegetation root system and cover m	Engineering/Design	l.s.	$35,000	-	-	1	$0	$0	$35,000
							Sub-Total	**$0**	**$0**	**$85,000**
3.1.4.2	**Phase 2 - Examination for Mine Engineered Cover Systems**									
	Review and Field Program Design	Engineering/Design	l.s.	$10,000	-	-	1	$0	$0	$10,000
	Geochemical Assessment of Cover and Underlying Material:	Engineering/Design	l.s.	Included in material characterization program for Engineered Cover Evaluations				$0	$0	$0
	Destructive sampling of vegetation root system and cover m	Engineering/Design	l.s.	$35,000	-	-	1	$0	$0	$35,000
	Project Management and Reporting	Engineering/Design	l.s.	$15,000	-	-	1	$0	$0	$15,000
							Sub-Total	**$0**	**$0**	**$60,000**
							Rooting Study Total	**$0**	**$0**	**$145,000**

Breakdown of Item 3.1 Research Program Tasks Continued

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.5	**Passive Treatment Detailed Plan**									
3.1.5.1	**Phase 1: Information Gathering**									
	Continued characterization of water requiring treatment	Engineering/Design	l.s.	$5,000	-	1	1	$0	$5,000	$5,000
	Target constiuents and performance goals	Engineering/Design	l.s.	$5,000	-	1	1	$0	$5,000	$5,000
	Existing wetland characterization (to guide plant selection) a	Engineering/Design	l.s.	$35,000	-	1	1	$0	$35,000	$35,000
							Sub-Total	**$0**	**$45,000**	**$45,000**
3.1.5.2	**Phase 2: Indoor Pilot Scale**									
	Design	Engineering/Design	l.s.	$10,000	-	-	1	$0	$0	$10,000
	Assembly	Engineering/Design	l.s.	$5,000	-	-	1	$0	$0	$5,000
	Performance Monitoring	Engineering/Design	l.s.	$5,000	-	-	5	$0	$0	$25,000
							Sub-Total	**$0**	**$0**	**$40,000**
3.1.5.3	**Phase 3: Outdoor Pilot Scale**									
	Assembly	Engineering/Design	l.s.	$10,000	-	-	1	$0	$0	$10,000
	Performance Monitoring	Engineering/Design	l.s.	$5,000	-	-	5	$0	$0	$25,000
							Sub-Total	**$0**	**$0**	**$35,000**
3.1.5.4	**Phase 4: On-Site Demonstration Scale**									
	Design	Engineering/Design	l.s.	$10,000	-	-	1	$0	$0	$10,000
	Construction									
	Excavate Pond	Construction	cu.m	$5	-	-	1,980	$0	$0	$8,910
	Load, haul dump fill, mulch, organics material	Construction	cu.m	$3	-	-	1,320	$0	$0	$3,458
	Planting Wetland Vegetation	Construction	ha	$8,000	-	-	1	$0	$0	$5,280
	Performance Monitoring		l.s.	$5,000	-	-	5	$0	$0	$25,000
							Sub-Total	**$0**	**$0**	**$52,648**
3.1.5.5	**Phase 5 Full Scale Implementation**	See costs for Passive Water Treatment for the LSDP and Events Pond								
							Sub-Total	**$0**	**$0**	**$0**
							Passive Treatment Detailed Plan Total	**$0**	**$45,000**	**$172,648**
3.1.6	**Heap Biological Detoxification**									
	Review of operational parameters of the heap leach facility	Engineering/Design	l.s.	$5,000	-	-	1	$0	$0	$5,000
	Setup of a sequential test facility adjacent to the heap	Engineering/Design	l.s.	$5,000	-	-	1	$0	$0	$5,000
	Operation of the columns	Engineering/Design	l.s.	$1,500	-	-	12	$0	$0	$18,000
	Post-treatment simulation	Engineering/Design	l.s.	$15,000	-	-	1	$0	$0	$15,000
							Sub-Total	**$0**	**$0**	**$43,000**
							Heap Biological Detoxification Total	**$0**	**$0**	**$43,000**
3.1.7	**Groundwater Arsenic Attenuation**									
	Geochemical Modelling	Engineering/Design	l.s.	$30,000	-	1	1	$0	$15,000	$30,000
	Monitoring of potential As Sources onsite	Engineering/Design	l.s.	$5,000	-	1	1	$0	$2,500	$5,000
	As Evaluation	Engineering/Design	l.s.	$5,000	-	1	1	$0	$2,500	$5,000
							Sub-Total	**$0**	**$20,000**	**$40,000**
							Groundwater Arsenic Attenuation Total	**$0**	**$20,000**	**$40,000**
Total Estimated Cost for Research Program Execution								**$0**	**$107,500**	**$685,000**

NOTES The estimates are based on previous OKC programs and are estimated to be +/-30%. The final detailed cost will be based on areas, number of monitoring locations, number of samples, and resulting tests that need to
Costs to conduct monitoring including net radiation, wind speed and direction, snow surveys, maintenance of systems, and data analysis for 5 years of monitoring are included as part of EMSAMP

Breakdown of Item 3.2 Closure Plan Development Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.2.1	**Reclamation and Closure Planning**									
	Optimization Workshop	Engineering/Design	l.s.	$7,500	0	0	1	$0	$0	$7,500
	Community and First Nation Engagement	Engineering/Design	l.s.	$2,500	1	1	1	$2,500	$2,500	$2,500
	Reclamation Research Plan	Engineering/Design	l.s.	$5,000	0.5	0.5	1	$2,500	$2,500	$5,000
3.2.2	**Closure Cost Estimation**	Engineering/Design	l.s.	$18,000	0.5	1	1	$9,000	$18,000	$18,000
3.2.3	**Report Writing**	Engineering/Design	l.s.	$22,000	0.5	1	1	$11,000	$22,000	$22,000
Total Estimated Cost for Closure Development								**$25,000**	**$45,000**	**$55,000**

Open Pit, Estimated Closure Costs - Phase 6

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
	OPEN PIT RECLAMATION									
6.1	**Open Pit**									
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	$36.18	-	24	96	$0	$868	$3,473
		Trades Labourer	hrs	$50.15	-	12	24	$0	$602	$1,203
		Support equipment	l.s.	$1,000	-	1	1	$0	$1,000	$1,000
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	$155.40	-	-	20	$0	$0	$3,108
		Haul Truck D250E	hrs	$159.79	-	-	20	$0	$0	$3,196
	Signage	General Labourer	hrs	$36.18	-	-	20	$0	$0	$724
	Highwall perimeter safety berm/trench (~7km)	Cat 235 Excavator	hrs	$155.40	-	-	-	$0	$0	$0
	Construct inflow spillway from upgradient of pit	Cat 235 Excavator	hrs	$155.40	-	-	40	$0	$0	$6,216
		Haul Truck D250E	hrs	$159.79	-	-	20	$0	$0	$3,196
		Produce rip-rap	cu.m	$15.75	-	-	200	$0	$0	$3,150
		Load, haul and place rip-rap	cu.m	$15.75	-	-	200	$0	$0	$3,150
	Construct exit channel into Platinum Gulch water conveyance channel	Cat 235 Excavator	hrs	$155.40	-	-	20	$0	$0	$3,108
		Produce rip-rap	cu.m	$15.75	-	-	200	$0	$0	$3,150
	Rip-rap shoulder exiting pit-spillway	Load, haul and place rip-rap	cu.m	$15.75	-	-	200	$0	$0	$3,150
		General Labourer	hrs	$36.18	-	-	10	$0	$0	$362
	Scarify Surface	Cat 16H grader	hrs	$141.06	-	50	-	$0	$7,053	$0
	Revegetate	Revegetation cost per ha. Including application cost	ha	$2,994.00	-	7.9	-	$0	$23,772	$0
	Project Management & Engineering		%		7.00%	7.00%	7.00%	$0	$2,331	$2,673
							Sub-Total	**$0**	**$35,626**	**$40,858**
Total Estimated Cost in Reclaiming Open Pit								**$0**	**$35,626**	**$40,858**

Heap Leach Facility, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
	Heap Closure (including embankment area)	102									
7.1	Heap Reclamation Cover										
	Roll crest and recontour		D9H Dozer	hrs	$350	-	-	-	$0	$0	$0
	Additional compaction, as req'd		Vibratory Roller	hrs	$150	-	-	-	$0	$0	$0
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$2.62	11,370	158,070	306,660	$29,789	$414,143	$803,449
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$2.62	7,580	105,380	204,440	$19,860	$276,096	$535,633
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994	4	52	102	$11,347	$157,095	$305,388
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$4,270	$59,313	$115,113
								Sub-Total	$65,266	$906,648	$1,759,583
7.2	Heap Passive Treatment CWTS										
	Develop closure sump piping drainage control		Drilling	lump sum	$20,000	-	1	1	$0	$20,000	$20,000
	Rework Events Pond		Misc.	lump sum	$10,000	-	1	1	$0	$10,000	$10,000
	Develop subsurface flow component	~200 m buried pipe	Misc.	lump sum	$30,000	-	1	1	$0	$30,000	$30,000
	Form Berm (400 m x 4 m high x 5 m wide)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$3	-	8,000	8,000	$0	$20,960	$20,960
	Haul and place bedding and topsoil layers 0.8 m plus 0.4 m bedding provision		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$3	-	42,840	42,840	$0	$112,241	$112,241
	Wetland Planting		Wetland plants (4,000 seedlings per ha)	ha	$8,000	-	4	4	$0	$28,560	$28,560
	Project Management & Engineering		7% of Total Cost			7.00%	7.00%	7.00%	$0	$15,523	$15,523
								Sub-Total	**$0**	**$237,284**	**$237,284**
7.3	**Heap Passive In Situ Treatment**										
	Nutrients added to heap for cyanide degradation		In Situ Treatment Reagent--Reducing Sugars and Nutrients	ton	$1,200	-	-	972	$0	$0	$1,166,400
	Nutrients added to heap for heap bioreactors		In Situ Treatment Reagent--Alcohols and Nutrients	ton	$1,200	-	-	205	$0	$0	$246,067
	Management of heap in situ treatment		Environmental Scientist	hrs	$116	-	-	1,080	$0	$0	$125,280
	Sonic Drilling for physical testing to confirm detoxification	500 m	Drilling	m	$75	-	-	500	$0	$0	$37,500
	Moving pumps, piping, drip emitter connections, solution application		Site Caretaker	monthly	$9,210	-	-	24	$0	$0	$221,039
	Project Management & Engineering		7% of Total Cost			7.00%	7.00%	7.00%	$0	$0	$125,740
								Sub-Total	**$0**	**$0**	**$1,922,027**
Total Estimated Cost in Reclaiming Heap Leach Facility									**$65,266**	**$1,143,932**	**$3,918,893**

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

			Equipment / Labour			Quantity			Cost		
Item No.	**Work Item Description**	**Area (ha) / Length (m)**	**Description**	**Units**	**Unit Rates**	**Current**	**2-Year**	**EOM**	**Current**	**2-Year**	**EOM**
	WASTE ROCK AND OVERBURDEN DUMPS										
4.1	**Eagle Pup (s 8.8)**	**82.90**									
	Roll crest and recontour		D9H Dozer	hrs	$350.00	-	-	-	$0	$0	$0
	Additional compaction, as req'd		Vibratory Roller	hrs	$150.00	-	8.82	140	$0	$1,323	$21,000
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$3.62	-	15,669	248,700	$0	$56,722	$900,294
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$3.62	-	10,446	165,800	$0	$37,815	$600,196
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	5.2	82.9	$0	$15,638	$248,203
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$7,805	$123,878
								Sub-Total	**$0**	**$119,302**	**$1,893,571**
4.2	**Platinum Gulch WRSA (s 8.9)**	**31.70**									
	Roll crest and recontour		D9H Dozer	hrs	$350.00	-	-	-	$0	$0	$0
	Additional compaction, as req'd		Vibratory Roller	hrs	$150.00	-	27	70	$0	$4,077	$10,500
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch)	cu.m.	$4.71	-	36,930	95,100	$0	$173,940	$447,921
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch)	cu.m.	$4.71	-	24,620	63,400	$0	$115,960	$298,614
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	12.3	31.7	$0	$36,856	$94,910
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$23,158	$59,636
								Sub-Total	**$0**	**$353,992**	**$911,581**
4.3	**Temporary Ore Stockpiles and Pads (s 8.10)**	**7.87**									
	Removal of bottom layer of material to Eagle Pup WRSA		Custom Rate B (Load, haul, place soil cover Eagle Pup)		$3.62	7,870	7,870	7,870	$28,489	$28,489	$28,489
	Recontour		D9H Dozer	hrs	$350.00	20	20.00	20	$7,000	$7,000	$7,000
	Place 20 cm topsoil cover		Cat 235 Excavator	hrs	$155.40	30	30.00	30	$4,662	$4,662	$4,662
			Trades Labourer	hrs	$50.15	30	30.00	30	$1,504	$1,504	$1,504
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	8	7.87	8	$23,563	$23,563	$23,563
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$4,565	$4,565	$4,565
								Sub-Total	**$69,784**	**$69,784**	**$69,784**
4.4	**Reclamation Stockpiles**	**9.52**									
	Recontour		D9H Dozer	hrs	$350.00		36	36	$0	$12,600	$12,600
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	6	5.80	10	$17,365	$17,365	$28,503
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$1,216	$2,098	$2,877
								Sub-Total	**$18,581**	**$32,063**	**$43,980**
4.5	**Ice Rich Overburden Storage Area**	**5.60**									
	Recontour and scarify surface		D9H Dozer	hrs	$350.00	12	12	20	$4,025	$4,025	$7,000
			Cat 16H grader	hrs	$141.06	6	5.75	10	$811	$811	$1,411
			Trades Labourer	hrs	$50.15	6	5.75	10	$288	$288	$501
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	3	3.22	6	$9,641	$9,641	$16,766
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$1,034	$1,034	$1,797
								Sub-Total	**$15,799**	**$15,799**	**$27,476**
4.6	**Eagle Pup Passive Treatment Ditch**										
	Combined pipeline/ditch for Eagle Pup - transport to constructed wetlands		Cat 235 Excavator	hrs	$155.40	-	-	-	$0	$0	$0
			Cat 16H grader	hrs	$141.06	-	-	-	$0	$0	$0
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Provision for ditching filter material under rip-rap		Load, haul and place rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Sedimentation Pond (# of ponds)		Misc.	l.s.	$50,000.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
Total Estimated Cost in Reclaiming Overburden and Waste Rock Dumps									**$104,163**	**$590,939**	**$2,946,392**

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

			Equipment / Labour			Quantity			Cost		
Item No.	Work Item Description	Area (ha) / Length (m)	Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
	ADR AND ANCILLARY FACILITIES										
9.1	**Buildings and Structures Demolition**										
	Remove salvageable equipment		General Labourer	hrs	$36.18	-	1,344	1,344	$0	$48,626	$48,626
			Trades Labourer	hrs	$50.15	-	504	504	$0	$25,273	$25,273
			30 ton Crane	hrs	$121.61	-	84	84	$0	$10,215	$10,215
	Decontaminate Building-hosing and clean-up		Trades Labourer	hrs	$50.15	-	168	168	$0	$8,424	$8,424
	Dismantle Buildings		General Labourer	hrs	$36.18	5,376	5,376	5,376	$194,504	$194,504	$194,504
			Trades Labourer	hrs	$50.15	4,032	4,032	4,032	$202,185	$202,185	$202,185
			Cat 235 Excavator	hrs	$155.40	210	210	210	$32,633	$32,633	$32,633
			30 ton Crane	hrs	$121.61	672	672	672	$81,719	$81,719	$81,719
	Concrete Demolition		Blaster	hrs	$44.96	-	-	-	$0	$0	$0
			Cat 235 Excavator w hammer	hrs	$275.00	252	252	252	$69,300	$69,300	$69,300
			D9H Dozer	hrs	$350.00	168	168	168	$58,800	$58,800	$58,800
	Misc. Supplies & Tools		Misc.	l.s.	$15,000.00	1	1	1	$15,000	$15,000	$15,000
	Scrap haul to solid waste facility		Cat 235 Excavator	hrs	$155.40	168	168	168	$26,106	$26,106	$26,106
			Haul Truck D250E	hrs	$159.79	168	168	168	$26,844	$26,844	$26,844
	Haul and place overburden for revegetation (0.2 m thickness)	2.83	Custom Rate A (Load, haul, plac	cu.m.	$2.62	5,660	5,660	5,660	$14,829	$14,829	$14,829
	Revegetate	2.83	Revegetation cost per ha. Includ	ha	$2,994.00	2.83	2.83	2.83	$8,473	$8,473	$8,473
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$51,127	$57,605	$57,605
								Sub-Total	**$781,520**	**$880,536**	**$880,536**
9.2	**Fuel Storage Area**										
	Cleanout tanks-remove sludge, pressure wash		General Labourer	hrs	$36.18	504	504	504	$18,235	$18,235	$18,235
			Removal to Licensed facility	l.s.	$12,500.00	1	1	1	$12,500	$12,500	$12,500
	Remove bulk fuel storage and piping facilities		General Labourer	hrs	$36.18	756	756	756	$27,352	$27,352	$27,352
			Trades Labourer	hrs	$50.15	336	336	336	$16,849	$16,849	$16,849
			30 ton Crane	hrs	$121.61	84	84	84	$10,215	$10,215	$10,215
			Support Equipment	l.s.	$7,500.00	1	1	1	$7,500	$7,500	$7,500
			Cat 235 Excavator	hrs	$155.40	-	-	-	$0	$0	$0
			General Labourer	hrs	$36.18	-	-	-	$0	$0	$0
			Tractor Trailer (lowbed)	hrs	$180.00	-	-	-	$0	$0	$0
	Fold and Bury Liner		Cat 235 Excavator	hrs	$155.40	48	48	48	$7,459	$7,459	$7,459
			D9H Dozer	hrs	$350.00	24	24	24	$8,400	$8,400	$8,400
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$7,596	$7,596	$7,596
								Sub-Total	**$116,105**	**$116,105**	**$116,105**
9.3	**Reagents Removal and Cleanup**										
	Load and return extra reagents/chemicals		General Labourer	hrs	$36.18	-	96	96	$0	$3,473	$3,473
			Support Equipment	l.s.	$2,500.00	-	1	1	$0	$2,500	$2,500
			Disposal Cost-bulk materials	l.s.	$5,000.00	-	1	1	$0	$5,000	$5,000
			Disposal Cost-lab pacs	pallets	$2,000.00	-	5	5	$0	$10,000	$10,000
	Removal of drums, steel, oils, glycol & batteries etc.		Contractor quote	l.s.	$50,900.00	-	1	1	$0	$50,900	$50,900
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$5,031	$5,031
								Sub-Total	**$0**	**$76,904**	**$76,904**
9.4	**Reclaim Crusher Area and Screening Area**										
	Test soils for contamination		Environmental Scientist	hrs	$116.00	10	20	20	$1,160	$2,320	$2,320
			Analytical Costs	l.s.	$6,000.00	1	1	1	$6,000	$6,000	$6,000
	Haul any contaminated soils to Land Treatment Facility		Cat 235 Excavator	hrs	$155.40	20	40	40	$3,108	$6,216	$6,216
			Haul Truck D250E	hrs	$159.79	20	40	40	$3,196	$6,391	$6,391
	Haul any ore contaminated soils to heap		Load, haul & place mat'l on heap	cu.m.	$10.00	50	100	100	$500	$1,000	$1,000
	Re-contour area and slopes to bury footings and establish drainage		D9H Dozer	hrs	$350.00	60	60	60	$21,000	$21,000	$21,000
	Scarify Surface	11.00	Cat 16H grader	hrs	$141.06	60	60	60	$8,463	$8,463	$8,463
	Haul and place overburden cap (0.5m thickness)	11.00	Unit Rate	cu.m	$5.50	55,000	55,000	55,000	$302,500	$302,500	$302,500
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$24,215	$24,772	$24,772
								Sub-Total	**$370,142**	**$378,663**	**$378,663**
9.5	**Truck Shop Area (s 6.9.7)**										
	Remove salvageable equipment		General Labourer	hrs	$36.18	-	504	504	$0	$18,235	$18,235
			Haul Truck D250E	hrs	$159.79	-	-	-	$0	$0	$0
			Trades Labourer	hrs	$50.15	-	84	84	$0	$4,212	$4,212
	Dismantle buildings		General Labourer	hrs	$36.18	-	2,100	2,100	$0	$75,978	$75,978
			30 ton Crane	hrs	$121.61	-	168	168	$0	$20,430	$20,430
			Cat 235 Excavator	hrs	$155.40	-	120	120	$0	$18,647	$18,647
	Haul building pieces off site - equipment		Tractor Trailer (lowbed)	hrs	$180.00	-	168	168	$0	$30,240	$30,240
	Scrap haul to site landfill		Haul Truck D250E	hrs	$159.79	-	24	24	$0	$3,835	$3,835
			Cat 235 Excavator	hrs	$155.40	-	24	24	$0	$3,729	$3,729
	Excavate & haul contaminated materials to site LTF		Misc.	l.s.	$6,250.00	-	1	1	$0	$6,250	$6,250
	Bury footings - haul and place fill, locally sourced		Unit Basis (footing burial)	each	$5.25	-	300	300	$0	$1,575	$1,575
	Recontour		D9H Dozer	hrs	$350.00	24	24	24	$8,400	$8,400	$8,400
	Haul and place overburden for revegetation (0.2 m thickness)	6.05	Custom Rate A (Load, haul, plac	cu.m.	$2.62	12,100.00	12,100.00	12,100.00	$31,702	$31,702	$31,702
	Revegetate	6.05	Revegetation cost per ha. Includ	ha	$2,994.00	6.05	6.05	6.05	$18,114	$18,114	$18,114
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$4,075	$16,894	$16,894
								Sub-Total	**$62,291**	**$258,241**	**$258,241**
9.6	**Water Treatment Plant**										
	Phase 2-5 Capital Costs		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$0	$3,207,050	$6,481,100
	Phase 2-5 Pipeline and Containment		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$0	$251,799	$251,799
	Phase 6 Capital Costs		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$0	$0	$2,526,550
	Phase 6 Pipeline and Containment		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$0	$226,413	$310,788
								Sub-Total	**$0**	**$3,685,262**	**$9,570,237**
Total Estimated Cost in Reclaiming Mill and Ancillary Facilities									**$1,330,057**	**$5,395,711**	**$11,280,686**

Breakdown of Item 9.6 Water Treatment Plant

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 2-5									
	SITE CIVIL									
	24.38m)(145'x80') Year 2 will utilize existing building (i.e., warehouse or truck shop)	ls			-	-	1	$ -	$ -	$ 282,000.00
	Building Erection	ls		$ -	-	-	1	$ -	-	$ 227,000.00
	Building Concrete (all)	m^3		$ 850.00	-	-	515	$ -	$ -	$ 437,750.00
	Steel Mezzanine	ls		$ -	-	-	1	$ -	-	$ 120,000.00
	Lab Sink	ls		$ 1,000.00	-	1	1	$ -	$ 1,000.00	$ 1,000.00
	MCC	ls		$ 150,000.00	-	1	1	$ -	$ 150,000.00	$ 150,000.00
	Control Room	ls		$ 12,000.00	-	1	1	$ -	$ 12,000.00	$ 12,000.00
	HVAC	ls		$ -	-	-	1	$ -	$ -	$ 80,000.00
	Electrical	ls		$ -	-	1	1	$ -	$ 65,000.00	$ 85,000.00
	SITE CIVIL SUBTOTAL		Subtotal					$ -	$ 228,000.00	$ 1,394,750.00
	PROCESS EQUIPMENT									
	Microfilter (Transverse 200mm)	ea		$ 1,050,000.00	-	1	2	$ -	$ 1,050,000.00	$ 2,100,000.00
	CIP Skid w/CHN	ea		$ 160,000.00	-	1	1	$ -	$ 160,000.00	$ 160,000.00
	IPS 2000	ea		$ 368,000.00	-	2	4	$ -	$ 736,000.00	$ 1,472,000.00
	Thickener Tank	ea		$ 35,000.00	-	1	1	$ -	$ 35,000.00	$ 35,000.00
	Polymer system	ea		$ 6,800.00	-	1	1	$ -	$ 6,800.00	$ 6,800.00
	Duplex Sump Pump System	ea		$ 28,000.00	-	1	1	$ -	$ 28,000.00	$ 28,000.00
	Strainer	ea		$ 28,200.00	-	1	1	$ -	$ 28,200.00	$ 28,200.00
	Plant Feed Pumps	ea		$ 18,200.00	-	2	2	$ -	$ 36,400.00	$ 36,400.00
	Process Water Transfer Pumps	ea		$ 10,700.00	-	6	11	$ -	$ 64,200.00	$ 117,700.00
	Chemical Pumps	ea		$ 8,000.00	-	8	12	$ -	$ 64,000.00	$ 96,000.00
	Waste Pumps	ea		$ 4,700.00	-	3	5	$ -	$ 14,100.00	$ 23,500.00
	EOM Reaction Tank - 225 m3 Year 2 Reaction Tank - 120m3	ea		$ 202,200.00	-	1	1	$ -	$ 110,000.00	$ 202,200.00
	Chemical Storage Tanks - 20 m3	ea		$ 10,100.00	-	5	7	$ -	$ 50,500.00	$ 70,700.00
	EOM Finished Water Tank - 225 m3 -insulated Year 2 Reaction Tank - 120m3 -insulated	ea		$ -	-	1	1	$ -	$ 136,000.00	$ 225,000.00
	EOM MF Feed Tank - 60 m3 Year 2 MF Fee Tank - 40m3	ea		$ -	-	1	1	$ -	$ 50,000.00	$ 75,000.00
	Neutralization Tank - 14 m3	ea		$ 8,600.00	-	1	1	$ -	$ 8,600.00	$ 8,600.00
	Filter Press System	ea		$ 202,000.00	-	1	1	$ -	$ 202,000.00	$ 202,000.00
	Safety Shower System	ea		$ 68,000.00	-	1	1	$ -	$ 68,000.00	$ 68,000.00
	Air compressors and reciever tank	ea		$ 8,000.00	-	1	1	$ -	$ 8,000.00	$ 8,000.00
	Citric Acid Mix Tank, 0.2 m3	ea		$ 3,250.00	-	1	1	$ -	$ 3,250.00	$ 3,250.00
	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ -	$ 2,859,050.00	$ 4,966,350.00
	PIPING									
	Primary Piping	m		$ 125.00	-	870	870	$ -	$ 108,750.00	$ 108,750.00
	Secondary Piping	m		$ 90.00	-	500	500	$ -	$ 45,000.00	$ 45,000.00
	Chem Piping	m		$ 50.00	-	800	800	$ -	$ 40,000.00	$ 40,000.00
	PIPING SUBTOTAL		Subtotal					$ -	$ 193,750.00	$ 193,750.00
	CONTROL									
	PLC Integration	ls		$ 45,000.00	-	1	1	$ -	$ 45,000.00	$ 45,000.00
	Instrumentation	ls		$ 75,000.00	-	1	1	$ -	$ 75,000.00	$ 75,000.00
	CONTROL SUBTOTAL		Subtotal					$ -	$ 120,000.00	$ 120,000.00
						Mine Water Treatment Plant Phase 2-5	Subtotal	$0	$3,400,800	$6,674,850
	Phase 2-5 Pipeline and Containment									
	SITE CIVIL									
	Concrete manhole	m^3		$ 850.00	-	48	48	$ -	$ 40,800.00	$ 40,800.00
	Valves	ls		$ 1,800.00	-	1	1	$ -	$ 1,800.00	$ 1,800.00
	Containment Earthwork	m^3		$ 15.00	-	10000	10000	$ -	$ 150,000.00	$ 150,000.00
	Containment Liner	m^2		$ 19.25	-	1850	1850	$ -	$ 35,612.50	$ 35,612.50
	Electrical	ls		$ 20,000.00	-	1	1	$ -	$ 20,000.00	$ 20,000.00
	SITE CIVIL SUBTOTAL		Subtotal					$ -	$ 248,212.50	$ 248,212.50
	PIPING									
	ADR Feed Pipeline - 150mm HDPE SDR11 Artic Pipe	m		$ 56.25	-	1500	1500	$ -	$ 84,375.00	$ 84,375.00
	Discharge Pipeline - 300mm HDPE SDR11 Artic Pipe	m		$ 181.06	-	400	400	$ -	$ 72,424.00	$ 72,424.00
	Discharge Diffuser	ls		$ 75,000.00	-	1	1	$ -	$ 75,000.00	$ 75,000.00
	PIPING SUBTOTAL		Subtotal					$ -	$ 231,799.00	$ 231,799.00
						Phase 2-5 Pipeline and Containment	Subtotal	$0	$251,799	$251,799

Breakdown of Item 9.6 Water Treatment Plant Continued

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 6									
	SITE CIVIL									
	Pre-Engineered Building (30.48m x 24.38m)	ls		$ 194,000.00	-	-	1	$ -	$ -	$ 194,000.00
	Building Erection	ls		$ 157,000.00	-	-	1	$ -	$ -	$ 157,000.00
	Building Concrete (all)	m^3		$ 850.00	-	-	370	$ -	$ -	$ 314,500.00
	Mezzanine (Bio Filters)	ls		$ 65,000.00	-	-	1	$ -	$ -	$ 65,000.00
	Mezzanine (Filter Press)	ls		$ 105,000.00	-	-	1	$ -	$ -	$ 105,000.00
	HVAC	ls		$ 35,000.00	-	-	1	$ -	$ -	$ 35,000.00
	Electrical	ls		$ 65,000.00	-	-	1	$ -	$ -	$ 65,000.00
	SITE CIVIL SUBTOTAL		Subtotal					$ -	$ -	$ 935,500.00
	PROCESS EQUIPMENT									
	Thickener Tank	ea		$ 35,000.00	-	-	1	$ -	$ -	$ 35,000.00
	Polymer system	ea		$ 7,000.00	-	-	1	$ -	$ -	$ 7,000.00
	Filter Press	ea		$ 307,000.00	-	-	1	$ -	$ -	$ 307,000.00
	Plant Feed Pumps	ea		$ 9,300.00	-	-	2	$ -	$ -	$ 18,600.00
	Plate Clarifier IGS-1130	ea		$ 370,000.00	-	-	1	$ -	$ -	$ 370,000.00
	Bio Tank Thickener	ea		$ 35,000.00	-	-	1	$ -	$ -	$ 35,000.00
	Bio Filters	ea		$ 270,000.00	-	-	1	$ -	$ -	$ 270,000.00
	Duplex Sump Pump System	ea		$ 28,000.00	-	-	1	$ -	$ -	$ 28,000.00
	Process Water Transfer Pumps	ea		$ 7,500.00	-	-	10	$ -	$ -	$ 75,000.00
	Chemical Pumps	ea		$ 8,000.00	-	-	12	$ -	$ -	$ 96,000.00
	Waste Pumps	ea		$ 4,700.00	-	-	6	$ -	$ -	$ 28,200.00
	Reaction Tank - 30 m3	ea		$ 11,000.00	-	-	4	$ -	$ -	$ 44,000.00
	Chemical Storage Tanks - 20 m3	ea		$ 19,100.00	-	-	4	$ -	$ -	$ 76,400.00
	Hot Water Tank	ea		$ 12,300.00	-	-	1	$ -	$ -	$ 12,300.00
	Heat Exchangers	ea		$ 5,400.00	-	-	2	$ -	$ -	$ 10,800.00
	Air compressors and receiver tank	ea		$ 8,000.00	-	-	1	$ -	$ -	$ 8,000.00
	Safety Shower System	ea		$ 5,000.00	-	-	1	$ -	$ -	$ 5,000.00
	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ -	$ -	$ 1,426,300.00
	PIPING									
	Primary Piping	m		$ 38.00	-	-	500	$ -	$ -	$ 19,000.00
	Secondary Piping	m		$ 27.50	-	-	500	$ -	$ -	$ 13,750.00
	Chem Piping	m		$ 15.00	-	-	800	$ -	$ -	$ 12,000.00
	PIPING SUBTOTAL		Subtotal					$ -	$ -	$ 44,750.00
	CONTROL									
	PLC Integration	ls		$ 45,000.00	-	-	1	$ -	$ -	$ 45,000.00
	Instrumentation	ls		$ 75,000.00	-	-	1	$ -	$ -	$ 75,000.00
	CONTROL SUBTOTAL		Subtotal					$ -	$ -	$ 120,000.00
				Mine Water Treatment Plant Phase 6			Subtotal	$0	$0	$2,526,550
	Phase 6 Pipeline and Containment									
	SITE CIVIL									
	Earthwork	m^3		$ 850.00	-	48	48	$ -	$ 40,800.00	$ 40,800.00
	Containment Earthwork	m^3		$ 15.00	-	10,000	10,000	$ -	$ 150,000.00	$ 150,000.00
	Containment Liner	m^2		$ 19.25	-	1,850	1,850	$ -	$ 35,612.50	$ 35,612.50
	SITE CIVIL SUBTOTAL		Subtotal					$ -	$ 226,412.50	$ 226,412.50
	PIPING									
	ADR Feed Pipeline - 150mm HDPE SDR11 Artic Pipe	m		$ 56.25	-	-	1,500	$ -	$ -	$ 84,375.00
	PIPING SUBTOTAL		Subtotal					$ -	$ -	$ 84,375.00
				Phase 6 Pipeline and Containment			Subtotal	$0	$226,413	$310,788

Infrastructure, Estimated Closure Costs, Phase 6/7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
	MISCELLANEOUS SITES AND FACILITIES										
10.1	**Mine Camp and Related Infrastructure (including guard house area)**										
	Disconnect Services		Trades Labourer	hrs	$50.15	106.18	106	106	$5,324	$5,324	$5,324
	Remove salvageable equipment		General Labourer	hrs	$36.18	318.53	319	319	$11,524	$11,524	$11,524
	Dismantle buildings		General Labourer	hrs	$36.18	637.06	637	637	$23,049	$23,049	$23,049
			Cat 235 Excavator	hrs	$155.40	79.63	80	80	$12,374	$12,374	$12,374
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$159.79	26.54	27	27	$4,241	$4,241	$4,241
			Cat 235 Excavator	hrs	$155.40	26.54	27	27	$4,125	$4,125	$4,125
	Site Clean-Up		General Labourer	hrs	$36.18	212.35	212	212	$7,683	$7,683	$7,683
	Decommission water supply wells		Fill with concrete	each	$2,000.00	2.00	2	2	$4,000	$4,000	$4,000
	Haul and place overburden for revegetation (0.2 m thickness)	3.95	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$2.62	7,900.00	7,900	7,900	$20,698	$20,698	$20,698
	Revegetate	3.95	Revegetation cost per ha. Including application cost	ha	$2,994.00	3.95	4	4	$11,826	$11,826	$11,826
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$7,339	$7,339	$7,339
								Sub-Total	**$112,184**	**$112,184**	**$112,184**
10.2	**Explosive / Magazine Storage Facility**										
	Remove salvageable equipment		General Labourer	hrs	$36.18	-	72	72	$0	$2,605	$2,605
			Trades Labourer	hrs	$50.15	-	72	72	$0	$3,610	$3,610
	Dismantle buildings		General Labourer	hrs	$36.18	-	48	48	$0	$1,737	$1,737
			Cat 235 Excavator	hrs	$155.40	-	24	24	$0	$3,729	$3,729
	Disconnect Services		Trades Labourer	hrs	$50.15	-	24	24	$0	$1,203	$1,203
	Crane services		30 ton Crane	hrs	$121.61	-	48	48	$0	$5,837	$5,837
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$159.79	-	24	24	$0	$3,835	$3,835
			Cat 235 Excavator	hrs	$155.40	-	24	24	$0	$3,729	$3,729
	Haul and place overburden for revegetation (0.2 m thickness)	2.91	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$2.62	-	5,820	5,820	$0	$15,248	$15,248
	Revegetate	2.91	Revegetation cost per ha. Including application cost	ha	$2,994.00	-	2.9	2.9	$0	$8,713	$8,713
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$3,517	$3,517
								Sub-Total	**$0**	**$53,765**	**$53,765**
10.5	**Electrical Dismantle and Remove**	44 km									
						see T15					
								Sub-Total	**$0**	**$0**	**$0**
10.6	**Conveyor Dismantle and Remove**										
	Remove salvageable equipment		General Labourer	hrs	$36.18	-	1,344	1,344	$0	$48,626	$48,626
			Trades Labourer	hrs	$50.15	-	1,008	1,008	$0	$50,546	$50,546
	Crane services		30 ton Crane	hrs	$121.61	-	280	280	$0	$34,049	$34,049
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$9,326	$9,326
								Sub-Total	**$0**	**$142,547**	**$142,547**
Total Estimated Cost in Reclaiming Miscellaneous Sites and Facilities									**$112,184**	**$308,496**	**$308,496**

Waste Disposal / Remediation - Phase #

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
11.1	**Solid Wastes Disposal**										
	Disposal at the onsite landfill (see individual cost sheets for hauling and T12)					-	-	-	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
11.2	**Hazardous Materials Disposal**										
	Off-Site Disposal			l.s.	$2,500.00	2	5	10	$5,000	$12,500	$25,000
								Sub-Total	**$5,000**	**$12,500**	**$25,000**
11.3	**Hydrocarbon Contaminated Soils**										
	Off-Site Disposal			l.s.	$2,500.00	1	-	-	$2,500	$0	$0
	On-Site Land Treatment Farm (LTF)										
	Prepare and submit closure plan		Misc	l.s.	$2,000.00	-	1	1	$0	$2,000	$2,000
	Characterize final soil hydrocarbon concentrations		Misc	l.s.	$4,000.00	-	1	1	$0	$4,000	$4,000
	Recontour		D9H Dozer	hrs	$350.00	-	36	36	$0	$12,600	$12,600
	Haul and place overburden cover from nearby		Cat 235 Excavator	hrs	$155.40	-	48	48	$0	$7,459	$7,459
			Haul Truck D250E	hrs	$159.79	-	48	48	$0	$7,670	$7,670
			D9H Dozer	hrs	$350.00	-	24	24	$0	$8,400	$8,400
	Final Decommissioning of LTF			l.s.	$17,500	-	1	1	$0	$17,500	$17,500
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$175	$4,174	$4,174
								Sub-Total	**$2,675**	**$63,803**	**$63,803**
11.4	**Process Residue Contaminated Soils**										
	Off-Site Disposal			l.s.	$3,500	5	5	5	$17,500	$17,500	$17,500
								Sub-Total	**$17,500**	**$17,500**	**$17,500**
Total Estimated Cost for Waste Disposal / Remediation									**$25,175**	**$93,803**	**$106,303**

Landfills - Phase 6 and 7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
12.1	**Expansion of Facility to Accommodate Closure Phase Debris**										
	Expand landfill		Cat 235 Excavator	hr	$155.40	-	252	252	$0	$39,160	$39,160
			General Labourer	hr	$36.18	-	252	252	$0	$9,117	$9,117
			Vibratory Roller	hr	$150.00	-	36	36	$0	$5,400	$5,400
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$3,757	$3,757
								Sub-Total	**$0**	**$57,434**	**$57,434**
12.2	**Operation During Closure Phase**										
	Disposal of solid waste at the onsite landfill (see individual cost sheets for hauling solid waste)								$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
12.3	**Final Closure**										
	Prepare detailed closure plan		Misc	l.s.	$2,000.00	-	1	1	$0	$2,000	$2,000
	Characterize final waste area		Misc	l.s.	$2,000	-	1	1	$0	$2,000	$2,000
	Remove recyclables and special waste materials		Tractor Trailer (lowbed)	hrs	$180.00	-	24	24	$0	$4,320	$4,320
	Final Compacton & Grading		D9H Dozer	hrs	$350.00	-	36	36	$0	$12,600	$12,600
	Haul and cover with adjacent fill and place overburden cap		Cat 235 Excavator	hrs	$155.40	-	24	24	$0	$3,729	$3,729
			Haul Truck D250E	hrs	$159.79	-	24	24	$0	$3,835	$3,835
	Compaction of cover		D9H Dozer	hrs	$350.00	-	24	24	$0	$8,400	$8,400
	Revegetation		Revegetation cost per l	ha	$2,994.00	-	1.5	1.5	$0	$4,491	$4,491
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$2,896	$2,896
								Sub-Total	**$0**	**$44,272**	**$44,272**
Total Estimated Landfill Costs									**$0**	**$101,706**	**$101,706**

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

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
13.1	**On Site Access and Haul Roads (s 8.13.3) (51.2h**	**60.18**									
	Recontour crests		Cat 235 Excavator	hrs	$155.40	602	602	602	$93,517	$93,517	$93,517
	Scarify surfaces		Cat 16H grader	hrs	$141.06	210	210	210	$29,622	$29,622	$29,622
	Revegeate		Revegetation cost per ha. Including application co	ha	$2,994.00	60	60	60	$180,179	$180,179	$180,179
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$21,232	$21,232	$21,232
								Sub-Total	**$324,549**	**$324,549**	**$324,549**
13.2	**Culverts**										
	Culvert excavation		Cat 235 Excavator	hrs	$155.40	50	50	50	$7,770	$7,770	$7,770
	Culvert removal		General Labourer	hrs	$36.18	168	168	168	$6,078	$6,078	$6,078
	Recontour slopes and drainage		D9H Dozer	hrs	$350.00	36	36	36	$12,600	$12,600	$12,600
	Stabilize slopes		General Labourer	hrs	$36.18	20	20	20	$724	$724	$724
	Silt Curtains (20m^2 per crossing)		Erosion Barrier	sq. m.	$3.15	140	140	140	$441	$441	$441
	Enviro matting (15m^2 per crossing)		Enviro matting	sq. m.	$3.00	105	105	105	$315	$315	$315
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$1,955	$1,955	$1,955
								Sub-Total	**$29,883**	**$29,883**	**$29,883**
Total Estimated Cost for Closure of Roads & Trails									**$354,432**	**$354,432**	**$354,432**

Water Management, Estimated Closure Costs - Phases 5 and 6

Item No.	Work Item Description	Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
14.1	**Diversion & Collection Ditches**										
	Raise and/or widen operational 1:10 year ditches			km	$12,500.00	6	6	6	$75,000	$75,000	$75,000
	Removal of Corrugated Steel Hlf Pipe	2000	Cat 235 Excavator	hr	$155.40	20	20	20	$3,108	$3,108	$3,108
			Tractor trailor for off-site salvage	hr	$180.00	30	30	30	$5,400	$5,400	$5,400
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$5,846	$5,846	$5,846
								Sub-Total	**$89,353**	**$89,353**	**$89,353**
14.2	**Groundwater Wells - Decommissioning**										
	Production Wells			l.s.	$3,600.00	4	4	12	$14,400	$14,400	$43,200
	De-Watering Wells			l.s.	$3,600.00	4	4	12	$14,400	$14,400	$43,200
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$2,016	$2,016	$6,048
								Sub-Total	**$30,816**	**$30,816**	**$92,448**
14.3	**Pumping**										
	Phase 5										
	Heap Rinsing (See Tab T17b)			$/kw	$ 0.14	-	3,562,152	325,240	$0	$0	$0
	Project Management & Engineering		7.5% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.4	**Construction of New Drainage Channels and Diversions for Closure**										
	Contour ditching (m)		Cat 235 Excavator	hrs	$155.40	100	100	100	$15,540	$15,540	$15,540
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
			Load, haul and place rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$3,293	$3,293	$3,293
								Sub-Total	**$50,332**	**$50,332**	**$50,332**
14.5	**Lower Dublin North Pond**										
	Removal of infrastructure and Liner		General Labourer	hr	$36.18	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$155.40	-	-	-	$0	$0	$0
	Haul waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Breaching and re-contouring			ha	$10,700.00	-	-	-	$0	$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	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.6	**Lower Dublin South Pond**										
	Removal of infrastructure and Liner		General Labourer	hr	$36.18	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$155.40	-	-	-	$0	$0	$0
	Haul waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Breaching and re-contouring			ha	$10,700.00	-	-	-	$0	$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	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.7	**Platinum Gulch Pond**										
	Removal of infrastructure and Liner		General Labourer	hr	$36.18	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$155.40	-	-	-	$0	$0	$0
	Haul waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Breaching and re-contouring			ha	$10,700.00	-	-	-	$0	$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	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.8	**Dublin Gulch Diversion Channel**										
	Removal of Armourmax liner		General Labourer	hr	$36.18	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$155.40	-	-	-	$0	$0	$0
	Removal of Fabriform		Cat 235 Excavator w hammer	hr	$275.00	-	-	-	$0	$0	$0
			General Labourer	hr	$36.18	-	-	-	$0	$0	$0
	Haul Waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Backfill Diversion Channel		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$2.62	-	-	-	$0	$0	$0
	Engineering for Armouring for restabilization of channels		Engineering Support	l.s.	$25,000.00	-	-	-	$0	$0	$0
	Produce armouring materials		Produce rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Armouring for restoration of Channels		Load, haul and place rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Re-contour channel			ha	$10,700.00	-	-	-	$0	$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	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.9	**Re-setablish Dublin Gulch**										
	Channel Excavation and Grading			ha	$10,700.00	-	-	-	$0	$0	$0
	Wood Toe Structure			m	$125.00	-	-	-	$0	$0	$0
	Log Drop Structure			each	$1,500.00	-	-	-	$0	$0	$0
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
Total Estimated Cost for Water Management									**$170,502**	**$170,502**	**$232,134**

Post Closure Care, Maintenance, and Monitoring - Phase 6,7,8

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Annual Cost (for NPV Calc)	Quantity			Cost			NPV		
						Current	2-Year	EOM	Current	2-Year	EOM	Current	2-Year	EOM
15.1	**Onsite Management**													
	Project Management and Engineering - Included in PME Costs in each Closure Component													
	Pickup truck													
	Phase 7/8	Light truck	monthly	$2,000	$24,000	36	84	204	$72,000	$168,000	$408,000			
	Fuel		monthly	$200		36	84	204	$7,200	$16,800	$40,800			
	Heavy equipment maintenance													
	Phase 7/8	Unit Cost Basis	annually	$10,000	$10,000	3	7	17	$30,000	$70,000	$170,000			
	Power and heat													
	Phase 7/8	Unit Cost Basis	monthly	$5,000	$60,000	36	84	204	$180,000	$420,000	$1,020,000			
	General Administrative expenses													
	Phase 7/8	Unit Cost Basis	monthly	$1,500	$18,000	36	84	204	$54,000	$126,000	$306,000			
	Camp Costs													
	Phase 7/8	Unit Cost Basis	man-day	$55	$0	-	-	-	$0	$0	$0			
	Subtotal - Phase 7/8 Onsite Management:				**$112,000**				**$343,200**	**n/a**	**n/a**	**n/a**	**$489,880**	**$920,581**
15.2	**Transport Costs**													
	Employee transport costs													
	Phase 7/8	Unit Cost Basis	monthly	$500	$6,000	36	84	204	$18,000	$42,000	$102,000			
	Subtotal - Onsite Management:				**$6,000**				**$18,000**	**n/a**	**n/a**	**n/a**	**$36,206**	**$52,616**
15.3	**Water Treatment Costs**													
	Active Treatment (Phase 6)													
	Capital Costs (See T9)	Misc.	annually	$0.00	$0	-	1	1	$0	$0	$0			
	Capital Replacement Costs					-	-		$0	$0	$0			
	Phase 2-5 WTP, 10-YEAR FREQUENCY	Misc.	10-yrs	$537,600	$537,600	-	-	1	$0	$0	$537,600			
	Phase 2-5 WTP, 4-YEAR FREQUENCY	Misc.	4-years	$118,987	$118,987	-	0.45	2	$0	$53,544	$237,974			
	Phase 6 A WTP, 4-YEAR FREQUENCY	Misc.	4-years	$82,500	$82,500	-	1	1	$0	$82,500	$82,500			
	Subtotal - Capital Replacement Costs :								**$0**	**n/a**	**n/a**	**n/a**	**$121,502**	**$681,665**
	Annual Operating Costs													
	Phase 2-5 WTP	Misc.	annually	$330,684	$330,684	-	0.52	3	$0	$171,129	$992,053			
	Phase 6 WTP	Misc.	annually	$615,836	$615,836	-	2.3	3	$0	$1,416,423	$1,847,508			
	Subtotal -Annual Operating Costs :								**$0**	**n/a**	**n/a**	**n/a**	**$1,501,474**	**$2,271,395**
	Draindown Pumping (Phase 6)													
	Year 1 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-	Electrical power costs to recirculate heap solution inventory and managed draindown see Tab T17b Draindown			$0	$141,576	$282,483	n/a	$133,391	$229,333
	Year 2 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-				$0	$48,882	$97,533	n/a	$45,375	$78,012
	Year 3 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-				$0	$10,735	$36,031	n/a	$9,818	$28,394
	Subtotal - Draindown Costs :								**$0**	**n/a**	**n/a**	**n/a**	**$188,584**	**$335,739**
	Passive Treatment (Phase 7/8)													
	Capital Costs (Occurs in Phase 6)	Misc.	annually	$133,952	$133,952	-	1	1	$0	$133,952	$133,952	n/a	$122,505	$105,558
	Operating Costs	Misc.	annually	$10,000	$10,000	-	5	15	$0	$50,000	$150,000	n/a	$43,739	$105,149
	Subtotal Passive Treatment Costs:								**$0**	**n/a**	**n/a**	**n/a**	**$166,244**	**$210,707**
	Subtotal Water Treatment Costs:								**$0**	**n/a**	**n/a**	**n/a**	**$1,977,804**	**$3,499,506**
15.4	**Reclamation & Closure Research Plan (Long Term Funding)**													
	Reclamation & Closure Research Plan	Misc.	annually	$15,000	$15,000	-	2	3	$0	$34,500	$45,000	n/a	$41,775	$35,996
	Subtotal Reclamation Research:								**$0**	n/a	n/a	**n/a**	**$41,775**	**$35,996**
15.5	**Monitoring & Reporting**													
	Disbursements (non-labour/non-analytical)	Misc.	annually	$0	$0	-	-	-	$0	$0	$0	n/a	$0	$0
	Water Quality Monitoring													
	Phase 6	Misc.	annually	$157,935	$157,935	-	2	3	$0	$363,251	$473,805	n/a	$439,847	$379,002
	Phase 7/8	Misc.	annually	$110,555	$110,555	3	7	17	$331,664	$773,882	$1,879,427	n/a	$667,124	$726,827
	Sediment Monitoring:													
	Phase 6	Misc.	annually	$1,272	$1,272	-	1	2	$0	$1,463	$1,908	n/a	$1,181	$1,017
	Phase 7/8	Misc.	annually	$890	$890	2	4	9	$1,336	$3,116	$7,568	n/a	$3,036	$5,865
	Biological Monitoring (Benthos):													
	Phase 6	Misc.	annually	$1,272	$1,272	-	1	2	$0	$1,463	$1,908	n/a	$1,181	$1,017
	Phase 7/8	Misc.	annually	$890	$890	2	4	9	$1,336	$3,116	$7,568	n/a	$3,036	$5,865
	Site groundwater monitoring	Misc.												
	Phase 6	Misc.	annually	$41,785	$41,785	-	2	3	$0	$96,106	$125,355	n/a	$116,371	$100,273
	Phase 7/8	Misc.	annually	$29,250	$29,250	3	7	17	$87,749	$204,747	$497,242	n/a	$176,502	$192,297
	Geotechnical Inspections:													
	Phase 6	Misc.	annually	$15,000	$15,000	-	2	3	$0	$34,500	$45,000	n/a	$41,775	$35,996
	Phase 7/8	Misc.	annually	$15,000	$15,000	3	7	17	$45,000	$105,000	$255,000	n/a	$90,515	$121,414
	Reclamation Inspections:													
	Phase 6	Misc.	annually	$0	$0	-	2	3	$0	$0	$0	n/a	$0	$0
	Phase 7/8	Misc.	annually	$10,000	$10,000	3	7	17	$30,000	$70,000	$170,000	n/a	$60,343	$80,944
	Monitoring of piezometers, thermistors													
	Phase 6	Misc.	each	$0	$0	-	2	3	$0	$0	$0	n/a	$0	$0
	Phase 7/8	Misc.	each	$0	$0	3	7	17	$0	$0	$0	n/a	$0	$0
	Annual Inspection + report	Misc.	annually	$12,500	$12,500	3	9	20	$37,500	$116,250	$250,000	n/a	$110,242	$173,652
	Subtotal:								$534,583	n/a	n/a	**n/a**	**$1,711,152**	**$1,824,170**
15.6	**Post Closure Maintenance and Decomissioning**													
	CWTS--Carry out inspection recommendations/maintenance	Misc.	annually	$7,500	$7,500	-	7	17	$0	$52,500	$127,500	n/a	$45,258	$86,193
	Misc. maintenance work related to the site after closure	Misc.	annually	$60,000	$60,000	1	7	17	$60,000	$300,000	$600,000	n/a	$262,436	$427,006
	Electrical Dismantle and Remove	44 km												
	De-energize, Disassemble structures and dismantle (521 structures)		Trades Labourer	hrs	$50.15	-	1,042	1,042	$0	$52,251	$52,251			
			General Labourer	hrs	$36.18	-	1,042	1,042	$0	$37,700	$37,700			
			30 ton Crane	hrs	$121.61	-	521	521	$0	$63,356	$63,356			
	Backfill foundation anchor holes		Haul Truck D250E	hrs	$159.79	-	130	130	$20,812	$20,812	$20,812			
			D9H Dozer	hrs	$350.00	-	48	48	$16,800	$16,800	$16,800			
	Haul scrap to Solid Waste Faiclity		Haul Truck D250E	hrs	$159.79	-	130	130	$0	$20,812	$20,812			
			Cat 235 Excavator	hrs	$155.40	-	48	48	$0	$7,459	$7,459			
	Project Management & Engineering		7% of Total Cost	%		7.00%	7.00%	7.00%	$2,633	$15,343	$15,343			
	Sub-Total Electrical Dismantle amd Remove:								**$40,245**	**$234,533**	**$234,533**	n/a	$199,103	$147,828
	Water Treatment Plant Decommissioning (Phase 7/8)													
	Remove salvageable equipment	General Labourer	hrs	$36.18		-	672	672	$0	$24,313	$24,313			
		Haul Truck D250E	hrs	$159.79		-	-	-	$0	$0	$0			
		Trades Labourer	hrs	$50.15		-	252	252	$0	$12,637	$12,637			
	Dismantle buildings	General Labourer	hrs	$36.18		-	960	960	$0	$34,733	$34,733			
		30 ton Crane	hrs	$121.61		-	168	168	$0	$20,430	$20,430			
		Cat 235 Excavator	hrs	$155.40		-	120	120	$0	$18,647	$18,647			
	Haul building pieces off site - equipment	Tractor Trailer (low	hrs	$180.00		-	168	168	$0	$30,240	$30,240			
	Scrap haul to site landfill	Haul Truck D250E	hrs	$159.79		-	24	24	$0	$3,835	$3,835			
		Cat 235 Excavator	hrs	$155.40		-	24	24	$0	$3,729	$3,729			
	Excavate & haul contaminated materials to site LTF	Misc.	l.s.	$6,250.00		-	1	1	$0	$6,250	$6,250			
	Bury footings - haul and place fill, locally sourced	Unit Basis (footing	each	$5.25		-	300	300	$0	$1,575	$1,575			
	Recontour	D9H Dozer	hrs	$350.00		-	24	24	$0	$8,400	$8,400			
	Haul and place overburden for revegetation (0.2 m thic	Custom Rate A (Lo	cu.m.	$2.62		-	2,080	2,080	$0	$5,450	$5,450			
	Revegetate	Revegetation cost	ha	$2,994.00		-	1.04	1.04	$0	$0	$0			
	Subtotal Water Treatment Decommissioning Costs:								**$0**	**$170,238**	**$170,238**	n/a	$144,521	$107,303
	Subtotal:								**$100,245**	n/a	n/a	n/a	**$651,317**	**$768,330**
Total Estimated Cost for Post Closure Site Management									**$996,028**	**n/a**	**n/a**	**n/a**	**$4,908,134**	**$7,101,199**

Breakdown of Item 15.3 Water Treatment Costs

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Phase 2-5 Equipment Replacement Costs									
	10-YEAR FREQUENCY									
	MF Membranes	ea		$ 3,200.00	-	0	168	$ -	$ -	$ 537,600.00
	10-YEAR SUBTOTAL		Subtotal					$ -	$ -	$ 537,600.00
	4-YEAR FREQUENCY									
	Feed Pumps	ea		$ 18,243.50	-	0.45	2	$ -	$ 8,209.58	$ 36,487.00
	Transfer Pumps	ea		$ 7,500.00	-	1.13	5	$ -	$ 8,437.50	$ 37,500.00
	Chemical Pumps	ea		$ 7,500.00	-	1.35	6	$ -	$ 10,125.00	$ 45,000.00
	4-YEAR FREQUENCY SUBTOTAL		Subtotal					$ -	$ 26,772.08	$ 118,987.00
	Phase 6 Equipment Replacement Costs									
	4-YEAR FREQUENCY									
	Transfer Pumps	ea		$ 7,500.00	-	5	5	$ -	$ 37,500.00	$ 37,500.00
	Chemical Pumps	ea		$ 7,500.00	-	6	6	$ -	$ 45,000.00	$ 45,000.00
	4-YEAR FREQUENCY SUBTOTAL		Subtotal					$ -	$ 82,500.00	$ 82,500.00
	Phase 2-5 Annual Operating Costs									
	EQUIPMENT POWER COSTS									
	Transverse 200 Microfilter	Kw/h	3 kW @ 100%	$ 0.14	-	0.45	2	$ -	$ 1,407.29	$ 6,254.64
	Feed Pumps	Kw/h	50 Hp (37.285kW) @ 50%	$ 0.14	-	0.45	2	$ -	$ 8,745.16	$ 38,867.38
	Process Transfer Pumps	Kw/h	20 Hp (14.914 kW) @ 50%	$ 0.14	-	2.25	10	$ -	$ 17,490.32	$ 77,734.75
	Filter Press	Kw/h	15 Hp (11.185) @ 20%	$ 0.14	-	0.23	1	$ -	$ 524.69	$ 2,331.94
	SUBTOTAL EQUIPMENT POWER		Subtotal					$ -	$ 28,167.46	$ 125,188.70
	LABOUR COSTS									
	Transverse 200 Microfilter	hrs/yr	Trades Labourer	$50.15	-	117	520	$ -	$ 5,866.97	$ 26,075.40
	Filter Press	hrs/yr	Trades Labourer	$50.15	-	234	1040	$ -	$ 11,733.93	$ 52,150.80
	Plate Clarifiers	hrs/yr	Trades Labourer	$50.15	-	23	104	$ -	$ 1,173.39	$ 5,215.08
	Chemical Batching	hrs/yr	Trades Labourer	$50.15	-	23	104	$ -	$ 1,173.39	$ 5,215.08
	SUBTOTAL LABOUR		Subtotal					$ -	$ 19,947.68	$ 88,656.36
	CHEMICAL COSTS									
	Process Chemical									
	Ferric Chloride, 39%	L/y		$0.40	-	21380	95023	$ -	$ 8,552.07	$ 38,009.20
	Sulfuric Acid, 93% Micro C	L/y		$0.38	-	7390	32846	$ -	$ 2,808.33	$ 12,481.48
	Sodium Hydroxide, 50%	L/y		$1.00	-	12971	57647	$ -	$ 12,970.58	$ 57,647.00
	Cleaning Chemical									
	Sodium Bisulfite 40%	L/y		$0.70	-	329	1460	$ -	$ 229.95	$ 1,022.00
	Sodium Hypochlorite, 12.5%	L/y		$0.47	-	986	4380	$ -	$ 463.19	$ 2,058.60
	Citric Acid, Solid	kg/y		$2.20	-	575	2555	$ -	$ 1,264.73	$ 5,621.00
	SUBTOTAL LABOUR		Subtotal					$0	$26,289	$116,839
	Total Phase 2-5 Annual Operating Costs							**$ -**	**$ 74,403.98**	**$ 330,684.34**
	Phase 6 Operating Costs									
	EQUIPMENT POWER COSTS									
	Process Transfer Pumps	Kw/h	@ 50%	$ 0.14	-	10	10	$ -	$ 38,867.38	$ 38,867.38
	SUBTOTAL EQUIPMENT POWER		Subtotal					$ -	$ 38,867.38	$ 38,867.38
	LABOUR COSTS									
	Bio Filters	hrs/yr	Trades Labourer	$50.15	-	520	520	$ -	$ 26,075.40	$ 26,075.40
	Plate Clarifiers	hrs/yr	Trades Labourer	$50.15	-	936	936	$ -	$ 46,935.72	$ 46,935.72
	Chemical Batching	hrs/yr	Trades Labourer	$50.15	-	416	416	$ -	$ 20,860.32	$ 20,860.32
	SUBTOTAL LABOUR		Subtotal					$ -	$ 93,871.44	$ 93,871.44
	CHEMICAL COSTS									
	Process Chemical									
	Micro C		L/y	$0.40	-	182,500	182,500	$ -	$ 73,000.00	$ 73,000.00
	Sodium Bisulfite 40%		L/y	$0.70	-	19,126	19,126	$ -	$ 13,388.20	$ 13,388.20
	Sodium Hypochlorite, 12.5%		L/y	$0.47	-	262,414	262,414	$ -	$ 123,334.58	$ 123,334.58
	Sodium Hydroxide, 50%		L/y	$1.00	-	179,503	179,503	$ -	$ 179,503.00	$ 179,503.00
	SUBTOTAL LABOUR		Subtotal					$0	$ 483,097.22	$ 483,097.22
	Total Phase 6 Annual Operating Costs							**$ -**	**$ 615,836.04**	**$ 615,836.04**

Breakdown of Item 15.3 Passive Treatment Systems

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	PG Passive Treatment (Reasearch Pond = 0.66 ha)									
	Included in T5 Reclamation Research			$ -	-	0	0	$ -	$ -	$ -
	HLF Passive Treatment (85% of Events Pond = 3.57 ha)									
	Included in T7 Passive treatment system			$ -	-	-	-	$ -	$ -	$ -
	LDSP Passive Treatment (85% of LDSP Pond = 2.3 ha)									
	Construction									
	Excavate Pond	cu.m	Excavation of Soil	$ 4.50	-	23000	23000	$ -	$ 103,500.00	$ 103,500.00
	Load, haul dump fill, mulch, organics mate	cu.m	.oad, haul, place wetl	$ 2.62	-	4600	4600	$ -	$ 12,052.00	$ 12,052.00
	Planting Wetland Vegetation	ha	plants (4,000 seedlin	$ 8,000.00	-	2.3	2.3	$ -	$ 18,400.00	$ 18,400.00
	SUBTOTAL LABOUR		Subtotal					$0	$ 133,952.00	$ 133,952.00

Interim Care and Maintenance

Item No.	Work Item Description	Equipment / Labour: Description	Equipment / Labour: Units	Equipment / Labour: Unit Rates	Quantity: Current	Quantity: 2-Year	Quantity: EOM	Cost: Current	Cost: 2-Year	Cost: EOM
16.1	**Personnel**									
	On-site Caretaker									
	Full time (2 people on alternate 7in-7out schedule, $6,710 each per month)	Site caretaker	$9,209.97	$/man-month	24	24	24	$221,039	$221,039	$221,039
	Extra Personnel									
	Electrician (estimate 1 mo/yr total total for EOM)	Trades Labourer	$50.15	$/hr	88	88	176	$4,413	$4,413	$8,826
	Mechanic (estimate 1 mo/yr total total for EOM)	Trades Labourer	$50.15	$/hr	88	88	176	$4,413	$4,413	$8,826
	Senior Operator/Supervisor (estimate 2mo/yr total for EOM)	Site Supervisor	$59.85	$/hr	176	176	352	$10,534	$10,534	$21,067
	Camp Costs									
	for above personnel (365+30+30+60)	Unit Cost Basis	$57.75	mandays	425	425	485	$24,544	$24,544	$28,009
			Sub-Total - Personnel					**$264,942**	**$264,942**	**$287,766**
16.2	**Equipment**									
	Small Excavator (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Dozer (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Loader (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Pick-Up Truck (1)	Misc.	$2,500	monthly	12	12	12	$30,000	$30,000	$30,000
	Snow Machine & ATV	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
			Sub-Total - Equipment					**$70,000**	**$70,000**	**$70,000**
16.3	**Tasks**									
	Interim water treatment (active)	Misc.	See T15	annually	See Breakdown in T15			$0	$74,404	$330,684
	Water Quality monitoring	Misc.	$157,935	annually	1	1	1	$157,935	$157,935	$157,935
	Geotechnical Assessments	Misc.	$15,000	annually	0.33	0.67	1	$5,000	$10,000	$15,000
	Sediment monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Biological monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Groundwater monitoring	Misc.	$41,785	annually	1	1	1	$41,785	$41,785	$41,785
	Monitoring of piezometers and thermistors	Misc.	$3,000	annually	-	-	-	$0	$0	$0
	Communications & reporting	Misc.	$12,500	annually	1	1	1	$12,500	$12,500	$12,500
			Sub-Total - Tasks					**$219,764**	**$299,168**	**$560,448**
16.4	**Miscellaneous**									
	Misc Supplies	Misc.	$50,000	annually	1	1	1	$50,000	$50,000	$50,000
	Annual Fuel	Misc.	$1.80	$/litre	1,000	1,000	1,000	$1,800	$1,800	$1,800
	Power to maintain water recirculation	$/kw	$ 0.14	annually	-	1,319,029	2,826,490	$0	$45,534	$395,709
			Sub-Total - Miscellaneous					**$51,800**	**$97,334**	**$447,509**
			Annual Cost for ICM					**$606,506**	**$731,444**	**$1,365,723**
			Number of Years					**1**	**2**	**2**
			Total ICM Cost					**$606,506.15**	**$1,462,887.43**	**$2,731,446.38**

Table of Quantities

Item Description	Value Current	Value 2- Year Peak (End of Y1)	Value EOM	Units	Source/Comment EOM
Open Pit					
Inflow Spillway Rip-Rap	0.00	0.00	200.00	m^3	
Exit Channel Rip-Rap	0	0	200	m^3	
Open Pit Area	0	7.9	0	ha	
Overburden for revegetation	0	15,880	0	m^3	0.2 m thickness
Heap Leach Facility					
Heap Leach Facility	0.00	48.90	98.43	ha	
Colluvium for revegetation	0	146,700	295,290	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation	0	97,800	196,860	m^3	0.2 m thickness over total area
Heap Leach Facility - Embankment Area	3.79	3.79	3.79	ha	
Colluvium for revegetation	11,370	11,370	11,370	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation	7,580	7,580	7,580	m^3	0.2 m thickness over total area
Passive Treatment CWTS Area	0.0	3.6	3.6	ha	85% of Events Pond area available for CWTS
Passive Treatment berm	8,000	8,000	8,000		400 m x 4 m high x 5 m wide
Bedding and topsoil layers	0	42,840	42,840		0.8 m topsoil layer plus 0.4 m bedding provision
Nutrients added to heap for cyanide degradation	0	972	972	ton	
Nutrients added to heap for heap bioreactors	0	205	205	ton	
Waste Rock and Overburden Dumps					
Eagle Pup Area	0.00	5.22	82.90	ha	
Eagle Pup Waste Rock	0	4,177,000	64,360,000	t	
Colluvium for revegetation - Eagle Pup	0	15,669	248,700	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Eagle Pup	0	10,446	165,800	m^3	0.2 m thickness over total area
Platinum Gulch Area	0.00	12.31	31.70	ha	Year 2 Area from AutoCAD
Platinum Gulch Waste Rock	0	2,709,000	21,620,000	t	
Colluvium for revegetation - Platinum Gulch	0	36,930	95,100	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Platinum G	0	24,620	63,400	m^3	0.2 m thickness over total area
Temporary Ore Stockpiles and Pads Area	7.9	7.9	7.9	ha	
Pad material removal to Eagle Pup	7,870	7,870	7,870	m^3	0.1 m depth of removal
Reclamation Stockpiles Area	5.8	5.8	9.5	ha	
Ice Rich Overburden Storage Area	3.2	3.2	5.6	ha	
Eagle Pup Passive Treatment Ditch Rip-Rap	0	0	0	m^3	No longer required.
Process Plant & Ancillary Facilities					
Process Plant Area	2.83	2.83	2.83	ha	Year 2 Area from AutoCAD
Overburden for revegetation	5,660	5,660	5,660	m^3	0.2 m thickness
Crusher and Screening Area	11.0	11.0	11.0	ha	
Ore contaminated soils to be hauled to heap	100	100	100	m^3	
Overburden cap	55,000	55,000	55,000	m^3	0.5 m thickness
Truck Shop Area	6.05	6.05	6.05	ha	
Overburden for revegetation	12,100	12,100	12,100	m^3	0.2 m thickness
Water Treatment Plant area	1.04	1.04	1.04	ha	
Overburden for revegetation	2,080	2,080	2,080	m^3	0.2 m thickness
Miscellaneous Sites and Facilities					
Mine Camp area	3.95	3.95	3.95	ha	
Overburden for revegetation	7,900	7,900	7,900	m^3	0.2 m thickness
Explosive / Magazine Storage Facility area	2.91	2.91	2.91	ha	
Overburden for revegetation	5,820	5,820	5,820	m^3	0.2 m thickness
Roads and Trails					
On site access and haul roads	52	52	52	ha	
Contruction Trails	8	8	8	ha	
Slope Stabilization					
Silt Curtains (m^2 per crossing)	20	20	20	m^2	
Enviro matting (m^2 per crossing)	15	15	15	m^2	
Number of crossings	7	7	7		
Silt Curtains Total	140	140	140	m^2	
Enviro matting Total	105	105	105	m^2	
Water Management					
New Drainage channels and diversions					
Provision for Rip-Rap	1,000	1,000	1,000	m^3	

Breakdown of Item 14.3 Pumping during Phase 6 Draindown

Assumption	Value	Unit
Maximum power draw per pump	149	kW
Maximum capacity per pump	520	m^3/hr
Maximum capacity per pump	144	L/s
Draindown Pumping Factor	75%	%
Ramp up at the end of Y1 (2-Year Peak)	802,900	L/hr
Ramp up at the end of Y1 (2-Year Peak)	223	L/s
Cost per Kw	0.14	$/kw-hr

Item No.	Work Item Description	Month	Hrs per month	EOM: Days of Rinse	EOM: Pumping Rate (m^3/hr)	EOM: Number of Pumps	EOM: Duration Energy Consumption (kW-hr)	EOM: Total Phase 5 Rinsing Power Cost	2-Year Peak: Days of Rinse	2-Year Peak: Pumping Rate (m^3/hr)	2-Year Peak: Number of Pumps	2-Year Peak: Duration Energy Consumption (kW-hr)	2-Year Peak: Total Phase 5 Rinsing Power Cost
14.4	Phase 5 - Recirculation Pumping												
			Total Duration	460	1500	3	3,562,152	$ 498,701.22	90	700	2	325,240	$ 45,533.59
Item No.	Work Item Description	Month	Hrs per month	EOM: Pumping Rate (L/s) during draindown month*	EOM: No. of pumps req'd for recirculation	EOM: Maximum Power draw (kW)	EOM: Energy Consumption per month (kW-hr)	EOM: Monthly Power Cost	2-Year Peak: Pumping Rate (L/s) during draindown month	2-Year Peak: No. of pumps req'd for recirculation	2-Year Peak: Maximum Power draw (kW)	2-Year Peak: Energy Consumption per month (kW-hr)	2-Year Peak: Monthly Power Cost
14.4	Phase 6 - Draindown Pumping												
	Year 1	1	744	445	4	596.56	256,382	$ 35,893.48	223	2	298.28	128,495	$ 17,989.31
		2	672	415	3	447.42	215,959	$ 30,234.30	208	2	298.28	108,236	$ 15,153.01
		3	744	390	3	447.42	224,694	$ 31,457.20	195	2	298.28	112,614	$ 15,765.91
		4	720	360	3	447.42	200,719	$ 28,100.73	180	2	298.28	100,598	$ 14,083.69
		5	744	335	3	447.42	193,007	$ 27,020.93	168	2	298.28	96,732	$ 13,542.51
		6	720	300	3	447.42	167,266	$ 23,417.27	150	2	298.28	83,831	$ 11,736.41
		7	744	285	2	298.28	164,200	$ 22,987.96	143	1	149.14	82,295	$ 11,521.24
		8	744	252	2	298.28	145,187	$ 20,326.19	126	1	149.14	72,766	$ 10,187.20
		9	720	230	2	298.28	128,237	$ 17,953.24	115	1	149.14	64,271	$ 8,997.91
		10	744	210	2	298.28	120,989	$ 16,938.49	105	1	149.14	60,638	$ 8,489.34
		11	720	185	2	298.28	103,148	$ 14,440.65	93	1	149.14	51,696	$ 7,237.45
		12	744	170	2	298.28	97,944	$ 13,712.11	85	1	149.14	49,088	$ 6,872.32
				Year 1 Total			2,017,733	$ 282,482.56				1,011,259	$ 141,576.31
	Year 2	13	744	155	2	298.28	89,302	$ 12,502.22	78	1	149.14	44,757	$ 6,265.94
		14	672	142	1	149.14	73,895	$ 10,345.23	71	1	149.14	37,035	$ 5,184.88
		15	744	132	1	149.14	76,050	$ 10,647.05	66	1	149.14	38,115	$ 5,336.15
		16	720	120	1	149.14	66,906	$ 9,366.91	60	1	149.14	33,533	$ 4,694.56
		17	744	112	1	149.14	64,528	$ 9,033.86	56	1	149.14	32,340	$ 4,527.65
		18	720	109	1	149.14	60,773	$ 8,508.28	55	1	149.14	30,459	$ 4,264.23
		19	744	100	1	149.14	57,614	$ 8,065.95	50	1	149.14	28,875	$ 4,042.54
		20	744	90	1	149.14	51,853	$ 7,259.35	45	1	149.14	25,988	$ 3,638.29
		21	720	80	1	149.14	44,604	$ 6,244.61	40	1	149.14	22,355	$ 3,129.71
		22	744	70	1	149.14	40,330	$ 5,646.16	35	1	149.14	20,213	$ 2,829.78
		23	720	65	1	149.14	36,241	$ 5,073.74	33	1	149.14	18,163	$ 2,542.89
		24	744	60	1	149.14	34,568	$ 4,839.57	30	1	149.14	17,325	$ 2,425.52
				Year 2 Total			696,664	$ 97,532.94				349,158	$ 48,882.15
	Year 3	25	744	55	1	149.14	31,688	$ 4,436.27	28	1	149.14	15,881	$ 2,223.40
		26	672	50	1	149.14	26,019	$ 3,642.69	25	1	149.14	13,040	$ 1,825.66
		27	744	48	1	149.14	27,655	$ 3,871.66	24	1	149.14	13,860	$ 1,940.42
		28	720	41	1	149.14	22,860	$ 3,200.36	21	1	149.14	11,457	$ 1,603.98
		29	744	39	1	149.14	22,469	$ 3,145.72	20	1	149.14	11,261	$ 1,576.59
		30	720	40	1	149.14	22,302	$ 3,122.30	20	1	149.14	11,178	$ 1,564.85
		31	744	39	1	149.14	22,469	$ 3,145.72	20	1	149.14	11,261	$ 1,576.59
		32	744	32	1	149.14	18,436	$ 2,581.10	16	1	149.14	9,240	$ 1,293.61
		33	720	31	1	149.14	17,284	$ 2,419.78	16	1	149.14	8,663	$ 1,212.76
		34	744	30	1	149.14	17,284	$ 2,419.78	15	1	149.14	8,663	$ 1,212.76
		35	720	26	1	149.14	14,496	$ 2,029.50	13	1	149.14	7,265	$ 1,017.16
		36	744	25	1	149.14	14,403	$ 2,016.49	13	1	149.14	7,219	$ 1,010.64
				Year 3 Total			257,367	$ 36,031.38				128,989	$ 18,058.42
	Year 4	37	744	20	1	149.14	11,523	$ 1,613.19	10	1	149.14	5,775	$ 808.51
		38	672	18	1	149.14	9,367	$ 1,311.37	9	1	149.14	4,695	$ 657.24
		39	744	15	1	149.14	8,642	$ 1,209.89	8	1	149.14	4,331	$ 606.38

NOTES:

* Based on HLF Water Balance Model draindown curve, and the conservative assumption that 8L/s is directed to treatment during draindown.

At 20L/s recirculation pumping will no longer be required; Phase 7/8 begins.