Faro Mine Closure
Fermeture de la mine Faro

# Faro Mine Complex
# Closure and Remediation Plan

## Project Description - Draft 4A





***Prepared for:***

Yukon Government

***Prepared by:***

SRK Consulting
*Engineers and Scientists*

*March 2010*

# Faro Mine Complex
# Closure and Remediation Plan

# Project Description

# Draft 4A

**Prepared for**

## Yukon Government

**SRK Consulting (Canada) Inc.**
Suite 2200, 1066 West Hastings Street
Vancouver, B.C. V6E 3X2

Tel: 604.681.4196 Fax: 604.687.5532
E-mail: vancouver@srk.com Web site: www.srk.com

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Appendix A: List of Supporting Documents and References

# List of Supporting Documents

**A Project Description and Public Communication**

A1 Faro Mine Complex Closure and Reclamation- Project Description (Draft 4), (SRK, 2009)

*A2 Public Consultation Presentations (May 2009)*

*A3 IPRP/Federal Meeting Presentation (Jan 29/31, 2008)*

**B Environmental Conditions**

B1 Anvil Range Mine - 2005 Investigation of Hydrocarbon-Contaminated Soils (GLL, 2006)

B2 Current Environmental Conditions Supporting Document (AECOM, 2009)

B3 Aquatic Ecosystem Monitoring Program, Faro Mine, Yukon (Minnow, updated 2010)

**C Socio-Economic Conditions**

C1 Socio Economic Baseline Conditions (L. Zanasi, 2010)

**D Hydrogeology & Hydrology**

D1 Detailed comparison of Alternative for the Relocation of the Faro Creek Diversion (Golder, 2004)

D2 Continued Seepage Investigation - Zone 2 Pit Outwash Area (SRK/RGC, 2007)

D3 2005 Seepage investigation at the ETA (SRK/RGC, 2006)

D4 2005 Seepage Investigation at the Emergency Tailings Area (SRK/RGB, 2005)

D5 2005 Seepage Investigation at the Grum Dump Area (SRK/RGC, 2007)

D6 Hydrotechnical Study for Closure Planning, Faro Mine Site Area, Yukon (nhc, BGC, 2004)

D7 Rose Creek Probable Maximum Flood (WMC, 2006)

D8 Review of Flood Estimation Methodologies, Faro Mine, Yukon Territory (Golder, 1988)

D9 Rational Method, Email (P. Bryan, 2009)

D10 An Analysis of Probable Maximum Precipitation for the Faro Mine Site, Yukon Territory (Taylor/Hale, Oct.2005)

D11 An Analysis of Probable Maximum Precipitation for the Faro Mine Site, Yukon Territory (Taylor/Hale, Dec 2005)

**E Geochemical Characterization**

E1 Assessment of Select Oxide fines and Ore Stockpiles (SRK, 2007)

E2 Preliminary Seepage collection Options Faro & Grum Waste Rock Dumps (SRK/RGC, 2006)

E3 2008 S-cluster Groundwater Investigation and Option Assessment - DRAFT (SRK/RGC, 2008)

E4 Geochemical Studies of Waste Rock at the Anvil Range Mining Complex - Phase 3 (SRK, 2004)

E5 2007 Waste Rock and Seepage Monitoring Report (SRK, 2008)

E6 Initial Review of Groundwater Quality - Memo (RGB, 2004)

E7 2005 Seepage Investigation at the S-cluster area Below the Faro Waste Rock Dump (SRK/RGB, 2006)
E8 Continued Seepage Investigation Zone 2 Pit Outwash Area (SRK/RGC, 2007)
E9 Overview of WQ Model - Presentation (LG, 2009)
E10 Design Options for Seepage Collection Grum Waste Dump (SRK, 2004)
*E11 Water Quality Model (LG, 2010)*

**F Geotechnical**
F1 RCTailings Impoundment Seismic Stability Assessment- Report, Addendum (KCB, June 2006)
F2 RCDC Closure Scenarios - Geotechnical Considerations (NWH, 2004)

**G Care and Maintenance**
G1 2008 Annual Inspection, Waste Water Management Facilities (SRK, 2009)
G2 AMP Event#4 response: 2008 Status Report (SRK, 2008)
G3 2007 Annual Inspection, Waste Water Management Facilities (SRK, 2008)
G4 AMP Event#4 response: 2007 Status Report (SRK, 2008)

H Reclamation and Revegetation
H1 2008 Reconnaissance-level landform grading field investigation (BGC/SRK, 2009)
H2 Waste Rock Cover Trials - Preliminary Performance Report - Draft (SRK, 2008)
H3 Investigation in Support of Progressive Reclamation of the Emergency Tailings Area (SRK, 2006)
H4 Mine Area Cover Optimization and Landform Engineering (SRK 2008)
H5 Results from Trial Covers at Rose Creek Tailings Impoundment: 2007 Data Summary (SRK, 2008)
H6 Monitor Mine Waste Rock Trial Covers: 2007 Data Report (SRK, 2008)
H7 Anvil Range Mining Complex Additional Borrow Studies (SRK, 2006)
H8 Additional Borrow Studies (SRK, 2006)
H9 Phase 2 Borrow Source Survey, Faro Mine, Yukon (SRK, 2003)
H10 Faro-Vangorda Haul Road Reclamation Costs Estimate (SRK, 2008)
H11 Waste Rock Pile Cover Trial - Construction As-built Report (SRK, 2006)
H12 Design and Installation of a Seepage Interception and Pumping System at the S-wells Area (SRK 2009)
H13 Re-Vegetation Study: Waste Rock Dumps and Tailings Impoundment (EDI, 2008)
H14 Revegetation Plan - Draft November 2009 (EDI, 2009)
H15 Monitor Mine Waste Rock Trial Covers: 2009 Data Report (SRK, 2010)

**I Water Management**
I1 Anvil Range Pit Lakes - Assessment of Post Closure Conditions (SRK, 2004)
I2 Sludge Management - 2007/08 Task 24 - Final (SRK, 2008)
I3 Anvil Range Water Treatment Sludge Management Plan (SRK, 2004)

I4 North Fork Rock Drain (BGC, 2006)
I5 PMF Flood Handling - Phase 1 - Letter (KCB, 2007)
I6 Intermediate Dam Spillway - PMF Flood Handling (KCB, 2008)
I7 Water & Load Balance Study for Rose Creek Tailings Storage Facility (RGC/SRK, 2006)
I8 Evaluation of In-Situ Treatment (SRK, 2006)
I9 Supplement Treatment of Grum Pit Water (SRK, 2008)
I10 Alternative Assessment of the Vangorda Creek Diversion (SRK, 2003)
I11 Water Treatment Requirements for the Anvil Range Site - Draft (SRK, 2005)
I12 Investigation of Anvil Range Mining Corporation Waste Dump Water Balance Vangorda Trail Covers Water Balance (J.R. Janowicz, 2008)
I13 Investigation of Anvil Range Mining Corporation Waste Dump Water Balance Average and Low Prediction Year Water Balance (J.R. Janowicz, 2007)
I14 Investigation of Anvil Range Mining Corporation Waste Dump Water Balance Final Water Balance (J.R. Janowicz, 2006)
I15 Emergency Preparation Plan for Selected Dams and Water Diversions Structures

**J Demolition**

**K Alternatives and Chosen Approaches**

K1 Faro Mine Complex - Options for Closure, including Attachments (SRK, 2008)

**L Monitoring and Maintenance Plans**

**M Implementation Strategy**

**N Cost Estimate**

*Note:* All documents are available for download from the Faro Mine Complex – Project Proposal FTP site.

*Italiced documents are in progress*.

# 1 Introduction

This document is Draft 4A of the Project Description of the Closure and Remediation plan for the Faro Mine Complex, Faro Mine in the Yukon and is a supporting document for Chapter 7 (Project Description) of the YESAB Project Proposal (Draft 1). A vicinity map of the Faro and Vangorda mine sites is provided in Figure 1.1. This update is based on Draft 4 of the Project Description, which was issued in December 4, 2009. It is recognized that as the EA and SEA assessments are completed changes to the Project Description may be required to mitigate potential impacts that arise due to the changing nature of the site.

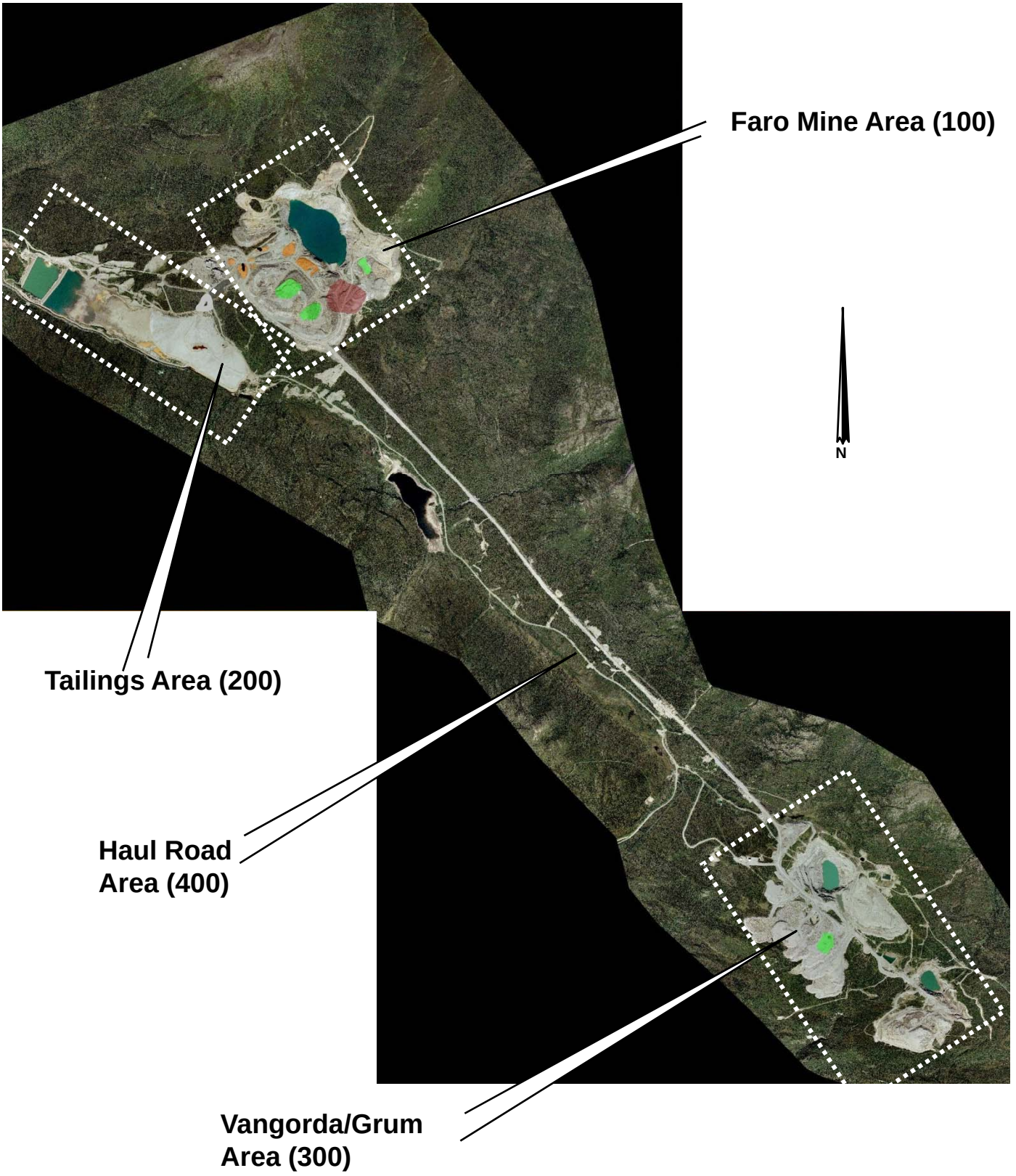
The objective of this document is to provide a current and common understanding of the status of the project description, including design objectives, and a level of certainty that stated design objectives can be achieved. The document also attempts to clearly identify those elements for which the project description is adequately advanced. It must be recognized that engineering for many of the activities are ongoing and will be modified where practical following the EA and SEA assessments. It should also be noted that there remains a number of variations in the design of some of the planned closure activities. These variations are presented in the document in the relevant sections.

Under the Yukon Environmental and Socio-economic Assessment Act (YESAA or the "Act") the Faro Mine Closure Project will be required to submit a "Project Proposal". Key elements of the Project Proposal include:

- Project purpose;
- Project description;
- Description of existing environmental and socio- economic conditions; and
- Identification of potential environmental and socio- economic effects and proposed mitigation measures.

On completion of both the Environmental and Socio-economic assessments, any modifications and required details will be incorporated into the final Project Description in preparation for inclusion in the final Project Proposal.

**Figure**




| | | |
|---|---|---|
| SRK Consulting<br>Engineers and Scientists<br>VANCOUVER | Faro Mine Closure<br>Fermeture de la mine Faro | Project Description (Draft 4)<br>**Vicinity Map** |
| Job No: 1CY001.026<br>Filename: Figure.1.1_Vicinity_20091127.ppt | Faro Mine Complex<br>Final Closure and Remediation Plan | Date: December 2009 \| Approved: \| Figure: **1.1** |

# 2 Document Organization

## 2.1 General

In February 2008, a document outlining the closure options for the Faro Mine Complex was issued. Following a lengthy consultation process, the option to stabilize in place was chosen. The Project Description presented herein is based on this selected closure option. The closure activities discussed in this document are grouped into three main areas; Faro Mine, Rose Creek Tailings, and the Vangorda/Grum areas. Chapter 3 provides a discussion of the underlying assumptions and decision making framework for each of the key and common closure activities. Chapters 4, 5, and 6 are devoted to each of these areas and each chapter is further subdivided into specific closure activities. Chapters 7, 8, and 9 present descriptions of closure activities related to the haul road, the timing and operation of the water treatment systems, sludge management, and the development of the borrow areas respectively. Chapter 10 presents a discussion on the site wide water balance and water quality modelling. Chapter 11 presents the preliminary project execution strategy. Chapter 12 addresses Surface Water Management and Chapter 13 presents the framework for the Adaptive Management Plan.

A series of figures and illustrations depicting the current conditions at each area and the proposed closure activities are presented at the end of each chapter. Each closure activity has been assigned an activity code number, which is cross referenced in the project schedule on Figure 11.1. The activity codes are also referenced on each of the figures and tables presented in the report. Relevant supporting documents that were used to develop the closure plan are listed in Appendix A.

It should be recognized that there are still a number of information gaps in the project description, which will be addressed as the project description evolves during the assessment process. There are also many decisions that still need to be made before the project description can be finalized. It is, therefore, the author's intent that this document be a work in progress that will be updated as decisions are made and as technical data is made available.

# 3 Design Criteria and Objectives

## 3.1 General

This chapter provides a discussion of the underlying assumptions and decision making framework for each of the key and common closure activities of the closure plan.

## 3.2 Covers

Covers over waste rock dumps and the Rose Creek tailings impoundment will be used as one of the technical solutions towards achieving the site wide closure objectives. Water that passes through the covers and ultimately enter either surface and/or groundwater will be collected and treated. Table 3.1 summarizes the four different cover types selected for use on the site, and the cover functions for which they are being designed.

**Table 3.1: Cover Types and Associated Function(s)**

| Cover Function | Cover Type | | | |
|---|---|---|---|---|
| | Rudimentary Cover | Low Infiltration Cover | Very Low Infiltration Cover | Tailings Cover |
| Physically isolate waste from human/terrestrial life | Yes | Yes | Yes | Yes |
| Provide a substrate that would support succesional vegetation | Yes | Yes | Yes | Yes |
| Reduce infiltration to specific target levels | No | Yes | Yes | No |

The preliminary design criteria for each of the cover types in order to meet these functions are listed in Table 3.2.

**Table 3.2: Preliminary Design Criteria for Proposed Covers**

| Element | Rudimentary Cover | Low Infiltration Cover | Very Low Infiltration Cover | Tailings Cover |
|---|---|---|---|---|
| Cover Performance (Target Infiltration) | Not designed to reduce infiltration, but the till is believed to reduce infiltration to less than 20% of MAP (expected range of 15-25%) | Less than 5% of MAP (expected range of 3-8%) | Less than 0.5% of MAP | Not to exceed that of uncovered tailings, set at 10% of MAP (expected range of 5-20%) |
| Cover Design | Loosely compacted till layer acting as store-and-release component and growth medium (0.3 to 1m thick) | Compacted till barrier layer (0.5 to 1m thick) underlying loosely compacted till layer as store-and-release component and growth medium (0.3 to 1m thick) | Compacted till barrier layer (1 to 1.5m thick) underlying loosely compacted till layer as store-and-release component and growth medium (0.3 to 1m thick)<br><br>OR<br><br>Complex cover consisting of; (1) bottom liner protecting bedding layer (0.3m compacted granular material or geotextile), (2) synthetic liner (Bituminous or HDPE), (3) upper liner protecting bedding layer (0.3m compacted granular material, or geotextile), and (4) loosely compacted till layer as growth medium (0.3 to 1m thick) | Trafficability layer if required (0.5m to 1m waste rock) underlying loosely compacted till layer as store-and-release component and growth medium (1 to 1.5m thick) |
| Allow Re-vegetation | Yes | Yes | Yes | Yes |

The cover design and performance targets are based on cover studies dating back to 2002. A comprehensive summary of reports that have been released documenting the results of these studies are provided in Appendix A. This information can be broken down into the following broad categories:

- Borrow Studies – A series of reports summarize the extent of onsite borrow characterization since 2002. These reports confirm the physical characteristics of the available sources of cover materials, their availability (volumes), and accessibility. This is the information that confirms that there is sufficient quantities of the candidate cover soils, and through appropriate definition of the borrow sites accurate cost estimates for cover placements could be developed.
- Water Balance Studies – A multi-year study was initiated to establish a water balance for the uncovered waste rock dumps on site. This included continuous climate monitoring (at two locations), regular seep and snow surveys, and ultimately led to production of a series of reports which provides a sound basis for determining baseline infiltration rates into uncovered waste rock piles at the site.

- Re-vegetation Studies – Early re-vegetation studies focused on the likelihood of re-vegetation success given the natural nutrient content of candidate cover soils. Further studies focussed on developing appropriate site specific re-vegetation designs linked to soil covers. This study provides justification for the cover thicknesses selected to support establishment of vegetation. Ongoing re-vegetation studies are underway to define this dataset.
- Rose Creek Tailings Test Covers – Two test covers was constructed on the Rose Creek Tailings impoundment in 2004, and were monitored continuously through to 2008. These tests were designed to provide information pertaining to the constructability of covers on tailings, cover settlement and the need to include a filter medium in the tailings cover design. Five annual data reports were produced. The final compilation report summarizing the ultimate findings of these test covers are currently in production. These tests confirm the constructability of covers on the tailings, and support the use of the trafficability layer. As part of the ongoing tailings characterization studies in support of the Rose Creek tailings dam stability assessments, an opinion was provided linking the tailings seismic stability with cover stability.
- Vangorda Waste Rock Pile Test Covers – A series of test covers was constructed on the Vangorda Waste rock pile in 2004/05. In 2007/08 the experiment was expanded to include two large scale lysimeters. The test covers was designed to provide performance data related to various configurations of soil covers under consideration for the Faro Mine Complex. Continuous monitoring of the system water balance is undertaken through a series of automated and manual data collection systems. Long term integrity of the covers is also evaluated through annual density and hydraulic conductivity testing. Annual data reports have been produced since 2005, and an early attempt at data interpretation was documented in a report submitted in late 2008. Preliminary data suggest that the cover designs and performance targets that have been specified for the project are achievable.

  Specialists responsible for carrying out the waste rock dump water balance (see earlier) have developed the world's leading edge Cold Regions Hydrological Model (CRHM), which allows for numerical simulations on catchment level hydrology to be made. Using data from the test covers, this model was used to simulate the performance of the test covers for two seasons. Detailed assessment of the data from these cover trials are scheduled to be carried out in 2010.
- Landform Engineering – Long term cover integrity is of paramount importance, and landform engineering principles have been adopted to evaluate where the biggest risks lie, and how they can be addressed. This work has led to the development of Reclamation Land Units (RLU's) for the site, which defines how every aspect of the site will be reclaimed. It has been demonstrated that the biggest risks linked to the success of covers are; (1) erosion, which is linked to the final slope angles and (2) the slow natural re-vegetation potential of the region.

Performance targets for the three different cover types for the waste rock piles are based on what is believed to be realistic and achievable performance targets for covers at this site, using the available till cover material. This is supported by preliminary predictive numerical modeling, as well as preliminary analysis of the cover trial data. Definitive final designs to achieve these performance

targets have not been prepared, and will be refined as site specific performance data is collected and analysed.

The project site has a net negative water balance, and the available till borrow material is a well graded soil with low clay content. The area is subject to seasonal wetting and drying as well as freeze/thaw cycles. This combination led to the decision to construct store-and-release covers to achieve the target infiltration rates. Because the area is subject to ground freezing and associated cold region hydrologic processes, there are seasonal periods when the water balance is net positive. It was therefore necessary to include a barrier layer in the design, either in the form of a compacted soil layer, or a synthetic liner.

The rudimentary cover is not designed to reduce infiltration, but rather to ensure isolation and provide a suitable growth medium to support long-term natural succession vegetation. Given the difference in physical and hydraulic properties between the uncovered waste rock and till cover material, the infiltration through this cover is however expected to be somewhere between 15 and 25% of MAP. The Low Infiltration cover is designed to reduce infiltration, and it is believed that by providing a combined compacted soil barrier and store-and-release cover, infiltration would reduce to between 3 and 8% of MAP. It should be noted that individual breakthrough events, or infiltration greater than target events for extreme annual precipitation years are to be expected with these cover variants. The Very Low Infiltration cover is designed to reduce the infiltration to as low as practicable (less than 0.5% of MAP). To achieve this two cover design variants are proposed; a synthetic liner which is proven to consistently achieve these performance targets and a combination compacted soil barrier and store-and-release cover which may result in breakthrough during extreme events and annual precipitation years.

The decision process of what type of cover to place on what individual waste rock pile has been an iterative procedure that takes into consideration source chemistry, cover construction and water treatments costs, uncertainty associated with predicted infiltration rates and source chemistry as well as collection practicality and efficiency.

All waste rock piles were demarcated throughout the site and the source chemistry from that location was characterized. Consistent with the site wide closure goals, it is understood that as far as practicable, all waste rock will be covered with at least a rudimentary cover. Using an estimated infiltration rate through this cover of 20% of MAP the waste load from each of these piles was calculated. The understanding is that this waste load would be collected and treated. In order to determine whether higher quality covers would be required for any of the waste rock piles; a cost-benefit analysis was carried out taking into consideration the net present value capital cost of constructing the cover and the net present value capital and operating cost of treating the associated waste load. If the savings in water treatment cost from a reduced waste load would be sufficiently big to cover the capital cost of upgrading from a Rudimentary cover to a Low Infiltration cover, the upgrade was considered appropriate. The same approach was used to determine whether it would be beneficial to upgrade from a Low Infiltration cover to a Very Low Infiltration cover. A similar

approach was used to determine whether relocation and consolidation of some waste streams would be warranted.

The cost-benefit analysis described above does not explicitly take into consideration the likely range of infiltration and source chemistry expected for each waste rock pile and cover type. Therefore, for the source load from every covered area is considered, and if the uncertainty would make an appreciable difference in the waste load from that area, the cost-benefit calculation is redone using the upper range of source chemistry and infiltration values. The final check to determine whether the selection of a cover type is appropriate revolves around the ability and cost to effectively collect the waste load. A cover type might be upgraded in the case where collection efficiency would be extremely challenging both from a technical and economic viewpoint. Following this decision process, areas where upgraded covers are justified is summarized in Table 3.3.

**Table 3.3: Locations for Low and Very Low Infiltration Covers**

| Low Infiltration Cover | Very Low Infiltration Cover |
|---|---|
| • Vangorda waste rock dump<br>• Mt Mungli east and west<br>• South west pit wall dump<br>• Vangorda pit ramp dump | • Low grade stockpile A<br>• Low grade stockpile C<br>• Faro main sulphide cell<br>• Faro intermediate sulphide cell<br>• Faro East sulphide cell<br>• Vangorda sulphide cell<br>• Baritic fines<br>• Grum ore transfer pad<br>• Grum sulphide cell |

A suitable cover design for the Rose Creek tailings impoundment would be similar to those proposed for the waste rock piles, with the exception that cover construction on unconsolidated tailings surface would not be practical. A cost-benefit analysis of different cover variants on the tailings impoundment concluded that a tailings cover that would not yield greater infiltration than the uncovered tailings (about 5 to 25% of MAP, depending on whether it is beach tailings or slimes) would be appropriate. This means that a Rudimentary cover would likely suffice; however, the cover cannot be placed on the tailings surface without first constructing a trafficability layer. This trafficability layer would be waste rock from the Faro side of the property that would in place have required only a Rudimentary cover. Since the tailings surface has no relief, the total cover thickness of the growth medium layer overlying the trafficability layer was increased by 50% from the waste rock Rudimentary cover to facilitate landscaping.

To ensure constructability and sustainability of the covers, appropriate landform engineering will be required to facilitate surface water management, erosion control and re-vegetation success. This final landscape is defined as a series of Reclamation Land Units (RLUs), where each RLU consist of various features including landscape, soil cover, vegetation, surface treatment, slope/aspect, and drainage. Complete RLU maps are presented in Support Document H-14.

Within each RLU, features are complimentary and build upon each other. The primary feature is the landscape feature, which is driven by the need to ensure long-term geotechnical stability, define site drainage and access, as well as ensure soil cover constructability. The next RLU feature is the cover type assigned to each individual area on the site, as described earlier in this section. Surface treatments describing how the final cover surface will be prepared prior to re-vegetation is the next RLU feature that is added. These surface treatments are designed to provide substrate for plants, minimize risk of ponding, and create micro-topography to enhance species establishment and diversity, minimize erosion, and retain moisture.

The re-vegetation feature describes the vegetation applications for all different areas of the site, taking into consideration structural integrity, erosion minimization, and promotion of successional advancement of vegetation. The last two RLU features are drainage courses and slope/aspect modifiers. These features provides added description of surface water conveyance system design, and large scale feature design associated with micro-climatic differences between north and south facing slopes and how this may impact re-vegetation.

## 3.3 Groundwater Collection

At both the Faro and Vangorda/Grum areas, contaminated groundwater flowing from underneath waste rock dumps and tailings facilities will constitute a source of significant load that could impact surface water ecosystems at both the Faro/Tailings areas (i.e., the NFRC and Rose Creek) and the Vangorda/Grum area (i.e., Vangorda Creek). Groundwater interception will be required for many areas, but the timing and methods may differ under the overall closure plan. The strategy for groundwater interception, including decisions on when and how groundwater interception systems are implemented, managed and, if necessary, modified or improved, will be based on the adaptive management plan (AMP) presented in Chapter 13.

The groundwater AMP approach will apply to each of the Faro, Tailings and Vangorda/Grum areas, but specific application will vary due to differences in proximity to receiving environment. For the Tailings Area and parts of the Faro Mine area, the final receiver is Rose Creek and the NFRC is an intermediate receiver, at least during early parts of the closure process. In these areas, groundwater interception will be complimentary. Early in the closure process, groundwater interception at specific areas of waste rock dump seepage will be required for protection of the NFRC, such as the S-wells and Zone II areas. Once the NFRC has been isolated from potential groundwater influence, the need for these localized high efficiency interception systems will be reduced. The groundwater AMP will then be managed on the basis of optimizing groundwater interception to avoid surface expression of contaminated water and minimize loading to the Rose Creek Aquifer in recognition of the presence of the Rose Creek Aquifer interception system. In other words, very high interception effectiveness may not be required once the NFRC is isolated as contaminated groundwater will be intercepted at the high efficiency Rose Creek Aquifer system. However, groundwater collection in these areas is expected to continue.

The Rose Creek Aquifer groundwater interception system, which will be located in the vicinity of the Cross Valley and Intermediate dams, represents the final, and most effective, line of interception downstream of the Faro and Tailings areas; all groundwater coming from the Faro and Tailings areas eventually flows through this area. Once this system is in place, it will be managed in perpetuity, adapting over time as necessary to achieve interception objectives. Prior to installation, activation of localized groundwater capture from specific locations, such as the Faro dump seepage and the ETA, will reduce loading to the Rose Creek Aquifer.

Groundwater interception at the Vangorda/Grum area is generally similar to the Faro area but there is no redundant collection system available and there is relatively limited area at Vangorda/Grum in which interception systems can be installed to avoid impact to Vangorda Creek. The decision process for groundwater interception implementation and management in this area will function similarly to that for the Faro and Tailings areas, but with AMP triggers set at levels providing ample time for system installation prior to observing detrimental impact on Vangorda Creek.

## 3.4 Surface Water Management

### 3.4.1 General

This section provides key assumptions and a decision making framework for short-term surface water management including management of contaminated and sediment laden runoff during construction and for a short period following closure as well as the diversion of clean water away from work areas during construction.

A more detailed discussion is presented in Chapter 12 of the strategy, based on Best Management Practices (BMP), to control, route, collect and treat surface water runoff from those areas that will be disturbed and reclaimed during the closure implementation. A key issue for the implementation of the Faro Mine Complex Closure plan is the management of the potentially contaminated surface runoff containing elevated levels of total suspended solids (TSS) and the total concentrations of metals potentially associated with them. Both the metals and suspended solids could cause potential ecological impacts and exceedance of stream or discharge standards. These metals can come from two sources including those associated with the natural chemical matrix of the TSS and those that have been transformed through time and sulphide oxidation into potential mobile and soluble secondary by-products. It is the suspension and possible dissolution of these metals from the runoff that could result in measurable and unacceptable damage to the receiving stream habitats and in turn impact the resident aquatic organisms including insects and fish. The end result could be the requirement of advanced treatment processes such as sulphide addition and/or filtration, not only for metals removal but also suspended solids.

Surface water management at the Faro and Vangorda/Grum areas is based on the following general concepts:

- Clean water will, to the extent practical, be kept separate from water which doesn't meet discharge criteria and will be diverted into the downstream environment as quickly and efficiently as possible.
- Water which is likely to be clean, other than elevated levels of suspended solids, will typically be directed to settling ponds prior to discharge.
- Water which has, or may have, elevated metal levels will be captured and treated prior to discharge.

Based on the duration, complexity and scale of the closure plan, there is likely to be a period of years between the final implementation of the closure plan and the point when the long term water quality objectives in many areas are routinely met. Given this situation, the initial water management plan will be based on the general expectation that the capability to capture, test and, if necessary, treat surface water will be a key component of surface water management in those areas where there is a reasonable likelihood that the water quality immediately during and following closure will not meet long term objectives.

The post closure strategy for surface water management, will be based on the adaptive management plan (AMP) presented in Section 13. The surface water AMP approach will apply to each of the Faro, Tailings and Vangorda/Grum areas.

### 3.4.2 Faro Mine Area

At the Faro Mine Area, the long-term objective for surface water management is the discharge of clean water within the pre-closure catchments, specifically, the NFRC catchment and Rose Creek catchment. In other words, surface water management structures will, to the extent practical, be arranged to mimic the current drainage patterns. Between closure implementation (i.e., construction) and final abandonment, there will likely be a period of time when some water coming off the site will not be suitable for discharge, thus changes to management techniques and structures will be required over the course of closure, both to handle water of poor quality and to allow final stabilization of newly completed closure elements, such as waste rock covers. During all phases of closure, Best Management Practices (BMPs) will be adhered to.

Active surface water management structures will consist of diversion ditches, berms and sedimentation ponds. On waste rock dumps, berms will be constructed both at the top and bottom of slopes, to minimize surface runoff onto and control runoff from slopes. Ditches will be constructed to convey diverted runoff to sedimentation basins and, if clean, discharged to creeks. If not suitable for discharge, water will be directed or pumped to the Faro Pit for treatment. During relocation and cover construction of oxide fines, diversion berms and temporary sedimentation ponds will be used to minimize contact with the oxide fines and promote infiltration into the waste rock dumps. Contact water will not be allowed to discharge to the environment.

Regrading of waste rock dumps and waste rock dump covers will be determined by Reclamation Land Unit (RLU). To minimize erosion on dump slopes, berms will be constructed, as previously mentioned, slopes will have intermediary diversion channels, berms and sedimentation ponds as necessary and all slopes will revegetated.

### 3.4.3 Tailings Area

At the Tailings Area, the long-term objective under normal circumstances is for water that reports to the surface of the Tailings Area to report directly to the inlet of the Intermediate Dam spillway. Surface water would, therefore, flow directly to the downstream environment, with no ponding on the Tailings Area. In order for this objective to be achieved, water which reports to the Tailings Area will have to meet discharge quality criteria.

Despite the long-term objectives noted above, it is expected that during closure implementation and for some unknown period thereafter, a portion of the water which reports to the Tailings Area will require settling and/or treatment prior to discharge. Given the challenges of separating clean water from water of poor quality at the Tailings Area, the water which reports to the surface of the tailings area in the short to medium term would be directed to the pond upstream of the Intermediate Dam. This water will, in turn, be pumped to the Faro Pit for subsequent water treatment.

During flood events that exceed the 1 in 500 year event, the plug dam at the upstream end of the Intermediate impoundment would erode, allowing some portion of the flows in the Rose Creek Diversion Channel to flow over the Tailings Area and into the inlet of the spillway. In this scenario, it is thought that, due to dilution, it would be acceptable for these flows to report to the spillway, even though the conditions at the Tailings Area may not yet be consistent with the long-term objectives described above.

### 3.4.4 Vangorda/Grum Area

At the Vangorda/Grum Mine Area, the long term objective is the same as for the Faro Mine Area the discharge of clean water within the pre-closure catchments. Active surface water management structures will consist of diversion ditches, berms and sedimentation ponds. On waste rock dumps, berms will be constructed both at the top and bottom of slopes, to minimize surface runoff onto and control runoff from slopes. Ditches will be constructed to convey diverted runoff to sedimentation basins and, if clean, discharged to creeks. If not suitable for discharge, water will be directed or pumped to the Vangorda Pit or Grum Pit for treatment. During cover construction of the Grum Ore Transfer Pad and Grum Sulphide Cell, diversion berms and temporary sedimentation ponds will be used to minimize contact with the oxide fines and promote infiltration into the waste rock dumps. Contact water will not be allowed to discharge to the environment.

Regrading of waste rock dumps and waste rock dump covers will be determined by Reclamation Land Unit (RLU). To minimize erosion on dump slopes, berms will be constructed, as previously mentioned, slopes will have intermediary diversion channels, berms and sedimentation ponds as necessary and all slopes will revegetated.

## 3.5 Water Treatment

Lime addition with high density sludge production has been selected as the primary water treatment methodology for application at the FMC. In the Vangorda/Grum Mine area, the existing water treatment plant will continue to operate during the initial years of the closure implementation and potentially throughout that period.

The timing and scale of future treatment requirements especially from the Grum Waste Rock means that any plans for water treatment on the Vangorda/Grum side of the property will need to be adaptable. Construction related activities will add additional uncertainty. Potential additional collection and treatment requirements from the Vangorda Dump and/or the Grum Pit could also affect water treatment needs. Finally, the need for contingency treatment to address inflow of clean water from Vangorda Creek during extreme floods needs to be considered.

Over the last several years, running the 2000 USgpm plant for treatment periods of only 60 days or less has been sufficient to control or even draw down the water level in the Vangorda pit. With the addition of an improved clarifier, it is reasonable to expect that the current plant has adequate capacity to treat all flows from the Vangorda area during the closure period. The Grum pit passive treatment system has proven to be highly effective at removing zinc from the surface water and shows promise for being the only treatment required for Grum Pit. If this treatment approach is successful, as the pit fills, it will become necessary to engineer a system for seasonal release of the treated water.

Once closure measures are complete, an active treatment system would definitely be required for the Vangorda flows, but it is possible that it may be much smaller than the current system. Depending on the flows needing treatment, the plant could have a capacity of 500 to 1700 USgpm.

A number of contingency measures have been identified that could be used to address additional water treatment capacity requirements. Early in the project, this may include construction of expanded clarifying capacity that could be used by the existing water treatment plant. This could be constructed at the location of the proposed new treatment plant for future use. Also, a 2500 USgpm treatment plant may eventually be required of lime treatment of all flows at the Vangorda/Grum site is needed.

Once the new treatment system is operational the sludge will be disposed in the Vangorda pit. A tremie system would be used to place the sludge near the pit bottom, and prevent mixing with the water column. The volume available in the pit is estimated to be about 6,000,000 $m^3$ providing capacity for over 1000 years of water treatment.

The interim operation of the existing treatment system will continue to produce sludge with much lower density. For similar reason to those discussed for the Faro Mine area, this sludge is not suitable for storage in the Vangorda Pit. Sludge produced from the existing treatment system is currently stored in impoundments on waste rock. Storage of sludge at suitable locations on waste

rock is expected to continue for the duration of operation of the existing treatment system. The excess alkalinity in the sludge will neutralize some acid potential in the waste rock.

A conceptual plan for water treatment at both the Faro Mine and the Vangorda/Grum areas is described in more detail in Section 8 of this document.

## 3.6 Site Wide Water Balance and Water Quality

A site wide water quality and water balance model has been developed in GOLDSIM to provide estimates of contaminant concentrations in the receiving environment over time due to the implementation of the proposed closure plan. The GOLDSIM Model was run with a range of inputs selected to represent the uncertainties associated with specific components of the project: stochastically. Specific input parameters that are being modeled stochastically include cover infiltration for rudimentary and low infiltration covers, NP availability and groundwater collection efficiency. The results of the GOLDSIM model are time-base predictions of a range of contaminant concentrations with “error bars” denoting the uncertainty.

The three main contributors of contaminant load to the receiving environment are the waste rock dumps, the tailings impoundment and discharge of compliant water from the water treatment facilities.

The approach taken for the development of time based estimates for loadings from the waste rock dumps was to develop a stochastic model that would attempt to predict the possible range of concentrations at any one time based on the known properties and conditions within the waste rock dumps, including the potential effects of the closure measures including changes in infiltration due to cover placement. Consideration was given to the rate of neutralization potential (NP) and acid potential (AP) depletion based on current measures of oxidation rate in the dumps. Then, assuming covers are placed, the oxidation rates were adjusted to reflect the changed conditions. The existing seep water quality data set (average (best estimate) and maximum (upper bound) concentrations) was used as a measure of potential water quality conditions that may develop within each of the dumps over time.

For the Faro tailings, estimates of porewater displacement have been combined with porewater quality estimates to provide time-based estimates of contaminant loadings from the base of the tailings deposit. Attenuation below the tailings and within the aquifer has recently been demonstrated to be important in limiting the ultimate release of these contaminants. Attenuation has not been accounted for in the predictions presented to date.

The model assumes that all groundwater seepage, from either the tailings area or the waste rock dumps, that is collected is then routed to Faro Pit on the Faro side and Vangorda Pit on the Vangorda Plateau side. The model also assumes that the pit water is treated using a high density sludge treatment system and discharged seasonally (May to September) to the receiving environment. The discharge location on the Faro side is assumed to be immediately downstream of the confluence of

the North and South Forks of Rose Creek. On the Vangorda side the discharge locations is assumed to be in the area where Vangorda Creek crosses the site access road, below the existing drop structure. In addition the model assumes that the water in Grum Pit will continue to be treated biologically. During the open water season treated surface water in Grum Pit will be discharged to Vangorda Creek.

In the Rose Creek/Anvil Creek drainage the receiving environment model points include the North Fork of Rose Creek, Rose Creek downstream of discharge location, mouth of Rose Creek and mouth of Anvil Creek.

In the Vangorda Creek drainage, the model points include the main stem of Vangorda Creek at V27, downstream of the discharge location, and in Vangorda Creek at V8 near the Town of Faro at location V8.

In the Pelly River drainage, water quality model points include downstream of the inflows from Vangorda and Anvil Creeks.

## 3.7 Environmental Adaptive Management Plan

An adaptive management approach will be a critical component of any successful closure plan for the Faro Mine Complex. The overall success of the closure plan for the Faro Mine Complex will be measured against the closure objectives. Meeting objectives related to protection and restoration of the environment, protection of human health, and restoration of land are predicated on performance of several key project components, especially vegetation/covers, groundwater collection and water treatment.

Comprehensive monitoring, investigation, research and design programs have formed the basis for predictions about future site conditions and performance of closure measures. However, actual site conditions and performance will vary from the assumptions used in the predictions. For all of the noted project components, there are areas of outstanding uncertainty about future conditions where variations from the assumptions could lead to effects on the environment. The Environmental Adaptive Management Plan will be implemented for these areas of uncertainty to detect changes in site conditions or performance in a timely manner and guide appropriate and effective responses that will prevent unacceptable environmental effects. A framework for the Environmental Adaptive Management Plan (AMP) is provided in Chapter 13 and summarized in this section.

The uncertainties addressed by the AMP are limited to those that relate to the overall performance of the closure project. With a project of this scale, there are many uncertainties and changes that will arise during implementation. As part of good project management, modifications, refinements and adjustments will be made to address these changing conditions. While these more routine areas of uncertainty are not addressed in the AMP, they will be addressed through implementation of a series of “best management practices” that will form part of the overall project management approach.

The key events that will be addressed through specified adaptive management plans include the following.

- Rose Creek Aquifer
  - Phase 1 – degradation of aquifer water quality leading to collection and treatment requirements.
  - Phase 2 – bypass of water around the Rose Creek Aquifer collection system
- Contaminated Groundwater/Seepage
  - Phase 1 – degradation of groundwater or seepage quality down-gradient of a mine component, leading to collection or treatment requirements.
  - Phase 2 – bypass of water around a mine component collection or treatment system
- Receiving Water Quality – degradation of water quality in receiving waters downstream of the mine site.
- Receiving Water Flow – changes in winter flows downstream of the mine site due to groundwater collection activities (potential effects on fish and fish habitat).
- Receiving Water Temperature – changes in water temperatures (winter) downstream of the mine site due to groundwater collection activities (potential effects on fish and fish habitat).
- Water Treatment Source Water Quality/Quantity – ability of treatment systems to function effectively in changing conditions:
  - Changes in water quality, water quantity or parameters of concern for water that is being treated.
  - Emerging sources requiring treatment.
- Cover Vegetation Success/Performance – vegetation on soil covers failing to meet objectives (e.g. erosion control, vegetation coverage, invasive species, wildlife habitat, etc.)
- Terrestrial Effects – effects on the terrestrial environment are different than anticipated.
- Sludge Management – sludge properties or quantities lead to the need for major changes in approach for sludge management.

To be effective, an AMP must provide an operational structure for detecting changes as well as the development and implementation of timely responses. This structure is provided by several common elements that are included in each specific AMP. These common elements provide the framework that is necessary to ensure that the AMPs will be proactive in detecting changes and implementing responses before unacceptable environmental effects occur. The following common elements form part of each specific AMP.

- "Event" describes the specific event that is addressed by the AMP.
- "Possible Environmental Consequences" describes the environmental consequences that could arise if the event were allowed to proceed without appropriate responses.

- The "Narrative Response Trigger" is a narrative description of the trigger for the AMP event and leads to the development of the specific indicators and thresholds.
- "Specific Indicators" describe the environmental parameters to be monitored and assessed as part of the AMP. The indicators are selected to provide early detection of relevant changes in environmental conditions or system performance.
- "Specific Thresholds" define the conditions for specific indicators that would lead to actions being taken. There are often a series of staged thresholds or multiple thresholds for an individual event.
- "Monitoring Requirements" describes the monitoring (e.g. parameters, locations, frequencies) that will be carried out to support implementation of the AMP. Monitoring requirements may change at various stages of an AMP.
- "Evaluation of Monitoring Results" describes the methods and processes that will be used to evaluate the monitoring data and determine whether any specific thresholds have been reached or exceeded.
- "Approach to Development of Response/Mitigation/Intervention" describes the overall approach to responses that will be implemented if any thresholds have been reached or exceeded. In most cases, the responses will include a range of actions that may be taken to address the events. The selection of appropriate responses would depend on the conditions of changed site conditions or system performance.

The Environmental AMP for the Faro Mine Complex is an integral component of the mine closure project. The AMPs will guide decisions in three broad areas: (1) timing for implementation of mine closure measures (e.g. Rose Creek Aquifer collection), (2) locations for implementation of mine closure measures (e.g. waste rock seepage collection areas), and (3) performance adequacy of closure measures that have been implemented (e.g. vegetation success). Due to these areas of application, without the AMPs the project would cause unacceptable environmental effects. Because of the critical nature of the AMPs, a governance structure must be in place to support effective application of the adaptive management approach.

# 4 Faro – Area 100

## 4.1 Background

### 4.1.1 Faro Pit

The Faro Pit, as shown in Figure 4.1, is roughly 1700m long and 1000m wide. The pit was allowed to flood in the 1990s, after the economically extractable ore was mined, and now contains a water body that is commonly referred to as the Faro Pit Lake. The walls of the pit contain significant pockets of mineralized rock. Waste rock was deposited in a series of dumps that surround the pit. There is now a total of about 260 million tonnes of waste rock in the Faro dumps, and they cover roughly 335 ha of surface area. There are roughly 30 separate dumps, each with a unique history and composition. Figure 4.2 shows (in 3D) the overall area including the pit and waste rock dumps.

Much of the waste rock from the Faro Mine is acid-generating and is leaching metals. The worst of these are the oxide fines (OF) and low-grade ore stockpiles (LGSP) (Figure 4.3) which are composed of strongly mineralized materials and contain significant soluble contaminants. The stockpiles include: Oxide Fines #1, #2 and #3, Crusher Stockpile, Medium-Grade Ore Stockpile (i.e., MGO Stockpile), and Low-grade Stockpile "A" and "C". While there are some segregated pockets of strongly acid-generating waste rock, such as sulphide cells, the majority of the waste rock at the Faro Mine Site is generally poorly segregated. As a result, all of the waste rock dumps at Faro would release contaminants and could lead to severe contamination of aquatic ecosystems.

Above the water level, the exposed pit walls and some of the surrounding waste rock are sources of contaminants that drain into the pit lake. The northeast wall is physically unstable and is gradually ravelling downwards into the pit.

The water level in the Faro pit is maintained safely at about 15 m below the overflow elevation to the environment (via the buried Zone II pit). Annual pumping and treatment is carried out to manage the water level. Approximately 1.5 million $m^3$ of water is pumped annually from the Faro pit to the treatment plant.

### 4.1.2 Groundwater Collection

As described in Chapter 3, infiltration through the waste rock dumps is leading to contamination of groundwater at the Faro Mine Area. In certain areas, such as the S-wells, this groundwater contamination currently causes an increase in contaminant levels in some surface waters (e.g., the North Fork Rose Creek [NFRC] at the S-wells). Contamination of groundwater is expected to increase significantly in the future. Generally, contaminated groundwater is expected to migrate either eastward toward the NFRC, or south-westward to the Rose Creek Aquifer below the tailings impoundment.

In 2004, Robertson GeoConsultants Inc. (RGC) completed a review of the available groundwater data and identified a number of areas of varying significance to groundwater collection. Three high priority areas were identified where high contaminant concentration, low flow groundwater conditions occur and at which localized groundwater collection should be focused. These high priority areas are the Emergency Tailings Area (ETA) (see Figure 4.4), the S-wells area (also referred to as the S-Cluster), and the Zone II Pit outwash area (see Figure 4.5).

The ETA, located below the Faro mill, overlaps a section of the Faro Creek channel. Investigations in 2004 and 2005 found that groundwater in the aquifer below the ETA and Faro Creek was contributing significant load to the Rose Creek Valley tailings facility. A preliminary conceptual groundwater collection system was presented by SRK in 2006 to be combined with removal of the ETA tailings. In 2007 an interim collection system was installed below the mine access road. In 2009, additional investigation of bedrock and overburden flow was completed at the downstream end of the Faro Canyon. A large majority of contaminant load moves through the overburden, and perhaps shallowly weathered bedrock, from the ETA towards the Rose Creek Aquifer. Based on the SRK 2006 study, at the mouth of the Faro Creek Canyon (i.e., FCS-4), surface water and groundwater flows ranged from about 4 to 7 L/s, zinc load from 37 to 70 tonnes/year and sulphate load from about 700 to 1300 tonnes/year with iron load remaining relative constant at about 170 tonnes/year. Bedrock load was estimated to be 3 to 4 orders of magnitude lower than load within overburden units.

The S-wells area is located alongside the North Fork of Rose Creek (NFRC), just down gradient of the North Fork rock drain. The RGC 2004 study found that sulphate and zinc, amongst other parameters, had increased significantly and were “indicative of a ‘breakthrough’ of neutralized WRD seepage”. Field investigations conducted in 2004, 2005, and 2008, assessed the distribution of contaminants, potential impacts to the North Fork of Rose Creek (NFRC), and presented options for groundwater interception. Results of all field investigations indicated high levels of contaminants in close proximity to the NFRC with a component of contaminated groundwater currently discharging into the NFRC. In addition to the high levels of contaminants in close proximity to the North Fork, the adaptive management plan (AMP) identified increasing trends in contaminant levels within the North Fork (as measured at station X2), especially in winter. Details are described in the Annual Reports, specifically the AMP appendices. Two separate contaminated aquifers were identified: the shallow aquifer (a relatively constrained near-surface feature) and the deep aquifer (a broad feature consisting of weathered bedrock and immediately overlying permeable sediments). In early 2009, a first phase groundwater interception system was installed, with water pumped to the Faro Pit. Within the first 5 ½ months (March 1 to mid-August, 2009), approximately 29,000 $m^3$ of water was intercepted and pumped to the Faro Pit with an average zinc concentration of 293 mg/L; 8 tonnes of zinc were pumped to the Faro Pit during this period. This pumping included contributions from freshet runoff and seepage from the toe of the waste rock dump, which infiltrate the permeable trench. Assessment monitoring of system performance is on-going.

In the Zone II Pit outwash area, studies conducted in 2005 and 2008 identified that contaminated groundwater was likely seeping from the waste rock dumps with potential contribution from the outwash tailings themselves and, perhaps, the Zone II Pit. While these investigations suggested that this area was not currently contributing significant load to the NFRC, contaminated groundwater could eventually, if not already, travel down gradient in the permeable materials underneath the NFRC and possibly discharge to the NFRC downstream. A conceptual Seepage Intercept System (SIS) was presented by SRK in 2006. Loading estimates presented in this report suggested that estimates of seepage from the water balance for the Zone II pit itself may be conservative but should be used for SIS design purposes. Total annual flow to the NFRC aquifer (i.e., permeable sediments in the NFRC stream valley) was estimated at 9,800 $m^3$/year, with zinc loading of 0.8 tonnes/year and sulphate loading of 24 tonnes/year.

During closure planning, it was recognized that ensuring significant capture of contaminant load discharging from the high priority areas was important, but could be expensive and technically challenging. In order to provide the best protection for the NFRC, immediate collection in the S-Well area, and probable eventual collection in the Zone II area, would be combined with isolation of the NFRC, thereby immediately protecting the NFRC and actively intercepting contaminated groundwater relatively close to the source. Over the long term, this approach lessens reliance on extremely high interception efficiencies and, combined with interception of contaminated groundwater at the ETA, will remove a significant load from the Rose Creek Valley tailings facility.

Groundwater collection in additional “medium priority” areas, such as Guardhouse Creek near the Faro mill and below the Faro mill, were the focus of field investigations during the 2008 drilling season. In general, water quality does not show the effects of contaminated seepage to such a degree that collection is currently required. Each of the medium priority areas will have conceptual groundwater collection systems defined and adaptive management plans, but implementation is not considered urgent.

The current closure plan calls for pumping of contaminated water from the Emergency Tailings Area (ETA), S-wells, and Zone II Areas to the Faro Pit for seasonal treatment using a High Density Sludge (HDS) plant.

### 4.1.3 Surface Water Diversion

Faro Creek initially flowed directly over the Faro Pit area and joined Rose Creek near the middle of the current tailings area. The Faro Creek Diversion Channel (FCDC) (see Figure 4.6) captures the water above the Faro Valley dumps and routes it northeast of the pit where it flows into the North Fork of Rose Creek. The Faro Creek West Valley Interceptor Ditch (see Figure 4.6) collects runoff from the west hillside above Faro Creek and directs the flow into the diversion. The diversion has been upgraded several times over the life of the mine. Recent studies show that progressive ravelling of the pit wall will ultimately undermine the diversion channel (Golder Associates Ltd., 2004a). Consequently, it will eventually be necessary to relocate the FCDC to a new alignment further up the hillside, beyond the anticipated limit of pit wall failure.

### 4.1.4 Water Treatment

Water treatment for removal of zinc and other contaminants has been conducted at Faro for many years. This has involved water treatment in the former mill and also in a simplified lime addition system adjacent to the Cross Valley pond. The water treatment system has been adapted several times over the past decade in response to the evolving requirements for collection and treatment of contaminated water. In early 2009, a groundwater collection system was installed in the S-wells area near to NFRC. Operation of this system has initiated several key changes to the water management system at Faro; namely year-round pumping of water, and additional chemical load to be treated.

A discussion on the future of the existing water treatment plant and the timing of the construction and commissioning of a new permanent water treatment plant is provided in Chapter 8.

## 4.2 Closure Activities for the Faro Mine Area (100)

### 4.2.1 General

The following sections describe the recommended closure activities pertaining to the Faro Mine area. Covers will be placed on all waste rock, which includes sulphide cells and oxide fines. Other activities include construction of a safety berm around the pit perimeter, realignment of the Faro Creek Diversion, upgrading the North Wall Interceptor Ditch, removing the tailings at the ETA, installing groundwater collection systems, demolishing buildings, and removing contaminated soil. Figure 4.7 provides an overview of each of the closure activities for this area.

### 4.2.2 Safety Berm – Activity 101.2

A safety berm will be constructed around the Faro Pit to restrict access to the pit, as shown in Figure 4.8. An access road will be built along the alignment of the berm. The berm will be about 2.0m high with 2H:1V side slopes. The construction will be a typical load, haul, place, and dump operation where hummocks will be left as is rather than contoured. Details of a typical safety berm are provided in Figure 4.9.

The construction of the safety berms around the pit is scheduled for Year 13 of the Project (see Figure 11.1).

### 4.2.3 Relocation of Faro Creek Diversion Channel – Activity 102.1/2

The objective of this activity is to direct clean water around the Faro Pit and minimize seepage losses that could impact the stability of the Faro Pit walls and add to water treatment volumes. The Faro Pit wall rock is not considered stable in the long-term and, consequently, the closure plan calls for the relocation of the existing diversion channel and the existing Faro West Interceptor ditch to a new alignment further up the hillside. This would involve construction of a new diversion channel that would intercept Faro Creek and run along the eastern slope of Faro Creek Valley, above the existing FCDC and discharge into the existing FCDC. The plan also calls for constructing a new West Valley interception upslope of the existing ditch.

This activity may be constructed sooner as a risk mitigation measure if the pit wall monitoring suggests an increased risk.

### Design Criteria

Table 4.1 lists preliminary design criteria for the new diversion based on a study carried out by Golder Associates Ltd. in 2004.

**Table 4.1: Faro Valley Interceptor Design Criteria**

| | |
|---|---|
| **Hydraulic Design** | - Catchment Area = 15.8 sq $km^2$<br>- $27m^3/s$ = corresponding to a 1:500 year event(1)<br>- $150m^3/s$ with an emergency overflow system = corresponding to the probable maximum flood(1) into the Faro Pit<br>- Minimum 0.5% grade along the channel alignment<br>- Channel will be lined to minimize seepage into the ground<br>- Leakage of maximum 5% of channel flow<br>- Construction can occur anytime of the year as existing diversion will be maintained during construction |
| **Ice and Permafrost Conditions** | - Minimal ice damming due to low winter flows(1)<br>- Construction method to preserve and minimize permafrost degradation<br>- Stabilizing buttress to ensure slope stability in frozen, thawing and thawed conditions<br>- Liner will not be exposed |
| **Water Quality** | - Minimal risk of water contamination as all the inflow will be considered clean water |
| **Maintenance and Monitoring** | - A maintenance access route will be constructed along the channel alignment using spoil material<br>- Minimal maintenance and monitoring is expected |
| **Revegetation** | - All disturbed areas from construction will be revegetated<br>- The old channel will be preserved |

1. Golder Associates Ltd., (2004a).

### Preliminary Design and Construction Method

Prior to the construction of the new diversion, a detailed field investigation will be required to define the *in situ* condition of the soil for design purposes, specifically the ice content in the frozen soil. The *in situ* ice conditions will provide further engineering parameters for thermal protection, slope stability, preferred construction schedule, and methods.

A plan and profile for the diversion are shown on Figure 4.10. The new channel will be excavated and spoil will be used to construct a maintenance access road. A thermal protection blanket will be placed and compacted on all exposed slope areas. A Geosynthetic Clay Liner (GCL) will be placed along the channel alignment and topped with a bedding and riprap layer. A typical channel cross section is shown in Figure 4.11. The estimated disturbed footprint of the channel is $127,000m^2$ and the excavated volume is about $16,500m^3$.

The existing FCDC will be preserved. The PAG rock will be removed and the smaller channel stabilized. Pending the timing of the pit wall regression, a means to collect clean runoff from below the new channel will be provided and the water pumped (seasonally) into the new channel.

All the material required for the road, thermal blanket, bedding, and riprap layers will be sourced and produced from local borrow areas. The borrow source details are identified in Section 9 of this report. Optimization of the design and construction will be carried out during the detail design stage.

### 4.2.4 North Wall Interceptor Ditch - Activity 102.3

Uncontaminated surface runoff from the north side of Rose Valley, including Upper Guardhouse Creek, is currently diverted to the north end of the tailings impoundment area by the North Wall Interceptor ditch (NWI). Runoff collected in the NW Interceptor is diverted from discharging into the Rose Creek Tailings area.

The objective of this work is to remediate the existing NW Interceptor ditch and discharge to a location below the Cross Valley Dam.

The location of the ditch is shown in Figure 4.12.

Table 4.2 lists the conceptual design criteria for the NWI ditch.

**Table 4.2: North Wall Interceptor Ditch Breach Criteria**

| | |
|---|---|
| **Seismic** | - N/A |
| **NW Interceptor Remediation** | - Improve or construct access road<br>- Clean out existing ditch<br>- Upgrade discharge location as necessary |
| **Water Quality** | - Minimal risk of water contamination as all the inflow will be considered clean water |
| **Maintenance and Monitoring** | - A maintenance access route will be constructed along the channel alignment<br>- Minimal maintenance and monitoring is expected |
| **Revegetation** | - All disturbed areas from construction will be revegetated |

#### Preliminary Design and Construction Method

An access road will be improved or constructed for the NW Interceptor. All the material required for the road will be sourced and produced from local borrow areas. The borrow sources are identified in Section 9 of this report.

### 4.2.5 Guardhouse Creek – Activity 102.4

Guardhouse Creek is currently divided into two disconnected reaches: Upper Guardhouse Creek and Lower Guardhouse Creek. Upper Guardhouse Creek is diverted into the NW Interceptor ditch; Lower Guardhouse Creek, which collects seepage from the mill pad, runoff from the area between the creek and NW Interceptor ditch, and any leakage from the ditch, discharges into the Rose Creek Tailings area. Water in Upper Guardhouse Creek is clean. The primary source of loading to Lower Guardhouse Creek appears to be drainage from the mill pad and crusher stockpile via a collection ditch discharging into Lower Guardhouse Creek.

The objective of this work is to intercept seepage from the mill pad and associated stockpiles and redirect this water to the Faro Pit via a pipeline connecting with the ETA pipeline (Activity 105). Surface water interception will include a sump and pumping station. A monitoring network will be installed and, if data indicates bypass at levels of concern, additional interception components will be installed or existing components modified. These could include a groundwater cut-off wall, interception trench, a larger sump or additional pumping capacity.

Residual contaminated drainage below the interception system will continue to discharge to the Rose Creek Tailings area, which, even after cover placement, will pond on the upstream side of the Intermediate Dam, until a time that water is discharge quality. If residual seepage from Lower Guardhouse Creek continues to have significant load at such time a decision is made to discharge any surface water from within the tailings area, this water will be intercepted and pumped to the Faro Pit.

Figure 4.12 shows a plan view of the Guardhouse Creek.

Table 4.3 explains the design criteria for remediation.

**Table 4.3: Design Criteria for NW Rock Dump, Lower and Upper Guardhouse Creek**

| Area | Design | Reason |
|---|---|---|
| NW Waste Rock Dump | Pull back toe of dump and reslope to 3H:1V and revegetate | Prevent impact of Upper Guardhouse Creek by waste rock at the toe. |
| Interception System | Surface water diversion at top of Creek<br>- Excavate, place liner, riprap sump<br>- Pumping to ETA via insulated, heat traced HDPE pipeline<br>- Variable speed pump<br>Groundwater interception (contingency)<br>- Groundwater monitoring wells down gradient of sump<br>- If required, cut-off wall and collection trench.<br>- Pump water to ETA with surface water. | Prevent discharge of load from mill pad and crusher stockpile to Lower Guardhouse Creek and the tailings. |
| Monitoring | - Surface water monitoring along Lower Guardhouse Creek<br>- Groundwater monitoring below interception system | |

(1) Final design to be determined as a part of detailed engineering.

### Preliminary Design and Construction Methods

An access road will be improved or constructed to the NW Dump near Upper Guardhouse Creek. All the material required for the road will be sourced and produced from local borrow areas. The borrow sources are identified in Section 9 of this report.

The Northwest waste rock between W8 and W10 on Upper Guardhouse Creek will be removed for the construction of the trafficability layer on the Rose Creek tailings pond.

An insulated, heat-traced pipeline will be constructed from the collection sump, over the mill pad cover, to tie in to the ETA pipeline. Excavate, place liner and riprap a sump at the upstream end of Lower Guardhouse Creek, just outside of the toe of the final mill pad cover. A pumping station with a variable-speed pump will be installed.

A surface water and groundwater monitoring system will be installed and used as part of the AMP.

## 4.2.6 Zone II Pit – Activity 103.1

Zone II water is currently pumped on a seasonal basis to Faro Pit. The water level fluctuates between about 1106 and 1114 m. This is well below the spill elevation of the buried pit rim which is approximately 1127m. The NFRC is about 1105m elevation near to the Zone II pit, consequently there is always a small gradient from the pit towards the NFRC.

Closure activity will involve changing the maximum Zone II water level to about 1m below the NFRC to reverse the direction of groundwater flow. In order to reduce the effects of contaminant yield from the Zone II pit, the dewatering system will be modified for year-round pumping via an insulated and heat-traced line and an automatic controller to reduce the water level fluctuation to less than 1m. It is likely that these modifications will be implemented during care and maintenance.

## 4.2.7 Zone II Pit Outwash and Groundwater Collection Systems (North Fork Rose Creek) – Activity 107.2/3/4

The objective of this activity is to relocate the outwash material to the Intermediate Sulphide Cell and intercept the seepage from the Zone II Outwash area to reduce contaminant loading to the NFRC and underlying aquifer (see Figure 4.13). The initial phase of the seepage interception will be the installation of a groundwater Seepage Intercept System (SIS) comprising an interceptor trench and pumping wells with additional system upgrades implemented in other areas, as required. Additional phases would be implemented in a timely manner in accordance with the adaptive management plan integrated with an extensive monitoring network, as outlined in Chapter 13 of this report. Additional phases could include a cut-off wall and grouting of bedrock along the cut-off wall alignment.

### Design Criteria

Table 4.4 outlines a list of preliminary design criteria for the activity, specifically the initial SIS. If necessary, a cut-off wall will be installed to augment the performance of the SIS. No design work has been done on the cut-off wall.

**Table 4.4: Preliminary Design Criteria for SIS in Zone 2 Pit Outwash**

| | |
|---|---|
| **Extraction Wells** | - 150mm OD Well<br>- 1.9 L/s (30 USgpm) average pumping rate<br>- Average 20m screen depth<br>- Average 50m well spacing<br>- Average screen length of 10m<br>- Install within the high permeability trench<br>- Directed to a pipeline leading to Faro Pit Lake |
| **Permeable Trench** | - Average 1.5m wide<br>- Average 15m depth down to weathered bedrock<br>- Backfill material to be a bio-degradable slurry (such as Revert Mud) with 25mm minus drainage gravel |

### Preliminary Design and Construction Methods

The access road to the outwash area would be upgraded to ensure construction vehicle access and provide a mixing area for the slurry. A pumping trench will be excavated along the outwash of the Zone II Pit as shown in Figure 4.13. The trench will be excavated by conventional method by either a clamshell or long boom excavator down through the soil material to weathered bedrock contact. The trench excavation will be supported by a bio-degradable slurry mixture, such as Revert™ natural-polymer, and 25mm minus drainage gravel. The Revert polymer is practically nontoxic as rated by US MSDS.

When the trench excavation and backfill is completed, six pumping wells will be drilled to a minimum of 5m into weathered bedrock. The 10m screen will be set evenly between the weathered bedrock contact and the soil units. Typical well installation is shown in Figure 4.13. The current plan calls for pumping the contaminated water back into Faro Pit Lake for storage and dilution before water treatment.

## 4.2.8 Oxide Fines, Medium Grade Ore, Mt Mungly Dumps (East and West), Southwest Pit Wall dump and Low Grade Ore Stockpiles – Activity 104

The Oxide Fines (OF) and Low-Grade Ore Stockpiles (LGSP "C" and "A") are the sources of the most contaminated water in the Faro area. Table 4.5 provides material volume estimates and areal extent of the waste at both the Faro and Vangorda sites. Several remediation options including "cover in place", "consolidate and cover", relocation to Faro Pit, and alkali amendment were evaluated. The choices were narrowed to "cover in place" and "consolidate and cover" based primarily on cost[1]. Currently, the "consolidate and cover" option is the preferred option for the fact

[1] SRK, 2006. Anvil Range Mining Complex, Assessment of Select Oxide Fines and Ore Stockpile, July 2006.

that it will reduce the footprint area up to 8 ha, an approximate 40 percent reduction in surface area. The surface area reduction would result in a proportional reduction in infiltration and consequently metal and acidity loadings. Consequently, the oxide fines, the medium grade ore and a small area of low grade ore will be relocated to the Low Grade Ore Stockpile "C" and covered with a very low infiltration cover as shown in Figure 4.14, Detail 1. Furthermore, the cover for the Low Grade Ore Stockpile "A" would also get a very low infiltration cover as shown in Figure 4.14, Detail 1. Low infiltration covers will also be applied to the Mt Mungly waste dumps (East and West) and the Southwest Pit wall dump, as shown in Figure 4.14, Detail 2.

## Table 4.5: Estimated Total Waste Material Quantities

| LOCATIONS | Incremental Area ($m^2$) | Total Area ($m^2$) | Incremental Quantity (tonnes) | Total Quantity (tonnes) | Incremental Volume ($m^3$) | Total Volume ($m^3$) |
|---|---|---|---|---|---|---|
| **Faro Waste Rock Dumps** | | | | | | |
| Faro Valley North | 135,869 | | 3,514,050 | | | |
| Faro Valley South | 32,605 | 168,474 | 607,166 | 4,121,216 | | |
| Medium Grade Ore Stockpile | 6,000 | | 244,399 | | 135,777 | |
| Crusher Stockpile | 22,917 | | 171,585 | | 95,325 | |
| Low Grade Ore | 7,000 | | 80,528 | | 44,738 | |
| Oxide Fines #2 | 5,000 | | 119,158 | | 66,199 | |
| Oxide Fines #3 | 5,000 | 45,917 | 67,900 | 683,570 | 37,722 | 379,761 |
| Oxide Fines #1 (incl Brown, Green, and Med Grade Ore) | 49,800 | 49,800 | 322,670 | 322,670 | 693,000 | 693,000 |
| Low Grade Stockpile A | 42,500 | 42,500 | 460,800 | 460,800 | 256,000 | 256,000 |
| Upper Northwest Dump | 128,833 | | 2,665,666 | | | |
| Middle Northwest Dump | 158,069 | | 5,723,496 | | | |
| Lower Northwest Dump | 105,653 | | 6,558,132 | | | |
| Mt. Mungly West | 20,287 | | 251,854 | | | |
| Mt. Mungly East | 34,130 | | 882,728 | | | |
| Fuel Tank Dump W | 8,372 | | 86,616 | | | |
| Fuel Tank Dump E | 96,879 | | 2,479,776 | | | |
| Upper Parking Lot Dump | 53,716 | | 2,222,854 | | | |
| Lower Parking Lot Dump | 32,724 | | 677,080 | | | |
| Stock Piles Base | 91,250 | 729,913 | 2,832,056 | 24,380,258 | | |
| Southwest Pit Wall Dump | 78,294 | | 1,619,962 | | | |
| Low Grade Stockpile C | 91,000 | | 786,068 | | 436,704 | |
| Main East Sulphide Cell | 80,808 | | 12,606,018 | | | |
| Intermediate Dump Sulphide Cell | 92,839 | 342,941 | 11,512,005 | 26,524,053 | | |
| Ranch Dump | 42,305 | | 525,194 | | | |
| Ramp Zone Dump | 60,265 | | 2,182,144 | | | |
| Main Dump West | 220,861 | | 25,133,886 | | | |
| Main Dump East | 355,257 | | 55,063,032 | | | |
| Intermediate Dump | 328,624 | | 40,810,467 | | | |
| Outer Haul Road West | 186,942 | | 12,570,922 | | | |
| Outer Haul Road East | 86,644 | 1,280,898 | 4,481,826 | 140,767,471 | | |
| Lower Northeast sulphide cell | 17,459 | | 1,361,794 | | | |
| Outer Northeast Dump | 12,787 | | 198,422 | | | |
| Zone II West | 89,315 | | 6,006,008 | | | |
| Zone II East | 126,084 | | 16,304,844 | | | |
| Lower Northeast Dump | 272,892 | | 21,166,698 | | | |
| Upper Northeast Dump | 254,309 | 772,846 | 15,785,560 | 60,823,326 | | |
| **Faro Area Totals** | **3,433,289** | **3,433,289** | **258,083,364** | **258,083,364** | | |
| **Rose Creek Tailings** | | | | | | |
| Original | 417,000 | | 11,970,000 | | 6,300,000 | |
| Secondary | 545,000 | | 19,760,000 | | 10,400,000 | |
| Intermediate | 990,000 | | 22,610,000 | | 11,900,000 | |
| **Tailings Area Totals** | **1,952,000** | **1,952,000** | **54,340,000** | **54,340,000** | **28,600,000** | **28,600,000** |
| **Emergency Tailings Area** | | | | | | |
| Tailings | | | | | 51,000 | 51,000 |
| Final Clean up | | | | | 12,800 | 12,800 |
| **Emergency Tailings Area Totals** | | | | | **63,800** | **63,800** |
| **Vangorda Waste Rock Piles** | | | | | | |
| Vangorda Dump | | | 16,000,000 | | 8,232,000 | |
| Grum Dump | | | 28,000,000 | | 14,406,000 | |
| Ore Transfer Pad | | | 2447000 | | 1,259,000 | |
| Baritic Fines | 11,400 | 11,400 | NA | | NA | |
| Grum Overburden Dump | | | 15,549,000 | | 8,000,000 | |
| Till Stockpile at Vangorda dump | | | 1,079,000 | | 555,000 | |
| **Zone II Outwash** | | | | | **76,000** | **76,000** |
| **Ore Transfer Pad** | | | | | **1,259,000** | **1,259,000** |

### Design Criteria

Table 4.6 lists the design criteria for the low and very low infiltration covers.

**Table 4.6: Design Criteria for Low and Very Low Infiltration covers**

| | |
|---|---|
| **Low Infiltration Cover Design** | - Target performance is less than 5% of MAP (Range 3-8%)(1)<br>- Compacted till barrier layer (1 thick)<br>- Loosely compacted till layer as store and release component and growth medium (0.3 to 1m thick) |
| **Very Low Infiltration Cover Design** | - Target performance is less than 0.5% of MAP infiltration rate(1)<br>- Compacted till barrier layer (1 to 1.5m thick)<br>- Loosely compacted till layer as store and release component and growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Alternative Design for Very Low Infiltration Cover** | - Liner protecting bedding layer (0.3m compacted granular material or geotextile)<br>- Synthetic liner (Bituminous or HDPE)<br>- Liner protecting bedding layer(0.3m compacted granular material, or geotextile)<br>- Loosely compacted till layer as growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Other Design Criteria** | - Not steeper than 3H:1V side slopes<br>- Maximum down slope run of 100m<br>- Seed and fertilize using a low-flying helicopter application rate |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

### Preliminary Design and Construction Method

Figure 4.14 shows the current location and limits of the Oxide Fines, (1, 2, and 3), the low grade ore, the medium grade ore and the Low Grade Ore Stockpiles (A and C). All the OF piles, the LGO adjacent to OF#3, the medium grade ore stockpile and the crusher stockpile will be consolidated to the Low Grade Stockpile "C". Consolidation will be carried out with a load, haul, and dump operation using high capacity truck fleet such as CAT 777 off-road haul trucks. After the consolidation, the LGSP "A" and Consolidated LGSP "C" will be regraded to maximum of 3H:1V slopes. The LGSP's A and C will be capped with a very low infiltration cover. This cover will consist of a synthetic liner or an equivalent depth of compacted till to achieve an assumed infiltration rate of less than 0.5%. The low infiltration cover will consist of 1 metre compacted till. On top of the infiltration barrier, a 0.3 to1m-thick growth medium will be placed and then seeded and fertilized. Figure 4.14 shows typical cross-sections of the cover options.

It should be noted, however, that final selection of the cover type is still subject to further review and technical evaluation.

As discussed in Chapter 3, a system for managing highly contaminated water during the relocation and covering of the oxide fines and low-grade ore will be put in place.

### 4.2.9 Remediation of the Emergency Tailings Area – Activity 105

The objective of this activity is to intercept contaminated groundwater and surface water prior to discharge into the Rose Creek Tailings area. The ETA tailings will be removed to facilitate effective collection of the seepage from the rock piles and to reduce the contaminant loading to the groundwater. Groundwater and surface water interception systems will be installed at both upstream and downstream locations and water will be pumped to the Faro Pit. Clean water will be diverted around the ETA and discharged to the North Fork of Rose Creek in the vicinity of the water treatment plant at the upstream end of the Rose Creek Tailings Facility. Over time, water quality of runoff continuing to collect in the reclaimed ETA should improve. Until achieving discharge quality, this water would be pumped to the Faro Pit. Once water quality is sufficient for discharge to the environment, the water can be discharged via the clean water diversion system or allowed to pass onto the Rose Creek Tailings area cover.

Components of this activity are shown on Figure 4.15. Table 4.7 provides preliminary design criteria for the remediation work of the ETA.

## Table 4.7: Preliminary Design Criteria for ETA Remediation Work

| | |
|---|---|
| **Mechanical Relocation** | - Typical depth of 3.5m with deep pockets up to 7.5m<br>- Assumed minimum 1m thick, with pockets up to 2.3m, of natural soil below the tailings to be removed<br>- Small fleet of high efficiency trucks and excavators<br>- Trucks must equipped with gates and contingency measures to prevent tailings flowing out from truck during liquefaction |
| **Lime Amendment** | - Average .017 tonnes of CaO per $m^3$ of tailings(1) |
| **Access Improvements** | - New road to X23 along diversion ditch alignment<br>- After removal of ETA tailings, new access road to mine canyon sump<br>- New culvert or breach of mine access road, once ETA runoff water quality sufficient. Designed to bypass 1:500 year peak flow |
| **Pipelines** | - Primary, average flow pipeline HDPE with heat trace and insulation<br>- Drain valves for each individual reach<br>- Booster stations<br>- Backup uninsulated or heat traced pipeline for high flow events. |
| **Cut-off Walls** | - Up to 2m wide<br>- Approximately 10m deep<br>- Approximately 30m long<br>- Keyed into weathered bedrock<br>- Ties into relatively impermeable materials or ETA aquifer margins at abutments<br>- Bedrock grouting may also be required |
| **Combined Groundwater and Surface Water Collection Systems** | - Concrete manholes in rock-filled trenches with French drain style collector pipes.<br>- Redundant manhole and pumps for silt removal and backup pumping capacity<br>- Upstream rock filled apron for surface water capture.<br>- Average trench depth of 10m<br>- Variable rate sump pumps with combined total capacity of approximately 182 l/s |
| **Surface Water Sump** | - Excavated, lined and rip-rapped sump on upstream side of mine access road<br>- Variable speed sump pumps<br>- Approximately 10 L/s for each<br>- Heat trace and insulation<br>- Automatic level/flow controls with flow meters and dataloggers |
| **Diversion Ditch** | - Excavate, line and riprap diversion ditch along toe of covered dumps around the perimeter of the ETA<br>- Excavate, line and riprap diversion ditch alignment to NFRC<br>- Install culvert under mine access road; design to pass 1:500 year event. |
| **Monitoring and Maintenance** | - Monitoring wells up and down gradient of cut-off walls. Completed in bedrock and overburden materials<br>- Monitoring wells down gradient of interim SIS<br>- Monitoring wells monitored quarterly<br>- Pump discharge measured continuously and monitored regularly for water quality<br>- Periodic well development required to maintain efficiency<br>- Periodic pump replacement<br>- Periodic cleaning of sumps |

1. The average is the overall mathematical average throughout the tailings. The near surface tailings will require more lime amendment to facilitate neutralization, up to 40% more compared to tailings at depth.

### Preliminary Design and Construction Method

The primary activities in the ETA will be removal of the ETA tailings and interception of impacted groundwater and surface water. Groundwater and surface water interception systems will be constructed to intercept impacted waters.

Prior to removal of the ETA tailings:

- The interim ETA seepage interception system below the mine access road will continue to operate. This system will be upgraded as necessary to minimize bypass by improved tie-in to bedrock and abutments.
- A sump with a down gradient cut-off wall will be installed downstream of X23 for groundwater and surface water collection. Details of the combined surface water - groundwater interception systems will be developed as part of detailed engineering.
- A sump and pumping station will be constructed upstream of the mine access road for diversion of waters collecting in the ETA during construction.
- Intercepted water from the X23 sump will be gravity drained or pumped via a temporary pipeline to the sump up gradient of the access road.
- A diversion ditch will be constructed along the southeast side of the ETA to divert runoff from non-contact areas. The ditch will be aligned for future connection of additional ditches along the toes of covered dumps. Flows will be directed to discharge into the NFRC at the upstream end of the Rose Creek Tailings Facility.
- A permanent pipeline will be constructed from the surface water collection sump to the Faro Pit. Tie-ins will be included for water from the interim SIS, groundwater collection points at the upstream end of the ETA and water diverted from the upper end of Lower Guardhouse Creek (Activity 102.4).

The tailings will be mechanically relocated to the Rose Creek Tailings Facility for consolidation. Mechanical relocation of the tailings is favoured due to the relatively small volume. Furthermore, there is a strong likelihood that some of the soil underlying the ETA tailings will also be removed. Lime will be added to both the tailings and the underlying waste rock during handling.

An access road onto the tailings area will be upgraded and extended to facilitate disposal. Lime addition and mixing will be done during the relocation work. The lime will be mixed into the tailings during excavating, hauling, and spreading at the destination. The excavation and lime addition will continue into the contaminated natural soil until all contaminants are removed or as specified by the geochemist.

Haul trucks with a tail gate system will be used to relocate the tailings. The reclaimed ETA tailings area will be covered and revegetated.

Following removal of the tailings, additional water management components will be installed:

- A sump with a down gradient cutoff wall will be constructed in the northern canyon, below the mill, for groundwater and surface water interception (the mill canyon sump), similar to the X23 interception system.
- A sump will be constructed above the mine access road, at the lowest elevation area in the reclaimed ETA. The sump will be connected to the pipeline.
- The temporary pipeline from the X23 sump will be replaced with a pipeline connecting to, or running parallel to, the mill canyon sump pipeline and tying into the main pipeline to the Faro Pit.
- Following completion of waste rock dump and the mill pad covers, diversion ditches along toes of the covers will be connected to the existing diversion ditches.

The interim ETA SIS and surface water sump immediately up gradient of the mine access road will remain operational until water quality is discharge quality. This system will remain in place to provide contingency groundwater interception capacity in the event that groundwater cannot be effectively intercepted upgradient. As a contingency, if contaminated water continues to discharge into the Faro Creek canyon, the interim SIS will be used to capture this water and it will be pumped to the Faro Pit.

The adaptive management plan (AMP) will incorporate a monitoring system (wells and seepage flow monitoring) to identify bypass of contaminated groundwater. Triggers and remedial measures will be included in the AMP.

### 4.2.10 Waste Rock Dumps and Sulphide Cells Remediation – Activity 106

The primary objectives of the covers on the Faro Waste rock dumps are:

- Reduce infiltration in the dumps;
- Construct geotechnically stable landforms;
- Maximize diversion of uncontaminated run off from covers and surrounding areas; and
- Revegetate disturbed areas on all dump areas.

The objectives for the covers on the sulphide cells are similar and include:

- Consolidate the smaller piles of highly reactive material into the larger dumps where practical;
- Reduce infiltration; and
- Revegetate.

Tables 3.8 and 3.9 summarize preliminary design criteria for the covers.

**Table 4.8: Preliminary Design Criteria for Waste Rock Cover**

| | |
|---|---|
| **Cover Performance** | - Rudimentary Cover<br>- Infiltration less than 20% of MAP (Range 15-25%)(1) |
| **Rudimentary Cover Design** | - Loosely compacted till layer as store-and-release component and growth medium (0.3 to 1m thick)<br>- Revegetation<br>- Internal slopes to be not steeper than 2H:1V side slopes. Outer slopes to be 3H:1V where practical but not steeper than 2H:1V<br>- Install on all waste rock which does not require low or very low infiltration covers |
| **Other Design Criteria** | - Maximum downslope run of 100m with maximum runoff length of 50m<br>- Ditches and basins to be constructed to control surface run-off<br>- Revegetation suitable to the environment to stabilize slopes and prevent erosion<br>- Rapid establishment of vegetation to control erosion during and imeediately after construction<br>- Seismic: 0.10g = corresponding to a probabilistic 1:1000 year event<br>- 0.40g = corresponding to a deterministic maximum credible event (MCE) |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

**Table 4.9: Preliminary Design Criteria for Sulphide Cell Covers (Main, Intermediate and East)**

| | |
|---|---|
| **Cover Performance** | - Very Low Infiltration Cover<br>- Infiltration less than 0.5% of MAP (Range 3-8%)(1) |
| **Very Low Infiltration Cover Design** | - Compacted till barrier layer (1 to 1.5m thick)<br>- Loosely compacted till layer as store and release component and growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Alternative Cover Design** | - Liner protecting bedding layer (0.3m compacted granular material or geotextile)<br>- Synthetic liner (Bituminous or HDPE)<br>- Liner protecting bedding layer(0.3m compacted granular material, or geotextile)<br>- Loosely compacted till layer as growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Other Design Criteria** | - Maximum down slope run of 100m with maximum runoff length of 50m<br>- Construct swales so run-off is directed away from streams and rivers and to avoid run-off down plateaus<br>- Revegetation suitable to the environment to stabilize slopes and prevent erosion<br>- Compacted till layer to have a density of at least 2000kg/$m^3$<br>- Seismic: 0.10g = corresponding to a probabilistic 1:1000 year event<br>- 0.40g = corresponding to a deterministic maximum credible event (MCE) |

(1) Infiltration Rate = % of Mean Annual Precipitation MAP

## Preliminary Design and Construction Methods

### Waste Rock

Waste rock piles will be regraded in place and receive a rudimentary cover. The resloping will be completed by pushing the material downhill. This construction method can only be done where there is space for the toe of the slope to be expanded. Internal slopes will be regraded to no steeper than 2H:1V. The outer slopes will be regraded to 3H:1V where practical. Where space is limited,

such as above the S-wells, the dump crest will be pulled back. There may be some areas of the outer slopes where the toe cannot be extended and it is not practical to pull the crest back. In these locations, the slopes may be steepened to more than 3H:1V but they will be no steeper than 2H:1V. See Figure 4.14 for resloping locations and cover details. Figure 4.16 shows the outline of the existing dumps and the expected toe of the resloped outer dump faces assuming 3H:1V. The estimated new area disturbed by the resloping is about 350,000m$^2$.

Cover material will be hauled from the Grum Overburden dump using a high capacity truck fleet and placed in 0.5m lifts. The lifts will be levelled and lightly compacted with a dozer. The cover will be seeded and fertilized using a low-flying helicopter.

After contouring and re-sloping, all waste rock areas will be covered as soon as practical. It is expected that this work will be conducted about 6 to 9 months of the year, with hauling and stockpiling of till on a nearly year-round basis.

Surface water will be managed by lined and unlined plateau channels and a number of armoured slope channels. It is assumed that surface water will be clean but it is recognized that sediment control will be necessary. To address this, sediment control ditches and basins will be constructed (see Chapter 12).

Vegetation will be applied in accordance with the RLU designations, provided in Appendix B.

**Sulphide Cells**

Figure 4.14 shows the current location and limits of the Main, Intermediate and East Sulphide Cells. Each Cell will be graded to no steeper than 3H:1V slopes by pushing the material downslope, and capped with a very low infiltration soil cover. An HDPE liner will be placed between two protective layers (0.3m compacted granular material or geotextile). Then a 0.3m to 1.0m lift of till will be placed and lightly compacted as this layer will be reseeded and fertilized using a low-flying helicopter.

An adaptive management plan will be in place to monitor the cover performance. Maintenance and upgrades will be carried out as required.

### 4.2.11 Upgrading of the North Fork Rose Creek and Breaching of the North Fork Rock Drain- Activity 107.1 and 203.3

The objective of this activity is to protect the North Fork of Rose Creek from potential sources of contamination. This activity involves constructing a new low permeability channel offset from the existing alignment of the North Fork of Rose Creek. This activity would be carried out in conjunction with removal of the North Fork Rock Drain in the Vangorda Haul road. Figure 4.17 provides a plan view of North Fork Rose Creek and the Rock drain breach. Figure 4.18 presents a conceptual cross section for the new channel. Figure 4.19 presents options for channel designs.

Table 4.10 lists the preliminary design criteria for the lined channel of NFRC and the removal of the NFRD.

**Table 4.10: Design Criteria**

| | |
|---|---|
| **Hydraulics** | - Catchment Area 118 $km^2$<br>- Design flood event for inner channel = 1:500 year event(1); $Q_{500}$ = 81 $m^3/s$ (NWHC, 2004)<br>- Design flood event for floodplain = PMF (384$m^3/s$)<br>- Minimum 0.5% grade along the channel alignment<br>- Channel will be lined to minimize seepage into the ground<br>- Leakage of maximum 5% of channel flow<br>- Channel will be raised or lowered so as to achieve minimum gradient<br>- Construction will occur during low flow periods (August to October) over one year |
| **Ice and Permafrost Conditions** | - Minimal ice damming due to low winter flows(1)<br>- Thermal blankets will be constructed to preserve and minimize permafrost degradation<br>- Liner will not be exposed<br>- Channel will incorporate a "pilot channel" to allow winter flow under the ice to avoid glaciation blockage |
| **Water Quality** | - Minimal risk of water contamination |
| **Maintenance and Monitoring** | - A maintenance access route will be constructed along the channel alignment<br>- Minimal maintenance and monitoring is expected |
| **Revegetation** | - All disturbed areas from construction will be revegetated<br>- The old channel will be decommissioned and reclaimed |
| **Cut-off Wall at Confluence with Faro Creek Diversion** | - Cut-off to bedrock if practical to maximize uncontaminated flow which is routed into lined channel<br>- Cut-off wall will be constructed downstream of the inflow from the Faro creek diversion |
| **NFRD Breach** | - Excavated slopes to be 2H:1V or flatter if required<br>- Base width at creek elevation of 25m to allow construction of the lined channel |

### Preliminary Design and Construction Method

Geologic conditions must be determined before detailed design work can proceed. Required key information includes:

- Depth to and geometry of bedrock surface in the vicinity of the upstream cut-off wall (near to the inflow from the Faro diversion channel – preliminary investigation completed in 2009), and
- Soil and permafrost conditions along the alignment for the new lined channel on the south side of the existing NFRC.

The preliminary design for this component of the project includes:

- A cut-off wall to bedrock at the upstream end of the lined channel (see conceptual design in Figure 4.20). The cut-off wall is anticipated to be a cemented-slurry wall with soil cement and/or bedrock grouting as needed or is appropriate.
- A low permeability "floodplain" designed to accommodate the PMF (384 $m^3/s$) peak flow.
- A low permeability channel within the floodplain will be designed for the 1:500 year flood event (81 $m^3/s$).
- Other aspects of the lined channel are likely to include:

- A low permeability barrier with good long-term durability, such as compacted till, GCL, HDPE or bituminous material;
- A pilot channel to route the winter flow under the ice;
- Riprap cover on the liner to protect against extreme flows;
- Nominal flow velocity and in-channel features that are appropriate for fish passage;
- Nature stream features such as glides, riffles, and pools; and
- The section of the lined channel which passes through the breach of the NFRD may be constructed with erosion protection for the PMF.

The construction of the channel will occur in phases as part of an adaptive management plan based on ground and surface water quality. The initial section of the channel will most likely extend from the cut-off intake structure to the Mine Access Road as shown on Figure 4.17. Depending on the groundwater quality achieved by the seepage collection in the S-wells area and testing of groundwater in other areas, the low permeability channel may be extended as far as the confluence with South Fork of Rose Creek..

Typical cross sections through the raised inner channel and the raised flood plan are shown on Figure 4.18. It should be noted however that many sections of the channel may need to be lowered. Figure 4.19 shows typical natural stream features that would be incorporated into the design of channel. The in-channel treatments and proposed pilot channel will be reviewed following a detailed site reconnaissance of the existing channel bed.

As part of the adaptive management plan, if there is evidence that poor quality groundwater is affecting the surface water quality in the South Fork of Rose Creek, it will also be raised in a low permeability channel.

### 4.2.12 S-wells Groundwater Collection- Activity 107.4

The objective of this work is to capture contaminated groundwater relatively close to the source, before it discharges into the NFRC or becomes more dispersed and cannot be captured as efficiently. Interception will be implemented as an adaptive management plan, focusing initially on high concentration areas and utilizing an extensive monitoring system to identify areas requiring system upgrade.

#### Design Criteria

Table 4.11 lists design criteria for the S-wells work with information quoted from both previous and ongoing SRK studies.

**Table 4.11: S-Well Groundwater Interception**

| | |
|---|---|
| **Site Preparation** | - Access road improvements for heavy equipment<br>- Ground excavation to develop flat working surface |
| **Shallow Aquifer** | |
| **Sump and Interceptor Ditch and Access** | - Interceptor ditch constructed across entire width of surface aquifer<br>- Bottom of interceptor ditch keyed into relatively impermeable materials underlying shallow aquifer<br>- Interceptor ditch backfilled with permeable drain materials<br>- Pump water from central sump in ditch<br>- Pumping keeps water level in central sump low to keep gradient towards sump<br>- Automatic controls to maintain pump/sump operating parameters<br>- Permanent power to site |
| **Maintenance and Monitoring** | - Periodic removal of fines from sump bottom likely required<br>- Periodic replacement of pumping system components<br>- Groundwater monitoring system installed<br>- Surface water monitored regularly<br>- Pump discharge quantity and quality recorded |
| **Deep Aquifer** | |
| **Pumping Wells** | - Fence of 6-inch pumping wells installed into weathered bedrock and overlying permeable materials in current high contaminant concentration area<br>- 10m spacing for pumping wells<br>- Automatic controls to maintain pump operating parameters<br>- Pumps connected to central manifold or discharge to shallow aquifer sump for centralized pumping to treatment/disposal location<br>- Permanent power to site |
| **Maintenance and Monitoring** | - Periodic redevelopment of pumping wells to retain efficiencies<br>- Periodic replacement of pumping system components<br>- Groundwater monitoring system installed<br>- Surface water monitored regularly<br>- Pump discharge quantity and quality recorded |
| **Common Elements** | |
| **Pipeline** | - Pipeline required to transport intercepted groundwater to treatment plant or Faro pit<br>- 4-inch line or heat-traced and insulated for year around operation with a second uninsulated pipeline for freshet peak flow<br>- Insulation and heat tracing with appropriate controls |
| **Contingency** | |
| **Cut-off Wall and Permeable Pumping Trench** | - Grout slurry cut-off wall extending full distance across S-Well area<br>- Keyed into weathered bedrock<br>- Up-gradient trench with permeable backfill for collecting contaminated groundwater<br>- Pumping wells in permeable trench<br>- Automatic controls to maintain pump operating parameters |
| **Bedrock Grouting** | - Grout bedrock below cut-off wall if required |

## Preliminary Design and Construction Method

Construction of the shallow aquifer interception system was initiated in January 2009 as part of the S-wells Action Plan program and included an initial deep aquifer interception system, incorporating pumping wells installed as part of the 2008 field investigation activities. Completion of the deep aquifer system is planned for 2009. For the purpose of this project description, these components are termed “early remediation”.

### Shallow Aquifer

In the shallow aquifer, the early remediation interception system consists of an interceptor trench excavated to approximately 3.5 to 4m depth across the 25m width of the aquifer. A central corrugated metal pipe sump was installed to a depth of approximately 6 to 7m for the pumping system. A submersible pump is used to maintain a sump water level below that of natural conditions and pump groundwater to the Faro pit via a 4-inch heat traced pipeline. Power is supplied by generator, but will be tied into the site electric distribution system in the future. Figure 4.21 shows the layout for the shallow aquifer collection system. Figure 4.22 shows cross sections through the interception system.

Materials excavated for the shallow sump were placed behind an earthen berm down gradient of the sump itself. Permeable backfill for the sump was sourced from existing borrow areas or non-PAG waste rock.

The shallow aquifer pumping system has full automatic controls with alarms for power or equipment failures and will be upgradeable to remote telemetry options. Continuous flow and water level measurements are being recorded.

### Deep Aquifer

Initial deep aquifer interception components have been included as part of the current interception system. Two existing pumping wells used for site investigations were connected via insulated, heat-traced pipelines to the shallow aquifer sump, from where contaminated groundwater is pumped to the Faro pit via the 4-inch pipeline. The shallow aquifer pumping system controls record deep aquifer flow and level measurements.

Regular sampling of existing down gradient monitoring wells will be used in combination with water quality and quantity information collected from the phase one pumping wells to assess system performance.

The next phase of the deep aquifer interception system will focus, initially, on additional pumping wells completed into weathered bedrock in the areas of highest contaminant concentrations. Spacing and numbers of pumping wells will be based, in part, on observations during pumping of the deep wells associated with the shallow collection system. Figure 4.22 shows a typical pumping well configuration.

### Cut-off Wall

The final component of the adaptive management strategy will be installation of a cut-off wall. This cut-off wall would be constructed if monitoring indicates that the shallow aquifer sump and deep aquifer pumping wells alone do not provide sufficient capture of contaminated groundwater.

The cut-off wall would be keyed into bedrock and extend a maximum length of the entire S-wells area, from just below the rock drain past the historic S-wells. Method of installation has not been

assessed but could be a grout slurry wall or steel sheet piles. Up-gradient of the cut-off wall, a shallow trench backfilled with permeable fill would be installed. Pumping wells would be installed in the permeable trench to collect contaminated groundwater. If deemed necessary, bedrock under the cut-off wall would be grouted to prevent bypass underneath the cut-off wall. See Figure 4.23 for the layout of this area.

### 4.2.13 Miscellaneous Closure Activities – Activity 108

There are number of miscellaneous closure activities at the Faro Mine Complex (FMC). These activities include, but are not limited to:

- Site road closures;
- Building demolition and reclamation;
- Hazardous material removal and contaminated soil reclamation; and
- Establish a landfarm for contaminated soil treatment.

There are number of site access roads that are not necessary post closure for maintenance and inspection. Some of these roads have associated culverts and stream crossings. The existing mill and administrative buildings will not be needed post-closure and will be a long-term safety hazard.

There are hazardous materials and contaminated soils around the plant site area that could cause long-term impact on the surrounding environment. There has been some sampling to identify soils contaminated with unacceptable levels of metal and hydrocarbons and any potentially acid generating soils in the mill area. Based on current testing results, all soils, including hydrocarbon contaminated soils, which contain high levels of metals, will be consolidated, relocated and covered. Investigations in 2004/2005 suggest that there is approximately 73,000 $m^3$ of hydrocarbon contaminated soil (light volatiles, diesel, oil and grease) and also metal contaminated soil (Pb and Zn) in the concentrate building and surrounding soil.

Any soils that are contaminated with only hydrocarbons will be treated at an on-site landfarm such as the Old Tank Farm. Once all hydrocarbon and metals contaminated soils have been removed, the mill area will be covered with rudimentary cover and revegetated. Some of the contaminated soil and waste may contain other chemicals. Any material contaminated with potentially hazardous chemical will be transported off site to a permitted disposal facility.

Under Best Practice Management, all the unnecessary roads should be reclaimed to prevent long-term erosion and crossings breached to prevent blockage. The buildings will be demolished along with their foundation. Only the contaminated foundation components will be removed for proper disposal while the clean foundations will be covered in place and revegetated.

All other hazardous wastes will be consolidated and transported off site for proper disposal. A hazardous materials audit has not been conducted. Due to clean-up activities during the care and maintenance period relatively little hazardous material remains on site.

Table 4.12 outlines the reclamation work for the miscellaneous closure activities.

**Table 4.12: Design Criteria for Miscellaneous Closure Activities**

| | |
|---|---|
| Road Closures | - All culverts and crossings will be breached and resloped<br>- Drainages to be restored<br>- Scarify road surface and revegetate |
| Buildings Demolition | - Demolition protocol will follow Federal and Territorial Codes |
| Bioremediation Cell or Landfarm | - Size: 50 x 250m<br>- Volume: up to 90,000$m^3$<br>- Liner: HDPE<br>- Location: to be determined |
| Hazardous Waste | - Type – acids, paints, oils, PCB's etc.<br>- Transport – regulated vehicles<br>- Destination – off site |

### Preliminary Design and Construction Methods

Road closure will be completed by an excavator scarifying the road surface and pulling back the safety berm onto the road. The revegetation will be carried out by a low-flying helicopter.

Prior to any demolition works, a full inspection will be performed on all site buildings to identify hazardous waste, salvageable materials, and structural safety concerns. All non-salvageable material and non-hazardous wastes will be buried within the toe of the resloped waste rock dump. Salvageable materials and hazardous wastes will be transported off-site for proper disposal. The building demolition will be mostly performed by special excavators with thumb and claw, and jackhammer attachments. Cranes and loaders will also be needed for heavier components. The contaminated foundation will be broken up and buried in the contaminated waste pile or landfarm, depending on the contaminant. Clean foundation will be left in place and covered with 1m of loose growth medium and revegetated with an application by a low-flying helicopter.

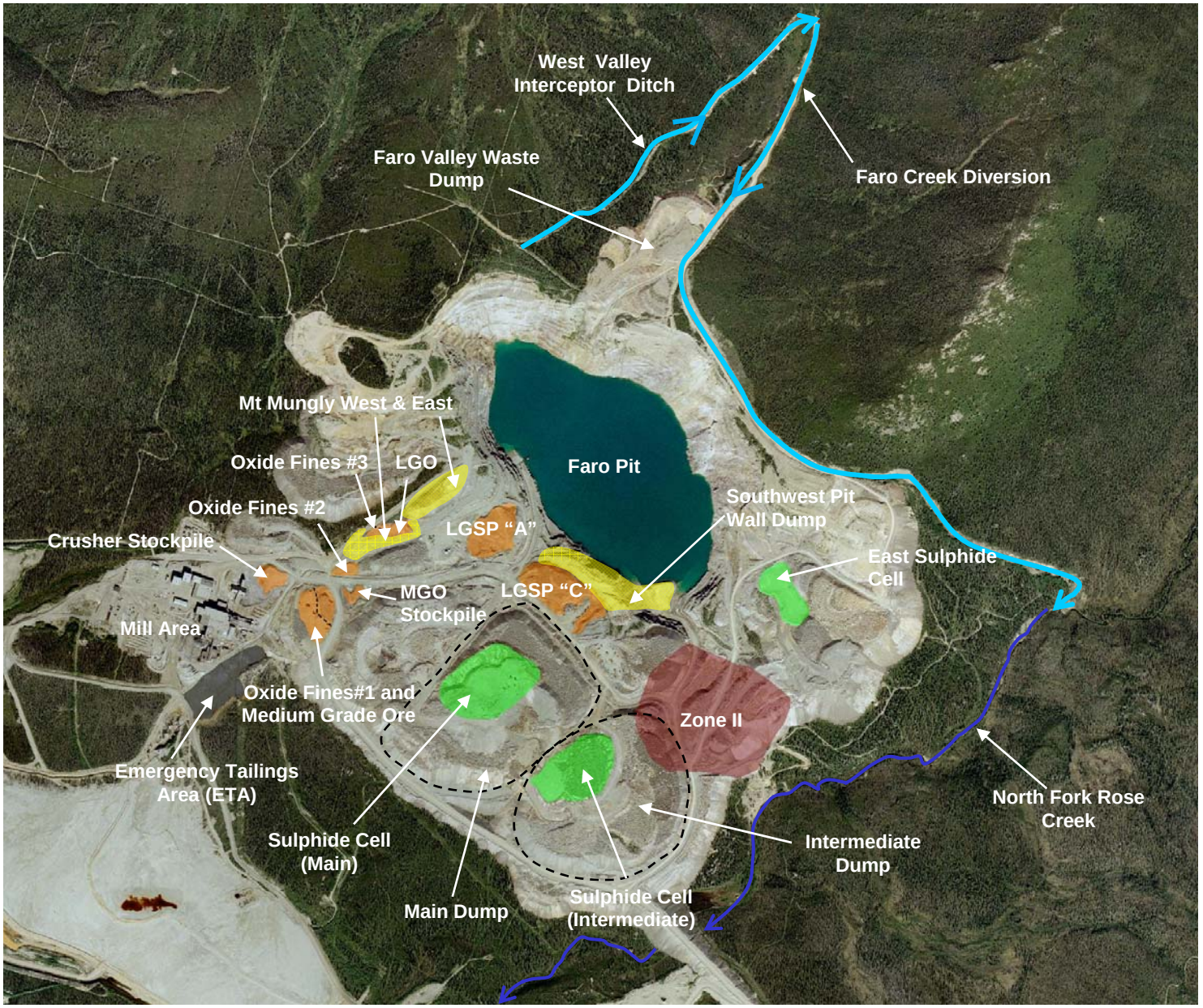
A designated contaminated soil disposal area will be established, most likely, within the mill area shown in Figure 4.24. All metals contaminated soil in the mill area will be consolidated at this location. Consolidation will be carried out with a load, haul, and dump operation using a high capacity truck fleet such as CAT 777 off-road haul trucks. The depth of material to be moved will be based on further test pitting in designated areas. After the consolidation, the contaminated disposal area pile will be graded to no steeper than 3H:1V slopes, and capped with a low infiltration soil cover. The cover will be placed in 0.5m lifts and the first 1.0m of cover will be highly compacted using a vibratory drum compactor. The second 1.0m lift will be lightly compacted as this layer will be reseeded and fertilized using a low-flying helicopter.

A landfarm will be constructed on site for hydrocarbon contaminant treatment. The location has not been confirmed but is likely to be on a waste rock dump near the mill site. The facility will be lined and sized according to the amount of estimated waste. The current estimated size of the landfarm is 50m x 250m x 2m, with allowance to be adjusted during detailed engineering. This area will handle roughly 90,000$m^3$ of contaminated soil in four batches. The lining system would be a 1.5mm HDPE

liner sandwiched between two layers of 542g/$m^2$ non-woven geotextile. Granular soil cushioning layers will be deployed as base and topping cap in the landfarm. A dose of fertilizer will be spread over the initial contaminated soil to facilitate bacteria growth. The landfarm will require minimum maintenance to mix the contaminated soil for thorough treatment. Testing will be performed on the material to ensure it is neutral prior to applying a final closure cover with 1m of growth medium.

Once the consolidation and cover of the contaminated soil pile is complete and all hydrocarbon contaminated material has been removed, the mill area will be regraded to no steeper than 3H:1V where practical. The area will be covered with rudimentary cover hauled from the Grum Overburden dump using CAT 777 Haul Trucks and placed in 0.5m lifts. The lifts will be levelled with a dozer and lightly compacted with a vibratory drum compactor. The cover will be seeded and fertilized using a low-flying helicopter.

# Figures




LEGEND

LGO - Low Grade Ore
LGSP – Low Grade Stockpile
MGO – Medium Grade Ore

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Faro Mine Closure
Fermeture de la mine Faro

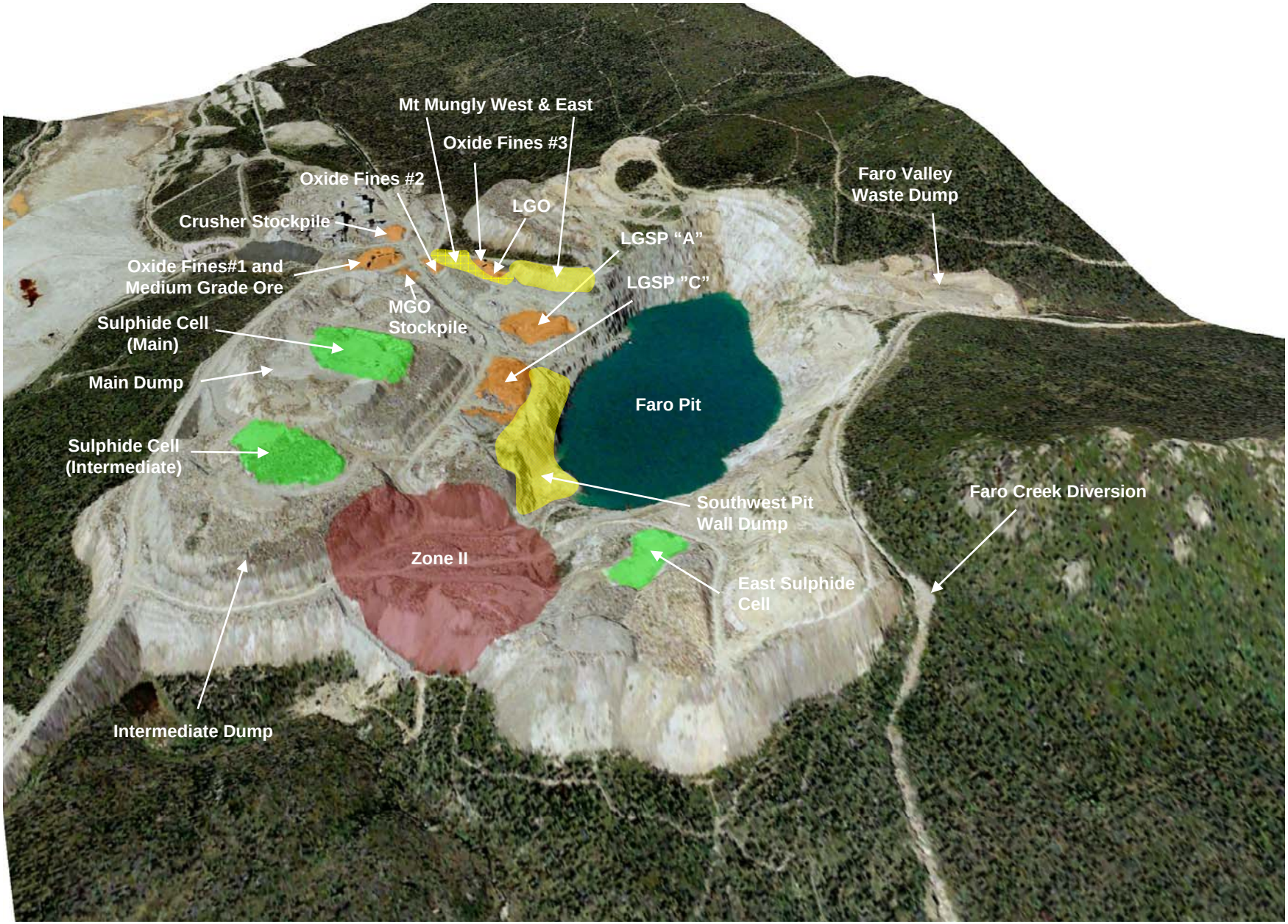
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Filename: Figures_4.1-6_Faro Mine_20091127.ppt

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**Site Plan**
**(Current Conditions)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.1** |




LEGEND

LGO - Low Grade Ore
LGSP – Low Grade Stockpile
MGO – Medium Grade Ore

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Job No: 1CY001.026
Filename: Figures_4.1-6_Faro Mine_20091127.ppt

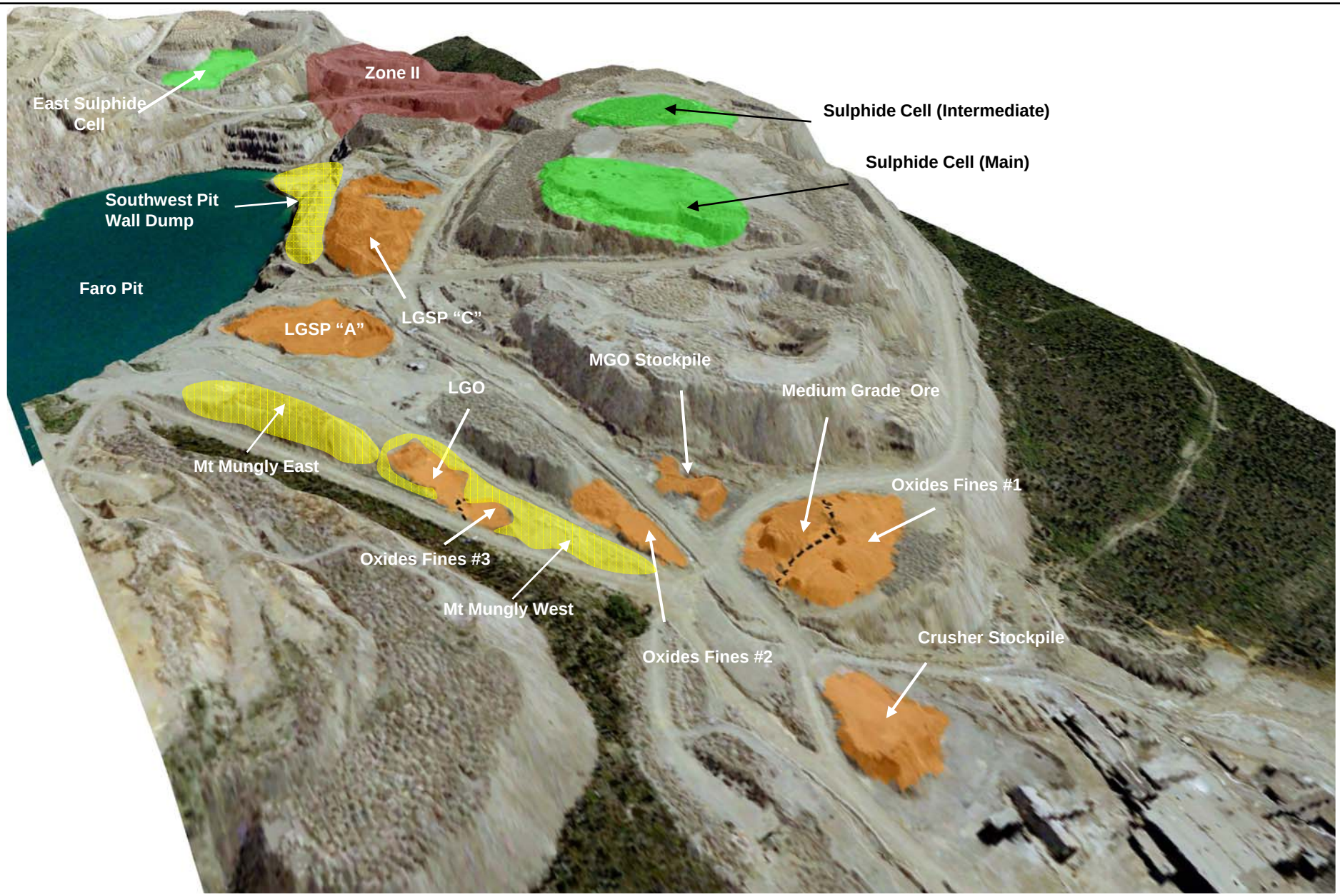
Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**Waste Dump**
**(Current Conditions)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.2** |




LEGEND

LGO - Low Grade Ore
LGSP – Low Grade Stockpile
MGO – Medium Grade Ore

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Faro Mine Closure
Fermeture de la mine Faro

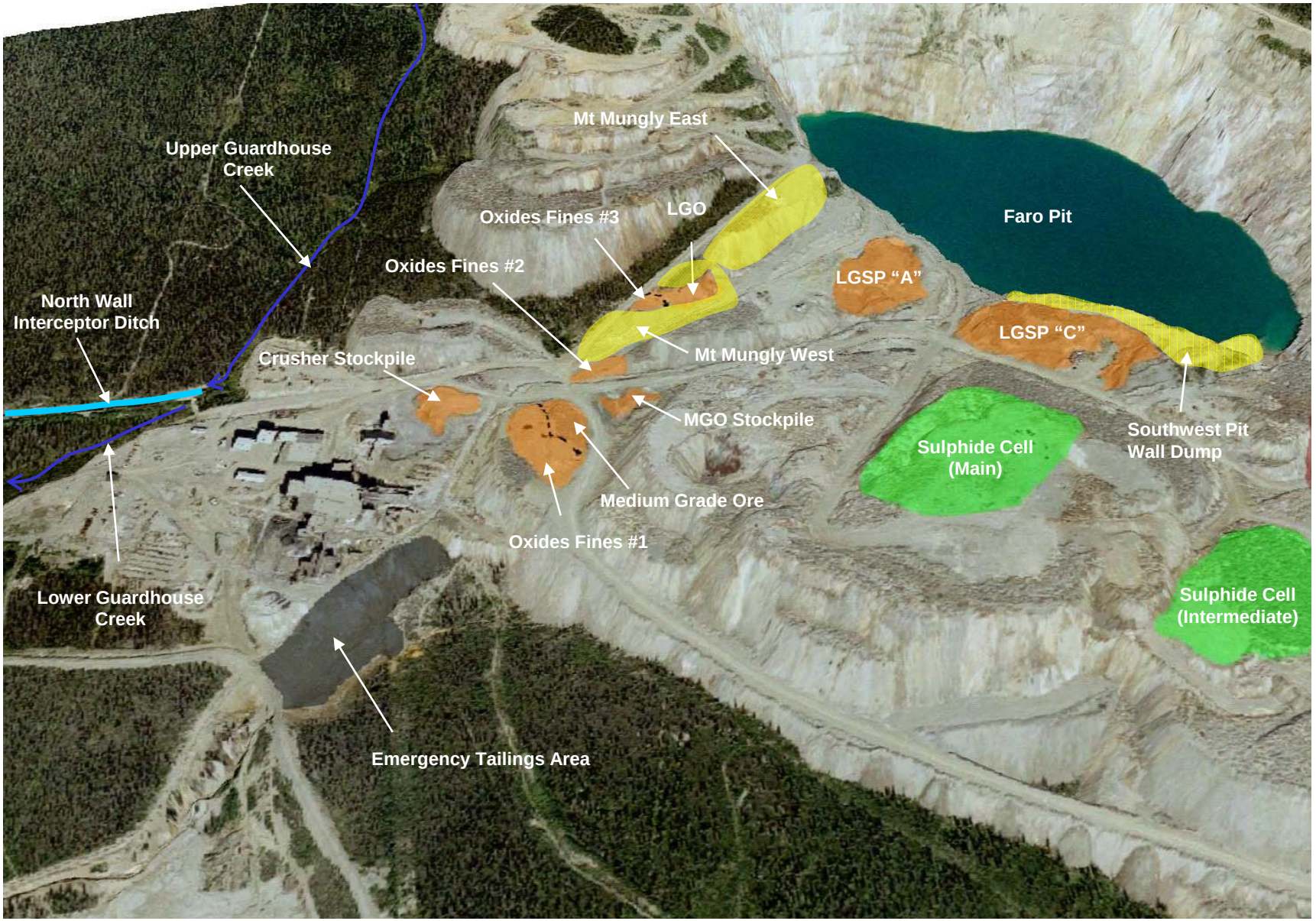
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**Oxide Fines and Low Grade Ore Stockpiles (Current Conditions)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.3** |




LEGEND

LGO - Low Grade Ore
LGSP – Low Grade Stockpile
MGO – Medium Grade Ore

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Job No: 1CY001.026
Filename: Figures_4.1-6_Faro Mine_20091127.ppt

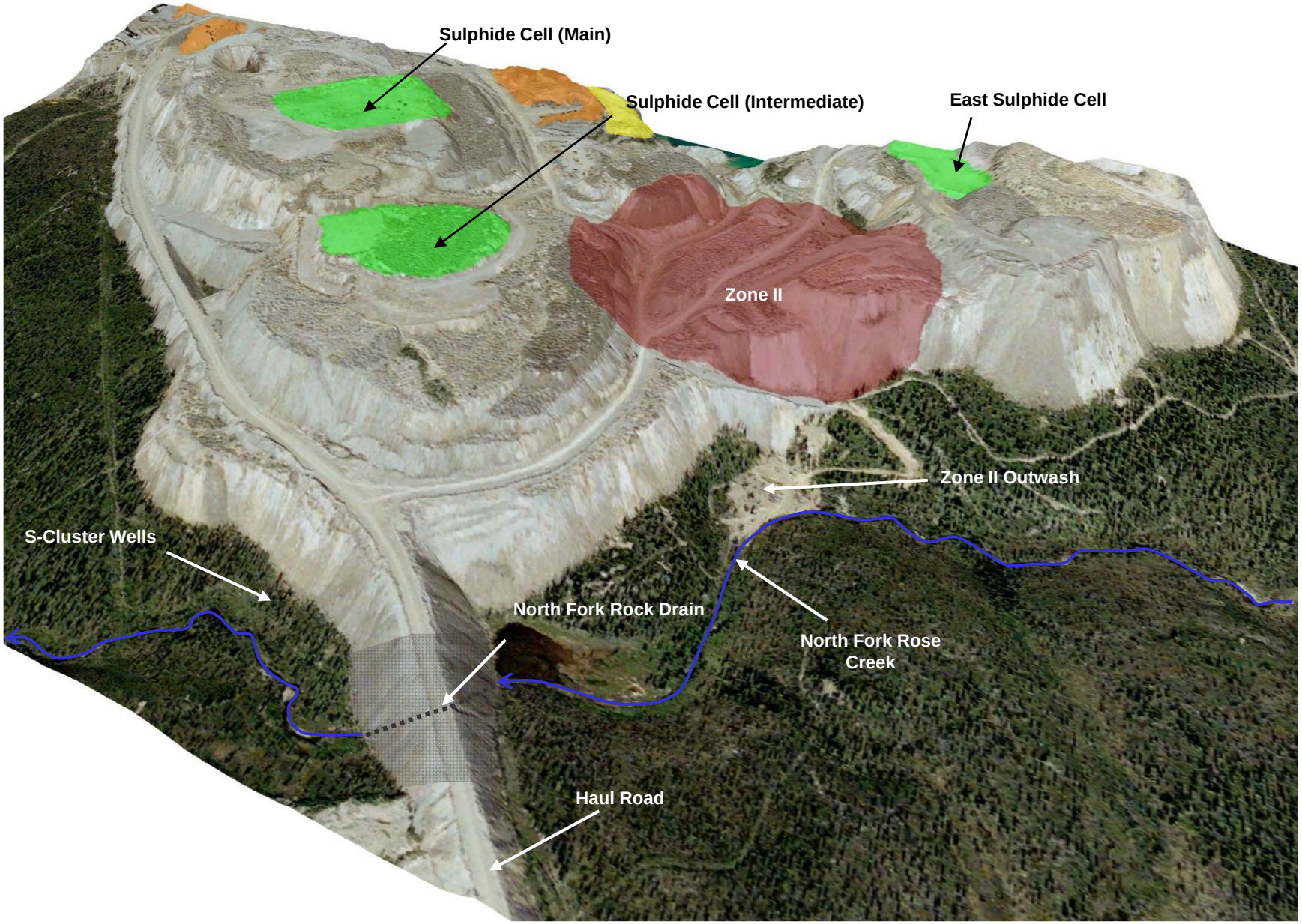
Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**Emergency Tailings Area**
**(Current Conditions)**

Date: December 2009
Approved:
Figure: **4.4**




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Faro Mine Closure
Fermeture de la mine Faro

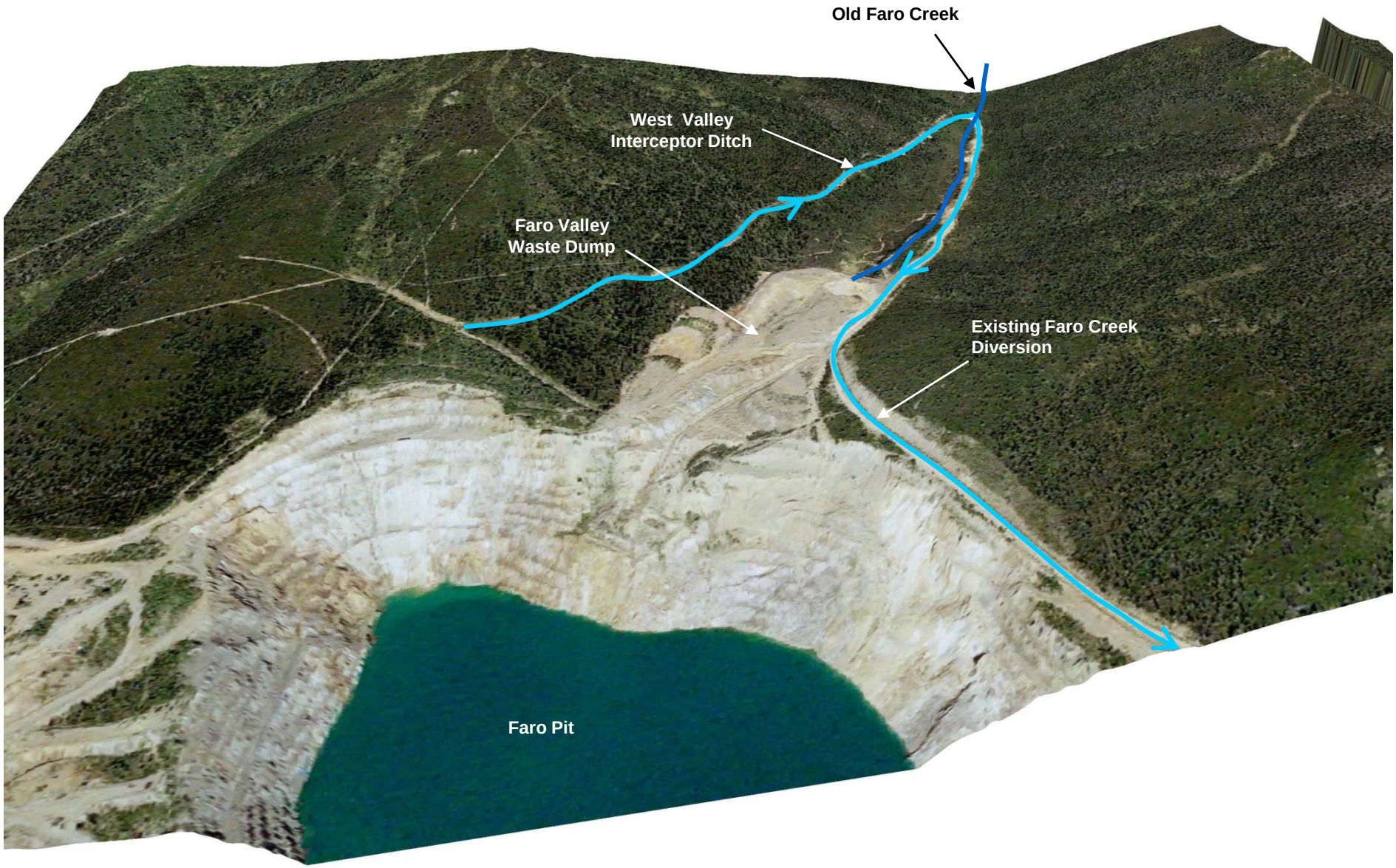
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**S-Wells and Zone II Outwash**
**(Current Conditions)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.5** |




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Faro Mine Closure
Fermeture de la mine Faro

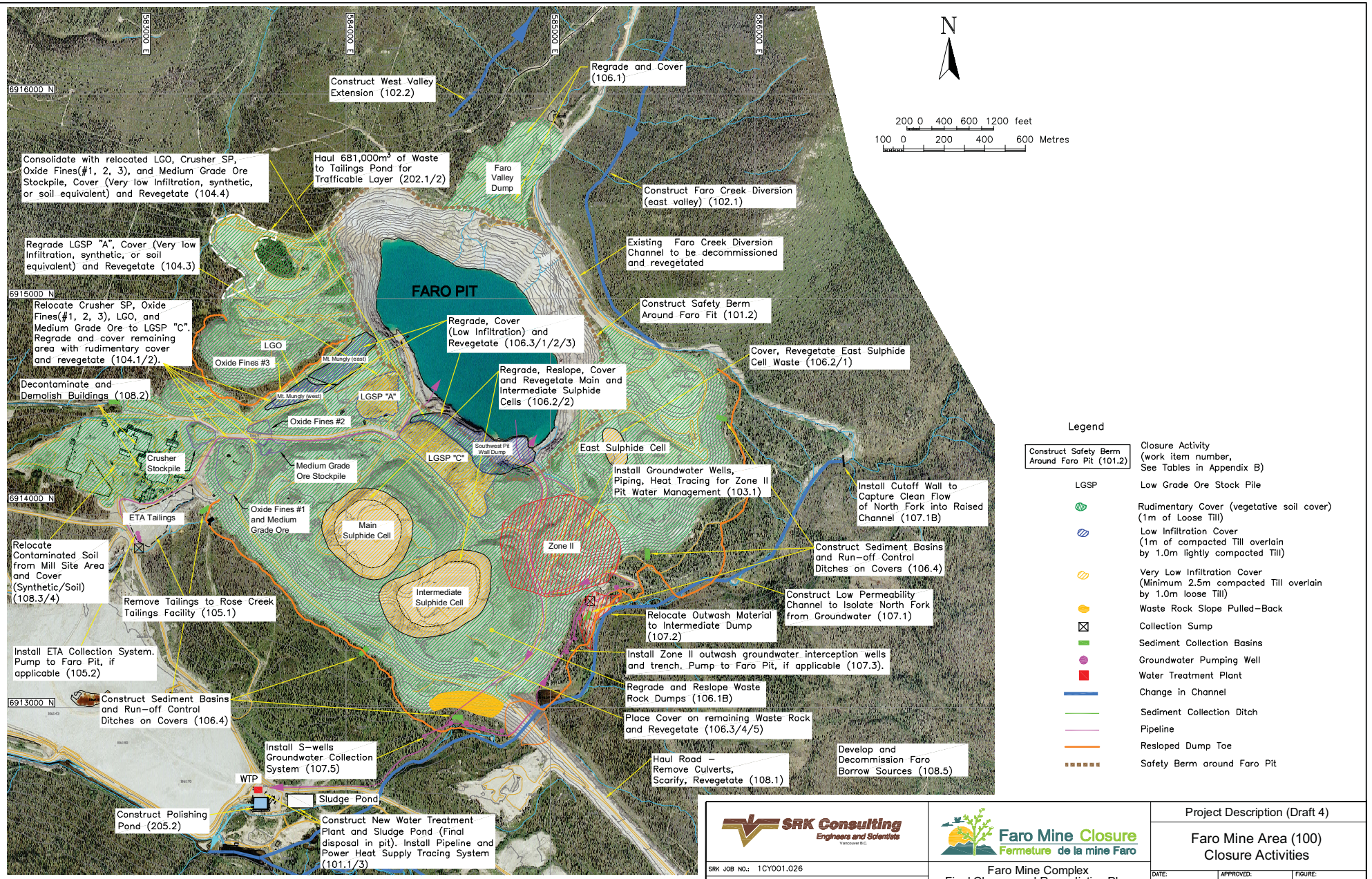
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Faro Mine Area (100)**
**Faro Creek Diversion**
**(Current Conditions)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.6** |




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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-2D_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

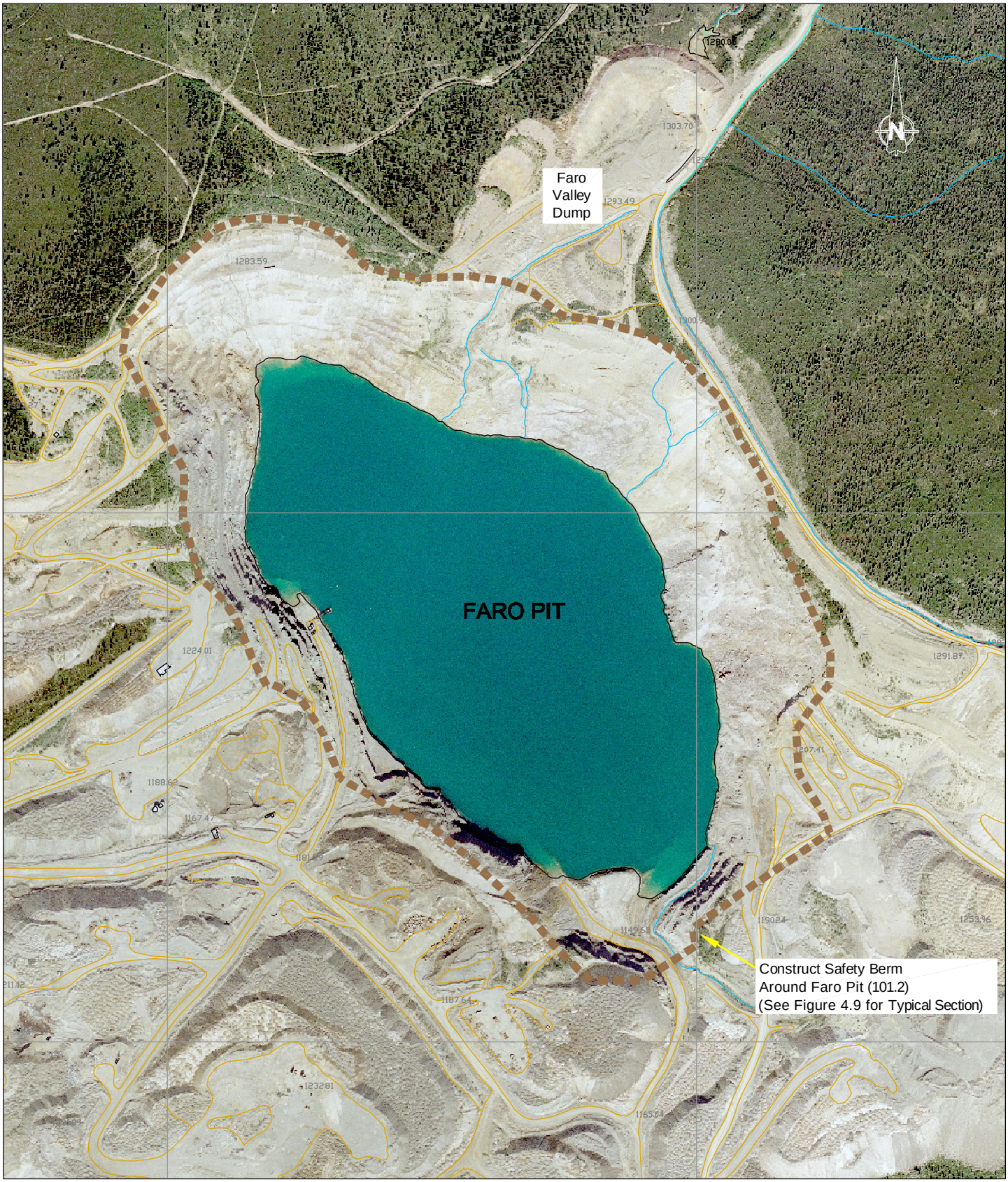
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

# Faro Mine Area (100) Closure Activities

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.7 |

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## NOTES

1. Projection is UTM Zone 8; Datum NAD27.
2. All units in metres, unless noted otherwise.

0 100 200 300 400 500

Scale in Metres

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Faro Mine Closure
Fermeture de la mine Faro

Project Description (Draft 4)

Safety Berm (Plan)

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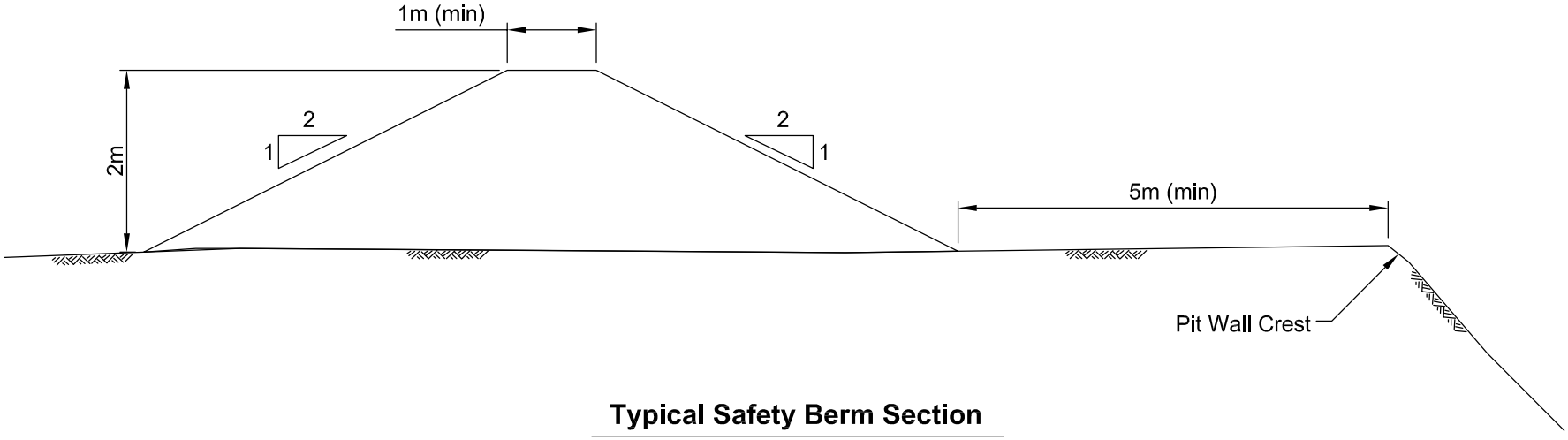
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Faro Mine Complex
Final Closure and Remediation Plan

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.8 |

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## Typical Safety Berm Section

0 1 2 3 4 5

Scale in Metres

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FILE NAME: 1CY001_026-11_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

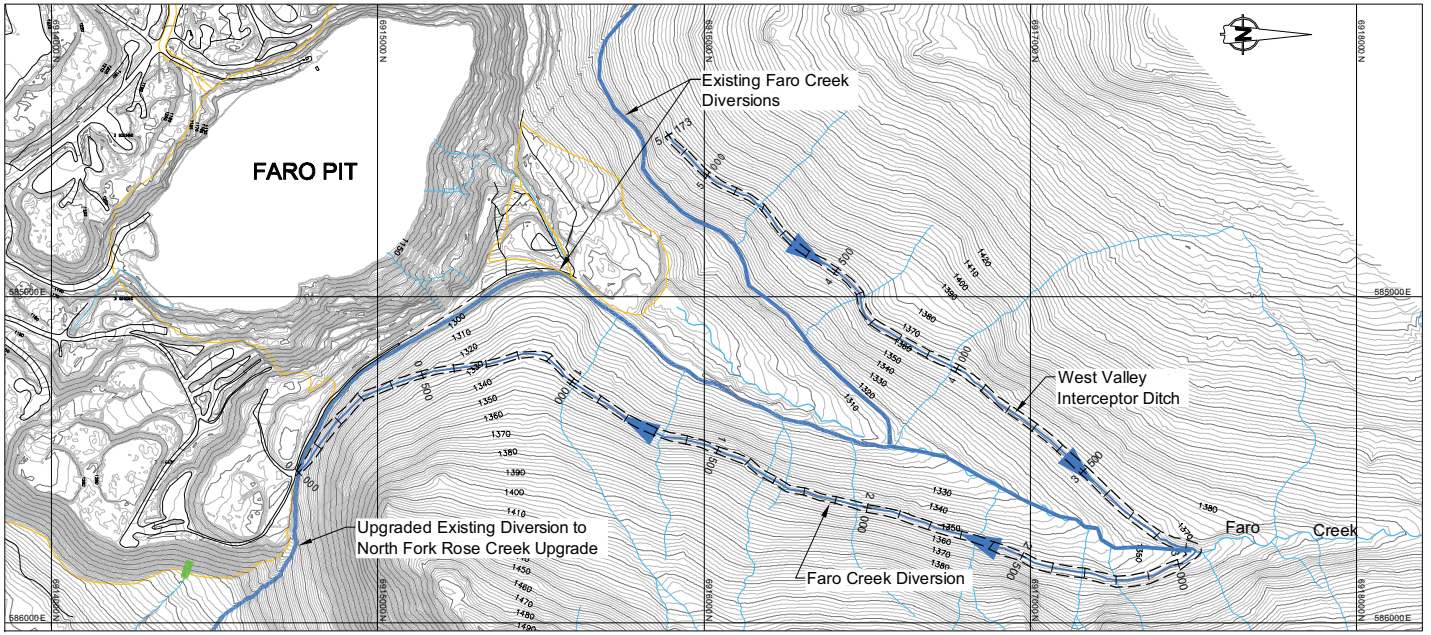
Project Description (Draft 4)

Safety Berm Section
(101.2)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.9 |

**NOTES**

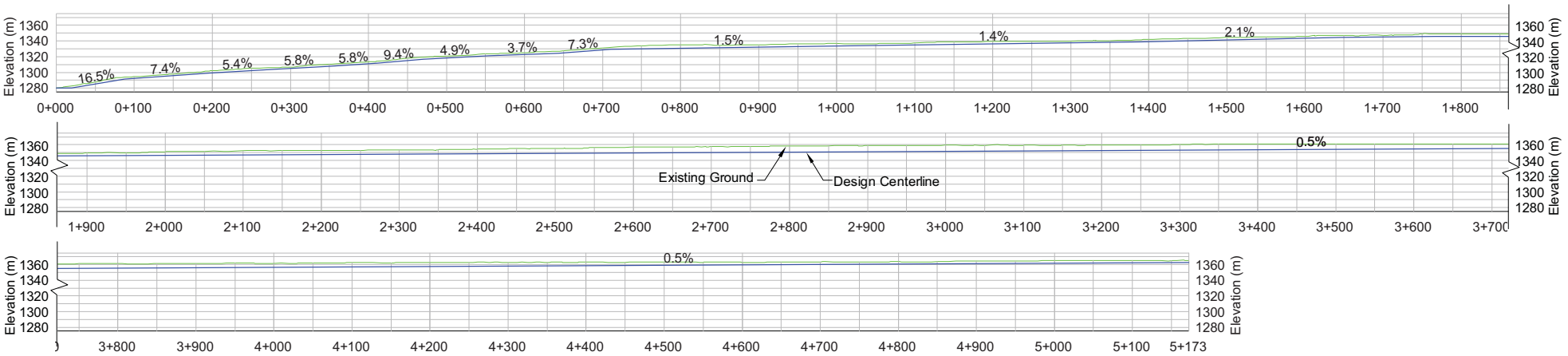
1. Projection is UTM Zone 8; Datum NAD27.
2. All units in metres, unless noted otherwise.




Note: See Figure 4.11 for typical section.

**Faro Creek Diversion Channel - Plan**

0 150 300 450 600 750
Scale in Metres




**Faro Creek Diversion Channel Profile**

0 50 100 150 200 250
Scale in Metres

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FILE NAME: 1CY001_026-12_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Faro Creek Diversion Channel Plan and Profile (102.1)

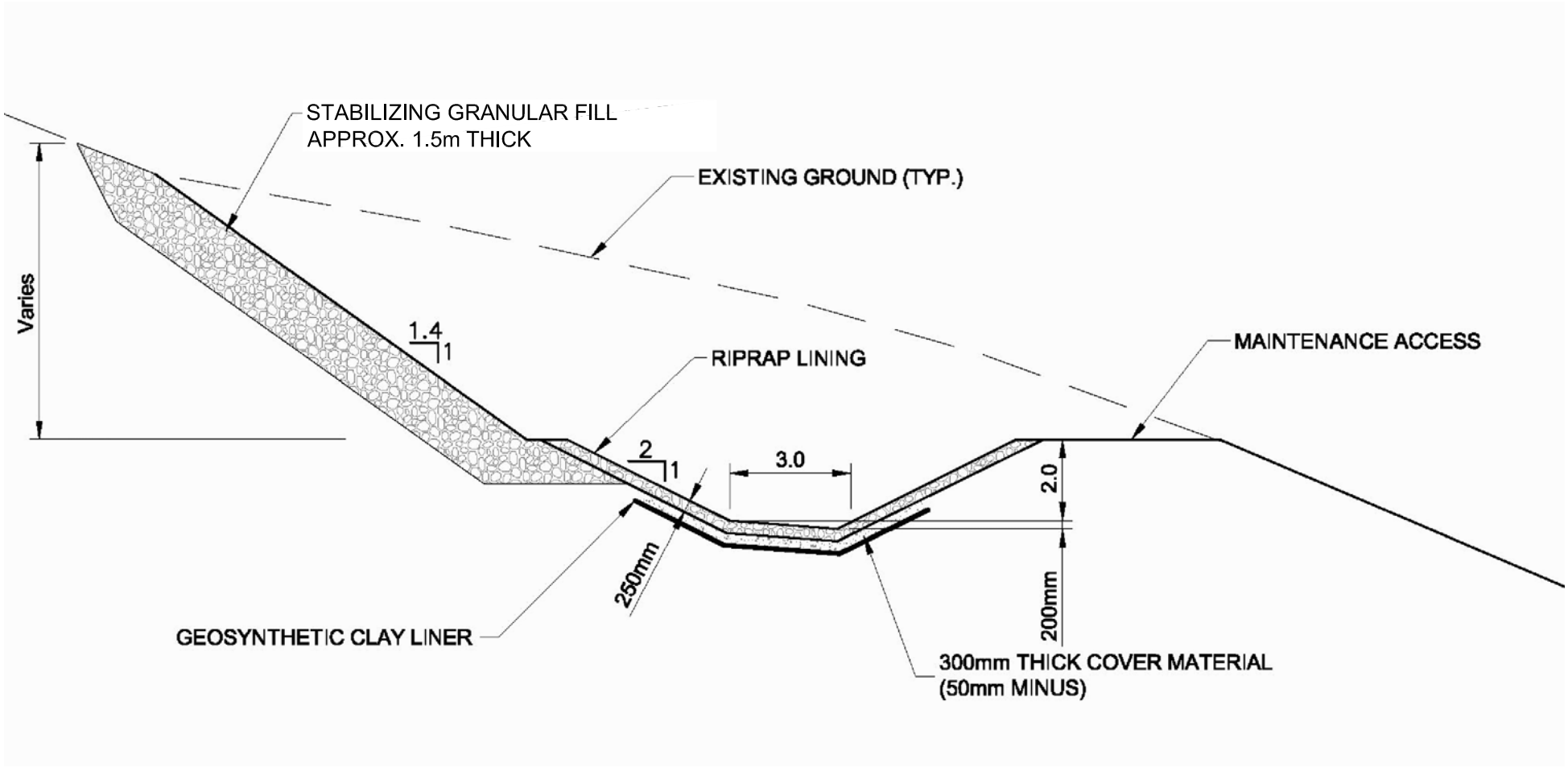
| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 4.10 |

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Catchment Area = 15.8km$^2$
Design Peak Flow $Q_{500}$ = 27m$^3$/s

NOTE: Channel to be designed with an emergency overflow redirect system to send the PMF into the pit ($Q_{PMF}$ = 150m$^3$/s)




0 1 2 3 4 5
Scale in Metres

## REFERENCE

Section obtained from Golder report titled "Detailed Comparision of Alternatives for the Relocation of the Faro Creek Diversion", dated February 5, 2004, with job number 022-1497/4000.

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FILE NAME: 1CY001_026-9_Rev_A.dwg

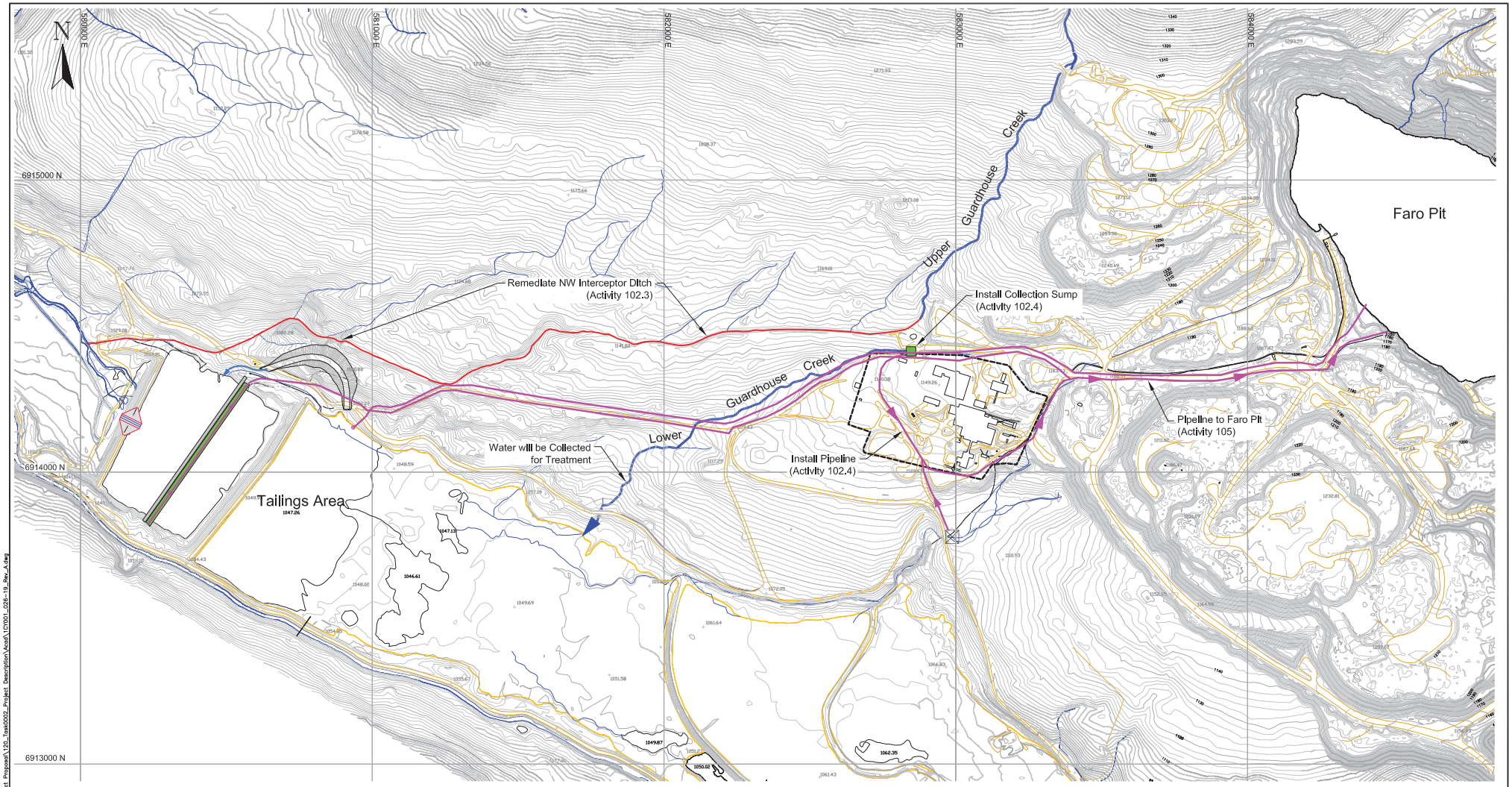
Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

# Typical Channel Section (102.2)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.11 |




## PLAN VIEW OF NORTHWALL INTERCEPTOR CHANNEL

0 100 200 300 400 500
Scale In Metres

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FILE NAME: 1CY001_026-19_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

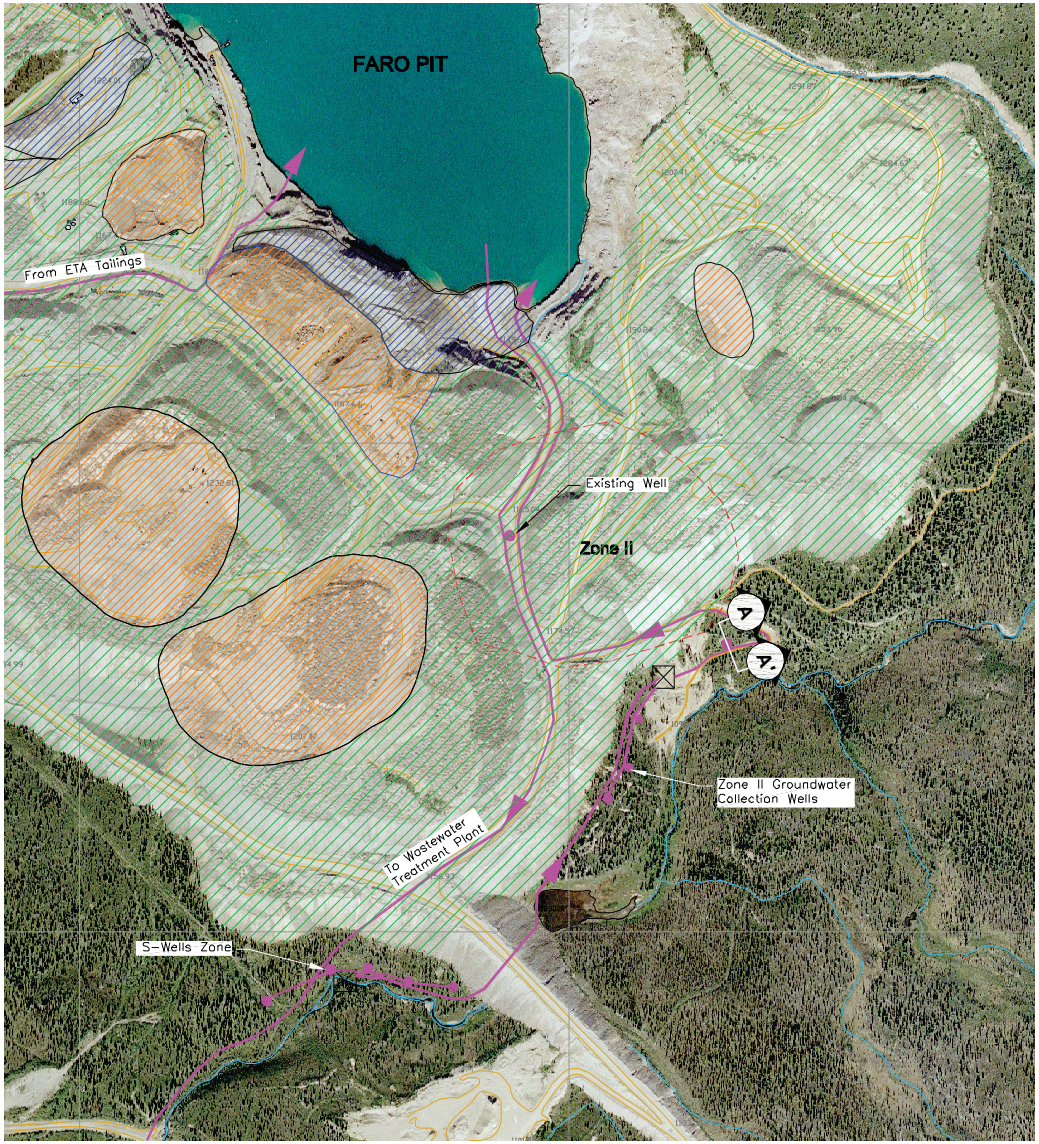
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Guardhouse Creek and North Wall Interceptor Ditch Channel Design (102.3/4)

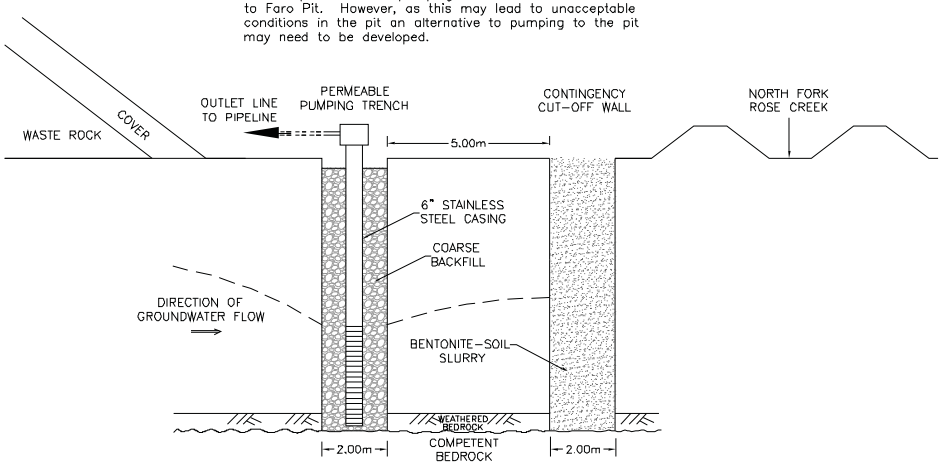
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| December 2009 | PMH | 4.12 |

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N

Note: Current plan calls for pumping the contaminated water back to Faro Pit. However, as this may lead to unacceptable conditions in the pit an alternative to pumping to the pit may need to be developed.




A Seepage Collection System Schematic
NTS

Legend

- Pumping Trench
- Groundwater Pumping Well
- Pipeline

0 100 200 300 400 500
Scale in Metres

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FILE NAME: 1CY001_026-4_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

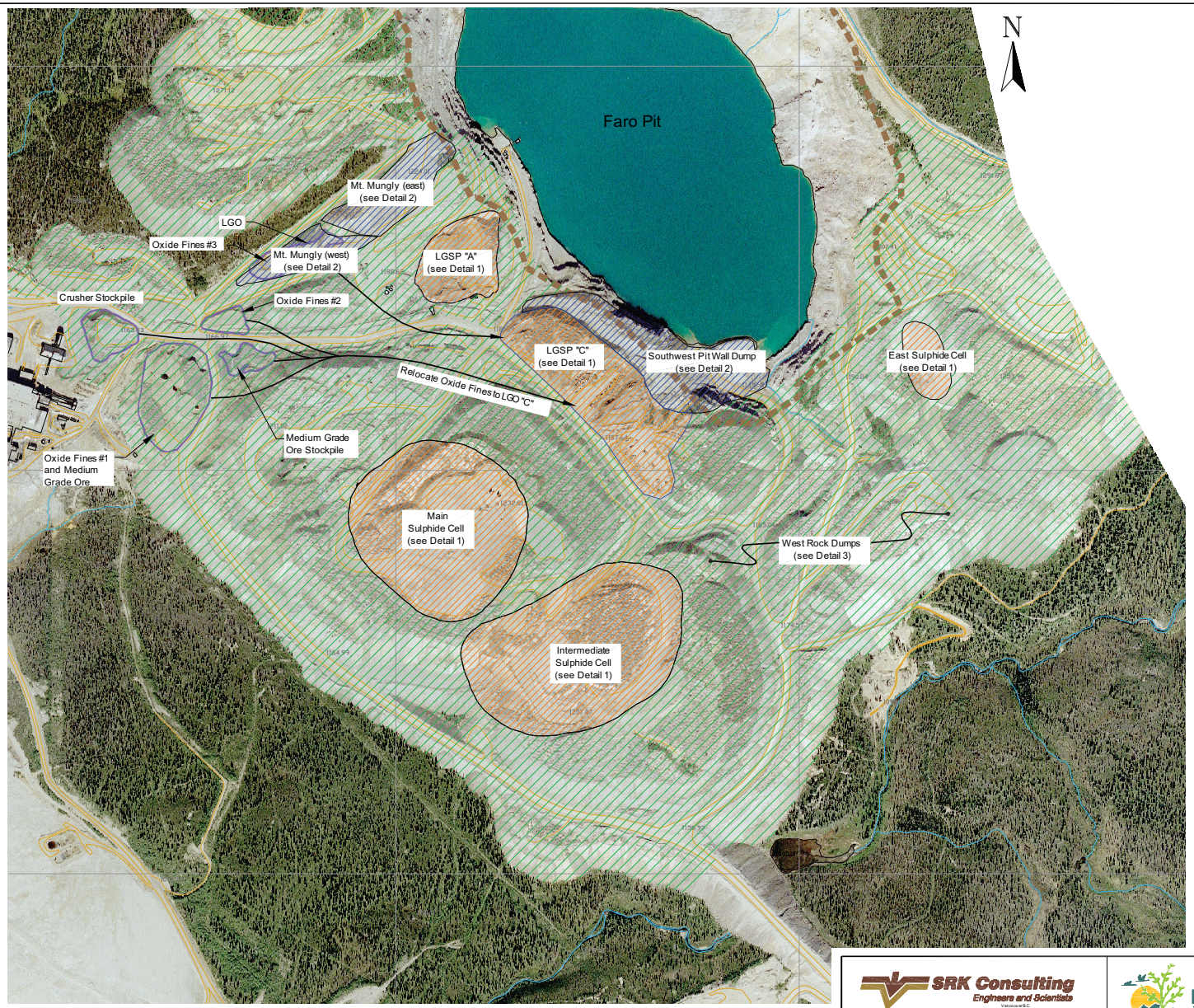
Faro Mine Complex
Final Closure and Remediation Plan

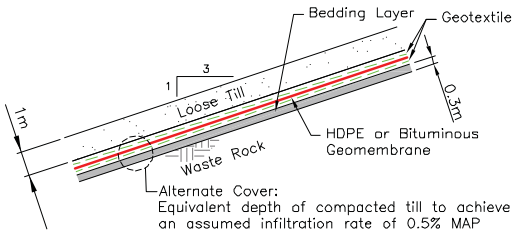
Project Description (Draft 4)

Zone II Pit Outwash Removal and Groundwater Collection Systems (107.2/3)

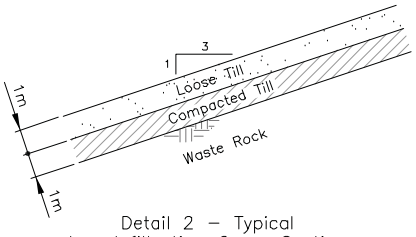
| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 4.13 |

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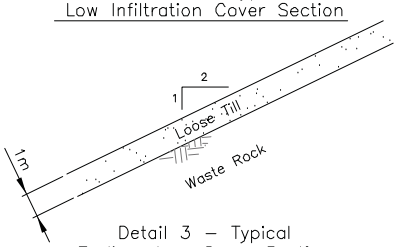



Detail 1 – Typical Very Low Infiltration Cover Section




Detail 2 – Typical Low Infiltration Cover Section




Detail 3 – Typical Rudimentary Cover Section

0 2 4 6 8 10
Scale in Metres

## Legend

| | |
|---|---|
| LGO | Low Grade Ore |
| LGSP | Low Grade Ore Stockpile |
| | Very Low Infiltration Cover and resloping location. (See Detail 1) |
| | Low Infiltration Cover and resloping location. (See Detail 2) |
| | Rudimentary Cover and resloping location. (See Detail 3) |

## Note

Final selection of cover type is still subject to further review upon technical evaluation.

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FILE NAME: 1CY001_026-4_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

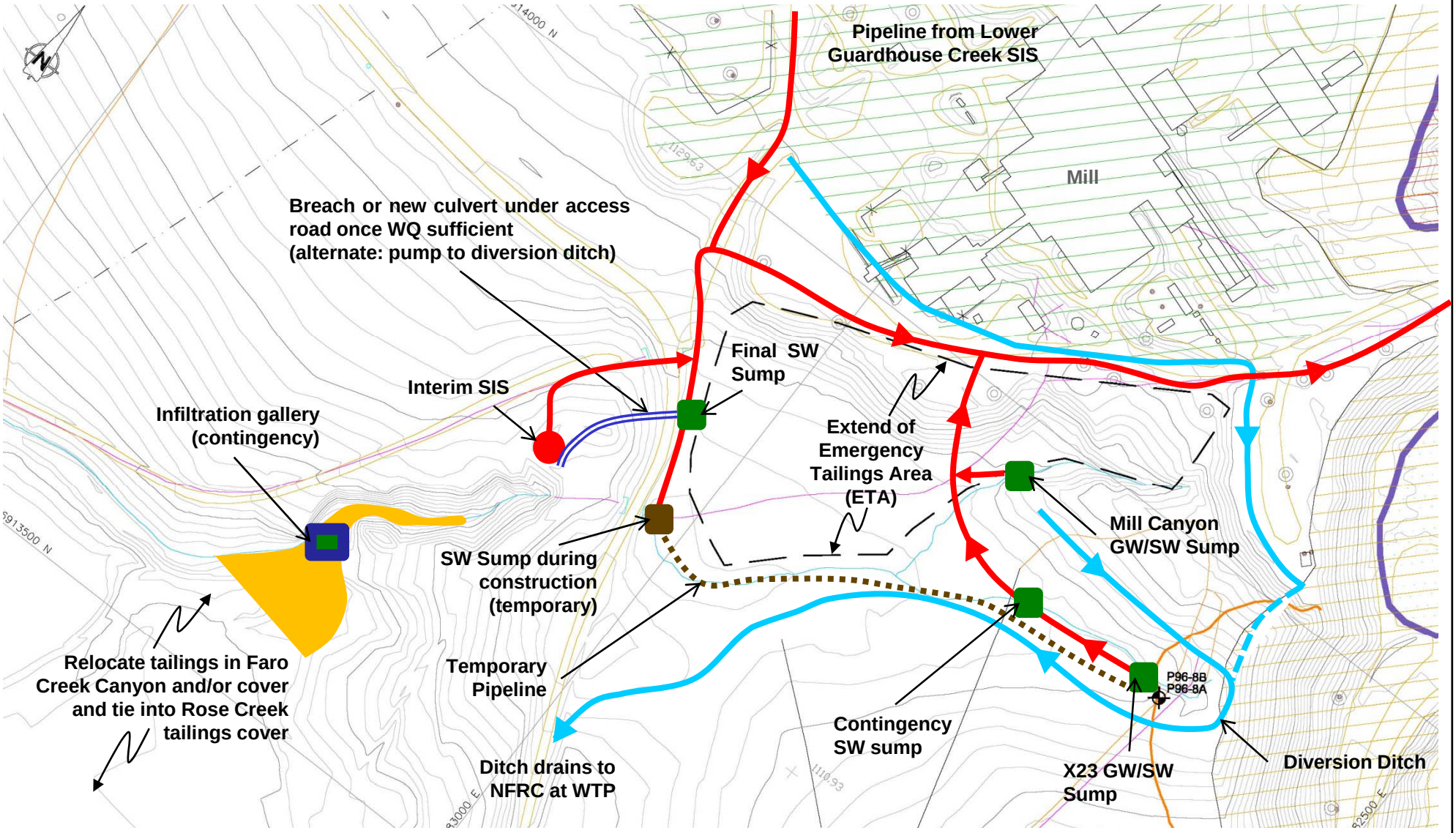
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

# Cover Details for Waste Rock, Sulphide Cells and Oxide Fines (104 / 106)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.14 |

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Faro Mine Closure
Fermeture de la mine Faro

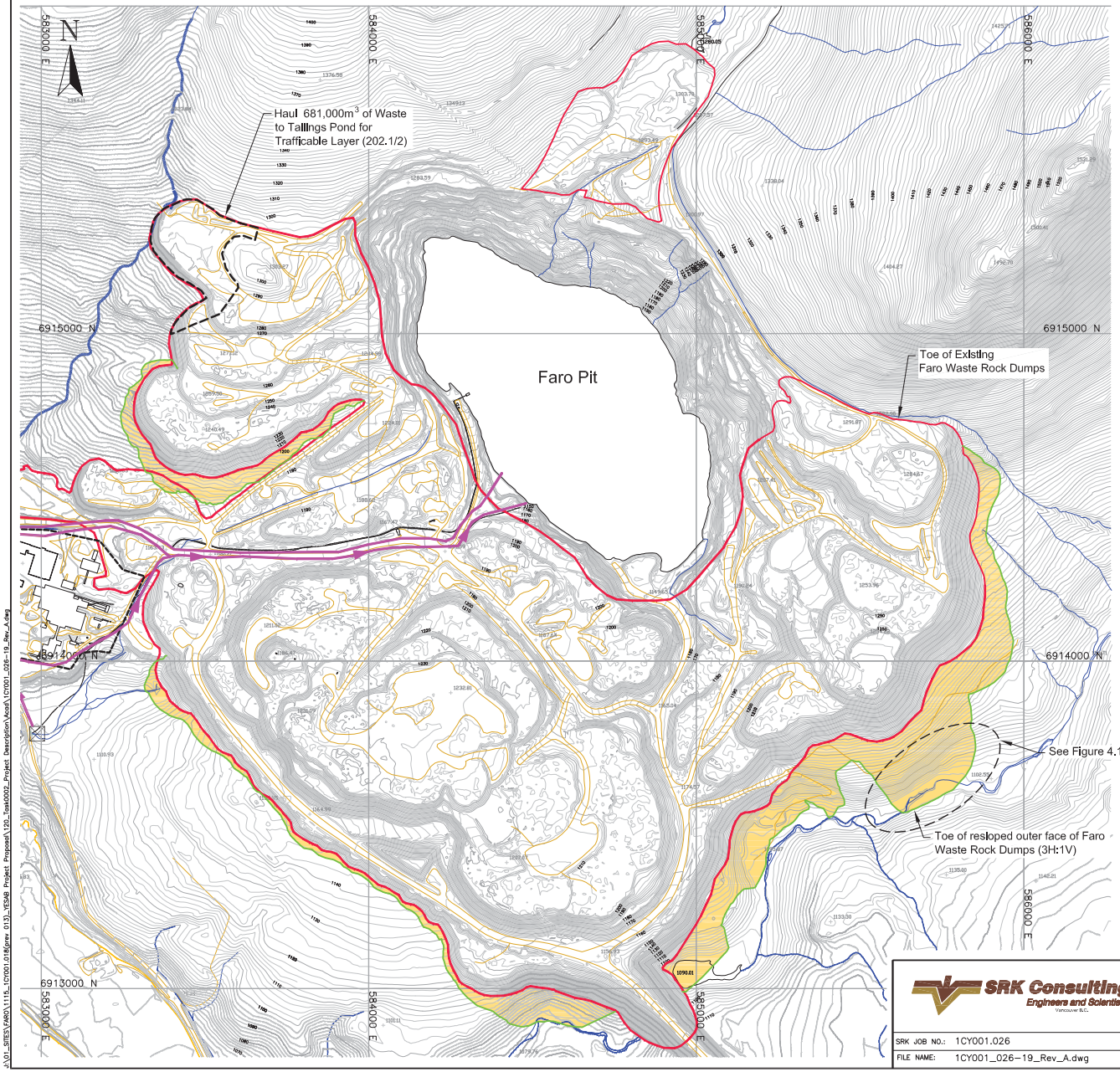
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Faro Mine Complex
Closure and Remediation Plan

Project Description (Draft 4)

**Emergency Tailings Area SIS Plan (105)**

| Date: | Approved: | Figure: |
|---|---|---|
| March 2010 | | **4.15** |




## LEGEND

- Waste Dump Boundary before Re-sloping
- Waste Dump Boundary after Re-sloping
- Area of Re-sloping Disturbance (Total Area Disturbed = 350,000m²)

0 100 200 300 400 500
Scale In Metres

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FILE NAME: 1CY001_026-19_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

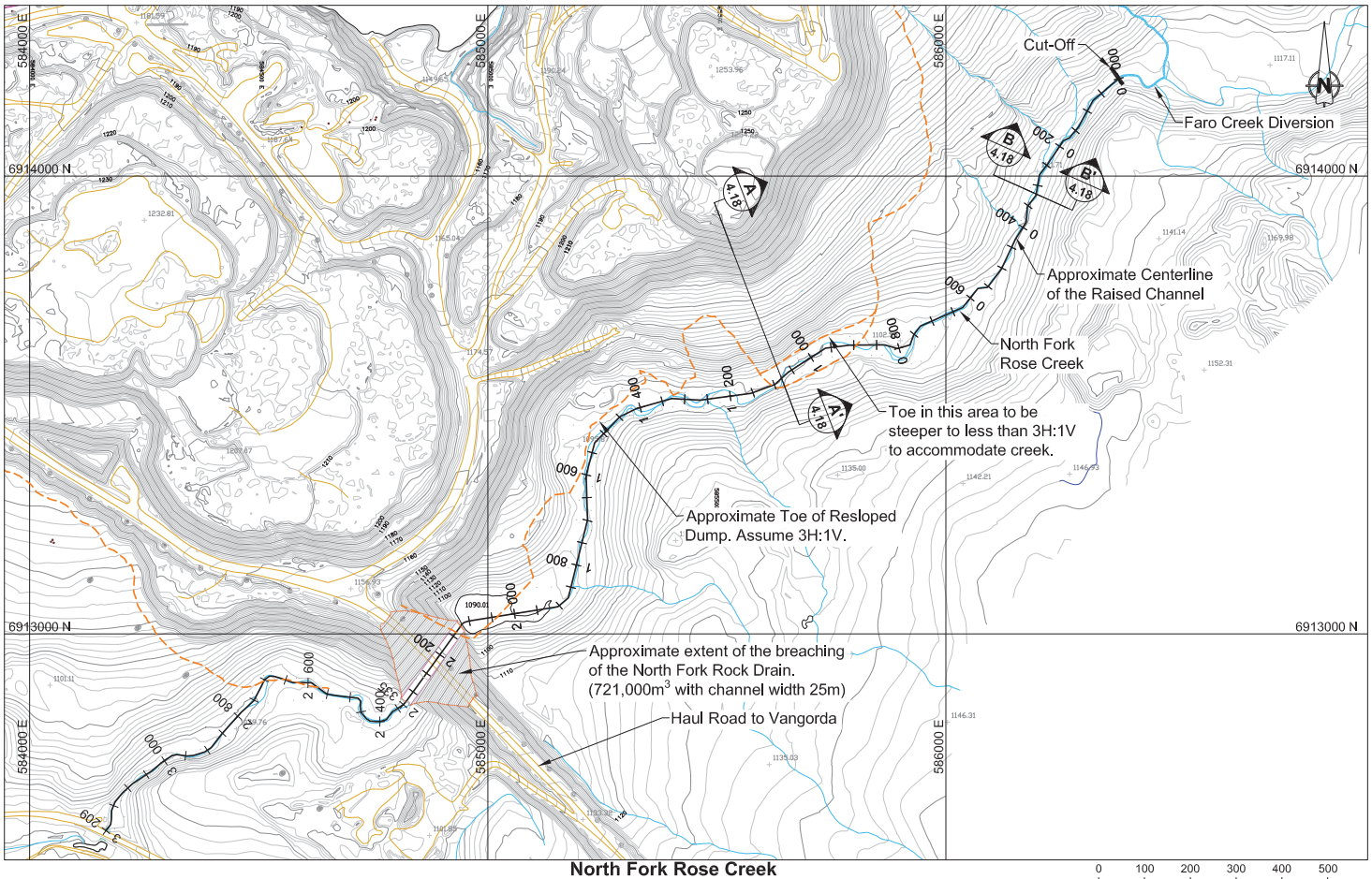
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Estimated Area of Disturbance

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.16 |

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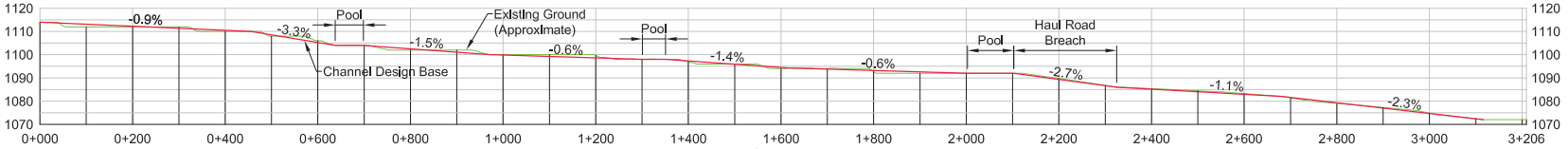



NOTE:

Centreline of raised channel would be offset from existing channel to allow construction.

**North Fork Rose Creek**
**Raised Channel Plan View**

0 100 200 300 400 500
Scale in Metres




**North Fork Rose Creek**
**Raised Channel Profile**

0 100 200 300 400 500
Scale in Metres
Vertical Exaggeration 5x

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FILE NAME: 1CY001_026-21_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

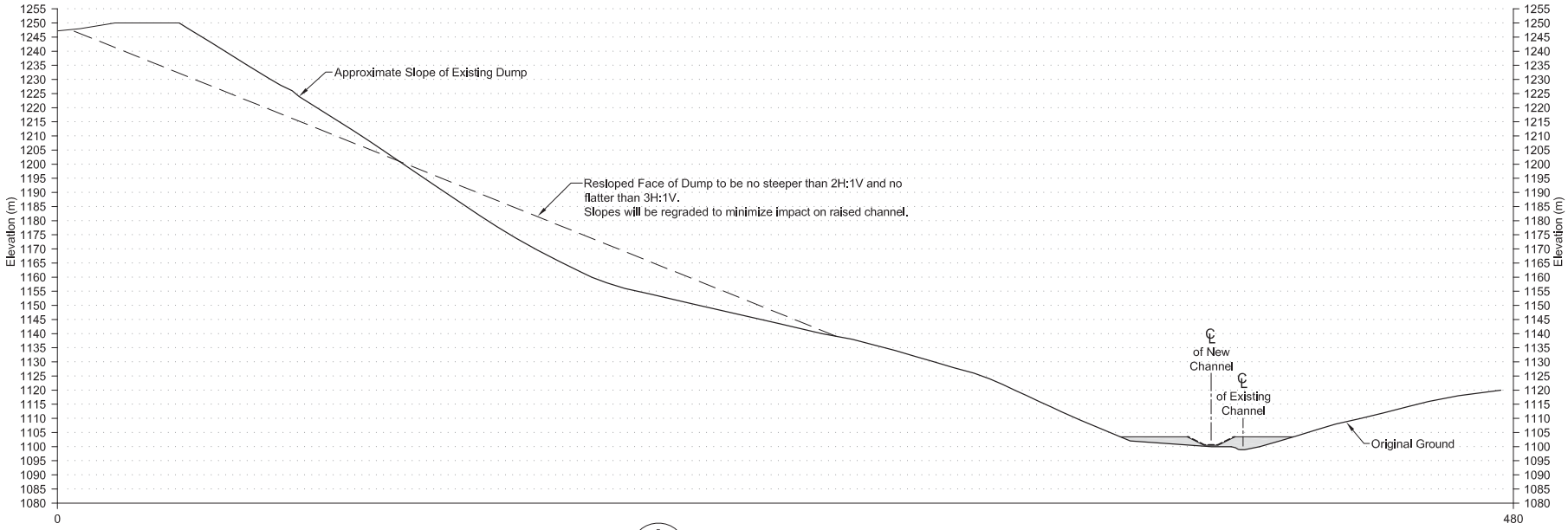
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

North Fork Rose Creek
Raised Channel
Plan and Profile

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.17 |

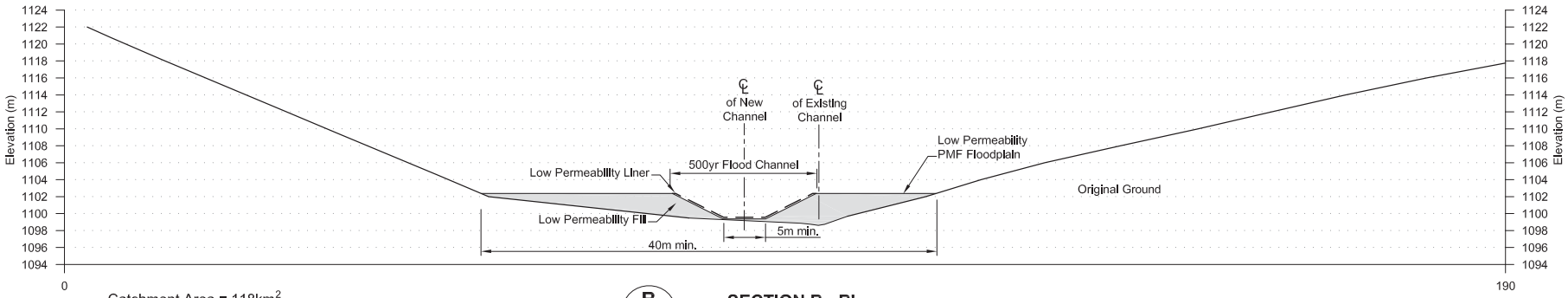
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A 4.17 **SECTION A - A'**

0 10 20 30 40 50

Scale In Metres




Catchment Area = 118km$^2$
Inner Channel Design Peak Flow $Q_{500}$ = 81m$^3$/s
PMF Design Peak Flow $Q_{500}$ = 386m$^3$/s

B 4.17 **SECTION B - B'**

0 5 10 15 20 25

Scale In Metres

NOTE:

Centreline of raised channel would be offset from existing channel to allow construction.

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FILE NAME: 1CY001_026-21_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

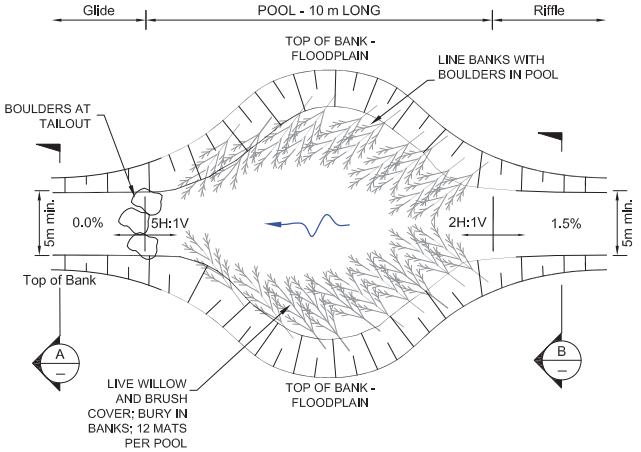
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

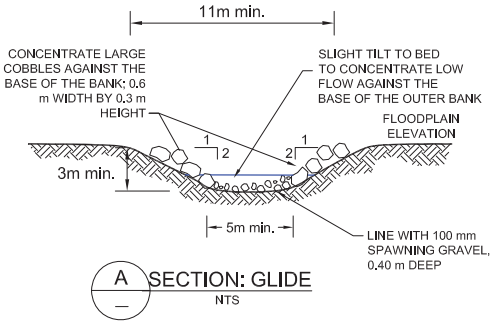
North Fork Rose Creek
Raised Channel
Sections

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.18 |

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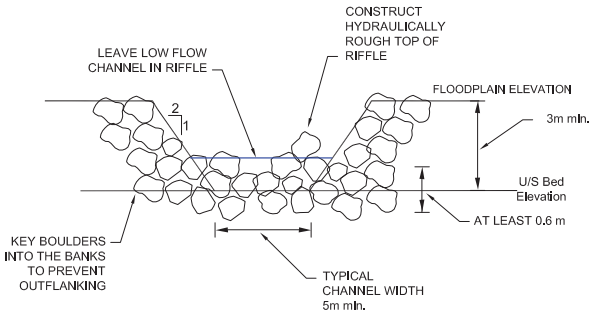



TYPICAL STREAM POOL - PLAN VIEW
NTS




A SECTION: GLIDE
NTS

GLIDE CONSTRUCTION NOTES:
1) LINE BED WITH 0.4 m DEEP, 100 mm ROUNDED SPAWNING GRAVEL.
2) LINE BANKS WITH 300 mm PLUS ROUNDED BOULDERS, 0.6 m HIGH 0.3 m WIDTH; 0.4 m³ BOULDERS PER UNIT LENGTH (BOTH BANKS), 4 m³ PER GLIDE.
3) USE EXCESS BOULDERS AS RANDOMLY SPACED COVER IN CENTRE OF CHANNEL.
4) SLIGHT TILT TO BED TO OUTSIDE OF BEND TO CONCENTRATE LOW FLOW AGAINST BASE OF BANK.




B SECTION: RIFFLE
NTS

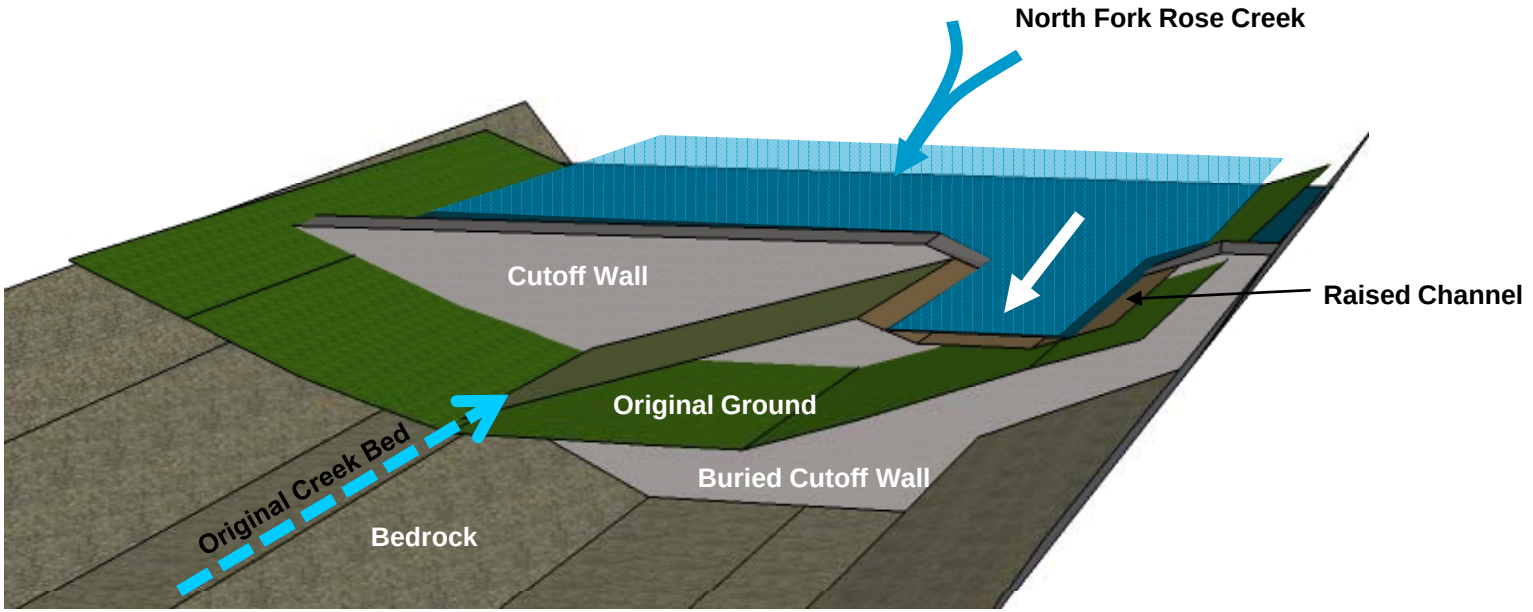
RIFFLE CONSTRUCTION NOTES:
1) CONSTRUCT RIFFLE CREST ELEVATION 0.2 m ABOVE UPSTREAM BED ELEVATION.
2) KEY RIFFLE 0.60 m INTO THE BED.
3) USE 300 mm PLUS, ROUNDED BOULDERS TO CONSTRUCT RIFFLE.
4) 10 m³ BOULDERS REQUIRED PER RIFFLE

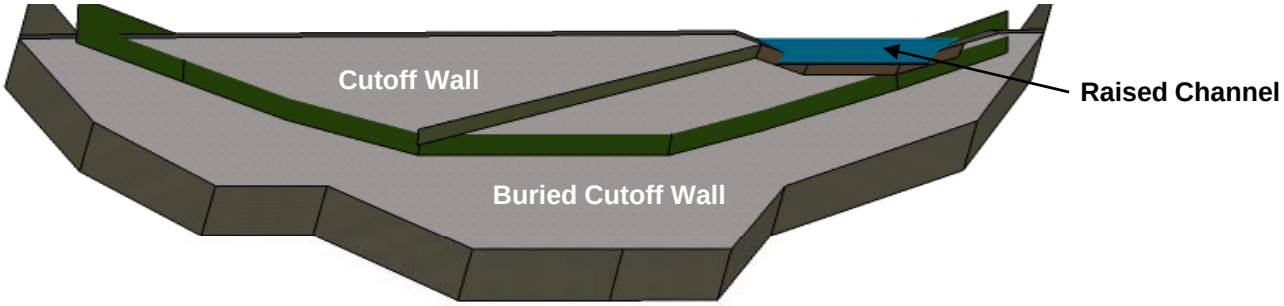
NOTES:

1. All dimensions and elevations are in metres.
2. In-channel treatment and proposed pilot channel to be reviewed following detailed site reconnaissance of existing channel bed.

| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists<br>SRK JOB NO.: 1CY001.026<br>FILE NAME: 1CY001_026-22_Rev_A.dwg | Faro Mine Closure<br>Fermeture de la mine Faro<br>Faro Mine Complex<br>Final Closure and Remediation Plan | Project Description (Draft 4)<br>In-Channel Treatment Options<br>DATE: December 2009 / APPROVED: PMH / FIGURE: 4.19 |

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Faro Mine Closure
Fermeture de la mine Faro

Job No: 1CY001.026

Filename: Figures_3.18_NFRC_CotoffWall_20091127.ppt

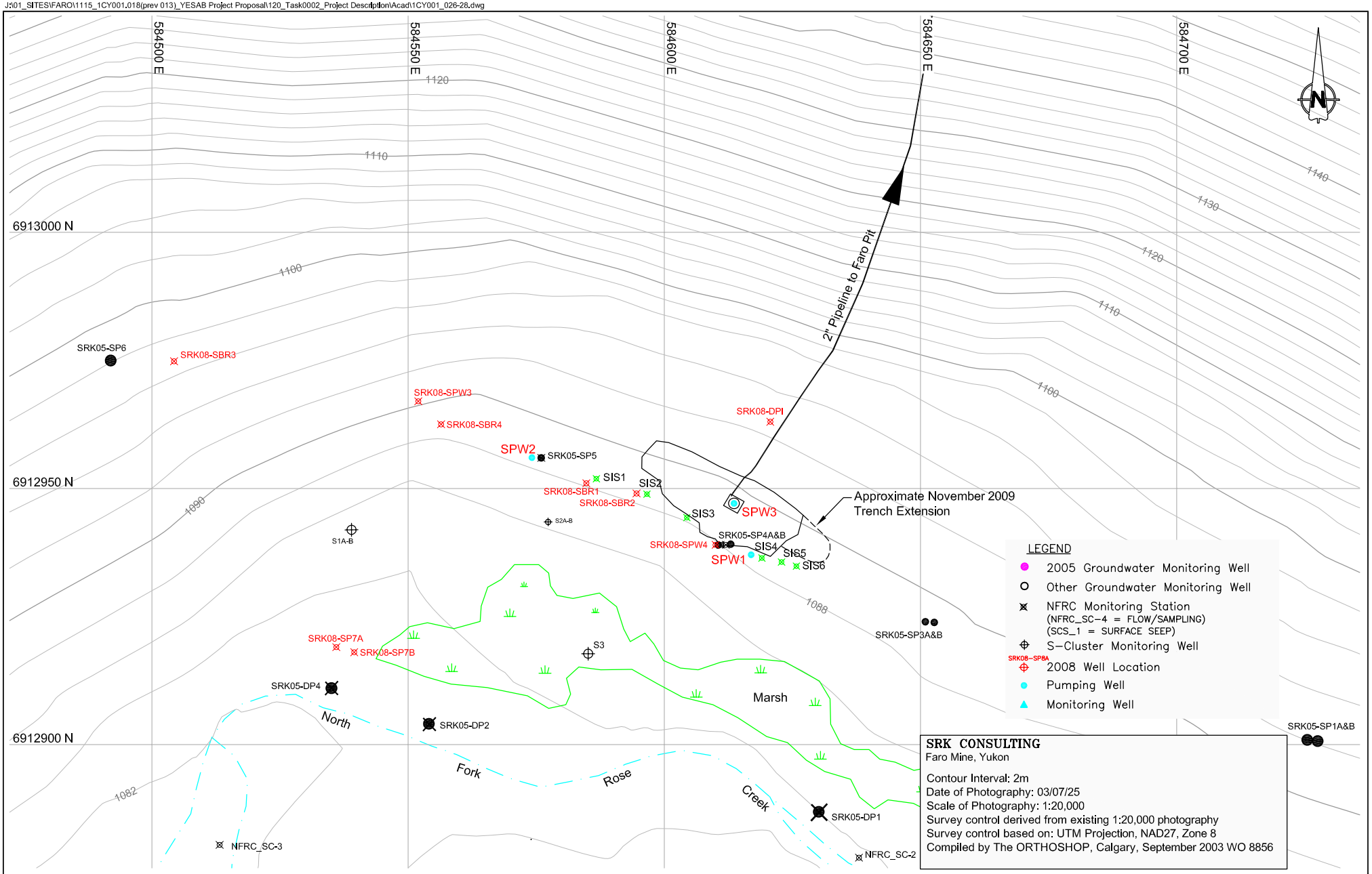
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**North Fork Rose Creek**
**Upgrade Cut-off Wall (107.1B)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **4.20** |

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Faro Mine Closure
Fermeture de la mine Faro

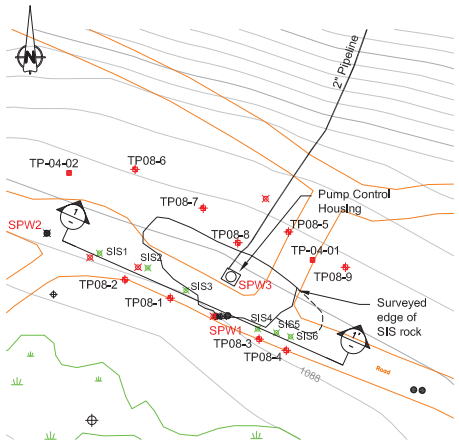
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FILE NAME: 1CY001_026-28.dwg

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

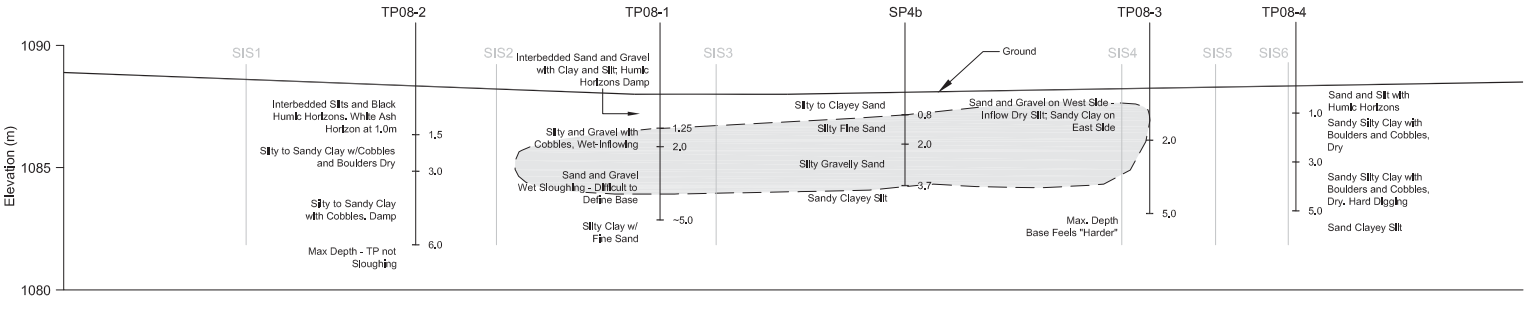
# General Location Map of Shallow Aquifer Interception Trench

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.21 |




Cross Section Locations

Scale A

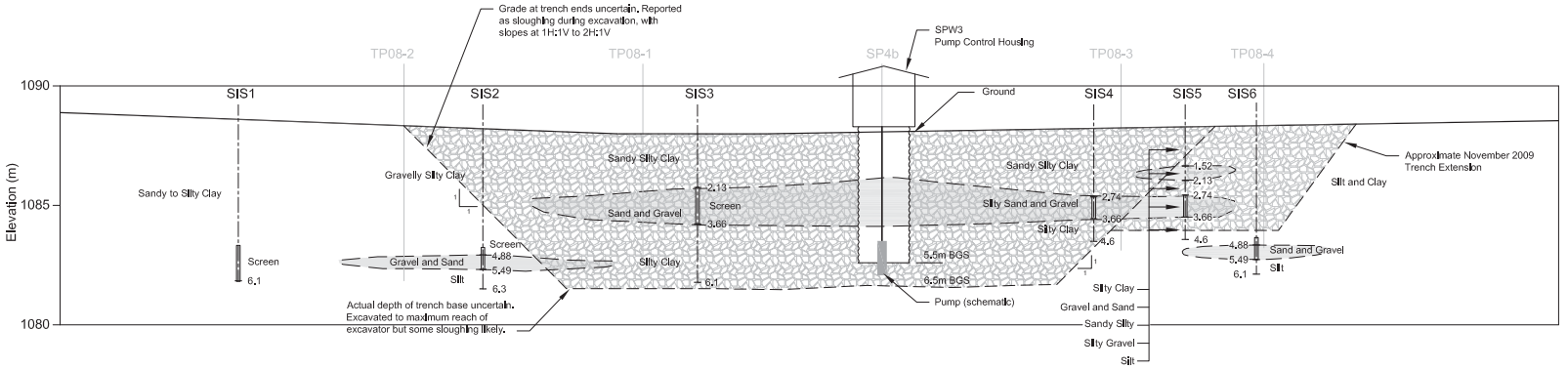



Section 1 - Test Pit Version

Scale B

LEGEND

- 2005 Monitoring Well
- 2008 Monitoring Well or Pumping Well
- Test Pit




Section 1 - SIS Monitoring Well Version

Scale B

| SIS WELL WATER QUALITY - AUG. 2009 | | |
|---|---|---|
| ID | Zn(mg/l) | $SO_4$(mg/l) |
| SIS 1 | No sample | Bailed dry with slow recovery |
| SIS 2 | 396 | 6900 |
| SIS 3 | 360 | 6000 |
| SIS 4 | 307 | 6000 |
| SIS 5 | No sample | Bailed dry with slow recovery |
| SIS 6 | No sample | Bailed dry with slow recovery |

Scale B: 0 2 4 6 8 10 Metres

Scale A: 0 10 20 30 40 50 Metres

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SRK JOB NO.: 1CY001.026

FILE NAME: 1CY001_026-28.dwg

Faro Mine Closure / Fermeture de la mine Faro

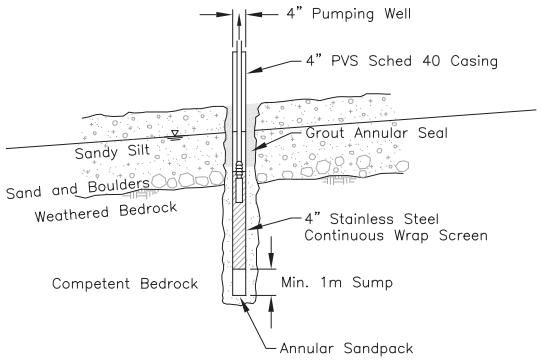
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

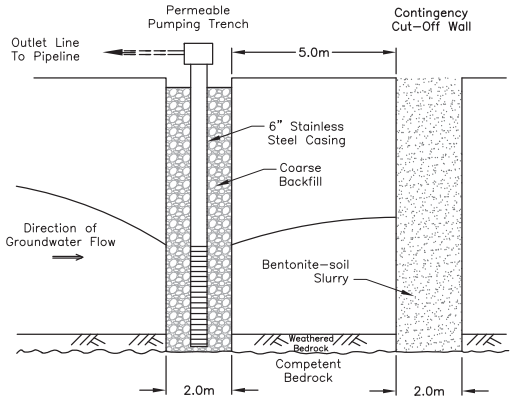
Cross Sections Through Shallow Aquifer Interception Trench

DATE: December 2009 | APPROVED: PMH | FIGURE: 4.22

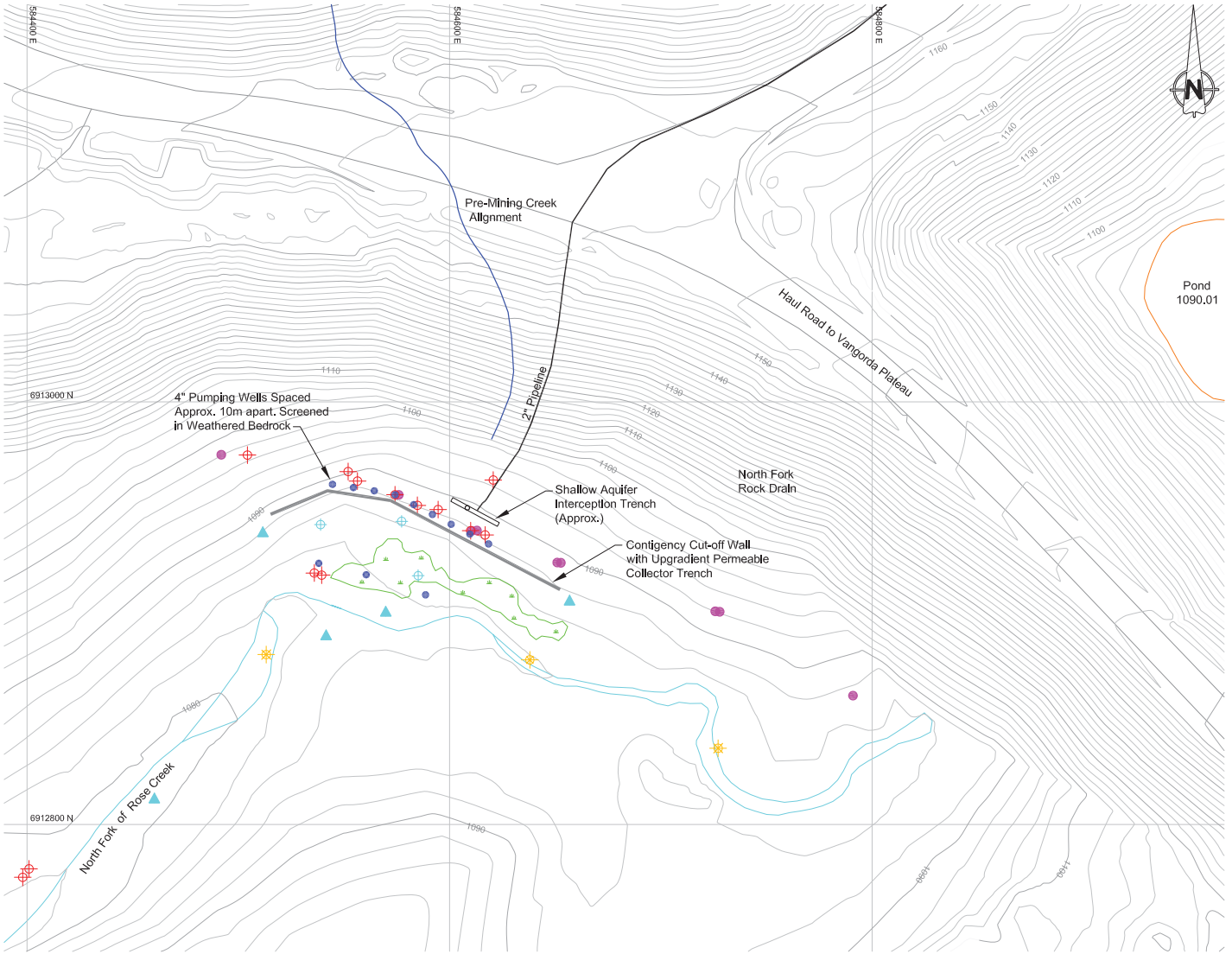
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Deep Aquifer Pumping Well
(NTS)




Permeable Collector Trench with Cut-off Wall
(NTS)




LEGEND
- 2005 Groundwater Monitoring Well
- Other Groundwater Monitoring Well
- NFRC Monitoring Station (NFRC_SC-4 = FLOW/SAMPLING) (SCS_1 = SURFACE SEEP)
- S-Cluster Monitoring Well
- SRK08-SP84 2008 Well Location
- Pumping Well
- Monitoring Well

SRK CONSULTING
Faro Mine, Yukon

Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20,000
Survey control derived from existing 1:20,000 photography
Survey control based on: UTM Projection, NAD27, Zone 8
Compiled by The ORTHOSHOP, Calgary, September 2003 WO 8856

Notes:

1. All dimensions and elevations are in Metres.

1:2,000 0 50 100 M

SRK Consulting Engineers and Scientists Vancouver B.C.

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-25_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

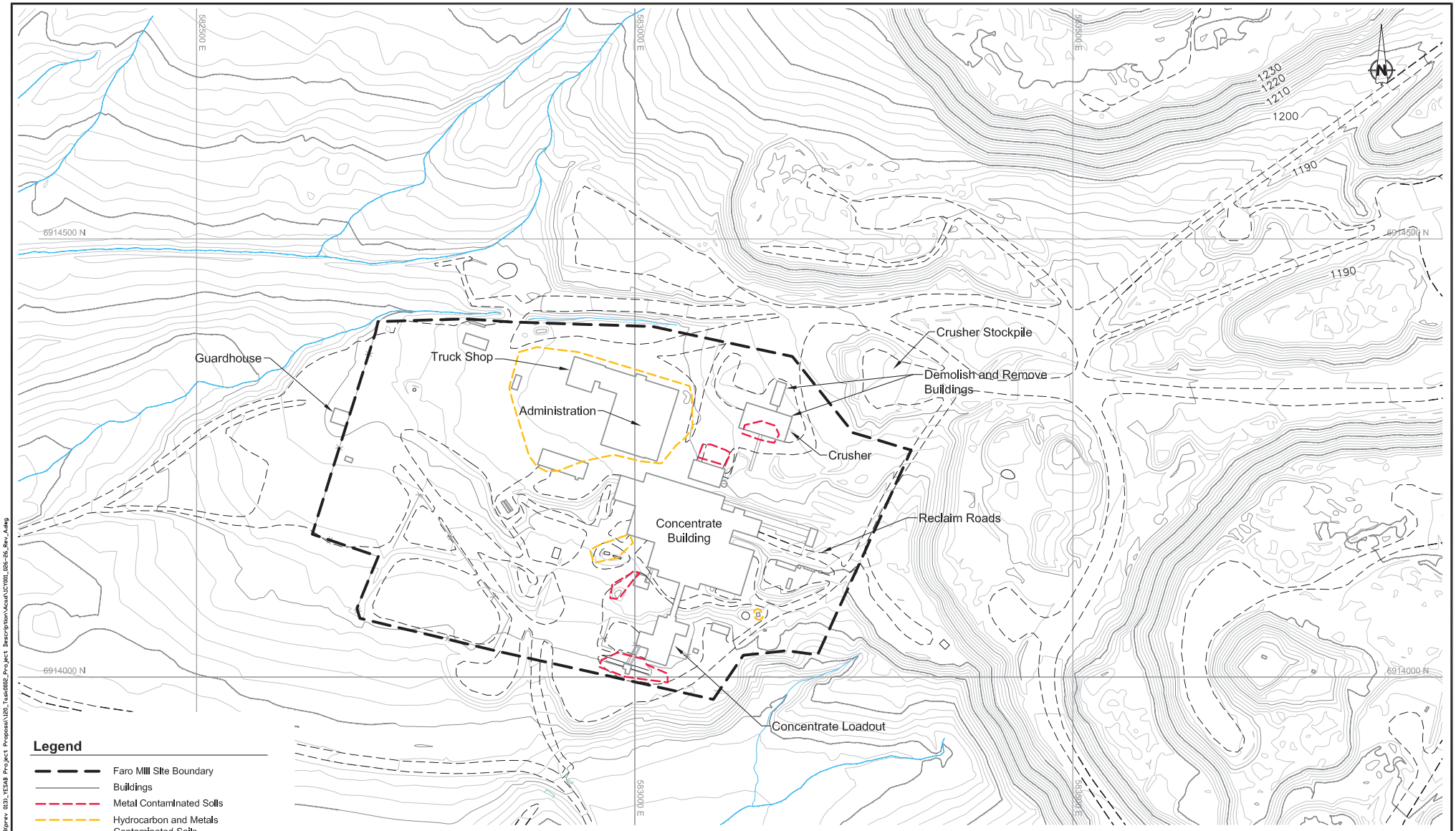
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Map Showing Conceptual Layout of Deep Aquifer Interception System

DATE: December 2009
APPROVED: PMH
FIGURE: 4.23

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## Legend

- Faro Mill Site Boundary
- Buildings
- Metal Contaminated Soils
- Hydrocarbon and Metals Contaminated Soils

## Note

Total area of metal contaminated soils is 3120m $^2$, and total area of hydrocarbon and metals contaminated soils is 22900m $^2$, based on Gartner Lee 2004 Phase 2 Environmental Site Assessment.

0 40 80 120 160 200
Scale in Metres

Faro Mine, Yukon
Map Scale:1:2000
Contour Interval: 2m
Survey control derived from existing 1:20000 photography Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003 WO 8856

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Vancouver B.C.

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-26_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Currently Defined Extents of Contaminated Soils at the Faro Mill Site (108.3/4)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 4.24 |

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# 5 Rose Creek Tailings – Area 200

## 5.1 Background

### 5.1.1 Rose Creek Diversion Channel

Presently, uncontaminated water from the North and South Forks of Rose Creek is diverted around the tailings impoundment through the Rose Creek Diversion Channel (RCDC) on the south side of the valley as shown in Figures 5.1 to 5.3. The present configuration of the RCDC can accommodate the 1 in 500 year flood event. Larger flows have the potential to spill on to the Intermediate tailings, overwhelm the small spillway on the Intermediate Dam, and breach the Intermediate Dam and the Cross Valley Dams.

### 5.1.2 Tailings

Throughout most of the operating periods at the Faro Mine Complex, tailings were deposited in the three impoundments that comprise the Rose Creek Tailings Facility (RCTF). The Original Impoundment, the Secondary Impoundment, and the Intermediate Impoundment store tailings as shown in Figure 5.2. The Cross Valley Pond serves as a polishing pond for treated mine effluent from the Faro Pit as shown in Figures 5.3 and 5.4.

The Original Impoundment was used from 1969 to 1975. It has a surface area of 41.7 hectares, and holds about 6,300,000$m^3$ of tailings. The Secondary Impoundment was used from 1975 to 1982 and again in 1986. It has a surface area of 54.5 ha and contains about 10,400,000$m^3$ of tailings. The Intermediate Impoundment was used from 1986 to 1992, has a surface area of 99 ha, and contains about 11,900,000$m^3$ of tailings. In total, there are about 28.6 $Mm^3$ of tailings.

The impoundments were created by a series of dams and dam raises. The dams that created the Original Impoundment are now almost entirely buried by the secondary tailings, but the Secondary and Intermediate Dams remain exposed. The east limb of the Secondary Dam is relatively low, rising only about 4m above the natural topography. The west limb of the Secondary Dam is higher, rising about 27m, about half of which is now covered by the intermediate tailings. The height of the Intermediate Dam is about 35m at its highest point.

The tailings contain an excess of acid generating sulphide minerals, and in fact most of the exposed tailings surface is acidic, (as low as pH =2 in some areas), with very high levels of soluble metals. The acidic conditions extend up to 6m deep in the Original Impoundment. Precipitation passing through the tailings picks up some of the soluble contaminants and transports them down in to the underlying tailings and soils.

Three closure options were considered for the Rose Creek tailings area: Stabilize in Place, Complete Relocation, and Partial Relocation. In fact, there were many options considered for the Rose Creek tailings area and only in the final analysis were they reduced to three. The option to stabilize in place was chosen and would involve covering the tailings with a waste rock trafficability layer under an infiltration resisting layer of glacial till, and revegetating.

## 5.2 Closure Activities for the Rose Creek Tailings Area (200)

### 5.2.1 General

The following sections describe the recommended closure activities pertaining to the Rose Creek Tailings area. These include upgrading the Rose Creek Diversion Channel (RCDC), replacing the existing fuse plug with a new fuse plug, placing a soil cover on the tailings impoundment, raising the Intermediate Dam (ID), building a new emergency spillway at the ID, breaching the Cross Valley Dam (CVD) and installing a groundwater collection and management system. Figure 5.6 provides an overview of the each of the closure activities for this area.

The design criteria used at the tailings area include the probable maximum flood (PMF) and the maximum credible earthquake (MCE). These events exceed the levels that would be suggested by the Dam Safety Guidelines (Canadian Dam Association, 2007), based on the likely classification of the ID.

The following description of closure activities for the tailings area and RCDC is a technically viable strategy. However, optimization studies and detailed design studies that are either under way or remain to be done will undoubtedly lead to modifications and improvements to the basic concepts outlined below. For example, two studies have been completed in relation to the design of the new emergency spillway at the ID. The first study was based on maintaining the invert of the spillway inlet at a level commensurate with the existing tailings level. This allows the tailings surface close to the spillway inlet to remain essentially unchanged, but leads to the need for raises of the RCDC and ID of approximately 4.8 and 9.4m, respectively. The second study was based on lowering the invert of the spillway inlet so that the raises of the RCDC and ID would be minimized. This study demonstrated that, by lowering the spillway inlet about 8m, no raise of the RCDC would be required and only a 2m raise of the ID would be necessary. However, in order to maintain the integrity and stability of the tailings, the surface of the tailings would require substantial regrading and erosion protection. It is thought that these two studies bracket the likely range of designs, and illustrate the interdependence of the ID spillway, tailings cover and RCDC and ID crest elevations. As noted above, the final design of these elements will require further study beyond what has been completed to date.

### 5.2.2 Overview of Rose Creek Diversion Channel Upgrade

Upgrade of the RCDC will include:

- Construction of an inlet structure and upgrade of the channel upstream of the fuse plug;
- Construction of a new fuse plug that would breach under flow conditions in excess of the 1:500 year event;
- Minor repair of the diversion channel and dike from the fuse plug to the confluence with the natural channel of Rose Creek below the CVD; and

- Raising the dyke along a significant portion of the RCDC downstream of the fuse plug to accommodate the raise of the ID.

Long-term routing of water around the tailings impoundment is to consist of year-round flow in the existing RCDC. The channel can accommodate the 1:500 year return period flood event, estimated to be 135$m^3$/s. The fuse plug will be designed to be eroded by the overtopping flow, which will enter the tailings impoundment, pass over the cover and then report to a spillway constructed in the right (north) abutment of the ID.

The new spillway is to be located on the right (north) abutment of the Intermediate Dam and will be designed with a peak flow capacity of approximately 674$m^3$/s, which is the estimated peak flow of the PMF of Rose Creek upstream of the fuse plug. This flow capacity assumes that the entire flow enters the tailings area after the fuse plug has been eroded. However, hydraulic assessments indicate that about 80$m^3$/s may continue to flow down the RCDC during the PMF event.

### 5.2.3 RCDC Upgrade Upstream of Fuse Plug – Activity 203.1

The section of the RCDC between the confluence of the North and South Forks of Rose Creek and the fuse plug will be upgraded to effectively route the flow into the channel and provide erosion protection of the channel. At this section of the RCDC, the peak design flow is 674$m^3$/s (PMF).

The RCDC channel between the inlet and the fuse plug has sufficient cross-section area to pass the PMF in its current configuration. A typical section is shown in Figure 5.8. Upgrade works are expected to consist of minor reshaping of the channel geometry plus the addition of rip rap to prevent erosion. The design criteria listed in Table 5.1 apply to the RCDC upstream of the fuse plug.

**Table 5.5.1: RCDC Design Parameters for Upgraded Channel Upstream of Fuse Plug**

| Parameter | Design Value |
|---|---|
| Design Flow (PMF) | 674 $m^3$/s |
| Bank slopes | 2.5H:1V |
| Longitudinal grade | 0.0020 to 0.0022 |
| Freeboard | 1m |

### 5.2.4 Fuse Plug – Activity 203.4

The top of the existing RCDC fuse plug is at El. 1058m. It contains large boulders which may prevent the breaching of the fuse plug during a flood event. The existing fuse plug will be removed and rebuilt with material that will be designed to fully breach when flows exceed the 1 in 500 year event. The top of the rebuilt fuse plug will be at El. 1059.5m, which will direct all floods smaller than the 1:500 year event (135$m^3$/s) along the existing RCDC alignment. The fuse plug will have an upstream facing of riprap which will overly a till core designed to prevent seepage through the structure. Erodible sand and gravel will make up most of the fuse plug. A plan and typical section through the fuse plug are shown in Figures 5.7 and 5.8, respectively.

### 5.2.5 RCDC Upgrade Downstream of Fuse Plug – Activity 203.5

Downstream of the fuse plug, the RCDC will be required to pass the flow of Rose Creek on a year-round basis for all flows up to the 1:500 year flood event ($135m^3/s$). The channel currently has capacity for this, however the freeboard is inadequate. In addition, sections of the dike, particularly in the vicinity of the ID, have experienced settlement in the past. It is believed that this is due to poor foundation conditions and thawing permafrost. Periodic raising of the dike has been conducted.

Detailed engineering of the requirements to upgrade this section of the RCDC to the 1:500 year flood has not yet been conducted. Repairs and improvements to the channel and the dike would consist of riprap modifications in the channel and the steep channel section past the Intermediate Dam. The replacement of existing drop structures in the downstream portion of the RCDC with a larger fish bypass system has been considered but is still under review.

Portions of the dike may be raised and/or buttressed to mitigate future concerns related to settlement and loss of freeboard. However, raises and/or buttresses between the plug dam and the ID typically involve placement of fill on tailings, which is likely to present performance issues such as long-term settlement of the fill and fill stability during a major seismic event. Design options to address or at least mitigate these issues exist, but their implementation would add cost and potential complexity to raising the RCDC.

In addition to maintaining freeboard within the RCDC, several historic studies have considered the potential need to raise the RCDC between the ID and the fuse plug in order to maintain appropriate freeboard for the PMF to pass through the ID spillway without overtopping the RCDC. As noted in Section 5.1, two recent studies related to the design of the new emergency spillway at the ID have bracketed the likely range of design options, and illustrate the interdependence of the ID spillway, tailings cover and RCDC and ID crest elevations. While the final design of these elements will require further study beyond what has been completed to date, it is likely that the ID crest will have to be raised a nominal amount. The existing RCDC crest is approximately 4.6 m above the existing ID crest (Figure 5.10) but, due to the potential RCDC stability issues noted above, final design would be based on limiting the ID crest raise to an elevation at or below the elevation of the existing RCDC crest.

### 5.2.6 Erosion Dissipation Structures – Activity 203.2

An erosion dissipation layer will be constructed on the tailings cover, just down gradient of the fuse plug, in the area where the flow velocity would be high enough to damage the cover. Beyond the erosion dissipation layer, swales will be constructed in the till cover to ensure that the flow does not become concentrated. Comments on each of these structures are provided below.

Once the flood water depth in the RCDC overtops the fuse plug, the fuse plug will begin to erode and RCDC flow into the Intermediate Impoundment will commence. The peak flow (PMF event) in the RCDC at the fuse plug is estimated to be $674m^3/s$. Assuming that the fuse plug erodes to the bottom of the RCDC channel, approximately $80m^3/s$ could continue to flow in the RCDC and the balance, up to about $600m^3/s$, will flow into the Intermediate Impoundment.

Immediately downstream of the fuse plug, the inlet channel to the Intermediate Impoundment is relatively narrow. In order to maintain low flood flow velocities in this area, an energy dissipation layer consisting of a riprap apron will be required over top of the tailings cover between the fuse plug and the point approximately 700m downstream of the plug where the channel widens to 250m (Figure 5.7). This 700m long portion of the inlet channel will be regraded to match the top of the tailings cover at its downstream end and the bottom elevation of the RCDC at the fuse plug. The entire 700m of the inlet channel will be lined with riprap to provide erosion protection, distribute flows and slow flow velocities. The total volume of riprap needed for the erosion protection is approximately 76,000$m^3$.

In order to maintain and increase the distribution of flow achieved by the riprap apron in the inlet channel, distribution swales will be constructed as shown on Figure 5.7. These swales will be depressed alignments in the tailings cover. Each swale will be about 1 m deep with 10H:1V side slopes and a gradient of 0.15%, which is consistent with the regraded tailings surface downstream of the riprap apron. The primary propose of the swales is to keep the flow distributed over as large an area as possible, thus decreasing flow velocities by keeping the "channel width" as wide as possible. They are not intended to accommodate the entire PMF flow. They will have full flow capacity of 10$m^3$/s at a velocity of 0.9m/s which is an acceptable velocity for glacial till-like material without any erosion protection.

### 5.2.7 Tailings Cover – Activity 202

A cover will be placed over the Rose Creek Tailings area with the objectives of preventing direct contact by wildlife and birds with the tailings and to minimize contaminated runoff.

The Original and Secondary Impoundment surfaces are elevated relative to the surface of the Intermediate Impoundment. Furthermore, the level of the pond behind the ID is relatively close to the surface of much of the Intermediate Impoundment. As a consequence of this setting, the drainage and trafficability conditions on the surface of the Original and Secondary Impoundments are better than on the vast majority of the surface of the Intermediate Impoundment. These differences have potential implications to the design and construction of the tailings cover in each of these two subareas, as described below.

#### Preliminary Design

The basic tailings cover design is summarized in Table 5.2 and illustrated in Figure 5.11.

**Table 5.2: Rose Creek Tailings Cover Design**

| | |
|---|---|
| **Cover Performance** | - Infiltration less than 10% of MAP (Range 5-20%)(1) |
| **Tailings Cover Design** | - 0.5m thick layer of waste rock (trafficability)(2)<br>- 1.5m thick layer of loosely compacted till (growth medium)<br>- Swales to route runoff towards pond upstream of the ID<br>- Revegetation |
| **Other Design Criteria** | - 0.15% slope towards pond upstream of the ID(3) |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)
(2) May not be necessary for trafficability on the surface of the Original and Secondary Impoundments
(3) Excludes the regraded slope on the downstream face of the embankment at the Secondary Impoundment

The preliminary design concepts outlined in Table 5.2 and Figure 5.11 are expected to apply to most of the tailings area. However, during final design of the cover, some adjustments may be deemed appropriate, such as the possible elimination of the waste rock trafficability layer from all or part of the Original and Secondary Impoundments. In addition, the following select areas warrant design adjustments to suit site specific conditions: the regraded slope of the Secondary Dam, localized areas of potential groundwater upwelling, the intersection of the Faro Creek canyon with the tailings area and the pond that will remain in place, following modification, immediately upstream of the ID.

The slopes on the downstream face of the Secondary Dam are presently too steep to accommodate the construction of a stable cover. These slopes will be modified by regrading and the possible relocation of tailings from elsewhere at the impoundment in order to develop an overall slope that will be suitable for the placement of a stable tailings cover. Preliminary design remains a work in progress, but it is likely these slopes will be regraded to about 3H;1V. Adjustments to the typical cover design outlined above may be needed to overcome the potential for erosion and other destabilizing influences.

Groundwater discharge areas, such as the one immediately downstream of the location of the proposed riprap apron or the graded area close to the spillway in the event the tailings surface must be adjusted to suit a lower spillway inlet, will likely require the construction of a sub-cover drainage layer that will facilitate the capture and conveyance of this groundwater to a suitable collection point or points. The detailed design of these capture and conveyance measures will be site specific and may be based on adaptive management concepts. The water collected from these drains will then be pumped to either the Faro Pit or the Water Treatment Plant. In the medium term, however, it may be that this water is simply directed to the ID pond and handled as part of the routine water management procedures that will be established for this pond as a function of its water quality.

Water which reports to the bottom of Faro Creek canyon will be intercepted before it flows onto the tailings area. It is possible that the quality of this water will, in the medium term at least, be unsuitable for discharge to the downstream environment. If so, this water may be conveyed onto the tailings cover, from which point it will flow down to the ID pond. Alternatively, this water may be pumped directly to either the Faro Pit or the Water Treatment Plant. Longer term management of this water will depend on the evolutionary quality of water reporting to the tailings area from all identifiable sources.

While the long term objective is for all water which reports to the surface of the tailings area to pass over the tailings cover and flow through the spillway into Rose Creek, it is expected that during closure implementation and for some unknown period thereafter, this water will require treatment prior to discharge. For this reason, water which reports to the surface of the tailings area during closure implementation and for some unknown period thereafter will be directed to the pond upstream of the ID, referred to here as the ID Pond. In turn, water in the ID Pond will be pumped to the Faro Pit for subsequent water treatment. Based on this expectation, it is likely that the current ID pond will be modified in order to reduce the total capacity of the ID Pond and, probably, to isolate the tailings from the pond water. However, the details around the modification of the ID Pond

require further assessment in the context of, for example, the capacity of the pumps that will be used to transfer water from this pond to the Faro Pit. This assessment has yet to be undertaken.

### Construction Methods and Maintenance

The condition of the surface of the tailings within the tailings area varies by season. During winter, the surface freezes solid except for the area within the ID Pond. During the freshet, as the thaw front advances down through the frozen tailings, the tailings surface becomes very soft and saturated, and it is at its worst in relation to trafficability. Except for wet periods, the tailings surface generally dries over the course of late spring and summer, by which point the trafficability is relatively good on the Original and Secondary Impoundments. However, at the Intermediate Impoundment, due to the finer gradation of the tailings and the shallow water table, the trafficability is, at best, marginal over the summer period. Areas within the Intermediate Impoundment which might be somewhat trafficable based on one or two equipment passes will become untrafficable after multiple equipment passes.

Based on these conditions, there are limitations as to when and where equipment can be expected to successfully work on the tailings surface. If in the final analysis a trafficability layer is deemed appropriate in order to construct a cover over the Intermediate Impoundment and probably over all or most of the Original and Secondary Impoundments, a layer of waste rock at least 0.5m thick will be placed over the tailings to provide adequate stability for construction vehicles. It is expected that most of this work will be conducted in late winter when the tailings are frozen. If, however, the placement of a cover over the Intermediate Tailings is attempted in late summer or fall, it will be beneficial to substantially dewater the ID Pond as soon as possible post-freshet. Rock drain placement over the Intermediate Tailings will advance in a general downslope direction, starting in the vicinity of the Faro Creek channel. Fewer constraints are likely needed at the Original and Secondary Impoundments, but the general understanding is that the cover will be placed by moving from “good ground” to “bad ground”. This will allow the thickness of the waste rock layer to be modified, if necessary.

A 1.5m thick layer of loosely compacted till will be placed over top of the waste rock, but the timing of the till placement will depend on the condition of the tailings below the waste rock, as well as the thickness of the waste rock layer. To the maximum extent practical, the placement of the till cover will follow the advance of the rock cover. The till layer will subsequently be vegetated using, to the extent possible, vegetation types appropriate for the region and the needs of wildlife.

It is expected that some level of maintenance will be required until the vegetation has become established and is significantly stabilizing the till cover. It is also expected that differential settlement will occur over time. The cover should be capable of handling the differential settlement with little or no impact. If depressions form that result in ponds, these will be filled in with additional till as part of long-term cover maintenance.

However, in response to a large earthquake, it is possible that the ruptures and/or boils may form in the surface of the tailings cover. Should this occur, it is likely that some tailings will report to the surface of the cover. The volume of tailings will depend on a variety of factors, such as the magnitude and duration of the earthquake, the location of the water table and the condition of the cover relative to the time of year.

**Surface Water Management**

During construction of the tailings cover, surface water management will continue in a manner which is generally consistent with current care and maintenance practice. However, when the water treatment facilities at the Faro plant site are decommissioned, water from the ID Pond will be pumped to the Faro Pit.

### 5.2.8 Intermediate Dam Spillway – Activity 201.3

In order to accommodate the peak flood flows large enough to erode the fuse plug, a new spillway will be constructed in bedrock at the north abutment of the ID (Figure 5.9). Klohn Crippen Berger (KCB) completed two studies that evaluated spillway design on the basis of two concepts which bracket the range of realistic design options. The results of these two studies are summarized in Table 5.3 and the corresponding spillway design sections are provided on Figure 5.10.

**Table 5.3: Intermediate Dam Spillway – Comparison of Studies to Date**

| Descriptor/Report | Option 1: KCB(1) (2008) | Option 2: KCB(1) (2009) |
|---|---|---|
| Study Objectives | Maintain spillway invert; raise ID as necessary | Lower spillway invert; minimize ID raise |
| Peak Design Flow | 600m$^3$/sec | 695m$^3$/sec |
| Spillway Inlet Invert | 1049.5m | 1041.8m |
| Spillway Width | 20m | 30m |
| ID Raise | 9.4m | ~ 2m |
| Final ID Crest Elevation | 1058.8m | ~ 1051.4m |
| RCDC Raise | 4.8m | 0m |
| Final RCDC Crest Elevation | 1058.8m | 1054m |
| Tailings Gradient at Spillway | 0.15% | 0.07% |
| Tailings Surface Grading | Little grading required | Extensive grading required |
| Tailings Cover | Conforms to typical cover design, Table 5.2 | Significant cover redesign may be required |

(1) Report prepared by Klohn Crippen Berger (KCB).

#### Preliminary Design

Table 5.3 illustrates the range of design scenarios and impact of the ID spillway design on the closure design of various other elements at the tailings area. In particular, Option 1 is based on maintaining the spillway at a level that coincides approximately with the current level of the tailings in the general vicinity of the spillway inlet. Based on this approach, both the ID and the RCDC would have to be raised significantly, but little or no modification of the tailings level adjacent to the spillway would be required. With Option 2, the spillway level is assumed to have dropped

significantly with the intention of avoiding, or at least minimizing, any raises of the ID and/or RCDC. The KCB assessment indicates the raise of the ID would only be about 2m, and no adjustment to the RCDC would be required. However, a major regrading of the tailings would be required, as well as potential changes to the design requirements of erosion protection to the cover surface.

These two design scenarios have bracketed the likely range of design options. While the final design of these elements will require further study beyond what has been completed to date, it is likely that the spillway design will be somewhere between Options 1 and 2, with the expectation that the spillway inlet invert will have to drop several metres to limit the ID crest raise to an elevation at or below the elevation of the existing RCDC crest.

The spillway width is likely to be in the order of 20 to 30m wide. It will route the flood around the Intermediate Dam and into the drained Cross Valley pond area prior to exiting through the breach in, or former location of, the CVD. It is intended that the spillway will be located such that the maximum PMF flow depth is within bedrock. The bedrock at the spillway location shown on Figure 5.9 consists of phyllite (identified as schist in the KCB 2008 report) with significant foliation. Available data suggests that the bedrock is relatively susceptible to physical degradation due to freeze-thaw processes. Therefore, portions of the spillway may have to be concrete lined.

Preliminary design assumes channel side slopes of 1H:1V for excavation in bedrock and 5m wide benches at 10m intervals. The bedrock cuts will require rock support. Overall channel side slopes in overburden will be 2.5H:1V.

### 5.2.9 Intermediate Dam – Activity 201.2

During the PMF, flood waters will temporarily enter the impoundment area faster than they can be routed out via the spillway. The extent to which the PMF flood waters rise within the Intermediate impoundment will depend on the spillway inlet invert, as well as the final surface of the tailings and freeboard requirements. As noted previously, the final design of these elements will require further optimization beyond what has been completed to date. However, in order to keep the ID crest level at or below the elevation of the existing RCDC crest, the raise of the ID crest would have be 4.6m or less. In order to pass the PMF and limit the ID crest raise to no more than 4.6 m, the spillway inlet invert will have to drop several metres.

#### Preliminary Design and Construction Methods

Based on the foregoing, the crest of the ID will likely be raised by between 2 and 4.6m. Sections illustrating the potential raise are provided on Figure 5.10. It is anticipated the raise will be achieved using the downstream construction method. However, depending on the magnitude of the raise, centreline construction could be considered as well. The core will be raised by tying in additional glacial till with the existing till core. At approximately el. 1032m, there is a drainage layer, with an overlying filter layer, within the downstream portion of the existing ID. The detailed design of the ID raise will account for the extension of this drainage/filter layer through the material placed on the

downstream face of the ID as part of the dam raise. Erosion protection will be placed on the downstream face of the ID.

It is anticipated that most, if not all of the fill required for raising the ID will be obtained from the deconstruction of the CVD.

In order to allow construction of the ID raise, sludge and contaminated sediments within the Cross Valley polishing pond will need to be removed from and disposed of at the current sludge disposal area on the Original Tailings Impoundment.

### 5.2.10 Secondary Dam – Activity 201.4

The top of the existing Secondary Dam is approximately at el. 1062m. The PMF level in the RCDC, flowing parallel to the Secondary Dam East Limb, is estimated to be el. 1060.9m at the upstream end of the RCDC and el. 1057.6m near the fuse plug. This leaves a flood freeboard of 1.1 to 4.4m, which is considered to be adequate.

There is loose soil in the foundation of the Secondary Dam. The dam foundation in the area near the inlet to the RCDC requires upgrading to provide an adequate safety factor against foundation liquefaction, and potential dam failure, during the Maximum Credible Earthquake (MCE). Dynamic compaction methods will be used to improve foundation strength.

### 5.2.11 Cross Valley Dam – Activity 201.1

The CVD will be breached in order to allow water to egress from the Intermediate Dam spillway and enter the Rose Creek downstream of the CVD. The extent of the breach may vary depending on the potential need for the material that comprises the CVD. However, as a minimum, the CVD breach will be based on the design criteria outlined in Table 5.4.

**Table 5.4: Design Criteria for Cross Valley Dam**

| | |
|---|---|
| Cross Valley Dam Breach | - $Q_{pmf} \approx 600 m^3/s$ (1)<br>- 20m wide base (2)<br>- 7m wide pilot channel at base of breach<br>- Line base of slope with rip rap for erosion protection<br>- 3H:1V side slopes<br>- Volume of breach: 38,700$m^3$ (minimum) |

(1) Actual design flow volume will depend on the ID spillway design.
(2) The width shown is the minimum width, and could increase depending on the need to use CVD material for the ID raise or other closure works.

The CVD is comprised of approximately 260,000 $m^3$ of material that is available for use in a raise of the ID or, if necessary, on other aspects of mine closure.

### Preliminary Design and Construction Methods

The breach in the Cross Valley Dam will have 3H:1V side slopes extending to the crest of the dam and it will be designed to accommodate the PMF (about 600$m^3$/s) peak flow. It will have 2m wide slot cut in the base of the breach to prevent scour and will then widen to a 20m wide channel lined with riprap for erosion protection. The minimum breach volume is 38,700$m^3$. This assumes excavating the breach to an invert elevation of 1019m as shown on Section A of Figure 5.9.

Prior to breaching the Cross Valley Dam, the Cross Valley polishing pond will be drained and the sludge and sediments, which may have accumulated over the years, removed to allow the construction of the ID Raise. The sludge and sediments will be disposed at the existing sludge pond to the north of the tailings impoundment.

Materials removed from the CVD could be used for the Intermediate Dam raise. However, temporary stockpiling of some of the removed materials may be required while the foundation for the dam raise is being prepared.

The original polishing pond floor and the remainder of the dam will be revegetated.

## 5.2.12 Groundwater Collection – Activity 204

A seepage interception system (SIS) will be installed across the Rose Creek Valley in the vicinity of the Intermediate Dam (ID) and Cross Valley Dam (CVD) alignments. The SIS will consist of a cut-off wall keyed into bedrock and an up-gradient shallow, permeable trench with a series of pumping wells that direct water either to a central sump or directly into a pipeline, from which water will be pumped to the Faro Pit or directly to the WTP during the treatment period of the year (early spring to early winter). A monitoring system will be installed up and down gradient from the collector system to assess performance and identify system bypass. Design criteria for the groundwater collection system at the toe of ID are shown shown in Table 5.5.

In the event of site-wide power failure and shut-down of the SIS, sufficient temporary power will be available to pumping of contaminated water to either the ID pond or to the Faro Pit.

**Table 5.5.2: Design Criteria for Groundwater Collection at Toe of the Intermediate Dam**

| | |
|---|---|
| **Cut-off wall** | - Install grout cut off wall to bedrock in the area of the Intermediate and Cross Valley dams |
| **Permeable collector trench** | - 5m deep and 1m wide trench, filled with permeable material, same length as cut-off wall |
| **Pumps in permeable collector trench** | - Variable rate sump pumps approximately every 55m along trench<br>- Automatic pumping controls<br>- Heat traced, insulated pipelines from trench pumps to central pumping sump |
| **Central pumping sump or booster stations** | - Concrete sump with minimum depth to bottom of collector trench<br>- Pump to move water to Faro Pit Lake via pipeline<br>- Heated housing to cover sump and hold centralized pumping controllers<br>- Alternate is direct connection of interception wells to pipeline with booster stations as necessary. |
| **Pumping Wells** | - Fence of 4-inch or 6-inch pumping wells installed into weathered bedrock and overlying permeable materials<br>- 10m spacing for pumping wells<br>- Automatic controls to maintain pump operating parameters<br>- Pumps connected to central manifold or discharge to central pumping sump for centralized pumping to treatment/disposal location<br>- Permanent power to site |
| **Monitoring** | Monitoring system installed up and down gradient from collector system. |

## Preliminary Design and Construction Methods

The cut-off wall will be installed to bedrock in the vicinity of the ID and CVD alignments at a point suitable to constructability. Construction of the cut-off wall would begin after the planned upgrade of the ID, which will see the toe extended into the polishing pond footprint. If required due to deterioration of groundwater quality, the cut-off wall can be installed prior to the ID raise, however it would have to be far enough downstream that it would not interfere with the construction of the dam raise. This will provide less flexibility in the long-term adaptive management plan but may be required by groundwater quality. The cut-off wall design will include a grout curtain to prevent seepage. An assessment of the cut-off wall design has not been completed.

The permeable collector trench will be installed up gradient of the cut-off wall. It will be at least 5m deep and 1m wide and backfilled with a permeable material. Sump pumps will be installed into the trench every 55m and pump water to either a centralized pumping sump or directly into a pipeline. Optimization and detailed design will be done during the detailed engineering design phase.

Prior to completion of the wall and trench, a monitoring system will be installed both up and down gradient of the collector system. In the event that the collector trench does not provide enough seepage collection, groundwater wells extending to bedrock will be drilled and used to pump groundwater to the central pumping station.

### 5.2.13 Polishing Pond

A new polishing pond will be constructed near the Water Treatment Plant, east of the tailings area (Figure 5.6). The pond will be used as a final discharge point from the Water Treatment Plant.

The dimensions of the pond would be determined during the next phase of the design but is expected to be about 50m wide by 50m long and about 10m deep.

### 5.2.14 Miscellaneous Closure Activities – Activity 205

#### Preliminary Design and Construction Methods

The tailings in the Faro Creek Canyon, downstream of the Emergency Tailings Area, will be "flushed out of the canyon and deposited on the surface of the tailings area prior to covering".

Any unnecessary roads at the tailings facility will be scarified and revegetated.

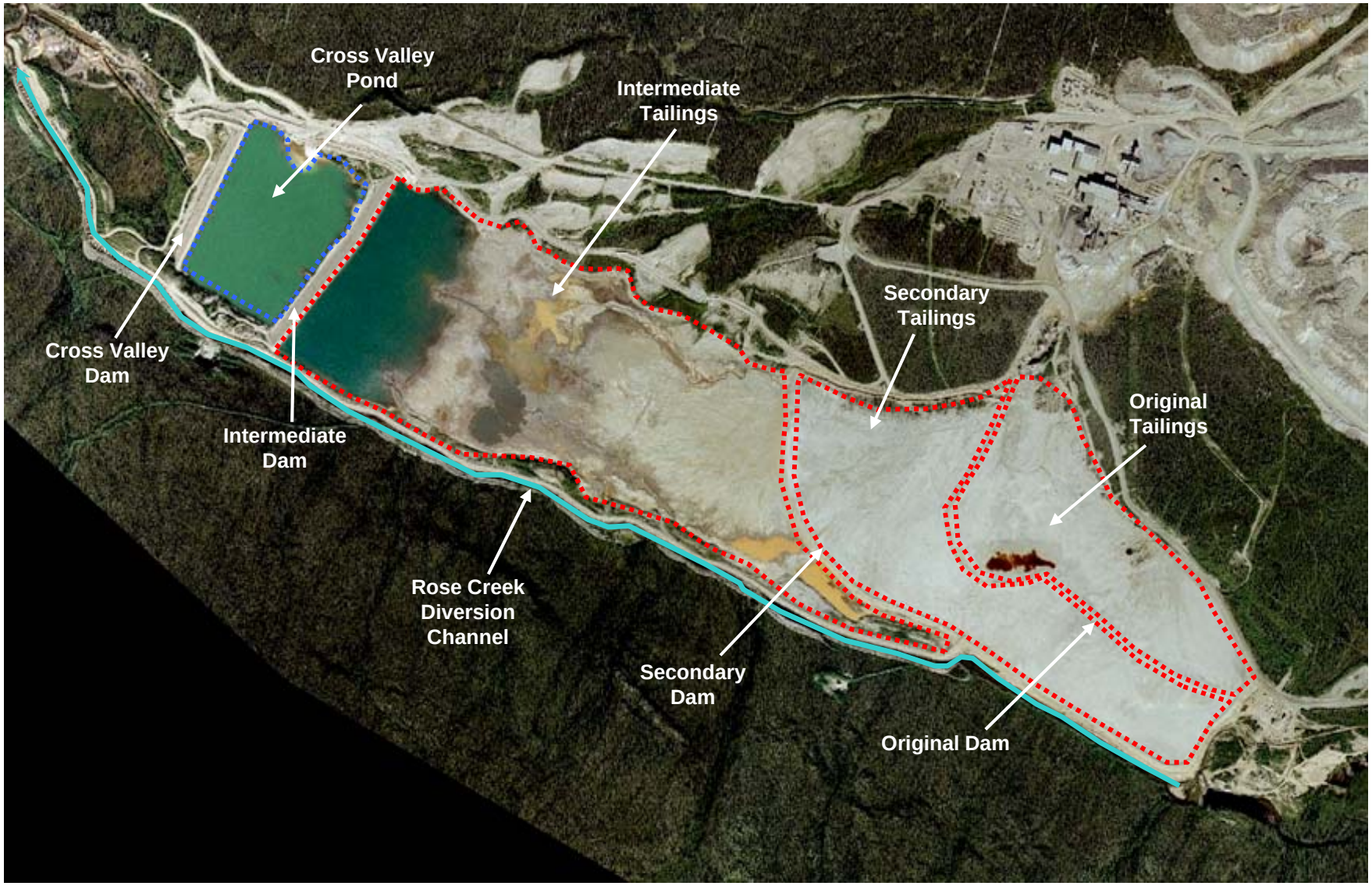
All disturbed areas from remediation activities, including borrow areas, will be revegetated. The vegetation selected will help to stabilize slopes and prevent erosion. Road closure will be done by an excavator scarifying the road surface and pulling the safety berm onto the road if necessary. The revegetation will be done with an application by a low-flying helicopter, with manual planting on the ground, as appropriate.

Vegetation within the RCDC channel and on the downstream face of the ID will be removed.

Post-closure maintenance will be a required as and when necessary. This is likely to include, but not be limited to, spillway maintenance, cover repair (from erosion), vegetation removal from the RCDC and ID face.

Annual geotechnical inspections will be required for key structures, such as the ID, RCDC and the ID spillway.

# Figures




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Faro Mine Closure
Fermeture de la mine Faro

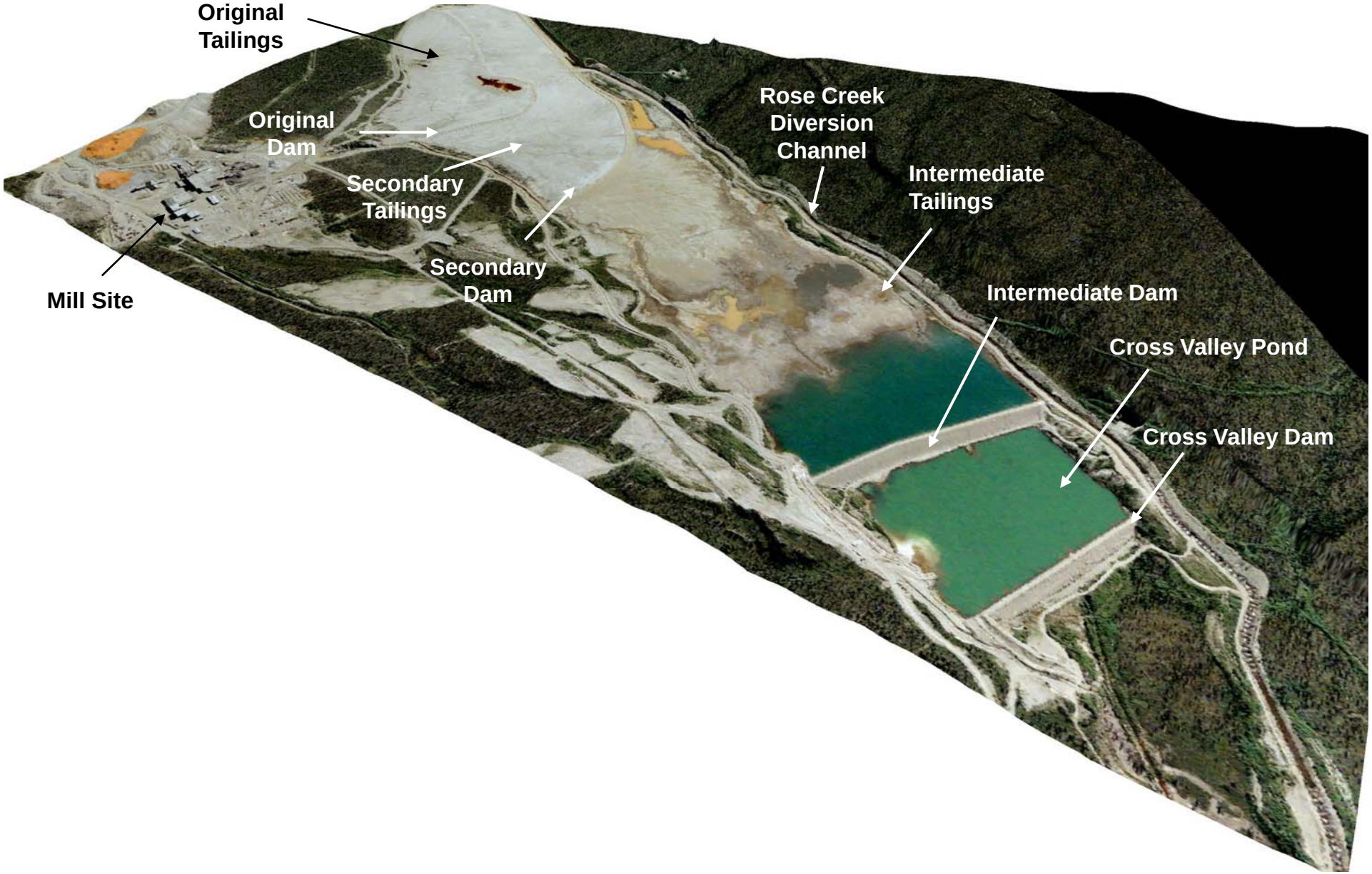
Project Description (Draft 4)

**Tailings Area (200)**
**Current conditions**

Job No: 1CY001.026
Filename: Figures_5.1-5_Tailings_20091127.ppt

Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009
Approved:
Figure: **5.1**




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Faro Mine Closure
Fermeture de la mine Faro

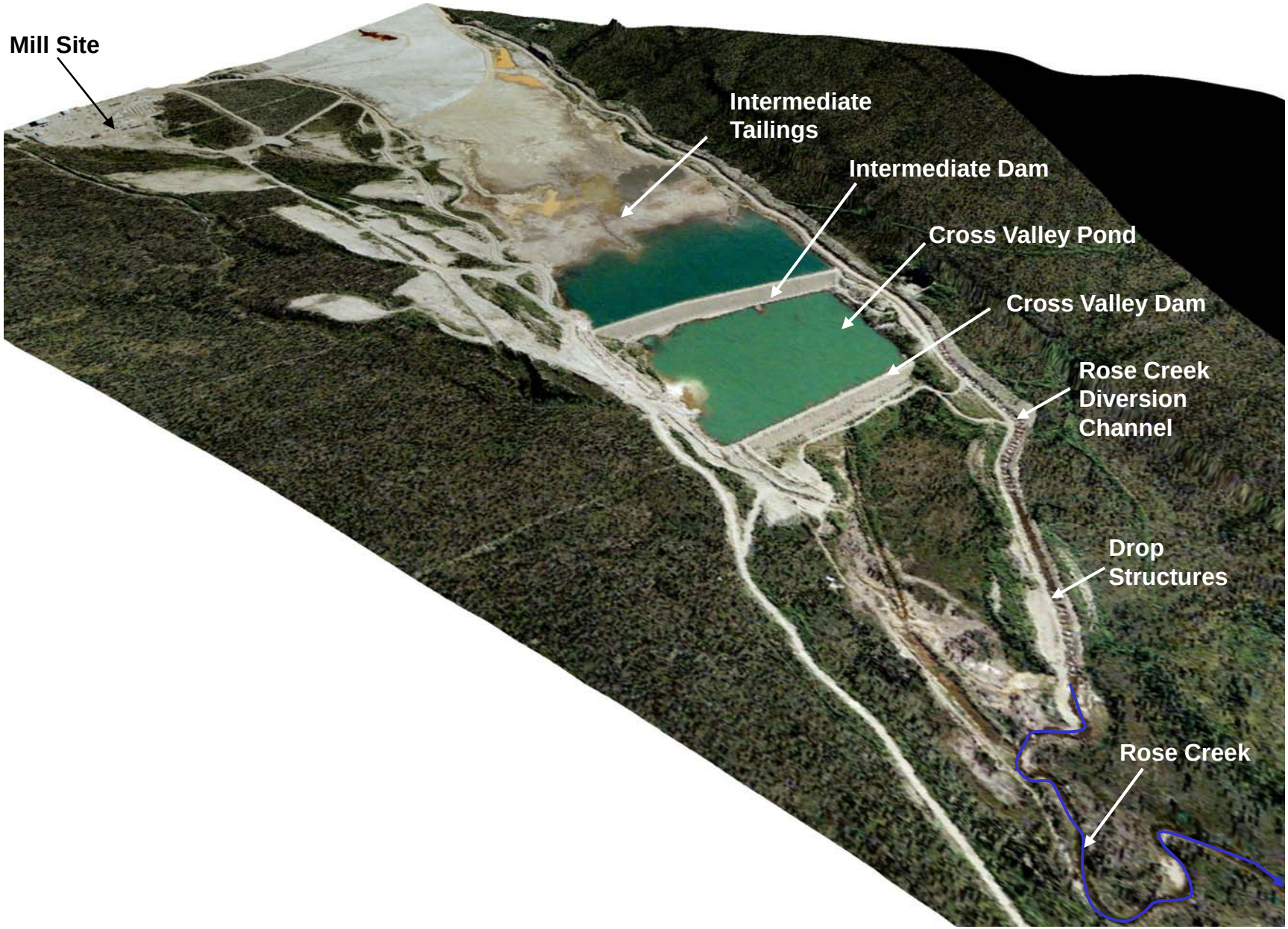
Project Description (Draft 4)

**Tailings Area (200)**
**Current Conditions**

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Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009
Approved:
Figure: **5.2**




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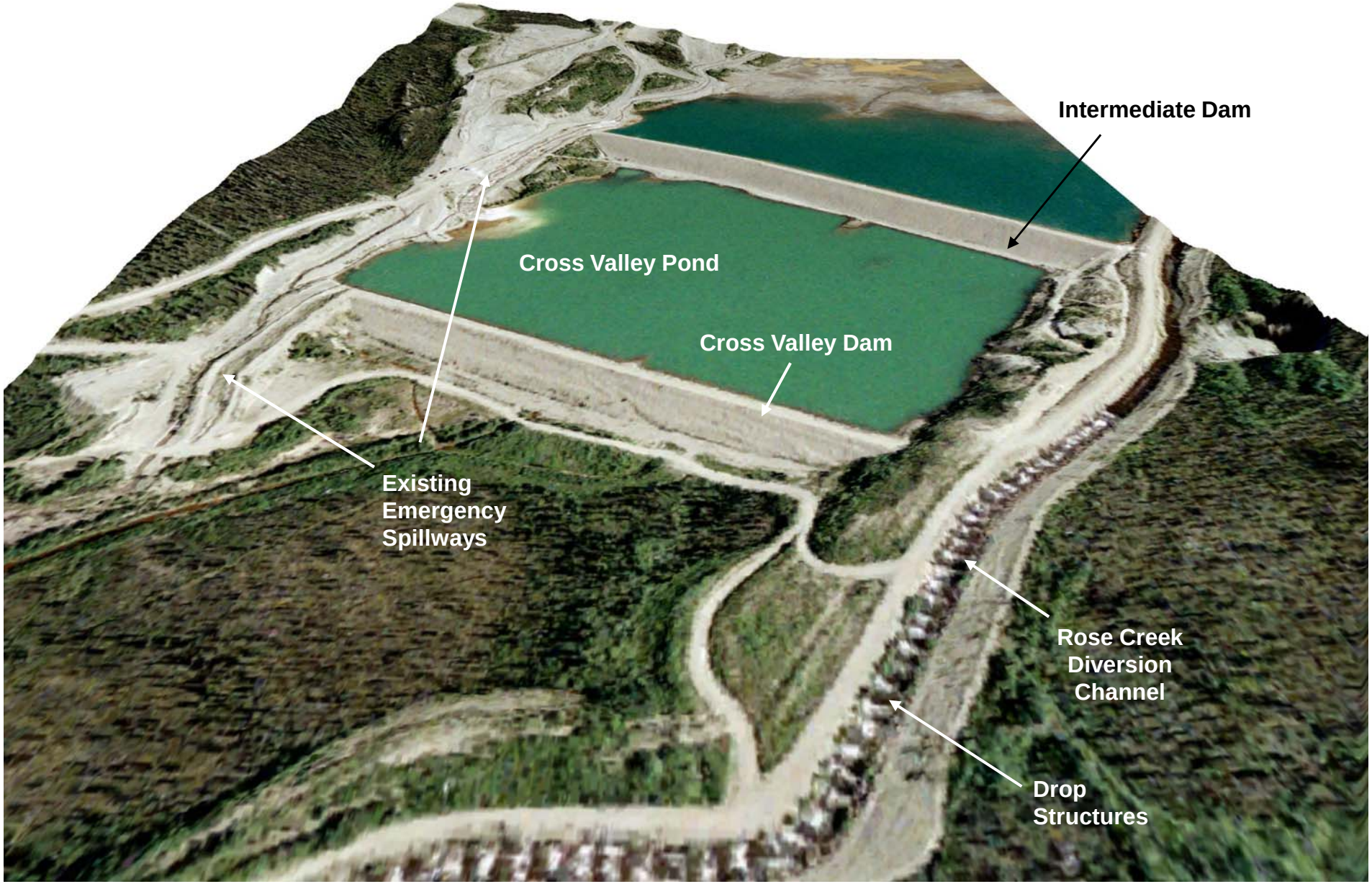
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Tailings Area (200)**
**North End**
**Current Conditions**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **5.3** |




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Faro Mine Closure
Fermeture de la mine Faro

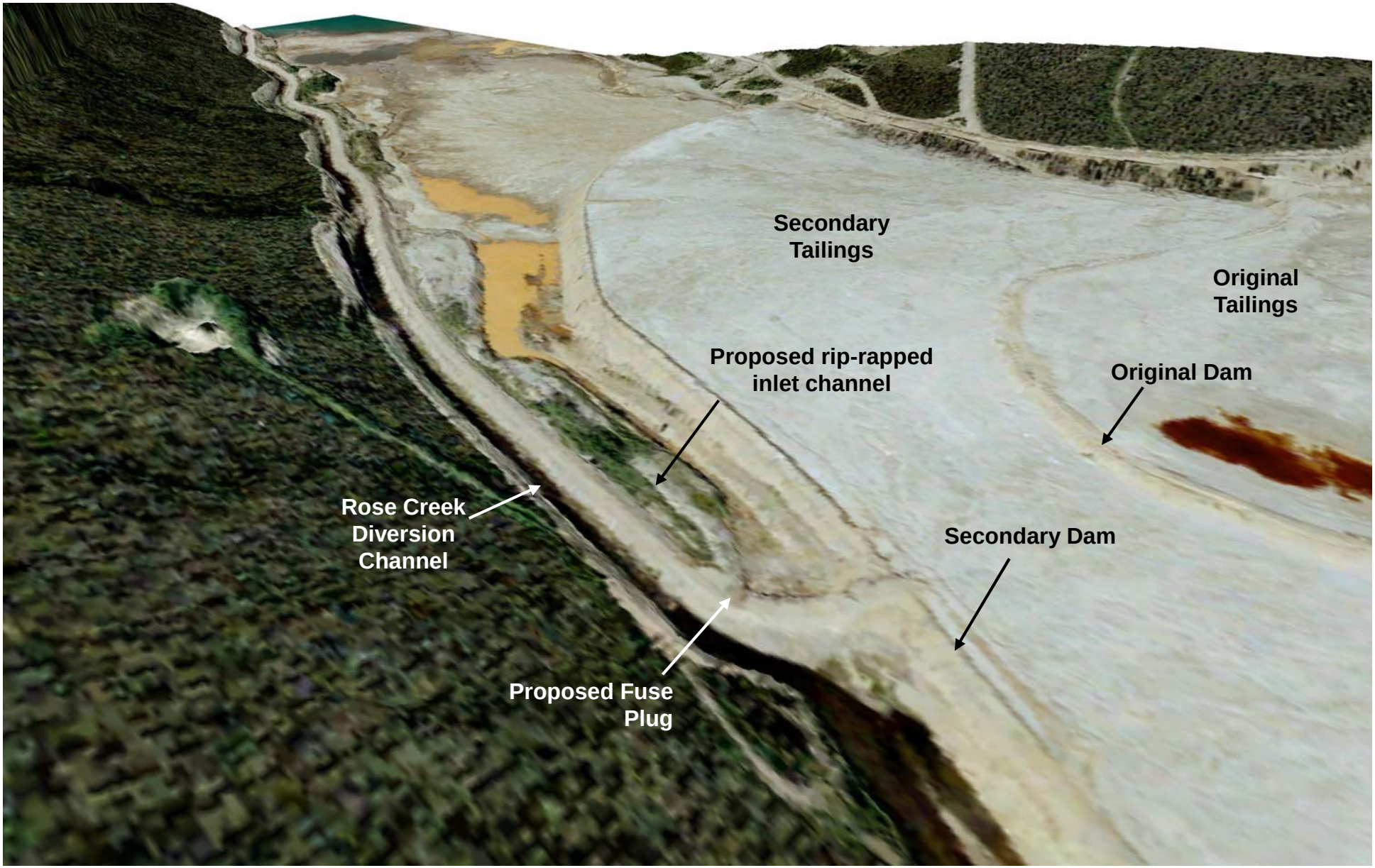
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Tailings Area (200)**
**Intermediate Dam**
**Current Conditions**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **5.4** |




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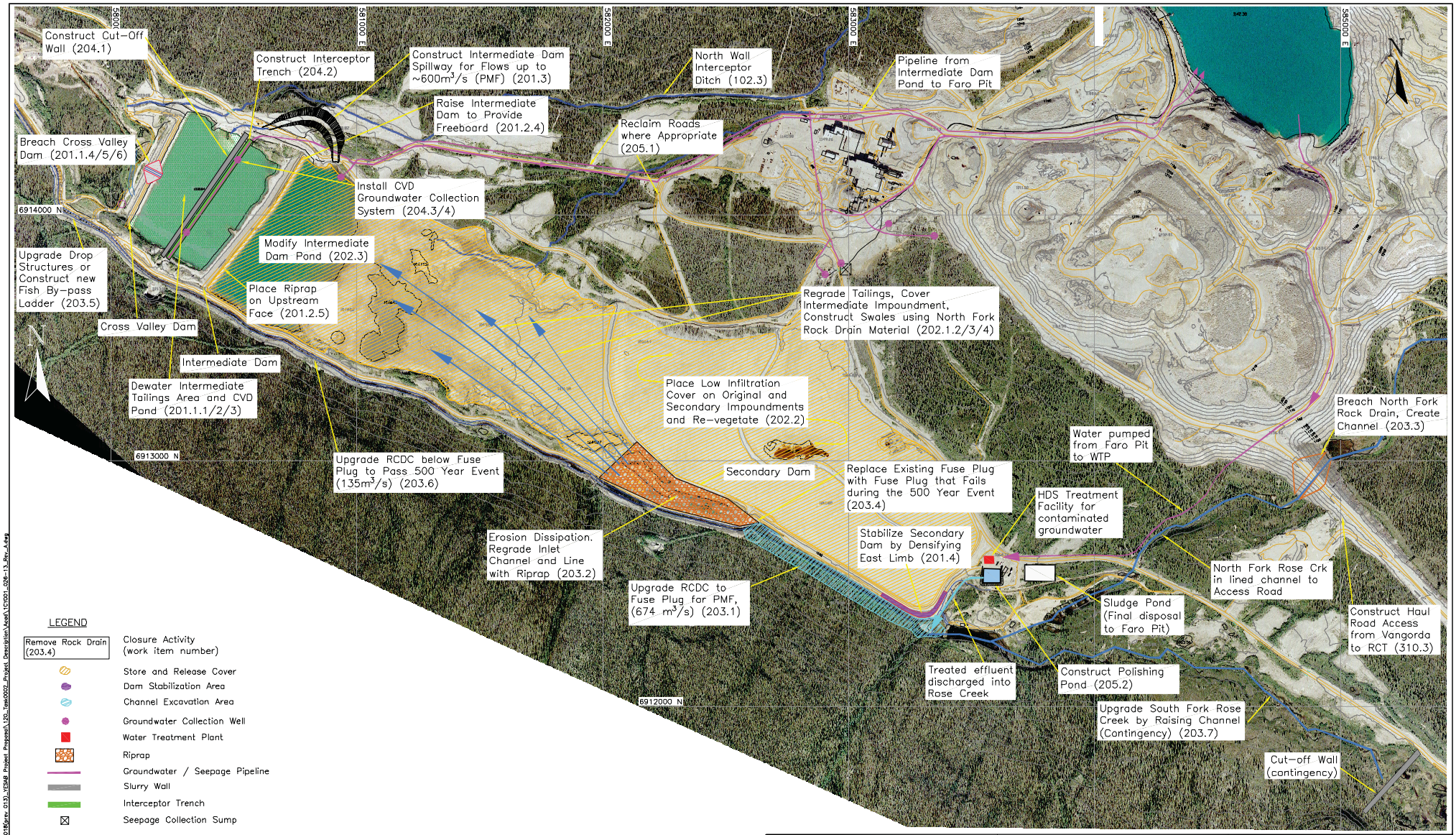
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Tailings Area (200)**
**Fuse Plug**
**Current Conditions**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **5.5** |




REFERENCE

Klohn Crippen Berger report titled "Intermediate Dam Spillway – PMF Flood Handling", dated April 2008 with job number M09237A06.

200 0 400 600 1200 feet

100 0 200 400 600 Metres

Faro Mine, Yukon

Contour Interval: 10m
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-13_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

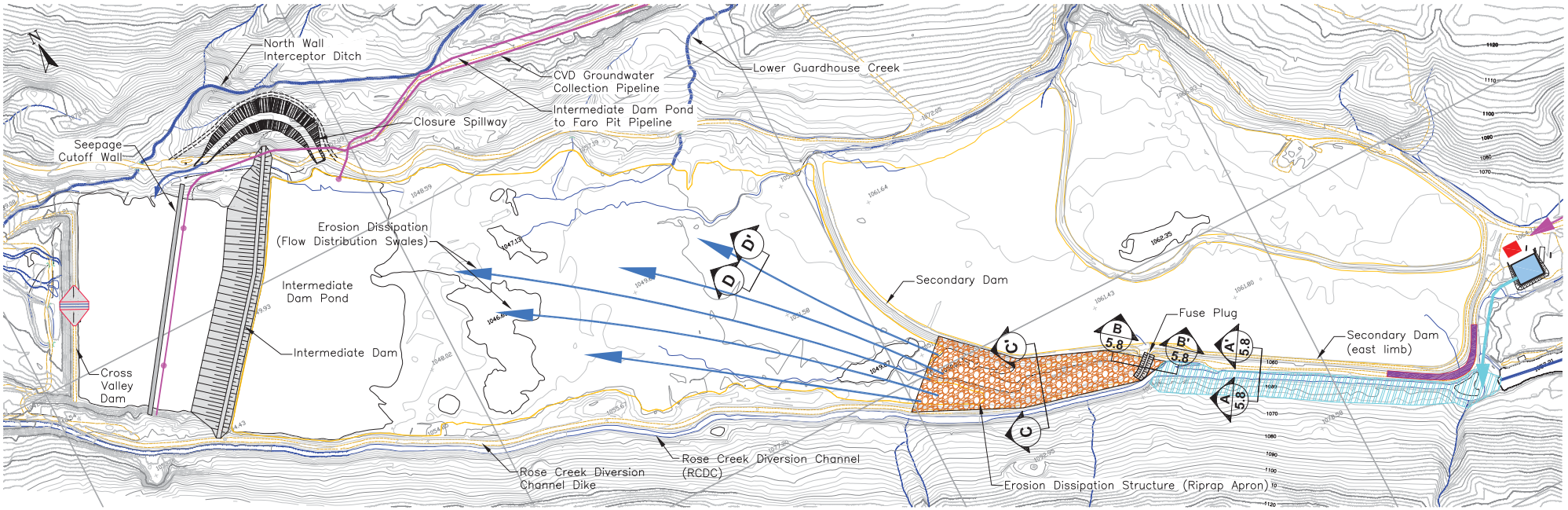
Faro Mine Complex
Final Closure and Remediation Plan

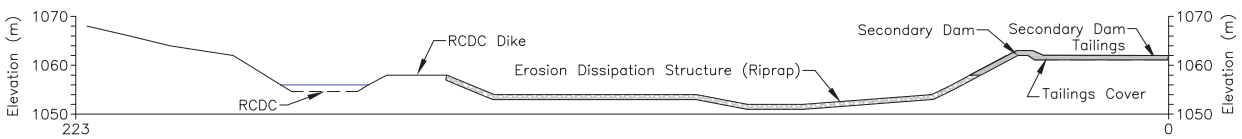
Project Description (Draft 4)

Tailings Area (200)
Closure Activities

DATE: December 2009
APPROVED: PMH
FIGURE: 5.6

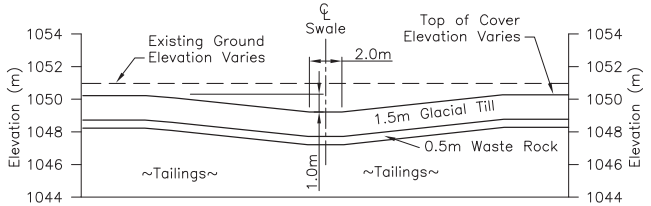
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**C CROSS SECTION C - C'**

0 10 20 30 40 50
Scale In Metres




**D TYPICAL FLOW DISTRIBUTION SWALE**

0 2 4 6 8 10
Scale In Metres

NOTES

1. All dimensions in metres unless noted otherwise.
2. Design of spillway and elevation of Intermediate Dam crest and RCDC crest are dependent on detailed design study.

Faro Mine, Yukon

Contour Interval: 10m
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-7_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

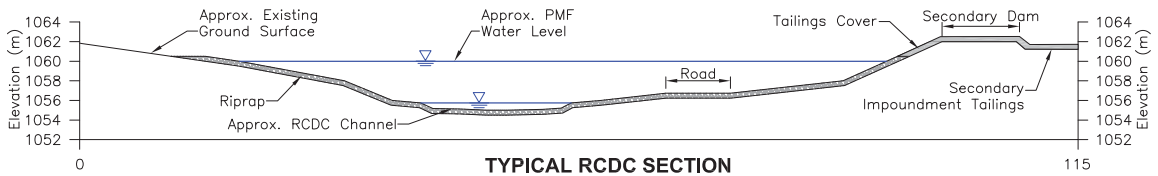
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Fuse Plug Plan (203.4)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 5.7 |

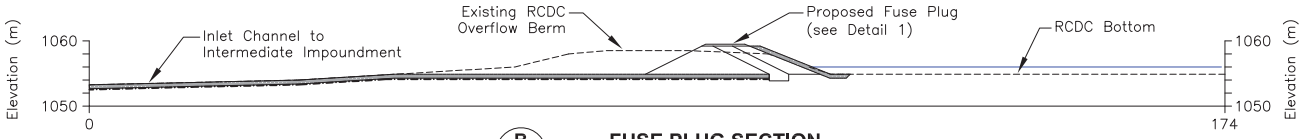
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**A 5.7 TYPICAL RCDC SECTION UPSTREAM OF FUSE PLUG**

0 5 10 15 20 25

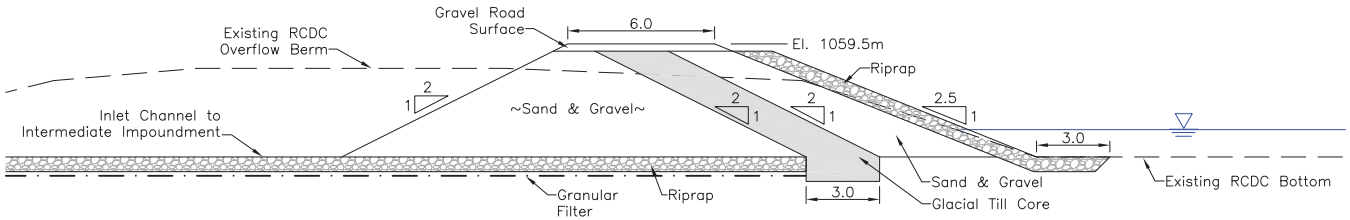
Scale In Metres




**B 5.7 FUSE PLUG SECTION**

0 5 10 15 20 25

Scale In Metres




**1 DETAIL 1 - PROPOSED FUSE PLUG**

0 2 4 6 8 10

Scale In Metres

NOTE

All dimensions in metres unless noted otherwise.

Faro Mine, Yukon

Contour Interval: 10m
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-7_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

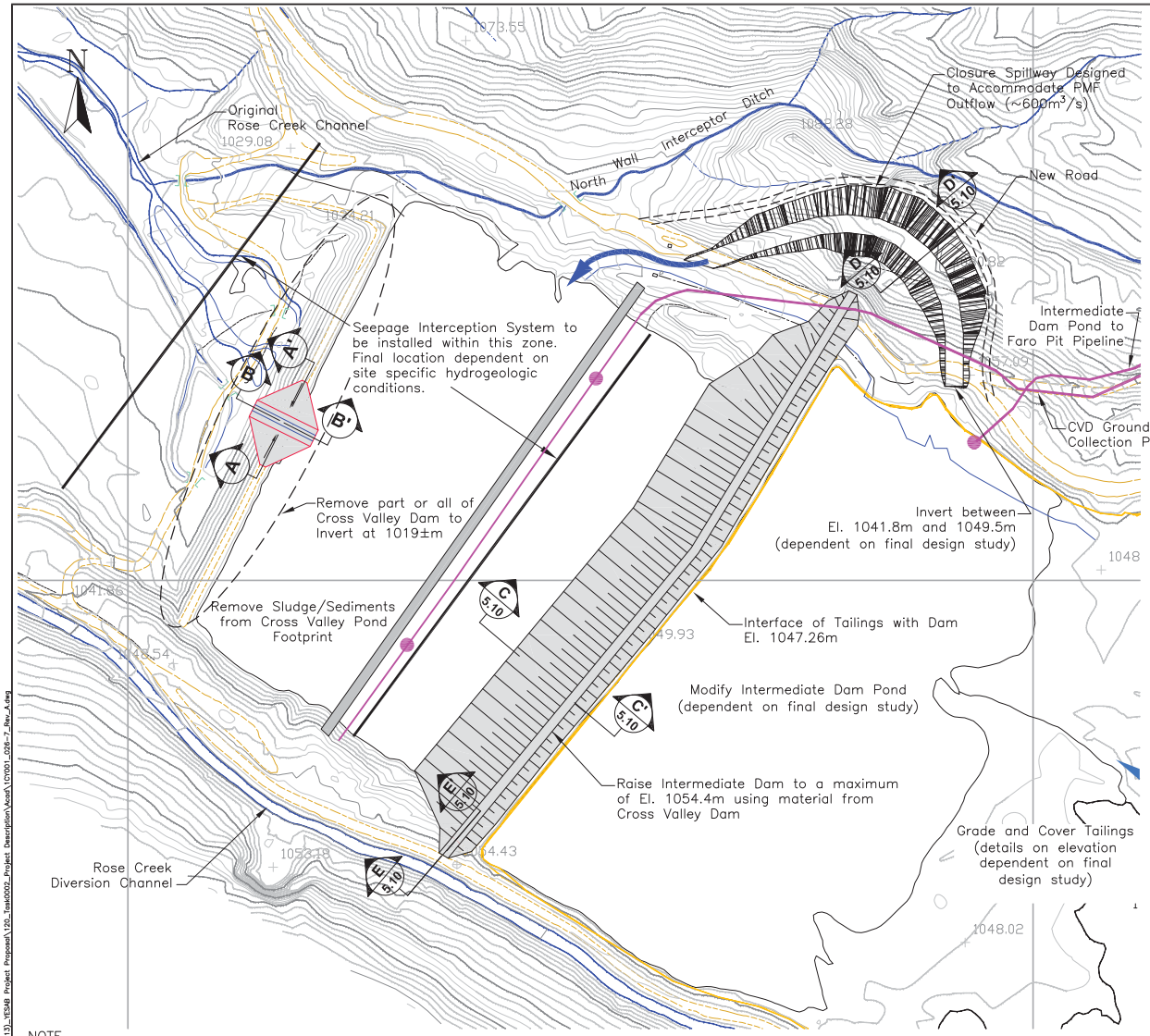
Faro Mine Complex
Final Closure and Remediation Plan

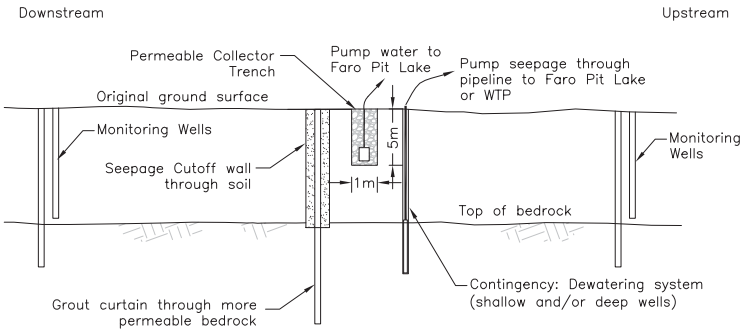
Project Description (Draft 4)

RCDC (203.1) and Fuse Plug Sections (203.4)

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| December 2009 | PMH | 5.8 |

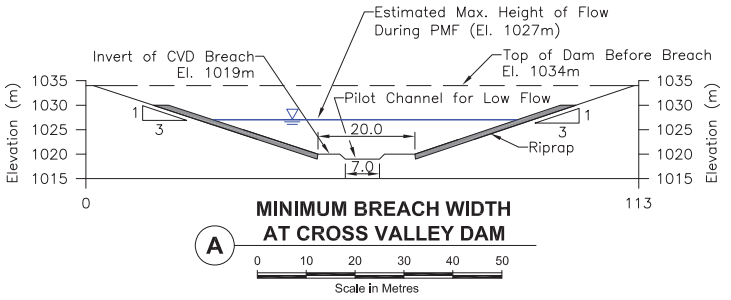
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**TYPICAL SECTION THROUGH SEEPAGE INTERCEPTION SYSTEM**

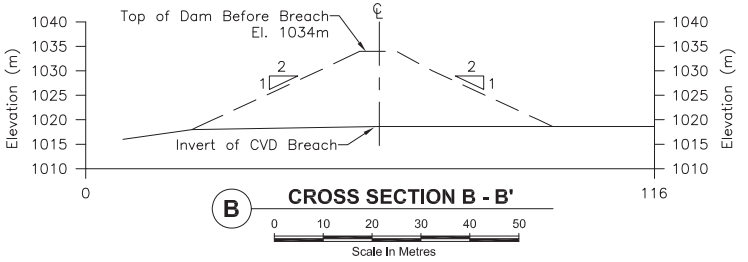
*Not to Scale*




**A** MINIMUM BREACH WIDTH AT CROSS VALLEY DAM

0 10 20 30 40 50

Scale in Metres




**B** CROSS SECTION B - B'

0 10 20 30 40 50

Scale In Metres

NOTE

All dimensions in metres unless noted otherwise.

REFERENCE

Klohn Crippen Berger reports titled "Intermediate Dam Spillway – PMF Flood Handling", dated April 2008 and "Intermediate Dam – Dam Raise and Spillway Options Review", dated Dec. 2009.

0 50 100 150 200 250

Scale In Metres

Faro Mine, Yukon

Contour Interval: 10m
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

SRK Consulting Engineers and Scientists

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-7_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

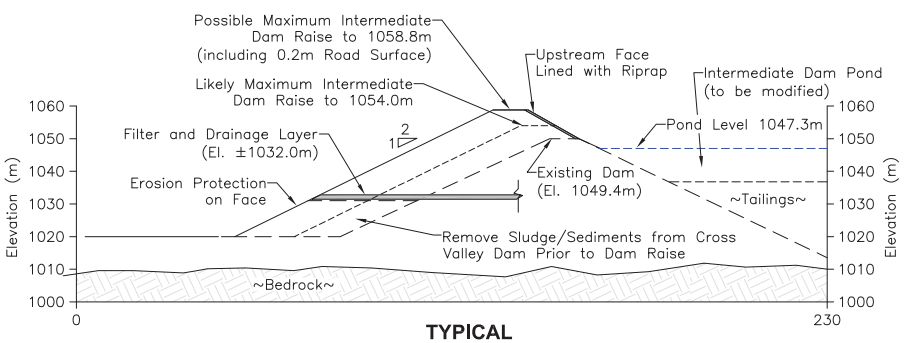
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Cross Valley Dam Breach (201.1)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 5.9 |

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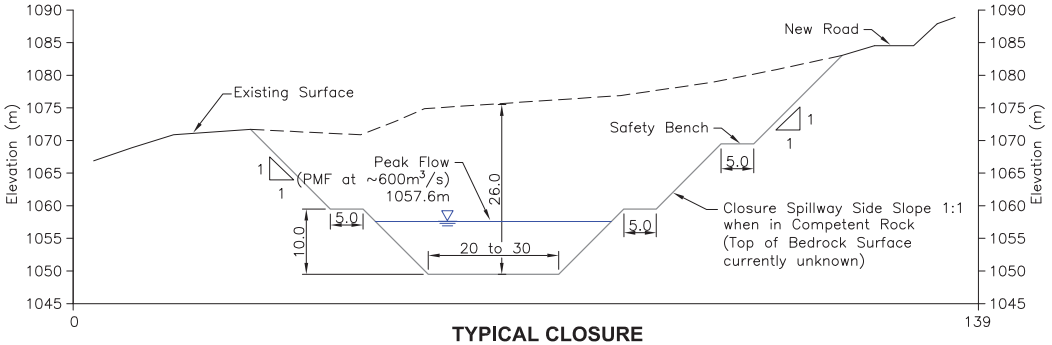



**TYPICAL INTERMEDIATE DAM SECTION**

C 5.9

0 10 20 30 40 50

Scale in Metres

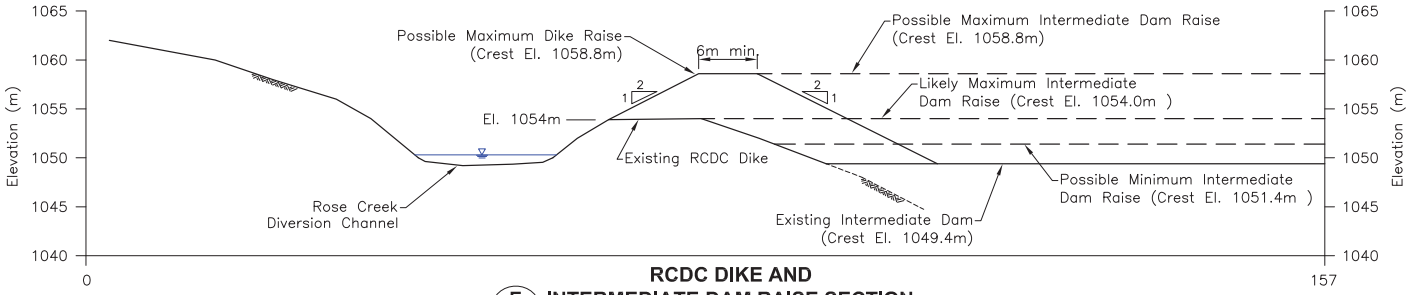



**TYPICAL CLOSURE SPILLWAY SECTION**

D 5.9

0 5 10 15 20 25

Scale In Metres




**RCDC DIKE AND INTERMEDIATE DAM RAISE SECTION**

E 5.9

0 5 10 15 20 25

Scale In Metres

NOTES

1. All dimensions in metres unless noted otherwise.
2. Design of spillway and elevation of Intermediate Dam crest and RCDC crest are dependent on detailed design study.

REFERENCE

Klohn Crippen Berger reports titled "Intermediate Dam Spillway – PMF Flood Handling", dated April 2008 and "Intermediate Dam – Dam Raise and Spillway Options Review", dated Dec. 2009.

Faro Mine, Yukon

Contour Interval: 10m
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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Vancouver B.C.

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-7_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

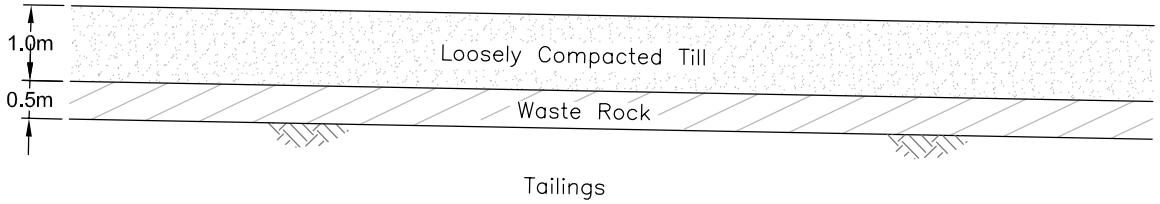
Project Description (Draft 4)

RCDC Dike, Intermediate Dam and Spillway Cross Sections (201.2 and 201.3)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 5.10 |

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0 1 2 3 4 5
Scale in Metres

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FILE NAME: 1CY001_026-8_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Tailings Cover Section
(202)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 5.11 |

# 6 Vangorda/Grum – Area 300

## 6.1 Background

### 6.1.1 Vangorda Pit

The Vangorda pit is about 1150m long and 350m across at its widest point. The deepest point in the pit was about 150m from the crest, but the bottom of the pit is now completely flooded. The southeast half of the pit is narrower and shallower, and includes a ramp and ore and waste stockpiles. Figures 6.1 to 6.4 show the overall area.

### 6.1.2 Vangorda Waste Dump

The Vangorda dump contains about 16 million tonnes of material and covers about 40 hectares. Geochemical studies of the Vangorda waste rock indicate that the Vangorda waste is net acid generating. The walls of the Vangorda Pit and the in-pit dumps are also net acid generating. Seepage from the Vangorda waste rock dump is currently collected and treated. The contaminant load is expected to continue increasing over the next few decades, and the water will require treatment for several centuries. Without collection and treatment, contaminant loads would severely impair aquatic ecosystems.

As a result of the high proportion of the sulphide waste rock relative to other types of waste rock from the Vangorda Pit, the original mine plan involved segregation of the sulphide and phyllite waste rock, and encapsulation with a till cover. However, the quantity of till available for capping was less than expected and the final cover was not constructed as originally configured.

### 6.1.3 Vangorda Creek Diversion

The development of the Vangorda Pit in the early 1990s required the diversion of Vangorda Creek around the perimeter of the pit. Between 1991 and 1992, the diversion was realigned due to the changing footprint of the pit. Since the cessation of mining activities at Faro Mine in January 1998, the diversion channel has been maintained in order to ensure a slow rate of pit filling while a long-term management plan for the site is developed. In 1999, there was a rock fall from a near vertical slope, which overlooks one section of the flume. This rock fall necessitated emergency replacement of approximately 39 metres of the flume.

The flume is also subjected to continuous pressure annually from ice build-up. The cross braces have buckled and many of the seals between each of the flume sections were damaged. Seepage loss from the flume is currently collected in an underdrain beneath the lower reaches of the flume. Some of this flow is directed into the pit through a pipe but most of the seepage is captured in the channel section supporting the flume and discharges into the plunge pool at the end of the flume. The quantity of leakage is considered minor and does not impact the groundwater. However, if leakage

increases, the stability of the slope may become an issue. It is also possible that on-going freeze-thaw cycles in the presence of some seepage will result in additional rock falls.

The existing Vangorda Creek Diversion system consists of the following components:

- Headworks comprising an 8m high earth dam and a 1.5m diameter culvert within the dam which directs the water into an 800m long, 2400mm dia. half round CSP culvert section.
- A plunge pool or stilling basin located at the end of the culvert sections.
- A drop box structure, culvert, and an outfall basin to convey the discharge beneath the haul road and back into Vangorda Creek.

The following list summarizes the key parameters of the original design for the flume:

- The diversion channel was designed to accommodate the 1:100 year event, with a peak instantaneous flow of 10.0$m^3$/s.
- The diversion channel was designed to be reasonably watertight. Hence, the use of a half-round corrugated steel pipe (CSP).
- The upstream headworks was designed to retain water to the 1:100 year level of 1168m allowing for one metre of freeboard. The dam crest was built to Elevation 1169m.
- A 1.5m diameter CSP was designed to convey the water through the upstream collection dam.
- The main diversion channel was designed with the CSP flume in a riprap-lined trapezoidal section. A longitudinal slope of 0.5% was selected to ensure subcritical flow within the section, which was considered preferable for this application. However, the as-built grade is steeper than 0.5% in the lower reaches of the flume, which could cause overtopping of the channel during supercritical flow conditions.
- During the 100 year flood event the depth of water flow in the channel is expected to rise to a maximum of 0.73m.

In general, since construction of the flume, the system has successfully conveyed Vangorda Creek during normal runoff events. However, in June 2004, a rainfall event, estimated to be the 1:100 year flood, damaged the piping system and nearly overtopped the headworks dam. The following year an overflow spillway was installed in the headworks dam to allow discharge into Vangorda Pit.

This event also necessitated reconstruction of the flume and upgrade to the culvert that empties into the drop box. The original design and alignment has not changed.

### 6.1.4 Grum Pit

The Grum pit is roughly circular with a diameter of about 1000m from crest to crest. A ramp that was cut as part of the Phase 2 expansion extends further 300 to 400m to the southeast. The north wall of the Grum pit is a till slope that is gradually sliding into the pit. The pit bottom has been allowed to flood. Pit wall rock and waste rock continue to release contaminants into the water that

accumulates in the pit. Without pumping and treatment, the Grum Pit would fill with water and overflow because inflows from runoff and seepage exceed outflows. Without treatment, water quality in Grum Pit would remain problematic for decades. The contaminant loads in Grum Pit will have a negative impact on water quality if released.

### 6.1.5 Grum Dump and Sulphide Cell

The Grum Dump contains about 28 million tonnes of material and covers about 148 hectares. It includes a sulphide cell where most of the Grum sulphide waste was placed. The sulphide cell in the Grum Dump contains strongly acid generating material, but the remainder of the Grum Dump contains only pockets of acidic material.

Sulphide waste rock was segregated in the Grum Pit and placed in two sulphide waste rock cells or lifts encapsulated by phyllite waste rock in the Main Dump, as a condition of the Water Licence. The original construction design was modified by Anvil Range Mining Corporation (1996) and would have resulted in a single sulphide cell constructed in four lifts. The need for internal till layers was abandoned in favour of a final 3m till cover. Operations ceased before the cover was completed and sulphide waste rock remains exposed in places on top of the Main Dump.

### 6.1.6 Grum Ore Transfer Pad

During operations, Grum ore was hauled out of Grum Pit and stored on the Grum Ore Transfer Pad (GOTP) prior to being hauled to the Faro mill. The current understanding is that the GOTP was constructed by placing clean phyllite waste on original ground northwest of the pit to form a large, level to moderately sloping facility to accommodate transfer of ore to appropriate trucks for the haul to Faro. Operating practice was to temporarily store ore above grade on the GOTP; some ore remains stockpiled above grade at this time. The phyllite pad is thought to have originally low lead, zinc, and total sulphur concentrations typical of phyllite waste rock, and excess neutralization potential.

### 6.1.7 Grum Interceptor Ditch

The Grum Interceptor ditch diverts Grum Creek in a riprapped channel around the upper perimeter of the Grum Pit and discharges the flow in the sedimentation ponds called the Sheep Pad Ponds.

### 6.1.8 Sheep Pad Ponds

The Sheep Pad Ponds were built to capture sediment from the Grum Interceptor Ditch before discharging into Vangorda Creek. Flow from these ponds discharges into the plunge pool at the outlet of the Vangorda Creek Diversion.

# 6.2 Closure Activities for the Vangorda/Grum Area (300)

## 6.2.1 General

The following sections describe the recommended closure activities pertaining to the Vangorda mine area. These include constructing safety berms around the two pits, upgrading the Vangorda Creek Diversion channel, regrading and covering the waste at both Vangorda and Grum waste drums, covering the sulphide cell in the Grum Dump, breaching the Grum Interceptor ditch, breaching the sheep pad pond dams, and installing a groundwater collection and management system. A water treatment plant will also be built. Figure 6.5 provides an overview of each of the closure activities for this area.

## 6.2.2 Vangorda Pit – Activity 301

Safety berms will be constructed to restrict access to the pit. Table 6.1 provides design criteria for this activity.

**Table 6.1: Design Criteria for Safety Berms around Vangorda Pit**

| | |
|---|---|
| **Safety Berm** | Minimum 2m in height<br>Crest width of 1m<br>Side slope of minimum 2H:1V<br>Minimum 5m offset from current pit wall crest |

### Preliminary Design and Construction Methods

A safety berm will be constructed around the Vangorda Pit to restrict access. An access road will be built along the alignment of the berm. The berm will be 2.0m high with a crest width of 1m and 2H:1V sideslopes. The construction will be a typical load, haul, place and dump operation with little variation. A dozer will be used to shape the berms. All the granular construction material will be sourced from borrow areas identified in Chapter 9. Construction and design optimization will be completed during the detailed engineering process.

## 6.2.3 Resloping and covering of the Vangorda Dump – Activity 302 and 301.3

The objective of this work is to decrease infiltration through the dump and to prevent dust migration and direct uptake by animals. The cover would be placed in unison with the Landform Engineering and vegetation programs. Recent optimization studies have indicated that the segregated Sulphide waste in the the dump would receive a very low infiltration cover.

Table 6.2 lists the design criteria for the Vangorda Waste Rock Dump.

**Table 6.2: Design Criteria for Vangorda Waste Rock Dump excluding the Sulphide cell**

| | |
|---|---|
| **Cover Performance** | - Low Infiltration Cover<br>- Infiltration less than 5% of MAP (Range 3-8%)(1) |
| **Low Infiltration Cover Design** | - Compacted till barrier layer (0.5 to 1m thick)<br>- Loosely compacted till layer as store-and-release component and growth medium (0.3 to 1m thick)<br>- Revegetation<br>- Not steeper than 3H:1V side slopes (unless impacts existing collection ditch) |
| **Other Design Criteria** | - Maximum downslope run of 100m with maximum runoff length of 50m<br>- Revegetation to stabilize slopes and prevent erosion<br>- Sedimentation control<br>- Compacted till layer to have a density of at least 2000kg/$m^3$<br>- Seismicity: 0.10g = corresponding to a probabilistic 1:1000 year event<br>- 0.40g = corresponding to a deterministic maximum credible event (MCE) |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

Table 6.3 lists the design criteria for the Baritic Fines at the Vangorda Dump.

**Table 6.3: Design Criteria for Vangorda Baritic Fines and Vangorda Sulphide Cell**

| | |
|---|---|
| **Cover Performance** | - Very Low Infiltration Cover<br>- Target performance is less than 0.5% infiltration rate(1) |
| **Very Low Infiltration Cover Design** | - Compacted till barrier layer (1 to 1.5m thick)<br>- Loosely compacted till layer as store and release component and growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Alternative Cover Design** | - Liner protecting bedding layer (0.3m compacted granular material or geotextile)<br>- Synthetic liner (Bituminous or HDPE)<br>- Liner protecting bedding layer(0.3m compacted granular material, or geotextile)<br>- Loosely compacted till layer as growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Other Design Criteria** | - Install on highly reactive waste<br>- Maximum down slope run of 100m with maximum runoff length of 50m<br>- Construct swales so run-off is away from streams and rivers and avoid run-off down plateaus<br>- Seed and fertilize using a low-flying helicopter application rate |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

## Preliminary Design and Construction Methods

### Baritic Fines

On the northeastern side of the dump there is an area where baritic fines have been stockpiled (Figure 6.6). The area of fines is 11,400 $m^2$. The baritic fines will be covered with a very low infiltration cover, which must be completed prior to regrading the waste rock (Figures 6.7 to 6.9). The waste rock upslope of the fines will be sloped to 3H:1V and covered with a low infiltration cover.

**Waste Rock**

In order to place a cover on the Vangorda Dump the slopes must be regraded. The main dump slopes will be regraded to 3H:1V to allow the placement of low infiltration cover. The majority of the dump will have the slopes regraded by pushing material from the crest down towards the toe area. There are some areas of the dump where the toe cannot be extended. Some of these areas may require material to be pushed sideways or hauled. There are some areas on north and south side that may require slightly steeper slopes (i.e. 2.7H:1V) in order to minimize the amount of material that has to be hauled or pushed sideways. There is a cut and fill balance for the material and therefore, no additional material will be required for regrading. Figures 6.8 and 6.9 show typical sections of the regraded (3H:1V) dump slopes.

**In Pit Waste Rock Piles**

There are also smaller waste rock dumps in the southeastern portion of the Vangorda Open Pit. The pit lake will not rise far enough to cover these dumps with water, so they will be regraded to 3H:1V slopes and covered.

The low infiltration cover on the Vangorda Dump and waste rock piles in the pit area will consist of 1m of lightly compacted till overlaying 1m of compacted till, the density of which would be between 1800 and 2000kg/$m^3$. Till tends to hold its density and is not expected to break down with freeze/thaw cycles. Slopes will not be steeper than 3H:1V. A typical section through the cover is shown on Figure 6.7 (Detail 2).

Once the cover is placed, surface run-off will be considered clean and so no treatment of surface runoff is required, but drainage swales or resloping will be incorporated to control the runoff. There is an existing ditch at the toe of the slope that is currently used to collect and direct the seepage to Little Creek Pond. This ditch will act as a temporary sediment control during construction. New seepage collection wells will be placed at the toe of the dump slopes to collect and pump water to the pit.

All areas will be revegetated. Revegetation will follow within days of resloping. Dump slopes will be broken into south, east, north, and west facing. The south slopes are more susceptible to erosion and are windswept so they will have a different vegetation cover treatment than other slopes. Rooting depth is important and so the upper 1m of loose till will ensure that roots are able to find moisture and will not be stressed.

### 6.2.4 Vangorda Creek Diversion – Activity 303 (Early Remediation Project)

The final design for the permanent realignment of the Vangorda Creek diversion is currently in progress. Energy dissipation, erosion prevention measures and an intake structure which may limit the flow into the new diversion will be incorporated into the final design.

Table 6.4 provides design criteria for this activity.

**Table 6.4: Vangorda Diversion Design Criteria**

| | |
|---|---|
| **Plunge Pool** | At outlet of diversion |
| **Channel slope** | Variable, up to 11% |
| **Slope protection** | Riprap on slopes in soil greater than 1% or in poor rock |
| **Side slopes** | 2H:1V for till or fractured rock; 1H:1V for competent rock |

### Preliminary Design and Construction Methods

During the initial stages of the current design several vertical and horizontal alignments were examined to optimizes the cut and fill volumes. The current alignment follows a near-surface route varying in grade from 1.5 percent in the upper reaches to a relatively steep grade of 11% in the lower reach before entering the plunge pool and the existing dropbox system.

A stepped chute approach was initially considered for as an energy dissipation measure in the steep sections of the diversion. However, the overall length of this steep section and the fact that no similar type of structure has ever been attempted, has resulted in a delay in this early remediation project until 2011.

## 6.2.5 Upgrade Surface Runoff Interceptor Ditch to Dixon Creek – Activity 303.3

Uncontaminated surface runoff from the northeast side of the Vangorda will be diverted to the south and into Dixon Creek via the Dixon Creek Diversion. Its location is shown in Figure 6.10.

Table 6.5 provides the conceptual design criteria for the Dixon Creek Diversion.

**Table 6.5: Dixon Creek Upgrade Design Criteria**

| | |
|---|---|
| **Hydraulics** | - Peak flow corresponding to a 1:500 year event<br>- Minimum 0.5% grade along the channel alignment<br>- Channel will be lined only if necessary to minimize seepage into the ground |
| **Ice and Permafrost Conditions (if applicable)** | - Minimal ice damming due to low winter flows(1)<br>- Liner (if required) will not be exposed |
| **Water Quality** | - Minimal risk of water contamination as all the inflow will be considered clean water |
| **Maintenance and Monitoring** | - A maintenance access route will be constructed along the channel alignment<br>- Minimal maintenance and monitoring is expected |
| **Revegetation** | - All disturbed areas from construction will be revegetated |

### Preliminary Design and Construction Method

Prior to the upgrade of the Dixon Creek Diversion, a detailed field investigation will be required to define soil conditions for design purposes, specifically for identification of zone where seepage losses could be a concern. Examination for frozen soil will also be conducted.

The channel will be upgraded to pass the 1:500 year storm. This will require a minimum of 1.5m in channel depth and a base width of at least 1.5m. Depending upon the results of the seepage

investigation, the base materials in the channel may also need to be upgraded. A filter material and riprap sized for the flows in the channel will be placed in order to prevent erosion. Cross-sections showing the minimum requirements in the channel are shown on Figure 6.10.

### 6.2.6 Grum Pit– Activity 304

Safety berms will be constructed to restrict access to the pit. *In situ* bioremediation of the Grum pit water is planned. A series of polishing ponds will be constructed in the Slot which will allow biomass trapped in the pit to be treated prior to discharge into natural drainage. Continuous monitoring will be carried out and further water treatment might be required depending on the water quality after the bioremediation. See Figure 6.11.

Table 6.6 outlines the design criteria for the Grum Pit safety berms.

**Table 6.6: Design Criteria for Grum Pit Safety Berms**

| | |
|---|---|
| **Safety Berm** | Minimum 2 m in height<br>Crest width of 1m<br>Sideslopes of minimum 2H:1V<br>Minimum 5 m offset from current pit wall crest |

#### Preliminary Design and Construction Methods

A safety berm will be constructed around the Grum Pit to restrict access. An access road will be built along the alignment of the berm. The berm will be 2m high with 2H:1V sideslopes. The construction will be a typical load, haul, place and dump operation with little variation and a dozer will be used to shape the berms.

All the granular construction material will be sourced from local borrow identified in Section 8.

The fertilization of Grum Pit entails the distribution, by boat, of about 320L of fertilizer mix to the surface of the pit lake during each fertilization event. The fertilizer addition is repeated weekly from early June until the end of July each year. The water is then tested to determine the success of the program. Evaluations of the current treatment program indicate that biological treatment effectively removes the same amount of zinc loaded into the pit lake each year, so that there is no net gain of zinc experienced in the pit lake. Overall depth weighted concentrations have decreased from 10 mg/L at the start of the program to 6.5 mg/L during last year's evaluation.

Evaluation of the effectiveness of the biological treatment will continue and future water treatment strategies will be based on the results of the evaluations. If the *in-situ* bioremediation eventually proves to be an ineffective, other treatment options will be examined.

### 6.2.7 Breach Grum Interceptor Ditch and divert to Grum Pit – Activity 305

This activity involves breaching the existing Grum Interceptor Ditch and the Grum settling pond and routing the flow into the Grum Pit. Currently biological treatment through the growth of algae that

uptakes zinc is utilized for the removal of zinc from the pit lake water. Once pit lake chemistry supports a flow-through operating system at the Grum Pit, this activity will take place.

Table 6.7 shows a preliminary design criteria for the Grum Interceptor Ditch.

**Table 6.7: Preliminary Design Criteria for Grum Interceptor Ditch**

| | |
|---|---|
| **Hydraulics** | - 1:500 year, 24 hr storm<br>- Minimum 0.5% grade along the channel alignment |
| **Ice and Permafrost Conditions** | - No permafrost is anticipated in the specified area at the time of the writing of this document. Further field investigation would be required to confirm this |
| **Water Quality** | - Discharge water quality shall meet the requirements listed in the Water License (Number QZ03-059), Part C |
| **Maintenance and Monitoring** | - Post construction monitoring will be required to determine possibility of free discharge of treated water<br>- Regular maintenance will be need in the polishing pond to ensure performance |

### Preliminary Design and Construction Methods

An access road will be constructed along the proposed ditch alignment, shown in Figure 6.11. An earth dam will be built at the headworks using low permeability material from a local borrow area. The earth dam will reroute the runoff from the original diversion channel to the new interceptor. The trapezoidal interceptor channel will be excavated into the overburden material with a 1m bottom width and depth at 2H:1V side slopes up to the pit crest. The water is then allowed to run off the pit walls and into the pit. Slots will be cut into the pit bench crest if necessary to let the water flow through. Channels will be excavated along flat sections of the alignment and berms will be constructed if excavation is not possible.

A slot cut will be constructed in the south end of the Grum Pit to allow water to flow through and to prevent overtopping the pit. A series of polishing ponds will be constructed upstream of the slot cut to act as an algae filter and trap the biomass before discharge. The polishing ponds will be wetland type feature constructed in a terraced configuration to slow the flow of water so the biomass can be consumed prior to discharge to the environment.

## 6.2.8 Grum Waste Dump, covers – Activity 306 and 307

The objectives of reclamation of Grum Dump (Figure 6.14) are as follows:

- To create long-term, geotechnically stable landforms (with recognition that maintenance will be required).
- To control infiltration.
- To maintain proper surface water drainage.
- To maintain vegetation growth.

Preliminary design criteria for the reclamation work at the Grum Dump are given in Tables 6.8 and 6.9.

**Table 6.8: Preliminary Design Criteria for Grum Waste Rock Reclamation**

| | |
|---|---|
| **Cover Performance** | - Rudimentary cover<br>- Infiltration less than 20% of MAP (Range 15-25%)(1) |
| **Rudimentary Cover Design** | - Loosely compacted till layer as store-and-release component and growth medium (0.3 to 1m thick)<br>- Revegetation<br>- Internal slopes to be not steeper than 2H:1V side slopes. Outer slopes to be 3H:1V where practical but not steeper than 2H:1V<br>- Install on all waste rock which does not require low or very low infiltration covers |
| **Other Design Criteria** | - Maximum downslope run of 100m with maximum runoff length of 50m<br>- Ditches and basins to be constructed to control surface run-off<br>- Revegetation suitable to the environment to stabilize slopes and prevent erosion<br>- Seismicity: 0.10g = corresponding to a probabilistic 1:1000 year event<br>- 0.40g = corresponding to a deterministic maximum credible event (MCE) |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

**Table 6.9: Preliminary Design Criteria for Grum Sulphide Cell Remediation**

| | |
|---|---|
| **Cover Performance** | - Very Low Infiltration Cover<br>- Target performance is less than 0.5% infiltration rate(1) |
| **Very Low Infiltration Cover Design** | - Liner protecting bedding layer (0.3m compacted granular material or geotextile)<br>- Synthetic liner (Bituminous or HDPE)<br>- Liner protecting bedding layer(0.3m compacted granular material, or geotextile)<br>- Loosely compacted till layer as growth medium 1m thick)<br>- Revegetation |
| **Other Design Criteria** | - Install on highly reactive waste<br>- Maximum down slope run of 100m with maximum runoff length of 50m<br>- Construct swales so run-off is away from streams and rivers and avoid run-off down plateaus<br>- Seed and fertilize using a low-flying helicopter application rate |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

## Preliminary Design and Construction Method

The main dump slopes will be regraded to a 3H:1V. Based on results of slope stability analyses, the internal dump slopes may be as steep as 2H:1V but all outer slopes will remain no steeper than 3H:1V. A CAT D10 type dozer will regrade the dump slopes by pushing material from the crest down towards the toe area. This process will be repeated in layers until the desired slope angle is achieved. There is a material balance between the pushed material on the crest and the deposited material at the toe; therefore, no additional material will be required for regrading. Figure 6.12 shows typical sections of the regraded (3H:1V) dump slopes.

A portion of the slope running next to the "Main Stem of Grum Creek" will be pulled back as shown on Figure 6.13. The toe of the slope cannot be pushed forward as it is close to the creek.

The Main Dump and Sulphide Cell will have different types of cover since they differ in geochemistry; the sulphide cell being much more reactive. A very low-infiltration cover will be placed over the sulphide cell and its buffer zone as part of an early remediation project planned for

2010. The very low-infiltration cover incorporates a synthetic liner sandwiched between either 0.3m thick layers of bedding material or geotextile, overlain by 1m of lightly compacted till. The purpose of the very low-infiltration cover is to significantly reduce the amount of water entering the surface of the waste (less than 0.5% of Mean Annual Precipitation).

The Main Dump will be covered with a rudimentary cover, which has the minimum thickness of soil needed to allow plant growth. The rudimentary cover consists of 1m of lightly compacted till.

Surface water will be managed by lined and unlined plateau channels and a number of armoured slope channels. It is assumed that surface water will be clean but it is recognized that sediment control will be necessary. To address this, sediment control ditches and basins will be constructed.

### 6.2.9 Grum Overburden Dump

The Overburden Dump (Figure 6.5) is the primary source of glacial till borrow material (8Mm$^3$). It is anticipated the all the material present in the Overburden Dump will be used, as discussed in Section 8 of this report. Furthermore, current till borrow requirements call for an additional 1Mm$^3$ of till to be excavated from beneath the overburden dump. Once all borrow material at the dump has been removed, the area will be regraded and revegetated as per the requirements in Chapter 9.

### 6.2.10 Ore Transfer Pad – Activity 308

#### Design Criteria

The Grum Ore Transfer Pad (GOTP) consists of an estimated 1,259,000m$^3$ of remaining ore and phyllite waste rock. The current plan is to place a very low infiltration cover over this material.

Table 6.10 shows the design criteria for the GOTP.

**Table 6.10: Preliminary Design Criteria for Ore Transfer Pad**

| | |
|---|---|
| **Cover Performance** | - Very Low Infiltration Cover<br>- Target performance is less than 0.5% infiltration rate(1) |
| **Very Low Infiltration Cover Design** | - Compacted till barrier layer (1 to 1.5m thick)<br>- Loosely compacted till layer as store and release component and growth medium (0.3 to 1m thick)<br>- Revegetation<br>- Not steeper than 3H:1V side slopes |
| **Alternative Cover Design** | - Liner protecting bedding layer (0.3m compacted granular material or geotextile)<br>- Synthetic liner (Bituminous or HDPE)<br>- Liner protecting bedding layer(0.3m compacted granular material, or geotextile)<br>- Loosely compacted till layer as growth medium (0.3 to 1m thick)<br>- Revegetation |
| **Other Design Criteria** | - Install on highly reactive waste<br>- Maximum down slope run of 100m with maximum runoff length of 50m<br>- Ditches and basins to be constructed to control surface run-off<br>- Revegetation suitable to the environment to stabilize slopes and prevent erosion |

(1) Infiltration Rate = % of Mean Annual Precipitation (MAP)

### Preliminary Design and Construction Methods

The existing GOTP has a current volume of 1,259,000$m^3$ and footprint of 142,486$m^2$. The pad will receive a very low infiltration cover and will be seeded and allowed to revegetate naturally. The temporary sediment collection ditch will be constructed to divert run-off from the revegetated ore transfer pad away from a nearby stream until the vegetation has taken hold, then the ditch will be removed.

## 6.2.11 Grum Groundwater Collection – Activity 309

The objective of this work is to capture contaminated groundwater seeping from the Grum Waste Rock Dump. Interception will be implemented as an adaptive management plan, focusing initially on high concentration areas and utilizing an extensive monitoring system to identify areas requiring system upgrade. More details are provided in Chapter 8 of this report.

Table 6.11 lists design criteria for the Grum groundwater SIS with information quoted from both previous and ongoing SRK studies.

**Table 6.11: Grum Groundwater Interception**

| | |
|---|---|
| **Extraction Wells** | - Pumping wells<br>- Automatic controls<br>- Individual insulated, heat trace pipelines to central pond |
| **Central Pumping Sump** | - Excavated pond<br>- Geotextile liner<br>- Rip rap protection<br>- Pump to direct water to Vangorda Pit via pipeline<br>- Heated enclosure for pump and pump controls |
| **Pipeline** | - Insulated, heat trace pipeline to Vangorda Pit |
| **Monitoring and Maintenance** | - Down gradient groundwater monitoring system<br>- Periodic re-development of pumping wells<br>- Periodic replacement of pumps<br>- Periodic removal of fines from pond |
| **Contingency** | |
| **Cut-off Wall** | - Keyed into bedrock |
| **Permeable collector trench** | - Collector trench up gradient of cut-off wall<br>- Backfilled with permeable fill |
| **Pumps** | - Pumps would be installed along the collector trench to pump water to central sump<br>- Individual insulated, heat trace pipelines to central sump |

### Preliminary Design and Construction Method

The access road below the Grum Dump would be upgraded to ensure construction vehicle access. Pads for pumping wells would be constructed and pipeline alignments cleared. The central pond would be excavated in the vicinity of where Grum Creek crosses the access road. Pumping wells would be constructed and pipelines constructed from each pumping well to the central pond. The primary discharge pump would be housed in a heated enclosure on the side of the central holding pond. Groundwater monitoring wells would be installed between and down-gradient of pumping wells.

If monitoring indicated insufficient capture of contaminated groundwater, a cut-off wall and permeable collector trench would be constructed uphill of the access road. Pumps would be installed in the collector trench and direct water to the central pond.

The primary discharge pipeline would run along the access road, to the Vangorda Pit. Optimization and detailed design will be done during the detailed engineering design phase (See Figure 6.16).

### 6.2.12 Vangorda Waste Rock Dump Seepage Collection – Activity 309.4/6

There is currently a seepage collection system in place at the Vangorda Waste Rock Dump. This system consists of French Drains which funnel the seepage into a seepage collection ditch that discharges to Little Creek Pond. More active collection of groundwater seepage from the VWRD is currently not required, but may become necessary in the future if contaminant concentrations increase sufficiently. RGC (2007) completed a review of groundwater quality data from monitoring wells surrounding the Vangorda WRD and noted that, while "seepage collection is not yet required and generally has a lower priority than elsewhere on the site", an increase in contaminants of concern in a couple of monitoring wells were observed. The relatively slow rate of contaminant increase was attributed to the low permeability of till units underlying the WRD. Contaminant loading would also be minimized by placement of WRD covers, which will decrease infiltration and, subsequently, seepage. A conceptual design for a groundwater collection system will be developed when necessary.

Additional field investigation will be required to complete detailed engineering, but it is assumed that all intercepted seepage is pumped to the Vangorda Pit.

Table 6.12 provides design criteria for seepage collection at the Vangorda Waste Rock Dump.

**Table 6.12: Preliminary Design Criteria for Vangorda Waste Rock Dumps Seepage Collection System**

| | |
|---|---|
| **Groundwater Collection System** | - Pumping wells with stainless steel screens and stainless steel riser pipes<br>- 10+ pumping wells<br>- Heat trace and insulation<br>- Automatic level/flow controls with flow meters and dataloggers |
| **Monitoring and Maintenance** | - Monitoring wells down gradient of WRD, Little Creek Dam and haul road at Vangorda Creek alignment.<br>- Completed in bedrock and overburden materials.<br>- Monitoring wells monitored quarterly.<br>- Periodic well development required to maintain efficiency.<br>- Periodic pump replacement |

#### Preliminary Design and Construction Method

Contaminated groundwater seepage collection would consist of pumping wells installed from the existing access road along the toe of the WRD. If necessary, additional access would be completed from this road to minimize impacted area. Pumping wells would be installed and developed using contemporary drilling methods. Discharge pipeline(s) would be aligned along the existing road to

Vangorda Pit. All pipelines would be insulated and heat traced. Additional monitoring wells would be installed to assess performance and additional contingency measures would be outlined as part of an updated adaptive management plan. Figure 6.17 shows a preliminary conceptual layout for groundwater collection.

Little Creek Pond will not continue to operate as a seepage collection pond. It may be removed or used as a polishing pond for the water treatment plant.

### 6.2.13 Miscellaneous Closure Activities in Vangorda/Grum Area – Activity 311

Miscellaneous activities include, but are not limited to:

- Site road closures;
- Building demolition and reclamation;
- Breaching the dams at the Sheep Pad Ponds (sediment ponds) and WTP Settling Pond, (see Figure 6.18);
- Removal and proper disposal of existing sludge;
- Hazardous material removal and contaminated soil reclamation; and
- Establishment of a new landfarm for hydrocarbon contaminated soil treatment.

There are number of site access roads that will be decommissioned prior to final closure of the site. Some of these roads have associated culverts and stream crossings. The existing buildings will not be needed post-closure and will be a long-term safety hazard. There are hazardous materials and contaminated soils around the site that could cause long-term impact on the surrounding environment. Some of the contaminated soil and waste contain hydrocarbon and other chemicals, which will be treated differently from the net acid generating material.

Sludge from the existing Vangorda water treatment plant is periodically removed from the sludge pond to cells contained within the Grum Overburden dump. During closure the sludge will be removed from these cells and transported to the Grum Pit. The Water Treatment Settling Pond will be breached and covered after the new plant is operational (see Chapter 8).

#### Objectives

Under Best Practice Management, all the unnecessary roads should be reclaimed to prevent long-term erosion and crossings breached to prevent blockage. The buildings will be demolished along with their foundations. Only the contaminated foundation components will be removed for proper disposal while the clean foundations will be covered in place and revegetated. The dams forming the Sheep Pad Ponds and the WTP Settling Pond, will be breached and riprapped accordingly. A landfarm will be constructed on site to treat hydrocarbon wastes. All other hazardous wastes will be consolidated and transported off site for proper disposal.

Table 6.13 outlines the reclamation work for the miscellaneous closure activities.

**Table 6.13: Design Criteria for Miscellaneous Closure Activities**

| | |
|---|---|
| **Road Closures** | - All culverts and crossing will be breached and resloped to angle of repose<br>- Scarify road surface and revegetate |
| **Buildings Demolition** | - Demolition protocol will follow Federal and Provincial Codes |
| **Landfarm** | - Size: 50m x 25m x 2m (estimated)<br>- Liner: HDPE and Geotextile filter fabric<br>- Location to be determined |
| **Hazardous Waste** | - Type: e.g. paints, oils, acids, reagents<br>- Transport: regulated<br>- Destination: off site |
| **Dam Breaches** | - Water level must be below the final breach grade<br>- Sediment controls to be in place prior to any work on or nearby water source<br>- Final channel bottom of 2m<br>- Side slope minimum 3H:1V<br>- Minimum 0.5m of riprap along flow path |

## Preliminary Design and Construction Methods

Road closure will be carried out by an excavator scarifying the road surface and pulling safety berm onto the road if necessary. The revegetation will be carried out using low-flying helicopters.

Prior to any demolition works, a full inspection will be conducted on all site buildings to identify all hazardous waste, salvageable materials, and structural safety concerns. A solid waste management plan will be developed and a list of permits prepared. All non-salvageable material and non-hazardous wastes would be buried within the toe of the resloped waste rock dump. Salvageable materials and hazardous wastes would be transported offsite for proper disposal. The building demolition would be performed mostly by special excavators with thumb and claw, and jackhammer attachments. Cranes and loaders would also be needed for heavier components. The contaminated foundation will be broken up and buried in the landfill. Clean foundation will be left in place and covered with 0.5m of loose growth medium and revegetated with an application by a low-flying helicopter.

A landfarm will be constructed on site for hydrocarbon contaminant treatment. The location has not been confirmed but is likely to be on a waste rock dump nearby the mill site. The facility will be lined and sized according to the amount of estimated waste. The current estimated size of the landfarm is 50m x 25m x 2m, with allowance to be adjusted during detailed engineering. The lining system will be a 1.5mm HDPE liner sandwiched between two layers of 542g/$m^2$ non woven geotextile. Granular soil cushioning layers will be deployed as a base and a topping cap in the landfarm. A dose of fertilizer will be spread over the initial contaminated soil to facilitate bacteria growth. The landfarm will require minimum maintenance to mix the contaminated soil for thorough treatment. Testing will be done on the material to ensure neutralism prior final closure cover with 0.5m of growth medium.

Existing sludge from the WTP and the Overburden Dump will be trucked to the Vangorda Pit for disposal. The sludge should be pumped to the bottom of the pit or tremied so as to not mix the sludge with the pit water or disturb pit bottom sediments. Once the water treatment settling pond has

been cleaned of sludge, the berm should be breached with a minimum 20m wide channel with 3H:1V sideslopes. The material from the breach will be used to backfill the cell. If more material is required the breach will be made wider. The cell should then be resloped to a minimum of 3H:1V side, slopes covered with a low infiltration soil cover and revegetated. The Sheep Pads Ponds will be breached with 2m wide 3H:1V sideslope notches. These ponds do not require cover. (See Figure 6.18).

# Figures




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Faro Mine Closure
Fermeture de la mine Faro

Project Description (Draft 4)

**Vangorda/Grum Area (300)**
**Current Conditions**

Job No: 1CY001.026

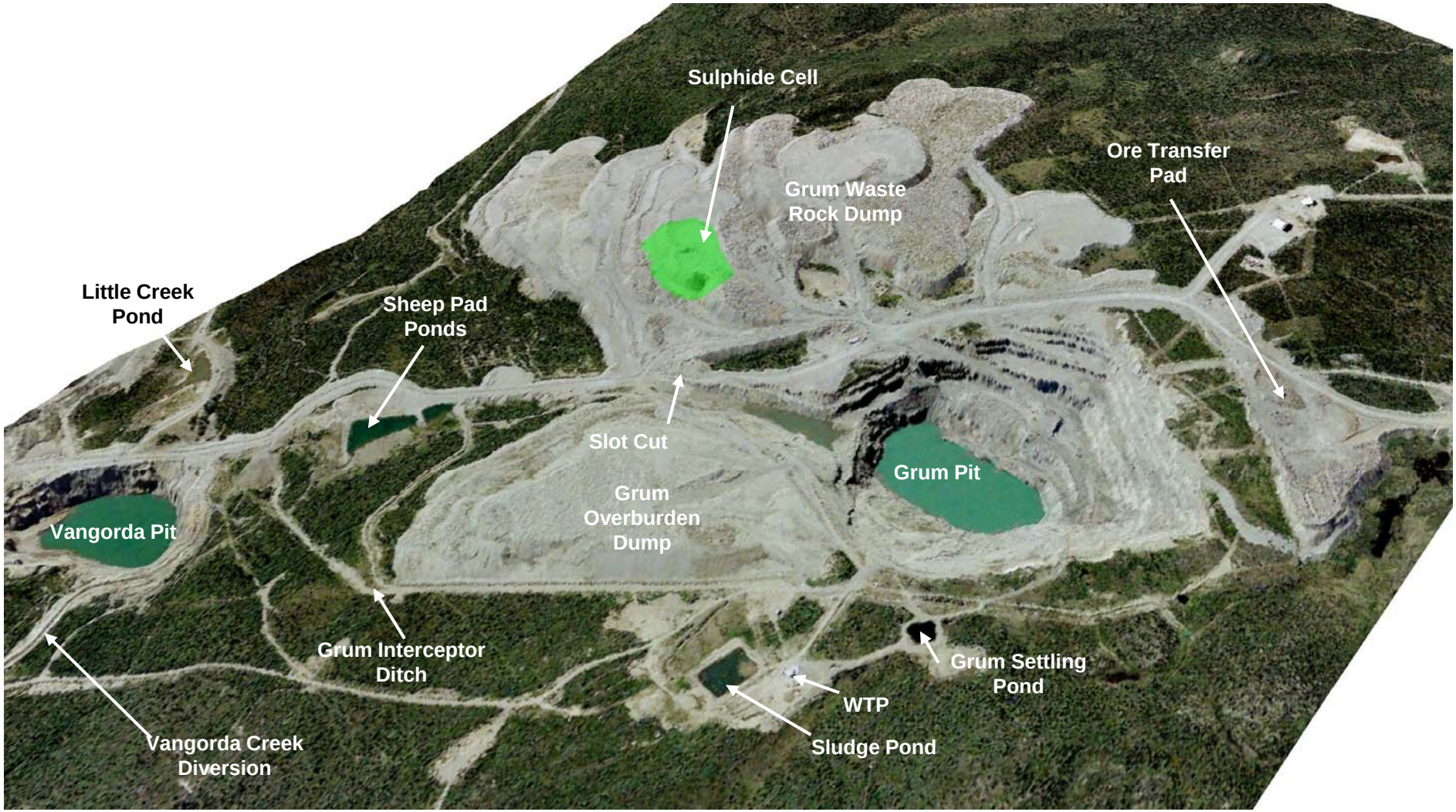
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Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009

Approved:

Figure: **6.1**




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Faro Mine Closure
Fermeture de la mine Faro

Job No: 1CY001.026

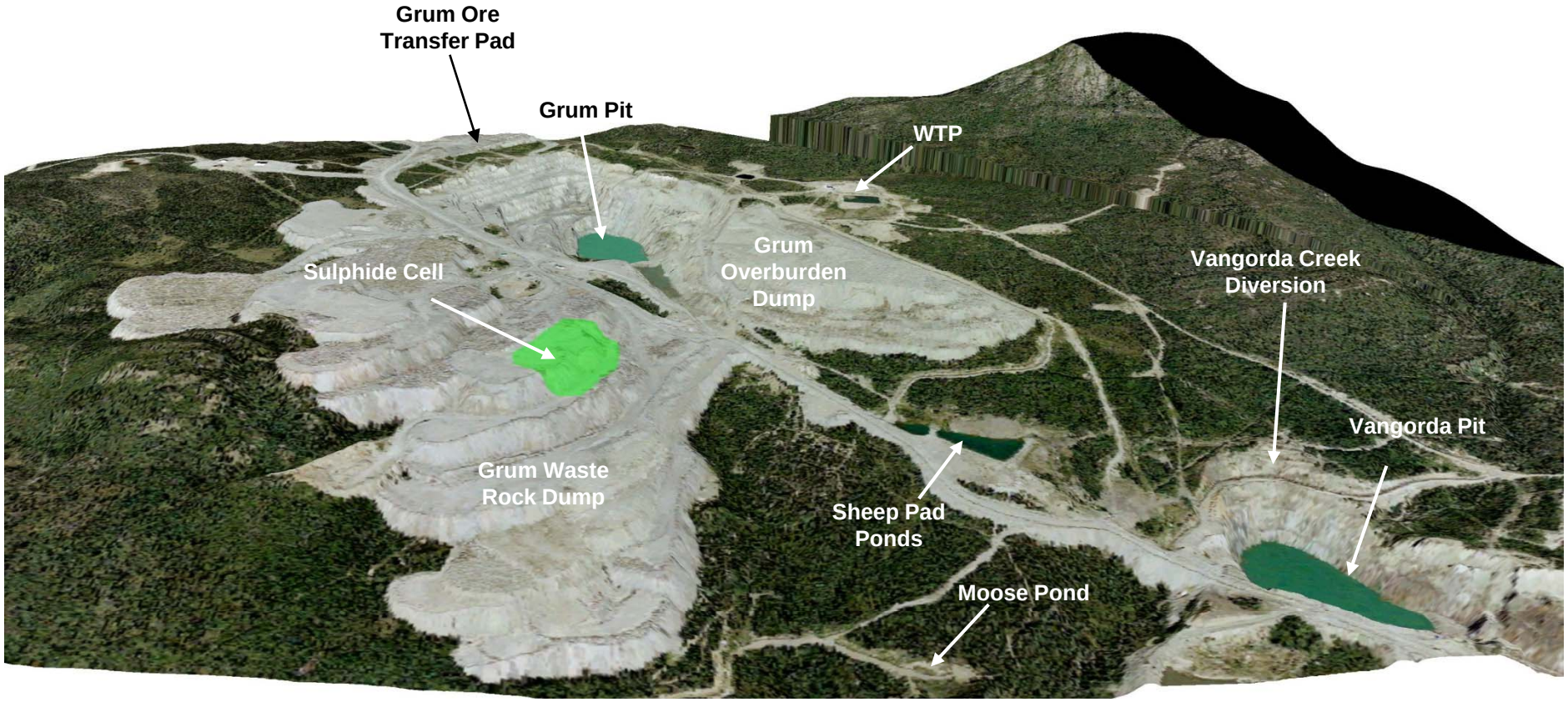
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Vangorda/Grum Area (300)**
**Current Conditions (View A)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **6.2** |




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Faro Mine Closure
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Project Description (Draft 4)

**Vangorda/Grum Area (300)**
**Current Conditions (View B)**

Job No: 1CY001.026

Filename: Figures_6.1-4_Vangorda-Grum_20091127.ppt

Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009

Approved:

Figure: **6.3**




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Faro Mine Closure
Fermeture de la mine Faro

Job No: 1CY001.026

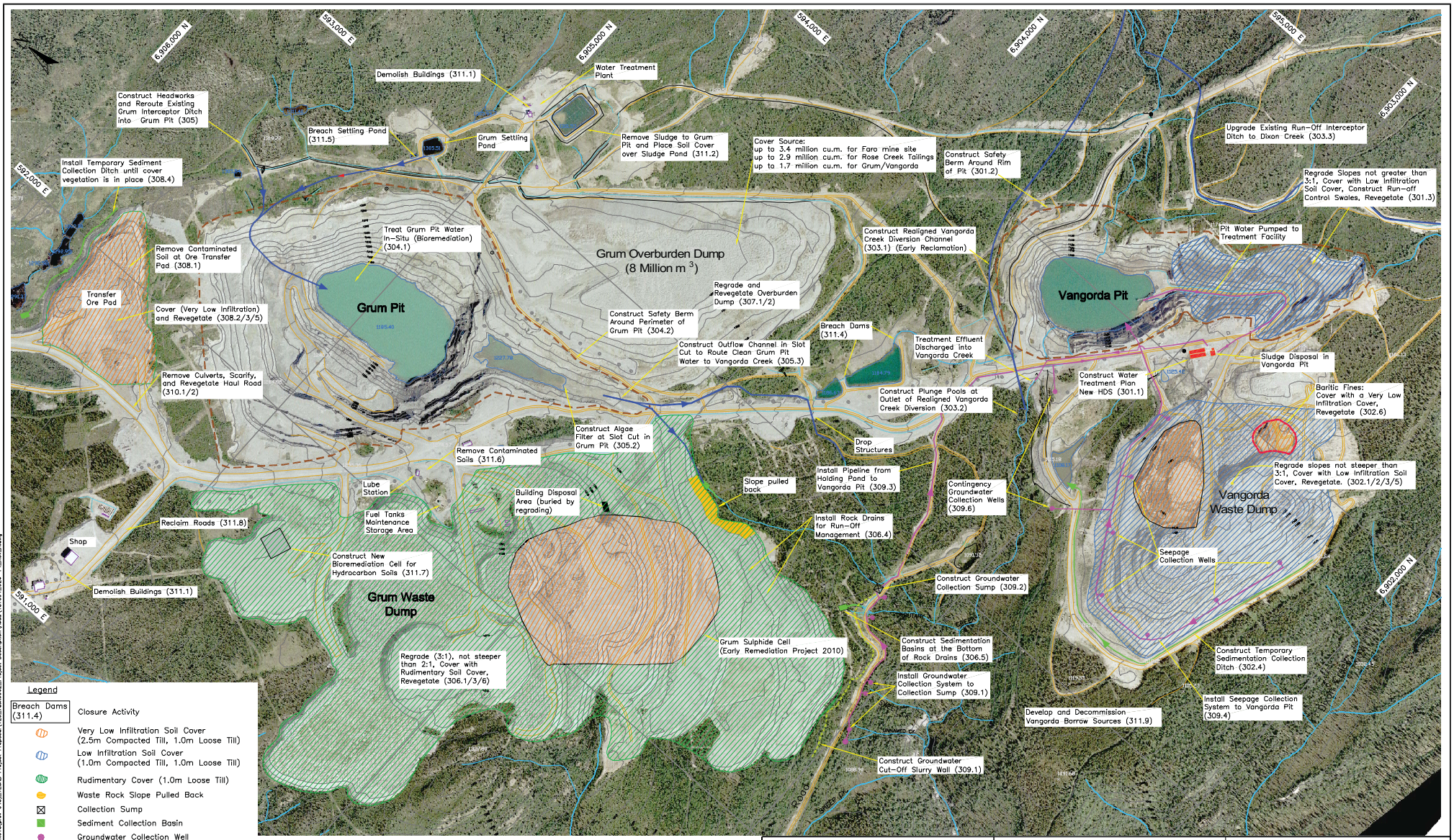
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Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Vangorda/Grum Area (300)**
**Current Conditions (View C)**

| Date: | Approved: | Figure: |
|---|---|---|
| December 2009 | | **6.4** |




Note: 3:1 resloping is defined as 3H:1V.

Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

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FILE NAME: 1CY001_026-14_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

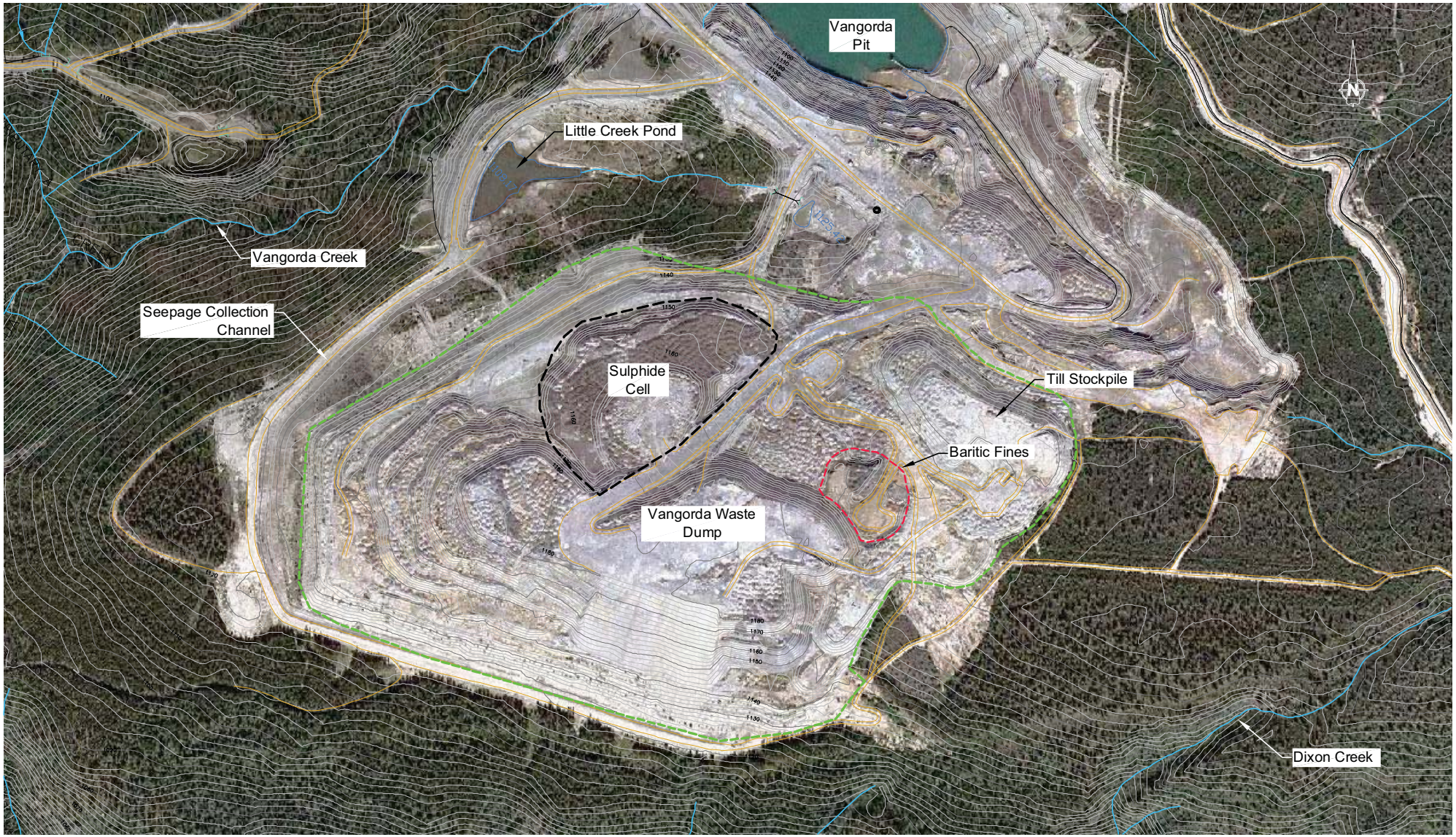
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

# Vangorda/Grum Area (300) Closure Activities

| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 6.5 |

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0 50 100 150 200 250

Scale in Metres

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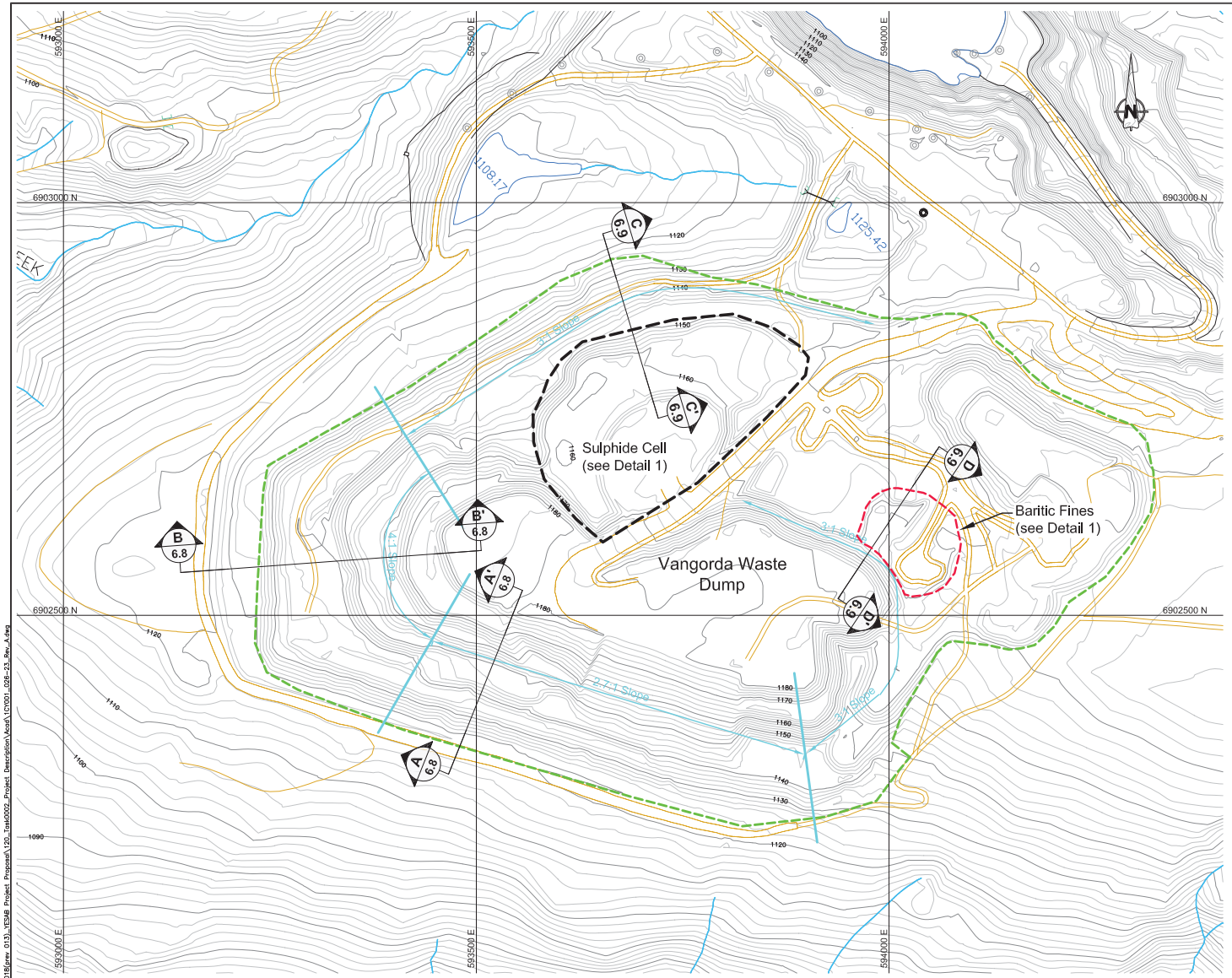
Faro Mine Closure
Fermeture de la mine Faro

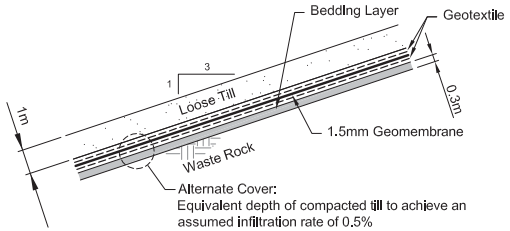
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

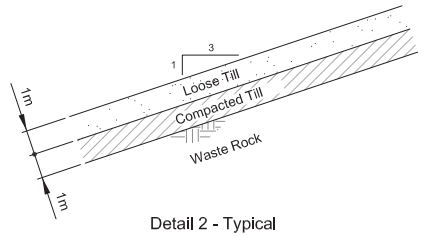
Vangorda Dump
Site Plan
Current Conditions

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.6 |




Detail 1 - Typical Very Low Infiltration Cover Section




Detail 2 - Typical Low Infiltration Cover Section

0 2 4 6 8 10
Scale in Metres

## LEGEND

- Extent of Very Low Infiltration Cover (see Detail 1)
- Extent of Low Infiltration Cover (see Detail 2)

## NOTE

No new disturbances due to regrade at Vangorda waste rock dump,

0 50 100 150 200 250
Scale in Metres

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Faro Mine Closure
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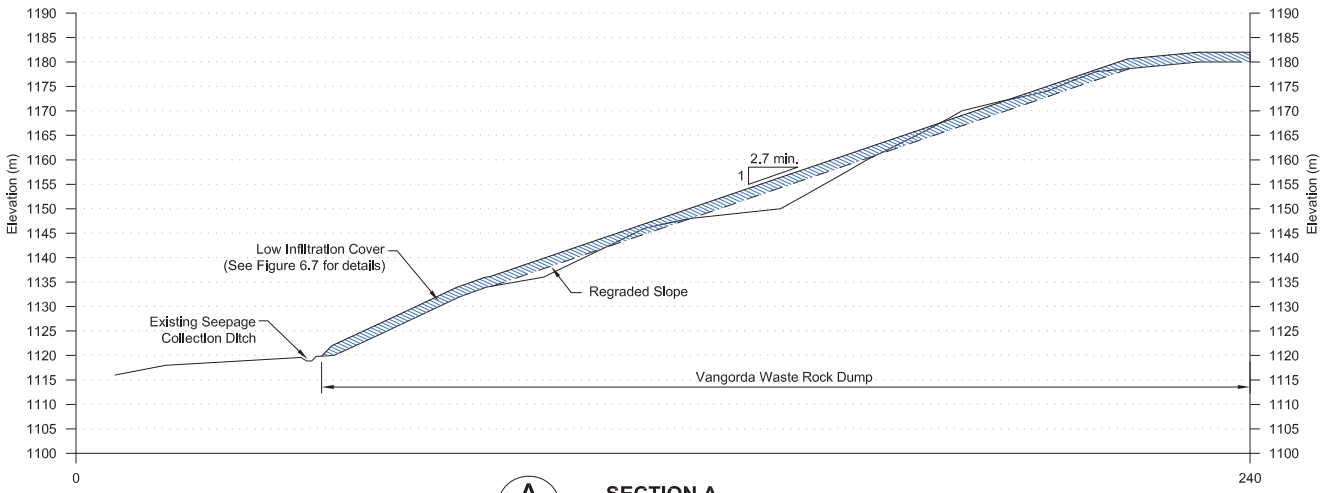
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

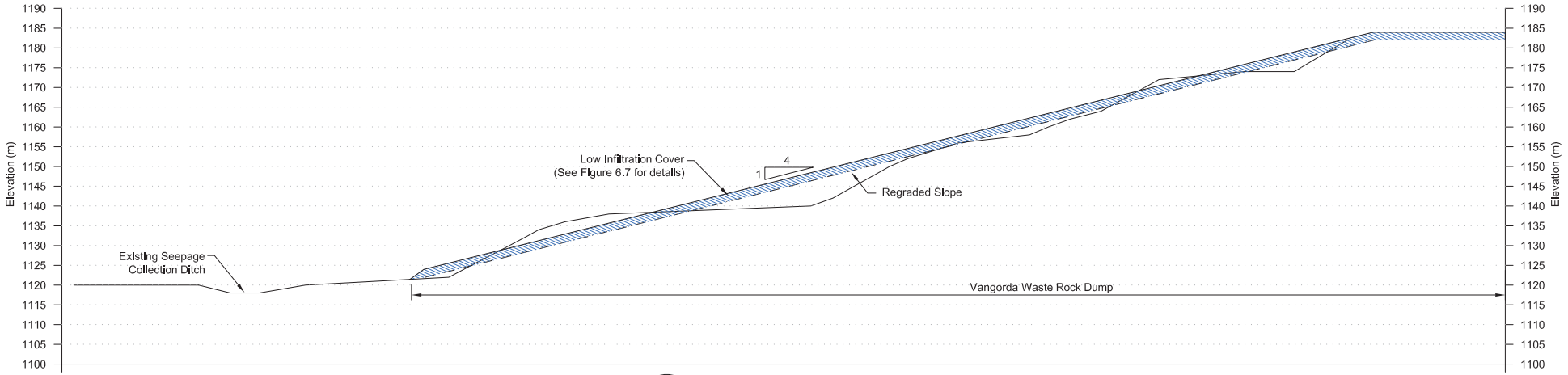
Vangorda Dump
Regrading Plan (302.1)

| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 6.7 |

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**A 6.7 SECTION A**




**B 6.7 SECTION B**

0 10 20 30 40 50
Scale in Metres

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FILE NAME: 1CY001_026-23_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

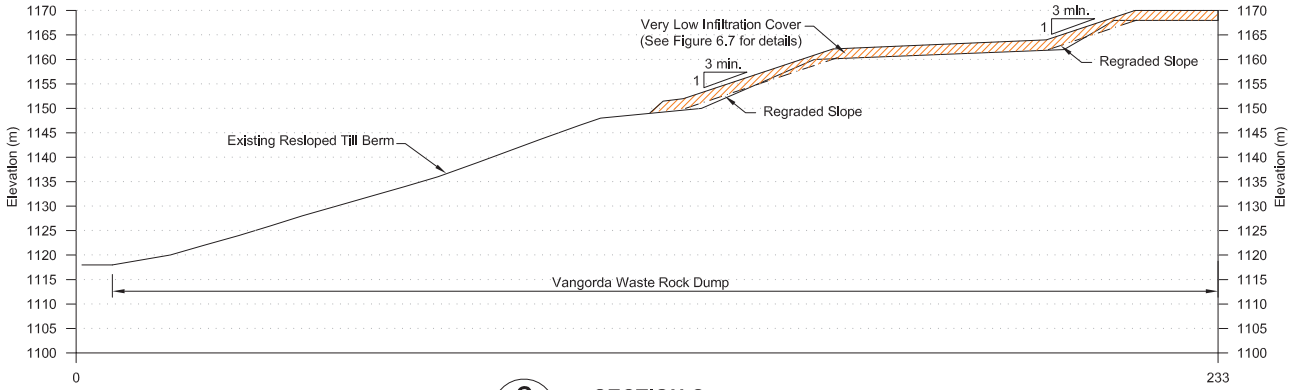
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

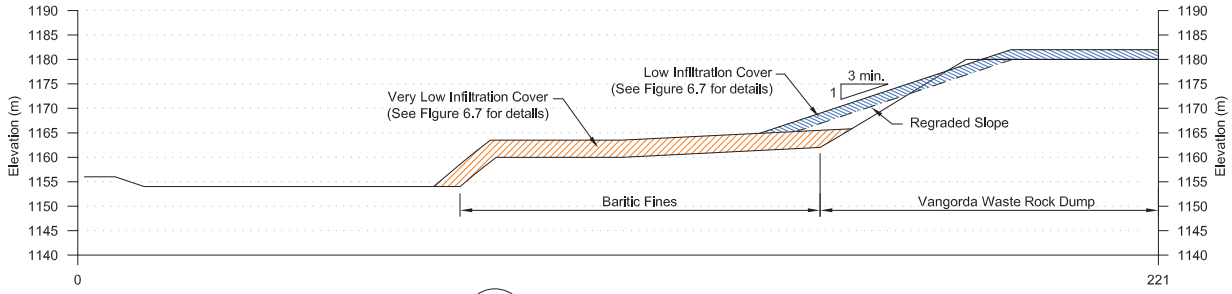
Vangorda Dump
Regrading Sections A & B (302.1)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.8 |

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C 6.7 **SECTION C**




D 6.7 **SECTION D**

0 10 20 30 40 50
Scale in Metres

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FILE NAME: 1CY001_026-23_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

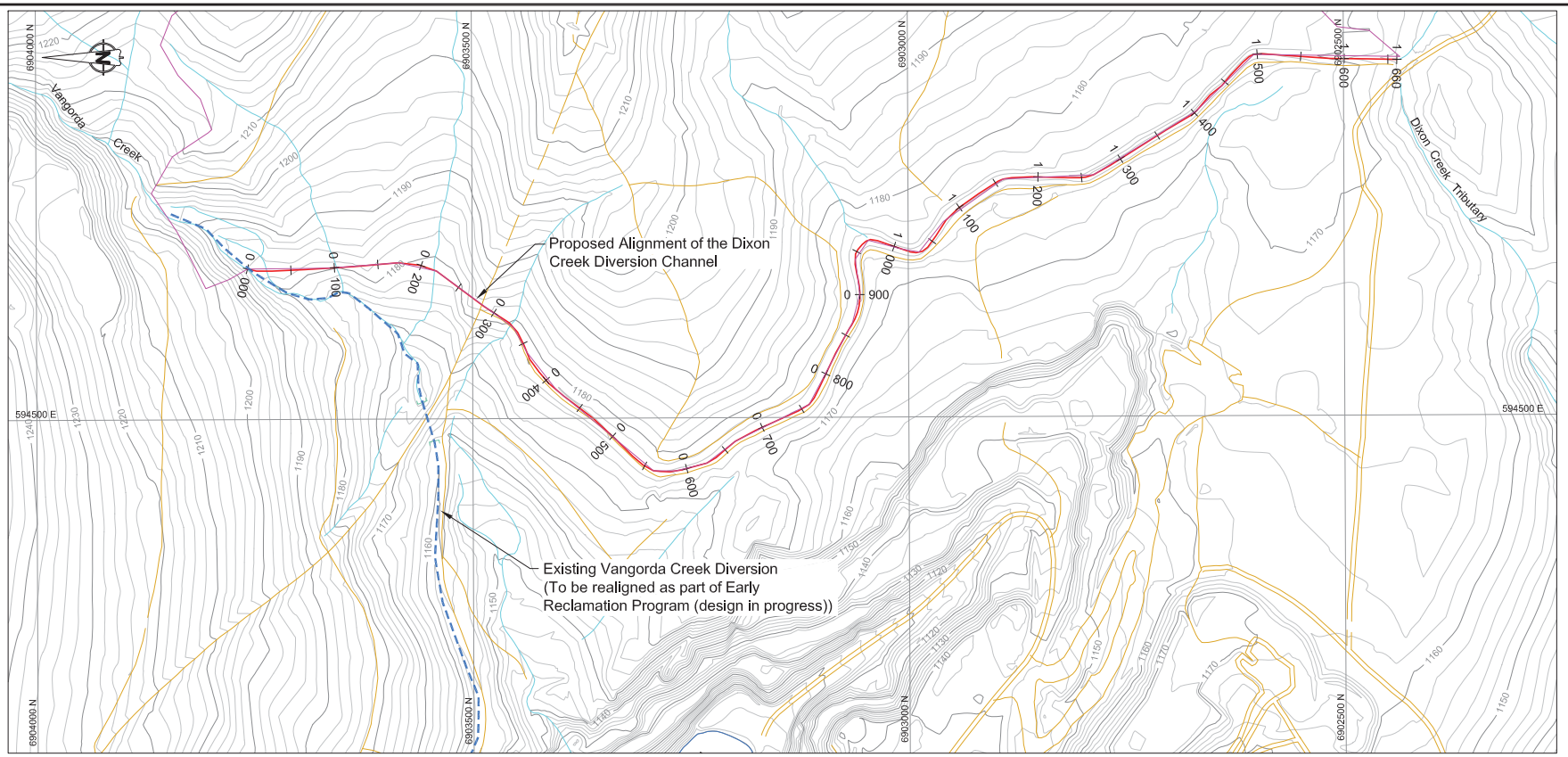
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

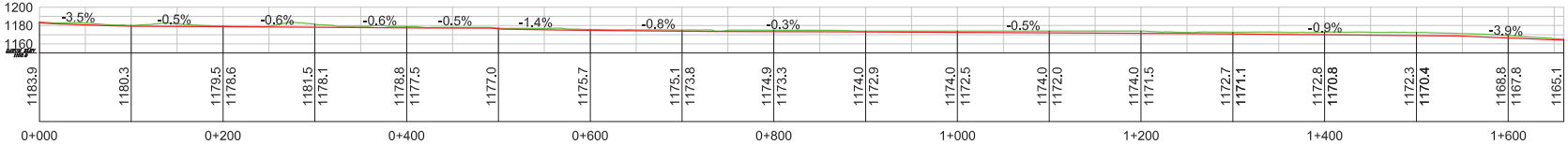
Vangorda Dump
Regrading Sections C & D (302.1)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.9 |

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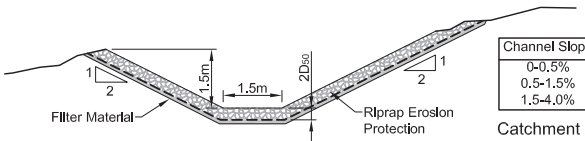



## DIXON CREEK DIVERSION PLAN VIEW




## DIXON CREEK DIVERSION PROFILE

0 50 100 150 200 250
Scale In Metres




## TYPICAL CHANNEL SECTION

0 1 2 3 4 5
Scale In Metres

| Channel Slope | Riprap $D_{50}$ |
|---|---|
| 0-0.5% | 30cm |
| 0.5-1.5% | 30cm |
| 1.5-4.0% | 30cm |

Catchment Area = 1.2km$^2$
Design Peak Flow $Q_{500}$ = 1.8m$^3$/s

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Faro Mine Closure
Fermeture de la mine Faro

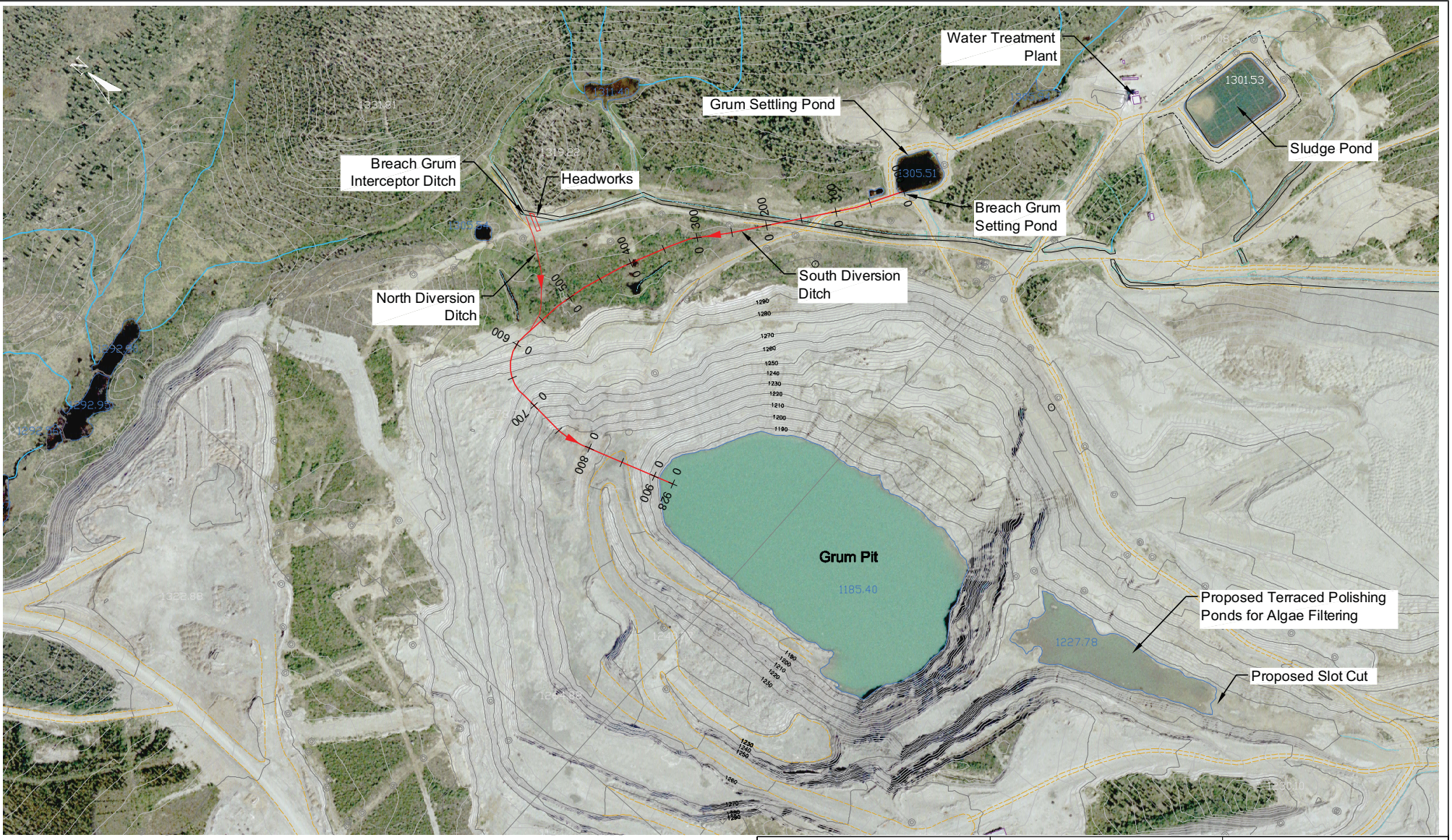
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Dixon Creek Diversion Channel (303.3)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.10 |

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Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

0 50 100 150 200 250
Scale in Metres

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Engineers and Scientists

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-6_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

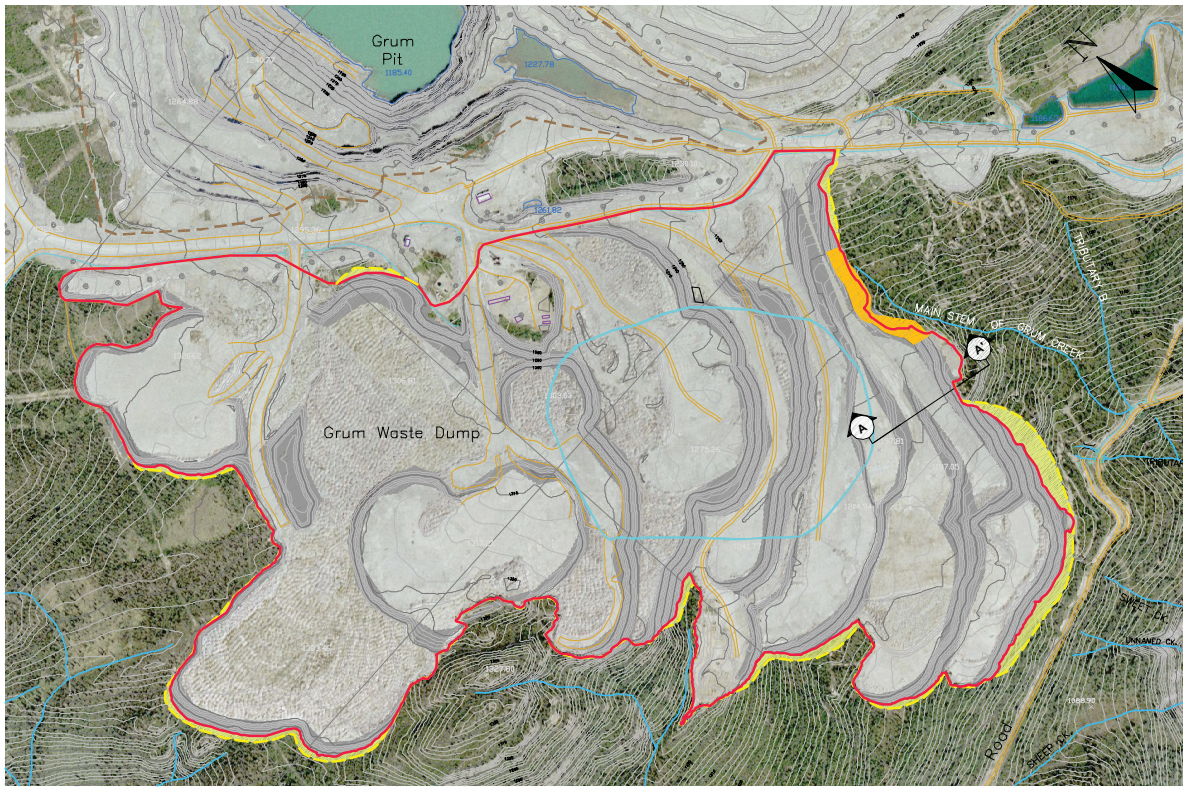
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Grum Settling Pond Diversion (305.1)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.11 |

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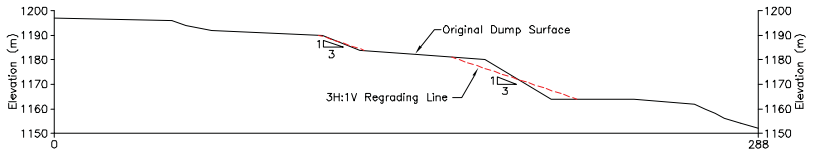

## Legend

- Dumps Slopes to be Regraded to 3H:1V
- Slope Pullback Zone
- Area of Re-Sloping Disturbance (Total Area Disturbed = 37,900m²)
- Grum Dump Boundary
- Sulphide Cell Boundary
- Waste Dump Boundary Before Re-Sloping
- Waste Dump Boundary After Re-Sloping

## Grum Waste Dump Plan

0 100 200 300 400 500

Scale in Metres




## A Section A - A'

0 1 2 3 4 5

Scale in Metres

Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
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FILE NAME: 1CY001_026-2_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

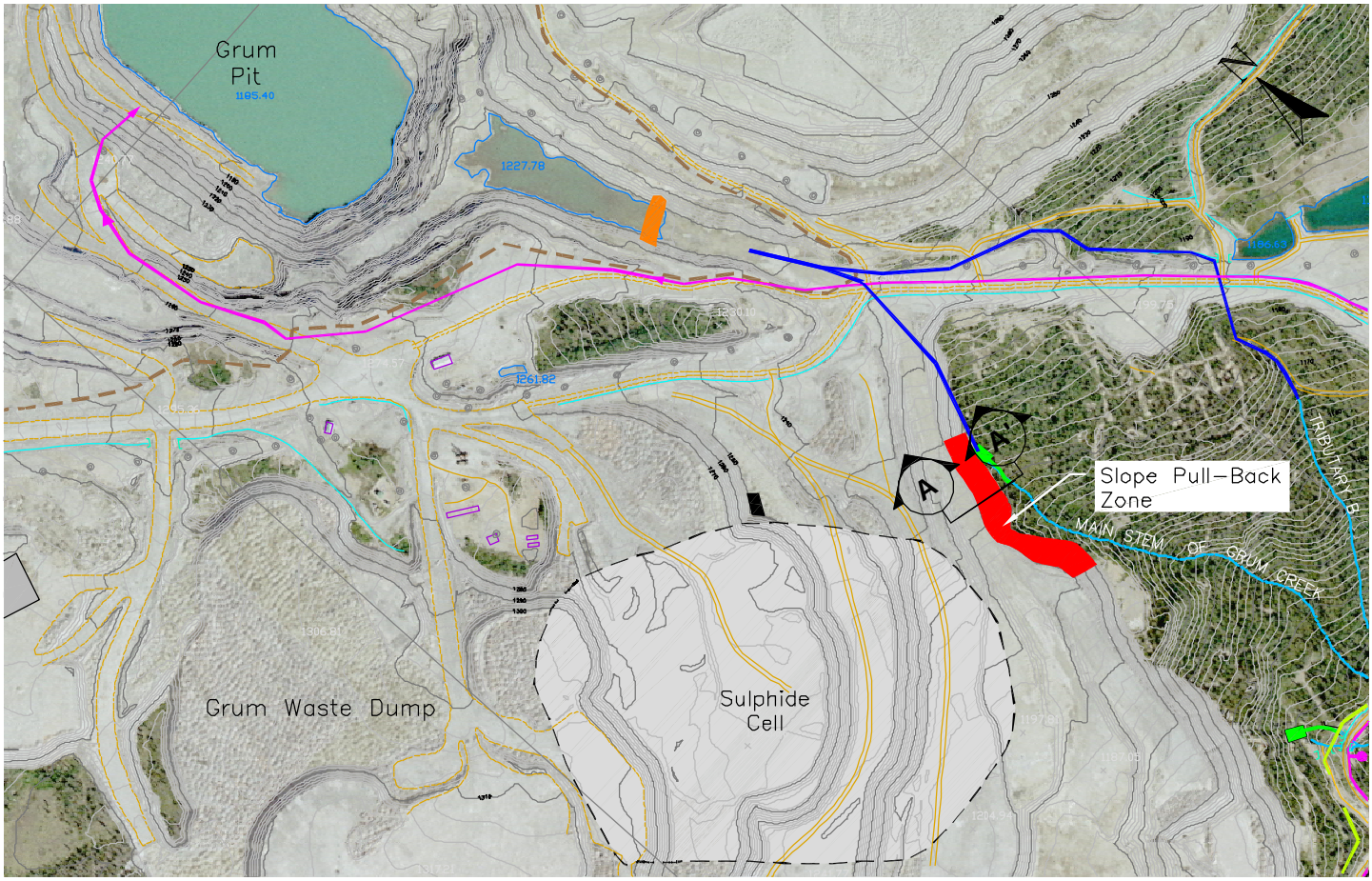
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Grum Waste Dump
Regrading (306.1)

| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 6.12 |

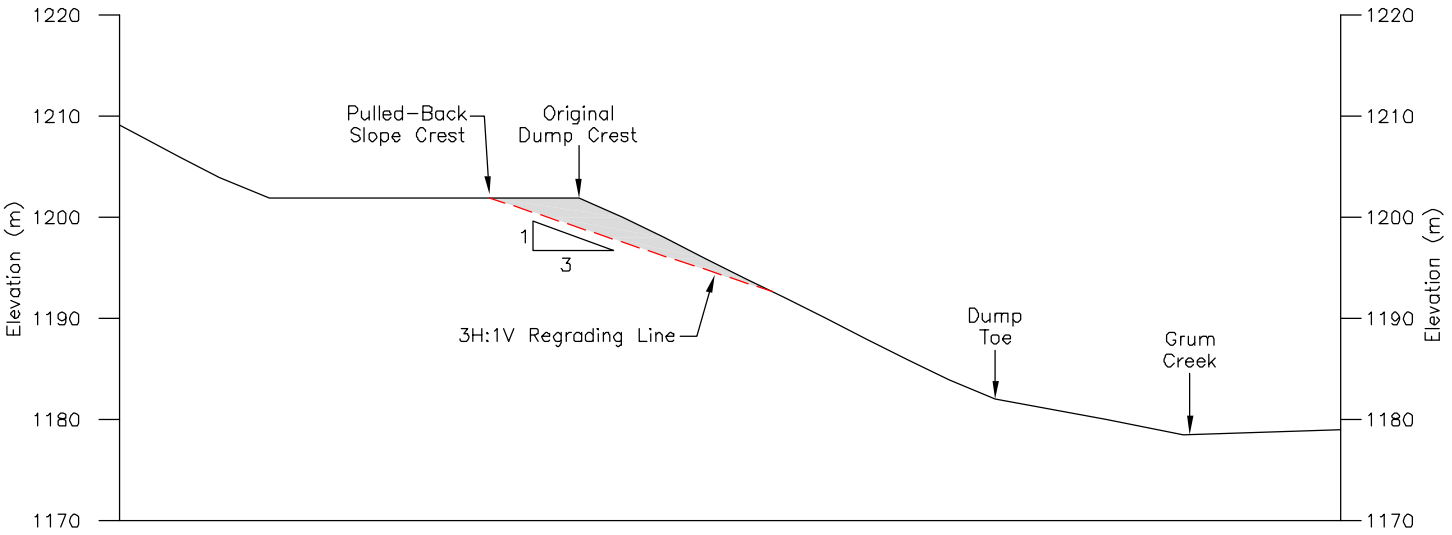
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**Grum Waste Dump Area**

0 100 200 300 400 500

Scale in Metres



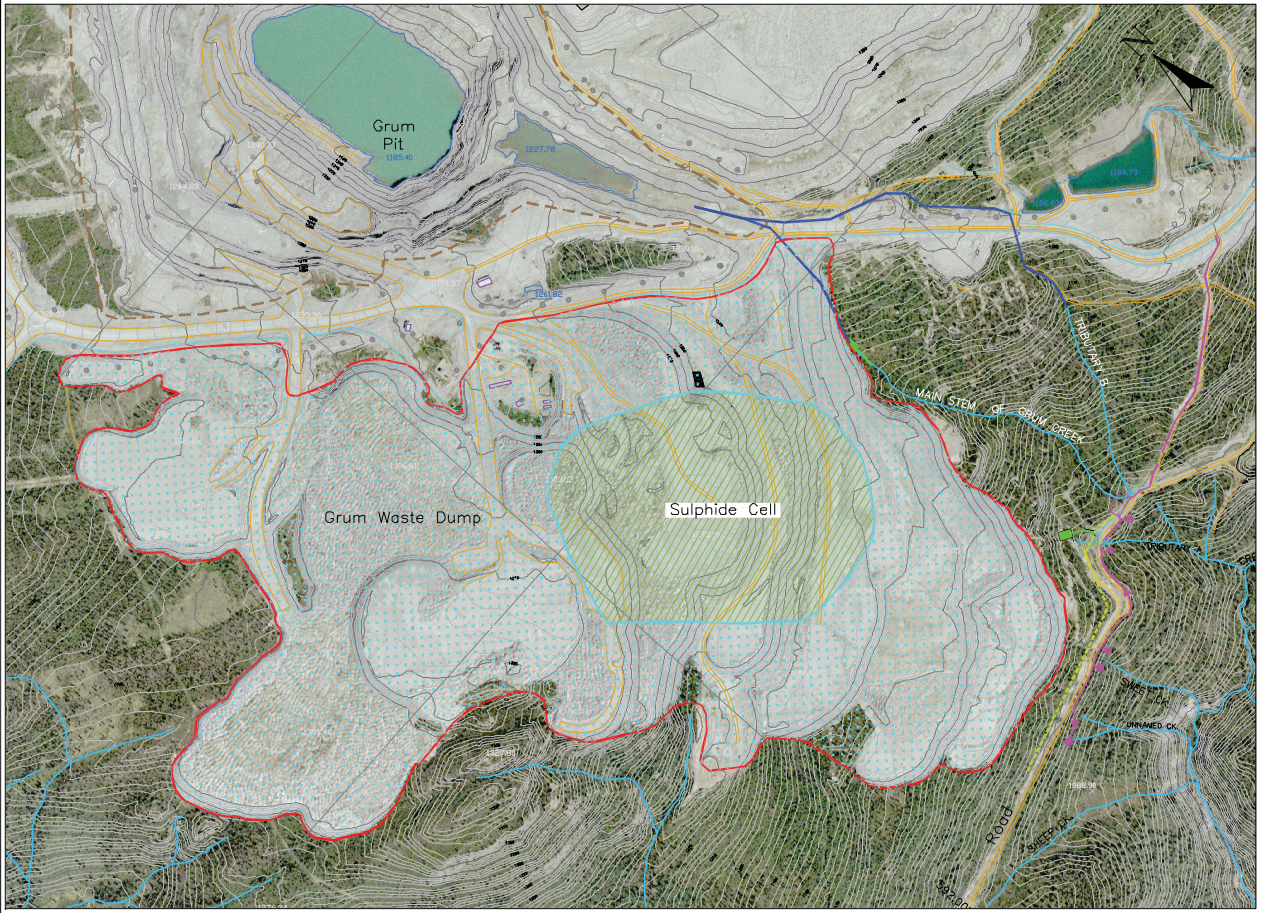

**A** **Regrading Pullback Section**

0 5 10 15 20 25

Scale in Metres

| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists, Vancouver B.C. | Faro Mine Closure / Fermeture de la mine Faro | Project Description (Draft 4) |
| | | Grum Waste Dump Slope Pullback Zone (306.2) |
| SRK JOB NO.: 1CY001.026 | Faro Mine Complex Final Closure and Remediation Plan | DATE: December 2009 / APPROVED: PMH / FIGURE: 6.13 |
| FILE NAME: 1CY001_026-1_Rev_A.dwg | | |

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## Legend

- Rudimentary Cover
- Very Low Infiltration Cover (early reclamation (2010))
- Grum Dump Boundary
- Sulphide Cell Boundary

## Note

Final selection of cover type is still subject to further review upon technical evaluation.

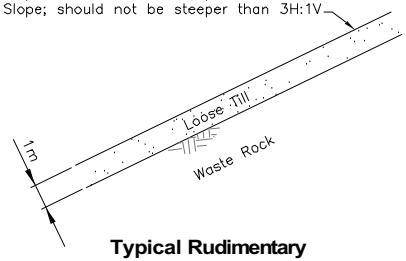
**Grum Dump Cover - Plan**

0 100 200 300 400 500

Scale in Metres

Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
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For Internal Slope; should not be steeper than 2H:1V
For External Slope; should not be steeper than 3H:1V




**Typical Rudimentary Cover Section (Grum Waste)**

0 2 4 6 8 10

Scale in Metres

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FILE NAME: 1CY001_026-2_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

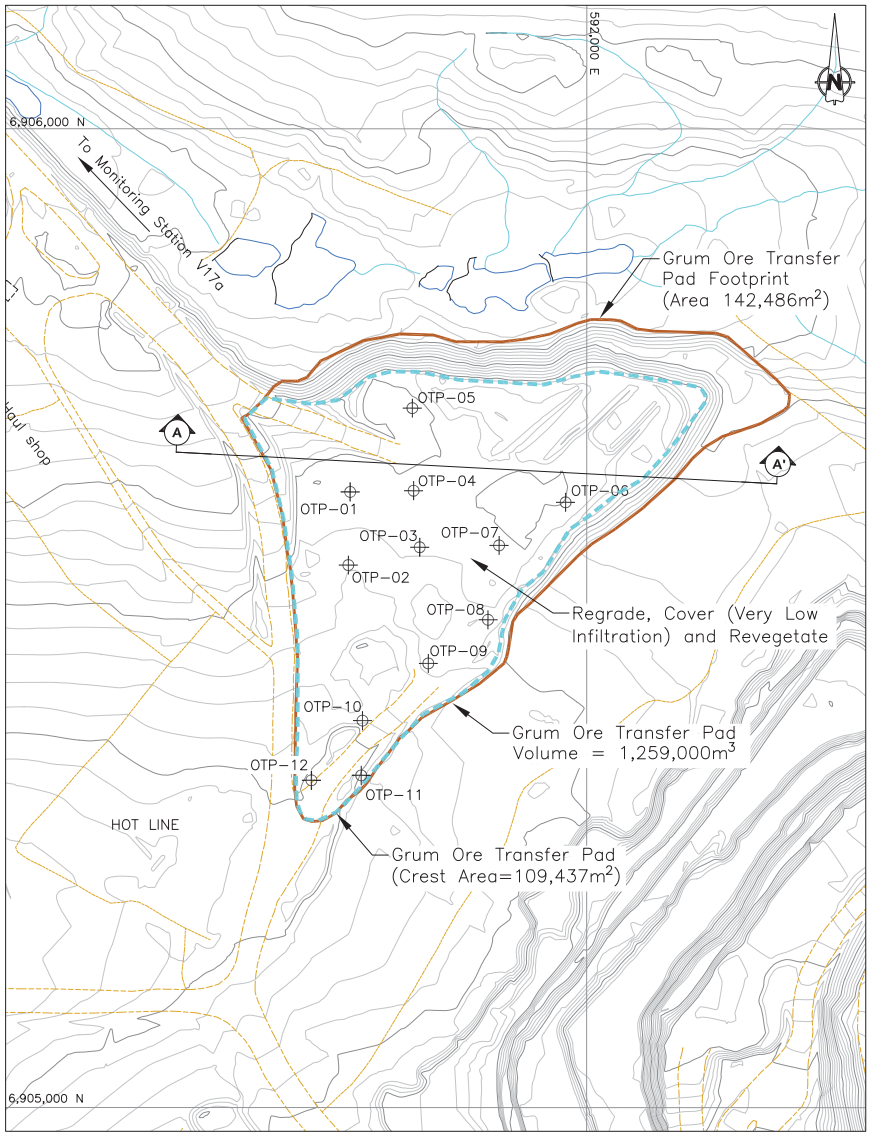
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Grum Waste Dump and Sulphide Cell Cover Plan (306)

| DATE: | APPROVED: | FIGURE: |
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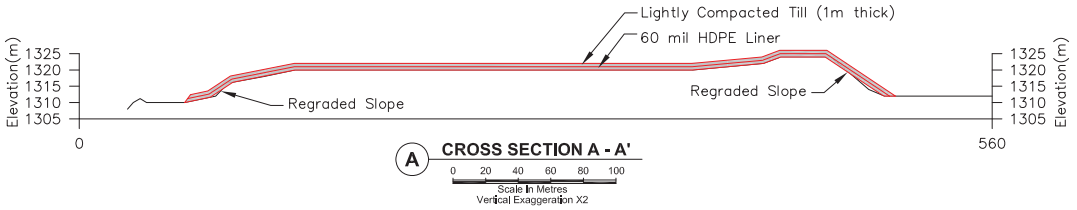



**GRUM ORE TRANSFER PAD (GOTP)**

0 50 100 150 200 250

Scale in Metres

Map Scale: 1:5000
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
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**A CROSS SECTION A - A'**

0 20 40 60 80 100

Scale in Metres
Vertical Exaggeration X2

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FILE NAME: 1CY001_026-16_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

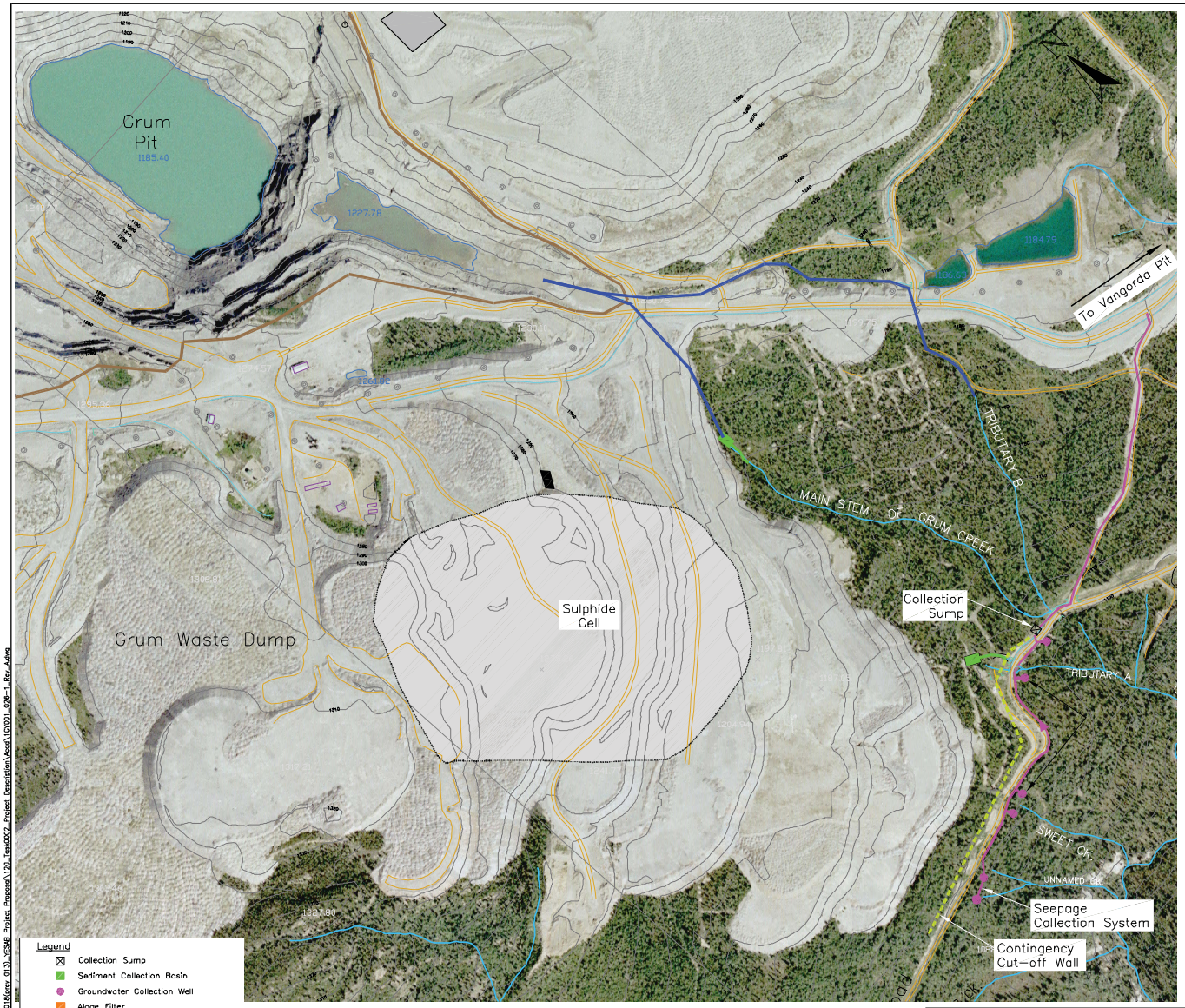
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

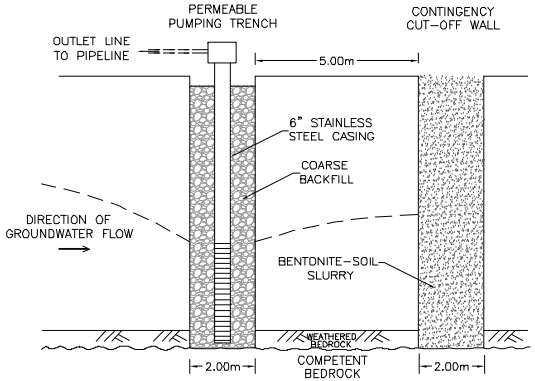
Grum Ore Transfer Pad

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.15 |

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Note: The primary discharge pipeline will run to Vangorda Pit




Seepage Collection System Schematic

0 1 2 3 4 5
Scale in Metres

Legend
- Collection Sump
- Sediment Collection Basin
- Groundwater Collection Well
- Algae Filter
- Proposed Creek Alignment
- Sediment Collection Ditch
- Groundwater / Seepage Pipeline
- Slurry Wall
- Safety Berm

Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
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0 50 100 150 200 250
Scale in Metres

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FILE NAME: 1CY001_026-1_Rev_A.dwg

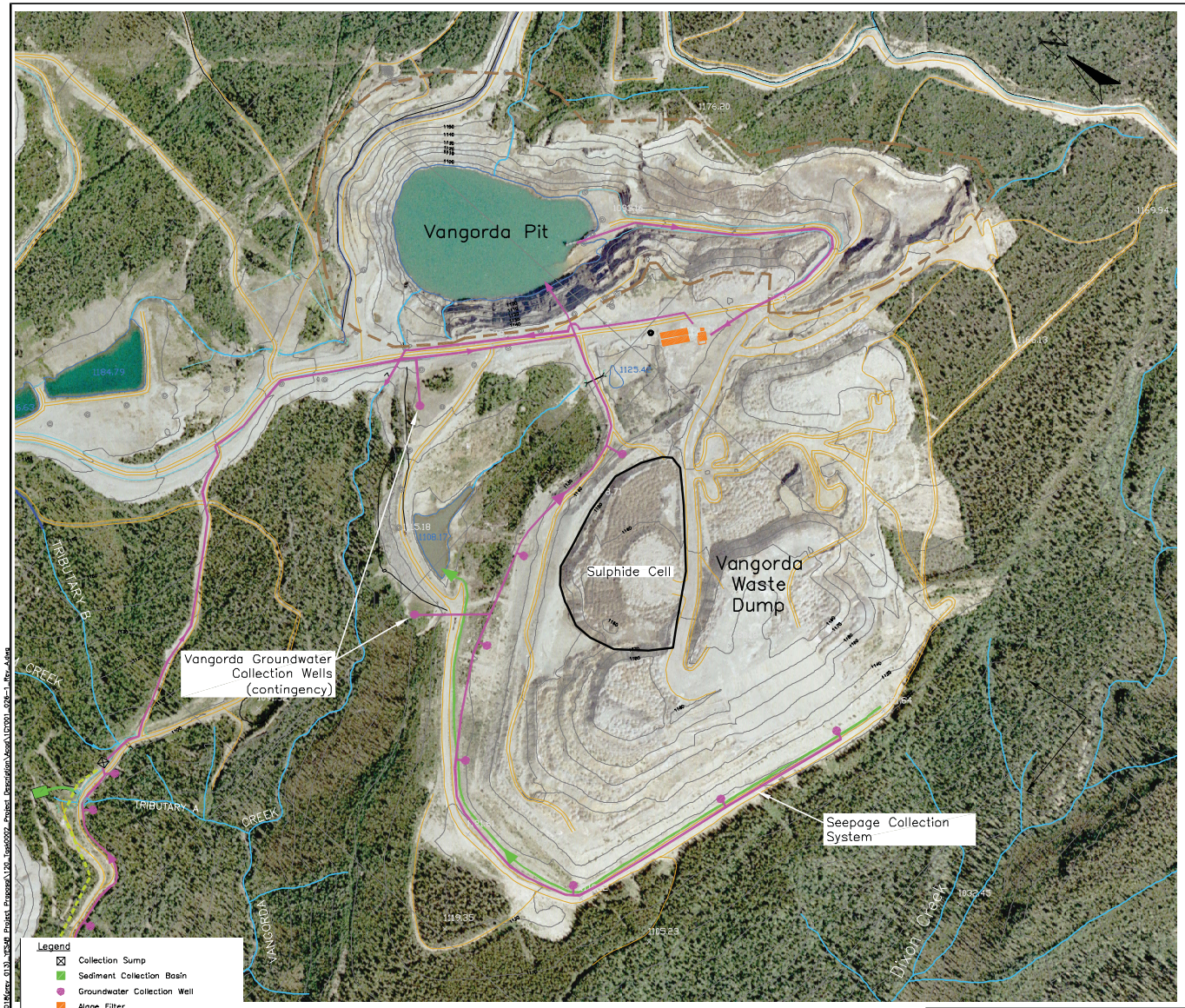
Faro Mine Closure
Fermeture de la mine Faro
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Grum Waste Dump
Seepage Collection System (309.1)

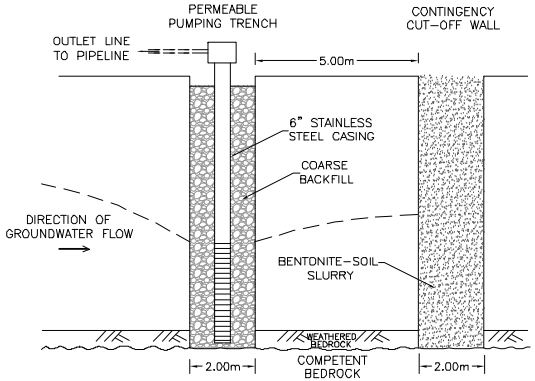
| DATE: | APPROVED: | FIGURE: |
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| December 2009 | PMH | 6.16 |

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Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
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0 50 100 150 200 250
Scale in Metres




Seepage Collection System Schematic

0 1 2 3 4 5
Scale in Metres

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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-1_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

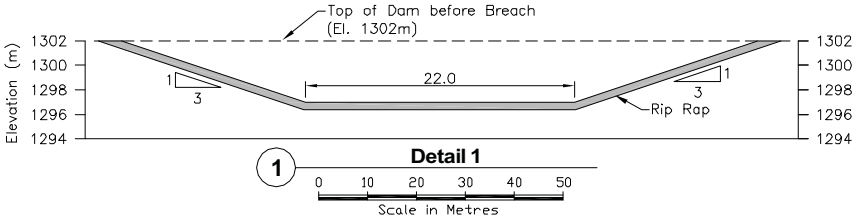
# Vangorda Waste Dump Seepage Collection System

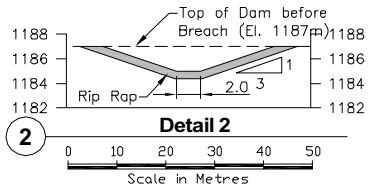
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| December 2009 | PMH | 6.17 |

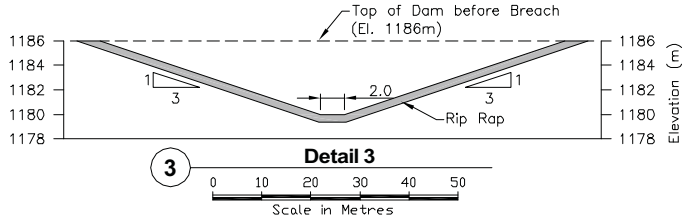



## Settling Ponds Plan View

0 50 100 150 200 250
Scale in Metres




Contour Interval: 10m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
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Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

# Vangorda-Grum Settling Ponds Breaching Plan and Sections (311.1)

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 6.18 |

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# 7 Haul Road

The location of the haul road between the Faro and Vangorda/Grum sites is shown on Figure 7.1. The haul road comprises waste rock fill that is typically about 30m wide and ranges in height from less than 10m to about 56m above original ground. Along its route, the haul road crosses a series of drainages, some of which are perennial and others of which are seasonal. Within the road fill there are ten major culvert crossings, including the NFRD, identified along the haul road with a total breach volume estimated to be about 1M $m^3$ as shown on Figure 7.1.

## 7.1 Closure Objectives

The reclamation objective for the haul road is to breach all culverts and crossings, and revegetate the disturbed areas. There is a minimum amount of Potentially Acid Generating (PAG) rock within the fill. It is expected that some of the non-acid generating (NAG) material will be used as borrow material for other closure activities.

Table 7.1 shows preliminary design criteria for the reclamation of the Faro Mine Complex Haul Road.

**Table 7.1: Preliminary Design Criteria for Reclamation of Haul Road**

| | |
|---|---|
| Base Width | 25m wide NFRD; 5m others |
| Safety Berms | To be removed or flattened |
| Top of surface of road | To be scarified and revegetated |
| Access Trails | Re-established |
| Resloping sideslopes | To be decided |

### Preliminary Design and Construction Method

It is assumed that reclamation of the haul road will start at the Faro end of the site, and move towards Vangorda. Safety berms will also be removed and/or flattened. Access trails across the road will be re-established.

The overall slope of the waste rock fill on either side of the breaches at each culvert would be 2H:1V.

The minimum base width of each drainage channel would be 5m, except for the North Fork Rock Drain breach which would be 25 m wide.

The decommissioning of the embankments will involve a combination of excavators and dozers during the breach of each crossing. Excavation will be carried out using 5m deep bench cuts. Temporary haul roads constructed will be built in 10m vertical increments. Temporary Safety berms should be considered during excavation.

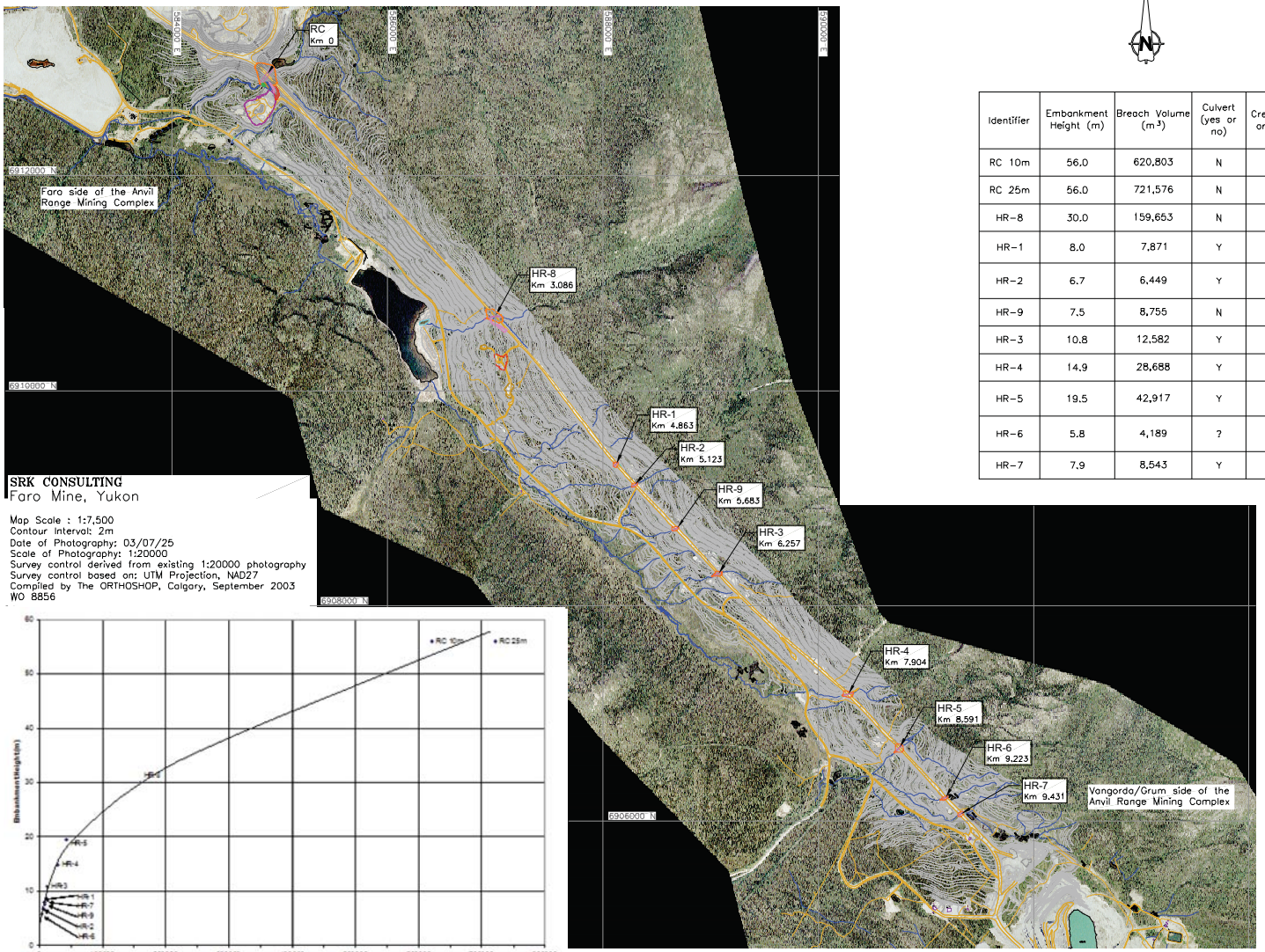
Drainages that require haul and dump operations will have a dump site identified at the nearest possible location. It is assumed that all the material removed from the excavation, including the culvert, can be buried inside the respective dump site. Each dump site, breached area, and area of disturbance will be reclaimed by hydro-seeding, which should eliminate the potential need for topsoil haulage. In addition, the top surface of the road will be scarified and revegetated.

A sediment control and surface water management plan will be developed for the work.

A typical plan and section of one of the culverts on the haul road are provided in Figure 7.2.

The flattening and revegetation of the haul road sideslope is currently under review.

# Figures




SRK CONSULTING
Faro Mine, Yukon

Map Scale : 1:7,500
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
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| Identifier | Embankment Height (m) | Breach Volume ($m^3$) | Culvert (yes or no) | Creek (perennial or ephemeral) | Other Remarks |
|---|---|---|---|---|---|
| RC 10m | 56.0 | 620,803 | N | P | Rose Creek Rock Drain assume 10m width at base of excavation |
| RC 25m | 56.0 | 721,576 | N | P | Rose Creek Rock Drain assume 25m width at base of excavation |
| HR-8 | 30.0 | 159,653 | N | P | Water partially pooled on u/s side of road, large flow from d/s side |
| HR-1 | 8.0 | 7,871 | Y | E | No evidence of culvert on d/s side (buried?); culvert bent and flattened on u/s side |
| HR-2 | 6.7 | 6,449 | Y | P | 2 culverts; flow through 1 culvert only. Doesn't appear as though all of the water is flowing through the culvert on the u/s side. |
| HR-9 | 7.5 | 8,755 | N | ? | Not observed in field. |
| HR-3 | 10.8 | 12,582 | Y | P | 2 culverts; flow through 1 culvert only. |
| HR-4 | 14.9 | 28,688 | Y | P | 2 culverts; flow through only 1 culvert only. |
| HR-5 | 19.5 | 42,917 | Y | P | Long till cover over culvert on d/s side; rock-lined trench built up to culvert on u/s side |
| HR-6 | 5.8 | 4,189 | ? | E | No evidence of culvert. Ponded area on u/s side of road; trickling flow seeping from toe of haul road on d/s side. |
| HR-7 | 7.9 | 8,543 | Y | P | Culvert partially buried on u/s side of road. |

Notes:

1. u/s = upstream; d/s = downstream.
2. Inspection data obtained from site visit on Sep. 16, 2007.
3. Embankment height is based on the haul road elevation and an interpolation between u/s and d/s toe elevations.
4. Breach volumes are based on excavation to original grade, 5m wide breach width and 2H:1V side slopes.

0 1000 2000 3000 4000 5000 6000 7000 Feet
1:20,000 0 500 1000 1500 2000 Metres

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FILE NAME: 1CY001_026-17_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

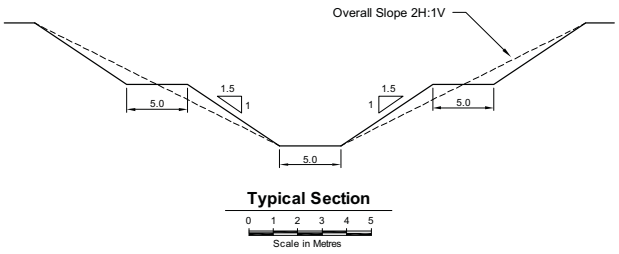
Plan View of Haul Road and Potential Breach Locations Area 400

DATE: December 2009
APPROVED: PMH
FIGURE: 7.1

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1:1000 0 20 40 60 80 100 Metres




**Typical Section**

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Faro Mine Closure
Fermeture de la mine Faro

Faro Mine Complex
Final Closure and Remediation Plan

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Plan View of Haul Road and Culvert Removal

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 7.2 |

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# 8 Water Treatment

## 8.1 General

Water treatment to remove zinc and other contaminants will be a long-term requirement for both surface and groundwater at the Faro Mine, Tailings and Vangorda/Grum Mine areas. Water treatment programs are a major component of current care-and-maintenance activities at both sites and their importance will persist throughout the closure and post-closure phases, with water treatment requirements expected to last at least several hundred years. Both the quantity and quality of water requiring treatment will change over time, potentially in both adverse and favourable ways at different stages in the project. Water treatment programs and facilities will need to be flexible to accommodate these changes.

There exist water treatment plants at both the Faro Mine and Vangorda/Grum Mine areas. These treatment plants will continue to operate during the initial phase of the closure project but will be supplemented and eventually replaced by new water treatment plants that are more suitable for long-term operations. Modeling of post-closure water treatment requirements predicts the need for additional water treatment capacity at both the Faro Mine and Vangorda/Grum Mine areas well into the future. While construction-related, water treatment requirements are difficult to predict, they will likely cause increased water treatment requirements during closure implementation and may lead to additional needs for water treatment capacity at that time

This section discusses water treatment requirements for both mine areas and for both closure and post-closure phases. The post-closure requirements are based on water quality modeling results described in Section 3.6 and Chapter 10, assuming that all waste rock dumps and tailings areas have been covered and that all closure requirements have been met. The interim requirements during closure are less certain and will require an adaptive approach that includes contingency planning to ensure that ongoing treatment needs can be met.

## 8.2 Faro Mine Area

### 8.2.1 General

Collection and treatment requirements for contaminated water at the Faro Mine area will vary over the life of the project.

Surface water from the both the mine and tailings areas will require careful management during the closure implementation and, as described in Section 3.4, some water will require treatment to remove chemical contaminants. Post-closure, with the covers in place, most surface water is expected to be suitable for discharge, though some may require settling to remove suspended solids. Some surface seepage is expected to require collection and treatment for the long-term and it is likely that surface water from the tailings will require collection and treatment for several years after completion of closure activities.

Collection and treatment of groundwater and seepage from the waste rock dumps has already been initiated in the S-Well and Emergency Tailings areas. Similar collection systems will be required at other waste rock areas at some time in the future. Collection and treatment of groundwater from below the tailings area is also expected to become required at some time in the future. The collection of contaminated groundwater and seepage from both waste rock and tailings areas will be required over the long-term.

Treatment of water that collects in the Faro Pit has been ongoing since the 1990s and will continue through the closure phase and post-closure.

Plans for handling and treating contaminated water will need to adapt as each of the source areas comes on- or off-line. The water and load balances presented elsewhere in this report allow the broad outlines of the water treatment plan to be defined, and some of the details to be proposed, especially for the post-closure phase. The discussion below follows the normal sequence for preliminary design of water treatment systems, starting with analysis of the flow rates and water quality needing treatment, and then moving on to details of treatment methods, locations and timing.

For the closure phase, past experience at the site provides some guidance about the expectations for water treatment. The early implementation of long-term water treatment facilities provides contingency to meet construction-related water treatment requirements. The storage capacity in the Faro Pit also provides substantial contingency and flexibility for water treatment programs.

### 8.2.2 Flows Requiring Collection and Treatment

Water requiring treatment includes waste rock runoff and seepage, pit wall contact water, the tailings surface runoff and, in the future, tailings seepage.

The Faro Mine area waste rock is currently believed to generate about 600,000 $m^3$ of contaminated water each year. There is very little surface runoff, except into the Faro Pit. That situation is expected to continue or improve through the mine area closure program. Resloping activities will cause local changes in runoff patterns, but are not expected to make a significant change to overall flow rates (effects on water quality are discussed below). As soil covers are placed over the waste rock, there will be an increase in surface runoff. Ultimately, that runoff is expected to be clean, requiring only local treatment to remove suspended sediments. There may be interim requirements for chemical treatment of some runoff, especially during re-sloping activities.

The waste rock covers will also cause a decrease in infiltration. Current estimates are that the infiltration through the covers will total about 220,000 $m^3$ per year. Where that water exits as well defined surface seeps, for example in the X23 area, it could be captured with little dilution. However, where it goes to groundwater, the capture system would bring in some volume of clean groundwater. The total volume of water that would ultimately be collected is therefore uncertain. For the purposes of preliminary design, a conservative assumption is an average 5 x dilution. That leads to an estimated 1,100,000 $m^3$ per year of flow from the waste rock piles in the Faro Mine area.

Current direct inflows to the Faro pit from the pit walls and waste rock are estimated at about 440,000 $m^3$ per year. The pit lake itself has a net evaporation of about 70,000 $m^3$ per year. These numbers are not expected to change significantly, so a net 370,000 $m^3$ per year is a good estimate of long-term flows directly into the Faro pit.

Surface runoff from the tailings area is currently captured in the Intermediate Pond and then treated and discharged through one of two existing water treatment facilities: the existing water treatment plant in the Faro Mill; the lime addition system located adjacent to the Intermediate Dam. Annual flows have been highly variable, from 300,000 to 900,000 $m^3$ per year, in part due to attempts to either lower or raise the pond level. The historical values also probably included varying amounts of water from the ETA and from drain-down of deposited tailings. To estimate future surface runoff, an average runoff coefficient of 25% was assumed to apply to the entire tailings catchment, leading to an estimate of 580,000 $m^3$ per year. That runoff would continue to need collection and treatment as long as any part of the tailings surface remains uncovered, and possibly for several years thereafter.

It is expected that groundwater below the tailings will eventually become contaminated with dissolved metals seeping downward from the tailings. It will then be necessary to capture essentially all of the groundwater for treatment. Estimates of the groundwater flow that would need to be captured are uncertain, with 80 L/s as the high end of recent estimates. At that rate, year-round collection and treatment would create a total flow of about 2,500,000 $m^3$ per year.

The total flow collected for treatment from the waste rock, pit walls and tailings surface will therefore be about 2,100,000 $m^3$ per year during and for some time after closure. Once the tailings groundwater also needs to be collected for treatment, the total flow will increase to nearly 4,600,000 $m^3$ per year. Peak treatment requirements could be lower if surface collection requirements for waste rock and tailings diminish before the groundwater collection requirements for tailings materialize.

### 8.2.3 Year Round Flow or Storage

If those flows were routed directly to treatment year-round, the average treatment rate would initially be just over 1000 USgpm (all treatment plant flow numbers are in US gallons per minute). With the tailings seepage, the average treatment rate would be about 2300 USgpm.

The alternative would be to store water in Faro Pit for seasonal treatment. Storing 2,100,000 $m^3$ per year of water in Faro pit would cause the water level to rise by about 5 m. Storing 4,600,000 $m^3$ per year would cause the water level to rise about 10 m. If water were withdrawn for seasonal treatment over say a 5 month period, the initial flows would be 2400USgpm, increasing to 5600 USgpm when the tailings groundwater is included.

Although there are pros and cons for both options, seasonal treatment is preferred. Seasonal treatment would also allow all discharges of treated water to be in the open-water season, and the larger initial plant needed for seasonal treatment would allow greater flexibility to deal with any changes that arise during closure. For example, the treatment season could be extended to treat any additional water generated during wet years or during periods when closure activities cause greater disturbances of the waste rock or tailings surfaces. Seasonal treatment would have higher up-front costs but lower operating costs. Seasonal treatment would create long-term seasonal employment. The primary advantage of year-round treatment is that it would reduce up-front costs, which are largely determined by the average flowrate. But operating during the winter period would be complex and more costly over the long-term.

### 8.2.4 Water Quality and Contaminant Loadings

Treatment reagent requirements and sludge production rates are determined by the loading of contaminants in the water being treated. The relationship is complex and is generally established through extensive bench and pilot scale testing. However, there is enough experience treating water at Faro, and at other sites with similar contaminant loadings, that simpler methods can be used for preliminary estimates. The method used herein estimates "lime demand" from predicted zinc loadings. Based on estimates from the waste rock water and load balance model, the estimated lime demand of the water will be roughly 3.5 times the zinc concentration. That ratio was also applied to other sources for the calculations herein. Table 8.1 shows the estimated lime demand associated with each source area over time. The table assumes that the tailings area groundwater will be collected after Year 30. The execution schedule provided in Chapter 11 shows collection of the tailings area groundwater sometime after the completion of the Intermediate Dam raise. However the timing of this will be subject to an adaptive approach as discussed in Chapter 13.

Storage of water in the pit will have the effect of dampening any fluctuations in contaminant concentrations. The pit currently contains roughly 30,000,000 $m^3$ of water, so inputs and removals of 2,100,000 $m^3$ per year will cause only very gradual changes in concentrations. The addition of the relatively dilute tailings area groundwater will cause a downward shift in contaminant concentrations in the pit lake. Table 8.1 also shows the lime demand of the pit lake water.

**Table 8.1: Lime Demand of Source Water and Mixed Pit Lake**

| Year | Lime demand of water (g CaO / L) | | | | |
|---|---|---|---|---|---|
| | Waste Rock | Pit Walls | Tailings Surface | Tailing Groundwater | Pit Lake |
| 1 | 0.05 | 0.64 | 0.08 | 0.00 | 0.50 |
| 10 | 0.11 | 0.68 | 0.17 | 0.00 | 0.48 |
| 30 | 0.27 | 0.73 | 0.03 | 0.08 | 0.39 |
| 50 | 0.34 | 0.82 | 0.01 | 0.11 | 0.41 |
| 75 | 0.72 | 0.96 | 0.01 | 0.13 | 0.28 |
| 100 | 1.77 | 1.09 | 0.01 | 0.20 | 0.21 |
| 150 | 1.88 | 1.09 | 0.01 | 0.26 | 0.32 |
| 200 | 1.89 | 1.09 | 0.01 | 0.26 | 0.62 |
| 300 | 1.91 | 1.09 | 0.01 | 0.26 | 0.69 |
| 600 | 1.91 | 1.09 | 0.01 | 0.26 | 0.69 |
| 800 | 1.91 | 1.09 | 0.01 | 0.26 | 0.69 |
| 1,000 | 1.91 | 1.09 | 0.01 | 0.26 | 0.69 |

### 8.2.5 Treatment Method and Effluent Quality

The treatment methods for these types of water all involve lime addition to neutralize acidity and precipitate metals. The primary variants are simple lime addition, and lime addition with high density sludge (HDS) production. Simple lime addition systems are easier to operate but produce much larger volumes of sludge than HDS systems. Given the substantial amounts of sludge that are expected to be produced over the long term the slight additional complexity of an HDS circuit is acceptable. HDS is therefore the preferred system.

HDS systems are very effective at converting soluble contaminants to sludge. However, Canadian water licenses generally specify target levels of total metals, rather than dissolved metals. Small particles of sludge that are not removed in the HDS system can lead to total metal concentrations that exceed such targets. To provide added protection against high total metals concentrations, it is proposed that the system include a contingency polishing step using sand filters. Table 8.2 shows the anticipated effluent quality from the HDS system. The zinc levels are provided with and without the sand filter.

**Table 8.2: Anticipated Effluent Quality (mg/L)**

| Total Metals | Target Effluent Limit (mg/l) |
|---|---|
| Aluminum | 0.01 |
| Arsenic | 0.005 |
| Beryllium | 0.005 |
| Boron | 0.1 |
| Cadmium | 0.005 |
| Cobalt | 0.005 |
| Copper | 0.009 |
| Iron | 0.005 |
| Lead | 0.015 |
| Magnesium | 0.025 |
| Manganese | 0.3 |
| Nickel | 0.06 |
| Zinc (without Sand Filter) | 0.1 |
| Zinc (With Sand Filter) | 0.05 |

The existing treatment plant in the Faro Mill will continue to operate in the initial years of the closure implementation phase. This treatment system was constructed in the Faro Mill in the late 1990s and utilizes several modified components of the former milling facilities. The system relies on lime addition and mixing in modified flotation cells with clarification in former tailings thickeners. The system has a nominal capacity of 5000gpm but treatment rates have been variable over the years. Water from the existing system is discharged to the Cross-valley Pond for polishing prior to discharge. With polishing, the system consistently meets effluent discharge criteria including a zinc concentration of 0.5mg/L.

### 8.2.6 Sludge Production and Management

Sludge production rates can be estimated from lime usage. In a well run HDS system with influent concentrations as high as those in the Faro pit, essentially all of the lime is converted to gypsum and metal hydroxide sludge.

Table 8.3 shows the sludge tonnages and volumes that result when the lime is converted to gypsum and zinc hydroxide. The additional conversion from dry weight (tonnes) to volume ($m^3$) conservatively assumes a sludge density of 15% solids, which should be readily achievable with an HDS system. Sludge densities of 20% solids or higher are more likely.

It is proposed that the sludge be disposed in the Faro pit. A tremie system would be used to place the sludge near the pit bottom, and prevent mixing with the water column. The volume available in the pit, without constructing a plug dam, is estimated to be about 35,000,000 m3. According to Table 8.3, this would provide capacity for over 300 years of water treatment. If higher sludge densities are assumed, and if consolidation is taken into account, that estimate would increase to over 500 years.

It is worth noting that simple lime treatment would produce a sludge with a much lower solids content and would generate 2-3 times the sludge volumes estimated in Table 8.3. The capacity of the Faro Pit would then be reached in about 150 years. Furthermore, the lower density sludge could prove more difficult to tremie to the bottom of the pit without dispersion. These arguments support the choice to utilize HDS treatment.

The interim operation of the existing treatment system will continue to produce sludge with much lower density, approximately 5% solids. For the reasons stated above, this sludge is not suitable for storage in the Faro Pit. Sludge produced from the existing treatment system is currently stored in impoundments on the tailings surface. This practice will continue until the tailings are covered. During closure, the sludge will remain on the tailings (distributed and/or incorporated) under the cover materials. In this location, any excess alkalinity will serve to neutralize acidity in the tailngs. If low-density sludge is produced after placement of the tailings cover, that sludge will be placed in an appropriate location on waste rock where alkalinity can be similarly consumed, and where the material will ultimately be covered.

**Table 8.3: Treatment flows, Lime Usage and Sludge Production**

| Year | Treatment Flow ($m^3$/yr) | Lime Use (tonnes CaO/yr) | Sludge Production | | |
|---|---|---|---|---|---|
| | | | (dry tonnes/yr) | ($m^3$/yr) | Cumulative ($m^3$) |
| 1 | 2,050,000 | 1,000 | 4,700 | 32,000 | 30,000 |
| 10 | 2,050,000 | 800 | 3,900 | 26,000 | 260,000 |
| 31 | 4,570,000 | 1,300 | 6,100 | 41,000 | 1,120,000 |
| 50 | 4,570,000 | 1,000 | 4,700 | 31,000 | 1,710,000 |
| 75 | 4,570,000 | 1,500 | 7,100 | 47,000 | 2,890,000 |
| 100 | 4,570,000 | 2,800 | 13,700 | 92,000 | 5,180,000 |
| 150 | 4,570,000 | 3,100 | 15,200 | 101,000 | 10,250,000 |
| 200 | 4,570,000 | 3,200 | 15,300 | 102,000 | 15,330,000 |
| 300 | 4,570,000 | 3,200 | 15,300 | 102,000 | 25,550,000 |
| 600 | 4,570,000 | 3,200 | 15,300 | 102,000 | 56,220,000 |
| 800 | 4,570,000 | 3,200 | 15,300 | 102,000 | 76,660,000 |
| 1,000 | 4,570,000 | 3,200 | 15,300 | 102,000 | 97,100,000 |

### 8.2.7 Timing

Both Table 8.1 and Table 8.3 assume that collection and treatment of the tailings groundwater will begin in Year 30, after all waste rock dumps have been covered. The significant effect on the quantity and average quality of water needing treatment is clear. However, the Year 30 assumption is quite uncertain. Currently, sulphate from the tailings is clearly present in the groundwater, but zinc is only apparent in some locations. The possibility that zinc will be attenuated by organic matter below the tailings and within the aquifer further complicates estimates of the arrival time for the groundwater contaminants of concern. Equally plausible assumptions could range from as early as Year 10 to as late as Year 100.

Given that range of uncertainty, it does not makes sense to construct the full treatment system in Year 1. Instead, the construction should be phased to initially provide only enough capacity to deal with water from the waste rock, pit walls and tailings surface runoff. As noted above, a 2400 gpm treatment system would be sufficient to treat the expected initial annual flows in about 150 days per year. In the early closure implementation years, the existing treatment system will still be available for contingency treatment. Storage capacity in the Faro Pit will provide additional contingency for unexpected treatment requirements. Also, the Adaptive Management Plan (Chapter 13) includes detailed adaptive management monitoring, triggers and responses to ensure that water treatment requirements will be addressed as needed.

It is proposed that a slightly larger capacity system be constructed, with a design capacity of 5000 gpm. That would provide flexibility to deal with shorter treatment season (say 90 days) and additional flows that might arise in wet years or be generated during closure activities. It would also provide increased capacity that might be needed to compensate for start-up delays in some years.

It is further proposed that the initial 5000 gpm system be constructed as soon as practicable. Early construction would reduce risks associated with the current plant, and provide the site with additional capacity prior to starting major earthworks.

The tailings groundwater will be intensively monitored as described in the Adaptive Management Plan with thresholds that include sulphate concentrations that will give advance warning of more significant contamination and adequate time for planning and implementing treatment. There should be many years of clear trends in the monitoring data before the second phase treatment system needs to be constructed. Those trends will also allow the design capacity of the system to be refined. For the purposes of the current report, the Phase 2 system is expected to be a second 5000 gpm HDS plant.

### 8.2.8 Location

Several locations for the treatment plant(s) have been considered. The decision to store water in the pit means that there is no cost advantage in locating the plant(s) close to any of the sources. Since all of the treated water will need to be withdrawn from the pit, treated and discharged to Rose Creek, any site that is hydrologically between the pit and Rose Creek is equally effective in terms of pumping cost.

Site selection can therefore consider other factors. One other factor is the desire to avoid the complications that could arise if the treatment plant is constructed too near other closure activities. That consideration rules out use of the current mill or any other site in the mill area.

A second factor is that the water treatment plant will ultimately be the only structure remaining on the site. It would be desirable to choose a site that is near the entrance to areas that remain under some form of long-term control, to allow the plant or additions to the plant to function as a site gatehouse, office, shop and warehouse. That consideration reduces the attractiveness of sites at the toe of the Intermediate or Cross Valley dams.

A third factor is that it would be desirable to locate the plant in an area that would be as pleasant as possible for long-term staff.

After considering all of the above, the former BXL site, at the eastern end of the tailings area, has been identified as a preferred location for the water treatment plant(s). That site is out of the way of most other closure activities, and is well-suited for providing long-term control of access to the site. It also provides good foundation conditions, access to clean water (from the Rose Creek aquifer upgradient of the tailings) and is near to a suitable effluent discharge point at the confluence of the north and south forks of Rose Creek. Finally, it is in a broad part of the valley which will increase the exposure to sunlight, without significantly increasing exposure to wind.

# 8.3 Vangorda/Grum Mine Area

## 8.3.1 General

Collection and treatment of contaminated water from the Vangorda/Grum Mine area will continue to be required during closure and over the long term. Chemical treatment using lime addition and biological treatment relying on nutrient addition are both expected to be important components of contaminated water management activities for this area of the mine.

Surface water from the Grum and Vangorda Mine areas will require careful management during the closure implementation and, as described in Section 3.4, some of this water will require treatment to remove chemical contaminants. During the post-closure phase, most surface water is expected to be suitable for discharge though some may require settling to remove suspended solids.

The Vangorda Waste Rock Dump was designed with a seepage collection system. Water from this system is currently collected in the Little Creek Pond (LCP) and pumped to Vangorda Pit, then sent for treatment. Seepage collection from the Vangorda Waste Rock Dump will continue throughout the closure and post-closure phases, utilizing an upgraded seepage collection system. Groundwater collection will be initiated as needed in accordance with the Adaptive Management Plan. The future of the LCP is yet to be determined but it will not likely continue to function as a collection pond for contaminated seepage from the Vangorda Waste Rock Dump. Several possibilities include complete removal or it could be retained and function as polishing pond for the WTP.

Contaminated groundwater from the Grum Waste Rock Dump is expected to require collection and treatment at some time in the near future. Seepage and runoff from the western toe of the dump is currently collected and directed to a natural depression where it exfiltrates to ground. The Adaptive Management Plan will guide decisions about when collection and treatment are required. The quantity and quality of groundwater water requiring collection and treatment from the Grum Dump is expected to change over time.

Vangorda Pit currently serves as a reservoir for contaminated water at the Vangorda Mine (i.e. runoff from local catchment and inflows from Little Creek Pond). The water level is controlled by periodic pumping and treatment in the existing Vangorda water treatment plant. During closure and post-closure, Vangorda Pit will continue to serve as a reservoir for contaminated water for the Vangorda Waste Rock and Grum Waste Rock as well as the local pit catchment. This water will require treatment during all project phases.

Contaminated water in Grum Pit is currently treated annually by addition of nutrients to the pit, resulting in stabilization and settling of contaminants through biological activity. This passive treatment will continue during the closure and, if necessary, post-closure phases. If this treatment can achieve effluent discharge criteria, no other form of treatment will be required for Grum Pit. Otherwise, water from Grum Pit may require polishing treatment by other methods, potentially in a water treatment plant.

The timing and scale of future treatment requirements from the Grum Waste Rock means that any plans for water treatment on the Vangorda/Grum side of the property will need to be adaptable. Potential additional collection and treatment requirements from the Vangorda Dump and/or the Grum Pit could also affect water treatment needs. The Adaptive Management Plan will provide advance warning about upcoming treatment requirements so adjustments can be made as needed. However, some elements of the water treatment plan are clear, and the range of possibilities for future changes can be defined. The discussion below starts with analysis of the maximum flow rates and contaminant loadings that could ultimately require treatment, and then looks at the range of possibilities for combinations of active and passive treatment.

For the closure phase, past experience at the site provides some guidance about the expectations for water treatment. The early implementation of long-term water treatment facilities would provide some contingency to meet construction-related water treatment requirements. The storage capacity in the Vangorda Pit also provides substantial contingency and flexibility for water treatment programs.

### 8.3.2 Flows Requiring Collection and Treatment

Water requiring treatment includes waste rock runoff and seepage from both Vangorda and Grum Dumps, groundwater from the Grum Dump and possibly the Vangorda Dump, and water that accumulates in the Vangorda Pit (including inputs from three in-pit dumps in the catchment of Vangorda pit). Water from the Grum Pit currently requires ongoing passive treatment. In the future this water may also need to be addressed in a treatment plant or may require no treatment. The precipitation on the Vangorda and Grum waste rock is currently believed to generate about 400,000 $m^3$ of variably contaminated water each year. Water that infiltrates into the Vangorda waste rock becomes heavily contaminated and either seeps directly into the Vangorda Pit or is collected at the Little Creek Pond and then pumped to the pit. There is also some surface runoff from the Vangorda waste rock that reports directly to the Vangorda Pit. Precipitation on the Grum waste rock is generally not collected for treatment at present. A small portion that falls on the west side of the ore transfer pad reports to the Grum Pit, and seepage and runoff from the western toe of the Grum Dump is routed to a controlled exfiltration basin. Requirements to collect and treat groundwater from the toe of the Grum Dump are currently being investigated and will be addressed in accordance with the Adaptive Management Plan.

Other than possible changes to collect Grum dump groundwater, the current situation is expected to continue through the mine area closure program. Resloping activities will cause local changes in runoff but no significant change to overall flow rates. As soil covers are placed over the waste rock, there will be an increase in surface runoff. Ultimately, that runoff is expected to be clean, requiring only local treatment to remove suspended sediments. There may be interim requirements for chemical treatment of some runoff, especially during re-sloping activities.

The waste rock covers will cause a decrease in infiltration. Current estimates are that the infiltration through the covers on the Vangorda waste rock will total about 8,000 $m^3$ per year. That water will be collected in the seepage collection system and pumped to the Vangorda Pit. A dilution factor of 3x to cover the volume of clean groundwater that capture system would bring in, is conservatively assumed herein, leading to a total flow of 24,000 $m^3$ per year. If dilution is much higher than 3x, a more direct method of collecting seepage by installing wells behind the Vangorda till starter dyke could be considered. Infiltration through the covers on the Grum waste rock is estimated to be about 100,000 $m^3$ per year. Since it all will need to be collected as groundwater or seepage, some amount of clean groundwater will also be pulled in. For the purposes of this level of design, a conservative assumption is a 5x dilution of any contaminated flows that need to be captured as groundwater. That leads to an estimated 500,000 $m^3$ per year of total flow collected from the Grum waste rock.

Direct inflows to the Vangorda pit are estimated at about 60,000 $m^3$ per year, and net evaporation from the pit lake at about 10,000 $m^3$ per year. The Grum pit, with a much larger catchment, receives about 290,000 $m^3$ per year of inflow, and the pit lake has a net evaporation rate of about 30,000 $m^3$ per year. These numbers are not expected to change significantly, so net inflows of about 50,000 $m^3$ per year and 260,000 $m^3$ per year are expected for the Vangorda and Grum pits, respectively. However, as stated in 8.3.1, passive treatment will continue during the closure and, if necessary, during the post-closure phase. If this treatment can achieve effluent discharge criteria, no other form of treatment will be required for Grum Pit. If discharge criteria cannot be met, water from Grum Pit may require polishing treatment such as a series of polishing ponds that would be constructed in the Slot which will allow biomass trapped in the pit to be treated prior to discharge into natural drainage. As part of the adaptive management program, continuous monitoring will be carried out and further water treatment might be required depending on the water quality after the bioremediation.

In the extreme case, if at some time in the future all of these flows need to be treated by the HDS plant, the total flow to the treatment system would be about 830,000 $m^3$ per year, which includes the assumed dilution factors.

Table 8.4 below shows a conservative estimate of the lime demand associated with each of the above flows based on the extreme case above. The lime demand estimates were derived from the contaminant loading model using the methods described in the Faro water treatment (Section 8.2).

**Table 8.4: Lime Demand of Source Water**

| Year | Lime Demand of Water (g CaO / L) | | | |
|---|---|---|---|---|
| | Vangorda Waste Rock | Vangorda Pit Inflow | Grum Waste Rock | Grum Pit Inflow |
| 1 | 1.57 | 1.16 | 0.002 | 0.002 |
| 10 | 1.57 | 1.16 | 0.002 | 0.002 |
| 31 | 1.86 | 1.16 | 0.002 | 0.002 |
| 50 | 1.86 | 1.16 | 0.002 | 0.002 |
| 75 | 1.86 | 1.16 | 0.002 | 0.002 |
| 100 | 1.86 | 1.16 | 0.002 | 0.002 |
| 150 | 1.86 | 1.16 | 0.002 | 0.002 |
| 200 | 3.90 | 1.16 | 0.002 | 0.002 |
| 300 | 4.98 | 1.16 | 0.007 | 0.002 |
| 600 | 4.98 | 1.16 | 0.008 | 0.002 |
| 800 | 4.98 | 1.16 | 0.008 | 0.002 |
| 1000 | 4.98 | 1.16 | 0.008 | 0.002 |

### 8.3.3 Treatment Method and Effluent Quality

For the same reasons described in relation to the Faro Mine area, lime addition with high density sludge (HDS) production is the most appropriate long-term treatment method for the Vangorda/Grum Mine area. This will be supplemented by "passive" biological treatment in the Grum Pit with ongoing assessment of that treatment methodology to confirm its performance and apply lime treatment to this source if necessary.

The existing Vangorda treatment plant will continue to operate in the initial years of the closure implementation phase. This treatment system was constructed in 1990 as part of the initial development of the Vangorda/Grum Mine. It is a conventional lime treatment system with a nominal capacity of 2000 USgpm. The system relies on a clarification pond with a retention time of approximately 36 hours when the plant is operating at peak design flows. With polishing, the system consistently meets effluent discharge criteria including a zinc concentration of 0.5mg/L.

### 8.3.4 Treatment Combinations

There are a number of possible options and combinations for future treatment of water in the Vangorda-Grum area. There is also significant uncertainty about:

- Future flows and contaminant loadings from the covered Vangorda and Grum dumps;
- The level of contamination in groundwater below the Grum dump and the need for and timing of treatment;
- The capacity of the Grum in-pit treatment system to deal with future increases in contaminant loadings and flows; and
- The possibility of other passive treatment methods being proven applicable for the low zinc levels that are expected below much of the Grum Dump.

These uncertainties suggest that an adaptive management approach is warranted. Table 8.5 below summarizes the most likely treatment combinations and possible contingencies for both the closure and post-closure periods. The following paragraphs provide explanation.

### 8.3.5 Closure Period

Over the last several years, running the 2000 USgpm plant for treatment periods of only 60 days or less has been sufficient to control or even draw down the water level in the Vangorda pit. With the addition of an improved clarifier, it is reasonable to expect that the current plant has adequate capacity to treat all flows from the Vangorda area during the closure period. The Grum pit passive treatment system has proven to be highly effective at removing zinc from the surface water and shows promise for being the only treatment required for Grum Pit. If this treatment approach is successful, as the pit fills, it will become necessary to engineer a system for seasonal release of the treated water. The current plan, which was discussed earlier, is to route discharge through the slot cut area. A series of stop-logs structures and polishing ponds could be constructed in that area if necessary to ensure that discharge water quality is adequately controlled.

The need to collect and treat groundwater and seepage below the Grum Dump is currently being assessed, and options for local passive treatment are being investigated. The range of possibilities include doing nothing in areas where the groundwater is not contaminated, collecting groundwater and treating it locally in a passive system. Contaminated water that cannot be addressed by one of these methods will be sent to the Vangorda pit for storage and seasonal treatment in the current 2000 gpm system.

### 8.3.6 Post-Closure Period

Once closure measures are complete, monitoring will allow post-closure treatment needs to be better defined. Based on the current predictions, the Vangorda area will produce a low volume of highly contaminated water, and the Grum area a much higher volume of less contaminated water.

An active treatment system would definitely be required for the Vangorda flows, but it could be much smaller than the current system. The reasoning applied to the scheduling of active water treatment for the Faro area also applies to the Vangorda/Grum water treatment system; i.e. it is generally preferable to store water during the winter for treatment only in summer. The currently estimated post-closure flows of 75,000 $m^3$ per year from the Vangorda Waste dump and Vangorda Pit area could easily be stored in Vangorda pit and treated in less than 30 days with a treatment plant capacity of 500 USgpm.

The low strength Grum water might be suitable for treatment in the Grum pit. If the pit treatment capacity proves to be inadequate at some time in the future, the 500 USgpm plant could be expanded to treat some portion of the Grum flow. Assuming that 100% of the flow from the Grum waste rock seepage requires treatment, the estimated post closure flow from the Vangorda Waste dump, the Vangorda Pit and the Grum waste rock seepage dump would increase to about 575,000$m^3$ and would be stored in the Vangorda Pit and treated over a 60 day period with a treatment plant capacity of

about 1700 USgpm. In the extreme case, where all of the Vangorda and Grum flows need active treatment, treating the full 830,000 $m^3$ per year of water would require about 60 days of treatment at 2500 USgpm.

Table 8.5, below, outlines possible combinations of treatment methods.

**Table 8.5: Possible Combinations of Treatment Methods**

| Period | Vangorda Waste Rock Seepage and Pit Wall Inflows | Grum Pit Inflows | Grum Waste rock Seepage |
|---|---|---|---|
| Closure | Store in Vangorda Pit and treat seasonally in current 2000 USgpm plant near Overburden Dump | Treat passively in Grum pit and store | When treatment becomes necessary, treat using passive methods if practical and feasible. |
| Closure Contingency 1 | If zinc levels are high construct a 2500 USgpm temporary clarifier at the new plant location which would provide the extra clarifier capacity anticipated for the existing (2000gpm) plant. The new clarifier would be used by the new (500gpm) plants when required. | Treat passively in Grum pit and release seasonally through polishing ponds in Grum pit slot cut | If zinc levels are high, route to Vangorda pit for seasonal treatment in 2000 USgpm plant |
| Closure Contingency 2 | | | If zinc levels are high construct a 2500 USgpm temporary clarifier at the new plant location which would provide the extra clarifier capacity anticipated for the existing (2000 USgpm) plant. The new clarifier would be used by the new (500 USgpm) plants when required. |
| Post-closure | Store in Vangorda pit and treat seasonally by expanding the new 500USgpm plant near Vangorda Creek to 1700 USgpm | Treat passively in Grum pit and release seasonally through polishing ponds in Grum pit slot cut | Either continue using passive treatment methods or route to Vangorda Pit for seasonal treatment in the expanded 1700 USgpm treatment plant. |
| Post-closure Contingency 1 | Route all flows to Vangorda treatment plant expanded to 2500 USgpm capacity | | |

### 8.3.7 Sludge Production and Storage

Table 8.6 shows the sludge tonnages and volumes that result when the lime is converted to gypsum and zinc hydroxide. These volumes are based on the extreme case of 830,000$m^3$/year routed to the new WTP. The additional conversion from dry weight (tonnes) to volume ($m^3$) conservatively assumes a sludge density of 15% solids, which should be readily achievable with an HDS system. Sludge densities of 20% solids or higher are more likely.

It is proposed that the sludge be disposed in the Vangorda pit. A tremie system would be used to place the sludge near the pit bottom, and prevent mixing with the water column. The estimate

volume available in the pit is about 6,000,000 $m^3$. According to Table 8.6, that should be sufficient for over 1000 years of water treatment. If higher sludge densities are assumed, and if consolidation is taken into account, that estimate would increase.

The interim operation of the existing treatment system will continue to produce sludge with much lower density. For similar reason to those discussed for the Faro Mine area, this sludge is not suitable for storage in the Vangorda Pit. Sludge produced from the existing treatment system is currently in impoundments on waste rock. Storage of sludge at suitable locations on waste rock is expected to continue for the duration of operation of the existing treatment system. The excess alkalinity in the sludge will neutralize some acid potential in the waste rock.

**Table 8.6: Treatment Flows, Lime Usage and Sludge Production**

| Year | Treatment Flow | Lime Use | Sludge Production | | |
|---|---|---|---|---|---|
| | ($m^3$/yr) | (tonnes CaO/yr) | (dry tonnes/yr) | ($m^3$/yr) | Cumulative ($m_3$) |
| 1 | 830,000 | 117 | 566 | 3,772 | 3,772 |
| 10 | 830,000 | 99 | 480 | 3,202 | 32,590 |
| 31 | 830,000 | 99 | 499 | 3,326 | 102,447 |
| 50 | 830,000 | 103 | 511 | 3,405 | 167,142 |
| 75 | 830,000 | 106 | 511 | 3,405 | 252,269 |
| 100 | 830,000 | 106 | 511 | 3,405 | 337,396 |
| 150 | 830,000 | 106 | 511 | 3,405 | 507,650 |
| 200 | 830,000 | 106 | 747 | 4,980 | 756,657 |
| 300 | 830,000 | 154 | 884 | 5,894 | 1,346,015 |
| 600 | 830,000 | 183 | 887 | 5,912 | 3,119,662 |
| 800 | 830,000 | 183 | 887 | 5,913 | 4,302,283 |
| 1,000 | 830,000 | 183 | 887 | 5,913 | 5,484,904 |

### 8.3.8 Location

The site of the current 2000 gpm plant requires water to be pumped uphill from the Vangorda pit, so alternative locations have been considered. The decision to store water in the pits means that there is no cost advantage in locating the plant close to any of the sources. Since it is certain that water stored in the Vangorda pit will need active treatment, the logical location for the new 500 gpm plant is somewhere between the Vangorda pit and Vangorda Creek. That area also provides good foundation conditions, access to clean water (from the Vangorda Creek upstream of the pit) and is near to a suitable effluent discharge point into the Vangorda Creek downstream of the pit.

If the new plant needs to be expanded to 2500 USgpm sometime in the future, the Vangorda location would also be suitable.

# 9 Borrow Material Requirements and Sources

## 9.1 General

Closure activities for Faro Mine Complex will require large volumes of natural material for construction of elements such as covers and channel protection. This chapter identifies the type of material that will be required, where this material will be sourced, and a borrow material balance.

## 9.2 Material Type Requirements

The following lists the different types of material that would be used for closure activities:

- Glacial till for low permeability covers, vegetative covers, stabilizing or general fill;
- Granular soils for use in filter or drain material, stabilizing fill, general fill, road construction, protective covers for geosynthetic materials, erosion protection, and concrete aggregate;
- Coarse granular soil for erosion protection in channels (riprap) and road ballast;
- Organic soils for vegetative covers; and
- Waste rock used in the tailings cover, safety berms, and fuse plug construction.

Glacial till is found at both the Faro and Vangorda mine areas. Granular material, suitable for use as cover material, erosion protection and drainage material, occurs locally as glaciofluvial and alluvial deposits. In addition to the material identified in the haul road, reserves are present downstream of the tailings impoundment and in deposits at the Moose Pond and Grum Creek areas.

Riprap is not readily available and must be processed from a bedrock quarry.

Figures 9.1 and 9.2 identify most likely borrow areas for all material types at the Faro and Vangorda mine sites.

## 9.3 Borrow Sources and Capacity

Table 9.1 provides a summary of the available material types and quantities that have been identified at the Faro and Vangorda sites.

Tables 9.2 to 9.4 provide summaries of the source, type and quantity of material that will be required for the closure activities at each of the three areas.

In addition to the till and rock sources, there is an organics source at Faro West and 3,600$m^3$ of organics (peat) will be going to the Guardhouse Creek.

## Table 9.1: Borrow Material Balance

| Sources | Material | Capacity ($m^3$) | Allocated ($m^3$) | Remaining Material ($m^3$) |
|---|---|---|---|---|
| **Faro Area** | | | | |
| Rose Creek | Granular | 1,400,000 | 1,110,000 | 290,000 |
| Rose Creek Haul Road | Till | 800,000 | 743,000 | 57,000 |
| Tailings Borrow | Till | 500,000 | - | 500,000 |
| Haul Road | Granular | 150,000 | 150,000 | - |
| | Till | 720,000 | 257,000 | 463,000 |
| Faro WR Dumps | | | | |
| Calc. Silicate areas (Areas 1,2,3,4)* | Waste Rock | 600,000 | 62,000 | 538,000 |
| NW Dumps | Waste Rock | 681,000 | 681,000 | - |
| Rose Creek Diversion Quarry* | Riprap | 200,000 | 15,000 | 185,000 |
| **Vangorda/Grum** | | | | |
| Grum Overburden Dump (and Foundation) | Till | 9,000,000 | 8,881,000 | 119,000 |
| Vangorda Overburden Dump | Till | 400,000 | 390,000 | 10,000 |
| NE Area of Grum Pit | Till | 1,500,000 | - | 1,500,000 |
| Grum-Vangorda Back Road | Granular | 100,000 | - | 100,000 |
| Moose Pond Borrow | Granular | 45,000 | 40,000 | 5,000 |
| Grum Creek Borrow | Granular | 200,000 | 170,000 | 30,000 |
| Grum Dump Quarry | Riprap | 30,000 | 24,000 | 6,000 |
| **Other** | | | | |
| North Fork Rock Drain (Calc. Silicate) | Waste Rock/Rip Rap | 722,000 | 161,000 | 561,000 |
| Intermediate Dam Spillway | Riprap | 275,000 | 275,000 | - |
| Cross Valley Dam Breach | Granular | 38,700 | 38,700 | - |

*Estimated Capacity

## Table 9.2: Summary of Borrow Material Requirements at the Faro Area

| Location | Material Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Glacial Till | | Granular Soils | | Coarse Granular (Riprap) | | Waste Rock (Calc Silicate) | |
| | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source |
| **Faro Mine Area** | | | | | | | | |
| **Faro Pit** | | | | | | | | |
| Safety Berm | | | | | | | 22,000 | NRFD |
| Mt. Mungly (W+E), South West Pit Wall Dump | 283,436 | Grum Overburden Dump | | | | | | |
| **Diversions** | | | | | | | | |
| Faro Creek Diversion | | | 89,100 | Haul Road Borrow | 6,750 | Faro WR Dumps | | |
| West Valley Extension | | | 4,263 | Haul Road Borrow | 3,553 | Faro WR Dumps | | |
| North Wall Interceptor | | | 8,100 | Rose Creek Borrow | 10,800 | Faro WR Dumps | | |
| Guard House Creek | | | | | | | | |
| **Zone II Pit** | | | | | | | | |
| Collection Pipeline | | | 273 | Haul Road Borrow | | | | |
| **Oxide Fines** | | | | | | | | |
| LGSC A - Very Low Infiltration Cover | 36,139 | Vangorda Overburden Dump | 21,683 | Haul Road Borrow | | | | |
| LGSC C - Very Low Infiltration Cover | 109,541 | Vangorda Overburden Dump | 65,724 | Rose Creek Borrow | | | 454 | Faro WR Dumps |
| **ETA Tailings Area** | | | | | | | | |
| Collection Pipeline | | | 722 | Haul Road Borrow | | | | |
| **Sulphide Cells** | | | | | | | | |
| Main and Intermediate – Very Low | 173,647 | Grum Overburden Dump | 104,188 | Rose Creek Borrow | | | | |
| East Cell – Very Low | 17,441 | Grum Overburden Dump | 10,464 | Rose Creek Borrow | | | | |
| **Faro Waste Rock Dumps** | | | | | | | | |
| Rudimentary Cover | 2,366,797 | Grum Overburden Dump | | | 3,567 | NFRD | | |
| | 152,706 | Haul Road Borrow | | | | | | |
| | 420,000 | Rose Creek Haul Road | | | | | | |
| **Groundwater Collection Systems** | | | | | | | | |
| North Fork Rose Creek | 104,181 | Haul Road Borrow | 30,975 | Haul Road Borrow | 25,887 | NFRD | | |
| Zone II Outwash Collection System | | | 70 | Haul Road Borrow | | | | |
| S-wells Collection System | | | 738 | Haul Road Borrow | 775 | NFRD | | |

## Table 9.3: Summary of Borrow Area Requirements at the Rose Creek Tailings Area

| Location | Material Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Glacial Till | | Granular Soils | | Coarse Granular (Riprap) | | Waste Rock (Calc Silicate) | |
| | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source |
| **Rose Creek Borrow Tailings** | | | | | | | | |
| **Dams** | | | | | | | | |
| Intermediate Dam Raise | 63,000 | Rose Creek Haul Road | 38,700 | Cross Valley Dam Breach | 6,300 | Rose Creek Diversion | | |
| | | | 744,300 | Rose Creek Borrow | | | | |
| Intermediate Dam Spillway | | | 4,450 | Rose Creek Borrow | 8,900 | Rose Creek Diversion | | |
| Secondary Dam | | | 2,339 | Rose Creek Borrow | | | | |
| **Tailings** | | | | | | | | |
| Tailings Cover (0.5m WR, 1.5m Till) | 2,867,445 | Grum Overburden Dump | | | | | 275,000 | Intermediate Dam Spillway |
| | | | | | | | 680,815 | NW Dumps |
| **Rose Creek Borrow Diversion Channel** | | | | | | | | |
| Upstream of Fuse Plug | 45,000 | Rose Creek Haul Road | 162,615 | Rose Creek Borrow | 78,000 | NFRD | | |
| Erosion Dissipation Structure | | | | | 38,000 | Faro WR Dumps | | |
| North Fork Rock Drain | | | 1,177 | Haul Road Borrow | 1,962 | Faro WR Dumps | | |
| Fuse Plug | 700 | Rose Creek Haul Road | 3,550 | Rose Creek Borrow | 700 | Faro WR Dumps | | |
| Raise Downstream portion of RCDC Dike | 189,000 | Rose Creek Haul Road | | | | | | |
| **Groundwater Collection** | | | | | | | | |
| Intermediate Dam Interception Trench | | | 2,025 | Rose Creek Borrow | 30,375 | NFRD | | |
| Intermediate Dam Groundwater Collection System | | | 2,211 | Rose Creek Borrow | | | | |

## Table 9.4: Summary of Borrow Material Requirements at the Vangorda Area

| Location | Material Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Glacial Till | | Granular Soils | | Coarse Granular (Riprap) | | Waste Rock (Calc Silicate) | |
| | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source | $m^3$ | Source |
| **Vangorda/Grum Mine Area** | | | | | | | | |
| **Vangorda Pit** | | | | | | | | |
| Safety Berm | 15,000 | Vangorda Overburden Dump | | | | | | |
| Pit Waste Rock Cover (Low Infiltration) | 132,281 | Vangorda Overburden Dump | | | | | | |
| **Vangorda Dump** | | | | | | | | |
| Baritic Fines Synthetic Cover | 3,485 | Vangorda Overburden Dump | 3,485 | Moose Pond Borrow | | | | |
| Waste Rock Cover (Low Infiltration) | 1,197,077 | Grum Overburden Dump | | | 977 | Grum Dump Quarry | | |
| Sulphide Cell | 53,311 | Grum Overburden Dump | 31,987 | Moose Pond Borrow | | | | |
| **Vangorda Creek Diversion** | | | | | | | | |
| New Vangorda Diversion | | | 3,203 | Moose Pond Borrow | 10,677 | Grum Dump Quarry | | |
| Upgrade Dixon Creek | | | 2,104 | Grum Creek Borrow | 4,909 | Grum Dump Quarry | | |
| **Grum Pit** | | | | | | | | |
| Safety Berm | 20,000 | Vangorda Overburden Dump | | | | | | |
| Grum Interceptor Ditch | 24 | Vangorda Overburden Dump | 2,359 | Grum Creek Borrow | 5,056 | Grum Dump Quarry | | |
| **Grum Dump** | | | | | | | | |
| Sulphide Cell –Very Low Infiltration | 271,746 | Grum Overburden Dump | 163,047 | Grum Creek Borrow | | | | |
| Main Dump - Rudimentary Cover | 72,315 | Vangorda Overburden Dump | | | 2,708 | Grum Dump Quarry | | |
| | 1,512,768 | Grum Overburden Dump | | | | | | |
| **Ore Transfer Pad** | | | | | | | | |
| Rudimentary Cover | 137,569 | Grum Overburden Dump | | | | | | |
| **Groundwater Collection Systems** | | | | | | | | |
| Grum Dump GW Collection System | 1,476 | Vangorda Overburden Dump | 2,450 | Grum Creek Borrow | | | | |
| Vangorda Dump GW Collection System | | | 704 | Moose Pond Borrow | | | | |
| **Water Treatment** | | | | | | | | |
| Faro Misc. Pipelines | | | 975 | Haul Road Borrow | | | | |
| Faro/Tailings Plant Polishing Pond | 25,689 | Rose Creek Haul Road | | | | | | |
| Vangorda/Grum Misc. Pipelines | | | 517 | Moose Pond Borrow | | | | |

Figure 9.3 provides a flow diagram, which shows how much and the type of borrow material that will be required for each closure activity throughout the entire site.

### Preliminary Borrow Development Plan

Criteria used to select the final borrow sources include:

- Minimize disturbance area while maximizing volume;
- Avoid developing below grade and creating a crater which will collect and store water;
- Where material is excavated above bedrock maintain 0.5m of overburden for reclamation; and
- Rock quarries used for riprap should be geochemically tested prior to development.

When a borrow source is selected, standard industry practice will apply. Clearing and grubbing will be completed including salvaging the timber or disposing of it according to forestry practice. Topsoil and organics from the grubbing operation will be stockpiled nearby for later reclamation use. Surface water management practices will be adopted around all ground disturbances. The borrow area will be developed in benches according to equipment specifications and landscape. When the borrow/quarry is exhausted or work is completed, the slopes should be flattened to 3H:1V for long-term stability and the surface shaped to encourage natural drainage. A 0.3m lift of organic material from the stockpile would be spread for revegetation according to silvaculture requirements.

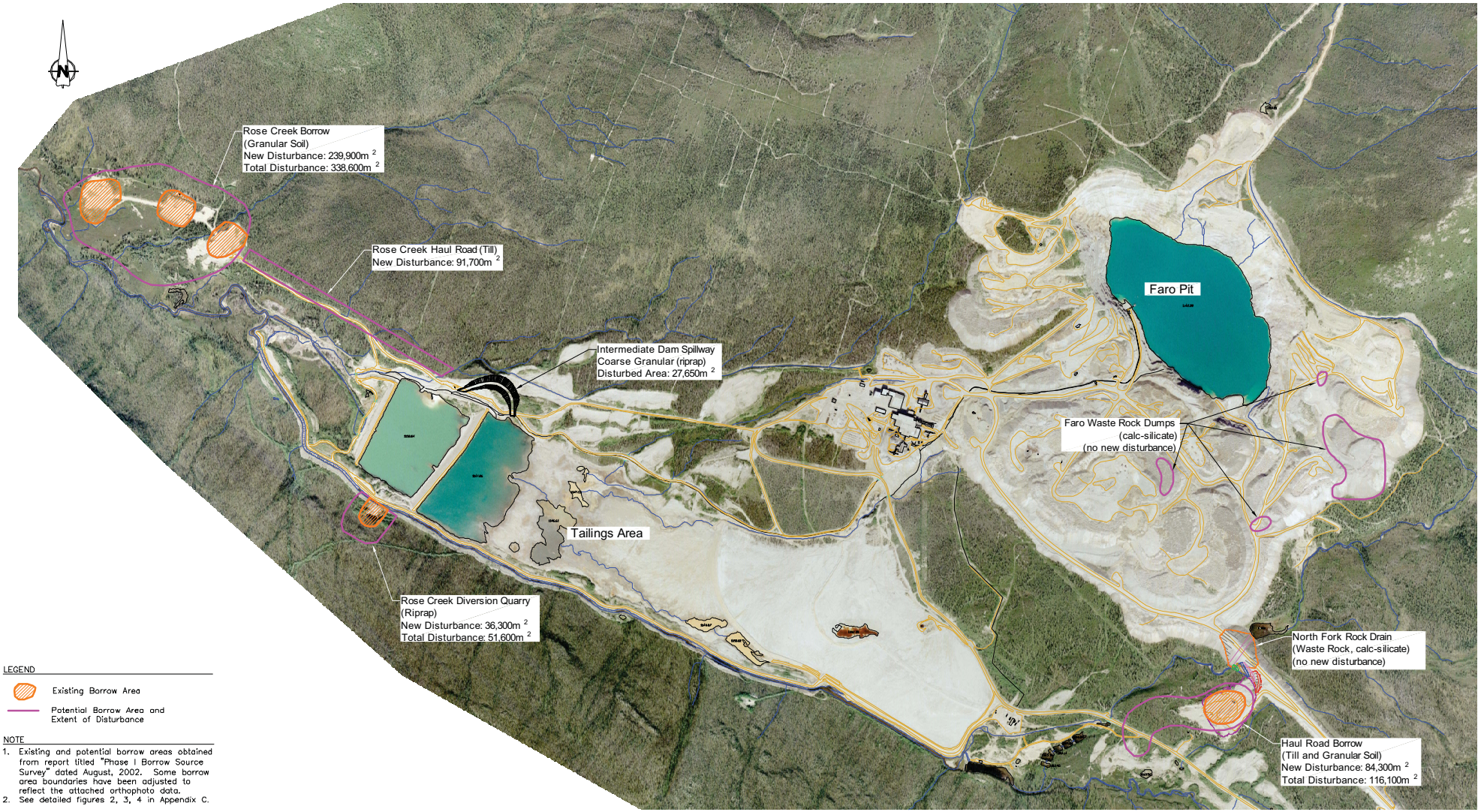
### Areas of Disturbance

Existing borrow areas will have minimal additional disturbance, but new borrow areas will create new areal disturbance. Table 9.5 below shows the areas that will be disturbed. All efforts will be made to minimize disturbance while developing new borrow areas.

**Table 9.5: Areas of Disturbance at Faro, Rose Creek Tailings, and Vangorda/Grum**

| Location | Borrow Material Used | Estimated New Disturbance Area |
|---|---|---|
| **Faro Area Sources** | **$m^3$** | **$m^2$** |
| Rose Creek (Granular) | 1,053,000 | 239,881 |
| Rose Creek Haul Road (Till) | 787,000 | 91,683 |
| Haul Road (Granular) | 149,000 | 49,567 |
| Haul Road (Till) | 604,000 | 34,727 |
| Rose Creek Diversion Quarry (Riprap) | 109,000 | 36,290 |
| Faro Regrade | N/A | 350,000 |
| **Vangorda/Grum Sources** | | |
| Vangorda Overburden Dump (Till) | 400,000 | 65,998 |
| Moose Pond (Granular) | 6,000 | 4,202 |
| Grum Creek (Granular) | 7,000 | 3,456 |
| Grum Dump Quarry (Riprap) | 24,000 | 12,163 |
| **Other Disturbance Due to Construction** | | |
| Faro Creek Diversion | N/A | 75,700 |
| West Valley Interceptor Ditch | N/A | 51,300 |
| Intermediate Dam Spillway | 28,624 | 27,654 |
| Vangorda Creek Diversion | N/A | 32,800 |
| North Wall Interceptor Ditch | N/A | 55,600 |
| North Fork Rose Creek Upgrade | N/A | 84,000 |
| Grum Regrade | N/A | 37,900 |

# Figures




LEGEND

Existing Borrow Area

Potential Borrow Area and Extent of Disturbance

NOTE

1. Existing and potential borrow areas obtained from report titled "Phase I Borrow Source Survey" dated August, 2002. Some borrow area boundaries have been adjusted to reflect the attached orthophoto data.
2. See detailed figures 2, 3, 4 in Appendix C.

**SRK CONSULTING**
Faro Mine, Yukon

Map Scale : 1:7,500
Contour Interval: 2m
Date of Photography: 03/07/25
Scale of Photography: 1:20000
Survey control derived from existing 1:20000 photography
Survey control based on: UTM Projection, NAD27
Compiled by The ORTHOSHOP, Calgary, September 2003
WO 8856

0 200 400 600 800 1000
Scale in Metres

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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-18_Rev_A.dwg

Faro Mine Closure
Fermeture de la mine Faro

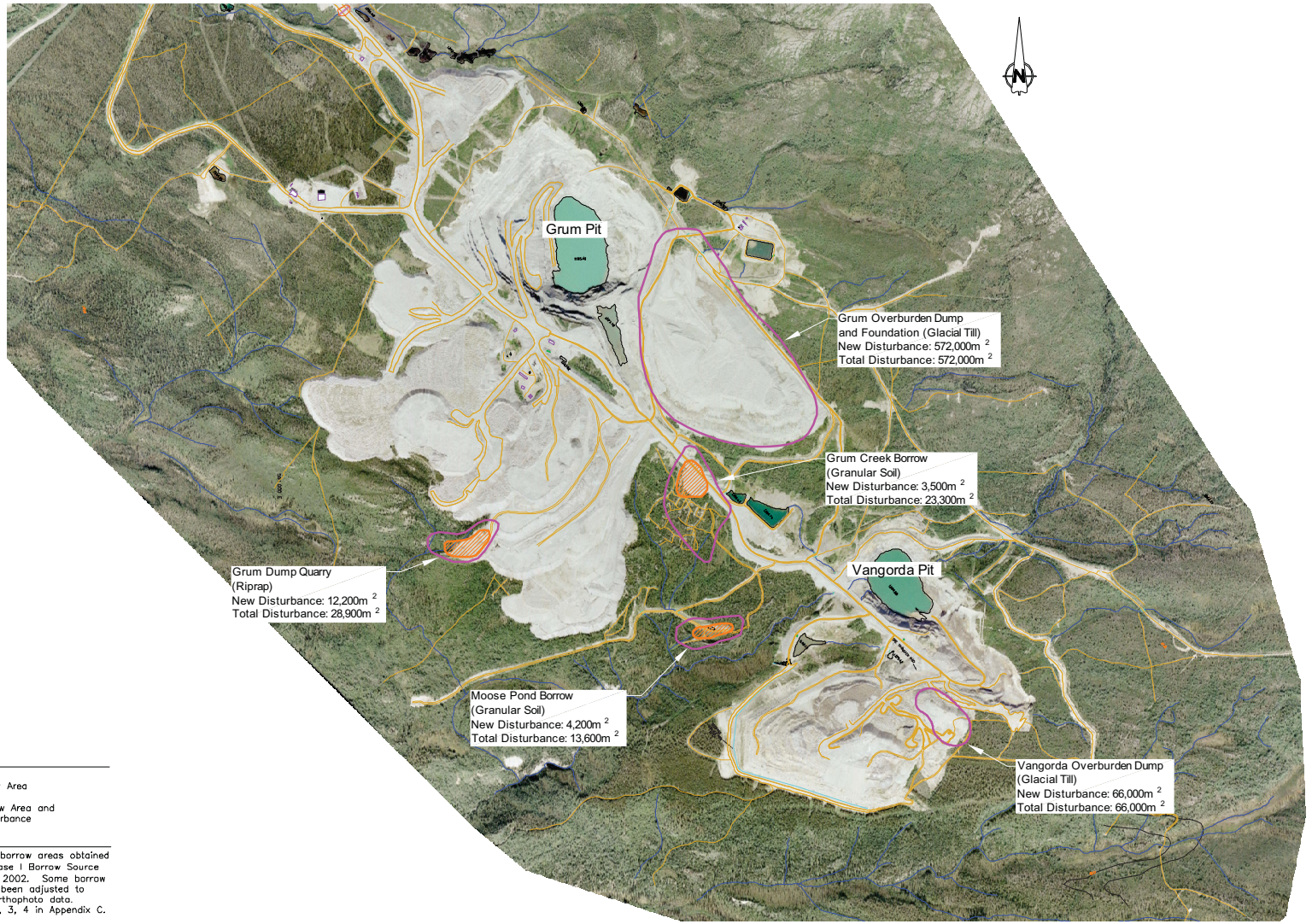
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Faro Pit Area
Existing and Potential Borrow Areas and Areas of Disturbance

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 9.1 |

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LEGEND

Existing Borrow Area

Potential Borrow Area and Extent of Disturbance

NOTE

1. Existing and potential borrow areas obtained from report titled "Phase I Borrow Source Survey" dated August, 2002. Some borrow area boundaries have been adjusted to reflect the attached orthophoto data.
2. See detailed figures 2, 3, 4 in Appendix C.

**SRK CONSULTING**
Faro Mine, Yukon

Map Scale : 1:7,500
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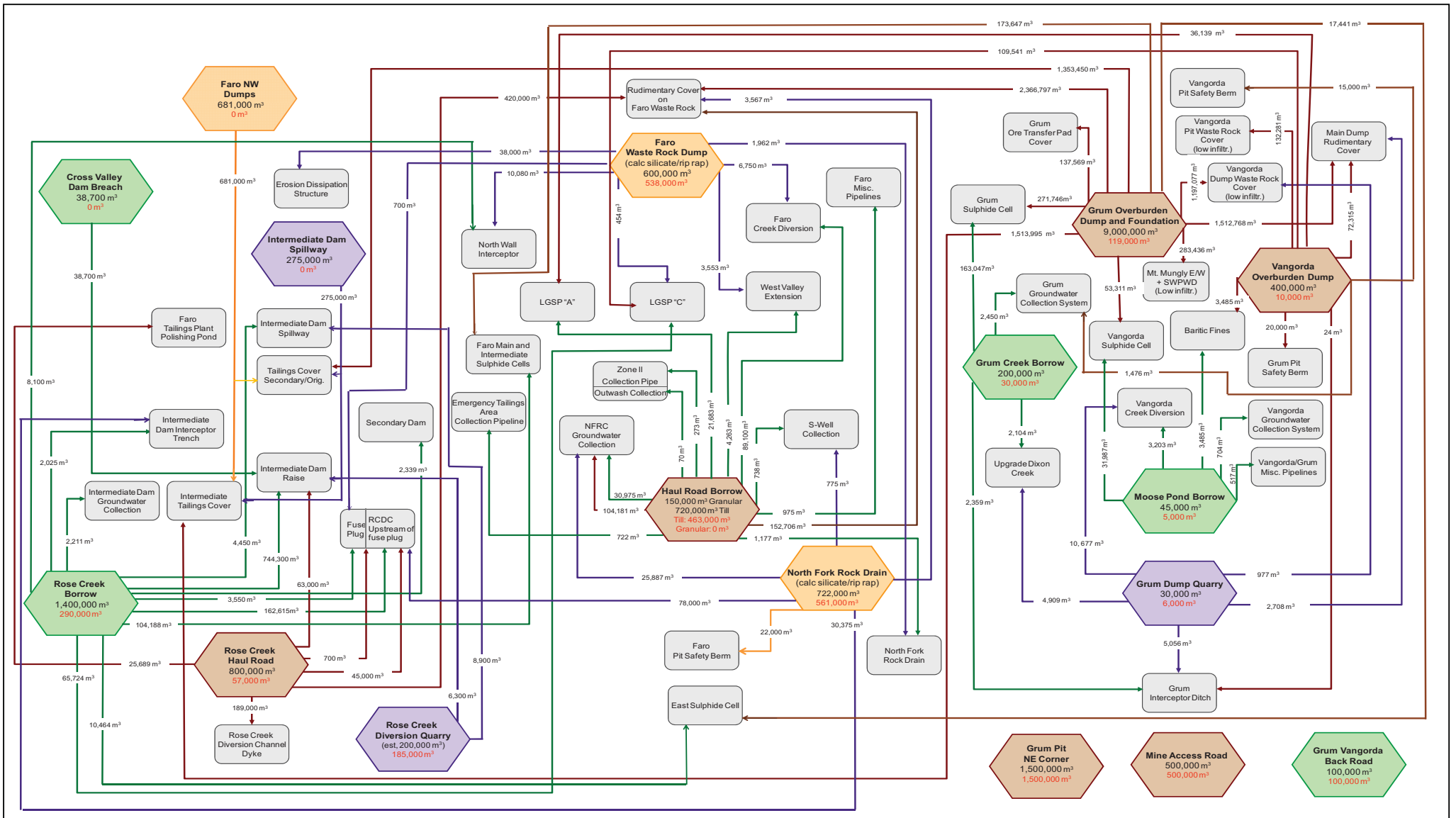
Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

Vangorda/Grum Pit Areas
Existing and Potential Borrow Areas
and Areas of Disturbance

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| December 2009 | PMH | 9.2 |

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## Key

- Glacial Till
- Waste Rock
- Coarse Granular (rip rap)
- Granular Soil

**Mine Access Road**
500,000 m³
500,000 m³

- **Borrow Source Name**
- Available Material
- Remaining Material

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Job No: 1CY001.026

Filename: Figure 9.3_BorrowBalance_20091203.ppt

Faro Mine Complex
Final Closure and Remediation Plan

Project Description (Draft 4)

**Borrow Material Balance**

Date: December 2009

Approved:

Figure: **9.3**

# 10 Water Quality Prediction

A site wide water quality and water balance model has been developed in GOLDSIM to provide estimates of contaminant concentrations in the receiving environment over time due to the implementation of the proposed closure plan. The GOLDSIM Model is run with a range of inputs selected to represent the uncertainties associated with specific components of the project: stochastically. Specific input parameters that are being modeled stochastically include cover infiltration for rudimentary and low infiltration covers, NP availability and groundwater collection efficiency. The results GOLDSIM model are time-base predictions of a range of contaminant concentrations with "error bars" denoting the uncertainty.

The three main contributors of contaminant load to the receiving environment are the waste rock dumps, the tailings impoundment and discharge of compliant water from the water treatment facilities.

The approach taken for the development of time based estimates for loadings from the waste rock dumps was to develop a stochastic model that would attempt to predict the possible range of concentrations at any one time based on the known properties and conditions within the waste rock dumps, including the potential effects of the closure measures including changes in infiltration due to cover placement. Consideration was given to the rate of neutralization potential (NP) and acid potential (AP) depletion based on current measures of oxidation rate in the dumps. Then, assuming covers are placed, the oxidation rates were adjusted to reflect the changed conditions. The existing seep water quality data set (average (best estimate) and maximum (upper bound) concentrations) was used as a measure of potential water quality conditions that may develop within each of the dumps over time.

For the Faro tailings, estimates of porewater displacement have been combined with porewater quality estimates to provide time-based estimates of contaminant loadings from the base of the tailings deposit. Attenuation below the tailings and within the aquifer has recently been demonstrated to be important in limiting the ultimate release of these contaminants. Attenuation has not been accounted for in the predictions presented to date.

The model assumes that all groundwater seepage, from either the tailings area or the waste rock dumps, that is collected is then routed to Faro Pit on the Faro side and Vangorda Pit on the Vangorda Plateau side. The model also assumes that the pit water is treated using a high density sludge treatment system and discharged seasonally (May to September) to the receiving environment. The discharge location on the Faro side is assumed to be immediately downstream of the confluence of the North and South Forks of Rose Creek. On the Vangorda side the discharge locations is assumed to be in the area where Vangorda Creek crosses the site access road, below the existing drop structure. In addition the model assumes that the water in Grum Pit will continue to be treated biologically. During the open water season treated surface water in Grum Pit will be discharged to Vangorda Creek.

Conceptual schematics of the Faro Water Quality and Water Balance Model are presented in Figures 10.1 and 10.2. Receiving environment water quality model points are presented in Figure 10.3. In the Rose Creek/Anvil Creek drainage the model points include:

- X2 – North Fork of Rose Creek;
- Confluence of the North and South Forks of Rose Creek;
- X14 – Rose Creek downstream of the water treatment plant discharge;
- Mouth of Rose Creek;
- Anvil Creek, downstream of confluence with Rose Creek; and
- Mouth of Anvil Creek.

In the Vangorda Creek drainage, the model points include the main stem of Vangorda Creek at V27, downstream of the discharge location, and in Vangorda Creek at V8 near the Town of Faro at location V8.

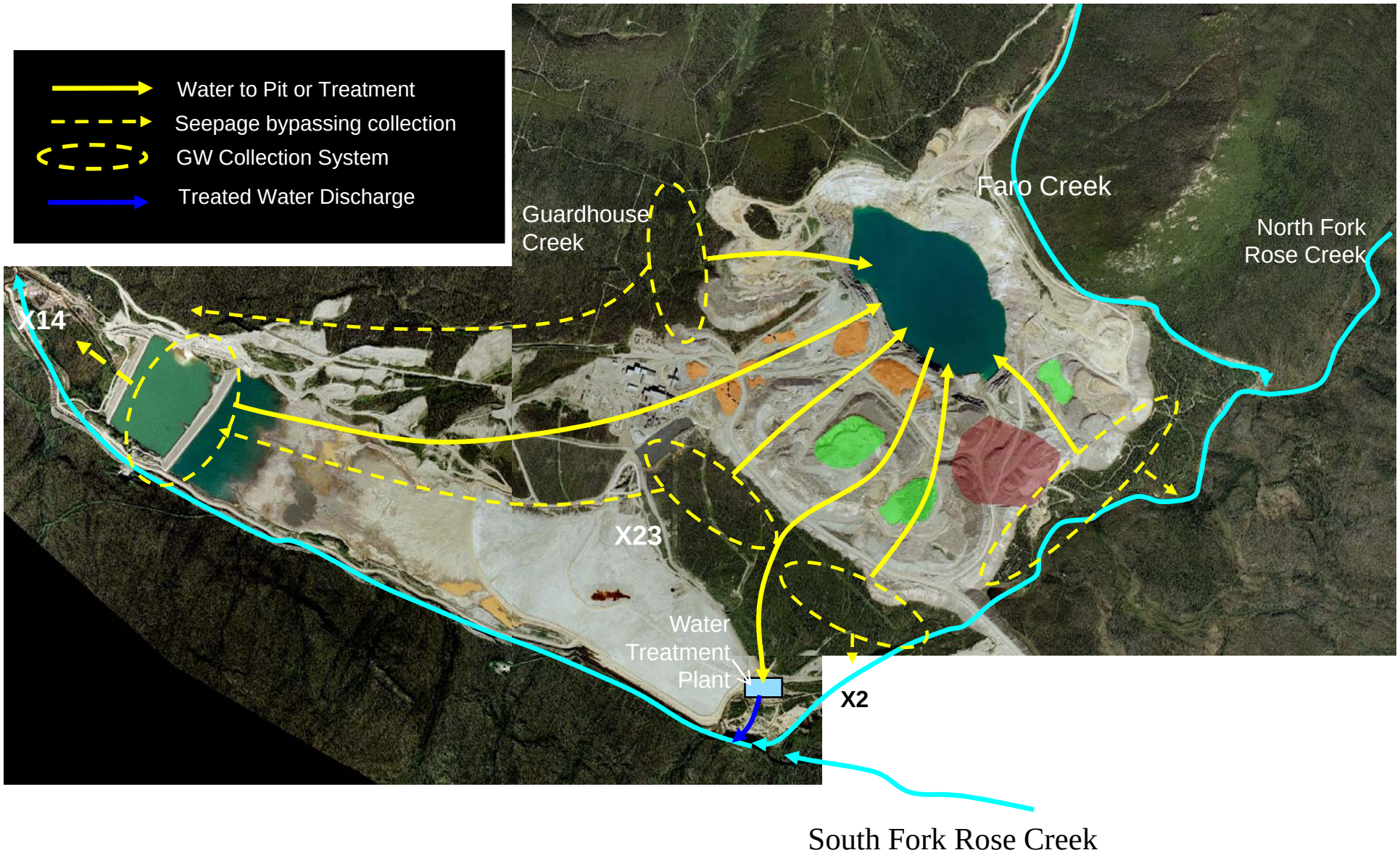
In the Pelly River drainage, water quality model points include:

- Pelly River downstream of the inflow of Vangorda Creek;
- Pelly River upstream of the inflow of Anvil Creek; and
- Pelly River downstream of the inflow of Anvil Creek.

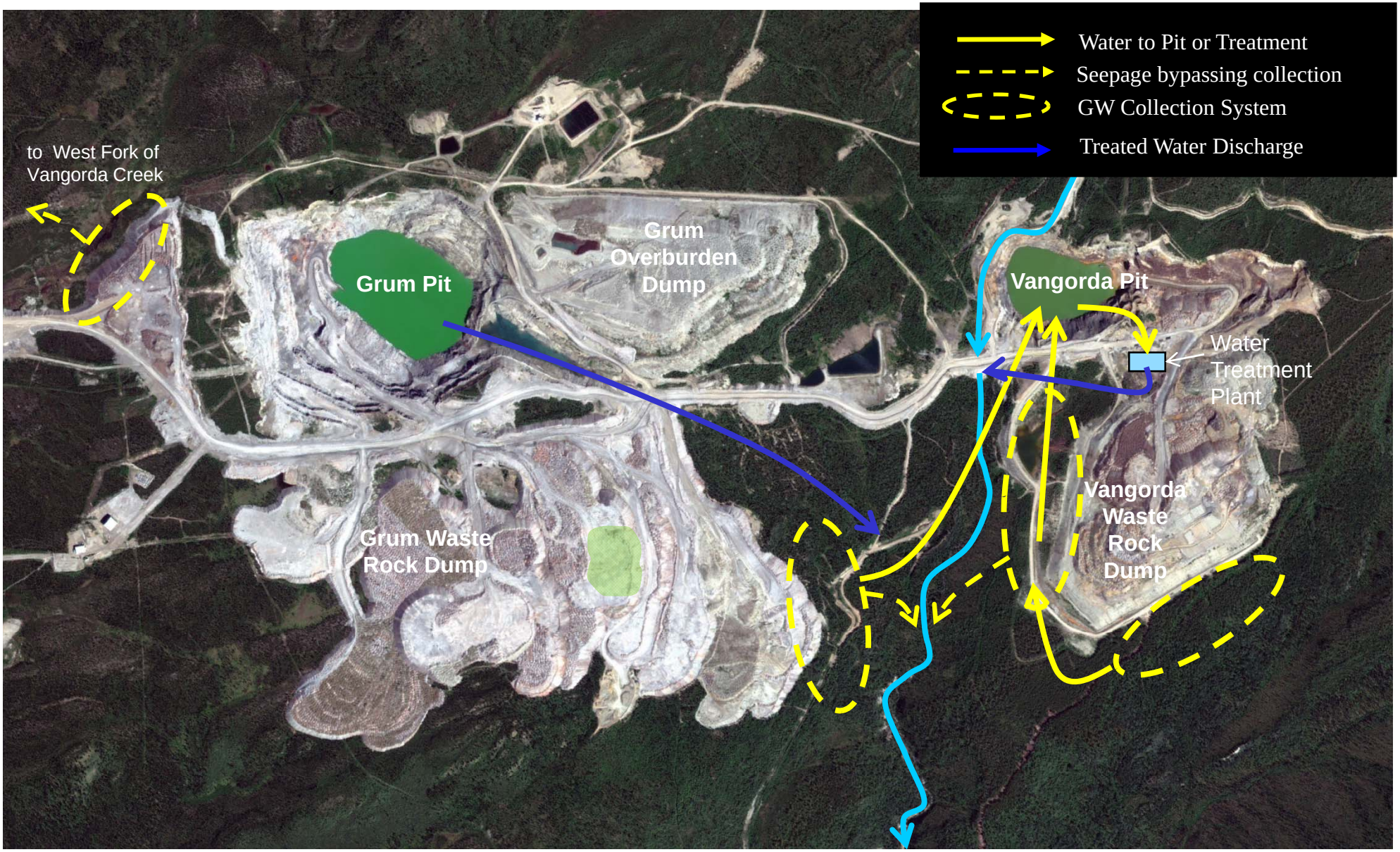
Two scenarios have been run using the model: Best Estimate and Upper Bound and Year-round treatment. The Best Estimate scenario assumes the average statistic of the compiled seepage data for both current (neutral) and future (acidic) conditions. The Upper Bound Scenario assumes the maximum statistic of the seepage data set for both current and future conditions. For both scenarios it is assumed that current chemistry applies until 70% of the available NP has been depleted. Then there is a linear increase in chemistry from current to future chemistry between 70% and 100 % NP depletion.

The model is run on monthly time steps for 200 years from 2012 to 2211 for 25 realizations. Full details of the model framework, assumptions and inputs as well as results from the various model runs are provided in Appendix D (Faro Site Wide Water Quality Model).

# Figures




| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists VANCOUVER | Faro Mine Closure Fermeture de la mine Faro | Project Description (Draft 4) |
| | | **Conceptual Schematic of Water Balance Model Faro - Tailings** |
| Job No: 1CY001.026<br>Filename: Figures_10.1-3_WQ_20091127.ppt | Faro Mine Complex<br>Final Closure and Remediation Plan | Date: December 2009 / Approved: / Figure: **10.1** |




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Faro Mine Closure
Fermeture de la mine Faro

Project Description (Draft 4)

**Conceptual Schematic of Water Balance Model Vangorda**

Job No: 1CY001.026
Filename: Figures_10.1-3_WQ_20091127.ppt

Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009
Approved:
Figure: **10.2**




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VANCOUVER

Faro Mine Closure
Fermeture de la mine Faro

Project Description (Draft 4)

**Water Quality Model Points Receiving Environment**

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Faro Mine Complex
Final Closure and Remediation Plan

Date: December 2009
Approved:
Figure: **10.3**

# 11 Project Execution Strategy

## 11.1 Introduction

This document presents a preliminary project schedule for the execution of the Faro Mine Complex Reclamation and Closure Project. As it is still very early into the project, it is expected that the sequencing of many of the closure and reclamation activities presented in this preliminary schedule will change before a final execution strategy is adopted. It should be noted that this document does not attempt to present an implementation strategy that considers all the social, environmental, economic and cultural factors. However, in an attempt to provide some of the required information for the assessment the future socio-economic opportunities and some of the environmental effects of the project, an overall activity sequencing strategy is presented along with a closure cost estimate and cashflow. A preliminary estimate of the type of equipment fleets needed and an initial estimate of the required workforce is also provided. The equipment requirements provided includes an estimate of the number of trucks trips required to mobilize equipment to site and an estimate of the number of fuel and lime delivery vehicles needed over the life of the project. The workforce estimate provides an annual breakdown of employment levels for skilled workers, specialized trades and professionals.

## 11.2 Strategic Sequencing Component Activities

As shown on Figure 11.1 (Preliminary Project Schedule), it is currently anticipated that construction for the project will occur over a 14 year period. Although not shown on the schedule, it is expected that Year 1 of the project would be 2012 given the projected timeframe for environmental and socio-economic assessment, regulatory permitting, developing local capacity, final design and bid tendering. It is expected that there would be a two to three year phase-in period to allow development of local capacity. This would likely occur between Year -1 to Year 1. After this period, work would be scheduled to provide continuity of expenditure and employment over the remainder of the implementation period. The implementation period would be followed by long-term care and maintenance. It is also expected that there would be an estimated 25-year transition period where an adaptive management approach would be adopted before the site care and maintenance settles down to a long-term equilibrium. Site management and water treatment will be required in perpetuity.

There are a number of activities that have been classified as high priority and have been scheduled for early remediation between Year -3 and Year 1. These include the covering of the Grum Sulphide Cell and possibly the construction of the upgraded Vangorda Creek Diversion. Other possible early remediation activities, which are still subject to further review, may include the removal of the tailings and underlying contaminated soil at the Emergency Tailings Area (ETA) and further advancement of the groundwater collection system at the S-wells area.

A number of factors have been considered in developing this initial strategy for sequencing the major key closure activities other than the activities scheduled for early remediation. These factors include:

- Prioritizing activities to optimize the reduction in the release of contaminants to the environment, targeting initial closure activities on the major sources of environmental contamination.
  - With respect to sources of contaminants to the aquatic receiving environment, the waste rock, particularly that at the Faro side of the property, is the largest source of contaminants. Of those the oxide fines, medium grade ore stockpile and Low Grade Ore Stockpiles A and B are a major source of water contamination at the site.
- Reducing the risk associated with flooding in the tailings area and the associated loss of tailings to Rose Creek.
- Identifying critical path items, interactions between the various closure components and inter-dependencies.
  - For example, the removal of the North Fork Rock Drain and its impact on the haul road from Vangorda. The removal of the rock drain will restrict vehicular access from Vangorda to the Faro Rock Dumps. Therefore alternate sources of clean waste rock such as the calcareous phyllite in the Northwest dump are being considered
- Cash Flow and Workforce Requirements.

In consideration of the above factors, an overall schedule was developed as shown in Figure 11.1. The key closure activities are discussed below.

The remediation of the oxide fines and the low grade ore stockpiles is one of the first activities to take place (Year 1). This was given a high priority as the waste is considered a major source of the water contamination on the site. Regrading, resloping and covering of the remainder of the remainder of the waste rock dumps at the Faro Mine area would follow in Year 2 to Year 6, focusing on higher source areas (East, Main and Intermediate Sulphide Cells) first.

Construction of the flood management structures associated with the Rose Creek Tailings facility would be initiated the following year (Year 2) to alleviate concerns about tailings release during a flood event greater than the current capacity of the Rose Creek Diversion Channel. This would involve construction of the Intermediate Dam Spillway, raising of the Intermediate Dam, breaching of the Cross Valley Dam and raising of the Rose Creek diversion dyke.

In order to maintain vehicular access from the Vangorda till borrow sources to the Faro dumps, breaching of the North Fork Rock Drain would not occur until the covers on the Faro waste rock dumps (including the oxide fines, low grade ore stockpiles and the sulphide cells) are completed. The closure plan calls for the trafficability layer in the tailings cover to consist of about 1 million cubic metres of large size granular material such as waste rock. As covering the tailings is considered a high priority, several potential borrow sources for the trafficability layer were

considered. The current source of this material is the Northwest dumps and the excavation of the Intermediate Dam Spillway. The regrading and cover placement on the Grum and Vangorda waste rock dumps are also scheduled to start in Year 7. The existing water treatment facilities at both Vangorda and Grum would continue to operate during the construction period and would complement the two new plants at Faro and Vangorda. It is expected that the WTP at Faro would be built within the first few years of the closure implementation phase. The demolition of the Faro Mill buildings and reclamation of the resulting mill area would start in Year 11.

## 11.3 Early Remediation

### 11.3.1 General

As mentioned above, there are a number of closure activities that have been classified as high priority and are scheduled for early remediation between Year -3 and first year of closure. The following sections provide additional details on each of these activities.

### 11.3.2 S-wells Groundwater Collection - Activity 107.4

Installation of initial groundwater interception components in the S-wells area started during the winter of 2009. The shallow aquifer sump has been installed and the existing deep aquifer pumping wells have been tied into this system. At present all water collected is routed to the Faro Main Pit. During the summer of 2009, additional deep aquifer pumping wells may be installed in areas of high contaminant concentrations.

The longer term groundwater monitoring system will be installed when required, incorporating existing monitoring wells, where possible. Adaptive management would be implemented immediately thereafter.

### 11.3.3 Grum Sulphide Cell Cover – Activity 306.2

This work would involve the following tasks:

- Resloping the Sulphide Cell;
- Covering the Sulphide Cell with Low Infiltration Cover; and
- Revegetation

This activity is scheduled to occur early in the project because of immediate groundwater quality concerns. This activity will also be completed before the resloping and placement of the rudimentary cover over the remainder of the Grum waste rock dump. The till for the low infiltration cover on the Grum Sulphide Cell will come from the Grum Overburden dump. The work would take place in Year -2.

### 11.3.4 Development of the Vangorda Till Borrow Area (Overburden Stockpile) – Activity 311.5

As the regrading and covering of the Grum Sulphide cell is scheduled to occur in Year -2 (2010), initial development of the borrow area for the cover material is also scheduled for Year -2. The primary source of this material is the Grum Overburden Stockpile, northeast of the Grum Pit.

### 11.3.5 Vangorda Creek Diversion – Activity 303

Final design of the channel is currently in progress and will be completed in 2010. Construction of the Vangorda Creek Diversion will likely take place in 2011. Since the diversion will likely cross the Haul Road that connects Vangorda/Grum area to Faro, and the Haul Road will be needed during the implementation of the closure plan at least up to Year 11, the existing drop box structure and culverts will be maintained in the short term. Flow from a new diversion would most likely be directed into the existing plunge pool. The Vangorda Creek Diversion would be extended and a new plunge pool constructed when the Haul Road is reclaimed in Year 11.

### 11.3.6 Remediation of the Emergency Tailings Area – Activity 105

This task is subject to further review as an early remediation candidate and would involve the removal of the tailings from the Emergency Tailings Area. Removed tailings will be placed in the Rose Creek Tailings Impoundment. The installation of a new groundwater seepage collection could occur before the tailings are removed. Therefore it is expected that the groundwater collection system could be installed as early as 2011 following the relocation of the ETA tailing.

## 11.4 Closure Activities in Major Areas

### 11.4.1 Faro Mine (Area 100)

#### Oxide Fines and Low Grade Ore Stockpile Relocation and Cover – Activity 104

This activity includes four main tasks:

- Relocate Oxide Fines, and other stockpiles to Low Grade Ore Stockpile “C” (LGSP “C”);
- Reslope LGSP “A” and LGSP “C”;
- Cover LGSP “A” and LGSP “C” with Very Low Infiltration Cover;
- Covering the Mt Mungly East and West dumps and the Southwest Pit Wall dump with low infiltration cover; and
- Revegetate.

This activity is scheduled to begin in Year 1 as it is considered a high priority for the improvement to the regional groundwater quality. The placement of a very low infiltration cover on both LGSP’s is expected to take about 7 months.

### Regrade and Reslope Faro Waste Rock Dumps – Activity 106.1B

This activity will occur after the relocation of the Oxide Fines and Medium Grade Ore Stockpiles. This will allow the areas where they are currently located to be regraded. Resloping and regrading of the waste rock will start in Year 5 with completion by Year 7.

### Cover Main, East and Intermediate Sulphide Cells (very low infiltration) & Revegetate – Activity 106.2, 106.3

This activity includes three tasks:

- Cover the Main, East and Intermediate Sulphide Cells with a Low Infiltration Cover; and
- Revegetate.

The regrading and resloping of the Main, East and Intermediate Sulphide Cells is scheduled to be completed in Year 2, followed by the placement of the very low infiltration covers on the Sulphide Cells. This would need to be completed before the placement of the 0.3 to1m thick rudimentary cover of loosely compacted till over the entire dump. Placement of the very low infiltration covers is expected to take approximately 3.5 months over the summer months.

### Place Rudimentary Cover on Remaining Faro Waste Rock & Revegetate – Activity 106.4/5/6

This activity includes two tasks:

- Cover the Faro Waste Rock Dumps with Rudimentary Cover; and
- Revegetate.

The placement of rudimentary cover on the Faro Waste Rock Dumps will start in Year 7 and continue until 3rd quarter of Year 9. In general, it is expected that placement of rudimentary till covers (including resloping, excavation of till at Grum, hauling, and spreading) will not be carried out year-round. Spreading of the till on the slopes may not be practical in the winter months. Shut-down during periods of very cold weather is likely. Placement of the low and very low infiltration covers is expected to be a summer only activity. It is, however, expected to be a 24-hour operation during this period.

The placement of till for the rudimentary cover on the waste rock dumps is expected to take place at a rate of approximately 1.23 million $m^3$ per year. Approximately 2,806,074$m^3$ will be placed on the waste rock dump and it is expected to take about 3 years. The material will be hauled from the Grum Overburden Dump.

### Relocate Zone II Outwash Material to Intermediate Sulphide Cell – Activity 107.2

Since the Zone II outwash material will be placed on the Intermediate Sulphide Cell, this activity will occur during the regrade of that area and before the placement of the very low infiltration cover.

It is currently scheduled to take place during the 2nd quarter of Year 2 and weather should not be an issue.

### North Wall Interceptor Ditch - Activity 102.3

This activity includes two tasks:

- Clean out the channel ; and
- Flatten side slopes

The scheduling of this activity is flexible. It is currently scheduled to take place early in the project life in the 2nd quarter of Year 6. This activity will be completed during a low flow period.

### Zone II Pit Outwash Groundwater Collection System – Activity 107.3

The optimal time for installation of the groundwater collection system in the Zone II Pit Outwash area has not been determined. Installation timing will be based on the groundwater monitoring in the area. As part of the adaptive management plan, once groundwater monitoring indicates that collection is necessary, the collection system will be installed. It is currently scheduled to take place in Year 9 but factors such as groundwater quality could result in earlier or later construction of the Zone II Pit Outwash Groundwater Collection System.

### Relocation of Faro Creek Diversion Channel – Activity 102.1/2

This activity includes two tasks:

- Construction of the Faro Creek Diversion ( East side of the valley); and
- Construction of the new West Valley Interceptor Channel.

Construction of the Faro Creek Diversion in the East Valley is currently scheduled in Year 8 and completed in Year 9. The construction of the West Valley interceptor channel would follow immediately after, starting in Year 9. The scheduling of this activity is flexible but it is current scheduled toward the middle of project life, in order to continue to keep clean water routed outside of the Faro Pit and minimize seepage losses that could impact the stability of the Faro Pit walls.

### Guardhouse Creek Water Management – Activity 102.4

The objective of this work is to intercept seepage from the mill pad and associated stockpiles and redirect this water to the Faro Pit via a pipeline connecting with the ETA pipeline (Activity 105). Surface water interception will include a sump and pumping station. A monitoring network will be installed and, if data indicates bypass at levels of concern, additional interception components will be installed or existing components modified. These could include a groundwater cut-off wall, interception trench, a larger sump or additional pumping capacity.

This activity has been scheduled for Year 3 in order to tie into the ETA pipeline.

### Construct Faro WT Plant and Piping – Activity101.1

The timing for the construction of the long-term Faro treatment plant is currently scheduled for Year 1 and 2. Until the new treatment plant is constructed and commissioned, the existing treatment plant in the Faro mill will remain in operation.

### Faro Sludge Disposal – Activity 101.3

The current sludge disposal facility is located on the Rose Creek Tailings Impoundment. Once the new Faro Water Treatment Plant has been constructed the sludge will be removed and the area will be regraded and covered. Based on the current schedule of the Faro Water Treatment Plant construction, sludge disposal to Faro Pit will begin in the Year 3.

### Install pump in existing wells (Zone II Pit) - Activity 103.1

This work will consist of the installation of a new pump in the existing groundwater well, piping, heat tracing and is currently scheduled for Year 9 of the project. This will take place after the waste rock dumps have been regraded and covered.

### Building Demolition and Road Reclamation – Activity 108.1/2

Road reclamation will likely occur after the completion of dump covering and construction of the pit safety berm. Building demolition will occur as buildings are phased out of service. These activities are currently scheduled to begin in Year 10 and continue for about 4 years.

### Mill Site Reclamation – Activity 108.3

This activity includes two tasks:

- Remove hydrocarbon contaminated soils to a bioremediation cell; and
- Consolidate and cover in place the PAG rock.

Excavation and treatment of much of the contaminated soil will be linked to the removal of buildings and infrastructure in the Faro mill complex area. The Faro mill may have to remain in operation for water treatment until later in the remediation process. This activity is currently scheduled to take place during the 3$^{rd}$ quarter of Year 11.

### Faro Pit Safety Berm – Activity 101.2

This activity will take place after all construction activity within the pit area has been completed. The construction of the safety berms around the pit is scheduled for Year 12 of the Project.

## 11.4.2 Rose Creek Tailings Facility (Area 200)

### General

In order to reduce the risk of a release of tailings due to peak flows in excess of the 1 in 500 year event, the construction the flood management systems associated with the Intermediate Dam raise has been scheduled for Year 3 immediately after the covering of the high concentration waste at the Faro Waste Rock Dumps. This would involve the following activities:

- Dewatering the CVD pond;
- Constructing PMF Intermediate Dam Spillway;
- Breaching of the Cross Valley Dam;
- Raising of the Intermediate Dam ; and
- Raising the Rose Creek Diversion Channel Dyke if required.

### Dewater Intermediate Tailings Area and CVD pond – Activity 201.1.1/2/3

This activity includes three tasks:

- Dewater the Intermediate Tailings;
- Dewater the Cross Valley Dam (CVD) Pond; and
- Remove sludge and contaminated soil from the CVD Pond.

This activity will be the first to take place in the Rose Creek Tailings Facility area. Dewatering of the areas will allow future construction and must be undertaken early in the RCTF implementation phase. This activity is currently scheduled for Year 3. Due to freezing temperatures during the winter months, this is expected to occur during the summer months.

### Construct Intermediate Dam Spillway – Activity 201.3

This activity includes two tasks:

- Excavation of the channel to design grades; and
- Installation of channel erosion protection.

The construction of the Intermediate Dam Spillway would begin after dewatering of the Intermediate Dam Pond. The existing spillway in the Intermediate Dam will continue to provide overflow protection during the construction of the new spillway. The construction of the Intermediate Dam Spillway will take place during from the 4$^{th}$ quarter of Year 3 until the 3$^{rd}$ quarter of Year 4. Further optimization of this activity is currently underway and could see a lowering and widening of the Spillway, which would lead to a smaller raise of the Intermediate Dam.

### Breach Cross Valley Dam – Activity 201.1.4/5/6

After the CVD Pond has been dewatered and the sludge has been removed, the Dam will be breached. This activity will occur at the same time as the Intermediate Dam raise as the material recovered from the breach will be used as fill material for the Intermediate Dam Raise. This activity is currently scheduled to occur in Year 5.

### Raise Intermediate Dam – Activity 201.2

As discussed above, this activity is linked to the breach of the Cross Valley Dam. Scheduling conflicts may require the material from the Cross Valley Dam breach to be stockpiled before being used as fill in the Intermediate Dam raise. The Intermediate Dam raise will begin in the 3rd quarter of Year 4 after the construction of the spillway. The raise is expected to take approximately 12 months.

### RCDC Upgrade Downstream of Fuse Plug – Activity 203.5

This activity includes three tasks:

- Compaction of the tailings along the RCDC;
- Placement of fill material to raise the RCDC dyke; and
- Installation of riprap erosion protection.

The upgrade of the Rose Creek Diversion Channel downstream of the Fuse Plug should occur at approximately the same time as the Intermediate Dam Raise since the majority of this work is also being carried out to accommodate potential flows in excess of the 1 in 500 year event. It will occur in Year 5.

### Stabilize Secondary Dam by Densifying East Limb – Activity 201.4

While the beginning of this activity is flexible, it must be completed before of the upgrades are made to the Rose Creek Diversion Channel upstream of the Fuse Plug on the southwest side of the tailings facility. The stabilization of the Secondary Dam will begin in Year 3 and take approximately 6 months to complete.

### RCDC Upgrade Upstream of Fuse Plug – Activity 203.1

This activity includes two tasks:

- Excavation of the channel to design grades; and
- Installation of channel protection.

The upgrade of the RCDC upstream of the Fuse Plug must be undertaken after the stabilization of the Secondary Dam. The east limb of the Secondary Dam forms one side of the RCDC channel in this section and until the stabilization is complete the channel cannot be upgraded. This activity will occur from the 1st to the 4th quarter of Year 11.

### Upgrading of the North Fork Rose Creek and Breaching of the North Fork Rock Drain - Activity 107.1A/B and 203.3

This activity includes two tasks:

- Breaching North Fork Rock Drain, and
- Upgrading of North Fork Rose Creek.

The construction of a low permeability natural channel for NFRC and removal of the NFRD will occur after the completion of the cover on the Faro waste rock dumps. Upgrades to the NFRC will not start until the NFRD has been removed. Removal of the rock drain is currently scheduled for the 4$^{th}$ quarter of Year 9. The upgrade to the North Fork of Rose Creek is scheduled to begin after the rock drain has been removed. Construction of the cut-off wall at the headwaters of the North Fork will begin immediately afterwards and take 1 to 2 years to complete.

If water quality impacts are predicted before the low permeability channel is constructed, then construction will be accelerated or interception of contaminated groundwater will be conducted by installation of groundwater collection wells, and if necessary, local cut-off walls.

### Intermediate Dam Tailings Cover – Activity 202.1. 2/3/4

This activity includes two tasks:

- Regrading of the Intermediate Tailings;
- Placement of trafficability layer (0.5m of waste rock);
- Placement of the glacial till cover (1.5m); and
- Revegetation.

The placement of the till cover on the Intermediate tailings impoundment will follow the placement of the 0.5m thick layer of waste rock. This waste rock will be installed primarily as a trafficability layer. Its placement will allow heavy equipment access to the tailings to place the till cover. The till cover (1.5m) will be sourced from the Grum Overburden Dump and will be dependent upon the completion of a new spur road from the haul road to the RCTF. Placement will begin on the cover in Year 5 and continue for 2 years. Approximately 505,000m$^3$ of waste rock and 1,514,000m$^3$ of till will be placed at a rate of 835,000 m$^3$ of material per year.

Dust control will be carried out using chemical dust suppressants such as binding agents or crusting agents will be used during the construction period.

### Construct a Fish Bypass (Ladder) – Activity 203.6

The replacement of the existing drop structures in the downstream portion of the RCDC with a larger fish bypass system is still under review but is currently scheduled for the 3$^{rd}$ quarter of Year 9.

### Fuse Plug – Activity 203.4

This activity includes two tasks:

- Remove existing fuse plug; and
- Construct new fuse plug.

This activity is dependent upon the completion of the Secondary Dam east limb stabilization. This activity is currently scheduled to take place during the 1st quarter of Year 6.

### Place Covers on Original and Secondary Impoundments and Revegetate – Activity 202.2

This activity includes two tasks:

- Regrade of the Original and Secondary Impoundments;
- Placement of cover; and
- Revegetation.

The placement of the till cover on the Intermediate tailings impoundment will follow the placement of the 0.5m thick layer of waste rock. This waste rock will be installed primarily as a trafficability layer. Its placement will allow heavy equipment access to the tailings to place the till cover. The till cover (1.5m) will be sourced from the Grum Overburden Dump and will be dependent upon the completion of a spur road from the haul road to the RCTF.

Placement of the cover will begin in Year 3. The cover for the Original and Secondary Impoundments is estimated to take about 24 months. Approximately 450,000$m^3$ of waste rock and 1,354,000$m^3$ of till will be placed at a rate of 902,000 $m^3$ of material per year.

Dust control will be carried out using chemical dust suppressants such as binding agents or crusting agents will be used during the construction period.

### Erosion Dissipation Structure – Activity 203.2

This activity includes two tasks:

- Constructing swales in the tailings cover; and
- Lining Intermediate Impoundment inlet channel with riprap downstream of Fuse Plug.

The two tasks addressed in this section will take place at separate times. The swales in the tailings cover will be constructed as the cover is installed.

The placement of the riprap erosion protection on the swales will take place after the cover has been completed. It is linked to the upgrade of the existing Fuse Plug. This work is currently scheduled to take place during the 2nd and 3rd quarter of Year 6.

#### Install Groundwater Collection System and Cut off Wall at Toe of Intermediate Dam – Activity 204

The optimal time for construction of the groundwater collection system at the Intermediate Dam has not been determined. It is expected that this will be conducted after construction of the Intermediate Dam Raise and the placement of the tailings cover. It is currently scheduled to begin during the 2nd quarter of Year 11 of the implementation phase and take approximately 26 months to complete. Factors such as deterioration of the groundwater quality could lead to early implementation of this activity.

### 11.4.3 Grum/Vangorda Mine (Area 300)

#### General

General resloping and cover placement in the Vangorda/Grum area is scheduled to begin in Year 10. This work will occur after the completion of the Intermediate Dam Spillway and related activities at the Rose Creek Tailings Facility.

#### Upgrade Diversion to Dixon Creek – Activity 303.3

This activity includes two tasks:

- Excavation of the channel to minimum grade; and
- Placement riprap erosion protection in the channel.

This activity will occur during the 1st quarter of Year 3 in order to continue the diversion of surface water away from the Vangorda Pit.

#### Reclamation of the Baritic Fines – Activity 302.6

This activity includes two tasks:

- Regrading of the Baritic Fines; and
- Covering with a Very Low Infiltration Cover (synthetic liner).

Resloping and covering of the Baritic Fines will occur during the 1st quarter of Year 10. The Baritic Fines need to be regraded and covered before the rest of the Vangorda Waste Rock Dump, since a portion of the fines will be covered by the resloping of the Vangorda Waste Rock. Revegetation of the Baritic Fines will occur as part of the revegetation of the Vangorda Waste Rock Dump. Placement of cover is expected to take about one month and would involve the placement of about 6,300$m^3$ of till.

Placement of a geosynthetic liner will not be affected by wet or cold weather. However, if compacted till is used, this task will need to occur over the summer season at the same time as the Vangorda Dump resloping.

### Reslope Vangorda Waste Dump and Pit Piles – Activity 301.3.1/302.1

This activity includes three tasks:

- Resloping Vangorda Waste Rock Dump; and
- Regrading the Waste Rock piles in the Vangorda Pit area.

This activity will take place during the 1st quarter of Year 10. The timing for this activity is controlled primarily by the completion of the resloping and covering of the Baritic Fines. Regrading on the northeast side on the Vangorda Waste Dump will require that a portion of the Baritic Fines be buried by the waste rock. The Very Low Infiltration Cover has to be in place on the Baritic Fines before they are buried as part of the resloping of the Vangorda Waste Rock.

### Place very low infiltration cover on Sulphide cell in Vangorda Dump – Activity 302.7

This activity would occur in Year 10.

### Place Low Infiltration Cover on Vangorda Dump Waste Rock and Revegetate – Activity 302.2/3/4/5,301.3.2/3

This activity includes three tasks:

- Covering the Vangorda Waste Rock Dumps with Low Infiltration Cover;
- Covering the waste rock piles in the Vangorda Pit with Low Infiltration Cover; and
- Revegetation.

The placement of Low Infiltration Cover on the Vangorda Waste Rock Dump and the waste piles in the Vangorda Pit will begin during the 2nd quarter of Year 10 and continue into the 3rd quarter. The placement of low infiltration cover on the Vangorda Waste Rock dump is expected to take 5 months and involve the placement of approximately 1,270,000$m^3$ of till.

### Construct Grum/Vangorda Bioremediation Cell – Activity 311.3.2

The scheduling of the construction of the bioremediation cell at Grum/Vangorda is flexible but it will have to be constructed prior to the removal of any hydrocarbon contaminated soils. This activity is currently scheduled to occur during the 2nd quarter of Year 11.

### Removal of Hydrocarbon Contaminated Soils – Activity 311.3.1

The primary controller on the removal of the hydrocarbon contaminated soil at the Grum fuel lube station is the construction of the bioremediation cell. The removal of the contaminated soil is currently scheduled to take place in the 3rd quarter of Year 11.

### Reslope and Regrade Grum Waste Dump and Pull Back Crest – Activity 306.1

The resloping and regrading of the Grum Waste Dump will begin in the 3rd quarter of Year 10 and finish during the 1st quarter of Year 12. It is not anticipated that this activity will be affected by wet or cold conditions.

### Breach Grum Interceptor Ditch and Divert to Grum Pit – Activity 305

Breaching the Grum Interceptor Ditch is currently scheduled for the 1st quarter of Year 7. The scheduling of this activity is flexible. If the water quality in the Grum Pit supports a flow-through operating system at that time, the ditch will be breached, if not the Grum Interceptor Ditch will be left in place.

### Rudimentary Cover on Grum Dump and Revegetate – Activity 306.3/4/5/6

This activity includes two tasks:

- Covering the Grum Waste Rock Dumps with Rudimentary Cover; and
- Revegetation.

This activity will immediately follow the regrading of the Grum Dump beginning in Year 11. In general, it is expected that placement of rudimentary till covers (including resloping, excavation of till at Grum, hauling, and spreading) will not be a year-round operation. Spreading on the slopes may not be practical in the winter months. Shut-down during periods of very cold weather is likely. This activity will last for 11 months and involve the placement of 1,645,000$m^3$ of till. This activity will be a 24 hour operation.

### Remove Culverts, Decommission, Revegetate – Activity 310.1/2

The culverts along the haul road can be removed any time after the North Fork Rock Drain is breached. This activity is currently scheduled to take place during the 2nd and 3rd quarter of Year 12.

### Construct Vangorda WTP and Piping – Activity 301.1

Year 6

### Remove WTP Settling Pond –Activity 311.2

The Water Treatment Settling Pond will be breached after the new Vangorda Waste Treatment Plant has been installed and after the sludge has been removed from the pond. This is currently scheduled to occur in the 4th quarter of Year 6.

### Demolish Buildings at Grum/Vangorda (Treatment Plant and the Steel Culvert over Grum Portal) – Activity 311.1

Once all the waste has been covered and the new water treatment plant has been constructed the remaining building at the Grum/Vangorda area will be demolished. This task is currently scheduled to take place in Year 10.

### Construct Safety Berms (Grum Pits) – Activity 304.2

This activity will take place once all construction activity within the pit area has been completed. The construction of the safety berms around the pit is scheduled for 1st quarter of Year 11 of the Project.

### Construct Safety Berms (Vangorda Pits) – Activity 301.2

This activity will take place once all construction activity within the pit area has been completed. The construction of the safety berms around the pit is scheduled for 1st quarter of Year 11 of the Project.

### Install Grum Groundwater Collection & Cut-off Walls – Activity 309.1/2/3/5

The optimal time for construction of the Grum Groundwater Collection System has not been determined. Groundwater quality has not yet deteriorated to a level that collection is required. As such, installation of the first phase of the SIS will be subject to results of the ongoing monitoring program. It is currently scheduled to take place in Year 10 but factors such as groundwater quality could result in earlier construction of the Grum Groundwater Collection System.

### Install Vangorda WR Dump Seepage Collection – Activity 309.4

The optimal time for construction of the Vangorda WR Seepage Collection System upgrade has not been determined. Quarterly monitoring of groundwater quality currently occurs and will be continued through project implementation. Additional components would be implemented on an as-needed basis. It is currently scheduled to take place in Year 12 but factors such as groundwater quality could result in earlier construction of the Vangorda WR Dump Seepage Collection System.

### Reclaim Grum/Vangorda Roads – Activity 311.4

This activity will take place once all major implementation activities on the site have been completed. It is currently scheduled to take place during the 3rd quarter of Year 14.

### Regrade Grum Overburden Dump Area and Revegetate – Activity 307

This activity includes two tasks:

- Regrading the remaining area of Grum Overburden Dump after all the till has been removed; and
- Revegetation.

The Grum Overburden Dump will be the primary borrow source for till covers on the Project. Once all cover operations requiring till are completed, the area of the Grum Overburden Dump will be reclaimed. This activity is currently controlled by the completion of the cover on the Intermediate, Secondary and Original Impoundments at the Rose Creek Tailings Facility. Some till will be required for cover and closure of the Faro Mill Site but this material will either be stockpiled during cover operations at the Faro Waste Rock Dumps or sourced from local Faro sources. This activity is currently scheduled to occur during Year 14.

## 11.5 Project Cost Estimate, Workforce and Equipment Requirements

### 11.5.1 General

This section provides preliminary information on the expected work force and equipment requirements to enable the socio-economic assessment (SEA) and environmental assessment (EA) teams to assess the future socioeconomic opportunities and some of the environmental effects of the project.

The information contained in this section is based on the current version of the Project Description (Draft 4) and the preliminary project schedule presented in Figure 11.1. It includes an overall closure cashflow of the entire project shown in Table 11.1, a graphical representation of the cashflow as shown on Figure 11.2, preliminary estimates of the required workforce, and initial estimates of the type of equipment fleets needed. The equipment requirements provided include an estimate of the number of trucks trips required to mobilize equipment to site and an estimate of the number of fuel and lime delivery vehicles needed over the life of the project. The workforce estimate provides an annual breakdown of employment levels for skilled workers, specialized trades and professionals.

### 11.5.2 Workforce

An initial estimate of the workforce requirements were developed using the preliminary project schedule in Figure 11.1 and the current cost estimate summarized in Table 11.1. Typically a number of iterations were made to determine the schedule, with a preliminary attempt made to level the resources to limit a fluctuation of work crews throughout the closure period. Additional iterations of the schedule will be performed in the future to further level the resources.

A preliminary level of precedence was established between the tasks as shown on Figure 11.1. The activity durations were established by summing the tasks for each activity in the cost estimate. Activities shown in red on Figure 11.1 were scheduled to be 24-hour operations with the remaining activities assumed to be 12-hour operations.

For each task in the cost estimate, a crew designation was assigned. The crew classifications are listed in Table 11.2.

**Table 11.2: Crew Designations**

| Code | Name | Description/Notes |
|---|---|---|
| A | Heavy Civil | • All earthworks with the exception of works involving 777 trucks. |
| B | Mining Fleet | • Large scale earthworks involving 777's (cover placement, waste rock relocation, etc. |
| C1 | Specialized Crew – Groundwater | • Groundwater wells and pipelines installations, etc. |
| C2 | Specialized Crew – Re-sloping | • Large scale re-sloping tasks on waste rock dumps.<br>• This was not included as Heavy Civil work to allow for re-sloping and other heavy civil work to be completed at the same time. |
| C3 | Specialized Crew – Revegetation | • All revegetation tasks |
| C4 | Specialized Crew – Other | • Building demolition, ground densification, Water treatment plant construction and cut-off walls |
| D | Hydraulic Monitoring | • Tailings relocation |
| E | Care & Maintenance/Water Treatment | • Bioremediation tasks, pumping and treating of water. |
| F | Indirect Office & Support Staff | • Indirect staff not included under a specific task.<br>• Supervisors, Surveyors, Mechanics, Engineers, administrators, Environmental Monitors. |

A crew designation was then assigned to each activity based on the most predominate crew type for each task. For example, if an activity consisted of 100 hours of a 'Heavy Civil' Task, and 10 hours of a 'Specialized Crew' task, the activity was given a 'Heavy Civil' designation. The activity crew designation was then used to plan the closure scenario schedule.

To calculate the Person-Year estimates, the percentage of each activity completed in a given year was put into an Excel cost estimate spreadsheet. All the tasks were assumed to occur at the same time within each activity. This is an over-simplification that causes the year-to-year fluctuation in crew size. In reality, the same crews could be assigned to other tasks in any given year. The percentage completed was then multiplied by the task durations to determine the hours of work completed for each task in a given year. The hours for each year for each particular category (crew type and trade/profession) were summed and then divided by an average of 1,500 hours per year with a 20% contingency added.

e.g. Person-Years = ((Total Hours) * 0.20)/1500

The initial pass at predicting the work force by trade and profession is provided in Figure 11.3. Similarly a prediction of the work force by crew type is provided in Figure 11.4.

Under the current plan, an average of 80 tradespersons and professionals would be employed yearly during the 14-year implementation phase, with peak employment of approximately 115 workers. There will be a heavy civil construction fleet, a heavy mining fleet and a specialized trades team. All these trades will have approximately 14 years of work. Throughout the implementation and the long-term phase, there will be a care and maintenance and water treatment team, and an overall

monitoring team. The majority of workers are expected to come from Faro and Ross River. Post-implementation it is expect the project will require 10 permanent workers, 5 seasonal and 5 workers related to technical and First Nation traditional environmental monitoring, land stewardship, and research in the post-construction phase.

## 11.5.3 Equipment Schedules

### General

Based on the current project schedule and cost estimate, SRK has estimated the number and types of equipment that would be on site in any given year throughout the closure implementation period. This schedule is shown in Table 11.3. It is assumed for the purpose of this exercise that in any given year, the same piece of equipment could be used for more than one activity.

SRK has made a preliminary estimate of the number of flatbed trucks (Lowboys) required to transport different types of equipment to site over the 14-year closure period. The estimate was made was based on the current project schedule and our a best guess of the type of equipment that would be needed to complete each activity. As the same equipment would be used for many other activities and would remain on site, the number of mob and demob trips were adjusted accordingly. A preliminary estimate of the number of flatbed trucks that would be arriving and leaving the site in any given year is also provided in Table 11.3.

## 11.5.4 Lime and Trucking Requirements

### Quantities

Lime requirement for the Faro mine site is based on two closure activities: blending lime with relocated waste and lime addition for water treatment both during closure and post closure. A description of each activity is provided below.

### Waste Relocation

Table 11.4 lists waste material that will be relocated during the closure process. The table provides a description of the type of waste, an estimate of the volume of waste to be relocated, the amount of lime that would be required for blending.

**Table 11.1: Waste Relocation and Lime Addition Quantifier**

| SOURCE | Material Volume (m3) | LIME ADDITION (tonnes) |
|---|---|---|
| Crusher stockpile | 95,325 | |
| Medium grade stockpile | 135,777 | |
| Oxide fines #2 | 66,199 | |
| Oxide fines #3 | 37,722 | |
| Low grade ore | 44,738 | |
| | **379,761** | 6,456 |
| Medium grade Stockpile (incl. Green and Brown) | **693,000** | 11,781 |
| ETA | 51,000 | 867 |
| ETA | 12,800 | 218 |
| Ore Transfer Pad | 715,000 | 12,155 |
| Total | **1,851,561** | **31,477** |

Note: Lime addition based on 0.017 tonnes/$m^3$ of waste.

A preliminary estimate of when the lime would be needed by activity is provided in Table 11.5. This lime schedule was based on the current preliminary project schedule shown in Figure 11.1 and the estimated lime quantity required.

### Water Treatment

It is currently proposed that the new water treatment plant or plants will be built on site in the first few years on closure construction . It is assumed that water treatment will continue on the mine site using the existing water treatment facilities. Lime requirements for this interim water treatment was estimated based on lime usage presented in the 2008 Annual Environmental Report over the last five years. A summary of lime usage for the 2008 year which was considered typical is provided below:

| | |
|---|---|
| Vangorda Water Treatment: | 218 tonnes |
| Faro Mill: | 417 tonnes |
| Down Valley: | 200 tonnes |
| **Total:** | **835 tonnes** |

A projection of the annual lime consumption for the ongoing water treatment up to Year 14 was estimated to be about 900 tonnes per year (see Table 11.5).

### Lime Truck Schedule

Table 11.6 presents an estimate of the number of trucks that would be needed by year to transport the lime to site for relocation. A Super B Train with 48 tonnes capacity was assumed to haul the lime to site.

#### Lime Costs

Table 11.7 provides a cashflow breakdown of the costs to supply lime over the closure implementation period.

### 11.5.5 Fuel and Trucking Requirements

#### Quantity of Fuel

An estimate of the quantity of fuel requirements for the entire project was derived from the current schedule and the fuel cost estimate and is shown on Table 11.8.

### 11.5.6 Fuel Truck Schedule

A schedule showing the number of fuel trucks that are expected to be arriving on site during the closure period is shown on Table 11.9. It was estimated that the capacity of each truck would be 17,000 L/load.

### 11.5.7 Fuel Costs

Table 11.10 provides a cashflow breakdown of the fuel costs over the closure implementation period.

## 11.6 Seasonal Concerns

There are certain activities that cannot be undertaken during the winter; primarily the placement of compacted till for the Low Infiltration Soil Cover and potentially the Very Low Infiltration Soil Cover. This affects the scheduling and duration of several cover activities such as: Faro Low Grade Ore Stockpile “A” and “C”, Mt Mungly dumps, the Southwest Pit wall dump, the Faro Sulphide Cells, the Grum Sulphide Cells, the Vangorda Waste Rock Dump and the Vangorda Sulphide.

Dewatering is another task that cannot be undertaken in the winter. This primarily affects the scheduling for the Rose Creek Tailings Impoundment and also the sludge removal activities project wide. Channel upgrades will be undertaken during low flow periods where possible, so that the surface water runoff does not interfere with construction.

To a lesser extent, extremely cold weather during the winters could lead to site-wide shut-downs, affecting all activities at the site.

# Tables

**Faro Mine Complex Closure and Reclamation Plan**
**Project Description - Draft 4A Table 11.1**
**Preliminary Cashflow - March 2010 (Draft)]**

| | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Faro Mine Complex Reclamation and Closure | | | | | | | | | | | | | | | | | | | |
| Faro Mine Area (Activity Code 100) | | | | | | | | | | | | | | | | | | | |
| Faro Pit Safety Berm | | | | | | | | | | | | | | | | | | | |
| Place a safety berm around the pit | | | | | | | | | | | | | | | $285,828 | | | | $285,828 |
| Surface Water Diversions | | | | | | | | | | | | | | | | | | | |
| Construct Faro Creek Diversion (east valley) | | | | | | | | | | | $2,350,831 | $2,753,830 | | | | | | | $5,104,661 |
| Construct West Valley Extension | | | | | | | | | | | | $805,064 | $324,850 | | | | | | $1,129,914 |
| North Wall Interceptor Ditch | | | | | | | | | $525,229 | | | | | | | | | | $525,229 |
| Guardhouse Creek Water Management | | | | | | $42,182 | | | | | | | | | | | | | $42,182 |
| Zone II Pit | | | | | | | | | | | | | | | | | | | |
| Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | $89,430 | $208,669 | | | | | | $298,098 |
| Oxide Fines and low Grade Ore | | | | | | | | | | | | | | | | | | | |
| Relocate oxide fines to LGSP C | | | | $4,615,381 | | | | | | | | | | | | | | | $4,615,381 |
| Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | $8,422,295 | | | | | | | | | | | | | | | $8,422,295 |
| Cover, revegetate LGSP A | | | | $1,731,422 | | | | | | | | | | | | | | | $1,731,422 |
| Cover revegetate LGSPC | | | | $3,382,854 | $1,821,537 | | | | | | | | | | | | | | $5,204,391 |
| Emergency Tailings Area | | | | | | | | | | | | | | | | | | | |
| Remove tailings to Rose Creek Tailings Facility | | | $1,007,117 | | | | | | | | | | | | | | | | $1,007,117 |
| Install ETA Collection System | | | $723,777 | | | | | | | | | | | | | | | | $723,777 |
| Waste Rock Dumps | | | | | | | | | | | | | | | | | | | |
| Regrade and reslope Main and Intermediate Sulphide Cells (costs incl in 106.1B) | | | | | | | | | | | | | | | | | | | |
| Regrade, Reslope Waste Rock Dumps | | | | | | | | $408,332 | $2,478,480 | $2,431,000 | | | | | | | | | $5,317,812 |
| Cover and Revegetate East Sulphide waste | | | | | $926,459 | | | | | | | | | | | | | | $926,459 |
| Cover and Revegetate Main and Intermediate Sulphide cells | | | | | $9,224,304 | | | | | | | | | | | | | | $9,224,304 |
| Place cover on remaining waste rock & revegetate | | | | | | | | | | $19,819,283 | $22,990,369 | $15,326,912 | | | | | | | $58,136,564 |
| Cover and Revegetate Mt Mungly (E & W), Southwest Pit Wall Dump | | | | | $990,498 | $4,374,698 | | | | | | | | | | | | | $5,365,196 |
| Faro Groundwater | | | | | | | | | | | | | | | | | | | |
| Upgrade North Fork Rose Creek | | | | | | | | | | | | $313,043 | $2,918,008 | $1,240,992 | | | | | $4,472,043 |
| North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | | $3,403,982 | $5,922,929 | $4,289,017 | | | $13,615,928 |
| Relocate Zone II outwash material to Intermediate Sulphide Cell | | | | | $439,460 | | | | | | | | | | | | | | $439,460 |
| Install Zone II Outwash Collection System | | | | | | | | | | | | $205,583 | | | | | | | $205,583 |
| Install S-wells groundwater collection system | $1,734,746 | | | | | | | | | | | | | | | | | | $1,734,746 |
| Faro Miscellaneous | | | | | | | | | | | | | | | | | | | |
| Reclaim unnecessary roads | | | | | | | | | | | | | | | | | $19,232 | | $19,232 |
| Decontaminate and Demolish Buildings | | | | | | | | | | | | | $5,596,978 | $4,267,427 | | | | | $9,864,405 |
| Relocate Contaminated Soil from Mill Site Area and cover (rudimentary) | | | | | | | | | | | | | | $428,476 | | | | | $428,476 |
| Tailings Area (Activity Code 200) | | | | | | | | | | | | | | | | | | | |
| Dams | | | | | | | | | | | | | | | | | | | |
| Dewater Intermediate Tailings Area and CVD pond | | | | | | $1,779,799 | | | | | | | | | | | | | $1,779,799 |
| Breach Cross-valley Dam | | | | | | | | $266,101 | | | | | | | | | | | $266,101 |
| Raise Intermediate Dam | | | | | | | $2,364,650 | $6,366,364 | | | | | | | | | | | $8,731,014 |
| Construct Intermediate Dam Spillway | | | | | | $3,703,353 | $9,470,871 | | | | | | | | | | | | $13,174,224 |
| Stabilize Secondary Dam by densifying East Limb | | | | | | $1,047,138 | | | | | | | | | | | | | $1,047,138 |
| Tailings Cover | | | | | | | | | | | | | | | | | | | |
| Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | $3,609,118 | $18,114,997 | $18,114,997 | $416,437 | | | | | | | | | $40,255,549 |
| Place covers on original and secondary impoundments and revegetate | | | | | $769,989 | $18,269,748 | $14,559,799 | | | | | | | | | | | | $33,599,536 |
| Rose Creek Diversion | | | | | | | | | | | | | | | | | | | |
| Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | | | | | $460,746 | $4,278,353 | | | | | $4,739,099 |
| Construct Erosion Dissipation Structure | | | | | | | | | $2,695,275 | | | | | | | | | | $2,695,275 |
| Breach North Fork Rock Drain, create channel | | | | | | | | | | | | $3,606,145 | | | | | | | $3,606,145 |
| Construct Fuse Plug | | | | | | | | | $86,799 | | | | | | | | | | $86,799 |
| Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | | $1,909,463 | | | | | | | | | | | $1,909,463 |
| Construct a Fish Bypass (ladder) | | | | | | | | | | | | $1,179,785 | | | | | | | $1,179,785 |
| Groundwater Collection | | | | | | | | | | | | | | | | | | | |
| Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | | $9,911,143 | $12,742,898 | | | $22,654,040 |
| Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | $839,705 | | | | | $839,705 |
| Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | $1,991,209 | | | | | $1,991,209 |
| Vangorda Grum Area (Activity Code 300) | | | | | | | | | | | | | | | | | | | |
| Vangorda Pit | | | | | | | | | | | | | | | | | | | |
| Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | | $211,000 | | $211,000 |
| Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | | | | $682,701 | | | | | | $682,701 |
| Vangorda Dump | | | | | | | | | | | | | | | | | | | |
| Reslope Vangorda Waste Dump | | | | | | | | | | | | | $378,481 | | | | | | $378,481 |
| Place Very Low Cover over Baritic Fines | | | | | | | | | | | | | $391,253 | | | | | | $391,253 |
| Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | | | | $7,800,789 | | | | | | $7,800,789 |
| Place Very Low Infiltration Cover over Main Dump Sulphide Cell | | | | | | | | | | | | | $1,771,300 | | | | | | $1,771,300 |
| Vangorda Creek Diversion | | | | | | | | | | | | | | | | | | | |
| Construct New Vangorda Diversion | | | $3,402,953 | $854,074 | | | | | | | | | | | | | | | $4,257,027 |
| Upgrade Runoff interceptor ditch to Dixon Creek | | | | | | $427,315 | | | | | | | | | | | | | $427,315 |
| Grum Pit | | | | | | | | | | | | | | | | | | | |
| Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | $229,908 | | | | | $229,908 |
| Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | $429,724 | | | | | | | | | $429,724 |
| Grum Dump | | | | | | | | | | | | | | | | | | | |
| Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | | | | $933,009 | $794,786 | | | | | $1,727,795 |
| Place very low infiltration cover on Grum sulphide cell | | $13,529,100 | | | | | | | | | | | | | | | | | $13,529,100 |
| Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | | | | $3,639,076 | $5,670,188 | | | | $9,309,263 |
| Grum Overburden Dump | | | | | | | | | | | | | | | | | | | |
| Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | $147,132 | | $147,132 |
| Grum Ore Transfer Pad | | | | | | | | | | | | | | | | | | | |
| Regrade, cover and revegetate Ore Transfer Pad | | | | | $5,487,527 | | | | | | | | | | | | | | $5,487,527 |
| Vangorda/Grum Groundwater | | | | | | | | | | | | | | | | | | | |
| Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | $3,971,379 | $2,299,220 | | | | | $6,270,599 |
| Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | $826,431 | | | | $826,431 |
| Install Vangorda Groundwater Collection System | | | | | | | | | | | | | | | $152,724 | | | | $152,724 |
| Vangorda/Grum Miscellaneous | | | | | | | | | | | | | | | | | | | |
| Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | $1,127,644 | | | | | | $1,127,644 |
| Remove WTP Settling Pond | | | | | | | | | $217,347 | | | | | | | | | | $217,347 |
| Remove contaminated soils (fuel lube station) | | | | | | | | | | | | | | $41,088 | | | | | $41,088 |

**Faro Mine Complex Closure and Reclamation Plan**
**Project Description - Draft 4A Table 11.1**
**Preliminary Cashflow - March 2010 (Draft)]**

| | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Construct Bioremediation cell | | | | | | | | | | | | | | $72,908 | | | | | $72,908 |
| Reclaim roads | | | | | | | | | | | | | | | | | $31,715 | | $31,715 |
| Haul Road | | | | | | | | | | | | | | | | | | | |
| Remove culverts, decommission, revegetate | | | | | | | | | | | | | | | $1,697,534 | | | | $1,697,534 |
| Construct haul road access from Vangorda to RCT | | | | | $90,207 | | | | | | | | | | | | | | $90,207 |
| Water Treatment | | | | | | | | | | | | | | | | | | | |
| Construct Faro Plant(s) and piping | | | | $8,625,680 | $4,904,798 | | | | | | | | | | | | | | $13,530,478 |
| Polishing Pond | | | | | | $1,241,073 | | | | | | | | | | | | | $1,241,073 |
| Construct Vangorda WT plant and piping | | | | | | | | $348,299 | $3,632,260 | | | | | | | | | | $3,980,559 |
| Borrow Area Development | | | | | | | | | | | | | | | | | | | |
| Develop and Decomisison Faro Borrow Sources | | | | $136,879 | | | | | | | | | | | | | | | $136,879 |
| Develop and Decomission Vangorda Borrow Areas | | $111,835 | | | | | | | | | | | | | | | | | $111,835 |
| Care and Maintenance | | | | | | | | | | | | | | | | | | | |
| Lime addition for ongoing water treatment | $248,314 | $294,802 | $295,935 | $297,069 | $298,203 | $295,935 | $294,802 | $295,935 | $295,935 | $295,935 | $295,935 | $297,069 | $295,935 | $295,935 | $295,935 | $297,069 | $266,455 | | $4,957,200 |
| Care and Maintenance | $4,508,234 | $5,352,242 | $5,372,827 | $5,393,413 | $5,413,998 | $5,372,827 | $5,352,242 | $5,372,827 | $5,372,827 | $5,372,827 | $5,372,827 | $5,393,413 | $5,372,827 | $5,372,827 | $5,372,827 | $5,393,413 | $4,837,603 | | $90,000,000 |
| Total | $6,491,294 | $19,287,978 | $10,802,609 | $33,459,067 | $30,366,980 | $36,554,069 | $35,651,481 | $33,082,319 | $33,419,150 | $28,765,206 | $31,009,962 | $29,970,274 | $32,234,570 | $29,195,892 | $30,135,538 | $22,722,397 | $5,513,137 | | $448,661,921 |

**Table 11.3: Equipment Schedule**

| | | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trucks** | CAT 777 | | 5 | | 6 | 6 | 3 | 6 | 6 | 8 | 8 | 8 | 6 | 6 | | | | |
| | Articulated Trucks | 3 | 6 | 6 | 4 | 6 | 6 | 6 | 6 | 12 | 8 | 8 | 6 | 4 | 4 | 6 | 4 | 2 |
| **Excavators** | **All - Models** | **2** | **2** | 2 | 1 | 2 | 2 | 3 | 4 | 4 | 2 | 2 | 3 | 2 | 5 | 4 | 2 | 1 |
| **Loaders** | CAT 992D | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | |
| | CAT 966F | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | |
| **Dozers** | Large (D11) | | | | 1 | 2 | 2 | 2 | | | 1 | 2 | 1 | | | | 1 | |
| | Medium (D10 & D8) | 1 | 4 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 2 | 1 |
| **Compactors** | CAT CP563 | | 1 | | 1 | 1 | 1 | 1 | | | 1 | 1 | | | | | | |
| **Graders** | CAT 14G | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| **Drills** | Air Rotary (GW Systems) | 1 | | | | | | 1 | | | | | | | 1 | | 1 | |
| | Air Track Rig (Drilling/Blasting) | | 1 | | | 1 | 1 | 1 | | 1 | | | 1 | | | | | |
| **TOTAL - Equipment** | | **7** | **21** | **11** | **18** | **23** | **21** | **26** | **23** | **32** | **27** | **26** | **22** | **16** | **12** | **12** | **11** | **4** |
| **Estimated Low-Boy Equipment Trips** | | **7** | **26** | **2** | **2** | **2** | **0** | **1** | **2** | **12** | **8** | **2** | **10** | **5** | **24** | **3** | **7** | **12** |

**Table 11.5: Lime Consumption (tonnes)**

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total (Tonnes) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | | |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | | | | | | | | | | | | |
| 102.2 | Construct West Valley Extension | | | | | | | | | | | | | | | | | | |
| 102.3 | North Wall Interceptor Ditch | | | | | | | | | | | | | | | | | | |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | | | | | | | | | | |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | | | | | |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | 6,456 | | | | | | | | | | | | | | 6,456 |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | 11,781 | | | | | | | | | | | | | | 11,781 |
| 104.3 | Cover, revegetate LGSP A | | | | | | | | | | | | | | | | | | |
| 104.4 | Cover revegetate LGSC C | | | | | | | | | | | | | | | | | | |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | 1,085 | | | | | | | | | | | | | | | 1,085 |
| 105.2 | Install ETA Collection System | | | | | | | | | | | | | | | | | | |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | | | | | | | | | | | | | | |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | | | | | | | | | | | | | | |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | 18,360 | | | | | | | | | | | | | 18,360 |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | | | | | | | | | | | | | | |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | | | | | | | | | | | | | |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | | | | | | | |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | | | | | | | | | | | | | | |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | | | | | | | | | | | | |
| 107.4 | Install S-wells groundwater collection system | | | | | | | | | | | | | | | | | | |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | | | |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | | | | | |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | | | |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1 1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | | | | | | | | | | | | | | |
| 201.1 4/5 | Breach Cross-valley Dam | | | | | | | | | | | | | | | | | | |
| 201.2 | Raise Intermediate Dam | | | | | | | | | | | | | | | | | | |
| 201.3 | Construct Intermediate Dam Spillway | | | | | | | | | | | | | | | | | | |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | | | | | | | | | | | | |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1, 2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | | | | | | | | | | |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | | | | | | | |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | | | | | | | | | | |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | | | | | | | |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | | | | | | | | | | |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | | | | | | | |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | | | | | | | | | |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | | | | | | | | | | | | |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 204.2 | Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | | | | | |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | | | |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safely Berms (Vangorda pits) | | | | | | | | | | | | | | | | | | |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | | | | | | | | | |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | | | | | | | | | |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | | | | | | | | | |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | | | | | | | | | |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | | | | | | | | | | | | | | | | | |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | | | | | | | | | | | | | | |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safely Berms (Grum pits) | | | | | | | | | | | | | | | | | | |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | | | | | | | | |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | | | | | | | | | |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | | | | | | | | | | | | | | | | | |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | | | | | | | | |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | | |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | 12,155 | | | | | | | | | | | | | | | | 12,155 |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | | | | | | | | | | | | | | | | | |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | | | |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | | | |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | | | | | |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | | | | | |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | | | | | | | | | |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | | | | | | | | | |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | | | |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | | | | | |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | | | | | | | | | | |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | | | | | | |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | | | | | |
| 205.2 | Polishing Pond | | | | | | | | | | | | | | | | | | |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | | | | | |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | | | | | |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomission Faro Borrow Sources | | | | | | | | | | | | | | | | | | |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | | | | | | | | | | | | | | | | | |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | | | | | 11,700 |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **900** | **13,055** | **1,985** | **19,137** | **19,260** | **900** | **900** | **900** | **900** | **900** | **900** | **900** | **900** | **0** | **0** | **0** | **0** | **61,537** |

**Table 11.6 Lime Truck Schedule** Load: 48 tonnes/truck

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total (Trucks) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | | |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | | | | | | | | | | | | |
| 102.2 | Construct West Valley Extension | | | | | | | | | | | | | | | | | | |
| 102.3 | North Wall Interceptor Ditch | | | | | | | | | | | | | | | | | | |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | | | | | | | | | | |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | | | | | |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | 135 | | | | | | | | | | | | | | 135 |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | 245 | | | | | | | | | | | | | | 245 |
| 104.3 | Cover, revegetate LGSP A | | | | | | | | | | | | | | | | | | |
| 104.4 | Cover revegetate LGSC C | | | | | | | | | | | | | | | | | | |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | 23 | | | | | | | | | | | | | | | 23 |
| 105.2 | Install ETA Collection System | | | | | | | | | | | | | | | | | | |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | | | | | | | | | | | | | | |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | | | | | | | | | | | | | | |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | 383 | | | | | | | | | | | | | 383 |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | | | | | | | | | | | | | | |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | | | | | | | | | | | | | |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | | | | | | | |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | | | | | | | | | | | | | | |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | | | | | | | | | | | | |
| 107.4 | Install S-wells groundwater collection system | | | | | | | | | | | | | | | | | | |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | | | |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | | | | | |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | | | |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1..1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | | | | | | | | | | | | | | |
| 201.1..4/5 | Breach Cross-valley Dam | | | | | | | | | | | | | | | | | | |
| 201.2 | Raise Intermediate Dam | | | | | | | | | | | | | | | | | | |
| 201.3 | Construct Intermediate Dam Spillway | | | | | | | | | | | | | | | | | | |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | | | | | | | | | | | | |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1, 2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | | | | | | | | | | |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | | | | | | | |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | | | | | | | | | | |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | | | | | | | |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | | | | | | | | | | |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | | | | | | | |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | | | | | | | | | |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | | | | | | | | | | | | |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 204.2 | Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | | | | | |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | | | |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | | | |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | | | | | | | | | |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | | | | | | | | | |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | | | | | | | | | |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | | | | | | | | | |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | | | | | | | | | | | | | | | | | |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | | | | | | | | | | | | | | |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | | | | | |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | | | | | | | | |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | | | | | | | | | |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | | | | | | | | | | | | | | | | | |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | | | | | | | | |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | | |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | 253 | | | | | | | | | | | | | | | | 253 |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | | | | | | | | | | | | | | | | | |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | | | |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | | | |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | | | | | |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | | | | | |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | | | | | | | | | |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | | | | | | | | | |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | | | |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | | | | | |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | | | | | | | | | | |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | | | | | | |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | | | | | |
| 205.2 | Polishing Pond | | | | | | | | | | | | | | | | | | |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | | | | | |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | | | | | |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomisison Faro Borrow Sources | | | | | | | | | | | | | | | | | | |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | | | | | | | | | | | | | | | | | |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 0 | 0 | 0 | 0 | 244 |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **19** | **272** | **41** | **399** | **401** | **19** | **19** | **19** | **19** | **19** | **19** | **19** | **19** | **0** | **0** | **0** | **0** | **1,282** |

**Table 11.7 Lime Costs** **Unit Cost:** **324** **/tonne**

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | | |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | | | | | | | | | | | | |
| 102.2 | Construct West Valley Extension | | | | | | | | | | | | | | | | | | |
| 102.3 | North Wall Interceptor Ditch | | | | | | | | | | | | | | | | | | |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | | | | | | | | | | |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | | | | | |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | $2,091,744 | | | | | | | | | | | | | | **$2,091,744** |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | $3,817,044 | | | | | | | | | | | | | | **$3,817,044** |
| 104.3 | Cover, revegetate LGSP A | | | | | | | | | | | | | | | | | | |
| 104.4 | Cover revegetate LGSC C | | | | | | | | | | | | | | | | | | |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | $351,540 | | | | | | | | | | | | | | | **$351,540** |
| 105.2 | Install ETA Collection System | | | | | | | | | | | | | | | | | | |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | | | | | | | | | | | | | | |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | | | | | | | | | | | | | | |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | $5,948,640 | | | | | | | | | | | | | **$5,948,640** |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | | | | | | | | | | | | | | |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | | | | | | | | | | | | | |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | | | | | | | |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | | | | | | | | | | | | | | |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | | | | | | | | | | | | |
| 107.4 | Install S-wells groundwater collection system | | | | | | | | | | | | | | | | | | |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | | | |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | | | | | |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | | | |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1 .1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | | | | | | | | | | | | | | |
| 201.1 .4/5 | Breach Cross-valley Dam | | | | | | | | | | | | | | | | | | |
| 201.2 | Raise Intermediate Dam | | | | | | | | | | | | | | | | | | |
| 201.3 | Construct Intermediate Dam Spillway | | | | | | | | | | | | | | | | | | |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | | | | | | | | | | | | |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1 .2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | | | | | | | | | | |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | | | | | | | |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | | | | | | | | | | |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | | | | | | | |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | | | | | | | | | | |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | | | | | | | |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | | | | | | | | | |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | | | | | | | | | | | | |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | | | | | |
| 204.2 | Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | | | | | |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | | | |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | | | |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | | | | | | | | | |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | | | | | | | | | |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | | | | | | | | | |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | | | | | | | | | |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | | | | | | | | | | | | | | | | | |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | | | | | | | | | | | | | | |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | | | | | |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | | | | | | | | |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | | | | | | | | | |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | | | | | | | | | | | | | | | | | |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | | | | | | | | |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | | |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | $3,938,220 | | | | | | | | | | | | | | | | **$3,938,220** |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | | | | | | | | | | | | | | | | | |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | | | |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | | | |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | | | | | |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | | | | | |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | | | | | | | | | |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | | | | | | | | | |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | | | |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | | | | | |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | | | | | | | | | | |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | | | | | | |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | | | | | |
| 205.2 | Polishing Pond | | | | | | | | | | | | | | | | | | |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | | | | | |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | | | | | |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomission Faro Borrow Sources | | | | | | | | | | | | | | | | | | |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | | | | | | | | | | | | | | | | | |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $291,600 | $0 | $0 | $0 | $0 | **$3,790,800** |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **$291,600** | **$4,229,820** | **$643,140** | **$6,200,388** | **$6,240,240** | **$291,600** | **$291,600** | **$291,600** | **$291,600** | **$291,600** | **$291,600** | **$291,600** | **$291,600** | **$0** | **$0** | **$0** | **$0** | **$19,937,988** |

**Table 11.8: Fuel Quantities (litres)**

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total (Litres) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | 26,651 | **26,651** |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | 42,700 | 507,900 | 187,475 | | | | | | | | | **738,075** |
| 102.2 | Construct West Valley Extension | | | | | | | | | 148,063 | | | | | | | | | **148,063** |
| 102.3 | North Wall Interceptor Ditch | | | | | | 73,057 | | | | | | | | | | | | **73,057** |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | 5,427 | | | | | | | | | **5,427** |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | 5,435 | | | | **5,435** |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | 293,598 | | | | | | | | | | | | | | **293,598** |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | 535,767 | | | | | | | | | | | | | | **535,767** |
| 104.3 | Cover, revegetate LGSP A | | | | 193,821 | | | | | | | | | | | | | | **193,821** |
| 104.4 | Cover revegetate LGSC C | | | | 467,782 | 116,945 | | | | | | | | | | | | | **584,727** |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | 63,880 | | | | | | | | | | | | | | | **63,880** |
| 105.2 | Install ETA Collection System | | | | | | | 14,162 | | | | | | | | | | | **14,162** |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | 75,891 | | | | | | | | | | | | | **75,891** |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | 341,509 | 495,188 | 225,776 | | | | | | | | | | | **1,062,473** |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | 971,536 | | | | | | | | | | | | | **971,536** |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | 1,215,474 | | | | | | | | | | | | | **1,215,474** |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | 1,202,714 | 4,737,965 | 4,756,188 | 1,330,275 | | | | | | | | | **12,027,143** |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | 227,343 | 214,100 | | | | | **441,443** |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | 119,276 | 471,681 | 471,681 | 21,686 | | **1,084,324** |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | 54,222 | | | | | | | | | | | | | **54,222** |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | 3,498 | | | | | | | | | | | **3,498** |
| 107.4 | Install S-wells groundwater collection system | 124,353 | | | | | | | | | | | | | | | | | **124,353** |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | 2,840 | | **2,840** |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | 257,288 | 388,163 | 38,668 | | **684,119** |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | 38,234 | | **38,234** |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1 .1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | 310,566 | | | | | | | | | | | | | **310,566** |
| 201.1 .4/5 | Breach Cross-valley Dam | | | | | 30,625 | 30,625 | | | | | | | | | | | | **61,249** |
| 201.2 | Raise Intermediate Dam | | | | | | 382,405 | 710,182 | | | | | | | | | | | **1,092,587** |
| 201.3 | Construct Intermediate Dam Spillway | | | | | 173,968 | 769,809 | | | | | | | | | | | | **943,777** |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | 96,969 | | | | | | | | | | | **96,969** |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1, 2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | 34,994 | 3,044,443 | 3,044,443 | 641,549 | | | | | | **6,765,428** |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | 2,412,046 | 3,044,330 | 163,925 | | | | **5,620,302** |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | 1,979,199 | | | | | | | | | **1,979,199** |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | 249,923 | | | | | | **249,923** |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | 2,074 | 39,404 | | | | | | | | **41,478** |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | 10,601 | | | | | | **10,601** |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | 9,984 | | | | | | | | **9,984** |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | 237,122 | | | | | | | | | | | **237,122** |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | 193,836 | 1,176,538 | 432,750 | | **1,803,123** |
| 204.2 | Construct Intermediate Dam Intercoption Trench | | | | | | | | | | | | | | | | 78,955 | | **78,955** |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | 39,824 | | **39,824** |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | 30,209 | | **30,209** |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | 129,248 | | | | | | | | **129,248** |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | 84,865 | | | | | | | | **84,865** |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | 12,040 | | | | | | | | **12,040** |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | 1,486,265 | | | | | | | | **1,486,265** |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | 308,200 | 77,352 | | | | | | | | | | | | | | | **385,552** |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | 54,199 | | | | | | | | | | | | | **54,199** |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | | | 34,166 | | **34,166** |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | 52,486 | | | | | | | **52,486** |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | 62,021 | 183,949 | 35,944 | | | | | | **281,914** |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | 460,829 | | | | | | | | | | | | | | | | **460,829** |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | 1,473,072 | 701,934 | | | | | | **2,175,006** |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | 17,938 | **17,938** |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | 657,751 | | | | | | | | | | | | | | | | **657,751** |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | 165,320 | | | | | | | | | | | | | | | | **165,320** |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | 29,087 | 6,349 | **35,436** |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | 421,922 | | **421,922** |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | 15,472 | 58,203 | | | **73,675** |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | 1,069 | | | | **1,069** |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | 6,041 | | | | | | | | **6,041** |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | 32,150 | | | | | | | | **32,150** |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | 3,987 | | **3,987** |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | 210,317 | | | | **210,317** |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | 16,054 | | | | | | | | | **16,054** |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | 765,939 | 443,438 | | | | **1,209,377** |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | 11,628 | | | | **11,628** |
| 205.2 | Polishing Pond | | | | | | | | | | | | | 73,926 | | | | | **73,926** |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | 356,096 | | | | **356,096** |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | 6,190 | 11,791 | | | **17,981** |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomission Faro Borrow Sources | | | | | 10,213 | | | | | | | | | | | | | **10,213** |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | 15,733 | | | | | | | | | | | | | | | | **15,733** |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | | | | | | | | | | | | | | | | | | **0** |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **124,353** | **1,607,833** | **141,232** | **1,490,968** | **3,355,148** | **2,953,798** | **6,068,373** | **5,264,088** | **3,703,560** | **4,906,461** | **4,753,950** | **4,279,340** | **4,217,571** | **2,136,376** | **2,106,376** | **1,172,328** | **50,938** | **48,332,693** |

**Table 11.9: Fuel Truck Schedule** **Load:: 17,000 Litre/Truck**

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total (Trucks) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | 2 | **2** |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | 3 | 30 | 11 | | | | | | | | | **43** |
| 102.2 | Construct West Valley Extension | | | | | | | | | 9 | | | | | | | | | **9** |
| 102.3 | North Wall Interceptor Ditch | | | | | | 4 | | | | | | | | | | | | **4** |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | 0 | | | | | | | | | **0** |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | 0 | | | | **0** |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | 17 | | | | | | | | | | | | | | **17** |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | 32 | | | | | | | | | | | | | | **32** |
| 104.3 | Cover, revegetate LGSP A | | | | 11 | | | | | | | | | | | | | | **11** |
| 104.4 | Cover revegetate LGSC C | | | | 28 | 7 | | | | | | | | | | | | | **34** |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | 4 | | | | | | | | | | | | | | | **4** |
| 105.2 | Install ETA Collection System | | | | | | | 1 | | | | | | | | | | | **1** |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | 4 | | | | | | | | | | | | | **4** |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | 20 | 29 | 13 | | | | | | | | | | | **62** |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | 57 | | | | | | | | | | | | | **57** |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | 71 | | | | | | | | | | | | | **71** |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | 71 | 279 | 280 | 78 | | | | | | | | | **707** |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | 13 | 13 | | | | | **26** |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | 7 | 28 | 28 | 1 | | **64** |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | 3 | | | | | | | | | | | | | **3** |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | 0 | | | | | | | | | | | **0** |
| 107.4 | Install S-wells groundwater collection system | 7 | | | | | | | | | | | | | | | | | **7** |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | 0 | | **0** |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | 15 | 23 | 2 | | **40** |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | 2 | | **2** |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1 .1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | 18 | | | | | | | | | | | | | **18** |
| 201.1 .4/5 | Breach Cross-valley Dam | | | | | 2 | 2 | | | | | | | | | | | | **4** |
| 201.2 | Raise Intermediate Dam | | | | | | 22 | 42 | | | | | | | | | | | **64** |
| 201.3 | Construct Intermediate Dam Spillway | | | | | 10 | 45 | | | | | | | | | | | | **56** |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | 6 | | | | | | | | | | | **6** |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1, 2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | 2 | 179 | 179 | 38 | | | | | | **398** |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | 142 | 179 | 10 | | | | **331** |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | 116 | | | | | | | | | **116** |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | 15 | | | | | | **15** |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | 0 | 2 | | | | | | | | **2** |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | 1 | | | | | | **1** |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | 1 | | | | | | | | **1** |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | 14 | | | | | | | | | | | **14** |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | 11 | 69 | 25 | | **106** |
| 204.2 | Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | | | 5 | | **5** |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | 2 | | **2** |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | 2 | | **2** |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | 8 | | | | | | | | **8** |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | 5 | | | | | | | | **5** |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | 1 | | | | | | | | **1** |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | 87 | | | | | | | | **87** |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | 18 | 5 | | | | | | | | | | | | | | | **23** |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | 3 | | | | | | | | | | | | | **3** |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | | | 2 | | **2** |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | 3 | | | | | | | **3** |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | 4 | 11 | 2 | | | | | | **17** |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | 27 | | | | | | | | | | | | | | | | **27** |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | 87 | 41 | | | | | | **128** |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | 1 | **1** |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | 39 | | | | | | | | | | | | | | | | **39** |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | 10 | | | | | | | | | | | | | | | | **10** |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | 2 | 0 | **2** |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | 25 | | **25** |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | 1 | 3 | | | **4** |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | 0 | | | | **0** |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | 0 | | | | | | | | **0** |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | 2 | | | | | | | | **2** |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | 0 | | **0** |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | 12 | | | | **12** |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | 1 | | | | | | | | | **1** |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | 45 | 26 | | | | **71** |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | 1 | | | | **1** |
| 205.2 | Polishing Pond | | | | | | | | | | | | | 4 | | | | | **4** |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | 21 | | | | **21** |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | 0 | 1 | | | **1** |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomission Faro Borrow Sources | | | | | 1 | | | | | | | | | | | | | **1** |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | 1 | | | | | | | | | | | | | | | | **1** |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | | | | | | | | | | | | | | | | | | **0** |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **7** | **95** | **8** | **88** | **197** | **174** | **357** | **310** | **218** | **289** | **280** | **252** | **248** | **126** | **124** | **69** | **3** | **2,843** |

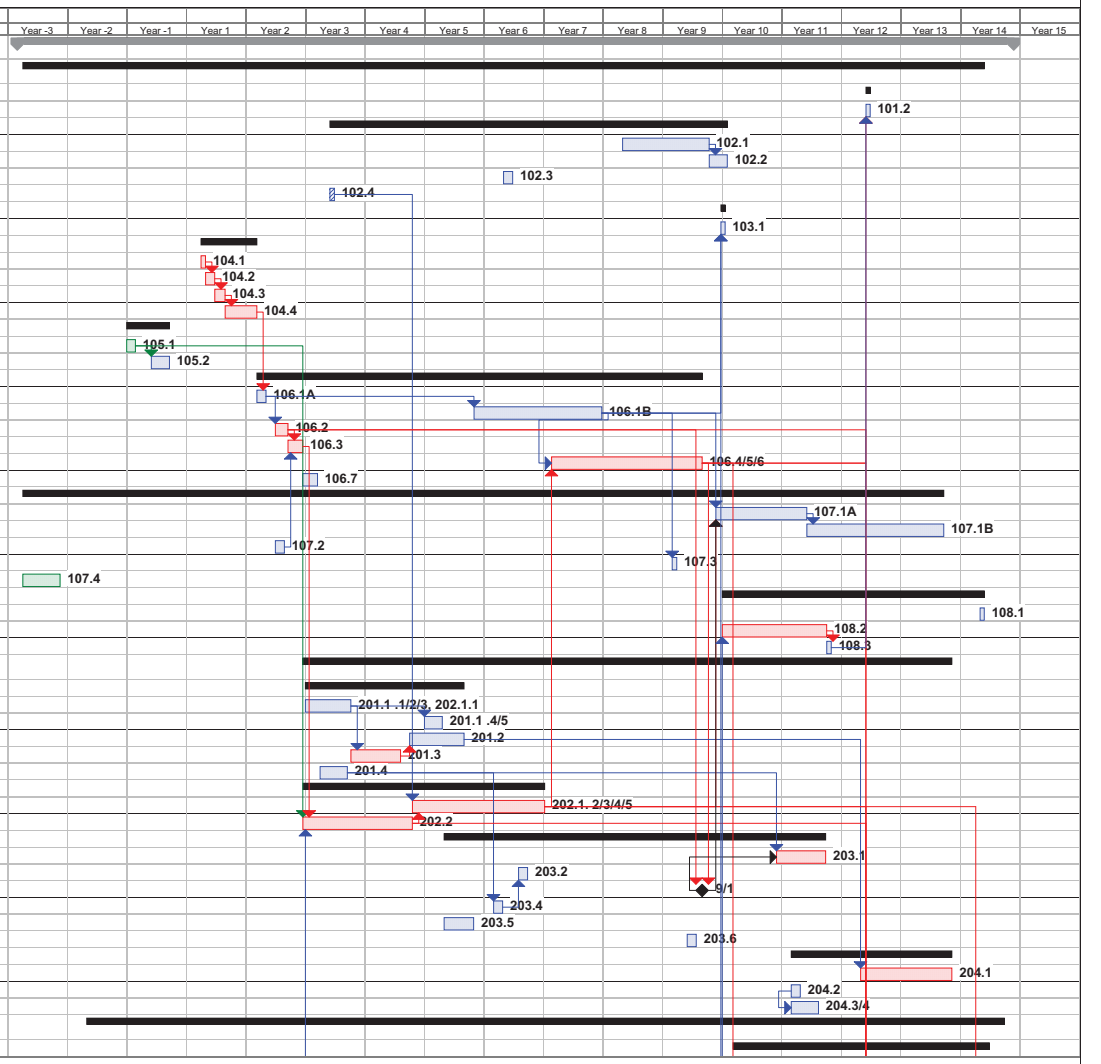
**Table 11.10: Fuel Cost** **Unit Cost: $1.30 per Litre**

| Activity Code | Task Name | Year -3 | Year -2 | Year -1 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Total Amount |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Faro Mine Area (Activity Code 100)** | | | | | | | | | | | | | | | | | | |
| **101** | **Faro Pit Safety Berm** | | | | | | | | | | | | | | | | | | |
| 101.2 | Place a safety berm around the pit | | | | | | | | | | | | | | | | | $34,646 | **$34,646** |
| **102** | **Surface Water Diversions** | | | | | | | | | | | | | | | | | | |
| 102.1 | Construct Faro Creek Diversion (east valley) | | | | | | | $55,510 | $660,270 | $243,718 | | | | | | | | | **$959,498** |
| 102.2 | Construct West Valley Extension | | | | | | | | | $192,482 | | | | | | | | | **$192,482** |
| 102.3 | North Wall Interceptor Ditch | | | | | | $94,974 | | | | | | | | | | | | **$94,974** |
| 102.4 | Guardhouse Creek Water Management | | | | | | | | | $7,055 | | | | | | | | | **$7,055** |
| **103** | **Zone II Pit** | | | | | | | | | | | | | | | | | | |
| 103.1 | Install pump in existing wells, piping, heat tracing | | | | | | | | | | | | | | $7,066 | | | | **$7,066** |
| **104** | **Oxide Fines and Low Grade Ore** | | | | | | | | | | | | | | | | | | |
| 104.1 | Relocate oxide fines to LGSP C | | | | $381,677 | | | | | | | | | | | | | | **$381,677** |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | | | | $696,497 | | | | | | | | | | | | | | **$696,497** |
| 104.3 | Cover, revegetate LGSP A | | | | $251,967 | | | | | | | | | | | | | | **$251,967** |
| 104.4 | Cover revegetate LGSC C | | | | $608,116 | $152,029 | | | | | | | | | | | | | **$760,145** |
| **105** | **Emergency Tailings Area** | | | | | | | | | | | | | | | | | | |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | | | $83,044 | | | | | | | | | | | | | | | **$83,044** |
| 105.2 | Install ETA Collection System | | | | | | | $18,411 | | | | | | | | | | | **$18,411** |
| **106** | **Waste Rock Dumps** | | | | | | | | | | | | | | | | | | |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells | | | | | $98,658 | | | | | | | | | | | | | **$98,658** |
| 106.1B | Regrade, Reslope Waste Rock Dumps | | | | | $443,962 | $643,745 | $293,508 | | | | | | | | | | | **$1,381,215** |
| 106.2A | Relocate East Sulphide waste to Main Sulphide cell | | | | | $1,262,997 | | | | | | | | | | | | | **$1,262,997** |
| 106.2B | Cover and Revegetate Main and Intermediate Sulphide cells | | | | | $1,580,116 | | | | | | | | | | | | | **$1,580,116** |
| 106.3/4/5 | Place cover on remaining waste rock & revegetate | | | | | | $1,563,529 | $6,159,355 | $6,183,045 | $1,729,357 | | | | | | | | | **$15,635,286** |
| **107** | **Faro Groundwater** | | | | | | | | | | | | | | | | | | |
| 107.1A | Upgrade North Fork Rose Creek | | | | | | | | | | | | $295,546 | $278,330 | | | | | **$573,876** |
| 107.1B | North Fork Rose Creek Cut-off Wall | | | | | | | | | | | | | $155,058 | $613,185 | $613,185 | $28,192 | | **$1,409,621** |
| 107.2 | Relocate Zone II outwash material to Intermediate Dump | | | | | $70,489 | | | | | | | | | | | | | **$70,489** |
| 107.3 | Install Zone II Outwash Collection System | | | | | | | $4,547 | | | | | | | | | | | **$4,547** |
| 107.4 | Install S-wells groundwater collection system | $161,659 | | | | | | | | | | | | | | | | | **$161,659** |
| **108** | **Faro Miscellaneaous** | | | | | | | | | | | | | | | | | | |
| 108.1 | Reclaim unnecessary roads | | | | | | | | | | | | | | | | $3,692 | | **$3,692** |
| 108.2 | Decontaminate and Demolish Buildings | | | | | | | | | | | | | | $334,475 | $504,612 | $50,268 | | **$889,355** |
| 108.3/4 | Relocate Contaminated Soil from Mill Site Area and cover (synthetic/soil) | | | | | | | | | | | | | | | | $49,704 | | **$49,704** |
| | **Tailings Area (Activity Code 200)** | | | | | | | | | | | | | | | | | | |
| **201** | **Dams** | | | | | | | | | | | | | | | | | | |
| 201.1 .1/2 | Dewater Intermediate Tailings Area and CVD pond | | | | | $403,736 | | | | | | | | | | | | | **$403,736** |
| 201.1 .4/5 | Breach Cross-valley Dam | | | | | $39,812 | $39,812 | | | | | | | | | | | | **$79,624** |
| 201.2 | Raise Intermediate Dam | | | | | | $497,127 | $923,236 | | | | | | | | | | | **$1,420,363** |
| 201.3 | Construct Intermediate Dam Spillway | | | | | $226,159 | $1,000,752 | | | | | | | | | | | | **$1,226,910** |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | | | | | | | $126,060 | | | | | | | | | | | **$126,060** |
| **202** | **Tailings Cover** | | | | | | | | | | | | | | | | | | |
| 202.1, 2/3 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | | | | | | | | | $45,492 | $3,957,775 | $3,957,775 | $834,014 | | | | | | **$8,795,056** |
| 202.2 | Place covers on original and secondary impoundments and revegetate | | | | | | | | | | | | $3,135,660 | $3,957,629 | $213,103 | | | | **$7,306,393** |
| **203** | **Rose Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | | | | | | | | | $2,572,959 | | | | | | | | | **$2,572,959** |
| 203.2 | Construct Erosion Dissipation Structure | | | | | | | | | | | | $324,900 | | | | | | **$324,900** |
| 203.3 | Breach North Fork Rock Drain, create channel | | | | | | | | | $2,696 | $51,225 | | | | | | | | **$53,921** |
| 203.4 | Construct Fuse Plug | | | | | | | | | | | | $13,781 | | | | | | **$13,781** |
| 203.5 | Construct a Fish Bypass (ladder) | | | | | | | | | | $12,979 | | | | | | | | **$12,979** |
| 203.6 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | | | | | | | $308,259 | | | | | | | | | | | **$308,259** |
| **204** | **Groundwater Collection** | | | | | | | | | | | | | | | | | | |
| 204.1 | Construct Intermediate Dam Cut-off Wall | | | | | | | | | | | | | | $251,986 | $1,529,499 | $562,574 | | **$2,344,060** |
| 204.2 | Construct Intermediate Dam Interception Trench | | | | | | | | | | | | | | | | $102,642 | | **$102,642** |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | | | | | | | | | | | | | | | | $51,771 | | **$51,771** |
| | **Vangorda Grum Area (Activity Code 300)** | | | | | | | | | | | | | | | | | | |
| **301** | **Vangorda Pit** | | | | | | | | | | | | | | | | | | |
| 301.2 | Construct Safety Berms (Vangorda pits) | | | | | | | | | | | | | | | | $39,272 | | **$39,272** |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | | | | | | | | | | $168,022 | | | | | | | | **$168,022** |
| **302** | **Vangorda Dump** | | | | | | | | | | | | | | | | | | |
| 302.1 | Reslope Vangorda Waste Dump | | | | | | | | | | $110,325 | | | | | | | | **$110,325** |
| 302.6 | Place Very Low Cover over Baritic Fines | | | | | | | | | | $15,652 | | | | | | | | **$15,652** |
| 302.2/3/4 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | | | | | | | | | | $1,932,145 | | | | | | | | **$1,932,145** |
| **303** | **Vangorda Creek Diversion** | | | | | | | | | | | | | | | | | | |
| 303.1/2 | Construct New Vangorda Diversion | | $400,660 | $100,558 | | | | | | | | | | | | | | | **$501,218** |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | | | | | $70,459 | | | | | | | | | | | | | **$70,459** |
| **304** | **Grum Pit** | | | | | | | | | | | | | | | | | | |
| 304.2 | Construct Safety Berms (Grum pits) | | | | | | | | | | | | | | | | $44,416 | | **$44,416** |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | | | | | | | | | | | $68,232 | | | | | | | **$68,232** |
| **306** | **Grum Dump** | | | | | | | | | | | | | | | | | | |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | | | | | | | | | | $80,627 | $239,134 | $46,727 | | | | | | **$366,488** |
| 306.2 | Place low infiltration cover on Grum sulphide cell | | $599,078 | | | | | | | | | | | | | | | | **$599,078** |
| 306.3/4/5 | Place Vegetative cover on Grum dump and revegetate | | | | | | | | | | | $1,914,994 | $912,514 | | | | | | **$2,827,508** |
| **307** | **Grum Overburden Dump** | | | | | | | | | | | | | | | | | | |
| 307 | Reslope Overburden Dump and Revegetate | | | | | | | | | | | | | | | | | $23,319 | **$23,319** |
| **308** | **Grum Ore Transfer Pad** | | | | | | | | | | | | | | | | | | |
| 308.1 | Remove contaminated soil at Ore Transfer Pad | | $855,076 | | | | | | | | | | | | | | | | **$855,076** |
| 308.2/3/4 | Regrade, cover and revegetate Ore Transfer Pad | | $214,916 | | | | | | | | | | | | | | | | **$214,916** |
| **309** | **Vangorda/Grum Groundwater** | | | | | | | | | | | | | | | | | | |
| 309.1/2/3 | Install Grum Groundwater collection & cut-off walls | | | | | | | | | | | | | | | | $37,813 | $8,254 | **$46,067** |
| 309.4 | Install Vangorda WR Dump Seepage Collection | | | | | | | | | | | | | | | | $548,499 | | **$548,499** |
| **311** | **Vangorda/Grum Miscellaneous** | | | | | | | | | | | | | | | | | | |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | | | | | | | | | | | | | | $20,113 | $75,664 | | | **$95,778** |
| 311.5 | Remove WTP Settling Pond | | | | | | | | | | | | | | $1,390 | | | | **$1,390** |
| 311.6 | Remove contaminated soils (fuel lube station) | | | | | | | | | | $7,853 | | | | | | | | **$7,853** |
| 311.7 | Construct Bioremediation cell | | | | | | | | | | $41,795 | | | | | | | | **$41,795** |
| 311.8 | Reclaim roads | | | | | | | | | | | | | | | | $5,183 | | **$5,183** |
| | **Haul Road (Activity Code 400)** | | | | | | | | | | | | | | | | | | |
| 310.1/2 | Remove culverts, decommission, revegetate | | | | | | | | | | | | | | $273,412 | | | | **$273,412** |
| 310.3 | Construct haul road access from Vangorda to RCT | | | | | | | | | $20,870 | | | | | | | | | **$20,870** |
| | **Water Treatment (Activity Code 500)** | | | | | | | | | | | | | | | | | | |
| 101.1 | Construct Faro Plant(s) and piping | | | | | | | | | | | | | $995,720 | $576,470 | | | | **$1,572,190** |
| 101.3 | Faro Sludge Disposal | | | | | | | | | | | | | | $15,116 | | | | **$15,116** |
| 205.2 | Polishing Pond | | | | | | | | | | | | | $96,104 | | | | | **$96,104** |
| 301.1 | Construct Vangorda WT plant and piping | | | | | | | | | | | | | | $462,925 | | | | **$462,925** |
| 301.4 | Vangorda Sludge Disposal | | | | | | | | | | | | | | $8,047 | $15,328 | | | **$23,375** |
| | **Borrow Area Development (Activity Code 600)** | | | | | | | | | | | | | | | | | | |
| 108.5 | Develop and Decomission Faro Borrow Sources | | | | | $13,277 | | | | | | | | | | | | | **$13,277** |
| 311.9 | Develop and Decomission Vangorda Borrow Areas | | $20,453 | | | | | | | | | | | | | | | | **$20,453** |
| | **Care and Maintenance** | | | | | | | | | | | | | | | | | | |
| | Lime addition for ongoing water treatment | | | | | | | | | | | | | | | | | | **$0** |
| | Care and Maintenance | | | | | | | | | | | | | | | | | | |
| | **Total** | **$161,659** | **$2,090,183** | **$183,602** | **$1,938,258** | **$4,361,693** | **$3,839,938** | **$7,888,886** | **$6,843,315** | **$4,814,629** | **$6,378,399** | **$6,180,135** | **$5,563,143** | **$5,482,842** | **$2,777,288** | **$2,738,289** | **$1,524,026** | **$66,219** | **$62,832,501** |

# Figures

# Faro Mine Complex
# Preliminary Project Schedule (March, 2010)

| Activity Codes | Task Name | Estimated Project Cost |
|---|---|---|
| | **Faro Mine Complex Reclamation and Closure** | ***$448,661,920*** |
| | **Faro Mine Area (Activity Code 100)** | ***$138,840,503*** |
| **101** | **Faro Pit Safety Berm** | ***$285,828*** |
| 101.2 | Place a safety berm around the pit | *$285,828* |
| **102** | **Surface Water Diversions** | ***$6,801,986*** |
| 102.1 | Construct Faro Creek Diversion (east valley) | *$5,104,661* |
| 102.2 | Construct West Valley Extension | *$1,129,914* |
| 102.3 | North Wall Interceptor Ditch | *$525,229* |
| 102.4 | Guardhouse Creek Water Management | *$42,182* |
| **103** | **Zone II Pit** | ***$298,098*** |
| 103.1 | Install pump in existing wells, piping, heat tracing | *$298,098* |
| **104** | **Oxide Fines and low Grade Ore** | ***$19,973,489*** |
| 104.1 | Relocate oxide fines to LGSP C | *$4,615,381* |
| 104.2 | Relocate Medium Grade Ore, incl. brown and green oxide fines (Oxide Fines #1) | *$8,422,295* |
| 104.3 | Cover, revegetate LGSP A | *$1,731,422* |
| 104.4 | Cover revegetate LGSPC | *$5,204,391* |
| **105** | **Emergency Tailings Area** | ***$1,730,894*** |
| 105.1 | Remove tailings to Rose Creek Tailings Facility | *$1,007,117* |
| 105.2 | Install ETA Collection System | *$723,777* |
| **106** | **Waste Rock Dumps** | ***$78,970,335*** |
| 106.1A | Regrade and reslope Main and Intermediate Sulphide Cells (costs incl in 106.1B) | *$0* |
| 106.1B | Regrade, Reslope Waste Rock Dumps | *$5,317,812* |
| 106.2 | Cover and Revegetate East Sulphide waste | *$926,459* |
| 106.3 | Cover and Revegetate Main and Intermediate Sulphide cells | *$9,224,304* |
| 106.4/5/6 | Place cover on remaining waste rock & revegetate | *$58,136,564* |
| 106.7 | Cover and Revegetate Mt Mungly (E & W), Southwest Pit Wall Dump | *$5,365,196* |
| **107** | **Faro Groundwater** | ***$20,467,760*** |
| 107.1A | Upgrade North Fork Rose Creek | *$4,472,043* |
| 107.1B | North Fork Rose Creek Cut-off Wall | *$13,615,928* |
| 107.2 | Relocate Zone II outwash material to Intermediate Sulphide Cell | *$439,460* |
| 107.3 | Install Zone II Outwash Collection System | *$205,583* |
| 107.4 | Install S-wells groundwater collection system | *$1,734,746* |
| **108** | **Faro Miscellaneaous** | ***$10,312,113*** |
| 108.1 | Reclaim unnecessary roads | *$19,232* |
| 108.2 | Decontaminate and Demolish Buildings | *$9,864,405* |
| 108.3 | Relocate Contaminated Soil from Mill Site Area and cover (rudimentary) | *$428,476* |
| | **Tailings Area (Activity Code 200)** | ***$138,554,881*** |
| **201** | **Dams** | ***$24,998,276*** |
| 201.1 .1/2/3, 202 | Dewater Intermediate Tailings Area and CVD pond | *$1,779,799* |
| 201.1 .4/5 | Breach Cross-valley Dam | *$266,101* |
| 201.2 | Raise Intermediate Dam | *$8,731,014* |
| 201.3 | Construct Intermediate Dam Spillway | *$13,174,224* |
| 201.4 | Stabilize Secondary Dam by densifying East Limb | *$1,047,138* |
| **202** | **Tailings Cover** | ***$73,855,085*** |
| 202.1. 2/3/4/5 | Cover Intermediate Imp./construct swales using North Fork Rock Drain Material | *$40,255,549* |
| 202.2 | Place covers on original and secondary impoundments and revegetate | *$33,599,536* |
| **203** | **Rose Creek Diversion** | ***$14,216,566*** |
| 203.1 | Upgrade Rose Creek Diversion Channel upstream of fuseplug to PMF | *$4,739,099* |
| 203.2 | Construct Erosion Dissipation Structure | *$2,695,275* |
| 203.3 | Breach North Fork Rock Drain, create channel | *$3,606,145* |
| 203.4 | Construct Fuse Plug | *$86,799* |
| 203.5 | Upgrade of RCDC downstream of FP to 1:500 (Dyke) | *$1,909,463* |
| 203.6 | Construct a Fish Bypass (ladder) | *$1,179,785* |
| **204** | **Groundwater Collection** | ***$25,484,954*** |
| 204.1 | Construct Intermediate Dam Cut-off Wall | *$22,654,040* |
| 204.2 | Construct Intermediate Dam Interception Trench | *$839,705* |
| 204.3/4 | Install Cross-Valley Dam Groundwater collection system | *$1,991,209* |
| | **Vangorda Grum Area (Activity Code 300)** | ***$55,520,771*** |
| **301** | **Vangorda Pit** | ***$893,701*** |




Faro_schedule_mm_pmh_ATedits_20100326.v41
Date: Fri 3/26/10 3:27 PM

Green bars indicate early remediation activities
Red bars indicate 24hr operation schedule

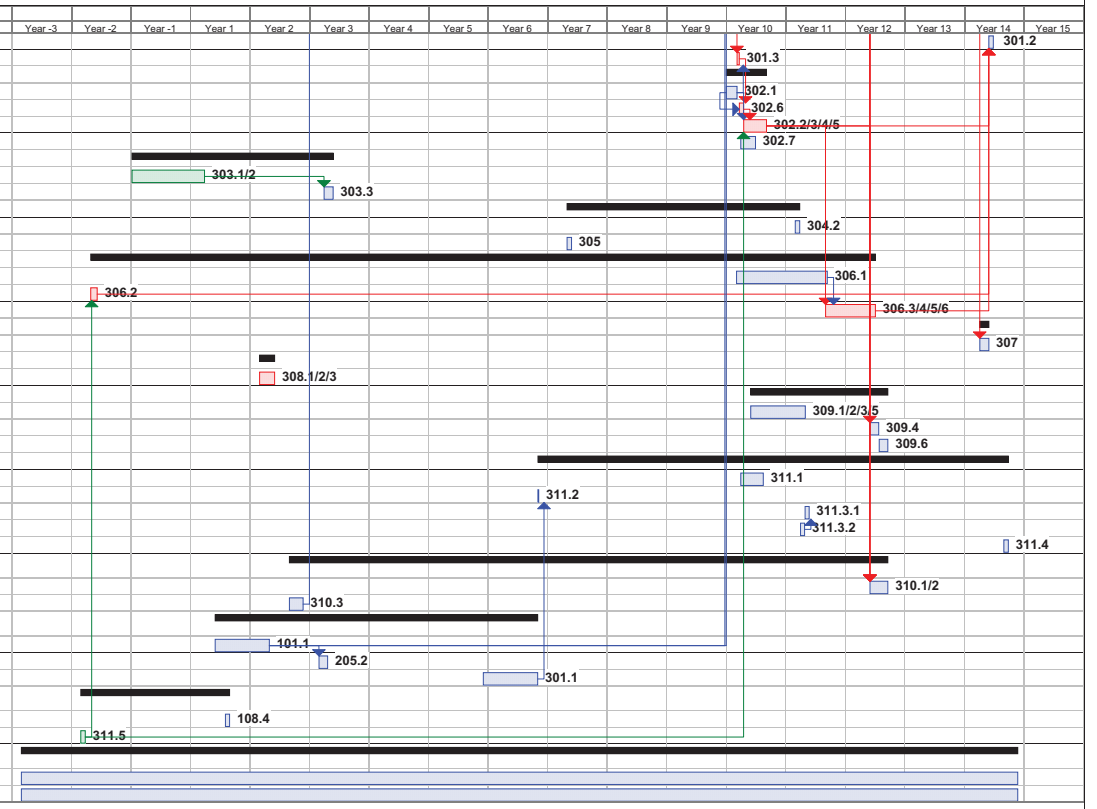
Task | Progress | Summary | External Tasks | Split
Split | Milestone | Project Summary | External MileTask



**Figure 11.1**

# Faro Mine Complex
# Preliminary Project Schedule (March, 2010)

| Activity Codes | Task Name | Estimated Project Cost |
|---|---|---|
| 301.2 | Construct Safety Berms (Vangorda pits) | *$211,000* |
| 301.3 | Reslope and Cover Vangorda Pit Waste Rock Piles | *$682,701* |
| **302** | **Vangorda Dump** | ***$10,341,823*** |
| 302.1 | Reslope Vangorda Waste Dump | *$378,481* |
| 302.6 | Place Very Low Cover over Baritic Fines | *$391,253* |
| 302.2/3/4/5 | Place Low Infiltration Cover on Vangorda waste rock and Revegetate | *$7,800,789* |
| 302.7 | Place Very Low Infiltration Cover over Main Dump Sulphide Cell | *$1,771,300* |
| **303** | **Vangorda Creek Diversion** | ***$4,684,342*** |
| 303.1/2 | Construct New Vangorda Diversion | *$4,257,027* |
| 303.3 | Upgrade Runoff interceptor ditch to Dixon Creek | *$427,315* |
| **304** | **Grum Pit** | ***$659,632*** |
| 304.2 | Construct Safety Berms (Grum pits) | *$229,908* |
| 305 | Breach Grum Interceptor Ditch to Grum Pit, build Algae filter | *$429,724* |
| **306** | **Grum Dump** | ***$24,566,158*** |
| 306.1 | Reslope and regrade Grum Waste Dump and pull back crest | *$1,727,795* |
| 306.2 | Place very low infiltration cover on Grum sulphide cell | *$13,529,100* |
| 306.3/4/5/6 | Place Vegetative cover on Grum dump and revegetate | *$9,309,263* |
| **307** | **Grum Overburden Dump** | ***$147,132*** |
| 307 | Reslope Overburden Dump and Revegetate | *$147,132* |
| **308** | **Grum Ore Transfer Pad** | ***$5,487,527*** |
| 308.1/2/3 | Regrade, cover and revegetate Ore Transfer Pad | *$5,487,527* |
| **309** | **Vangorda/Grum Groundwater** | ***$7,249,754*** |
| 309.1/2/3/5 | Install Grum Groundwater collection & cut-off walls | *$6,270,599* |
| 309.4 | Install Vangorda WR Dump Seepage Collection | *$826,431* |
| 309.6 | Install Vangorda Groundwater Collection System | $152,724 |
| **311** | **Vangorda/Grum Miscellaneous** | ***$1,490,702*** |
| 311.1 | Demolish buildings (treatment plant and the steel culvert over grum portal) | *$1,127,644* |
| 311.2 | Remove WTP Settling Pond | *$217,347* |
| 311.3.1 | Remove contaminated soils (fuel lube station) | *$41,088* |
| 311.3.2 | Construct Bioremediation cell | *$72,908* |
| 311.4 | Reclaim roads | *$31,715* |
| | **Haul Road** | ***$1,787,741*** |
| 310.1/2 | Remove culverts, decommission, revegetate | *$1,697,534* |
| 310.3 | Construct haul road access from Vangorda to RCT | *$90,207* |
| | **Water Treatment** | ***$18,752,110*** |
| 101.1 | Construct Faro Plant(s) and piping | *$13,530,478* |
| 205.2 | Polishing Pond | *$1,241,073* |
| 301.1 | Construct Vangorda WT plant and piping | *$3,980,559* |
| | **Borrow Area Development** | ***$248,714*** |
| 108.4 | Develop and Decomisison Faro Borrow Sources | *$136,879* |
| 311.5 | Develop and Decomission Vangorda Borrow Areas | *$111,835* |
| | **Care and Maintenance** | ***$94,957,200*** |
| | Lime addition for ongoing water treatment | *$4,957,200* |
| | Care and Maintenance | *$90,000,000* |




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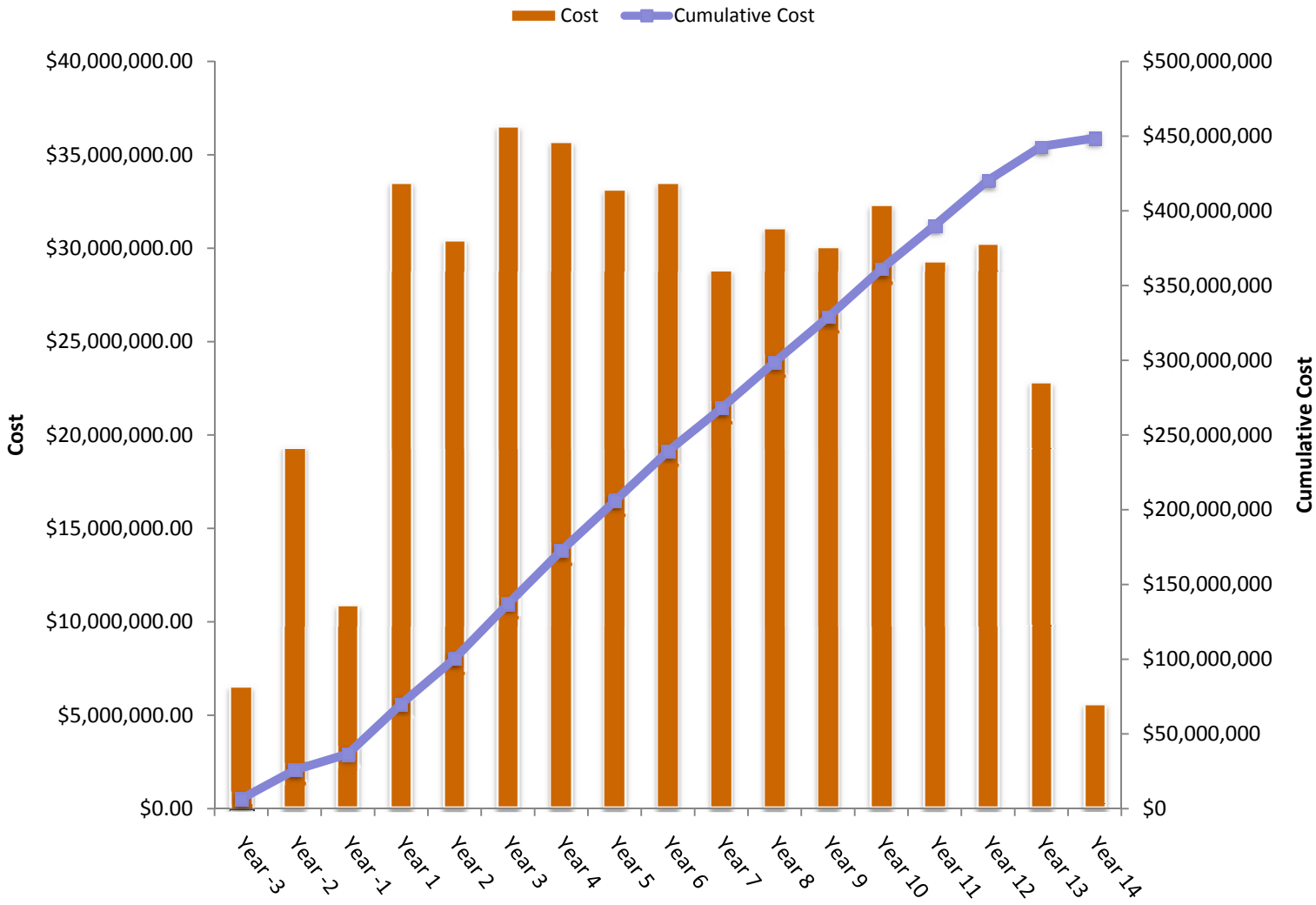
Green bars indicate early remediation activities
Red bars indicate 24hr operation schedule

Task | Progress | Summary | External Tasks | Split
Split | Milestone | Project Summary | External MileTask



**Figure 11.1**

# Cash Flow Report




SRK Consulting
Engineers and Scientists
VANCOUVER

Faro Mine Closure
Fermeture de la mine Faro

Project Description (Draft 4A)

**Cashflow**

Job No: 1CY001.026

Filename: Figures_11.2-4Cash-workforce_20100324.ppt

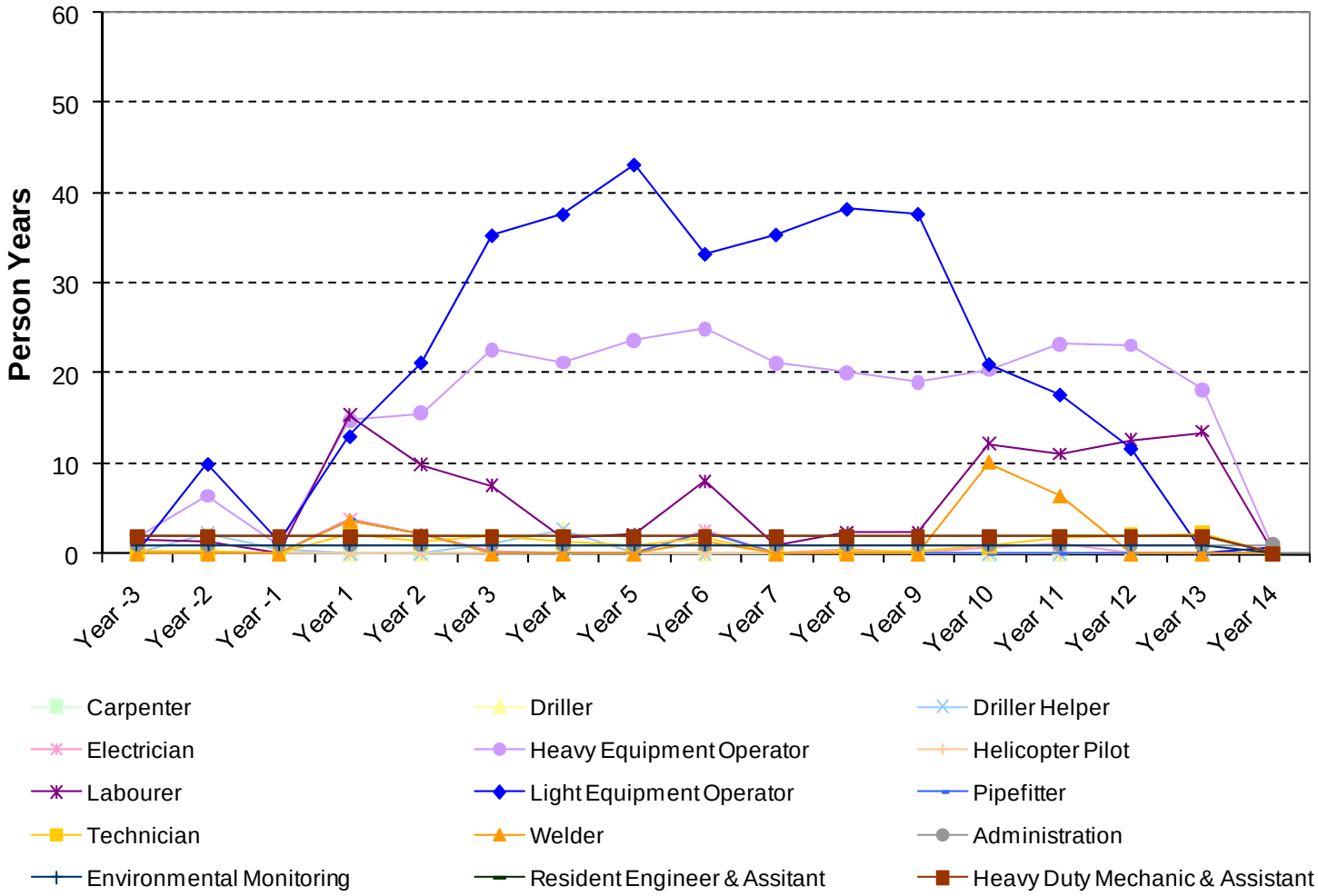
Faro Mine Complex
Closure and Remediation Plan

Date: March 2010

Approved:

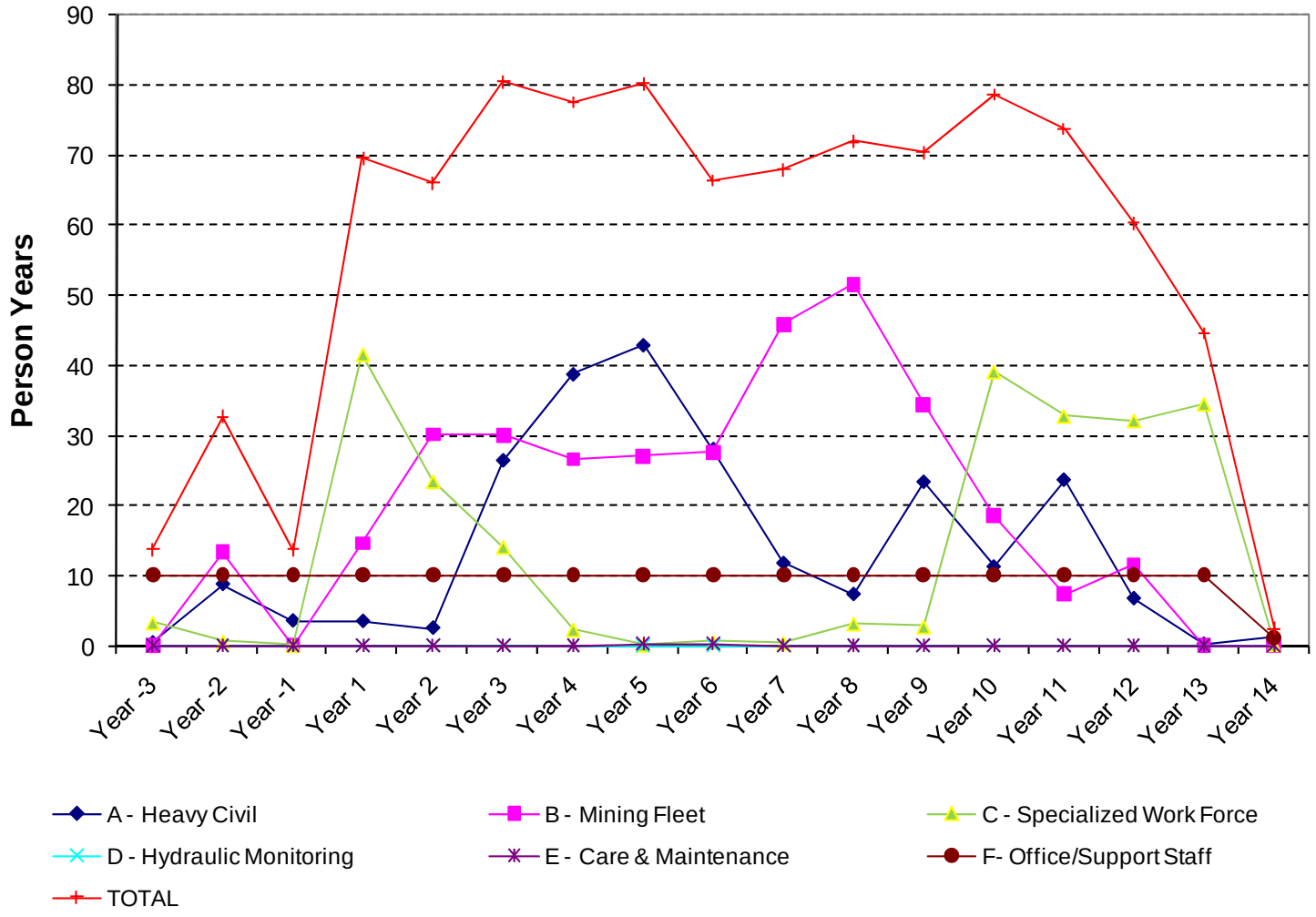
Figure: **11.2**

## Example Work Force by Trade/Profession




| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists VANCOUVER | Faro Mine Closure Fermeture de la mine Faro | Project Description (Draft 4A) |
| Job No: 1CY001.026<br>Filename: Figures_11.2-4Cash-workforce_2001127.ppt | Faro Mine Complex<br>Final Closure and Remediation Plan | **Workforce by Trade and Profession**<br>Date: December 2009 / Approved: / Figure: **11.3** |

## Example Work Force by Crew Type




| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists VANCOUVER | Faro Mine Closure Fermeture de la mine Faro | Project Description (Draft 4A) |
| | | **Workforce by Crew Type** |
| Job No: 1CY001.026<br>Filename: Figures_11.2-4Cash-workforce_2001127.ppt | Faro Mine Complex<br>Final Closure and Remediation Plan | Date: December 2009 / Approved: / Figure: **11.4** |

# 12 Surface Water Management Strategy

## 12.1 General

This chapter presents a strategy, based on Best Management Practices, to control, rout, collect and treat surface water runoff from those areas that will be disturbed and reclaimed during the closure implementation.

The following sections present an overall discussion of a number of engineering techniques which are widely used in practice to minimize and control the different types of soil runoff erosion and sedimentation that are likely to be seen at this site. In addition, as the level of protection is dependent on the severity of the storm event that would generate the surface runoff, a brief preamble on the selection of design storm events for the design of each treatment is also provided.

The last section describes the use of sediment and storm water control measures that are proposed at each of the three main areas at the site.

## 12.2 Design Storm Events

While an erosion control technique may be effective for a given soil during moderate runoff conditions caused by a light rain, it may not be effective during heavy runoff caused by a more severe storm. A measure of effectiveness, then, can be related to a type or severity of storm event. Common engineering practice uses the "design storm" as this measure of effectiveness or level of performance.

The permanent engineering structures proposed for the closure of this site are based on flood events that range from the 200 year runoff event up to the Probable Maximum Flood (PMF) selected for the Intermediate Dam emergency spillway.

However, it is proposed that all surface runoff berms, ditches and sedimentation basins that would be constructed at the beginning of closure implementation in a specific area to provide temporary erosion control protection, be sized to accommodate runoff volumes based on the a 10 year peak daily flow. These structures would be used throughout early post-closure reclamation until final vegetation is established and the soils have stabilized. Depending upon the success of the vegetation and the long-term erosion potential, structures such as the sedimentation basins may be removed and the areas revegetated.

Typical soil stabilization and contingency measures that would be applied are presented in Table 12.1.

**Table 12.1: Erosion Control Methods Applicable to the Closure Construction Phase**

| Soil Stabilization Measures | Contingency Measures |
|---|---|
| Vegetative Stabilization | Sandbag Sediment Barrier |
| Diversion Berm | Temporary Diversion Berms |
| Sedimentation Basins | |
| Riprap | |
| Slope Bench | |
| Silt Fences | |
| Straw Bales | |

## 12.3 General Engineering Methods for Erosion Control

The effects of erosion can be reduced by protecting the soil from the runoff forces, and by preventing any sediment-laden runoff from leaving the site. Sedimentation basins provide "treatment" for the runoff, discharging sediment-free waters from the site, while vegetative cover helps protect soils from the erosive forces.

Soil surfaces require some type of vegetation or artificial cover to reduce erosion and associated sediment yields. To initially establish vegetation successfully on disturbed soil, it is important that the soil slopes be mechanically stable, the area be protected from concentrated storm water runoff, and the soil surface stabilized with a mulch or a combination of mulch with a chemical soil stabilizer. On long slopes, it may be necessary to reduce the segments of decreasing elevation with a system of diversion berms or bench terraces.

Erosion control is a pre-requisite to creating conditions favourable for plant growth. The surface water management plan at the Faro Closure incorporates the following objectives:

- Minimization of areas in the site which discharge runoff without "treatment" in a sedimentation basin;
- Temporary control of sediment until more permanent structures and/or vegetation are established;
- Detention of storm water on the site and the release of sediment-free waters at non-erosive velocities;
- Use of diversion terraces, berms or swales to divert water from closure construction sites; and
- Establishment of cut-and-fill slopes as flat as feasible, consistent with the strengths of soil involved. Slope stability depends on length and steepness, soil strength, moisture content, density, and other factors.

Although various techniques, temporary or permanent, can be used for soil erosion control during the construction phase, some will be predominant during relocation of waste material, placement of the soil covers, and development of permanent diversion structures. These techniques include diversion berms, filter fabric, sediment traps/straw bale filters, sedimentation ponds, slope benches, and riprap.

A summary of the advantages and other considerations associated with these measures, together with additional erosion control criteria is presented in Table D-1 in Appendix D.

## 12.4 Erosion Control Techniques

Specific erosion control techniques that are proposed for the Faro Mine Complex Closure are presented in this section. These methods were selected based on the climatic conditions, soils, and vegetation in the plant area and in relation to the proposed construction phasing. Some of the erosion control methods were developed for possible application on steeper banks, which may be encountered during regrading of the waste dump slopes. The contingency methods described are for use on areas where experience has shown that storms reduce the effectiveness of other erosion control methods.

### 12.4.1 Landform Engineering

Long term cover integrity is of paramount importance, and landform engineering principles have been adopted to evaluate where the biggest risks lie, and how they can be addressed. This work has led to the development of Reclamation Land Units (RLU's) for the Faro Mine Complex, which defines how every aspect of the site will be reclaimed. It has been demonstrated that the biggest risks linked to the success of covers are; (1) erosion, which is linked to the final slope angles and (2) the slow natural revegetation potential of the region.

Surface water management is a key factor in the design of the new landforms. Techniques considered included drainage channels down and across the face of the resloped areas. These channels would be either lined with riprap or simply vegetated earth channels depending upon the associated drainage area and the channel slopes. A more detailed discussion on the various treatments proposed for the waste dumps is presented in Section 12.5.

### 12.4.2 Vegetation

The establishment of vegetation cover is essential for the successful control of erosion. Different soil types and slope conditions require different vegetation considerations. It will be especially important in the post-closure phase of the project that vegetative stabilization be established to provide proper erosion control.

All disturbed areas that cannot be directly revegetated at the Faro Project will be covered with a minimum of 1m of loosely compacted till to promote vegetative growth. Cover slopes in high risk/high consequence areas will be seeded with a grass and legume mixture. This mixture will promote rapid ground cover establishment to minimize erosion immediately after the cover construction. Quick establishment of the grass and legume mix currently requires an accompanying application of a low nitrogen, high phosphorous fertilizer.

Other areas will be seeded with a native grass seed mix and/or native woody species pursuant to the designated RLU for the area. This will minimize damage from wind, water, and/or human

disturbance. When used along sideslopes, grass seed mixes have a long-term advantage over other revegetation methods in providing locally adapted seed stock with low maintenance requirement (no added water, fertilizer, humus, or cutting needed). In the short-term, this method does not provide quick uniform ground cover as do grass and legume mixtures. However, the grass and legume mixtures compete with native successional vegetation for nutrients, light, moisture, and soil space.

Riparian areas that are likely to be flooded seasonally or occasionally will be vegetated with sustainable riparian vegetation, similar to what is found locally. This will prevent erosion in during high flood events and will have the additional benefit of providing habitat to riparian wildlife.

The native seed mixtures are considered to be permanent, self-sustaining and maintenance free. However, infrequent maintenance practices of mowing or herbicide spraying may be imposed to control native shrub and tree invasion where such invasion is considered undesirable. Reduction or elimination of maintenance practices several years before abandonment will permit native plant species to become established and provide a natural transition for the vegetation cover on these surfaces to a vegetative cover approaching that of the surrounding area.

During the project, seeding will be undertaken through application by a low-flying helicopter. The optimum seeding period for legume-based seed mixtures is April to June, whereas the optimum period for grass-based seed mixtures is August and September. Where completion of construction of various facilities does not permit an optimum seeding time, temporary erosion control methods will be used.

### 12.4.3 Diversion Berms

The diversion berm method, as applied at the Faro Project, is primarily focused at the waste rock dumps. Diversion berms would be used along the crest of the slopes to intercept runoff and direct the flow to drainage channels build down the slopes. The berms would prevent overland flow on the slopes and reduce the potential for surface erosion. They would be constructed prior to any excavation and movement of rock waste. This method will also be used along the toe of the waste dumps to prevent sediment entering the adjacent streams.

A typical design is shown in Figure 12.1.

Berms will be inspected after each major storm to identify any damaged areas and repairs should be completed before the next storm. Channel obstructions will be removed.

The effectiveness of this method depends on the size and stabilization of the slope above, and maintenance of the catch basin channel. It is most effective for removing large sediments during the early phases of stabilization.

### 12.4.4 Sedimentation Basin

A sedimentation basin is a temporary or permanent basin constructed in conjunction with a detention dam. This method is used to trap and store sediment contained in surface runoff and to serve as a flow detention facility for reduction of peak runoff.

Temporary detention structures will be used to contain storm water to trap sediment in runoff from construction sites. Larger permanent structures will be constructed along the toe of the Faro and Grum waste dumps to provide substantial reduction of peak runoff as well as sediment removal.

Sedimentation basins will be limited to drainage areas not exceeding 20 hectares. The design of the actual containment structure would be based on the settling velocity of 5 micron (0.05mm) particle sizes and a runoff rate based on the 10 year peal daily flow. The outlet from the basin would be a spillway in the embankment protected with riprap. The spillway would be designed to pass the peak instantaneous 200 year flood. It would also be designed with a smaller weir within the spillway to minimize glaciation of the channel during low flow periods in the winter.

An example design is shown on Figures 12.2 and 12.3.

### 12.4.5 Riprap

Riprap involves the use of stabilizing blankets comprised of large rocks placed on a slope or ground surface to be protected from surface water erosion. This method is used to protect banks and channels from erosion, maintain stream capacity, and prevent downstream sedimentation. Riprap will be used in permanent diversion channels on the Faro Closure Project and to enhance stabilization of all emergency spillways, pipe discharges, and in specific locations throughout the project area where flow velocities are such that riprap is deemed necessary to control erosion.

Consideration has been given to sizing of diversion structures to handle water flows from the entire contributing drainage area of the given stream or conveyance facility. Trees and other debris must be cleared from the channels after major storms to prevent alteration or blockage of flow and subsequent loss of facilities.

### 12.4.6 Slope Bench

A slope bench is a series of large steps, approximately 5.0 m wide, constructed in steeper slopes (Figure 12.4) such as the Intermediate Dam Spillway. The entire slope face, including the bench, will be revegetated. Material deposited on the bench will not be removed unless the quantity present will cause sloughing into the adjacent roadway surface.

The effectiveness of this method depends on the upslope area, the slope face angle and the grade of the bench. Benches with good grass cover are most effective in removing sediments and nutrients.

### 12.4.7 Temporary Sandbag Sediment Barrier

Temporary sediment barriers or diversions will be constructed of sandbags. Such barriers will be built to retain sediment on-site by slowing storm runoff and causing the deposition of sediment at the barrier.

Sandbag barriers do not provide a high degree of filtration but are valuable for emergency control. They can be used only for minor flows and to temporarily control spot failures on slopes where other methods were used or before other methods have been implemented.

Sandbag sediment barriers are used as training berms to direct or divert runoff flows, or as barriers to collect and store runoff from spot failures of other control methods. After every use, sandbag sediment barriers will be inspected; damaged bags replaced, and trapped sediment removed.

### 12.4.8 Temporary Diversion Berms

This method is identical to the diversion berm previously described but is constructed during storms or immediately following to prevent sedimentation from small areas where slope failure occurs.

### 12.4.9 Silt Fence

Silt fencing is often used as a perimeter barrier and to prevent or minimize sheetwash, rills and small gullies from carrying sediment off site. A geofabric, typically woven, embedded into the soil on the bottom and held up by wood or other suitable stakes makes up a common silt fence. This structure, when properly constructed, holds back soils being carried off site in a water stream. Often, silt fences are constructed around the perimeter of a site to protect erosion off-site through overland flow or to redirect the flow of site waters to appropriate facilities, such as runoff basins or straw bale discharge structures.

### 12.4.10 Straw Bales

Straw bales are used in drainage channels and ditches to slow runoff and trap sediment. Straw bales are staked in strategic locations to provide a barrier to sediment transport. Used as ditch checks or perimeter downslope protection, this temporary facility can be a valuable tool in controlling erosion.

The bales may be anchored to the ground with fence posts, steel pins or by other means, particularly in those areas where concentrated runoff may cause excessive erosion. Straw bales may be used in conjunction with fiber fabric in areas where runoff from the construction zone may concentrate.

## 12.5 Major Facilities

The following section describes the proposed sediment and storm water control structures at each of the key facilities on site. Post-closure, many of these structures will be left in place to limit run-on to the closed facility and new structures to control the sediment leaving site will be constructed.

### 12.5.1 Faro Mine Area

**Faro Waste Dumps**

One of the primary areas for surface water management in the Faro Mine Area is during the excavation and relocation t of the oxide fines. The first step in controlling the contact water during this activity will be to limit the amount of water that contacts the oxide fines. This will be done using temporary diversion berms constructed up-gradient of the facilities. Diversion berms will also be constructed down-gradient of the excavation activities. These will divert any water falling directly on the exposed oxide fines into temporary sediment control basins. These basins will be constructed to allow the collected water to infiltrate into the waste dumps thus preventing the exit of potentially contaminated water from site.

**Emergency Tailings Area**

Prior to excavation of the material at the ETA diversion berms/channels will be constructed upgradient of the facility to divert clean runoff from native ground on either side of the facility from contacting the excavated tailings. The diversion structures will be left in place post-closure to prevent mixing the clean runoff with the seeps collected in the area.

**Other Locations**

In other locations, where there is a risk of clean water contacting highly contaminated material, similar procedures will be followed. Water upgradient will be diverted away from the area either through the use of earthen diversion berms, sand bag structures or equivalent.

### Sediment Control

**Re-sloping Design: Faro Waste Dumps and Faro Mill Site**

During regrading of the dumps, slopes will get a surface treatment designed to reduce erosion as described in the RLU plan. Some of these include planar slopes to minimize the risk of surface ponding, hummocky surface, which will enhance vegetative species variation and retain the maximum amount of moisture, and rock armoured, which will minimize erosion in steep areas. Each slope will be examined and an appropriate surface treatment chosen based on slope angle, slope length, and future vegetation.

Table 12.2 gives a list of the six zones that were analyzed at the Faro dump site. The west end of the dump site was the focus as waste rock slopes and the original topography at this end are steep and creeks, including mainly the North Fork of Rose Creek (NFRC), are in close proximity to the dump toe. Zones and corresponding representative sections are labeled F-1 through F-6.

**Table 12.2: List of Identified Zones for example Landform Engineering**

| Site | Zone ID | Waste Dump ID | Waste Dump Name | Reference Figure |
|---|---|---|---|---|
| Faro | F-1 | NEU | Upper Northeast Dump | Figure 12.5 Figure 12.6 |
| | F-2 | NEU | Upper Northeast Dump | |
| | F-3 | NEL | Lower Northeast Dump | |
| | F-4 | Z II E | Zone II East | |
| | F-5 | OHRE, ID | Outer Haul Road East, Intermediate Dump | |
| | F-6 | OHRW | Outer Haul Road West | |

*Zone F-1:*

Zone F-1 has a slope angle of 30 degrees (1.75H:1V), a dump height of 88 m, and a crest length of 188 m. Resloping in this zone will be to 3H:1V. Any resloping shallower than 3H:1V will place the toe into the east-west extending creek (Faro Creek diversion).

*Zone F-2:*

Zone F-2 has an existing slope angle of 34 degrees (1.5H:1V), an original dump height of 68 m, and a crest length of 221 m. Resloping in this zone will be to 3H:1V .

*Zone F-3:*

Zone F-3 has an existing slope angle of 33 degrees (1.5H:1V), an original dump height of 75 m, and a crest length of 460 m. Resloping in this zone will be in the range 2.5H:1V to 3H:1V.

*Zone F-4:*

Zone F-4 has an existing slope angle of 36 degrees (1.4H:1V), an original dump height of 52 m, and a crest length of 271 m. A 3H:1V re-sloping is possible in this zone. Any shallower slope will affect the NFRC unless the whole slope is pushed back.

*Zone F-5:*

Zone F-5 has an existing slope angle of 35 degrees (1.4H:1V), an original dump height of 48 m, and a crest length of 400 m. At this zone, re-sloping can be carried out to a maximum of 3.5H:1V. The toe moves right onto the NFRC if a 1V:4H slope is adopted.

*Zone F-6:*

Zone F-6 has an existing slope angle of 35 degrees (1.4H:1V), an original dump height of 40 m, and a crest length of 430 m. At this zone, re-sloping can be carried out to a maximum of 3H: 1V. The toe reaches the NFRC if a 1V:4H slope is maintained.

Figure 12.7 shows the slope treatments and diversion channels planned for the Faro Mine Area. In order to prevent gully formation on the slopes, the maximum slope length has been designed at 55 m. Therefore, if a re-graded slope is longer than 55 m, benches will be constructed to control surface runoff down the slope face. Slope faces of the re-sloped dumps (at 33% slopes) will be divided into catchments of 5 ha or less, in order to facilitate the use of bioengineered channels. This can be achieved by building wavy slope faces as opposed to flat ones.

One of the most common areas of erosion is at the crest of slopes. Therefore surface water would be directed away from crests, where possible. In addition, berms would be constructed along crests (typically 2 m high) to block any excessive water. Top surfaces of the re-sloped dumps should be divided into catchments of less than 100 ha so that bio-engineered channels will be sufficient. Top surfaces can be graded to 2% or 5%. Bioengineered plateau channels will be constructed on the flat areas on the waste rock dumps that direct the majority of the surface water to the Faro Open Pit.

It is expected that in the long-term, these structures will ensure clean surface water. However, diversion berms will be constructed at the toe of the dumps in order to ensure there is no sediment discharge from the site, particularly in the early years before sufficient establishment of vegetation. These will divert runoff to sediment basins which will allow the sediment to settle and the clean water to be discharged.

Once the channels have been constructed the facility will be seeded from a low-flying helicopter. The vegetation will be monitored in the early years to ensure that it is established properly and that adequate coverage was achieved. Once the vegetation has become established it will limit the erosion from the slopes of the dumps.

Straw bales and silt fences will be utilized for short term sediment control prior to and during construction of the diversion berms and sediment basin.

**Diversion Channels**

All large diversions, such as the Faro Creek Diversion Channel will be lined with appropriately sized riprap or constructed in native bedrock. This will prevent the erosion of the channel bed, as well as slow the water flow allowing sediment carried from upstream to be deposited in the channel. A plunge pool will be constructed at the end of each engineered diversion channel to attenuate the flows exiting the site and entering natural streams. The plunge pools will also allow any remaining sediment to drop out. For the Vangorda Creek Diversion, Step Pools with large diameter boulders are included in the design to minimize erosion of the steeper section of the diversion

One exception to this is the low permeability channel for the North Fork of Rose Creek. Instead of begin constructed as an engineered channel, this channel will incorporate natural stream features. It is expected that all water flowing into the North Fork of Rose Creek will be clean, either having come from natural ground or from the sediment basins at the toe of the Faro Waste Dumps. The channel will be lined with rock but it will be placed so as to recreate natural stream features such as

glides, riffles, and pools. These will prevent erosion as well as forming potential habitat for wildlife. This area will also receive the riparian vegetation treatment outlined in the RLU plan.

## 12.5.2 Rose Creek Tailings Area

### Contact Water Control

Water that has contacted the surface of the tailings facility is potentially contaminated. The project execution schedule currently has the construction of the Intermediate Dam raise, the Emergency Spillway and the breach in the Cross Valley Dam concurrently with the placement of the cover on the Intermediate Tailings Impoundment. In the unlikely event that a PMF occurs before the tailings cover is completed, the removal or breach of the Cross Valley Dam will be delayed as long as possible to store as much of the resulting flood water. Water that is currently ponding on the tailings facility will be pumped to Faro Pit prior to the Intermediate Dam raise and the placement of the cover.

### Sediment Control

#### Intermediate Dam

The regraded tailings are expected to have a slope of only about 0.15%. This will lead to very low flow velocity which minimizes the chances of erosion of the tailings cover. One area of concern, though, is the inlet structure immediately downstream of the fuse plug. This area of the tailings surface provides a very narrow flow channel, in the case that the fuse plug overtops during a storm greater than the 1 in 500 year event. In order to prevent erosion in this section the tailings cover will be lined with riprap for a distance of 700m downstream of the fuse plug. This will not only serve to prevent erosion in the area of the inlet structure but also slow flows and allow the water to spread out.

In order to maintain the wide flow "channel width" established by the riprap lined inlet structure, swales will be constructed into the surface of the tailings cover. The swales will ensure that the inflow of water is distributed over the entire surface of the tailings impoundment instead of concentrating in a specific channel, which could lead to erosion of the cover. These swales will be constructed to only handle flows of $10m^3/s$ since their primary purpose is to direct water as opposed to accommodating the high flow volumes.

#### Rose Creek Diversion

The Rose Creek Diversion will be lined with appropriately sized riprap for flows up to the 1 in 500 year storm. This will control the erosion of the channel bed, as well as slow the water flow allowing sediment carried from upstream to be deposited in the channel.

## 12.5.3 Vangorda/Grum Area

### Contact Water Control

Diversion berms will be constructed down-gradient of the excavation activities. These will divert any water falling directly on the exposed materials in the Ore Transfer Pad to temporary sediment control basins. These basins will be constructed to allow the collected water to infiltrate into the waste dumps thus preventing the exit of potentially contaminated water from site. If the water in the basin begins to rise above the freeboard, the water will be pumped to the Grum Pit.

#### Other Locations

In other locations where there is a danger of clean water contacting highly contaminated material similar procedures will be followed. Water upgradient will be diverted away from the area either through the use of earthen diversion berms, sand bag structures or equivalent.

### Sediment Control

#### Grum Dump and Sulphide Cell

During regrading of the facilities, slopes will get a surface treatment designed to reduce erosion as described in the RLU plan. Some of these include planar slopes to minimize the risk of surface ponding, hummocky surface which will enhance vegetative species variation and retain the maximum amount of moisture, and rock armoured, which will minimize erosion in steep areas. Each slope will be examined and an appropriate surface treatment chosen based on slope angle, slope length, and future vegetation.

Table 12.3 gives the three zones were analyzed at Grum dump site for initial landform engineering. The west and southwest edges of the dump site were the focus as there are a number of creeks located close to current waste rock toe locations within this area. Zones and corresponding representative sections are labelled G-1 through G-3.

**Table 12.3: List of Identified Zones for example Landform Engineering**

| Site | Zone ID | Waste Dump ID | Waste Dump Name | Reference Figure |
|---|---|---|---|---|
| Grum | G-1 | G1-B | Grum Dump | Figure 12.8 Figure 12.9 |
| | G-2 | G1-B | Grum Dump | |
| | G-3 | G1-B | Grum Dump | |

*Zone G-1:*

Zone G-1 has an existing slope angle of 27 degrees (2H:1V), an original dump height of 20 m, and a crest length of 567 m. This zone can be re-sloped to 3H:1V, however shallower slope options are not possible unless the slope is pushed back.

*Zone G-2:*

Zone G-2 has an existing slope angle of 32 degrees (1.6H:1V), an original dump height of 38 m, and a crest length of 190 m. This zone can be re-sloped up to 3H:1V.

*Zone G-3:*

Zone G-3 has an existing slope angle of 33 degrees (1V:1.5H), an original dump height of 28 m, and a crest length of 395 m. This zone can be re-sloped up to 3H:1V.

Figure 12.10 shows the slope treatments and diversion channels planned for the Grum Dump Area. In order to prevent gully formation on the slopes, the maximum slope length has been designed at 55 m. Therefore if a re-graded slope is longer than 55 m, benches will be constructed to divert surface water flowing down the slope face. Slope faces of the re-sloped dumps (at 33% slopes) will be divided into catchments of 5 ha or less in order to facilitate the use of bioengineered channels. This can be achieved by building wavy slope faces as opposed to flat ones.

One of the most common areas of erosion is at the crest of slopes. Therefore surface water should be directed away from crests to the extent possible. In addition, berms should be constructed along crests (typically 2 m high) to block any excessive water. Top surfaces of the re-sloped dumps should be divided into catchments of less than 100 ha so that bio-engineered channels will be sufficient. Top surfaces can be graded to 2% or 5%. Bio-engineered plateau channels will be constructed on the flat areas on the waste rock dumps. These channels will direct water to the southwest along the top of the dumps and onto natural ground. The water will eventually discharge to an existing creek in the area.

It is expected that in the long-term these structures will ensure clean surface water. However, diversion berms will be constructed at the toe of the dumps in order to ensure there is no sediment discharge from the site. These will divert runoff to sediment basins which will allow the sediment to settle and the clean water to be discharged.

Once the channels have been constructed the facility will be seeded from a low-flying helicopter. The vegetation will be monitored in the early years to ensure that it is established properly and that adequate coverage was achieved. Once the vegetation has become established it will limit the erosion from the slopes of the dumps.

Straw bales and silt fences will be utilized for short term sediment control prior to and during construction of the diversion berms and sediment basin.

**Vangorda Waste Rock Dump**

During regrade of the facilities, slopes will get a surface treatment designed to reduce erosion as described in the RLU plan. Some of these include planar slopes to minimize the risk of surface ponding, hummocky surface that will enhance vegetative species variation and retain the maximum

amount of moisture, and rock armoured, which will minimize erosion in steep areas. Each slope will be examined and an appropriate surface treatment chosen based on slope angle, slope length, and future vegetation.

Table 12.4 shows the five zones analyzed at Vangorda dump site for example landform engineering. One of the zones, Zone V-1, coincides with the part of the waste dump where re-sloping had already been carried out for trial waste cover work. This part of the dump has an original slope of 1V:3H.

**Table 12.4: List of Identified Zones for example Landform Engineering**

| Site | Zone ID | Waste Dump ID | Waste Dump Name | Reference Figure |
|---|---|---|---|---|
| Vangorda | V-1 | V1-B | Vangorda Main Dump | Figure 12.11<br>Figure 12.12 |
| | V-2 | V1-B | Vangorda Main Dump | |
| | V-3 | V1-B | Vangorda Main Dump | |
| | V-4 | V1-B | Vangorda Main Dump | |
| | V-5 | V1-B | Vangorda Main Dump | |

*Zone V-1:*

Zone V-1 has an existing slope angle of 18 degrees (3H:1V), an original dump height of 48 m, and a crest length of 197 m. No further re-sloping is needed in this area.

*Zone V-2:*

Zone V-2 has an existing slope angle of 20 degrees (2.7H:1V), an original dump height of 60 m, and a crest length of 132 m. Re-sloping as flat as 3H:1V is possible without affecting any of the surrounding creeks.

*Zone V-3:*

Zone V-3 has an existing slope angle of 16 degrees (3.5H:1V), an original dump height of 20 m, and a crest length of 148 m. No re-sloping is needed.

*Zone V-4:*

Zone V-4 has an existing slope angle of 27 degrees (1V:2H), an original dump height of 18 m, and a crest length of 326 m. This zone can be re-sloped up to 3H:1V.

*Zone V-5:*

Zone V-5 has an existing slope angle of 19 degrees (3H:1V), an original dump height of 16 m, and a crest length of 542 m. No re-sloping is needed.

Figure 12.13 shows the slope treatments and diversion channels planned for the Vangorda Dump Area. In order to prevent gully formation on the slopes, the maximum slope length has been designed at 55 m. Therefore if a re-graded slope is longer than 55 m, benches will be constructed to

divert surface water flowing down the slope face. Slope faces of the re-sloped dumps (at 33% slopes) will be divided into catchments of 5 ha or less in order to facilitate the use of bioengineered channels. This can be achieved by building wavy slope faces as opposed to flat ones.

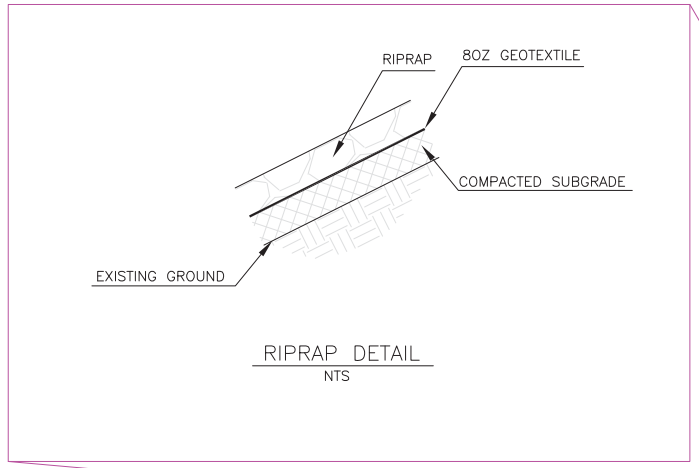
One of the most common areas of erosion is at the crest of slopes. Therefore surface water should be directed away from crests to the extent possible. In addition, berms should be constructed along crests (typically 2 m high) to block any excessive water. Top surfaces of the re-sloped dumps should be divided into catchments of less than 100 ha so that bio-engineered channels will be sufficient. Top surfaces can be graded to 2% or 5%. Bio-engineered plateau channels will be constructed to drain the low slopes at the top of the dump to north east and into the Vangorda Open Pit.

It is expected that in the long-term these structures will ensure clean surface water. There is currently a Seepage Collection Ditch at the toe of the Vangorda Dump which directs seepage to the Little Creek Dam. Under the current closure plan this ditch will be left in place and will serve to direct runoff from the side slopes into the Little Creek Dam or a newly constructed sediment basin.

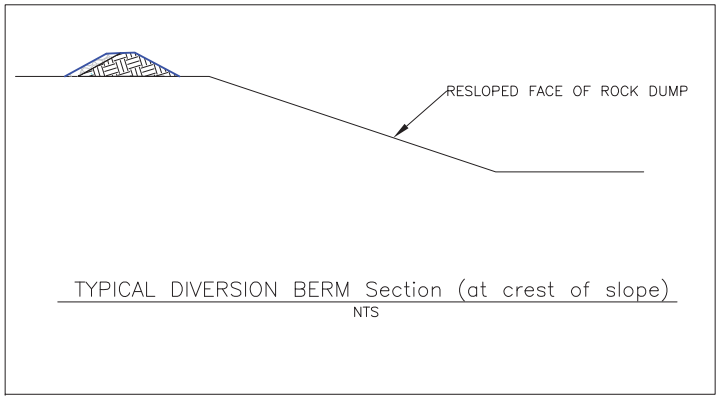
Once the channels have been constructed the facility will be seeded from a low-flying helicopter. The vegetation will be monitored in the early years to ensure that it is established properly and that adequate coverage was achieved. Once the vegetation has become established it will limit the erosion from the slopes of the dumps.

There may be some areas on the southeast side of the facility that require short term storm water control using straw bales or silt fences. The runoff from all other areas is collected in the Seepage Collection Ditch or flows onto disturbed ground and flows to the Little Creek Dam or Vangorda Pit.

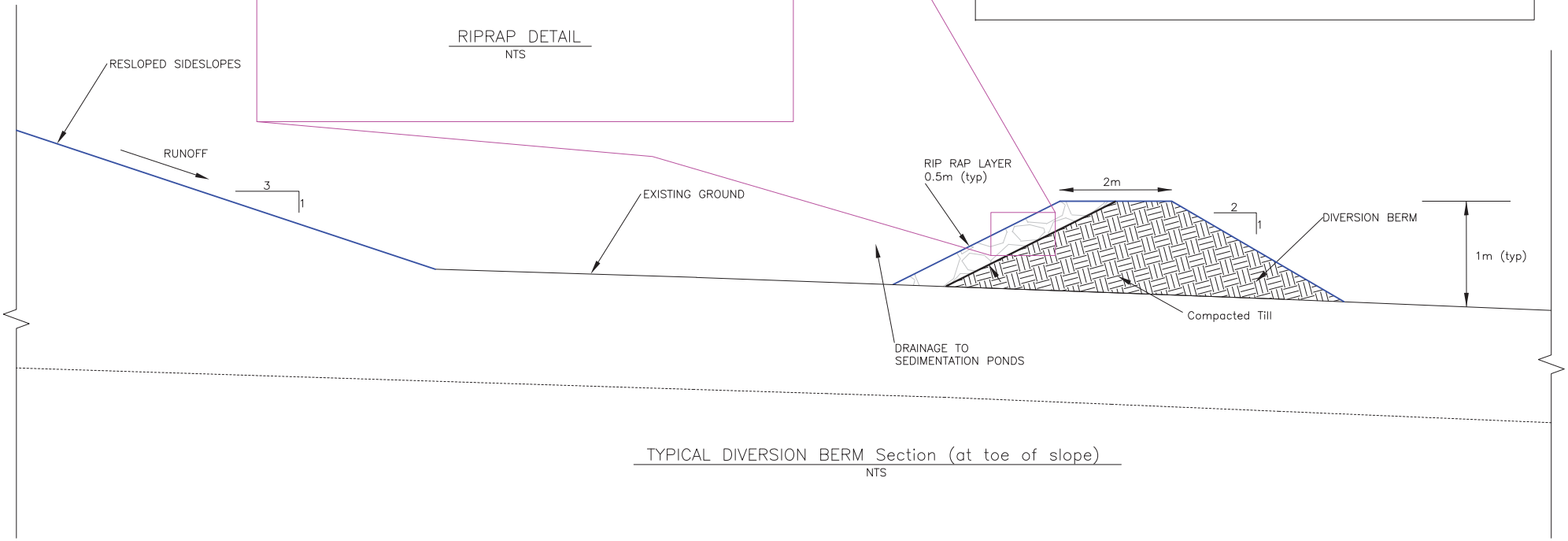
# Figures




RIPRAP DETAIL
NTS



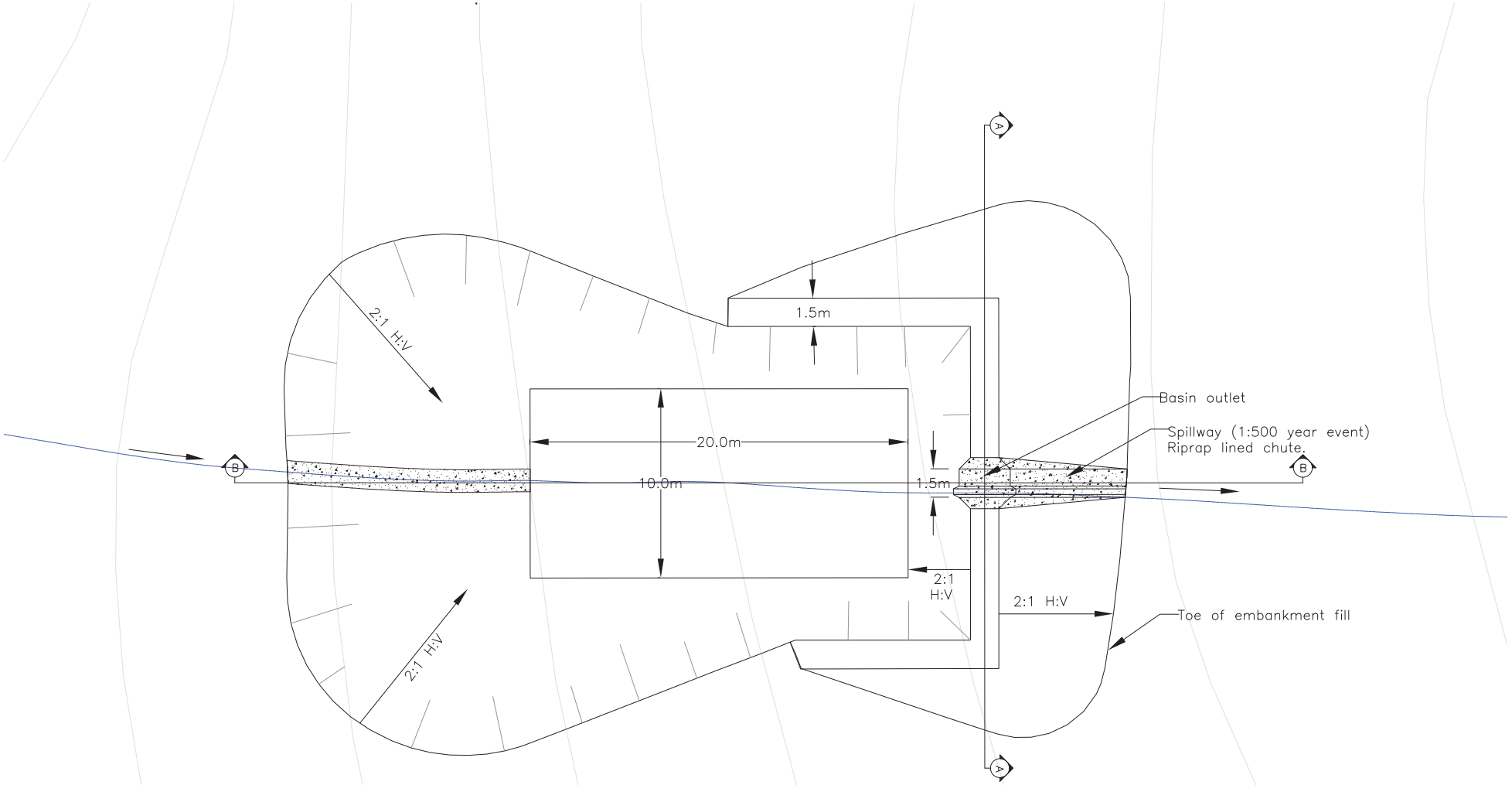

TYPICAL DIVERSION BERM Section (at crest of slope)
NTS




TYPICAL DIVERSION BERM Section (at toe of slope)
NTS

| | | |
|---|---|---|
| SRK Consulting Engineers and Scientists, Vancouver B.C. | Faro Mine Closure / Fermeture de la mine Faro | Project Description (Draft 4) |
| SRK JOB NO.: 1CY001.026 | FARO MINE COMPLEX | Diversion Berm Typical Details |
| FILE NAME: 1CY001_026-29.dwg | FINAL CLOSURE AND REMEDIATION PLAN | DATE: December 2009 / APPROVED: PMH / FIGURE: 12.1 |

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NOTE: Dimensions are not site specific.
For discussion purposes only.

0 2 4 6 8 10 metres
1:200

DATUM ELEV. = NAD 27 UTM
CONTOUR INTERVAL = 2m

SRK Consulting
Engineers and Scientists
Vancouver B.C.

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-30.dwg

Faro Mine Closure
Fermeture de la mine Faro

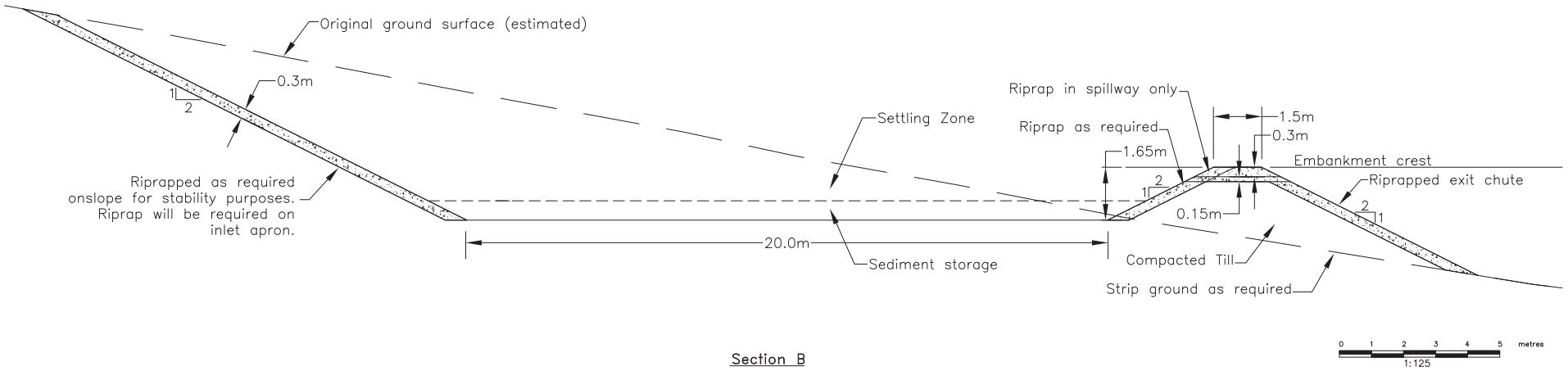
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

Project Description (Draft 4)

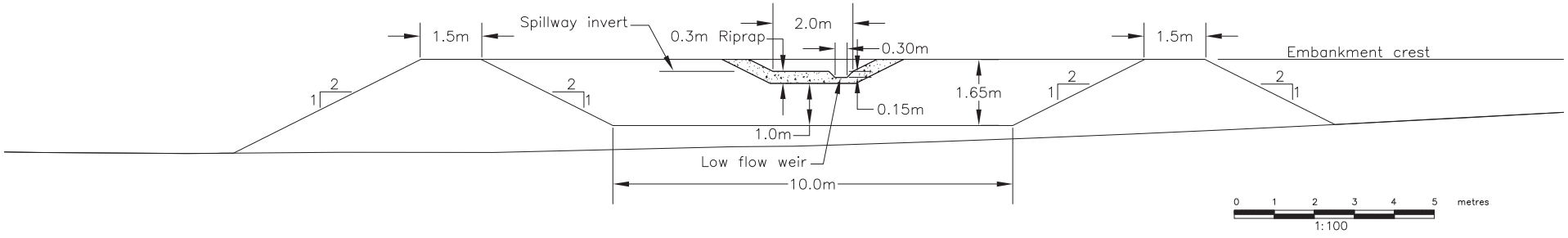
Example Design for Sedimentation Basin. Plan View

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Section B

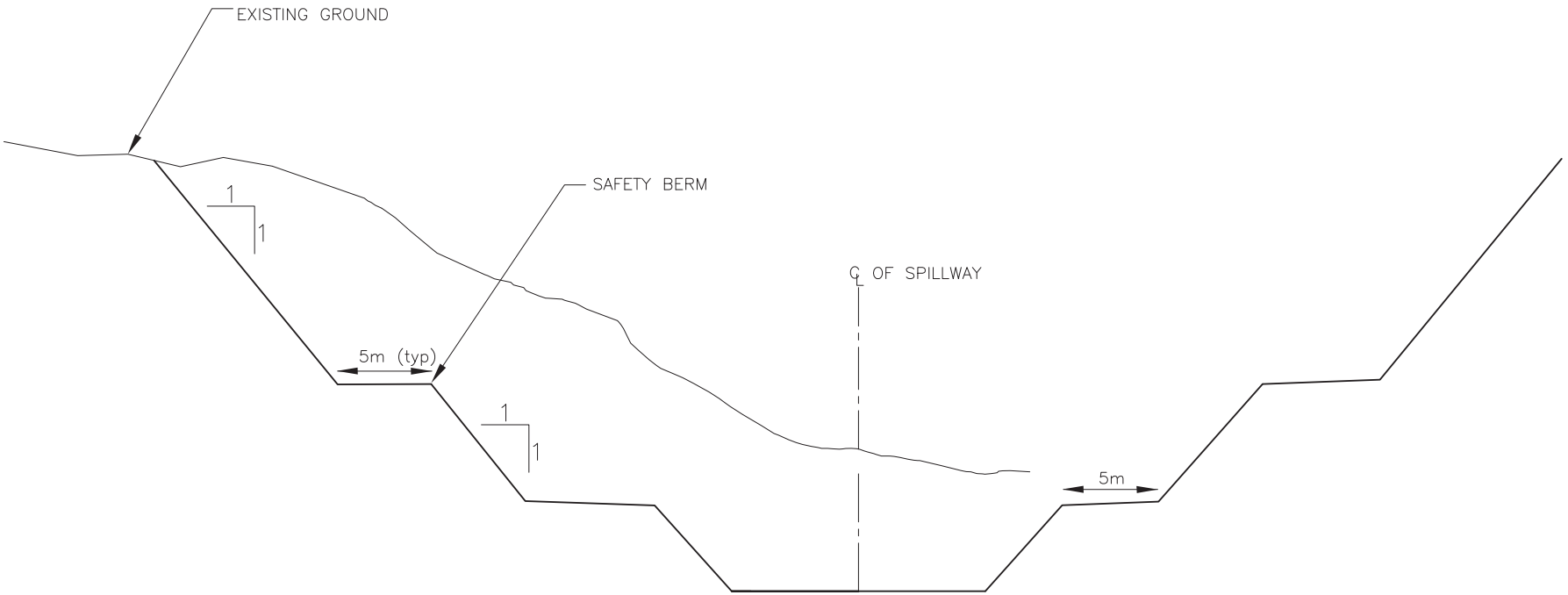



Section A

NOTE: Dimensions are not site specific.
For discussion purposes only.

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| SRK Consulting Engineers and Scientists Vancouver B.C. | Faro Mine Closure Fermeture de la mine Faro | Project Description (Draft 4) |
| SRK JOB NO.: 1CY001.026 | FARO MINE COMPLEX | Sedimentation Basin |
| FILE NAME: 1CY001_026-31.dwg | FINAL CLOSURE AND REMEDIATION PLAN | Typical Sections |
| | DATE: December 2009 / APPROVED: PMH | FIGURE: 12.3 |

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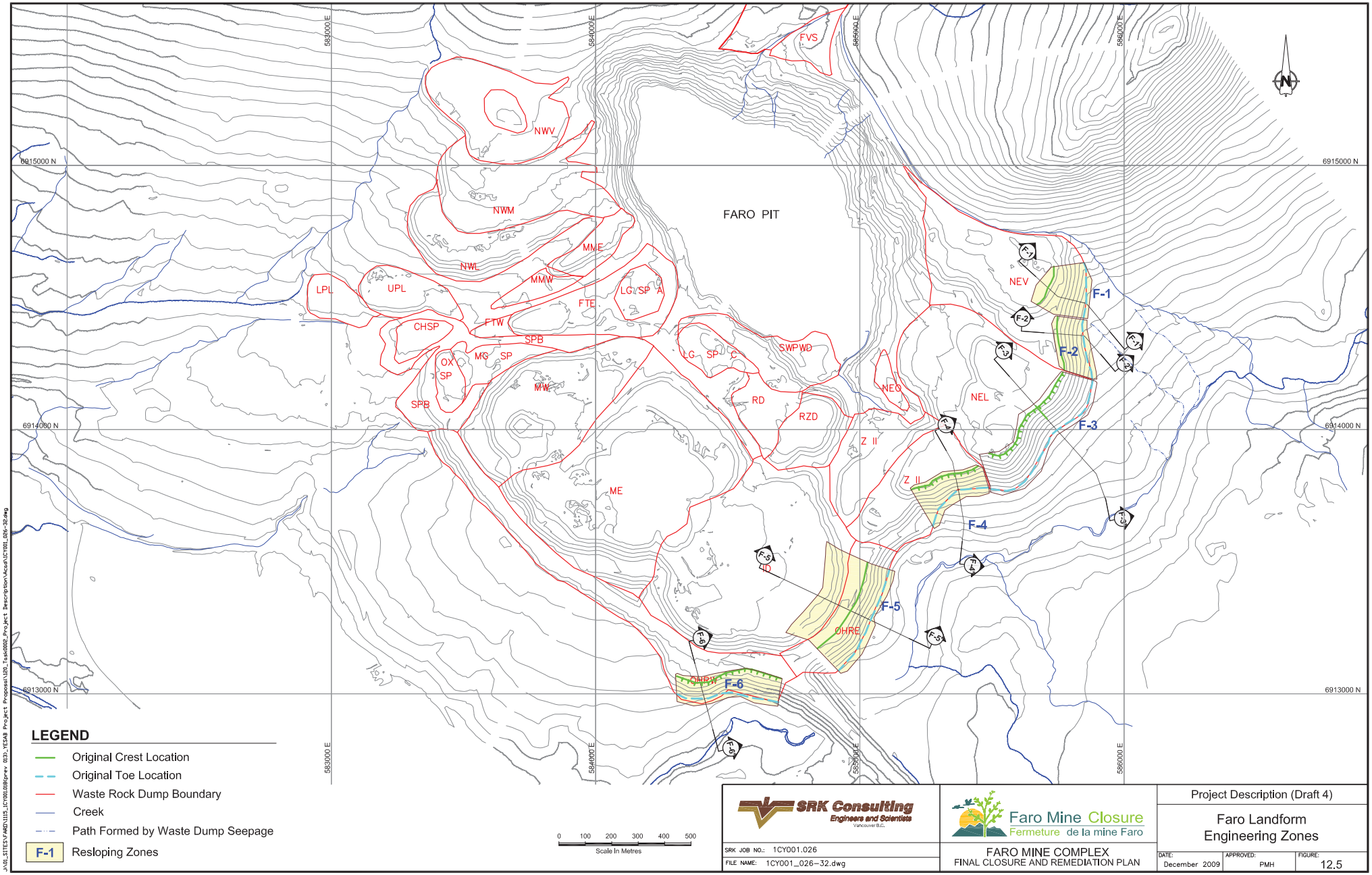



SLOPE BENCH TYPICAL SECTION

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| SRK Consulting Engineers and Scientists, Vancouver B.C. | Faro Mine Closure / Fermeture de la mine Faro | Project Description (Draft 4) |
| SRK JOB NO.: 1CY001.026 | FARO MINE COMPLEX | Slope Bench Typical Section |
| FILE NAME: 1CY001_026-29.dwg | FINAL CLOSURE AND REMEDIATION PLAN | DATE: December 2009 / APPROVED: PMH / FIGURE: 12.4 |

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## LEGEND

- Original Crest Location
- Original Toe Location
- Waste Rock Dump Boundary
- Creek
- Path Formed by Waste Dump Seepage
- F-1 Resloping Zones

SRK Consulting
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Vancouver B.C.

SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-32.dwg

Faro Mine Closure
Fermeture de la mine Faro

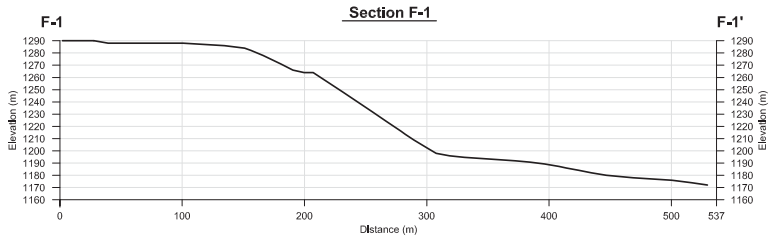
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

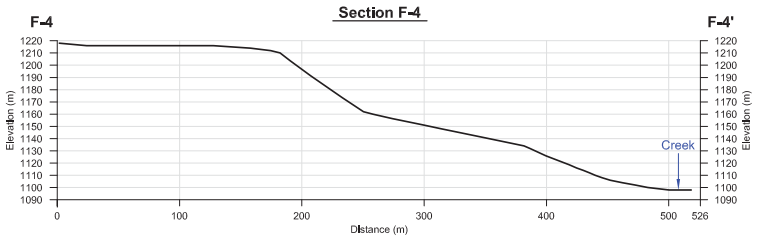
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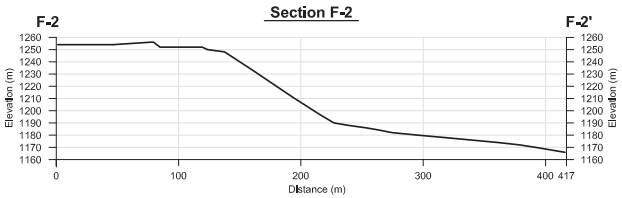
Faro Landform
Engineering Zones

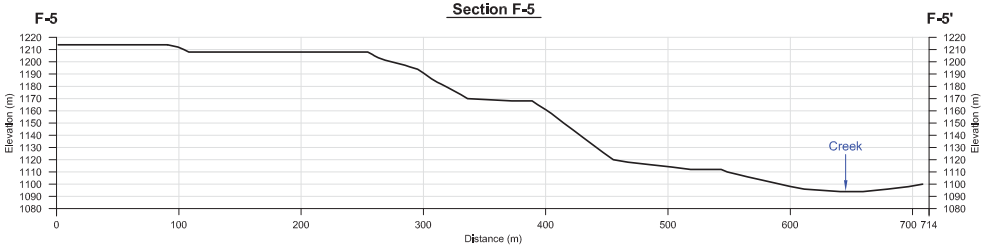
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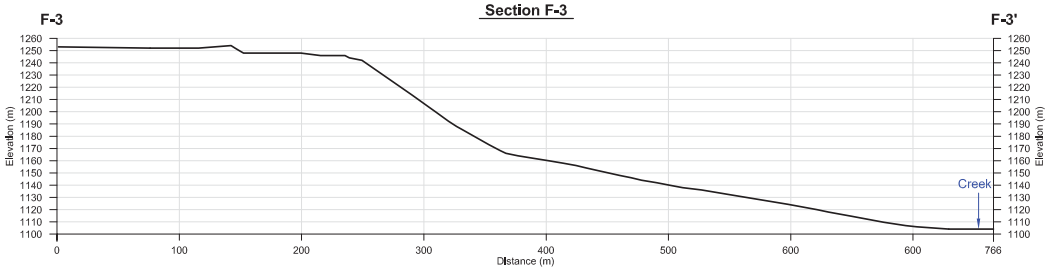
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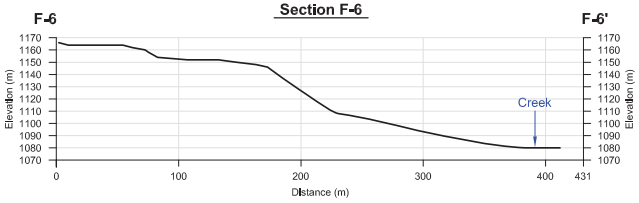



0 30 60 90 120 150

Scale In Metres

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Faro Mine Closure
Fermeture de la mine Faro

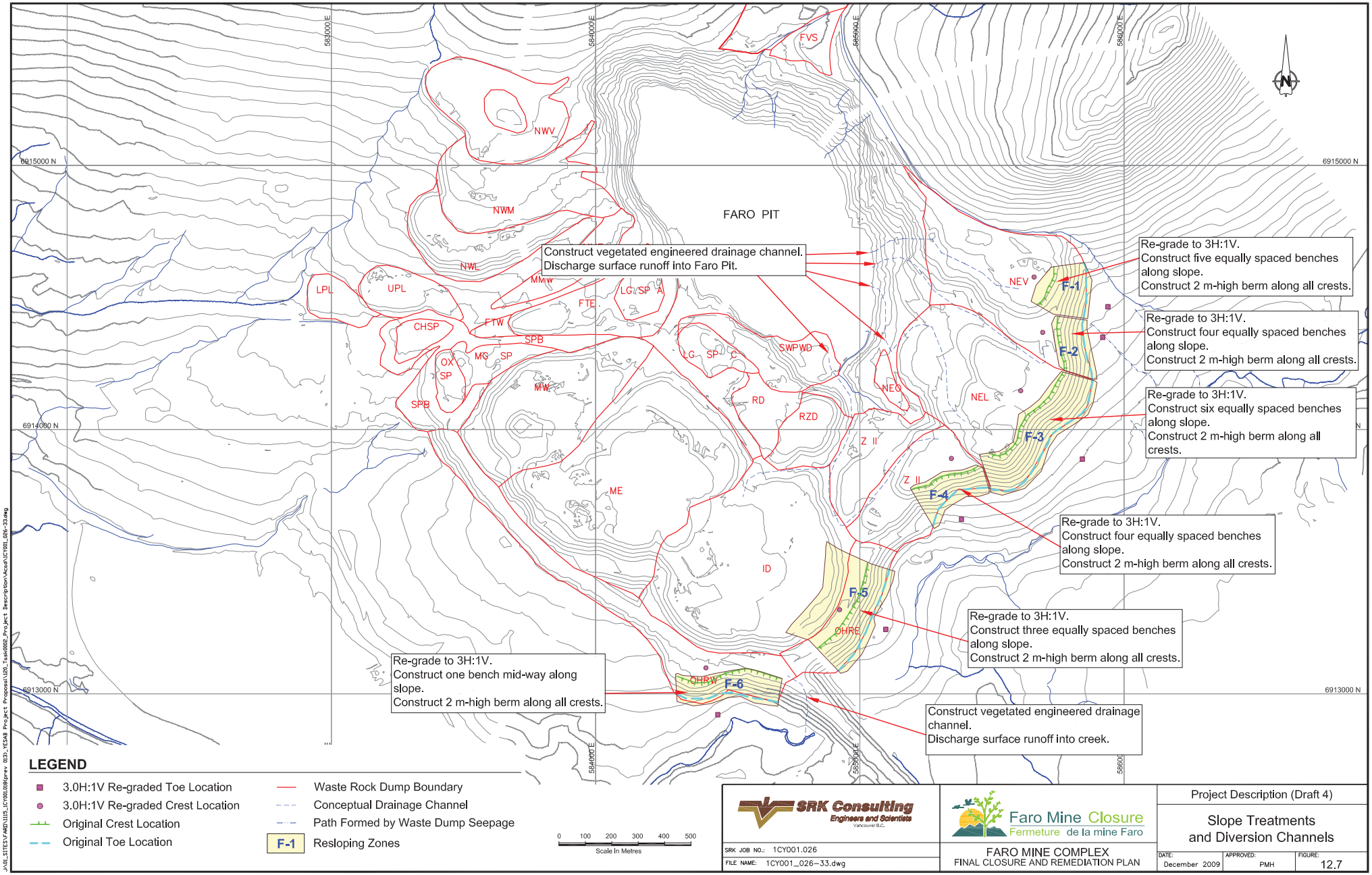
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

Project Description (Draft 4)

Existing Sections of Faro Zones

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## LEGEND

- 3.0H:1V Re-graded Toe Location
- 3.0H:1V Re-graded Crest Location
- Original Crest Location
- Original Toe Location
- Waste Rock Dump Boundary
- Conceptual Drainage Channel
- Path Formed by Waste Dump Seepage
- F-1 Resloping Zones

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Faro Mine Closure
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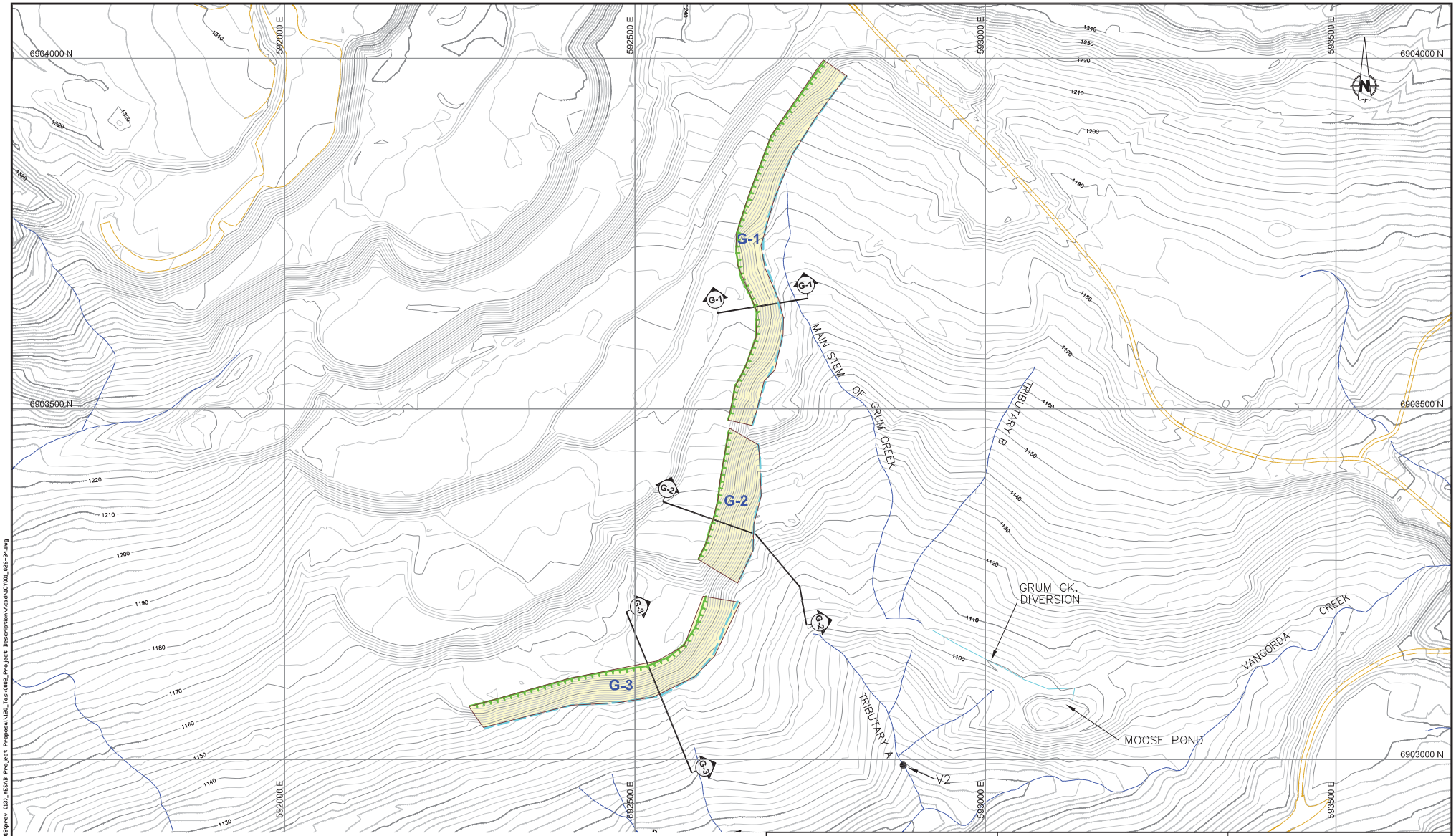
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

Project Description (Draft 4)

# Slope Treatments and Diversion Channels

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FIGURE: 12.7

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**LEGEND**

- Original Crest Location
- Original Toe Location
- G-1 Resloping Zones

0 50 100 150 200 250
Scale in Metres

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FILE NAME: 1CY001_026-34.dwg

Faro Mine Closure
Fermeture de la mine Faro

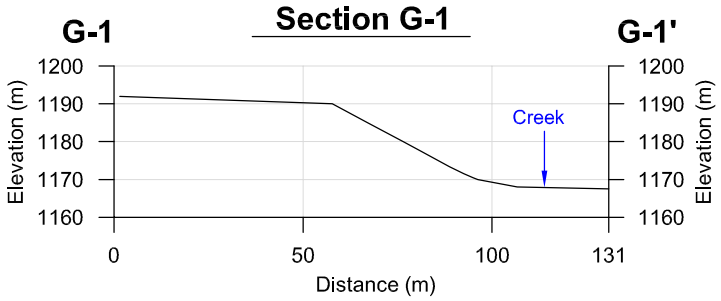
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FINAL CLOSURE AND REMEDIATION PLAN

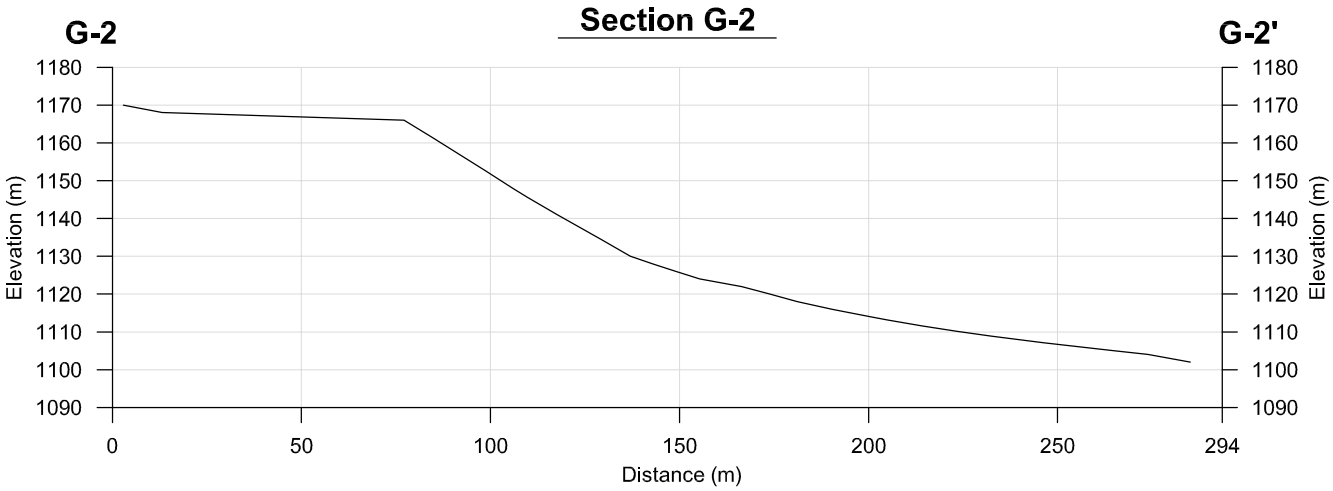
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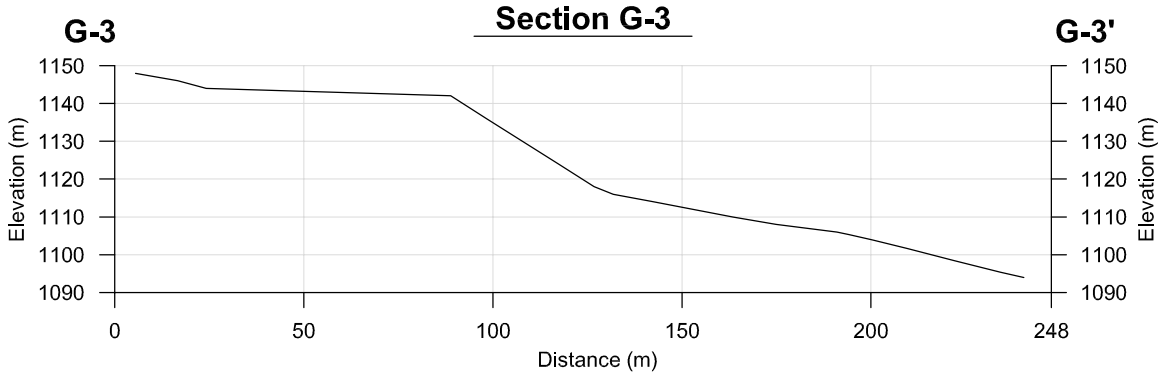
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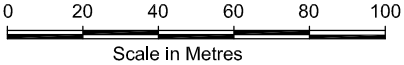
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FILE NAME: 1CY001_026-34.dwg

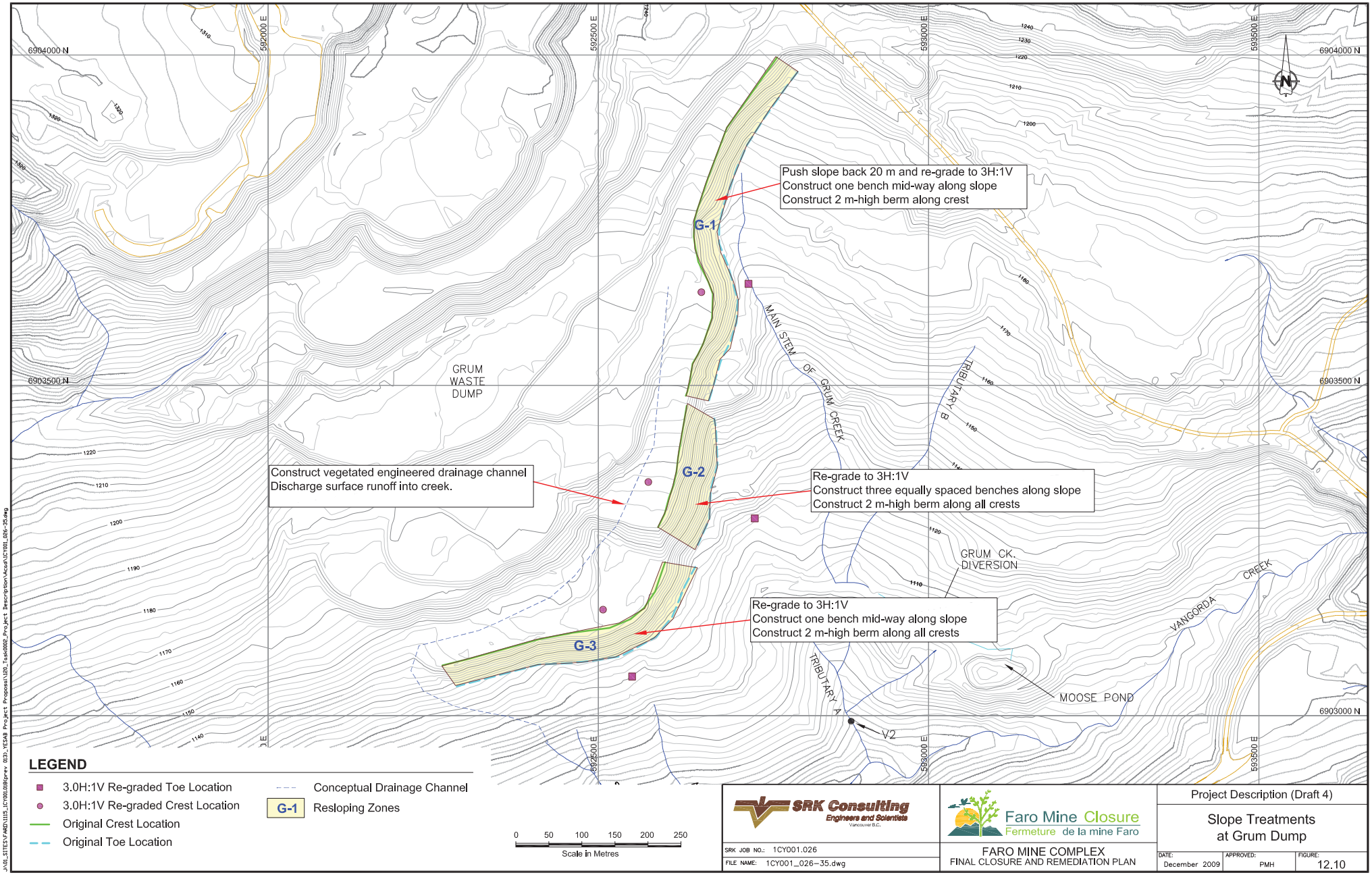
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

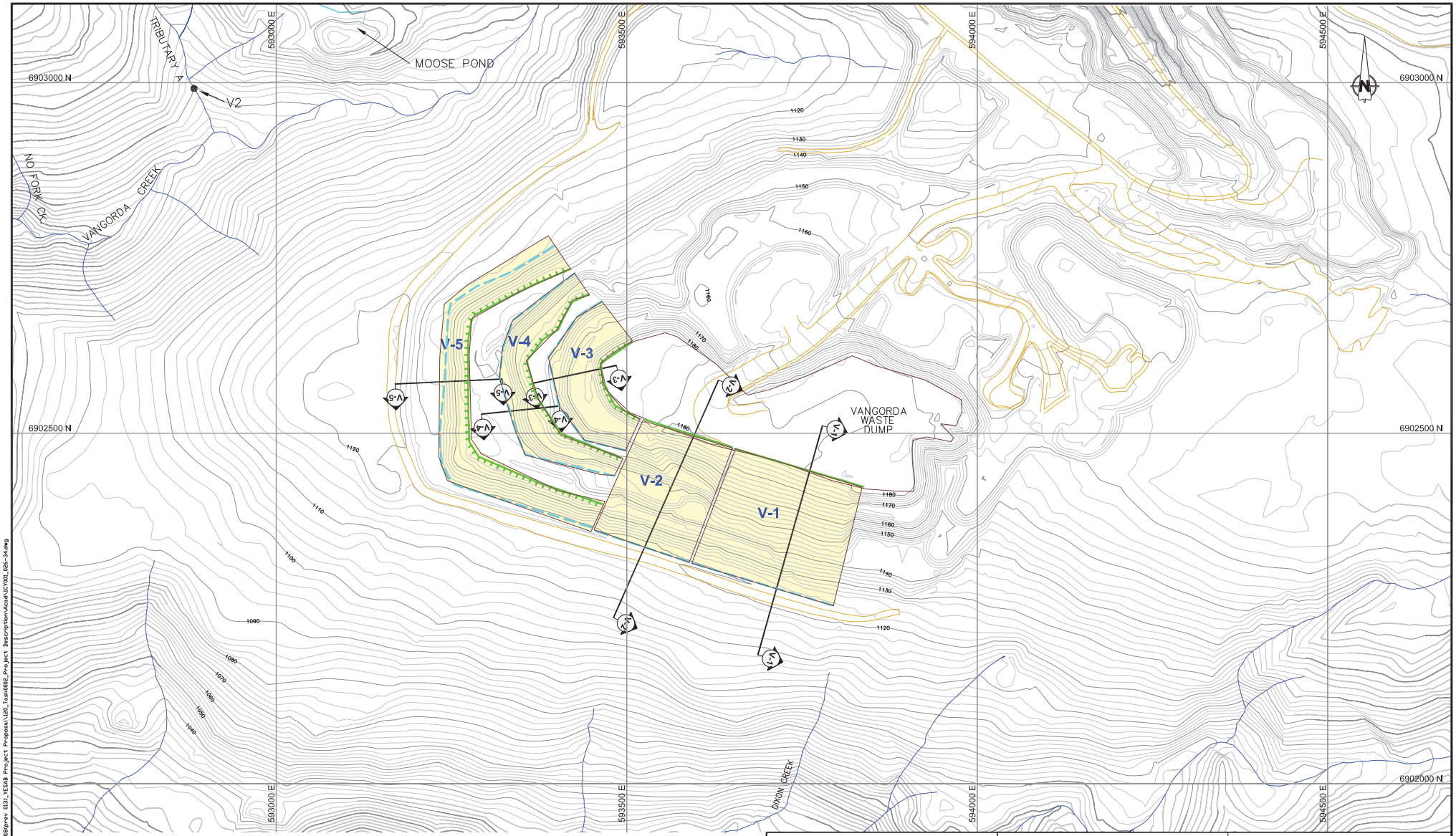
Project Description (Draft 4)

# Existing Sections of Grum Zones

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6904000 N
6903500 N
6903000 N
592000 E
592500 E
593000 E
593500 E
Push slope back 20 m and re-grade to 3H:1V
Construct one bench mid-way along slope
Construct 2 m-high berm along crest
G-1
MAIN STEM OF GRUM CREEK
GRUM WASTE DUMP
TRIBUTARY B
Construct vegetated engineered drainage channel
Discharge surface runoff into creek.
G-2
Re-grade to 3H:1V
Construct three equally spaced benches along slope
Construct 2 m-high berm along all crests
GRUM CK. DIVERSION
Re-grade to 3H:1V
Construct one bench mid-way along slope
Construct 2 m-high berm along all crests
G-3
VANGORDA CREEK
TRIBUTARY A
MOOSE POND
V2
LEGEND
3.0H:1V Re-graded Toe Location
3.0H:1V Re-graded Crest Location
Original Crest Location
Original Toe Location
Conceptual Drainage Channel
G-1 Resloping Zones
0 50 100 150 200 250
Scale in Metres
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SRK JOB NO.: 1CY001.026
FILE NAME: 1CY001_026-35.dwg
Faro Mine Closure
Fermeture de la mine Faro
FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN
Project Description (Draft 4)
Slope Treatments at Grum Dump
DATE: December 2009
APPROVED: PMH
FIGURE: 12.10




**LEGEND**

- Original Crest Location
- Original Toe Location
- V-1 Resloping Zones

0 50 100 150 200 250
Scale in Metres

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FARO MINE COMPLEX
FINAL CLOSURE AND REMEDIATION PLAN

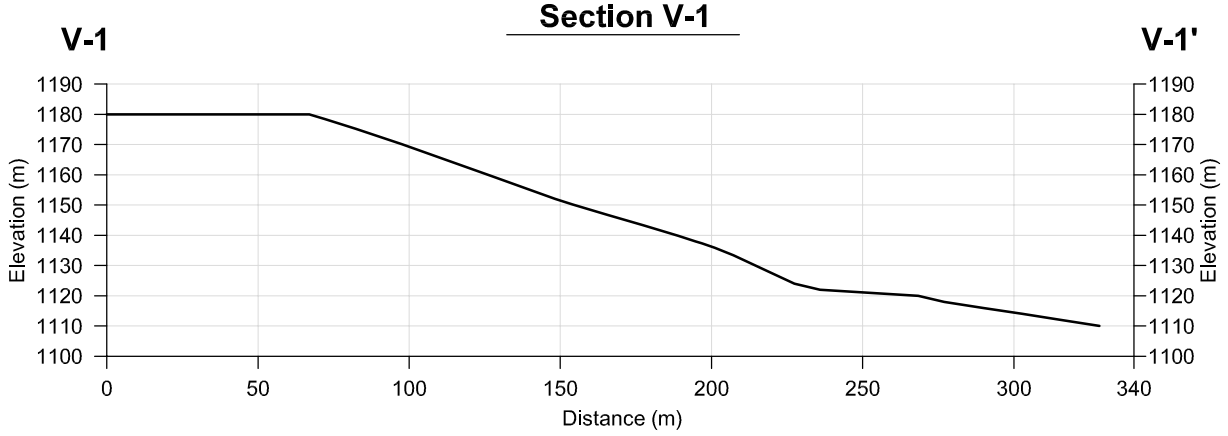
Project Description (Draft 4)

# Vangorda Landform Engineering Zones

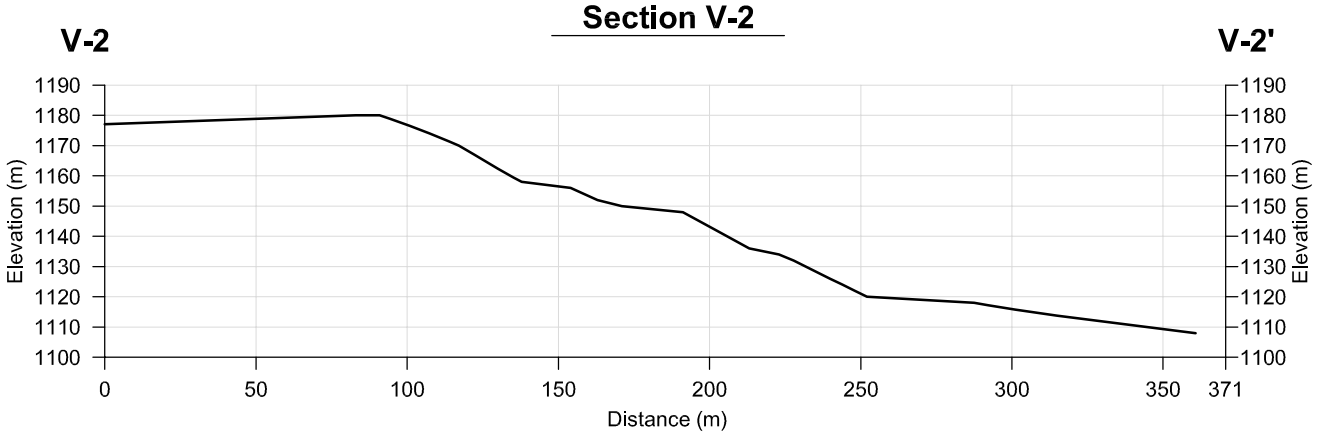
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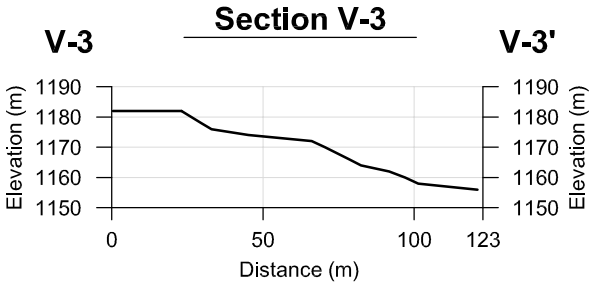
## Section V-1



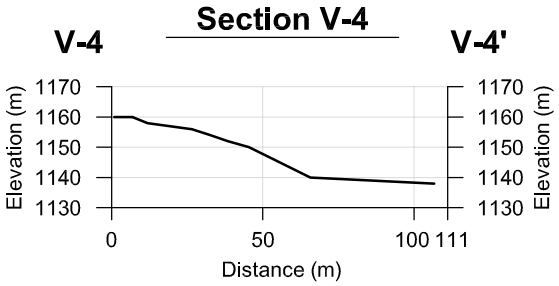

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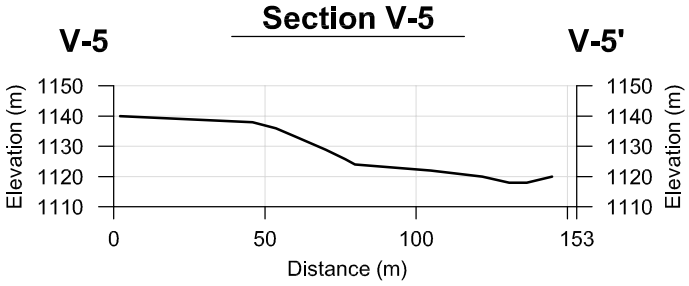

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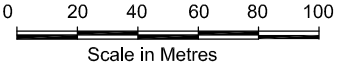



## Section V-4




## Section V-5




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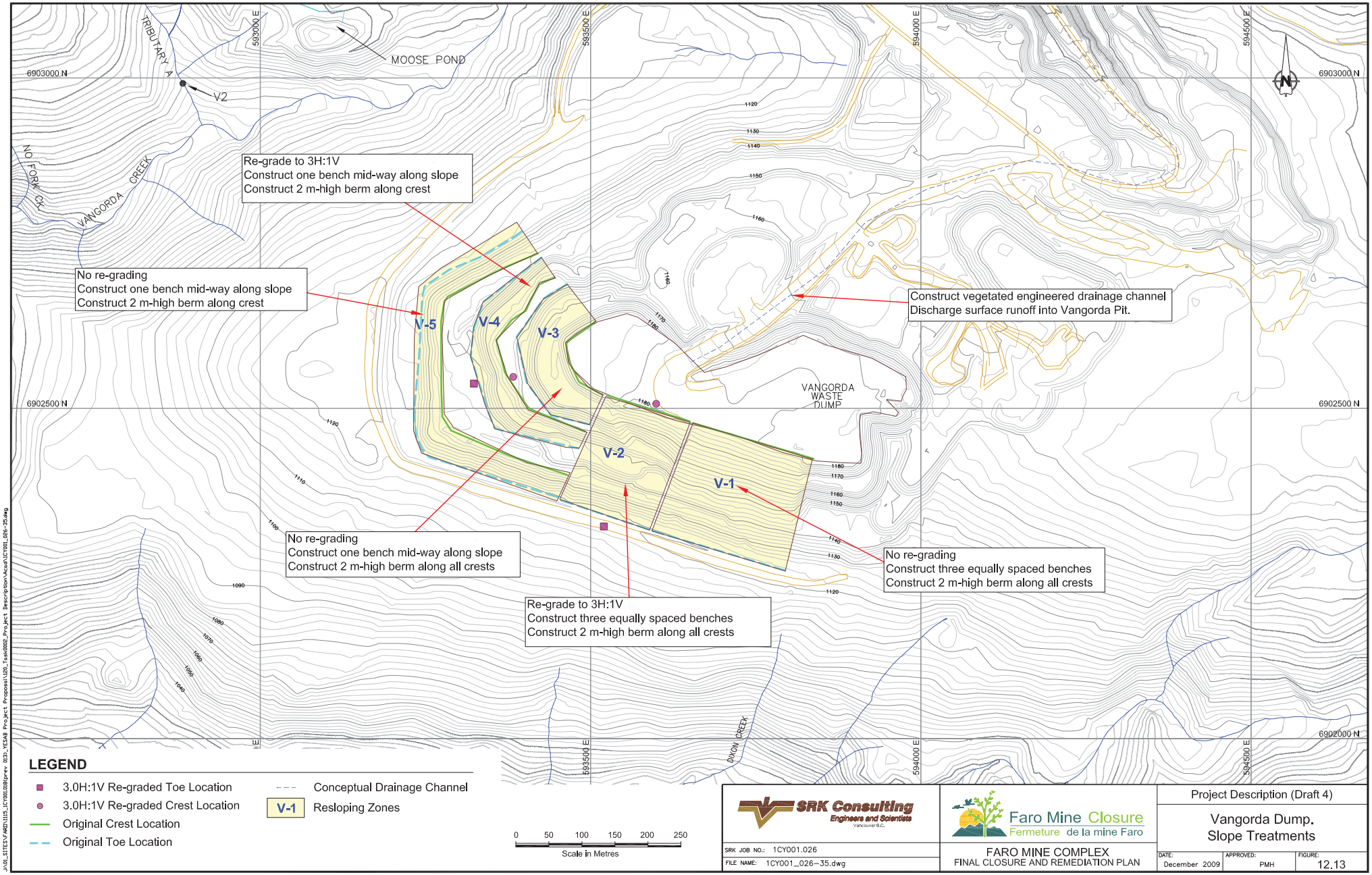
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Project Description (Draft 4)

Existing Sections of Vangorda Zones

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FINAL CLOSURE AND REMEDIATION PLAN

Project Description (Draft 4)

# Vangorda Dump. Slope Treatments

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# 13 Environmental Adaptive Management Plans

## 13.1 Introduction

Due to the complexity of the Faro Mine Complex and the proposed closure measures, there are areas of outstanding uncertainty about timing and locations for implementation of closure measures, and the performance of those measures once they are implemented. The range of uncertainty has been narrowed by extensive investigation, research and design programs that have culminated in a comprehensive understanding of site conditions, future predictions, performance objectives and performance expectations. However, the proposed project continues to rely on numerous assumptions that no amount of investigation and research can completely address. Actual site conditions and facility performance will undoubtedly vary from these assumptions. In some cases these variances could lead to unacceptable effects on the environment unless the project is adjusted to account for the changed site conditions or performance.

Areas of significant remaining uncertainty about site conditions or closure component performance that could lead to unacceptable environmental effects have been identified and a robust adaptive management approach will be used to monitor, detect and respond to changing conditions. The key components of such an approach include: (1) proactive monitoring to detect changing conditions in areas of expected uncertainty within a time frame that allows effective response, (2) clear triggers that will ensure timely implementation of effective responses, and (3) appropriate measures that can be undertaken to address unacceptable conditions or performance.

For the Faro Mine closure project, there are three broad types of uncertainty that will be addressed through the Adaptive Management Plan (AMP). These include uncertainty about:

- When implementation of specific closure measures will be required. For example, collection of groundwater from the Rose Creek Aquifer is not required until water quality in the vicinity of proposed collection has deteriorated. The timing for this collection is not known.
- Where specific closure measures will be required. For example, seepage and groundwater collection systems are currently envisioned for a limited number of areas down-gradient of waste rock. Depending on groundwater pathways and flow rates, other areas could emerge as future sources.
- Performance adequacy of closure measures that have been implemented. For example, vegetation on covers is intended to meet several objectives. The ability of proposed re-vegetation prescriptions to achieve these objectives remains uncertain.

### 13.1.1 Relationship to Best Management Practices

The AMP is not intended to address all areas of variability related to implementation and post-closure activities at the Faro Mine Complex. Instead, it will function within the context of, and in addition to, the application of best management practices for all aspects of the project. The

uncertainties addressed by the AMP are limited to those that relate to the overall performance of the closure project.

Some areas that will likely be addressed by specific management plans and practices include: operations, maintenance and surveillance plans (structures, water treatment, sludge management); operational water management; surface water management; traffic management; wildlife management; dust abatement; emergency and spill response; waste management; environmental monitoring; and fish habitat compensation.

### 13.1.2 Specific Adaptive Management Plan Events

There are six discrete events that comprise the AMP framework for the Faro Mine closure project. Within the specific AMPs, some of these events include multiple phases and stages that guide rational, stepped responses. There are inter-relationships between many of the AMP events. In some cases the events function in series, whereby a subsequent AMP may identify variances that an earlier AMP failed to detect. In other cases, the events function in parallel, whereby two AMPs could detect the same changes in conditions or performance via different monitoring approaches. Because of the inter-relationships, many of the key site or performance uncertainties are addressed by more than one AMP, providing additional confidence in the ability of the AMP to detect changes and bring about appropriate responses.

The following six events are included in the AMP framework:

- Rose Creek Aquifer Adaptive Management Plan. The first phase of this AMP is designed to address uncertainty about the timing for collection of groundwater from the Rose Creek Aquifer and ensure that collection will be initiated before irretrievable migration of contaminants downstream in the aquifer. The second phase is designed to detect inadequate performance of the Rose Creek Aquifer collection system and guide implementation of appropriate responses.
- Contaminated Groundwater/Seepage Adaptive Management Plan. The first phase of this AMP is designed to address uncertainty about locations and timing for collection or treatment of groundwater or seepage down-gradient of mine components (e.g. waste rock, pits, collection ponds) and ensure that collection and/or treatment will be initiated before irretrievable migration of contaminants towards receiving waters. The second phase is designed to detect inadequate performance of the collection or treatment systems and guide implementation of appropriate responses. This AMP will be applied in a variety of areas and application will vary depending on site-specific conditions.
- Receiving Water Quality Adaptive Management Plan. This AMP is designed to detect changes in receiving water quality that may indicate loading from mine related sources, and to ensure implementation of appropriate measures to understand and address sources. The receiving water conditions will provide a secondary check to confirm that Rose Creek Aquifer and Contaminated Groundwater/Seepage AMPs are functioning as planned, and that other contaminant sources are not emerging in areas that are not the subject of specific AMP programs.

- Receiving Water Flow Adaptive Management Plan. This AMP is designed to detect changes in Rose Creek flows as a result of groundwater collection activities, understand effects of any changes on fish and fish habitat, and identify appropriate responses for addressing changes in flows.
- Receiving Water Temperature Adaptive Management Plan. This AMP is designed to detect changes in Rose Creek water winter water temperatures as a result of groundwater collection activities, understand effects of any changes on fish and fish habitat, and identify appropriate responses for addressing changes in temperatures.
- Water Treatment Source Water Quality/Quantity Adaptive Management Plan. This AMP has two components. One component is designed to detect trends in influent water quality or quantity for water treatment systems and ensure that the treatment systems can address the changes, including potential changes in contaminants requiring treatment. The second component is designed to proactively identify future sources that may require treatment and ensure that treatment capacity will be in place to address these sources as required.
- Cover Vegetation Success/Performance Adaptive Management Plan. This AMP is designed to detect inadequate performance of vegetative covers (e.g. plant density, species diversity, invasive species, metal uptake) which form a critical component of cover systems that will be used extensively in the closure project. If inadequate performance is detected, the AMP will guide implementation of mitigation measures so that cover objectives can be achieved.
- Sludge Management Adaptive Management Plan. A sludge management plan will guide operational sludge management issues and approaches. However, the overall performance of the closure project could be affected by significant changes in sludge quantities or sludge properties that cause substantial impacts on pit water quality. This AMP is designed to detect and address changes that could lead to major changes in sludge management approaches.

### 13.1.3 Common Elements of Adaptive Management Plans

Consistency within the AMP framework is provided by several common elements that are included in each specific AMP. These common elements provide the structure that is necessary to ensure that the AMPs will be proactive in detecting changes and implementing responses before unacceptable environmental effects occur. The following common elements form part of each specific AMP.

- Event. This element describes the specific event that is addressed by the AMP.
- Possible Environmental Consequences. This element describes the environmental consequences that could arise if the event were allowed to proceed without appropriate responses.
- Narrative Response Trigger. This is a narrative description of the trigger for the AMP event and leads to the development of the specific indicators and thresholds. In general narrative response triggers state that monitoring indicates a specific type of unacceptable performance is occurring.
- Specific Indicators. This element describes the environmental parameters to be monitored and assessed as part of the AMP. The indicators will be selected to provide early detection of

relevant changes in environmental conditions or system performance. They should be representative of the issue being monitored and assessed, easily measured and reproducible.

- Specific Thresholds. This element defines the conditions for specific indicators that would lead to actions being taken. There may be a series of staged thresholds or multiple thresholds for an individual event.
- Monitoring Requirements. This element describes the monitoring that will be carried out to support implementation of the AMP. Parameters, locations, frequencies for sampling will be identified. Physical inspections and visual monitoring can also form part of monitoring requirements. Monitoring requirements may change at various stages of an AMP.
- Evaluation of Monitoring Results. This element describes the methods that will be used to evaluate the monitoring data and determine whether any specific thresholds have been reached or exceeded.
- Approach to Development of Response/Mitigation/Intervention. This element describes the overall approach to responses to be implemented if any thresholds have been reached or exceeded. In most cases, the responses will include a range of actions that may be taken to address the events. The selection of appropriate responses would depend on the conditions of changed site conditions or system performance.

Most of the AMPs apply a staged approach to detecting, interpreting and responding to changes in site conditions and performance. As a result, some of the common elements are revised and refined through these stages. Responses to an initial stage of the AMP often include requirements to conduct additional study and identify appropriate indicators and thresholds for subsequent stages. This staged approach provides confidence that changes in site conditions or performance will be addressed in a timely manner while recognizing the need for flexibility to address site-specific circumstances when we begin to see changes. The staged AMPs provide a series of action levels (from the monitoring program) that identify, with certainty, the first series of actions that should be taken and when they should be taken. These actions generally begin at low thresholds with additional monitoring requirements, and progress through a series of investigative and responsive actions until the problem is addressed.

Within the context of implementing the AMPs, there will be an ongoing need to understand the validity of monitoring results and confirm the circumstances of threshold or trigger activation. This validation and confirmation process will need to be conducted in a timely manner but is a necessary component to ensure that response actions are applied in appropriate circumstances.

For all stages of an AMP, if monitoring identifies conditions that are approaching or meeting triggers or thresholds, a stepped response will be implemented for validation and confirmation. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to validation and confirmation will be such that it expedites the process of responding to the trigger activation.

The first response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results or field observations and may require re-sampling (i.e. QA/QC data or field notes indicates sampling issues/errors).

The second step in the response will be a comprehensive analysis of the other related monitoring results including all of the monitoring data collected for this AMP and for other relevant monitoring results, possibly including results collected for other associated AMP events. The goal of this analysis will be to provide for a preliminary identification of the cause of the trigger activation.

The third step will be an analysis of the timing and potential consequences of trigger activation on the receiving environment. The results of this analysis will be used as a basis for the development of an appropriate response plan to prevent or mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program.

The fourth step may be to increase monitoring intensity (locations, parameters, frequencies) to verify and/or understand the cause/source of the trigger activation.

## 13.2 Rose Creek Aquifer Adaptive Management Plan

### Event

Degradation of Rose Creek Aquifer Water Quality.

The AMP for monitoring and addressing degrading water quality in the Rose Creek Aquifer has two phases. Phase 1 addresses uncertainty about the timing for constructing a groundwater collection system and initiating collection of aquifer water for treatment while Phase 2 addresses the uncertainty about the performance of the groundwater collection system once it is operating.

The Rose Creek Aquifer AMP is illustrated in Figure 13.1.

### Possible Environmental Consequences

Failure to respond appropriately to degradation of water quality in the Rose Creek Aquifer would eventually lead to degradation of downstream receiving environment (Rose Creek). If this were to occur, the overall objective of protecting the aquatic environment would not be met.

### 13.2.1 Phase 1 Rose Creek Aquifer AMP

#### Event

Degradation of Rose Creek Aquifer Water Quality at Intermediate Dam.

This AMP Event consists of three stages. Stage 1 will focus on identifying migration of contaminants of concern into the aquifer beneath the tailings. Stage 2 is intended to proactively identify appropriate timing for initiating design and construction of a groundwater collection system at the Intermediate Dam. Stage 3 will identify timing for collection system start-up.

### Phase 1 Narrative Response Triggers

Stage 1 – Monitoring of acid and zinc fronts in tailings and underlying soils indicate zinc front has arrived at the tailings/aquifer interface. Monitoring locations in this stage will be selected to show early arrival/advanced fronts. This would include areas with little or no organic soils remaining at the tailings/aquifer interface.

Stage 2 – Monitoring and investigations completed in response to Stage 1 triggers indicate that the zinc front is within 5 years of requiring collection at the Intermediate Dam.

Stage 3 – Zinc concentrations at the Intermediate Dam collection system reach thresholds for collection and treatment.

### Phase 1 Specific Indicators

Stage 1 – Acidity and dissolved zinc concentrations in and below the tailings in areas with little or no organic soils where acid, zinc fronts are most likely to be further advanced.

Stage 2 – Dissolved zinc concentrations in the aquifer upstream of the collection system, in locations intended to provide at least 5 years advance notice.

Stage 3 – Dissolved zinc concentrations in the aquifer at the collection system location.

### Phase 1 Specific Thresholds

The specific thresholds or triggers for the Rose Creek Aquifer AMP, Phase 1 that will initiate an action for any of the specific indicators, will be as follows:

Stage 1 – A statistically significant increasing trend in acidity or dissolved zinc concentrations at the base of the tailings and immediately below the base of the tailings in the aquifer, at selected multi-point monitoring wells.

Stage 2 – A statistically significant increasing trend in dissolved zinc concentrations in the aquifer, at target locations upstream of the Intermediate Dam.

Stage 3 – Dissolved zinc concentrations in the aquifer at the Intermediate Dam collection system location reach a pre-determined threshold value based on the results of the environmental assessment and proposed effluent discharge limits.

### Phase 1 Monitoring Requirements

Stage 1 – Acidity and dissolved zinc concentrations in multi-level wells that include sample points in the tailings, near the tailings/aquifer interface, and below in the aquifer. The specific locations of these wells will be chosen to include areas with known little or no organic soils as well as to cover the spatial and temporal variability in the movement of the fronts (i.e. coarse and fine tailings, timing of placement, and proximity to collection system). Frequency of monitoring will be determined

based on the site-specific characteristics of the sample locations and will range from annual to quarterly.

Stage 2 – Dissolved zinc concentrations in wells that include sample points in the aquifer. The specific location of these wells will be chosen with the intent of providing 5 years notice before collection is required at the Intermediate Dam. Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and will range from annual to quarterly.

Stage 3 – Dissolved zinc concentrations in wells located at the collection system location. Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and will be at least quarterly.

### Phase 1 Evaluation of Monitoring Results

For Stages 1 and 2, a preliminary review of the relevant data will be carried out within one month of receipt of each laboratory analysis report to identify immediate timing concerns and data issues. A more comprehensive review will be carried out annually including detailed data and trend evaluation.

For Stage 3, monitoring data will be compared to thresholds upon receipt of each laboratory analysis report.

### Phase 1 Approach to Development of Response/Mitigation/Intervention

Verification and confirmation of site or performance conditions will be conducted as described in Section 13.1.3. This will be followed or accompanied by responses described below.

Stage 1 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 1 trigger will include:

- Development and implementation of a program to monitor and investigate aquifer conditions. This may include water quality, groundwater levels, permeabilities, flow rates, as appropriate.
- Analyze information from monitoring and investigation programs to develop a comprehensive understanding of zinc front travel rates in the aquifer.
- Establish specific monitoring locations, parameters and thresholds for Stage 2, where these components will be intended, in combination, to provide at least five years notice before groundwater collection would be required at the Intermediate Dam collection system.

Stage 2 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 2 trigger will include:

- Re-evaluate monitoring frequency at the Stage 3 trigger locations and adjust if necessary.
- Design of the appropriate collection system will be initiated. This will include all aspects of design, planning and construction of the collection system to ensure that the facility is in place

before reaching a Stage 3 threshold. The initial system will be designed based on aquifer conditions at the time (quantity, quality and spatial variability) and a typical system could include:

- Interception trench, pumping wells and cut-off wall;
- North side collection only;
- Wells only; and
- Combination of above.

- Phase 2 of the AMP will be refined including identification of specific monitoring requirements and thresholds.

Stage 3 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 3 trigger will be to initiate collection of aquifer water and implement Phase 2 of Rose Creek Aquifer Adaptive Management Plan including finalization of monitoring requirements and specific thresholds.

### 13.2.2 Phase 2 Rose Creek Aquifer AMP

#### Event

Degradation of Rose Creek Aquifer Water Quality downstream of Intermediate Dam Collection System.

Phase 2 of the Rose Creek Aquifer AMP is intended to identify contaminated water bypassing the aquifer collection system and respond appropriately.

#### Phase 2 Narrative Response Triggers

Monitoring of hydraulic gradients, seepage presence or down-gradient water quality indicates that contaminants may be bypassing the Intermediate Dam collection system. Monitoring locations for water quality will be selected to provide timely information about system performance.

#### Phase 2 Specific Indicators

Sulphate and dissolved zinc concentrations in groundwater and seepage downstream or adjacent to the collection system.

Groundwater levels sufficient to understand gradients in the vicinity of the collection system.

#### Phase 2 Specific Thresholds

The specific thresholds or triggers for the Rose Creek Aquifer AMP, Phase 2 that will initiate an action for any of the specific indicators, will be as follows:

- A statistically significant decreasing trend of sulphate is not observed in near surface wells or seepage downstream of the collection system.

- A statistically significant increasing trend of dissolved zinc is observed in monitoring locations downstream of or adjacent to the collection system.
- Continued observation of contaminated seepage or groundwater at periphery or down-gradient of the system.
- Water levels that indicate failure of hydraulic containment during operation.

### Phase 2 Monitoring Requirements

Sulphate concentrations in near surface wells both upstream and downstream of the collection system and in seepage water downstream of the collection system. The specific locations will be chosen to include locations where contaminated water is most likely to bypass the system (i.e. peripheral areas). Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and types. Because the collection system will substantially cut off any supply of fresh water, the sulphate concentrations down-gradient of the collection system are expected to respond slowly and infrequent sampling (possibly annually) may be sufficient.

Dissolved zinc concentrations in wells and/or seepage downstream of the collection system. The specific locations will be chosen to include locations where contaminated water is most likely to bypass the system (i.e. bedrock and peripheral areas). Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and types.

Visual inspection for presence of seepage downstream of collection facility. Frequency of monitoring will be determined based on the site-specific characteristics and responsiveness of the system. Once the system has stabilized, monitoring will likely range from monthly to quarterly. Observation of new seepage locations would be immediately followed up with sampling for water quality.

Water levels in groundwater wells and collection facilities. Specific monitoring locations and frequencies will be determined based on the site-specific characteristics and responsiveness of the system. Adequate locations will be selected to develop an understanding about hydraulic containment during collection system operation. Frequency of monitoring once the system has stabilized will likely range from monthly to quarterly.

For all monitoring, more intensive sampling or observations will be conducted following system start-up or modification. This will include increased frequencies for all types of monitoring and may also include additional monitoring locations (e.g. in nearby receiving water).

### Phase 2 Evaluation of Monitoring Results

A review of the relevant data will be carried out following receipt of each laboratory analysis report and/or field inspection and data report to identify immediate performance concerns and data issues. The frequency of review will be more intensive following system start up or modification. A more

comprehensive review will be carried out annually including detailed data and trend evaluation as well as interpretation of water level information.

Phase 2 Approach to Development of Response/Mitigation/ Intervention

Verification and confirmation of site or performance conditions will be conducted as described in Section 13.1.3. This will be followed or accompanied by responses described below.

Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Phase 2 trigger may include:

- Development and implementation of a program for continued monitoring, analysis and reporting about implications of bypass conditions.
- Initiation of design for appropriate collection system modifications. This will include all aspects of design, planning and modification of the collection system, including timing. The modifications will be designed to address system inadequacies and could include:
  - Completion of initial system;
  - Grouting of bedrock;
  - Additional wells;
  - Second cut-off wall;
  - Upstream cut-off wall;
  - Increase downstream head;
  - Reduce clean water inflows; and
  - Pump and recirculation.

## 13.3 Contaminated Groundwater/Seepage Adaptive Management Plan

Event

Degradation of groundwater or seepage quality downstream of mine components, with potential for contamination of the aquatic receiving environment.

The AMP for monitoring and addressing degrading water quality downstream of mine components has two phases. Phase 1 addresses uncertainty about where groundwater or seepage collection or treatment systems may be required and the timing of construction for such systems. Phase 2 addresses uncertainty about the performance of groundwater or seepage collection systems once they are operating. Phase 2 includes fundamentally different approaches depending on whether bypass could be captured by redundant systems (e.g. the Rose Creek Aquifer collection system). In some instances, the appropriate Phase 2 approach will change after completion of closure measures. For example, collection systems along the North Fork of Rose Creek currently have no redundant collection system, but will have after completion of a lined channel for the Creek. On the other hand, surface bypass from the Emergency Tailings Area collection system is currently captured for treatment in the Intermediate Pond, a mechanism that will be ineffective for surface bypass after tailings reclamation.

The Contaminated Groundwater/Seepage Adaptive Management Plan is illustrated in Figure 13.2.

#### Possible Environmental Consequences

Failure to response appropriately to degradation of groundwater or seepage quality down-gradient of mine components could lead to degradation of downstream receiving environment (Rose Creek, Vangorda Creek). If this were to occur, the overall objective of protecting the aquatic environment would not be met.

### 13.3.1 Phase 1 Contaminated Groundwater/Seepage AMP

#### Event

Degradation of groundwater quality downstream of mine site components (e.g. waste rock dumps, collection ponds, and pits) to the extent requiring collection and/or treatment.

This AMP Event consists of three stages. Stage 1 is intended to identify early indicators of ARD products migrating towards aquatic receptors. Stage 2 is intended to guide the proactive establishment of collection and/or treatment facilities. Stage 3 will identify timing for start-up of collection and/or treatment systems.

#### Phase 1 Narrative Response Triggers

Stage 1 – Monitoring of sulphate concentrations in groundwater and/or seepage down-gradient of mine components indicates that ARD products are advancing towards receiving environments. Monitoring locations in this stage will be selected for early detection of ARD indicator fronts for specific mine components.

Stage 2 – Monitoring and investigations completed in response to Stage 1 triggers indicate that the front of ARD products is within 2 years of requiring collection or treatment.

Stage 3 – Zinc concentrations at collection/treatment location reach thresholds established in Stages 1 and 2 for the initiation of collection and/or treatment.

#### Phase 1 Specific Indicators

Stage 1 – Sulphate concentrations in seepage and/or groundwater down-gradient of mine components.

Stage 2 – Sulphate and/or dissolved zinc concentrations in seepage and/or groundwater. Choice of appropriate indicators will vary for specific mine components and will depend on site-specific conditions. The appropriate indicators will be developed as part of the response to a Stage 1 trigger. For example, for locations where plume travel times to the receiving environment are sufficiently long zinc may be used at monitoring locations up-gradient of the collection or treatment system, but for locations where there is minimal duration for implementation of action, sulphate would be used.

Stage 3 – Dissolved zinc concentrations in seepage and/or groundwater at the collection or treatment system location.

Note that receiving water quality (e.g. sulphate concentrations) may also lead to triggers and responses described in this AMP because the receiving water quality AMP (Event No.?) may lead to identification of mine component sources that specific monitoring at mine components fails to detect. The Receiving Water Quality AMP is intended to act as a redundant check to confirm overall performance at the site.

### Phase 1 Specific Thresholds

The specific thresholds or triggers for the Contaminated Groundwater/Seepage AMP that will initiate an action for any of the specific indicators, will be as follows:

Stage 1 – A statistically significant increasing trend in sulphate concentrations in seepage and/or groundwater down-gradient of a mine component. This may include seasonal (winter) and/or annual trends. Past site experience confirms that sulphate is an effective and timely advance indicator for ARD products.

Stage 2 - Contaminant plume characteristics (sulphate concentrations, zinc concentrations, travel times) indicate that collection and/or treatment will be required within two years in order to avoid escape of threshold contaminant loading/concentrations past the collection or treatment system location. The specific Stage 2 thresholds will be determined as part of the Stage 1 response and may differ for each mine component.

Stage 3 thresholds for dissolved zinc concentrations in seepage and/or groundwater will be established in Stage 2.

### Phase 1 Monitoring Requirements

Stage 1 – Sulphate concentrations in seepage and/or groundwater monitoring wells down-gradient of mine components. Monitoring locations will be selected to evaluate areas where there are known or anticipated pathways for ARD products to reach aquatic receiving environments. These would include monitoring facilities in existing known areas of contaminant migration as well as any emerging areas of concern about contaminant migration. Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and will range from annual to quarterly. In addition to monitoring at specific locations, less frequent monitoring (approximately every five years) will be undertaken at a wider range of locations to gain a synoptic understanding of contaminant migration and identify areas of emerging concern.

Stage 2 – Sulphate and/or dissolved zinc concentrations in wells and/or seepage locations down-gradient of mine components. Monitoring will include any new locations established as part of the response to a Stage 1 trigger. The Stage 2 monitoring program will be designed (parameters, locations, frequencies) with the intent of providing at least two years notice before collection or

treatment is required. Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and will range from annual to quarterly.

Stage 3 – Dissolved zinc concentrations in wells and/or seepage locations at the collection or treatment system location. Frequency of monitoring will be determined based on the site-specific characteristics of the sample locations and will be at least quarterly.

### Phase 1 Evaluation of Monitoring Results

A preliminary review of the relevant data from Stage 1 and Stage 2 will be carried out following receipt of each laboratory analysis report to identify immediate contaminant migration concerns and data issues. A more comprehensive review will be carried out annually including detailed data and trend evaluation. Stage 1 monitoring data from the broader synoptic investigations completed approximately every five years will be summarized in a specific review report, identifying the status of known contaminant plumes, identifying any emerging contaminant plumes and recommending alterations of AMP monitoring requirements.

For Stage 3, monitoring data will be compared to thresholds upon receipt of each laboratory analysis report.

### Phase 1 Approach to Development of Response/Mitigation/Intervention

Verification and confirmation of site or performance conditions will be conducted as described in Section 13.1.3. This will be followed or accompanied by responses described below.

Stage 1 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 1 trigger will include:

- Development and implementation of a program to monitor and investigate contaminant plume conditions to support a comprehensive understanding of concentrations, loading, trends, travel times and potential impacts to the receiving environment.
- Establishment of appropriate Stage 2 and 3 thresholds.
- Planning and design of an appropriate initial collection or treatment system that will be designed based on site-specific conditions at the time (flow rates, quality and spatial variability). A typical system could include:
  - Interception sumps and/or trenches;
  - Pumping wells;
  - Cut-off wall;
  - Permeable reactive barriers;
  - In-situ treatment;
  - Biological treatment; and
  - Stream isolation.

Stage 2 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 2 trigger will include:

- Initiation of the construction of the collection or treatment system with the intent of having a facility in place well in advance of any Stage 3 trigger.
- Refinement of Stage 3 thresholds.
- Monitoring frequency at the Stage 3 trigger locations will be increased, if required.
- Phase 2 of the AMP will be refined including identification of specific monitoring requirements and thresholds.

Stage 3 – Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Stage 3 trigger will be to initiate collection and/or treatment of seepage and/or groundwater and initiate Phase 2 of the Contaminated Groundwater/Seepage Adaptive Management Plan including finalization of Phase 2 monitoring programs and specific thresholds.

### 13.3.2 Phase 2 Contaminated Groundwater/Seepage AMP

#### Event

Degradation of groundwater, seepage or surface water quality down-gradient of a groundwater or seepage collection or treatment system for a mine component.

Phase 2 of the Contaminated Groundwater/seepage Adaptive Management Plan is intended to identify contaminated water bypassing any established collection or treatment system, and respond appropriately.

#### Phase 2 Narrative Response Triggers

Monitoring of hydraulic gradients, seepage presence or down-gradient water quality indicates that contaminants may be bypassing a collection or treatment system. Monitoring locations for water quality will be selected to provide timely information about system performance.

#### Phase 2 Specific Indicators

Sulphate and dissolved zinc concentrations in groundwater and seepage down-gradient or adjacent to the collection/treatment system.

Groundwater levels sufficient to understand gradients in the vicinity of the collection/treatment system.

Note that receiving water quality (e.g. sulphate concentrations) may also lead to triggers and responses described in this AMP because the receiving water quality AMP (Event No.?) may lead to identification of mine component sources that specific monitoring at mine components fails to detect. The Receiving Water Quality AMP is intended to act as a redundant check to confirm overall performance at the site.

### Phase 2 Specific Thresholds

The specific thresholds or triggers for the Contaminated Groundwater/seepage AMP, Phase 2 that will initiate action for any of the specific indicators will be as follows:

- For a collection system, water levels that indicate failure of hydraulic containment during operation.
- For collection or treatment systems, continued observation of contaminated seepage or groundwater at periphery or down-gradient of the system.

### Phase 2 Monitoring Requirements

Water levels in groundwater wells and collection facilities. Specific monitoring locations and frequencies will be determined based on the site-specific characteristics and responsiveness of the system. Adequate locations will be selected to develop an understanding about hydraulic containment during collection system operation. Frequency of monitoring once the system has stabilized will likely range from monthly to quarterly.

Visual inspection for the presence of seepage in peripheral areas and downstream of a collection or treatment facility. Frequency of monitoring will be determined based on the site-specific characteristics and responsiveness of the system. Once the system has stabilized, monitoring will likely range from monthly to quarterly. Observation of new seepage locations would be immediately followed up with sampling for water quality.

Sulphate and dissolved zinc concentrations in wells and/or seepage down-gradient of the collection system. The specific locations will be selected to include locations where contaminated water is most likely to bypass the system (i.e. bedrock and peripheral areas). Frequency of monitoring will be determined based on the site-specific characteristics of the monitoring locations and types (i.e. seepage vs. groundwater).

For all monitoring, more intensive sampling or observations will be conducted following system start-up or modification. This will include increased frequencies for all types of monitoring and may also include additional monitoring locations (e.g. in nearby receiving water).

### Phase 2 Evaluation of Monitoring Results

A review of the relevant data/observations will be carried out following receipt of each laboratory report, field inspection report or field data report. This preliminary review will identify immediate performance concerns and data issues. The frequency of review will be more intensive following system start-up or modification, consistent with the more intensive monitoring programs. A more comprehensive review will be carried out annually, including detailed data and trend evaluation as well as interpretation of water level information.

### Phase 2 Approach to Development of Response/Mitigation/Intervention

Verification and confirmation of site or performance conditions will be conducted as described in Section 13.1.3. This will be followed or accompanied by responses described below.

Once trigger activation is confirmed in accordance with the general steps described above, the specific responses to a Phase 2 trigger will include:

- Development and implementation of a program for continued monitoring, analysis and reporting about implications of bypass conditions.
- Design for appropriate collection or treatment system modifications. This will include all aspects of design, planning and modification of the collection or treatment system, including timing. The modifications will be designed to address system inadequacies and could include:
  - Completion/expansion/improvement of initial system;
  - Interception sumps and/or trenches;
  - Grouting of bedrock;
  - Pumping wells;
  - Cut-off wall;
  - Re-route water to redundant collection system (e.g. infiltration gallery to route to Rose Creek Aquifer);
  - Permeable reactive barriers;
  - In-situ treatment;
  - Biological treatment;
  - Stream isolation; and
  - Increase downstream head.

## 13.4 Receiving Water Quality Adaptive Management Plan

### Event

Degradation of receiving water quality downstream of mine site components (e.g. waste rock dumps, collection ponds, and tailings area) to the extent requiring implementation of upstream mitigation which could include triggering of implementation of groundwater and/or seepage collection and treatment.

This AMP Event consists of two stages. Stage 1 is intended to identify early indication of ARD products migrating into the aquatic receiving environment. Stage 2 is intended to identify timing for implementation of possible mitigation measures.

### Possible Environmental Consequences

Degradation of surface water quality downstream of the mine site area (Rose Creek and Vangorda Creek) may lead to an overall degradation in the downstream aquatic receiving environment which

could result in the inability to meet the overall objective of protecting the aquatic environment. Potential consequences include:

- Loss of secondary productivity in the receiving environment and points downstream;
- Avoidance of degraded area by fish – loss of habitat;
- Toxicity to early life stages of fish;
- Acute toxicity to adult and juvenile fish; and
- Contaminant uptake by fish and consequent food chain contamination.

### Narrative Response Triggers

Monitoring of surface water quality in Rose Creek and Vangorda Creek downstream of the mine site area indicates that the downstream water quality is starting to degrade or change and ARD products are advancing towards receiving environments. Monitoring locations and indicators in this stage will be selected for early detection.

### Specific Indicators

The specific indicators that should be monitored in the receiving environment to support this AMP are:

- Metal levels;
- Sulphate levels;
- Total suspended solids levels as an indicator of construction related runoff;
- Benthic community structure; and
- Fish community indicators including:
  - Seasonal use by salmonids and grayling
  - Year round use by slimy sculpins
  - Fish community structure (diversity)
  - Population age structure
  - Fish health indicators in sculpins (size, gonad condition etc.)
  - Metal levels in fish tissue.

### Stage 1 - Specific Thresholds

The following are potential thresholds that would be established to, if achieved, would trigger Stage 1 of the receiving water quality AMP. The specific threshold values will be defined to be “proactive” and “protective” and provide sufficient advance warning of changes in the receiving environment.

- Metal levels in the receiving environment increasing each year at a statistically significant rate, metal levels increasing at rates faster than predicted in the environmental assessment or metal concentrations increase to a percentage of the predefined threshold value (e.g. 75%).

- Sulphate levels in the receiving environment are increasing as a statistically significant rate, indicating that increases in zinc levels may follow.
- Total suspended solids levels increase during construction event above baseline levels or upstream concentrations.

### Stage 2 - Specific Thresholds

The following are potential thresholds that would be established to, if achieved, would trigger Stage 2 of the receiving water quality AMP. Similar to the Stage 1 threshold values, the specific threshold values for Stage 2 will be defined to be "proactive" and "protective" and provide sufficient advance warning of changes in the receiving environment and sufficient time to develop and implement appropriate responses and possible mitigation.

- Metal concentrations at various locations in the receiving environment reach levels predicted in the environmental assessment before expected and follow an increasing trend.
- Metal concentrations, at various locations in the receiving environment, reach predefined threshold value.
- Statistically significant change in benthic community at locations where increased metal levels are present, compared to reference area benthic community.
- Metal levels in resident fish, show a statistically significant increase compare to reference area fish.
- Fish health indicators in resident sculpins show statistically significant degradation compared to fish in reference areas or previous surveys.

### Monitoring Requirements

Monthly monitoring of metal and sulphate concentrations year round to ensure capture of the full range of flow conditions including winter baseflow and spring freshet.

Daily total suspended solids monitoring during prolonged rainfall events and peak flow events (spring freshet) during construction. This should be coupled with metal analysis although at a reduced frequency.

Biannual benthic surveys in the downstream receiving environment in Rose and Vangorda Creeks.

Fish health and fish contaminant level surveys every five years.

### Evaluation of Monitoring Results

Monthly assessment of all relevant AMP data, including comparison to thresholds and trend analysis with annual reporting of all AMP results. The assessment and reporting will link the water quality results to the ecological monitoring.

### Approach to Development of Response/Mitigation/Intervention

As appropriate, verification and confirmation of site and performance conditions will be conducted as described in Section 13.1.3. This may include more intensive or focussed monitoring and/or evaluation of potential effects on desired objectives.

Once Stage 1 of the receiving environment AMP is triggered the framework will be followed for the approach to the development of responses, mitigation or intervention.

- Examine source loading terms.
- Determine time until thresholds are met or exceeded at present trajectory.
- Adjust monitoring program as required.
- Develop conceptual source management plans.
- Address “easy fixes” to reduction of source loadings to the receiving environment.

Once Stage 2 of the receiving environment AMP is triggered the framework will be followed for the approach to the development of responses, mitigation or intervention.

- Detailed design of source loading management plans.
- Review timeline for thresholds being met or exceeded.
- Review timeline for future concentrations becoming ecologically significant.
- Adjust monitoring frequency for both receiving environment and source loadings.
- Implement appropriate intervention/mitigation.
- Continue enhance monitoring until stabilization or improvement in the receiving environment.

## 13.5 Receiving Water Flow Adaptive Management Plan

### Event

Reduction of downstream surface flows and downstream upwelling areas in Rose and Anvil Creeks below the site in winter due to the interception, storage and seasonal treatment and discharge of a significant portion of the groundwater in the valley (~98%).

### Possible Environmental Consequences

Winter surface flows depend largely on groundwater inflows due to the lack of significant water bodies or wetlands upstream. Interception of a significant portion of this groundwater, particularly during winter, may result in reduction in winter surface flows downstream of the site, particularly in Rose and Anvil Creeks.

Downstream winter fish habitats, including overwintering, salmon spawning and incubation, depend largely on groundwater contributions and upwelling . These habitats could be affected in terms of

reduction of extent and change in location of these areas and a corresponding reduction in fish utilization.

### Narrative Response Triggers

Winter stream flows that allow for fish survival and overwinter incubation of fall spawning fish lick Chinook salmon are a limiting habitat factor in Yukon's harsh winter climate. When winter flows are reduced to critical low levels, reductions in water temperatures may result in the streams freezing to the bottom resulting in surface glaciations and ice build-ups that divert the stream out of the channel. The resumption of channelized stream flows below such areas of glaciation may be the result of warmer groundwater or tributary stream contributions.

Groundwater upwelling areas and other habitats such as junctions of tributary streams and areas adjacent to glaciations are key overwintering fish habitats. Such areas are often open water during the winter or are the last to freeze in fall and first of open up in spring. Such overwintering habitats are generally limited and fish have adapted to utilize these areas.

### Specific Indicators

Reductions in winter surface flows in Rose and Anvil Creeks below the site.

Changes in the extent and location of winter glaciations in Rose and Anvil Creeks below the site.

Reductions in the number and area extent of winter upwelling areas in Rose and Anvil Creeks below the site.

Reductions in fish utilization of winter upwelling, glaciations and other key areas in Rose and Anvil Creeks below the site.

### Specific Thresholds

The specific thresholds for the Receiving Water Flow AMP event are:

- Reductions in winter surface flow below natural variability in flows under baseline conditions;
- Increase (>25%) and changes in locations of glaciations;
- Reductions in the number (<25%) and extent (>50%) of open water areas in winter; and
- Elimination of fish utilization in key overwintering areas including Chinook salmon spawning and incubation.

### Monitoring Requirements

Monitor surface flows using data loggers, including winter flows, in Rose Creek below the site prior to, during and after the installation of the groundwater interception systems.

Monitor visually the extent and location of open water areas and areas of glaciation in Rose and Anvil Creek in winter from freeze-up to break-up.

Monitoring of fish utilization in key overwintering areas including Chinook spawning and incubation.

### Evaluation of Monitoring Results

A significant reduction in overwinter flows would result in an increased intensity in the monitoring of winter open water areas, glaciations and fish utilization to evaluate and determine potential effects.

### Approach to Development of Response/Mitigation/Intervention

As appropriate, verification and confirmation of site and performance conditions will be conducted as described in Section 13.1.3. This may include more intensive or focussed monitoring and/or evaluation of potential effects on desired objectives. If significant impacts in terms of overwinter habitat and fish utilization are detected consideration may be given to potential mitigation which could include groundwater injection of clean water immediately downstream of interception system to augment the winter groundwater flows.

## 13.6 Receiving Water Temperature Adaptive Management Plan

### Event

Reduction of groundwater contributions to winter flows in Rose and Anvil Creeks below the site in winter due to the interception, storage and seasonal treatment and discharge of a significant portion of the groundwater in the valley (~98%) may result in changes in winter stream temperatures.

### Possible Environmental Consequences

A reduction in warmer groundwater contributions to winter flows in Rose and Anvil Creeks below the site may results in an overall reduction in stream temperatures and a reduction in the extent and location of overwintering habitats for fish and fish utilization and life history functions which are temperature sensitive such as Chinook salmon incubation

### Narrative Response Triggers

Elevated water temperatures resulting from warmer groundwater contributions are a critical element for the maintenance of overwinter stream habitat in a very harsh winter climate like the Yukon. Even very small (micro) changes in temperature may be important for maintaining stream flows and small microclimates in streams during winter that enable fish to survive and successfully complete life history functions such as spawning and egg incubation.

These changes in water temperature may be too small to be detected and monitored through winter temperature monitoring so indicators for overwinter flow monitoring such as open water areas,

glaciations and fish utilization and incubation success may be used as proxy indicators for monitoring stream water temperatures.

### Specific Indicators

Changes in winter temperatures in Rose and Anvil Creeks downstream of the site compared to baseline temperatures prior to installation of the groundwater interceptions system and winter temperatures upstream of the site.

Changes in the extent and location of open water areas and glaciations and changes in fish utilization in identified overwintering habitats.

### Specific Thresholds

The specific thresholds for the Receiving Water Temperature AMP event are:

- Any detectable reduction in winter water temperatures in Rose and Anvil Creeks below the site compared to baseline conditions prior to the interception of ground water flow or temperatures in Rose Creek above the site;
- Increase (>25%) and changes in locations of glaciations;
- Reductions in the number (<25%) and extent (>50%) of open water areas in winter; and
- Elimination of fish utilization in key overwintering areas including Chinook salmon spawning and incubation.

### Monitoring Requirements

Monitoring of micro changes in winter water temperatures using data loggers below and above the site in Rose Creek prior to, during the construction of the groundwater interception system, after the system is in full operation.

Monitor extent and location of open water and areas of glaciation in Rose and Anvil Creeks in winter from freeze-up to break-up.

Monitoring fish utilization in key overwintering areas including Chinook spawning and incubation.

### Evaluation of Monitoring Results

A detectable reduction in winter stream water temperature over pre-project baseline conditions or from conditions in Rose Creek upstream of the site would be an indication that the monitoring of winter open water areas, glaciations and fish utilization should be stepped up and evaluated to determine potential effects.

### Approach to Development of Response/Mitigation/Intervention

As appropriate, verification and confirmation of site and performance conditions will be conducted as described in Section 13.1.3. This may include more intensive or focussed monitoring and/or evaluation of potential effects on desired objectives. If significant impacts in terms of overwinter habitat and fish utilization are detected consideration may be given to potential mitigation which could include groundwater injection of clean water immediately downstream of interception location.

## 13.7 Water Treatment Source Water Quality/Quantity Adaptive Management Plan

### Event

Changes in source water quality or quantity requiring treatment in either the Faro or Vangorda water treatment facilities such that additional treatment capacity, either hydraulically or chemically, is required. This AMP has two components. One component is designed to detect trends in influent water quality or quantity for water treatment systems and ensure that the treatment systems can address the changes, including potential changes in contaminants requiring treatment. The second component is designed to proactively identify future sources that may require treatment and ensure that treatment capacity will be in place to address these sources as required.

### Possible Environmental Consequences

The inability of the treatment systems to handle existing and anticipated source water quality and flows may result in poorer effluent quality from the treatment systems and potential impacts on the downstream receiving environment as a result of the discharge of this effluent.

### Narrative Response Triggers

The trigger for implementation of the water treatment source AMP is source water quality and quantity requiring treatment displays a sustained and significant change such that the capacity of the treatment facilities is expected be exceeded in the short-term (~ 5 years). This includes both existing influent into the treatment systems as well as potential future sources that may require treatment in the future.

### Specific Indicators

Concentrations of key water quality parameters in the influent water quality to the treatment facilities.

Flowrate of the influent to the treatment facilities.

Water quality, including acidity, sulphate, metals, in seep and groundwater monitoring samples from various sources at the site not currently being collected for and routed for treatment (e.g. toe of waste rock dumps and Grum Pit).

### Specific Thresholds

The specific thresholds for the Water Treatment Source AMP will be developed to proactively assess the changes in influent water quality and flow as well as all potential new sources that will be requiring treatment that will ensure that sufficient time is available to implement any necessary changes required to ensure adequate treatment capacity will be in place.

### Monitoring Requirements

Routine monitoring of influent water quality and flow rate for all treatment facilities.

Monitoring of water quality in seepage and groundwater in areas that may be potential future sources (e.g. toe of waste rock dumps and Grum Pit). The monitoring requirements for this AMP are linked to other components of the site Adaptive Management Plan including Contaminated Groundwater/Seepage, Rose Creek Aquifer, and Receiving Water Quality Adaptive Management Plans.

### Evaluation of Monitoring Results

A review of the relevant data will be carried out following receipt of the required monitoring data to identify any immediate timing concerns and data issues. A more comprehensive review will be carried out annually including detailed data and trend evaluation.

### Approach to Development of Response/Mitigation/Intervention

As appropriate, verification and confirmation of site and performance conditions will be conducted as described in Section 13.1.3. This may include more intensive or focussed monitoring and/or evaluation of potential effects on desired objectives. This will be followed or accompanied by a range of appropriate responses that may include the following:

- Plan for and implementation of modification to existing treatment system to accommodate changes in influent water quality and quantity.
- Plan for and implementation of an expansion of existing treatment system to accommodate changes in influent water quality and quantity.
- Plan for and implementation of a replacement of existing treatment system.

## 13.8 Cover Vegetation Success/Performance Adaptive Management Plan

### Event

Inadequate performance of vegetation on waste rock or tailings covers (e.g. plant density, species diversity, invasive species, metal uptake, etc.).

Vegetation on waste rock and tailings covers helps in achieving several cover objectives including erosion control, infiltration reduction, establishment of appropriate post-reclamation land uses, isolation of contaminants, dust control and aesthetic outcomes. Vegetated covers comprise a major component of the Faro Mine closure project and inadequate vegetation success or performance could affect overall fulfillment of project objectives. (including Density, Specie Diversity, Invasive Species and Metal Uptake).

Criteria for evaluating cover success will vary for different types of covers, underlying materials and terrain conditions. The AMP will be applied on a site-wide basis with the overall intent of understanding and addressing cover performance throughout the range of cover types, objectives and re-vegetation prescriptions. This will require the application of several sub-components within the overall Cover Vegetation Success/Performance AMP. The sub-components will evaluate specific categories of cover vegetation with each category considering Reclamation Land Units (RLUs) with similar cove types and objectives.

### Possible Environmental Consequences

Failure to respond appropriately to inadequate vegetation success or performance could lead to several specific environmental consequences including:

- Increased cover infiltration, leading to increased loading of contaminants to aquatic receiving environments.
- Increased erosion leading to sedimentation of aquatic receiving environments or exposure of contaminated waste creating pathways for effects on both terrestrial and aquatic environments.
- Inability to establish self-sustaining vegetation could lead to ongoing effects on land use potential in the area.
- Use of the covered areas by terrestrial wildlife could be adversely affected – either too much use or too little use compared with objectives.
- Metal uptake by terrestrial animals or people.
- Propagation of invasive species, leading to effects on surrounding vegetation.

If these effects were to occur, the overall objectives related to protecting the environment and restoration of land use would not be met.

### Narrative Response Triggers

Monitoring indicates that a self-sustaining natural succession vegetation cover has not been achieved or that ineffective vegetation coverage including poor plant density, species diversity, presence of invasive species and/or metal uptake will lead to unacceptable cover performance that may include increased infiltration, increased erosion, metal uptake by animals or people or unacceptable land uses.

### Specific Indicators

Vegetation density, species diversity, presence of invasive species, plant metal concentrations and terrestrial wildlife population and use patterns can all be used for indicating success and performance of vegetation on covers. Specific selection of indicators will depend on the cover types and objectives for specific categories of RLU.

### Specific Thresholds

Table 13.1 describes the framework for establishing appropriate thresholds for vegetation success and performance. Distinct thresholds for each RLU category will be linked to the specific objectives and expected performance of the covers and vegetation.

**Table 13.1: AMP Thresholds for Vegetation Success**

| RLU Category | Vegetation Density | Species Diversity | Invasive Species | Metal Conc. | Wildlife Use |
|---|---|---|---|---|---|
| No. 1 Specific type of cover and vegetation prescription.<br><br>E.g. Rudimentary Cover with agronomic grass/legume mix. | % surface coverage within defined time periods. | Species types and species diversity within defined time periods (compared with desired outcomes). | Any evidence of propagation invasive species. | Specified concentrations of specific contaminants. | Evidence of wildlife use that is different than desired outcome. |
| No. 2 Specific type of cover and vegetation prescription.<br><br>E.g. Low infiltration cover with native grass seed mix and native woody species. | As above, but specific thresholds will vary. | As above, but specific thresholds will vary. | As above, but specific thresholds will vary. | As above, but specific thresholds will vary. | As above, but specific thresholds will vary. |

The Vegetation Success/Performance AMP is specifically focused on a component of the closure plan that is intended to improve conditions at the site. Therefore, in its early stages, this AMP will be designed with thresholds that seek ongoing improvement as the vegetation is established and develops into a viable, self-sustaining component of the local ecology. To achieve this, the thresholds will likely include several stages with improving performance expectations as time advances.

### Monitoring Requirements

- Detailed vegetation surveys by appropriate professional specialists using standardized procedures in years 1, 2, 3, 5, 10, 15, 20 and 25 after completion of vegetation prescriptions. Surveys will collect information about vegetation density, species diversity, invasive species and metal concentrations. For each category of RLU, specific monitoring plots and locations will be

established to understand the variability of vegetation performance across the site, taking into consideration climate, terrain, elevation, aspect, etc.

- Site wide wildlife surveys by appropriate professional specialists using standardized procedures in years 2, 5, 10, 15, 20 and 25 after completion of vegetation prescriptions. To the extent practical the survey will distinguish wildlife use in specific RLUs.
- Recording of wildlife observations on an ongoing basis identifying species, locations, dates, durations, etc.

### Evaluation of Monitoring Results

If significant changes in wildlife use patterns are observed, these will be reported immediately.

Comprehensive reports about vegetation performance or wildlife use patterns will be prepared at the conclusion of each survey.

### Approach to Development of Response/Mitigation/Intervention

As appropriate, verification and confirmation of vegetation performance conditions will be conducted as described in Section 13.1.3 which may include more intensive or focussed monitoring and/or evaluation of potential effects on desired objectives. This will be followed or accompanied by a range of appropriate responses that may include the following:

- Revision of schedules for detailed vegetation and/or wildlife surveys.
- Removal of invasive species.
- Reseeding of areas with more appropriate vegetation species to overcome specific stresses.
- Application of additional fertilizers.
- Reclassification of RLU.
- Removal of metal laden species.
- Introduce or change vegetation mix to include species that are more/less attractive to terrestrial wildlife.
- Mechanisms to exclude wildlife from problematic areas (e.g. fences, deterrents).
- Mechanisms to attract wildlife away from problematic areas.

## 13.9 Short-term Establishment of Vegetation Adaptive Management Plan

### Event

Establishment of vegetation from seed mixes and plantings is designed to provide a preliminary cover on the engineered covers and other exposed soils to reduce erosion by wind and water and provides microsites for establishment of additional native vegetation species through natural

colonization. Given the challenging substrate and climatic conditions at the Faro Mine Complex, and the lack of certainty regarding the efficacy of the revegetation treatments, there is some risk that initial vegetation treatment may not establish or provide sufficient cover over the short term. Short term in this environment is defined as 3-5 growing seasons after seeding.

Wildlife use of the reclaimed areas is proposed as a success criteria for the establishment of vegetation on the covers. However, wildlife use of the vegetation can also influence the success/failure of the establishment of the vegetation, as too much foraging could reduce the ability of the vegetation to establish.

### Possible Environmental Consequences

Given the challenging substrate and climatic conditions at the Faro Mine Complex, and the lack of certainty regarding the efficacy of the revegetation treatments, there is some risk that initial vegetation treatment may not establish or provide sufficient cover over the short term. This could lead to increased erosion by wind and water and unsuccessful establishment of additional native vegetation species.

### Narrative Response Triggers

Failure to establish sufficient persistent vegetation cover on a site after five years to assure further development of vegetation on the site.

### Specific Indicators

Regular monitoring of reclaiming landscapes will be linked to performance criteria for reclamation / revegetation objectives for each Reclamation Land Unit (RLU). Vegetation species composition and percentage cover are used as the key indicators of reclamation progress. Measurements include percentage cover estimates of:

- Each vascular vegetation species;
- Combined moss cover;
- Combined lichen cover;
- Litter (including any mulch); and
- Bare ground.

In riparian areas where early establishment of shrub cover is important, cover of living shrub material (stems/$m^2$) is also measured.

To determine if the vegetation covers are providing wildlife habitat or influencing vegetation establishment, relative use indicators such as number and types of pellets (ungulates/bears), percent vegetation browsed/damaged (various species), video/photo recording species use and behaviours (various species), point counts (birds), number of burrows (small mammals), and number and types

of tracks (ungulates/bears) will be combined with estimates of population such as mark-recapture (small mammals).

Specific indicators for wildlife use will include:

- Diversity of wildlife species observed;
- # of pellets per $m^2$;
- % vegetation browsed; and
- Population levels of selected wildlife species (e.g. small mammals, birds).

### Specific Thresholds

Performance criteria for short-term vegetation establishment include:

- Minimum live vegetation cover (>20% cover at year 5);
- Minimum live vegetation plus litter cover (>30% cover at year 5);
- Minimum # of live woody stems per hectare (tbd for areas planted with woody species);
- Minimum number of species per unit area (e.g. >4 sp/100 $m^2$ at > 2% cover each);
- Evenness of species abundance over the treatment area; and
- Absence of Yukon #1 invasive plant species.

Due to the large number of variables related to how and why wildlife will use habitats such as available forage species, distance from source populations, season, competition, predation risk, distance to suitable cover/breeding sites, mobility of species, etc. there are no initial performance criteria for wildlife use of the sites during the first five years of establishment. Monitoring will be conducted to establish trends and allow analyses of variables that will allow performance criteria for wildlife during short-term vegetation establishment to be developed. These criteria will be established within seven years of the project initiating and will be used as criteria for those covers established four years after project initiation. As more covers are established and more monitoring information becomes available on wildlife use of early covers, the performance criteria will be adjusted to reflect the new knowledge.

### Monitoring Requirements

Monitoring is conducted annually for the first five years to document trends in vegetation establishment and litter build up. If no vegetation is present after three years, early intervention may be needed to initiate other revegetation prescriptions.

Monitoring plots will be established over a 20m x 20m area. Microplot sampling for composition and cover will be done using ten 1 meter frames established on a 20m transect across the middle of the monitoring site. Percentage cover estimates of each vascular vegetation species, combined moss cover, combined lichen cover, litter (including any mulch) and bare ground, are recorded.

Monitoring will also be conducted to document which wildlife species are using the area and the extent of their use. For species such as moose, caribou and sheep, methods such as pellet counts and browse assessment surveys will be conducted. Small mammal use will be assessed through methods such as mark-recapture, burrow counts or track plates. Full-time monitoring of selected sites using video or photo capture methods will also be conducted to record species use patterns. Wildlife use of plots during the first six years after project initiation will be used to determine trends and develop performance criteria, which will be applied to reclaimed areas established in year four after project initiation and thereafter.

One metre by one metre plots will also be used for permanent photo records of monitoring site condition. From the photo plot location, additional photographs in the four compass directions are taken.

### Evaluation of Monitoring Results

Combining data from replicate monitoring plots (a minimum of 5 per treatment type per planting year representing both cool and warm aspects) will be used to identify emerging establishment successes and issues for both vegetation establishment and wildlife use.

### Approach to Development of Response/Mitigation/Intervention

In areas where establishment targets have not been met, this information needs to be linked to issues regarding; cover type; cover performance, metal content of surface cover materials and any urgency to reduce erosion of the covers or improve surface water quality.

Sites where vegetation establishment is not progressing may either be:

- Left to develop naturally;
- Revegetation may be assisted by:
  - In-planting,
  - Fertilizer input, and
  - Other surface amendments.
- Investigated further for levels of contaminants that can affect plant growth.

If wildlife use is found to be an impediment to vegetation establishment, measures may include:

- Preventing wildlife use through vegetation collars/tubing, scent deterrents (e.g. carnivore urine), fences or berms;
- Planting of less palatable species; or
- Removal of wildlife species (e.g. trapping of voles).

## 13.10 Long-term Establishment of Vegetation Communities Adaptive Management Plan

### Event

Closure objectives for the Project are in part, to: restore and reclaim the land to pre-mining uses to extent practicable. The landform and land use objectives for the site are, in part, to increase productivity, aesthetics and compatibility with surrounding land uses. These objectives form the context for planning reclamation and revegetation of the Faro Mine complex.

Long-term reclamation/revegetation objectives for each RLU are to:

- Establish sustainable vegetation cover;
- Establish successional trajectory towards native plant communities and structural diversity consistent with surrounding natural vegetation;
- Continued erosion control; and
- Continue to minimize infiltration of water into the covers.

The long-term objectives of establishing sustainable vegetation cover and native plant communities will also allow an objective of establishing wildlife use similar to the surrounding natural vegetation to be realised.

Risks to revegetating RLUs over time include failure to establish a relatively maintenance-free, self-sustaining community of plants with sufficient diversity and resilience to respond to extreme episodic events and climate change.

An intensive adaptive management program is planned for the closure and initial post-closure period. Regular monitoring of reclaiming landscapes will be linked to performance criteria for reclamation / revegetation objectives for each RLU.

### Possible Environmental Consequences

Risks over time include failure to establish a relatively maintenance-free, self-sustaining community of plants with sufficient diversity and resilience to respond to extreme episodic events and climate change.

### Narrative Response Triggers

Failure to establish a trend or trajectory towards a diverse, persistent, self-sustaining vegetation cover demonstrating succession towards the surrounding ecosystem.

### Specific Indicators

Off-site reference plots in natural vegetation communities at similar elevations, slopes aspects will be used to document target communities and expectations for vegetation development over the

25 year period of the water license and beyond. Consideration will also be given to the capability of the undeveloped soils present on the mine site, and the early seral conditions of the vegetation communities that will persist for many years.

Performance criteria should include:

- Erosion control (short to long-term);
  - Minimum live vegetation cover threshold,
  - Minimum live vegetation plus litter cover threshold, and
  - Minimum # live stems per hectare.
- Diversity (resilience);
  - Evidence of natural in-migration of native plant species,
  - Minimum number of species per unit area (e.g. > 5 sp/100$m^2$ at > 7% over each),
  - Evenness in species abundance over the treatment area, and
  - Absence of invasive species (category #1 Yukon Invasiveness rank).
- Sustainability
  - Presence of x number of native species,
  - Presence of x number of long-lived perennial species, and
  - Presence of reproducing species (Fruit/seed production).

To determine if the vegetation covers are providing wildlife habitat, relative use indicators such as number and types of pellets (ungulates/bears), percent vegetation browsed/damaged (various species), video/photo recording of species use and behaviours(various species), point counts (birds), number of burrows (small mammals), and number and types of tracks (ungulates/bears) will be combined with estimates of population such as mark-recapture (small mammals).

Specific indicators for wildlife use will include:

- Diversity of wildlife species observed;
- # of pellets per $m^2$;
- % vegetation browsed; and
- Population levels of selected wildlife species (e.g. small mammals, birds).

### Specific Thresholds

Achievable thresholds will be developed based on the natural communities that surround the mine site, the capability of the undeveloped soils present on the mine site to support vegetation and the early seral conditions of the vegetation communities that will persist for many years. Establishment of a trend towards self-sustaining communities will be important to identify success of revegetation efforts.

Due to the large number of variables related to how and why wildlife will use habitats such as available forage species, distance from source populations, season, competition, predation risk, distance to suitable cover/breeding sites, mobility of species, etc. there are no initial performance criteria for wildlife use of the sites. Monitoring will be conducted in natural communities at various successional stages to establish trends and allow analyses of variables that will allow performance criteria for wildlife use over the long-term. These criteria will be established within seven years of the project initiating and as the vegetation covers mature, comparison of wildlife use in the established covers to the natural vegetation communities will be conducted.

### Monitoring Requirements

Use of monitoring plots established during the initial revegetation of the site should be resurveyed at year 6, 8, 10 post-reclamation and then every 5 years unless the intervals are determined to be too infrequent.

Monitoring plots will be established over a 20m x 20m area. Microplot sampling for composition and cover will be done using ten 1 meter frames established on a 20m transect across the middle of the monitoring site. Percentage cover estimates of each vascular vegetation species, combined moss cover, combined lichen cover, litter (including any mulch) and bare ground, are recorded.

To determine if the plots are obtaining similar use patterns as the control sites. For species such as moose, caribou and sheep, methods such as pellet counts and browse assessment surveys will be conducted. Small mammal use will be assessed through methods such as mark-recapture, burrow counts or track plates. Wildlife use of plots would be compared to control sites with similar characteristics (e.g. vegetation communities, slope, aspect).

One metre by one metre plot will also be used for permanent photo records of monitoring site condition. From the photo plot location, additional photographs in the four compass directions are taken.

### Evaluation of Monitoring Results

Combining data from replicate monitoring plots (5 per treatment type per planting year) will be used to identify long-term establishment progress or issues.

### Approach to Development of Response/Mitigation/Intervention

Long-term establishment targets have not been met, this information needs to be linked to issues regarding cover type and cover performance.

Sites where vegetation establishment is not progressing may either be:

- Left to continue to develop naturally;
- Revegetation may be assisted by;
  - In-planting, and

  - Other surface amendments.
- Investigated further for levels of contaminants that can affect plant growth; and
- Treated by other methods developed through new research.

## 13.11 Establishment of Invasive Species on Covers Adaptive Management Plan

### Event

Exposed mineral substrates are suitable for establishment of disturbance-adapted exotic weeds. Seed mixes can include quantities of undesirable weedy or invasive species. Vehicles and equipment transported from other areas have potential to introduce weed species to new locations on tires or cavities in the undercarriage. The likelihood that exotic seed will be introduced to the Project area in trace quantities is high.

### Possible Environmental Consequences

Invasive plant species can prevent the establishment of desirable plant species on a revegetation site. They also have potential to invade undisturbed native ecosystems, particularly systems with natural disturbance components such as riparian areas.

### Narrative Response Triggers

Annual monitoring of newly revegetated areas for presence of Yukon Class 1 invasive species for the first two years post-seeding.

### Specific Indicators

Presence on the reclaiming covers of Yukon Class 1 invasive non-native species from the current list. In 2009 these species include:

| | |
|---|---|
| *Agropyron pectiniforme* | Crested wheat grass |
| *Bromus inermis* | Smooth brome |
| *Centaurea stoebe* | Spotted knapweed |
| *Cirsium arvense* | Canada thistle |
| *Crepis tectorum* | Hawkweed |
| *Elytrigia repens* | Creeping wild rye |
| *Euphorbia esula* | Common spurge |
| *Leucanthemum vulgare* | Oxeye daisy |
| *Leymus angustus* | Altai lyme grass |
| *Linaria dalmatica* | Dalmatica toadflax |
| *Linaria vulgaris* | Greater Butter-and-Eggs |
| *Matricaria perforata* | Scentless false mayweed |
| *Medicago falcata* | Lucerne |
| *Melilotus alba* | White sweetclover |
| *Melilotus officinalis* | Yellow sweetclover |
| *Phalaris arundinacea* | Reed canary grass |
| *Sonchus arvensis ssp. uliginosus* | Perennial Sow-thistle |

| | |
|---|---|
| *Tanacetum vulgare* | Common tansy |
| *Vicia cracca* | Tufted vetch |

### Specific Thresholds

Less than 1% persistent cover of non-native Class 1 invasive plant species on reclaiming covers and other project disturbances.

### Monitoring Requirements

Annual monitoring of newly revegetated areas for presence of Yukon Class 1 invasive species will occur for the first three years post-seeding. If these species are found, then monitoring and control will continue annually until two weed-free years are documented on site. Monitors will be trained and transects will be surveyed across revegetating areas at regular intervals. Presence of targeted species on transects will trigger expansion of the survey intensity in the surrounding area.

### Evaluation of Monitoring Results

Comparison of the results obtained from the monitoring to the threshold of < 1% persistent cover of non-native Class 1 invasive plant species or established background values for the Faro area will be the primary evaluation. Comparison of values over time will allow trends to be observed and if results suggest that the establishment of Yukon Class 1 invasive species is increasing, additional monitoring and control will be initiated.

### Approach to Development of Response/Mitigation/Intervention

Control measures for infestations of targeted species include:

- Hand pulling;
- Selective use of herbicides for dense or wide-spread infestations; and
- Potentially replanting treated sites.

## 13.12 Trace Metal Update by Vegetation on Covers Adaptive Management Plan

### Event

Metal uptake by vegetation species growing on covers designed to create a barrier to the underlying metal-rich waste has the potential to affect vegetation growth and survival, as well as the potential to be transferred to other species including birds, mammals and people. Although the proposed Covers at Faro have not been engineered to stop metals uptake by vegetation, it is expected that the depth of covers and use of an impenetrable layer over more toxic materials, will greatly reduce the availability of trace metals to vegetation species.

### Possible Environmental Consequences

Metal uptake by vegetation species growing on covers designed to create a barrier to the underlying metal-rich waste has the potential to affect vegetation growth and survival, as well as the potential to be transferred to other species including birds, mammals and people.

### Narrative Response Triggers

The trigger for this AMP will be based on detection of trace metals beyond expected background levels in vegetation species during the regular monitoring of the vegetation cover species.

### Specific Indicators

Regular monitoring of the vegetation existing on the Covers will be initiated two years after the Cover is planted. Specific trace metals to be monitored are lead and zinc, although a complete scan of all trace metals will be routinely performed on a regular basis on selected samples.

### Specific Thresholds

The thresholds for enacting the AMP will be if trace metals are found to be three times background levels, of if trend analysis suggests that they may reach that level prior to the next regular monitoring date.

### Monitoring Requirements

Initial monitoring for trace metals will commence two years after planting and will continue every three years thereafter.

Monitoring will consist of obtaining vegetation samples using standard techniques from a diversity of plant species. Initially, planted species will be targeted, but as the diversity of plants increases on the Covers due to natural in-seeding, additional species will be selected. A minimum of five composite samples from the same plant species will be required from each engineered Cover, revegetation treatment and aspect. Vegetation species to be selected should include samples from grasses, forbs, shrubs and eventually trees.

If elevated trace metals are discovered within samples, additional sampling to determine the extent of the issue will be required. This will include increasing the sampling intensity by obtaining more samples from the site to try to delineate the spatial extent (e.g. sample from a wider area of the site) as well as increasing the number of samples and species sampled to determine the variability.

Monitoring of small mammals on sites with elevated trace metals will also be initiated. This would involve trapping species such as voles and shrews and analysis of tissues such as muscle, liver and kidneys. A minimum of five specimens of the selected species from each site of interest would be required. Due to the uncertainty around the availability of species to sample, some assessment of population using mark recapture techniques may be required.

### Evaluation of Monitoring Results

Comparison of the results obtained from the monitoring to the established background values for the Faro area will be the primary evaluation. Comparison of values over time will allow trends to be observed and if results suggest that the trend is moving towards the threshold, additional monitoring will be initiated.

### Approach to Development of Response/Mitigation/Intervention

Where trace metals in vegetation are found to be high, response options include:

- Replant to less palatable species of vegetation;
- Replant to less absorptive species of vegetation;
- Rock armour the site with large size (> 30cm) boulders to prevent extensive revegetation and access to the vegetation by wildlife, and
- If large mammal use is a concern (e.g. Fannin Sheep), fence or berm the site to prevent use.

## 13.13 Sludge Management Adaptive Management Plan

### Event

This AMP event is related to long-term sludge storage once high density sludge water treatment plants are in place and long-term sludge management plans are being implemented. This is expected to comprise storage of sludge in the Faro and Vangorda Pits where the sludge will be tremmied to the bottom of the pits. There are two sub-events included in this AMP.

Sub-Event No. 1: Sludge storage capacity is being consumed more quickly than expected.

Sub-Event No. 2: Chemical conditions change and affect chemical stability of sludge and/or sludge storage is adversely affecting pit water quality.

### Possible Environmental Consequences

Exhausting available sludge storage capacity would lead to requirements for construction of additional sludge storage facilities and associated environmental consequences. Changes in chemical conditions could lead to re-dissolution of sludge materials and increased contaminant loadings for treatment plants.

### Narrative Response Triggers

Sub-Event No. 1: Monitoring indicates that sludge production rates are materially higher than predicted and may exhaust the long-term sludge storage needs. Monitoring and evaluations will compare predicted versus actual production/storage rates at frequencies that will allow effective responses.

Sub-Event No. 2: Stage 1 – Monitoring of pit water quality demonstrates a change in that may affect chemical stability of stored sludge, and/or that sludge storage is affecting pit water quality.

### Specific Indicators

Sub-Event No. 1: Total sludge production rates; sludge production rates per unit of water treated; sludge densities; volume and quality of water requiring treatment; consumed and remaining sludge storage capacity.

Sub-Event No. 2: PH and acidity of pit water throughout the water column; total and dissolved zinc concentrations throughout the water column.

### Specific Thresholds

The specific thresholds or triggers for the Sludge Management AMP that will initiate an action for any of the specific indicators, will be as follows:

Sub-Event No. 1 – Total volumetric sludge production and/or volumetric sludge production per unit of treated water is more that 20% above predicted sludge production over a five-year period. More than 20% change in consumed sludge storage capacity as compared to predicted consumed capacity over a five-year period.

Sub-Event No. 2 – A statistically significant decreasing trend in pH and/or increasing trend in acidity in pit water. Or, substantial difference between total and dissolved zinc concentrations indicating sludge solids within water column.

### Monitoring Requirements

Sub-Event No. 1 – Ongoing monitoring of sludge quantities and densities disposed of in pits. Ongoing monitoring of water treatment volumes and influent quality. Every five years, monitoring of consumed and remaining sludge storage capacity.

Sub-Event No. 2 – Annual under ice and open water monitoring of water quality throughout the water column in pits being used for sludge storage (pH, acidity, total and dissolved zinc concentrations).

### Evaluation of Monitoring Results

Sub-Event No. 1: Every five years, the rate of sludge production and consumption of sludge storage capacity will be compared with predicted rates. Updated predictions of sludge production rates and available storage capacity/duration will be prepared. These updated predictions will include consideration of expected changes identified through the Water Treatment Source Water Quality/Quantity AMP.

# Figures

## Figure 13.1 Rose Creek Aquifer AMP Decision Tree

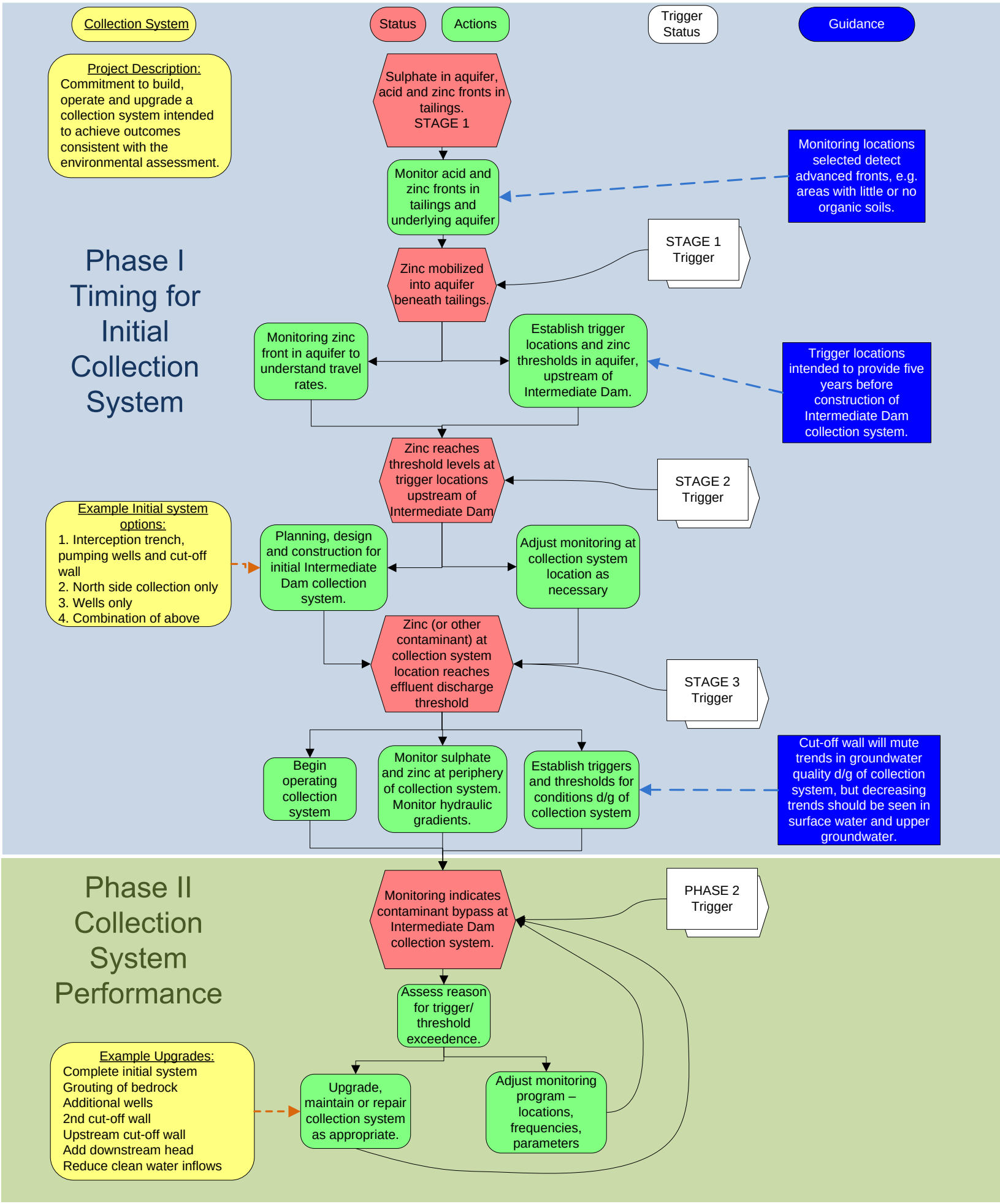


Figure 13.2 Contaminated Groundwater/Seepage AMP

