Reclamation and Closure Plan

Red Dog Mine, Alaska, USA

Prepared for

Teck Alaska Incorporated

Prepared by

SRK Consulting (U.S.), Inc.

329100.030

August 2016

Reclamation and Closure Plan

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List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollution Discharge Elimination System
ARD	Acid Rock Drainage
BMP	Best Management Practices
BTU	British thermal unit
CFR	Code of Federal Regulations
CONPAC	construction personnel accommodations complex
CSB	concentrate storage building
COSB	Coarse Ore Stockpile Building
DD-1	Diversion Ditch-1
DD-2	Diversion Ditch-2
DD-3	Diversion Ditch-3
DD-4	Diversion Ditch-4
DMTS	DeLong Mountain Regional Transportation System
HDPE	high-density polyethylene
IWMP	Integrated Waste Management Plan
LMPT	Large Mine Permitting Team
LOM	Life of Mine
ML/ARD	metal leaching/acid rock drainage
MOU	Memorandum of Understanding
MPD	Main Pit Dump
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
PAC	personnel accommodations complex
PMF	Probable Maximum Flood
SAG	semi-autogenous grinding
TAK	Teck Alaska Incorporated
TDS	Total dissolved solids
TSF	Tailings Storage Facility
WMP	Waste Management Permit
WRD	Waste Rock Dump
WTP1	Water Treatment Plant 1
WTP2	Water Treatment Plant 2
WTP3	Water Treatment Plant 3

Units of Measure

amsl	above mean sea level
C	Celsius
°	degree
ft	foot/feet
g	gram
gpd	gallons per day
gpm	gallons per minute
kg	kilograms
kW	kilowatt
lb	pound
m	meter
oz	ounce
pcf	pounds per cubic foot
ppm	parts per million
yd^2	square yard
yd^3	cubic yard

1 Introduction and Scope of Report

1.1 Purpose

Teck Alaska Incorporated (TAK) and NANA Regional Corporation, Inc. (NANA), as associates in the operation of the Red Dog Mine (Mine), are committed to protecting the environment and the people around the Mine. Part of that commitment includes developing plans for orderly closure of the Mine and reclamation of disturbed areas.

This document presents a comprehensive Closure and Reclamation Plan (Plan) for the Mine. Although current projections are that the Mine will remain in operation until 2030, closure and reclamation measures benefit from early plans that allow modification or restrictions of operations to facilitate long-term environmental protection. In addition, State of Alaska regulations require the early provision of funds to cover costs related to closure and reclamation, and the amount of such funds can only be determined from a thorough plan.

1.2 Applicant Information

1.2.1 Corporation Officer Completing Application

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Telephone: (907) 426-2170
Date: _________

1.2.2 Designated Contact Person

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Telephone: (907) 754-5138

1.2.3 Corporate Information

Business Name: Teck Alaska Incorporated
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Telephone: (907) 754-6170

President: Dale Andres
Treasurer: Les Panther
Secretary/Vice President: P. A. Pesek

1.2.4 Alaska Registered Agent

Name: CT Corporation Service Company
Address: 9360 Glacier Hwy, Suite 202
Juneau, Alaska 99801

1.3 Scope of Closure and Reclamation Plan

Figure 1 shows the location of the Mine. Figure 2 shows the boundary of the area considered in this Plan. The boundary corresponds to the limits of the Waste Management Permit **(2016DB0002),** and the current Air Quality Permit (**AQ0290TVP02**), and the boundary encompasses all areas that are permitted to be disturbed by operations (Appendix A provides a legal description of the property).

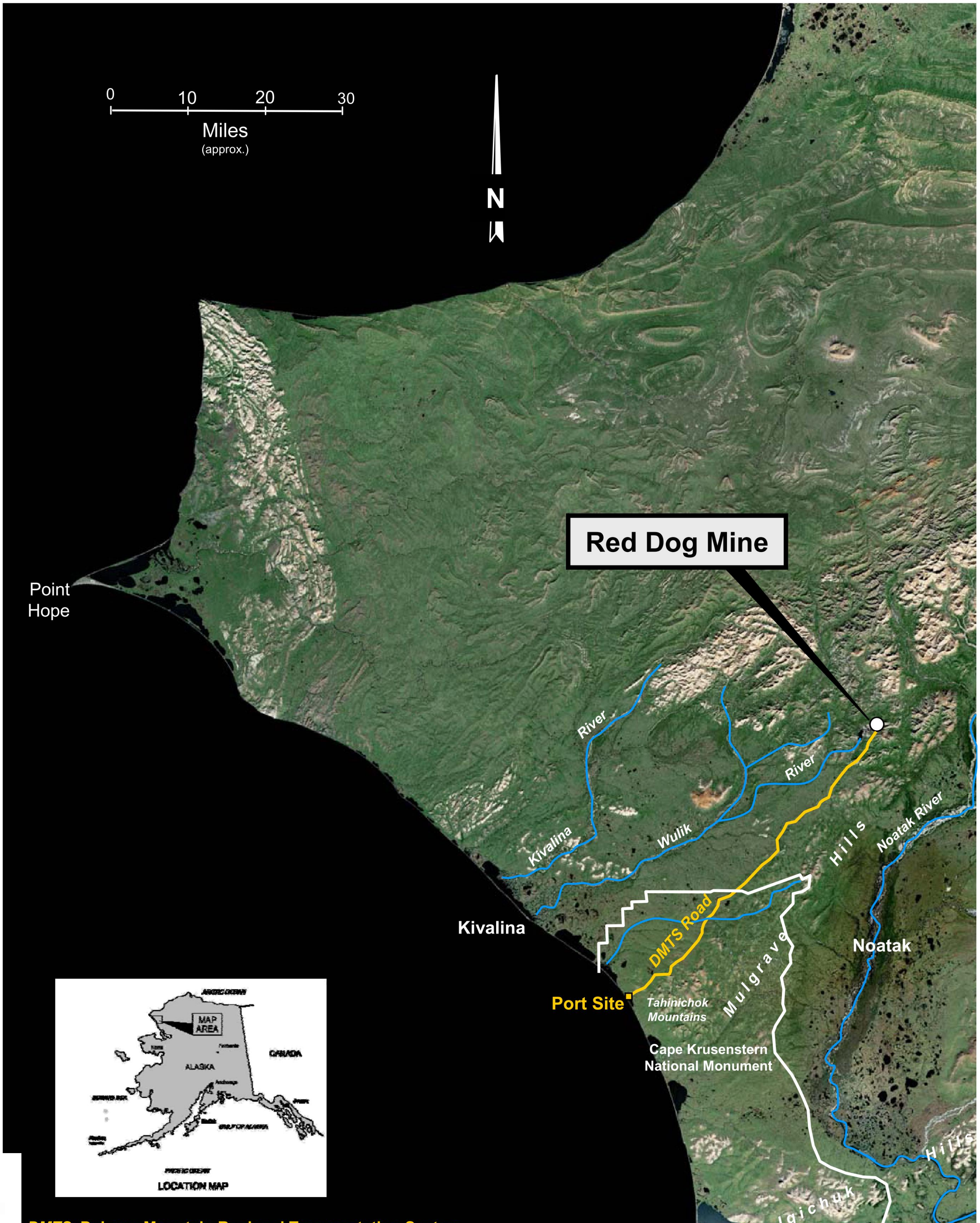
Port and road facilities shown in Figure 1 are generally outside the boundary and therefore outside the scope of this Plan. It is recognized that a comprehensive and global view of the area's environment must consider those features, but differences in ownership and use require that the Port and road be dealt with through other planning and regulatory processes.

The Plan considers three periods: operations, closure, and post-closure. Section 2 deals with the operations period, which is assumed to extend to the end of mining and ore processing, currently estimated at 2030. Changes to the site that will result from future operations are described. The long period of continuing operations will also allow for early reclamation of portions of the site. The closure period is assumed to begin when operations cease, and to extend until closure activities such as demolition, construction, and reclamation are complete. Section 3 describes the activities planned for the closure period.

The post-closure period is assumed to commence once the closure measures are completed, and to extend indefinitely thereafter. Water treatment, maintenance, and monitoring are post-closure activities that are expected to be required. Section 4 discusses the post-closure period.

The final section of this Plan, Section 5, presents a summary schedule and cost estimates covering all closure and reclamation activities discussed herein. It also discusses the costs that would be associated with premature closure of the Mine, i.e. prior to 2030.

This document is intended to present the proposed closure and reclamation activities in sufficient detail for most readers. However, technical reviewers may require more information in particular areas. A series of supporting documents are referenced where relevant in this Plan.



DMTS: **DeLong Mountain Regional Transportation System**

Source: Figures IV-15 and IV-16 of the 1984 EIS (EPA 1984)

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT DRAWN: JBM REVIEWED: APPROVED:	PREPARED BY: srk consulting	FIGURE TITLE: SITE VICINITY LOCATION
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	PROJECT: **RED DOG MINE** **RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016 REVISION: SRK PROJECT NO.: 329100.030 FIGURE NO.: 1

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TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: SDT	PREPARED BY: srk consulting	FIGURE TITLE: SOLID WASTE PERMIT BOUNDARY		
DRAWN: JBM				
REVIEWED:				
APPROVED:	PROJECT:			
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	**RED DOG MINE RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016	REVISION:	FIGURE NO.: 2
		SRK PROJECT NO.: 329100.030		

Red Dog Mine

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1.4 Reclamation and Closure Planning History

Consideration of closure and reclamation requirements was part of the earliest discussions about operation of the Mine. The Operating Agreement between NANA and TAK (the parties) has eight provisions that relate to environmental protection. Table 1 summarizes those provisions. The agreement called for a reclamation plan, first written in 1983 and revised in 1986. Reclamation plans were required by the State mining regulations adopted in 1992 (11 AAC 97.300 – 97.350). A reclamation plan was filed under that system, in 1994, and subsequently extended. Table 2 summarizes requirements of the State mining regulations. Neither the mining regulations nor the 1994 Plan covered other closure requirements.

In 1998, the State of Alaska Department of Environmental Conservation (ADEC) adopted Solid Waste Permit regulations (18 AAC 60.265) that have more comprehensive requirements for closure and reclamation planning, including provision for funding for long-term water treatment. Specifically, 18 AAC 60.265 states:

> "...(ADEC) will require proof of financial responsibility to cover the cost of closing a landfill and, if monitoring is required, the cost of post closure monitoring, if the department determines proof of financial responsibility is necessary to protect the public health, safety, welfare, or the environment. Proof of financial responsibility under this section may be demonstrated by self-insurance, insurance, surety, or other guarantee approved by the department to assure compliance applicable closure standards and post closure monitoring requirements."

A 2004 amendment to the State Dam Safety Regulation (11 AAC 93) has similar financial assurance requirements:

> "… the owner must provide a performance bond or other financial assurance adequate to provide sufficient money to pay for the costs of safely breaching the dam at the end of the dam's service life and restoring the stream channel and reservoir land to natural conditions, or for the costs of performing reclamation and post-closure monitoring and maintenance".

Table 1: Closure and Reclamation Provisions in the NANA – Teck Alaska Operating Agreement

(1)	The parties recognize that reclamation of disturbed lands is desirable.
(2)	The parties recognize that land disturbances related to surface mining and the deposition of tailings and waste rock are inevitable and complete return of all the disturbed land to its undisturbed condition is not possible.
(3)	Reclamation shall be generally designed to mitigate potential long-term danger to human life or the subsistence needs of the natives of the NANA Region, to mitigate any adverse visual or aesthetic conditions, and to the extent reasonably practicable, to restore the land to a condition compatible with surrounding land.
(4)	Disturbed land shall be restored to natural looking contours compatible with the surrounding terrain (it being recognized that the area of the mine excavation will not be refilled).
(5)	Where available in appropriate quantities, topsoil shall be separately removed and stockpiled for final application after reshaping of disturbed areas has been completed. However, the parties recognize that permafrost conditions could cause long-term stockpiling of topsoil to be impractical.
(6)	Appropriate measures shall be taken to control or reduce erosion, landslides and water runoff to the extent practicable.
(7)	Fisheries and wildlife habitats shall be rehabilitated to the extent practicable.
(8)	To the extent practicable, disturbed areas shall, through seeding, fertilizing, and other appropriate means be revegetated with a diverse vegetative cover of species native to the area and similar to that on adjoining areas.

Table 2: Reclamation Requirements in the State Mining Regulations (11 AAC 97.300 – 97.350)

"reclamation of the area so any surface that will not have a stream flowing over it is left in a stable condition to ensure:	11 AAC 97.200 (a)
• return of waterborne soil erosion to pre-mining levels within one year after the reclamation is completed, and that can reasonably be expected to achieve revegetation, where feasible, within five years after the reclamation is completed, without the need for fertilization or reseeding;	11 AAC 97.200 (a) (1)
• segregation of topsoil removed during the mining operation to protect it from erosion, protect it from contamination by acidic or toxic materials, and preserve it in a condition suitable for later use; and	11 AAC 97.200 (a) (2)
• promotion of natural revegetation wherever possible, including redistribution of topsoil where available"	11 AAC 97.200 (a) (3)
"reclamation of the area so that surface contours after reclamation are conducive to natural revegetation or are consistent with an alternate post-mining land use"	11 AAC 97.200 (b)
"reclamation of a pit wall is not required if the steepness of the wall makes it impracticable or impossible to accomplish; however, the wall must be left in a stable and safe condition"	11 AAC 97.200 (c)
"re-establishment of any stream channel, that was diverted and is no longer stable, to a stable location..."	11 AAC 97.200 (d)
"… reclaim a mined area that has potential to generate acid rock drainage (acid mine drainage) in a manner that prevents the generation of acid rock drainage or prevents the offsite discharge of acid rock drainage"	11 AAC 97.240

It is the intent of the State that all of the large operating mines file definitive closure and reclamation plans under the Solid Waste Permit and the Mining Reclamation regulations. The Large Mine Permitting Team (LMPT) comprised of representatives from the relevant state agencies under the coordination of the Alaska Department of Natural Resources (ADNR) was established in part to facilitate that process.

Discussions between TAK and the LMPT regarding an updated comprehensive closure and reclamation plan for the Mine started in 2002. A workshop to define requirements for additional technical studies was held in January of 2004. That workshop was attended by TAK staff, State staff, technical representatives of NANA, as well as many of the consultants who had worked on the site in recent years. Technical studies proceeded over the remainder of 2004 and continued into 2005.

That period included the completion of the *Red Dog Mine Development Plan* (TCAK 2004a), which provided the first definitive description of the future development of the Main, Aqqaluk, and Qanaiyaq Pits (extending the life of mine to 2030). Results of other technical studies were incorporated into a series of reports.

In parallel to the technical work, TAK and NANA undertook an intensive consultation program focusing on the communities of Noatak and Kivalina to ensure they were informed about the progress and the options under consideration. The consultation program also included meetings with other NANA communities, the NANA Subsistence Advisory Committee, the NANA Board and staff, the State LMPT and its consultants, and non-governmental organizations. In April and June 2006, two major workshops were held to provide interested stakeholders the opportunity for direct feedback on the selection of closure and reclamation measures. The workshops included representation from all of the groups listed above, and provided for both group and individual feedback. Results of the workshops indicated clear preferences for closure and reclamation options that formed the basis of the *Reclamation and Closure Plan* that was ultimately approved by the State of Alaska on December 2, 2009.

The current document has been prepared as part of a 2014 renewal of the *Integrated Waste Management Plan* (IWMP). It is largely an update to the 2009 *Reclamation and Closure Plan*, and incorporates sections of the earlier document where there have been no changes.

2 Site Components and Operations

2.1 Mine Area

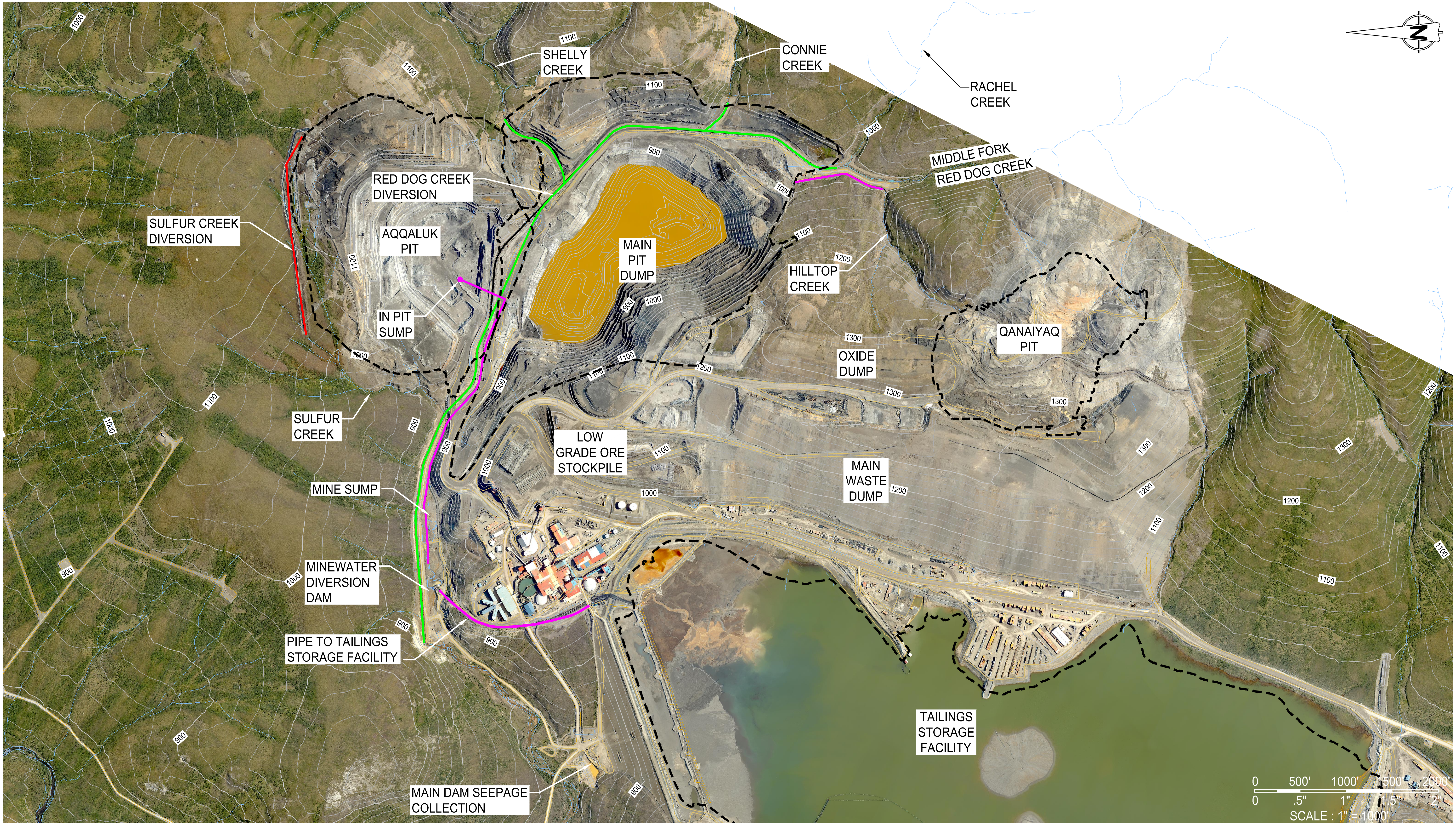
2.1.1 Current and 2030 Layouts

Figure 3 shows the current layout of the mine area, and identifies key mine components:

- Main Pit Dump, Aqqaluk Pit, and future Qanaiyaq Pit;
- Main Waste Dump, Oxide Dump, and Low Grade Ore Stockpiles;
- Middle Fork of Red Dog Creek, Rachel Creek, Connie Creek, Shelly Creek, and Sulfur Creek;
- Red Dog, Connie, Shelly, and Sulfur Creek diversion systems; and
- Mine Water Diversion Dam, Mine Sump, and piping to the Tailings Storage Facility (TSF).

The *Red Dog Mine Life of Mine Plan 2014-2030* has identified sufficient resources to support mining until the year 2030. Figure 4 summarizes the planned Life of Mine ore and waste production. The *Life of Mine Plan* (LOM Plan) is included in Appendix B. It is based on estimates of long-term metal prices and operating costs. Changes in metal prices or operating costs may affect future plans. For example, the Aqqaluk deposit continues north of the currently estimated pit limits, and an increase in metal prices could lead to expansion of the pit. Conversely, lower metal prices or higher operating costs could result in a reduction of the Aqqaluk Pit size. Future updates to the Reclamation and Closure Plan will address changes to the mining operation.

Figure 5 shows the mine area layout at the end of operations in 2031. The layout shown assumes continued mine and waste rock facility development, as well as concurrent reclamation measures.



RED DOG CREEK DIVERSION SYSTEM

SULFUR CREEK DIVERSION SYSTEM

MINE WATER COLLECTION SYSTEM

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT	
DRAWN: JBM	
REVIEWED:	
APPROVED:	

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PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: CURRENT MINE AREA LAYOUT

DATE: MARCH 2016

REVISION:

FIGURE NO.: 3

SRK PROJECT NO.: 329100.030

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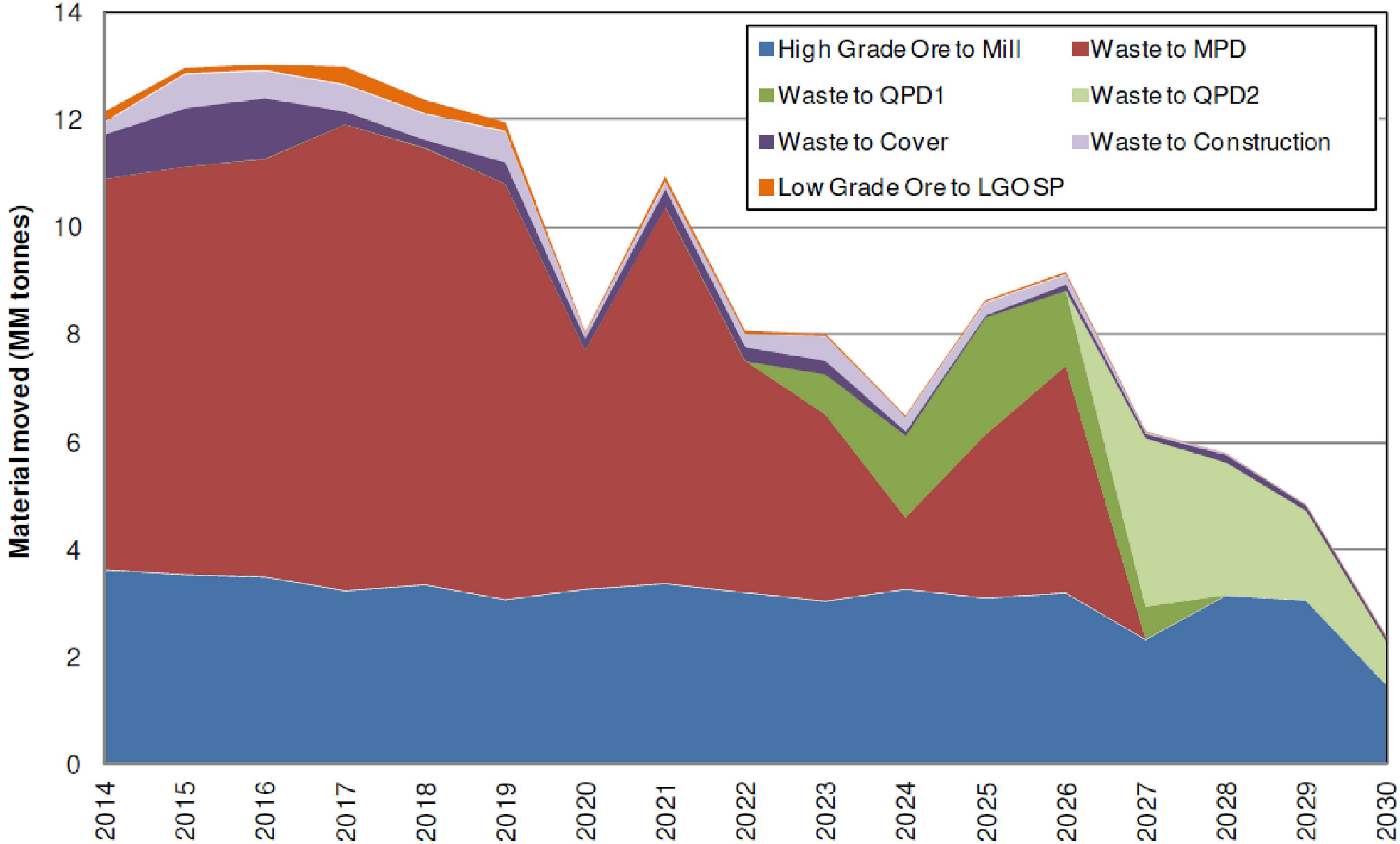

NOTE: WASTE TO COVER MATERIAL IS OVERBURDEN LOCATED WITH THE KEY CREEK PLATE. THE MATERIAL IS FOUND IN UPPER BENCHES OF AQQALUK PIT AND IS CURRENTLY BEING STOCKPILED FOR COVER ON THE MAIN WASTE DUMP. SEGREGATION CRITERIA IS CURRENTLY BEING REVIEWED. THE VOLUME AVAILABLE WILL EXCEED THE REQUIRED COVER VOLUME.

Red Dog Mine

DESIGN: RDM	PREPARED BY: srk consulting
DRAWN: IJC	
REVIEWED: BJ	
APPROVED: BJ	PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

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FIGURE TITLE: TOTAL MATERIAL MOVED BY DESTINATION (RECOVERED BASIS)

DATE:	REVISION:	FIGURE NO.:
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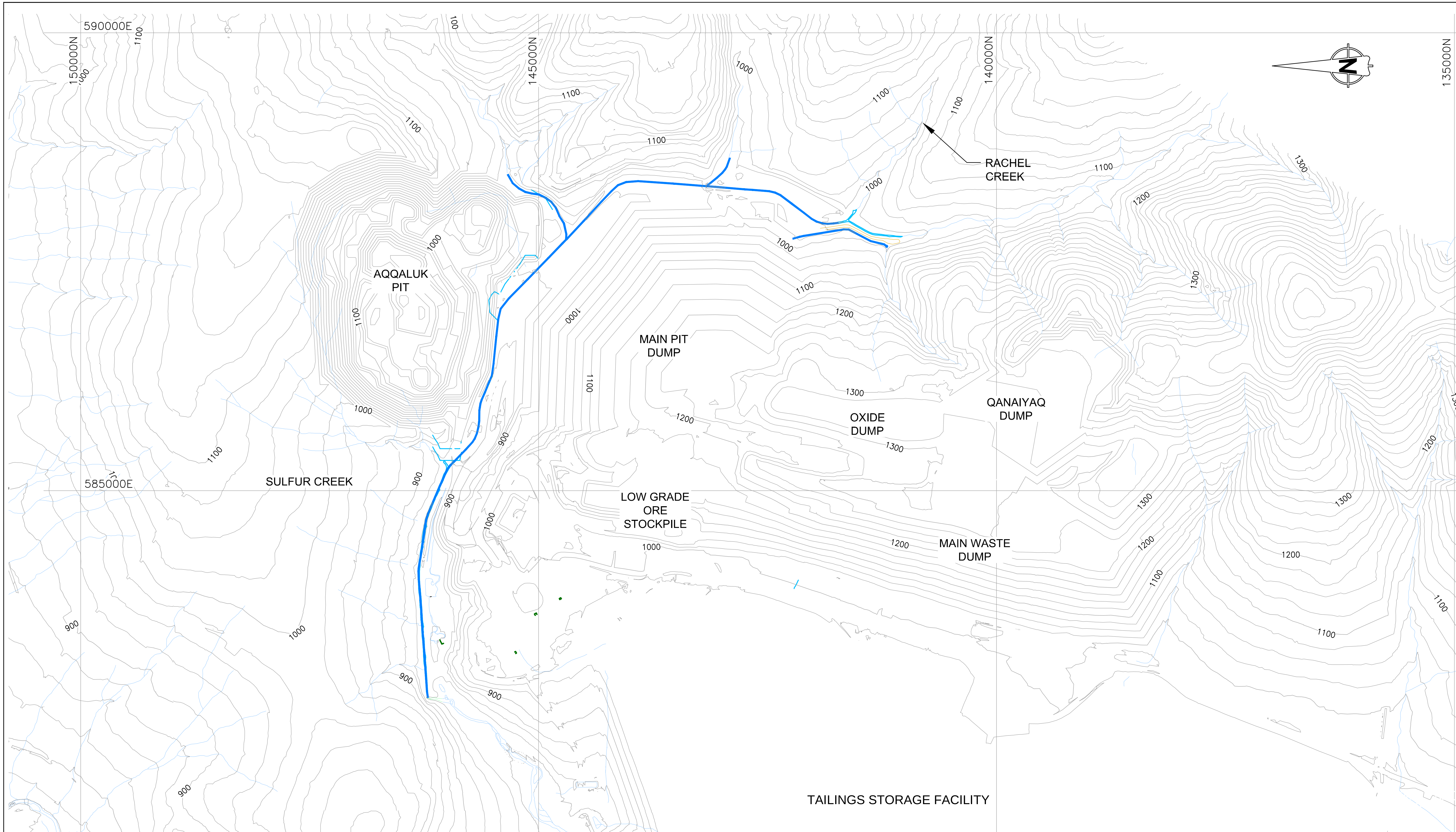

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PROJECT:
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	RED DOG MINE RECLAMATION AND CLOSURE PLAN

FIGURE TITLE: MINE AREA LAYOUT AT CLOSURE - YEAR 2031

DATE: MARCH 2016

REVISION:

FIGURE NO.: 5

SRK PROJECT NO.: 329100.030

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2.1.2 Pits

Main Pit

Mining in the Main Pit was completed in 2011. At that time, the Main Pit extended over a plan area of approximately 150 acres, with its deepest point at elevation 450 ft above mean sea level (amsl). Final design slope angles range from 41° to 47°. In 2012, approximately 640 million gallons of water from the TSF were transferred into the Main Pit. The current mine Plan requires waste rock from Aqqaluk and Qanaiyaq Pits to be placed into the Main Pit, filling the pit in its entirety and covering the pit walls by 2030.

Aqqaluk Pit

Mining of the Aqqaluk Pit was initiated in 2010, with an initial starter pit, followed by stripping overburden in 2011 and full production in 2012. TAK anticipates ore production through 2030 in the Aqqaluk Pit. Figure 6 illustrates the planned phases of development of the Aqqaluk Pit from current 2014 to 2030. The current LOM Plan assumes pit wall design slopes of 41° to 47°, with the final slope to be refined as mining operations continue and the walls are exposed for direct inspection and geotechnical evaluation. With the assumed slope angles, the pit will cover a plan area of approximately 115 acres, and the deepest point of the pit will be at elevation 450 ft amsl.

Qanaiyaq Pit

The LOM Plan indicates mining in the Qanaiyaq Pit is scheduled to begin in 2018, with cessation in 2027; however, TAK recently modified the mine plan to start Qanaiyaq Pit mining in 2016, as discussed in Appendix G. The final pit layout will vary slightly from the current Plan, but the overall disturbance footprint is not expected to increase. The Qanaiyaq Pit will be mined in two lobes. Waste material from the first lobe will be placed in the Main Pit Dump (MPD), and waste from the second lobe will be placed in the first lobe. Waste material from Aqqaluk Pit will be placed in second lobe of Qanaiyaq Pit.

The current LOM Plan assumes pit wall design slopes of 37°. Preliminary geotechnical drilling results indicate that the rock quality, rather than structure, will be the primary driver of slope instability. The final slope value will be refined as mining operations continue and the walls are exposed for direct inspection. Figure 7 shows the currently planned phases of pit development and final pit configuration. The area disturbed by the pit will cover approximately 77 acres, with a deepest elevation of 1,075 ft amsl.

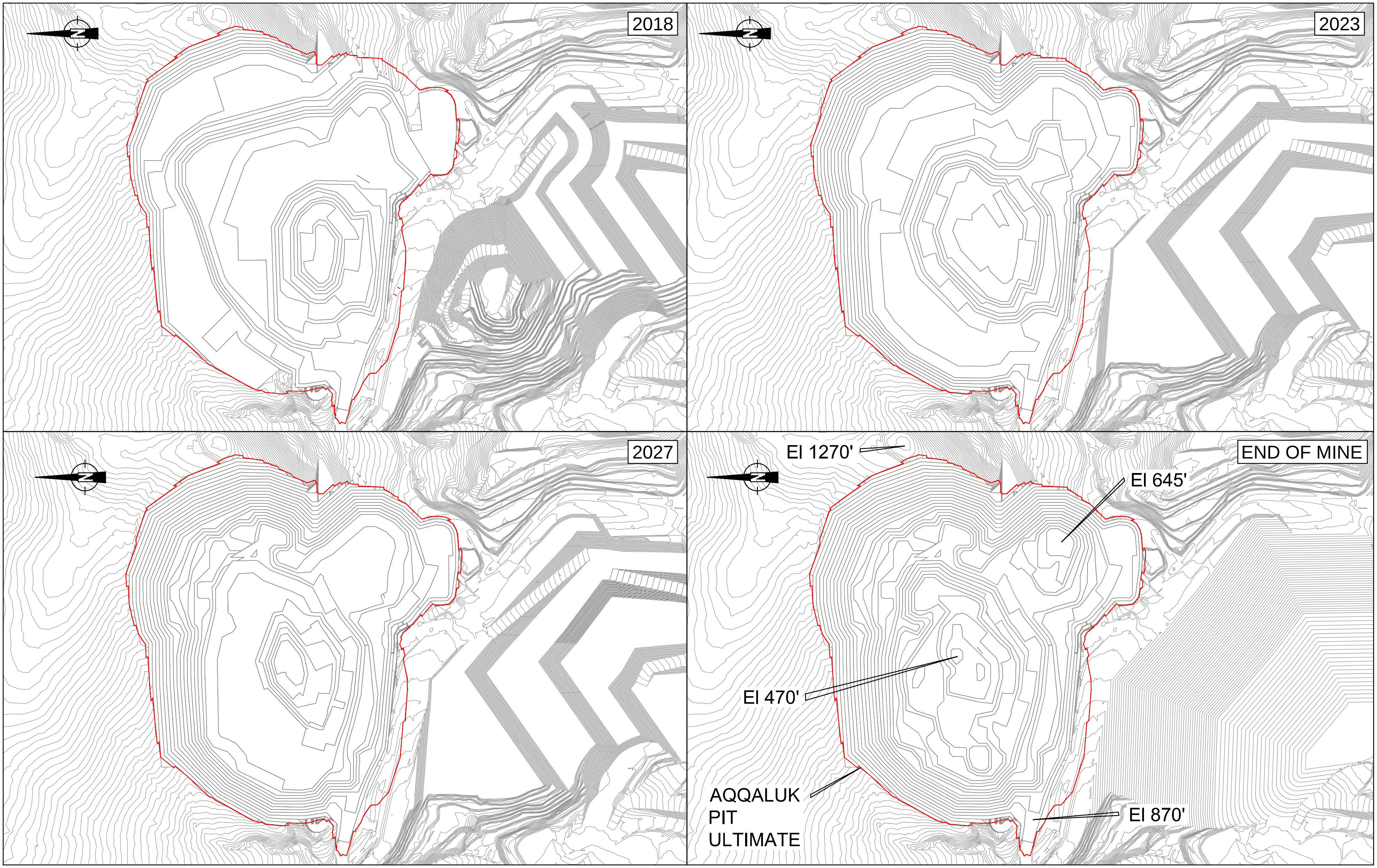
2.1.3 Waste Rock Dumps and Ore Stockpiles

Main Waste Dump

The Main Waste Dump (MWD) covers roughly 190 acres. The dump has been effectively inactive since 2012 and the dump face was recently re-sloped to 3H:1V. The final configuration may be adjusted pending geotechnical analysis for Qanaiyaq deposit. The section of the dump closest to Qanaiyaq will not be covered or revegetated until mining in the pit begins and geochemical characterization is confirmed. Portions of the MWD may be used for the first years of production instead of dumping waste in the MPD. Any additional low sulfide sulfur waste from the Qanaiyaq

Pit may be used to construct a domed surface to reduce the planar top surface of the MPD and enhance drainage.

The *Red Dog Mine Waste Rock Management Plan* (SRK 2016a) provides further information about the MWD and other waste rock areas.



0 550' 1100' 1650' 2200'

0 .5" 1" 1.5" 2"

SCALE : 1" = 1100'

Red Dog Mine

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: DST

DRAWN: JBM

REVIEWED:

APPROVED:

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PREPARED BY: srk consulting

PROJECT:

RED DOG MINE
RECLAMATION AND CLOSURE PLAN

FIGURE TITLE:

FOUR PHASES OF DEVELOPMENT OF AQQALUK PIT

DATE: MARCH 2016

REVISION:

FIGURE NO.: 6

SRK PROJECT NO.: 329100.030

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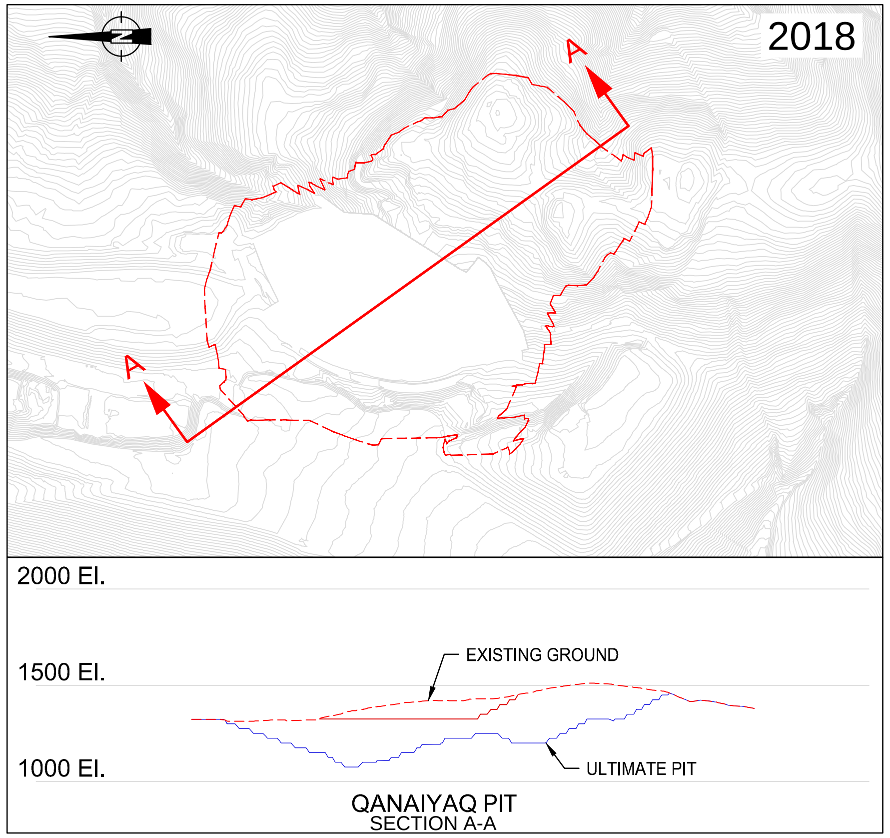

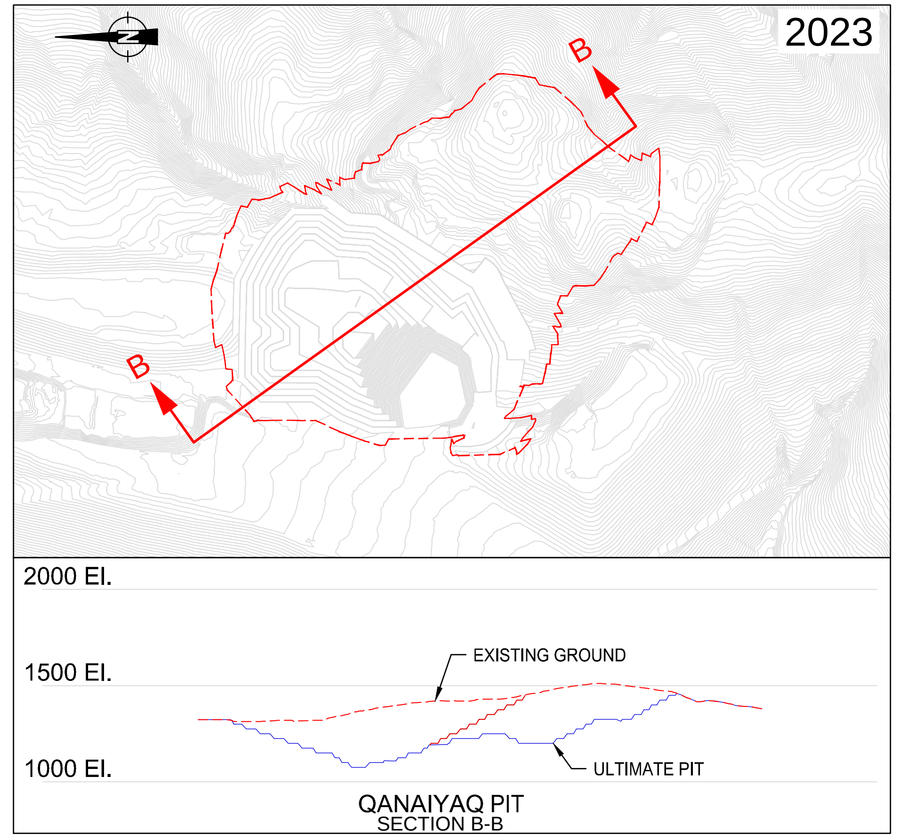

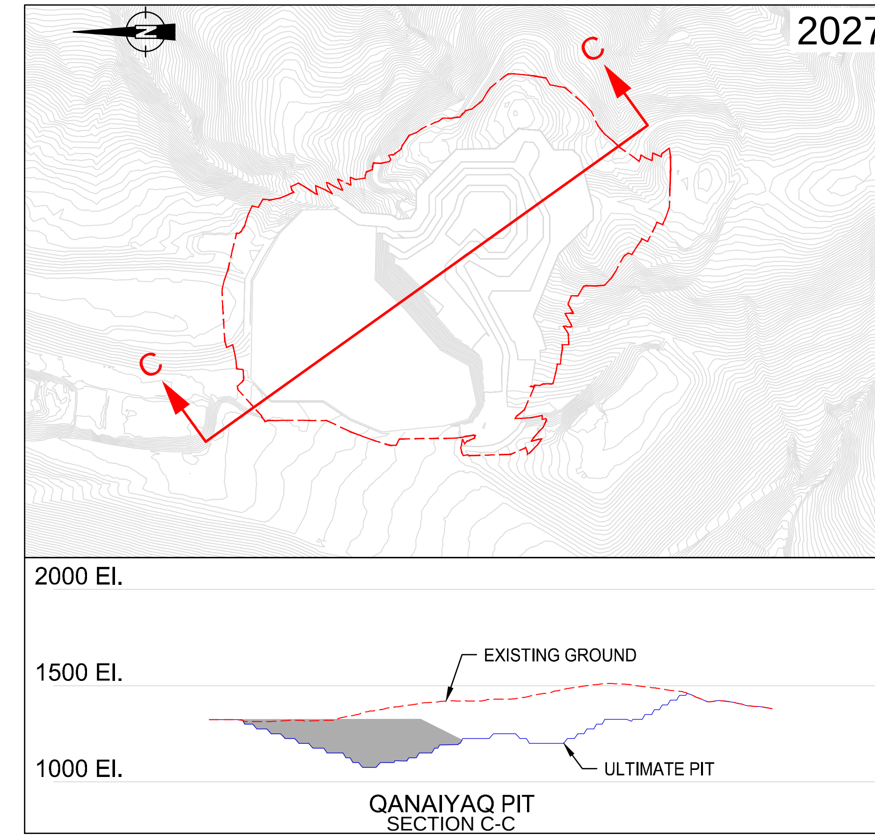

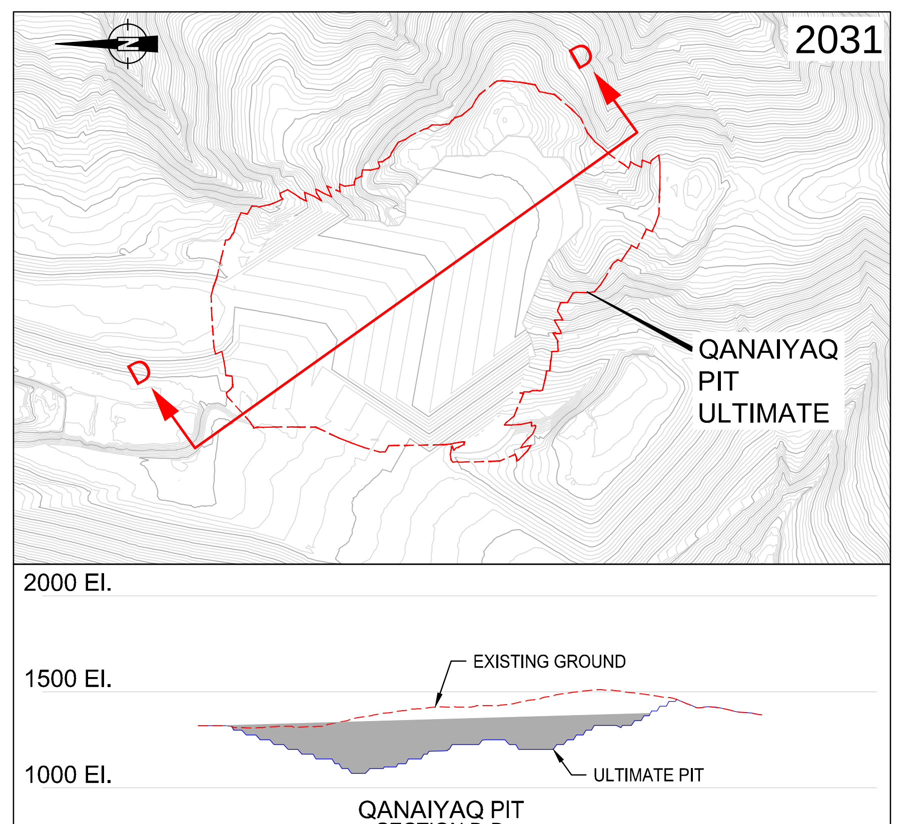

0 500' 1000' 1500' 2000'

SCALE : 1" = 1000'

Red Dog Mine

DESIGN:	
DRAWN: IJC	
REVIEWED: IJC	
APPROVED: RDM	

RDM

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PREPARED BY: srk consulting

PROJECT:

RED DOG MINE
RECLAMATION AND CLOSURE PLAN

FIGURE TITLE:

FOUR PHASES OF DEVELOPMENT OF QANIYAQ PIT

DATE:	REVISION:	FIGURE NO.:
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TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

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Figure 8 shows the MWD at the end of production in 2030. The highest bench of the MWD will have a maximum elevation of 1,300 ft amsl. The upper bench will be lower in the southwest corner to avoid interference with the flight envelope for the airport, which is just over a mile to the south.

Re-sloping and reclamation will be completed during the LOM. Details of the reclamation methods are discussed in Section 4 below.

The stability of the MWD was assessed as part of the initial designs in 1987, and reassessed in 1997, 2002, and 2003 (Golder 2003 and SRK 2005). The geochemistry of the MWD is reviewed in *Consolidation of Studies on Geochemical Characterization of Waste Rock and Tailings* (SRK 2003) and in *Supporting Geochemical Review and Interpretation* (SRK 2006). Key conclusions from these studies are that the majority of waste rock in the MWD weathers rapidly and either presently generates acid or has the potential to generate acid.

Main Pit Dump

The LOM Plan calls for approximately 87,350,000 tonnes of waste rock to be backfilled into the Main Pit. The resulting MPD is expected to cover approximately 150 acres. The pit will be allowed to fill with water to a maintained water level of 840 ft amsl by pumping into the tailings pond during operations and the Aqqaluk Pit after closure.

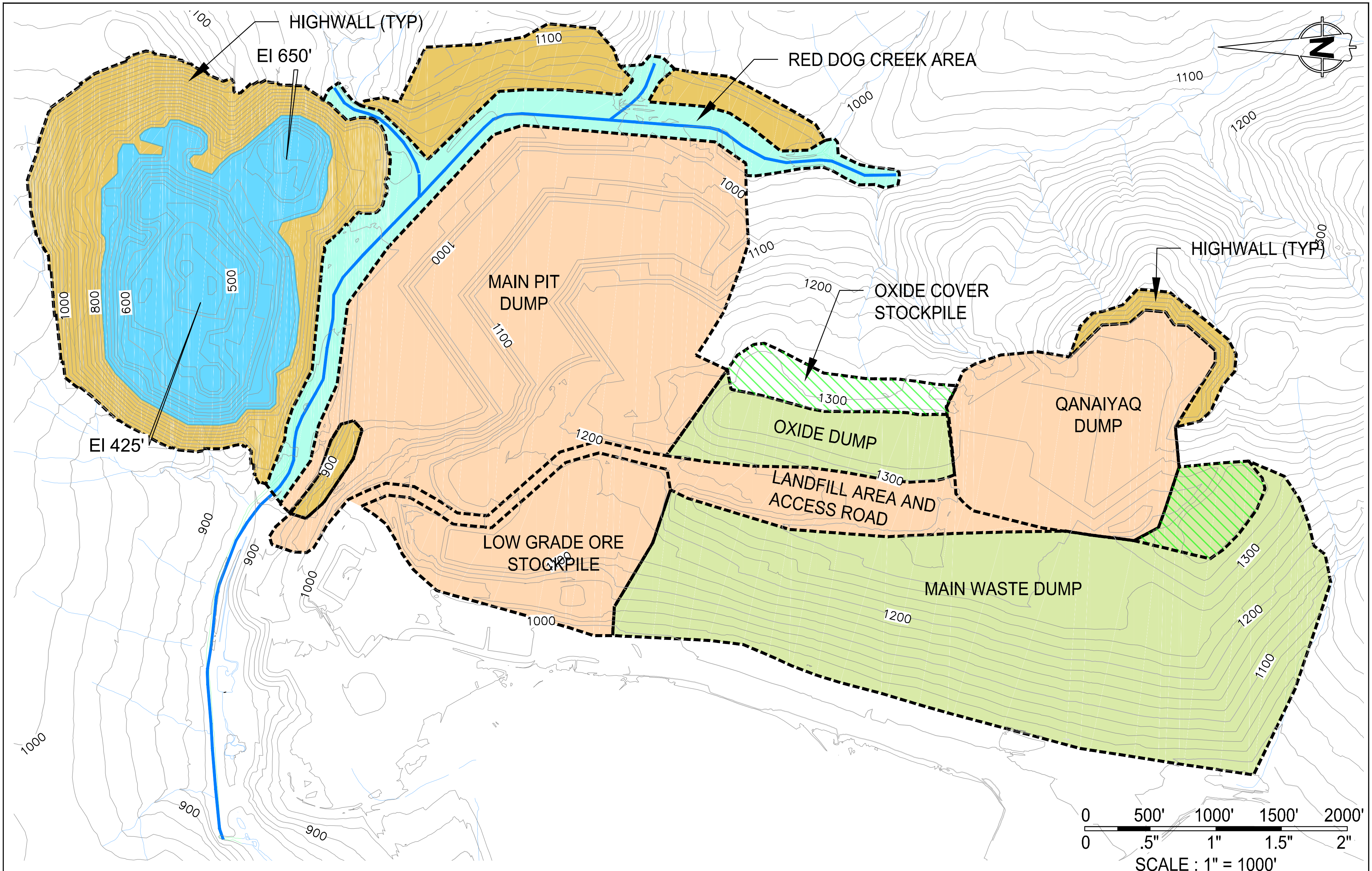
The majority of the waste rock that will be placed in the MPD will come from the Aqqaluk Pit, while approximately 17,500,000 tonnes will originate from the Qanaiyaq Pit. Waste rock from both of these deposits is similar to waste rock from the Main deposit in that the majority of the waste rock weathers rapidly and is potentially acid generating (SRK 2007a).

The LOM Plan also calls for Qanaiyaq waste to be placed on top of the MPD, where it will cover about half of the upper dump surface. However, further characterization of the Qanaiyaq waste may indicate that it would be preferable to encapsulate it in less reactive Aqqaluk material during LOM. Those details will be refined in future revisions of the Plan.

Stability assessments and material characterization have been completed on Aqqaluk waste rock. Based on the geology, it is very similar to rock in the MWD, and slopes have been designed accordingly.

Qanaiyaq Dump

Dumping in the Qanaiyaq Pit is expected to begin in 2022 and will continue through the remainder of the Aqqaluk and Qanaiyaq Pit mining.



TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT
DRAWN: JBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: LAYOUT OF WASTE DUMPS - YEAR 2030

DATE: MARCH 2016
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FIGURE NO.: 8
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Oxide Dump

The Oxide Dump covers about 30 acres. Oxide material has a high metal content, but cannot be processed in the current sulfide flotation system. The Oxide Dump was constructed on the TSF side of the ridge crest that separates the TSF catchment from the Middle Fork of Red Dog Creek.

Concurrent reclamation of the Oxide Dump began in 2008, and has included regrading, construction of a soil cover, and revegetation. Reclamation of the Oxide Dump is anticipated to provide valuable data for performance of the cover. The full scale test is being monitored for success of revegetation and soil stabilization. Performance of the cover will be evaluated over time and allow for refinements to the cover design during mining operations and considered in future cover designs for the site.

Low Grade Ore Stockpile

Currently, the Low Grade Ore Stockpile covers about 16 acres. The mine plan identifies additional quantities of low grade ore that will be mined from the Aqqaluk and Qanaiyaq deposits. As of the date of this Plan, it is assumed that low grade ore will be processed at the end of mine life. However, future cost effectiveness of processing low grade ore at the end of mine life is unknown and may not occur. Therefore for the purposes of the closure plan, it is assumed that the Low Grade Ore Stockpile will need to be closed and reclaimed.

Ore Stockpile(s)

To provide a consistent supply of ore to the mill, ore stockpiles are created and consumed as needed. All ore stockpiles are expected to be completely processed prior to closure.

2.1.4 Red Dog Creek Diversion

The term “non-contact water” refers to water that has not come into direct contact with mining activities or mine facilities. Examples include impounded fresh water, as well as surface water flows, and stormwater runoff diverted around mining infrastructure. Other than settling ponds to control turbidity, this water can be directly discharged without treatment. All non-contact water diverted or pumped must still meet water quality standards prior to discharge into navigable waters or waters of the State.

The main non-contact water drainage through the mine area is the Middle Fork of Red Dog Creek. Tributaries that enter the Middle Fork through the mine area are Rachel Creek, Connie Creek, Shelly Creek, and Sulfur Creek.

Flow is conveyed through the mine area in the Red Dog Creek Diversion, the major components of which are shown in Figure 9. The first section of the diversion starts below Hilltop Creek and is contained within a 96-inch-diameter, heat-traced culvert that is approximately 5,500 ft long and that runs between the Main Pit and the Aqqaluk deposit. The second section is a 3,200-foot-long, lined, open channel that runs from the culvert mouth to the Mine Water Diversion Dam area, where the flow re-enters the original stream channel. Intake weirs and/or pipelines direct Middle Fork, Rachel, Connie, and Shelly Creeks into the first section of the diversion (TCAK 2004b). Sulfur Creek enters the third section of the diversion. With the expansion of the ultimate Aqqaluk Pit shell, and the resulting changes in the Sulfur Creek clean water diversion, a permanent contact water ditch will be constructed as part of the diversion system. This ditch will prevent water from the active mining area from entering Sulfur Creek and ultimately Red Dog Creek.

The diversion system is designed to handle the estimated 100-year flow, with a safety factor of 1.3 (PN&D 2002). The 100-year design parameter is intended for the operations timeframe only; the channel will be redesigned to handle the 1000-year flow at closure, as discussed in Section 3.1.4.

2.1.5 Mine Water

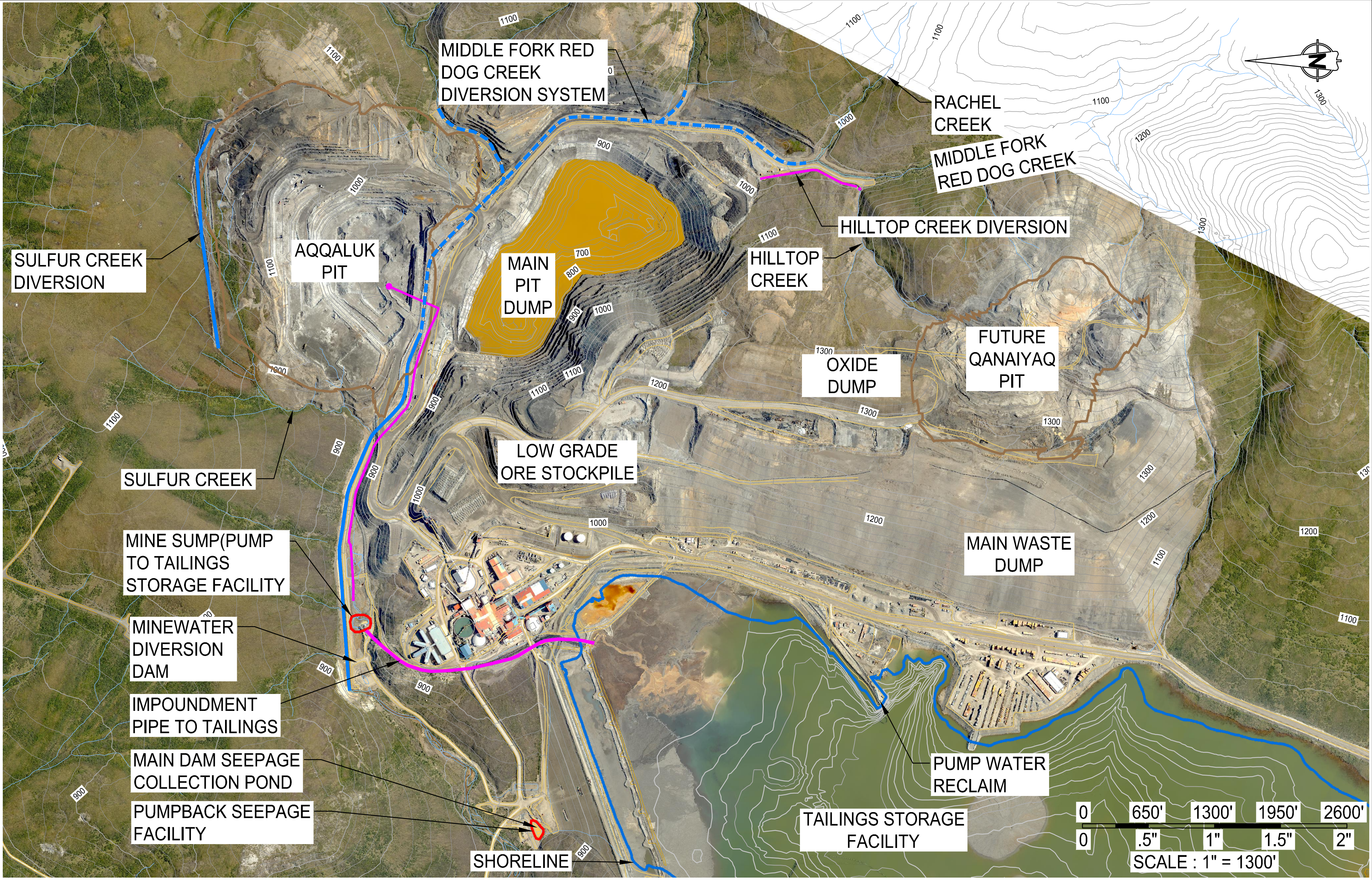
The term “contact water” refers to surface water and/or groundwater that has contacted mining facilities. This includes “mine drainage” defined in Title 40, Code of Federal Regulations (CFR) at 40 CFR Part 440.132(h) “as any water drained, pumped, or siphoned from a mine.” as well as storm water runoff and seepage from mining infrastructure”. Examples include runoff and seepage from waste rock piles, runoff and seepage from stockpiles, water that accumulates in the pit, or contacts metal leaching or acid generating rock. Flow rates and constituent concentrations in all contact water flows are discussed in Section 2.4 and in more detail in the *Red Dog Mine Water and Load Balance Update* (SRK 2016b). Primary collection points for contact water are the Main Pit, Aqqaluk Pit, MWD sumps, and Mine Sump. A total of eight pumps are available at the Mine Sump to pump water up to the TSF.

Contact water has potentially higher levels of suspended solids, total dissolved solids (TDS), and metals. Contact water is ultimately recovered from the TSF, treated and then discharged to Red Dog Creek at Outfall 001.

Other sources of water entering in the mine water collection system are:

- Hilltop Creek, which drains the east side of the ridge below the Oxide Dump and the Qanaiyaq deposit;
- Areas downstream of the diversion intake points for Connie Creek and Shelly Creek;
- The Aqqaluk and Qanaiyaq Pit areas;
- Groundwater seepage within the creek drainages not collected by the surface water diversion system;
- Surface infiltration from the Red Dog Creek and tributary diversion system; and
- The main haul road and truck run-out, located above and to the south of the Mine Sump.

Small areas above the confluences of Connie and Shelly are not captured by the diversion system, and flow into the mine collection system. Drainage from these areas is collected in French drains which pass under the diversions and into the Main Pit. Sulfur Creek runs through the area of disturbance associated with Aqqaluk Pit. Details of mine water collection from the Qanaiyaq Pit have not been finalized. Surface runoff from the Qanaiyaq deposit is presently being collected in the Main Pit or TSF, and development of the pit is not expected to significantly increase the volume of contact water. There could be slight increases from pit groundwater and from disturbed areas around the pits.



TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: DST	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

FIGURE TITLE: MINEWATER COLLECTION SYSTEM

DATE: MARCH 2016
REVISION:
FIGURE NO.: 9
SRK PROJECT NO.: 329100.030

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2.2 Main Waste Dump Seepage

A portion of the seepage from the MWD is collected in a series of interception wells located along the toe of the dump. This water is either pumped directly to treatment, or to the Main Pit. Seepage bypassing the interception wells flows by gravity into the TSF area. Section 2.4 discusses flow rates and constituent loadings.

2.3 Tailings Storage Facility

2.3.1 General Layout and Basin Bathymetry

The TSF is located in the valley below the MWD. Figure 10 shows the layout of the impoundment, along with topography and bathymetry from 2013.

2.3.2 Tailings

Tailings Physical Properties

Physical properties of tailings were provided by TAK: the specific gravity of tailings solids ranges from 2.87 to 3.18, based on composite samples from Main, Aqqaluk, and Qanaiyaq Pit ore; tailings gradation ranges from 68% to 93% less than 74 microns (No. 200 sieve). Tailings density information is presented in the *Red Dog Mine Tailings and TSF Water Management Plan* (SRK 2016c).

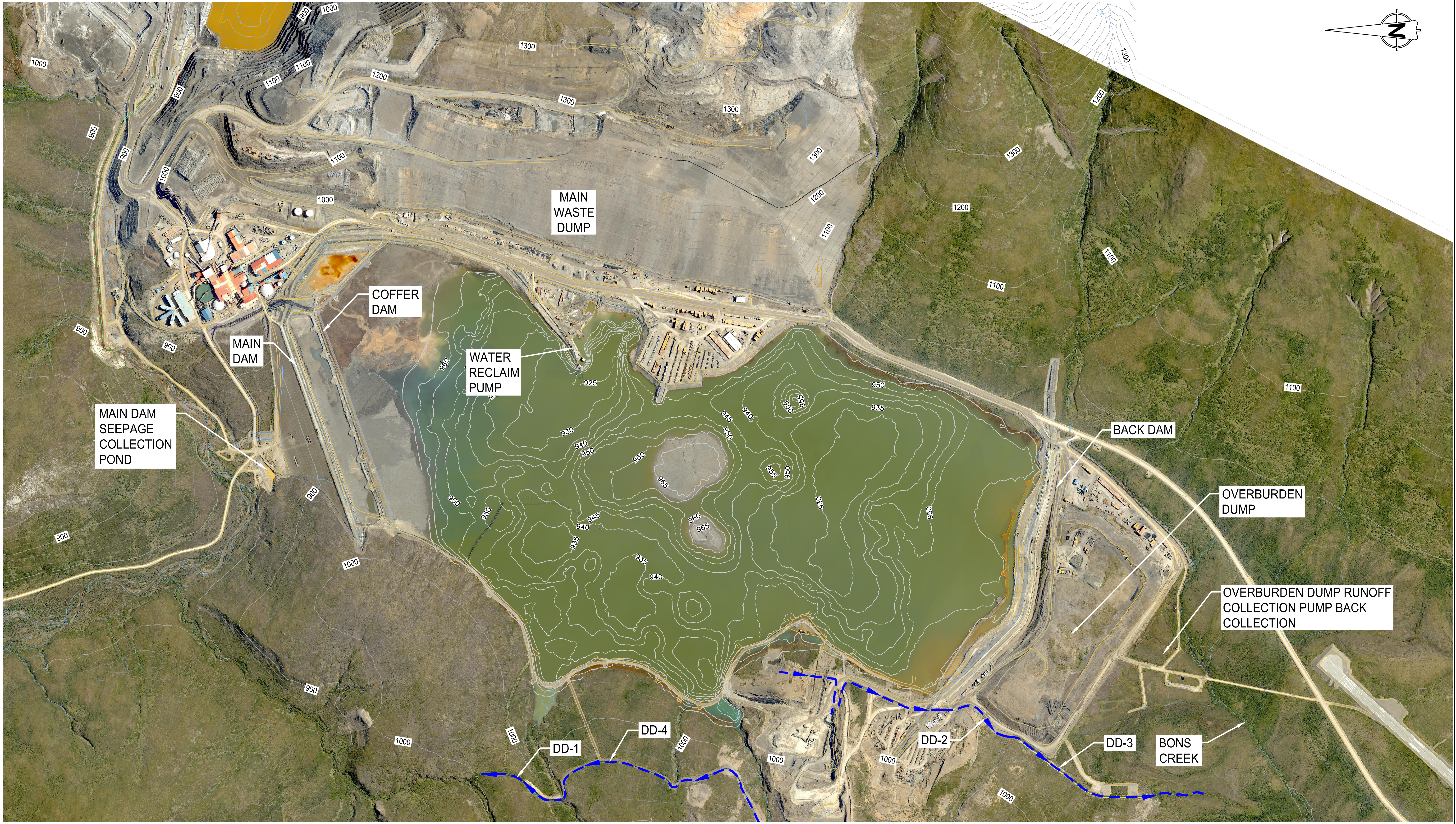
Tailings Geochemistry

Previous studies of the geochemistry of the tailings have been summarized in *Red Dog Mine Consolidation of Studies on Geochemical Characterization of Waste Rock and Tailings*, (SRK 2003) and *Red Dog Mine Closure and Reclamation Plan Supporting Geochemical Review, Interpretation* (SRK 2006). Key conclusions of the reports were:

- Content ranges for zinc are 2.4 to 6.2 weight percent, 1.2 to 2.8 weight percent for lead, and 4.6 to 11.4 weight percent for iron.
- Total sulfur content ranges from 9.65% to 16% (as S). Soluble sulfate, barite ($BaSO_4$) and galena (PbS) and anglesite (PbS-SO_4) account for roughly one-quarter of the sulfur. Sphalerite (Zn, Fe) S accounts for roughly another quarter, and pyrite (FeS_2) accounts for the remainder.
- Comparison of acid generation and neutralization potentials indicates that the tailings are acid generating. The acid generation potential is between 155 and 240 kg $CaCO_3$/tonne. The neutralization potential ranges from 0.4 to 9.4 kg $CaCO_3$/tonne.
- Humidity cell tests show evidence of preferential sphalerite oxidation. On a molar basis, zinc release was initially higher than iron release. Zinc release remained steady for about a year, with iron release slowly increasing. Leachate pH was acidic during this period, dropping to less than 3 as iron release increased. After about a year, sphalerite becomes depleted and zinc release decreases, with increases in iron observed at the same time. These observations are consistent with a galvanic interaction promoting the oxidation of sphalerite and delaying the oxidation of pyrite.

- The delay of pyrite oxidation creates a delay in the release of sulfate and acidity. The reason is that sphalerite oxidation produces less sulfate and less acidity than pyrite oxidation. In humidity cell tests, sulfate and acidity release rates increased by a factor of about 2.7 when the sphalerite was depleted.
- Maintaining a water cover over the tailings is an effective means to restrict oxidation and acid generation.

Ongoing monitoring and sampling results of tailings solids and decant solution are reported quarterly and there is no indication of any significant variations in the geochemical characterization of the tailings (TAK 2014).



CLEAN WATER DIVERSION

0 500' 1000' 1500' 2000'
0 .5" 1" 1.5" 2"
SCALE : 1" = 1000'

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT	
DRAWN: JBM	
REVIEWED:	
APPROVED:	

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: 2015 CURRENT LAYOUT AND BATHYMETRY (SEPT 2015) OF TAILINGS STORAGE FACILITY

DATE: MARCH 2016

REVISION:

SRK PROJECT NO.: 329100.030

FIGURE NO.: 10

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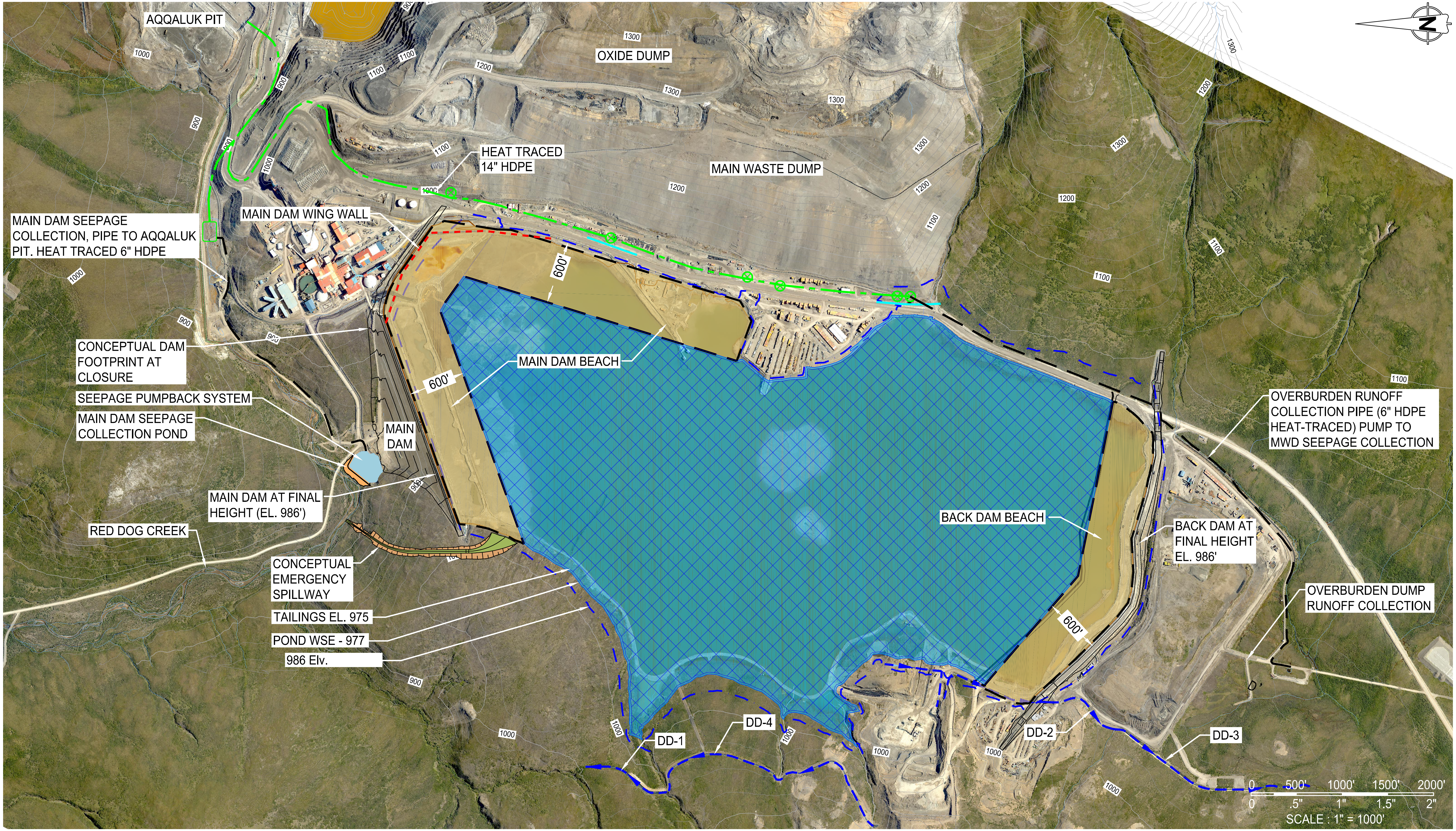
2.3.3 TSF Pond

The TSF Pond is a component of the Alaska Pollution Discharge Elimination System (APDES) treatment works, which allows for exceedances of water quality standards as defined in the permit. The TSF currently holds approximately 3.5 billion gallons, of free water. Inflow occurs throughout the year, but is dominated by spring freshet; direct precipitation, runoff from background areas, and inflows from the mine area add roughly 0.9 billion gallons to the Pond each year. Discharge of roughly 1.2 billion gallons per year of treated water is the dominant outflow, but occurs only during the open water season. Open water season normally begins by May 1 and normally ends by September 30. The dam operation permit requires that TAK maintain a freeboard of five feet below the crest of the Main Dam. An emergency spillway will be constructed with the final raise of the dam.

Figure 11 shows the expected limits of the tailings and the overlying water at closure in 2031. Sources of water and constituent inputs to the TSF Pond, along with pond water chemistry, are discussed further in Section 2.4 and in *Red Dog Mine Water and Load Balance Update* (SRK 2016b).

Ditches are currently in place in four locations to route non-contact water around the TSF Pond. The diversions are shown in Figure 10.

- Diversion Ditch 1 (DD-1) takes water from a draw on the slope above the west shore of the Pond and diverts it into the small catchment immediately west of the South Fork.
- Diversion Ditch 2 (DD-2) captures water from south of the DD-2 laydown area and routes it to the west end of the Overburden Dump.
- Diversion Ditch 3 (DD-3) extends DD-2 past the south end of the Overburden Dump.
- Diversion Ditch 4 (DD-4) captures additional water from the slope above the west shore of the Pond and routes it into DD-1.



MINIMUM POND ELEV. 977 FT.

TAILINGS YR 2030 ELEV. 975 FT.

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: IJC	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	

FIGURE TITLE: LIMITS OF TAILINGS AND POND AT CLOSURE

DATE:	REVISION:	FIGURE NO.:
MARCH 2016		11
SRK PROJECT NO.: 329100.030		

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2.3.4 Main Dam

Construction History

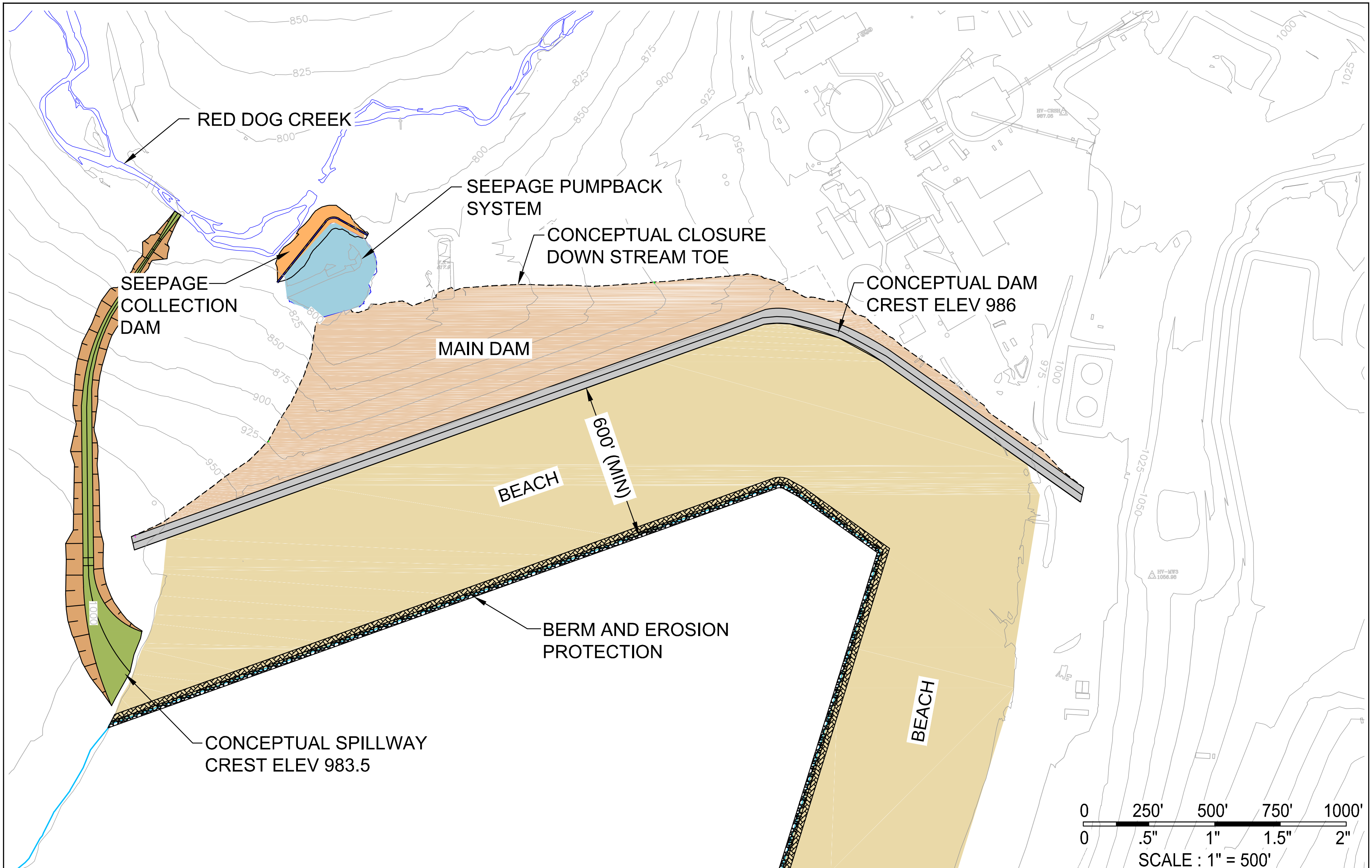
The Main Dam, located at the northern end of the TSF, is currently at a constructed maximum height of 198 ft., with a crest length of 4,983 ft. The dam has been constructed in ten stages, comprised of a starter dam and nine raises. Stage IX raised the dam crest to an elevation of 976 ft. Construction dates and crest elevations associated with each raise are provided in Table 3.

Table 3: Main Dam Construction Stages (from URS 2014)

Dam Stage	Year	Crest Elevation (ft amsl)	Maximum Height (ft)
Stage I (Starter Dam)	1988	865	75
Stage II	1989	890	102
Stage III	1990	910	124
Stage IV	1991	925	141
Stage V	1993	940	158
Stage VI	1993	950	172
Stage VII-A	2003/2004	955	177
Stage VII-B	2005-2007	960	182
Stage VIII	2008-2011	970	192
Stage IX	2012-2013	976	198
Stage X	By 2017	986	208

Future Raises

The current design for Stage X of the Main Dam calls for a crest elevation of 986 ft (URS 2014). A substantial extension will be needed where the dam passes over relatively flat ground to the east of the current structure. Figure 12 and Figure 13 show a plan view and conceptual section respectively of the proposed raise. Stage X dam construction will include widening the Stage IX embankment crest to 84 ft by downstream construction and additional upstream construction to widen the wing wall crest to 84 ft, and then adding a 10 ft raise to both the embankment and wing wall (URS 2014). The Stage X design report and prior documents include analyses of liner longevity, the potential for plugging of the underdrain, and the potential for earthquakes to cause settlement of the dam crest. Detailed analyses of stability and seepage through the raised dam are provided by URS (2014, 2007b, 2007c).



Red Dog Mine

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: SDT	PREPARED BY: srk consulting	FIGURE TITLE: CONCEPTUAL LAYOUT OF MAIN DAM AT 986 FT AMSL
DRAWN: JBM		
REVIEWED:		
APPROVED:	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED		REVISION:
		SRK PROJECT NO.: 329100.030
		FIGURE NO.: 12

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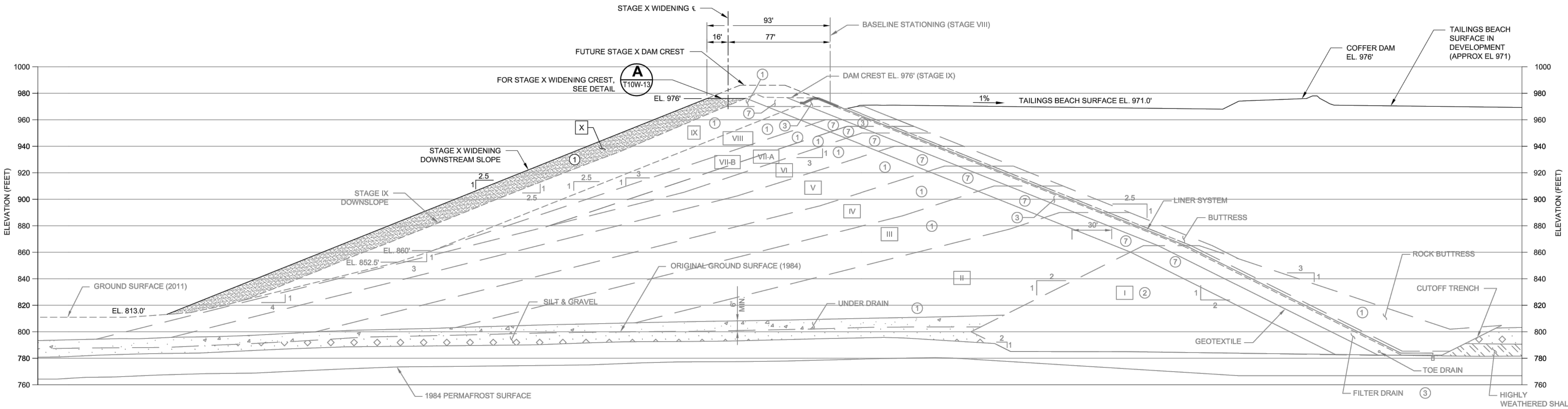
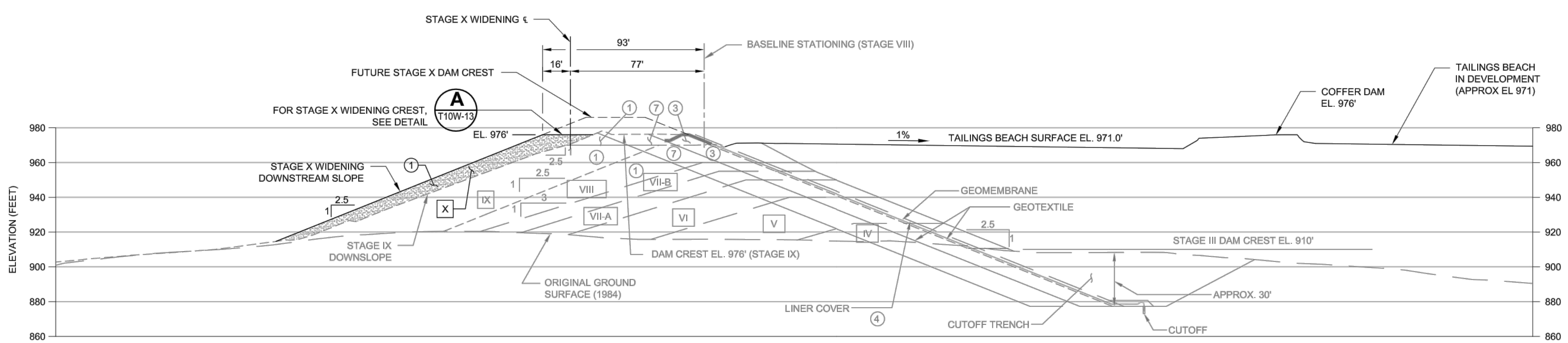


SECTION A
STA. 14+39
T10W-7

SCALE 0 40 80 FEET



SECTION B
STA. 9+79
T10W-7

SCALE 0 40 80 FEET

THIS DRAWINGS EXTRACTED FROM:
DESIGN REPORT
STAGE X WIDENING
RED DOG TAILINGS MAIN DAM
RED DOG MINE, ALASKA
URS JOB NO: 33764493
APRIL 11, 2014

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: SDT
DRAWN: JBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PREPARED FOR:

FIGURE TITLE: CONCEPTUAL SECTION THROUGH MAIN DAM AT 986 FT AMSL

PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

ISSUE:
DATE: MARCH 2016
SRK PROJECT NO.: 329100.030
REVISION:
FIGURE NO. 13

Foundation Conditions and Dam Components

The following points summarize key foundation conditions and dam components (SRK 2009):

- Foundation conditions below the dam include alluvial deposits varying in thickness from 4 to 8 ft, consisting of moderately graded silt, sand and gravel with occasional cobbles, overlying moderate to highly weathered shale with apparently non-continuous zones of clay gouge. An unfrozen talik was initially present along the creek alignment. The talik has grown wider and deeper and is predicted to reach a maximum width of about 800 ft if thawing continues. The thawed zone connects to sub-permafrost groundwater, but the sub-permafrost groundwater is isolated by a combination of impermeable geologic structures and the permafrost.

- Similar foundation materials occur in the left (west) abutment, with competent shale bedrock under the Stage IV raise and moderately weathered shale bedrock under the Stage VII raise.

- In the east abutment, colluvium overlies the highly weathered shale. The colluvium is typically about 5 ft thick, and consists of silty sandy gravel. Foundation conditions are more variable further to the east, below the Stage VII-B extension, with zones of fill up to about 20 ft in thickness, and fill up to greater than 25 ft in thickness. The fill consists of well-graded gravel and sand with cobbles. Data collected from thermistor TDAM T15, near the right abutment, indicates that permafrost has thawed to a depth of about 60 ft. Bedrock in the abutment includes zones of poorly durable black shale, with competent siltstone to the east of the current crest.

- The body of the Main Dam is a zoned rockfill structure constructed primarily with competent and durable material obtained from the mill site, the DD-2 borrow pit, and from mining in the Main Pit. The Stage IV raise also included zones of Kivalina shale, and blended Kivalina and Okpikruak shale. All raises have been by downstream construction.

- The upstream face of the dam is covered with 100-mil, high-density polyethylene (HDPE) geomembrane. The geomembrane is underlain by 1 foot of bedding consisting of rock crushed and processed to less than 1 inch. Below the bedding is a 16-oz, non-woven geotextile underlain by 8 ft of filter drain consisting of rock crushed to less than 3 inches. Below the drain rock is a second 10-oz. non-woven geotextile underlain by 12 ft of <12 inch rockfill. The HDPE geomembrane is covered with two protective layers, consisting of 1.6 ft rock crushed and processed to less than 1 inch, and 6.4 ft of random rockfill.

- Along the upstream toe of the dam, the geomembrane continues into a cut-off system. During the Stage I construction, a wide cut-off trench was excavated. The depth of excavation was greater than originally planned, so the design was refined in subsequent raises. The design for Stages II through VI called for a cut-off trench to be excavated to a depth of 30 ft below the ground surface, and a much narrower cut-off wall to be excavated to a depth of either 4 ft or to competent bedrock, whichever was greater. The geomembrane was inserted through the trench and into the cut-off wall excavation. Review of the construction records demonstrated that the cut-off wall was built according to the design in Stages II through IV, but that no cut-off wall was built in Stages V and VI because it was intended that tailings would cover the upstream face of the dam. The cut-off system for Stages V and VI was therefore constructed as part of the Stage VII-A and VII-B raises.

- A perforated drain pipe runs along the upstream toe of the dam, below the geomembrane, and collects any water that passes through. The pipe is connected to a gravel drain that runs under the dam along the base of the original valley. The gravel drain acts to keep the phreatic surface in the dam low.
- Tailings were placed to seal the upstream face of the dam starting in 1997, and a complete tailings beach formed by 2000. Due to dust concerns, the beach was allowed to become inundated over the period 2002 to 2004. A series of eight low rock berms were constructed across the beach to act as windbreaks, and a surface sealant applied where necessary. Seepage pumpback records indicate that the seepage rate decreased from about 600 to less than 100 gpm over the twelve months prior to August 2002, when the beach was not submerged. The implication is that the tailings beach contributes to seepage control. There are at least three possible mechanisms by which the beach reduces seepage rates: by forcing water to pass through a zone of low permeability tailings; by blocking the direct access of water to the random rockfill that is present above the geomembrane; or by keeping the pond away from permeable zones in one or both of the abutments.
- In the winter of 2005-06, a coffer dam was constructed along the tailings beach to provide a beach as the Pond rises. Current tailings beach information is presented in the *Red Dog Mine Tailings and TSF Water Management Plan* (SRK 2016c).
- The water treatment sand filters were relocated from the east abutment to an area near the WTP1 and WTP2, to facilitate future extensions of the dam and cutoff wall.

Seepage Collection System

A seepage collection and pumpback system is located about 250 ft downstream of the current toe of the Main Dam. The system consists of a pond formed by a lined Seepage Dam, which is less than 20 ft in height. Three pre-cast concrete pump chambers are set into the base of the pond, each fitted with a vertical turbine pump. The pumps are connected via pipes and a manifold system to a 14-inch-diameter HDPE pipe through which the seepage is transferred back to the TSF Pond.

Water volume pumped back from the seepage collection system below the Main Dam totals approximately 0.5 billion gallons per year:

- 2010, a volume of 436 million gallons
- 2011 a volume of 425 million gallons
- 2012 a volume of 562 million gallons
- 2013 a volume of 524 million gallons

Water chemistry data for the TSF seepage collection system are presented in the *Red Dog Mine Water and Load Balance Update* (SRK 2016b).

2.3.5 Back Dam

As the volume of tailings increases and the water surface rises, a back dam was required to prevent water from flowing into the Bons Creek drainage. A coffer dam was constructed in 2003 and 2004 to facilitate investigation and future construction along the northern toe of the

Overburden Dump, and the initial Back Dam, which was constructed in 2010. The current Back Dam elevation is 976 ft amsl.

The most recent Back Dam design report includes a future raise of the dam (Golder 2014). The design calls for additional waste rock to be placed to raise the dam crest to elevation 986 ft amsl. A cutoff wall would then be constructed from the new dam crest, to connect with the initial cutoff wall. Figure 14 shows the design of the Back Dam raised to elevation 986 ft amsl.

The conceptual design report for the Back Dam (Golder 2006) includes a seepage analysis. The analysis identifies seepage rates through the final dam to range from 20 to 40 gpm, for the case without a beach; while inclusion of a 600-ft wide beach is anticipated to reduce seepage rates to less than 20 gpm. As such and for the purposes of developing closure and reclamation costs, it has been assumed that a 600-ft-wide beach will be constructed. Continued monitoring of seepage during operations may lead to the conclusion that a narrower beach is adequate.

2.3.6 Overburden Dump

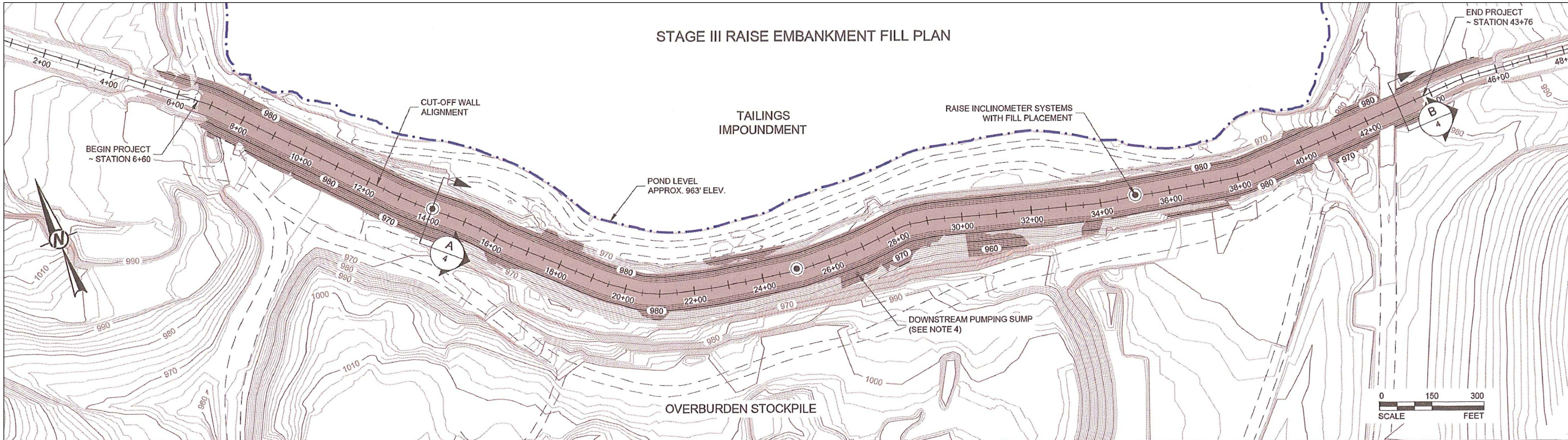
The southern end of the TSF area includes the Overburden Dump. The Overburden Dump has a plan area of 60 acres and a volume of approximately 6,600,000 cubic yards.

Material in the Overburden Dump consists of highly weathered, but relatively non-mineralized waste rock, stripped organic materials, and materials excavated from the tailings and mill site areas during construction. A survey of the dump surface in 2006 found it to be approximately 35% Kivalina shale, 25% Mélange, 20% Ikalukrok shale, 10% Okpikruak shale, and 10% Siksikpuk shale. Roughly 50% of the surface had zinc concentrations of less than 500 parts per million (ppm), and another 25% had zinc concentrations less than 1,000 ppm. Out of 21 samples, only one had a zinc concentration greater than 2,000 ppm.

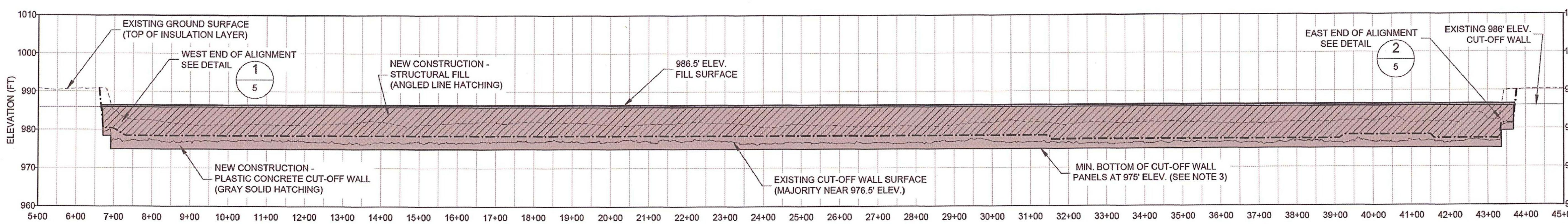
The Overburden Dump straddles the divide between the TSF and Bons Creek, and reaches a maximum elevation of approximately 1,020 ft. Prior to the dump construction, the lowest point of the divide was at an elevation of approximately 937 ft. A system of ditches, sumps, and wells on the Bons Creek side of the Overburden Dump captures runoff from the Overburden Dump. The collection system pumps the water back to the TSF Pond. Runoff from the Overburden Dump is approximately 50 million gallons per year.

Detailed water chemistry for Overburden Dump runoff is presented in the *Red Dog Mine Water and Load Balance Update* (SRK 2016b).

STAGE III RAISE EMBANKMENT FILL PLAN



STAGE III CUT-OFF WALL RAISE FILL PROFILE



EGEND

◉ INCLINOMETER / EXTENSOMETER SYSTEMS (6' OFFSET LEFT TYP.)

NOTES

1. FILL SURFACE SHOWN IN PLAN FOR RAISE CREST ELEVATION OF 986.5' ASSUMING ULTIMATE CREST ELEVATION OF 993.3' (SEE DRAWING 4). FILL SURFACE SHOWN IN PROFILE DOES NOT INCLUDE INSULATION LAYER.
2. PRIOR TO FILL PLACEMENT, CAREFULLY REMOVE AND REPLACE PROTECTIVE CASING FROM AROUND INCLINOMETER / EXTENSOMETER SYSTEMS. USE MEANS AND METHODS NECESSARY TO PROTECT THESE INSTRUMENTS DURING CONSTRUCTION.
3. EXCEPT FOR EAST AND WEST END OF ALIGNMENT, TRENCH EXCAVATION FOR MAJORITY OF CUT-OFF WALL PANELS SHALL BE TO A MIN. 975' ELEV. SEE DRAWING 5, DETAILS 1 AND 2.
4. INSTALL COMBINATION PIEZOMETER / TAC SYSTEMS AND SURVEY MONUMENTS AT SPECIFIED LOCATION AND DEPTHS FOLLOWING COMPLETION OF CUT-OFF WALL RAISE AND REPLACEMENT OF INSULATION LAYER.
5. RAISE SUMP PUMP CASING AND CONSTRUCT ROCKFILL WORK PLATFORM FOR ACCESS AS NECESSARY.

REFERENCE

EXISTING TOPOGRAPHY CONTOURS SHOWN WERE DEVELOPED FROM AREA-WIDE FIVE FOOT CONTOUR DATA CREATED FROM AUGUST 2010 STEREO PHOTOGRAPHY IMAGE (KODIAK MAPPING INC.) AND FROM 2012 AND 2013 TAK STAGE I AND STAGE II AS-BUILT SURVEYS OF BACK DAM. 1.3H:1V SIDE SLOPES WERE ASSUMED AT NORTHERN EDGE OF COFFERDAM ROAD (SOUTH END OF TAILINGS POND).

0 150 300
HORZ. SCALE FEET

0 15 30
VERT. SCALE FEET

THIS DRAWINGS EXTRACTED FROM:
STAGE III DESIGN
TAILINGS BACK DAM
GOLDER ASSOCIATES
PROJECT NUMBER: 13-02849
MAY 13, 2014

Red Dog Mine

DESIGN: SDT	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PREPARED FOR:
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	

FIGURE TITLE:
CONCEPTUAL LAYOUT AND PROFILE THROUGH BACK DAM RAISED TO ELEVATION 986 FEET AMSL

PROJECT:
RED DOG MINE
RECLAMATION AND CLOSURE PLAN

ISSUE:
DATE: MARCH 2016
SRK PROJECT NO.: 329100.030
REVISION:
FIGURE NO. 14

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.
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2.4 Water Treatment and Discharge

2.4.1 Water and Constituent Load Balance

Water and constituent load balances for the entire site have been developed. The water balance consists of a series of calculations that track water flows across the site, from precipitation through treatment and discharge. The constituent load balance is a similar series of calculations tracking constituent loadings from their respective sources to the "treatment works," which consist primarily of the TSF pond and the water treatment plant. Calculations, sources/inputs, calibration procedure, and results are described in more detail in the *Red Dog Mine Water and Load Balance Update* (SRK 2016b).

Figure 15 shows a schematic of the catchment areas and flow paths considered in the water balance during operations. Numbers on the schematic indicate average annual flows. The schematic shows that contact water on the site eventually ends up in the TSF Pond. As discussed in Section 2.1, seepage from the MWD, Oxide Dump, and Low Grade Stockpile contributes roughly 120 million gallons per year of water to the TSF Pond; mine water from the mine sump adds another roughly 40 million gallons per year.

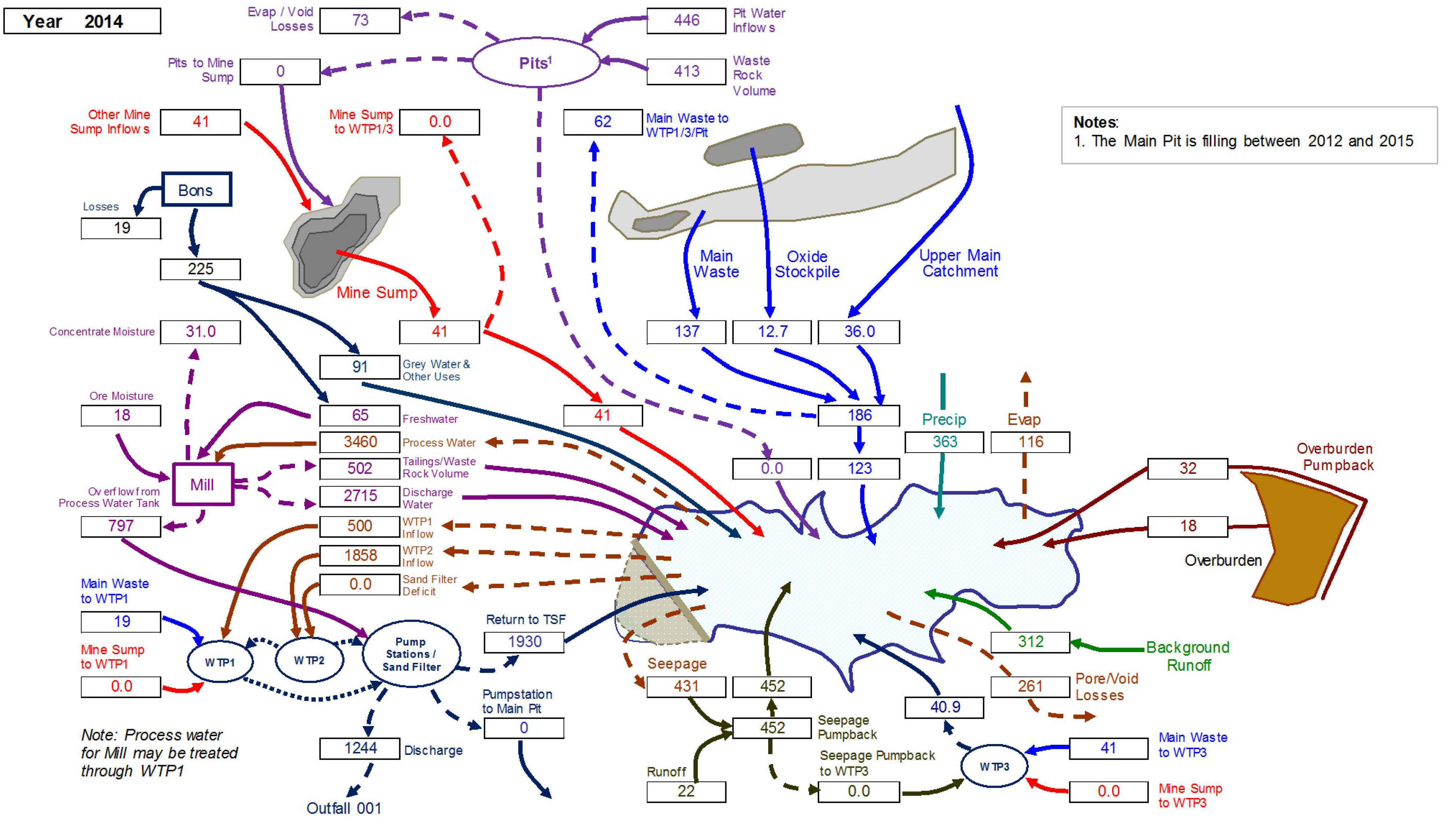
Major constituent concentrations from the mine area sources and TSF Pond are presented in detail in the *Red Dog Water and Load Balance Update* (SRK 2016b). Water and constituent load balances were used to simulate future operations and conditions after closure.

Red Dog Water Balance - Operations

Flows in MGals/year

Scenario: (A) During Operations: WTP3 at Current Capacity until 2015; Main Waste Seepage Concentrations Constant; Seepage Escape Decreased 25% by 2019; Late Implementation of Progressive Reclamation

At Closure in 2015: Main Waste Seepage Escape 25%, Cover Efficiency 75%, Mine Sump, Main Waste and Dam Seepage, Catchment 7, and Overburden Stockpile Pumpback Pumped to Pit



Red Dog Mine	DESIGN: RDM DRAWN: IJC REVIEWED: BJ APPROVED: BJ	PREPARED BY: srk consulting	FIGURE TITLE: WATER BALANCE SCHEMATIC AVERAGE ANNUAL FLOWS (MILLION GALLONS PER YEAR)
	IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN	DATE: MARCH 2016 REVISION: SRK PROJECT NO.: 329100.030 FIGURE NO.: 15

P:\Teck Alaska - Red_Dog\329100.030 IWMP\329100.030 IWMP\040_AutoCAD_GIS\Rec Plan Figures\Agency Draft Rev 2 -Figures SRK\FIGURE 15.dwg

2.4.2 Water Treatment

Contact water from the Mine and TSF areas is currently treated by three water treatment plants, located as shown in Figure 16. Potable water and sewage treatment are discussed under "Infrastructure" below.

Water Treatment Plant #1 (WTP1) can treat water reclaimed from the TSF Pond for use in the Mill or treat MWD seepage. Approximately 3 billion gallons of reclaim water is used in the Mill and returned to the TSF annually. Although this reclaim water has historically been pre-treated in the WTP1, currently this is not done. WTP1 is currently used to treat MWD seepage in the winter and TSF water during discharge season to increase discharge capacity.

Water Treatment Plant #2 (WTP2) treats water from the TSF Pond for discharge during the summer months via Outfall 001. About 60% of the water treated by WTP2 is released at Outfall 001. The remainder is returned to the TSF Pond along with the treatment sludge and filter backwash.

Water Treatment Plant #3 (WTP3) treats water from MWD seepage and discharges it to the TSF Pond. WTP3 treats approximately 30 million gallons of MWD seepage annually and operates during non-winter months.

All three plants use a lime treatment process. Lime is added to the water to raise the pH which results in metal hydroxide and gypsum (calcium sulfate) precipitates. WTP2 also includes sulfide addition to precipitate cadmium, and a sand filter system to remove suspended solids prior to discharge of water to Outfall 001. A review of water treatment methods was completed in 2004 (SENES 2004). The review concluded that lime addition is the preferred method of water treatment for the site, and water treatment efficiency could be improved by collecting higher strength water from the Mine Sump or MWD seepage and treating it prior to discharge into the TSF Pond. The latter is now being implemented through WTP3 and WTP1.

A further upgrade of the site's water treatment capabilities will likely be necessary around 2025, in order to reduce constituent concentrations in the TSF Pond prior to closure. A number of options remain under consideration, including direct liming of the Pond, and various modifications to the WTP1, WTP2, or WTP3. *Red Dog Mine Water and Load Balance Update* (SRK 2016b) includes a simulation case where WTP3 is upgraded in 2025 to treat all of the flows from the Mine Sump and MWD seepage.

2.4.3 Discharge of Treated Water

Treated water from WTP2 is discharged to the Middle Fork of Red Dog Creek at Outfall 001, which is also shown in Figure 16. The seasonal discharge is regulated by APDES Permit AK-003865-2 (April 8, 2014).

Since 1998, the total annual discharge at Outfall 001 has ranged from approximately 0.8 to 1.5 billion gallons. The exception was in 2012 when elevated selenium levels precluded discharging after June 30. In 2012 and 2013, approximately 640 million gallons of water from the TSF were transferred into the Main Pit. Until recently, annual discharges have been less than annual inflows, and the excess water has been stored in the TSF Pond. During future operations, however, it will be desirable to reduce the amount of excess water stored in the TSF Pond. The precise discharge requirements will depend on multiple factors, most importantly the volume of water in Red Dog Creek during freshet.

Red Dog Mine	DESIGN: SDT DRAWN: JBM REVIEWED: APPROVED:	PREPARED BY: srk consulting	FIGURE TITLE: PLAN OF MILL AREA - WATER AND DISCHARGE LOCATIONS
	IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016 REVISION: SRK PROJECT NO.: 329100.030 FIGURE NO.: 16

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2.5 Ore Processing Area

2.5.1 Process Overview

A site plan of the ore processing area is shown in Figure 16. Ore throughput is approximately 9,350 tonnes per day, for an annual concentrate production of about 1 million tonnes. The process flowsheet is shown in Figure 17.

2.5.2 Crushers

Primary crushing operations involve both a gyratory crusher and a jaw crusher. The gyratory crusher is housed in a building with associated systems, including the apron feeder and drive assembly for the conveyor belt that transports crushed ore to the Coarse Ore Stockpile Building (COSB). The older jaw crusher is located near the gyratory crusher and is operated when the gyratory crusher is down for maintenance. The jaw crusher is located in an enclosed building which also houses the feeder and related systems, and the drive system for the conveyor belt that transfers crushed ore to the coarse ore stockpile. Both crushers are equipped with baghouses to control dust.

2.5.3 Coarse Ore Stockpile Building

The COSB stores crushed ore prior to milling. It has a capacity of 16,500 tonnes and feeds conveyors that transport ore from the stockpile to the grinding circuit. The COSB and ore conveyors are completely enclosed. A baghouse to further control dust by creating a negative pressure in the COSB was installed in the third quarter of 2007.

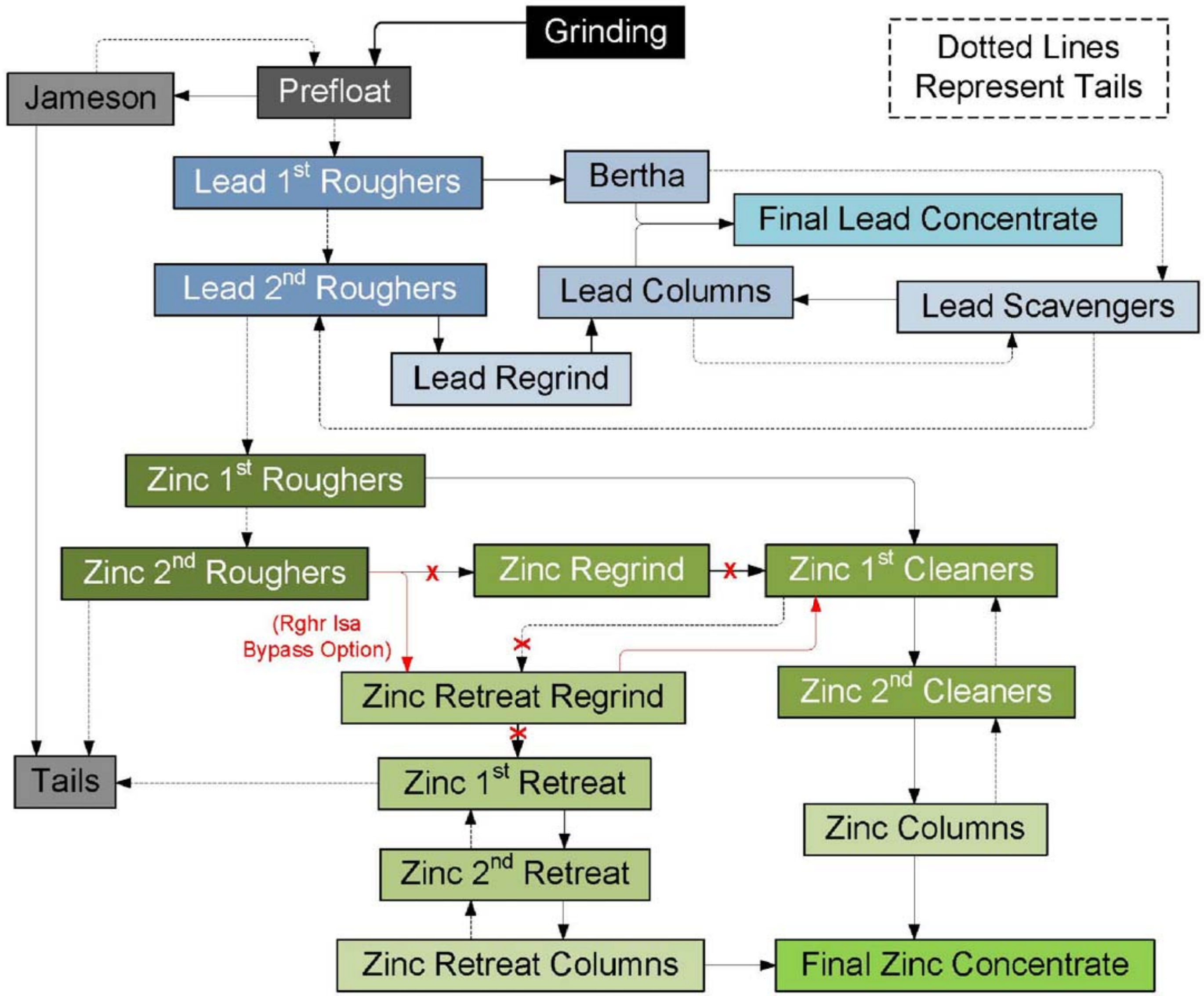
2.5.4 Mill Complex

The mill complex is enclosed. Inside the mill complex, crushed ore is subjected to primary and secondary wet grinding, lead and zinc rougher flotation and a regrinding operation, as well as lead and zinc cleaner flotation. In the primary grinding circuit, crushed ore is mixed with process water to form a slurry, which is wet-ground in semi-autogenous grinding (SAG) mills and ball mills that reduce the ore particle size to less than 65 microns.

Lead and zinc minerals are separated from the non-economic (gangue) minerals in the froth flotation circuits. Several stages of flotation are necessary to achieve high grade concentrate products with maximum recovery of economic minerals and an efficient separation of the lead and zinc minerals into their respective concentrates. The gangue minerals, referred to as tailings, are discharged in slurry form from the mill to the TSF for permanent storage.

2.5.5 Reagent Building

The reagent building is located to the west of the mill and is connected to it by an enclosed walkway/utilidor. The building provides temporary storage and facilities to mix process reagents, which are transferred to the mill via an enclosed utilidor. Reagents are mixed with water in mix tanks and transferred to day tanks from where they flow to holding tanks in the mill.



Red Dog Mine

DESIGN: RDM	PREPARED BY: srk consulting	FIGURE TITLE: MILL PROCESS FLOW SHEET	
DRAWN: IJC			
REVIEWED: BJ			
APPROVED: BJ	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016 / REVISION: ---	FIGURE NO.: 17
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED		SRK PROJECT NO.: 329100.030	

P:\Teck Alaska - Red_Dog\329100.030 IWMP\329100.030 IWMP\040_AutoCAD_GIS\Rec Plan Figures\Agency Draft Rev 2 -Figures SRK\FIGURE 17.dwg

2.5.6 Concentrate Storage Building

Slurried lead and zinc concentrates are thickened and filtered to approximately 9% moisture and transported via an enclosed conveyor to a concentrate storage building (CSB) adjacent to the mill. Filtered lead and zinc concentrates are stockpiled inside the building while awaiting shipment to the Port site. The CSB is completely enclosed and has a storage capacity of approximately 35,000 tonnes. Concentrate haul trucks enter the CSB along one side and front end loaders load the trailer with approximately 130 tonnes of concentrate. Haul trucks enter and exit the building through doors that are closed during loading. Concentrate is trucked about 52 miles from the CSB to the Port site, adjacent to the Chukchi Sea, where it is stored in two larger CSB's while awaiting the summer shipping season.

2.6 Infrastructure

Due to the remote nature of the site, the Mine includes extensive support infrastructure. Figure 18 shows the location of the facilities described below.

2.6.1 Airstrip

An asphalt airstrip capable of handling commercial jet aircraft is located approximately three miles south-southwest of the mill, in the Buddy Creek watershed. The airstrip is used year round to transport personnel, equipment, supplies, and perishables to and from the mine site.

2.6.2 Internal Roads

A series of internal roads provide access to each of the major facilities on site.

2.6.3 DD-2 Material Sites

The DD-2 material sites are located to the northwest of the Overburden Dump, in the drainage area of the TSF. The two sites are approximately 1,200 ft apart, connected by a road that runs along the western side of the TSF. Initially, both sites were used as borrow sites for non-mineralized construction rock. The northern site is still active, while the southern site, where suitable material was exhausted, is now used for storage of surplus equipment.

2.6.4 Personnel Accommodations Complex

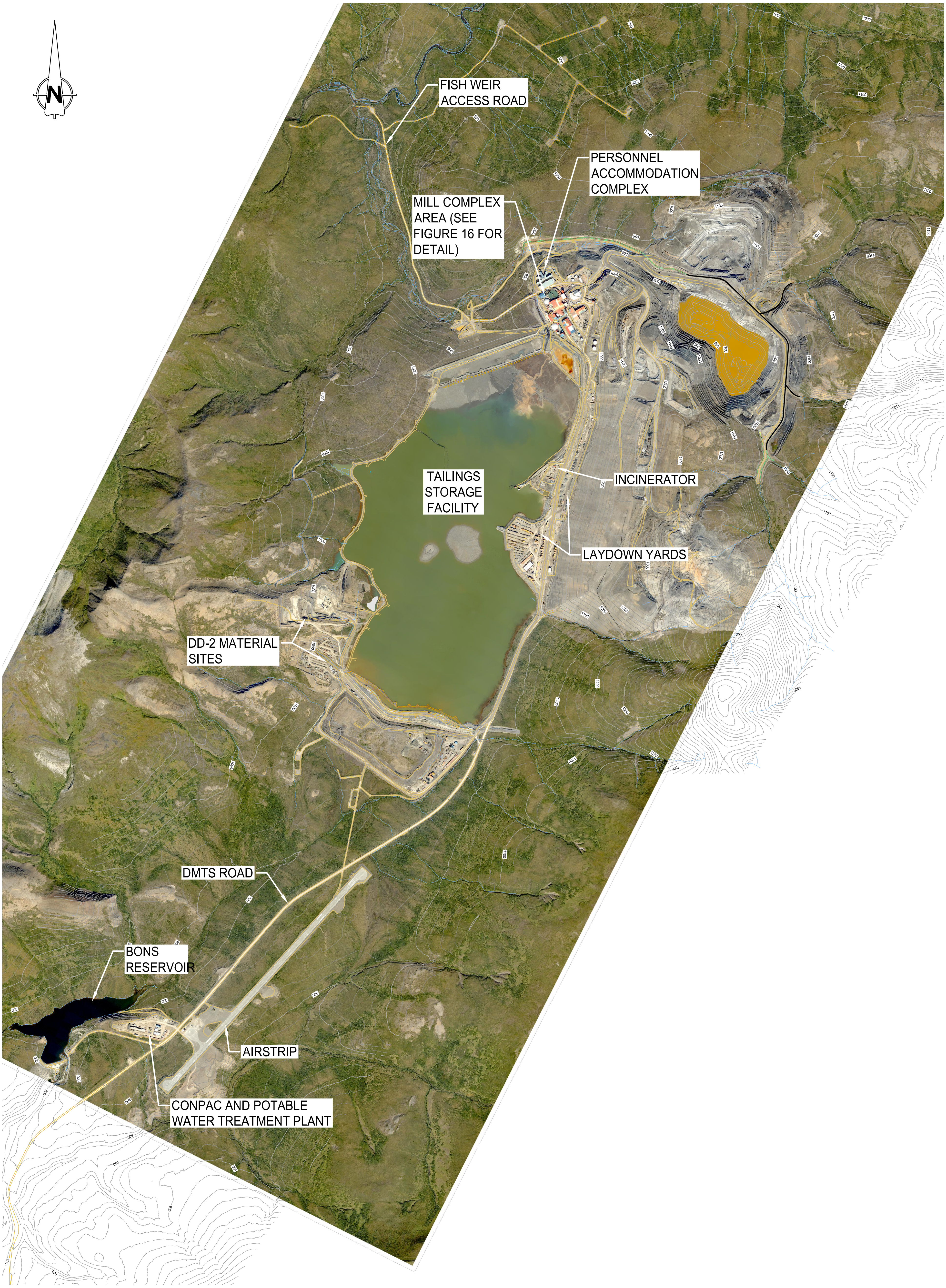
The personnel accommodations complex, or PAC, is located adjacent to the mill and connected to it by an elevated, enclosed utilidor. The PAC houses up to 365 people and includes kitchen, laundry, and recreation facilities.

2.6.5 Construction Personnel Accommodations Complex (ConPAC)

The construction personnel accommodations complex (ConPAC) is operated seasonally by contractors, as required, depending on construction and exploration activity. The camp is comprised of personnel living quarters, kitchen facilities, sewage and potable water treatment facilities, a backup generator, and an equipment staging yard.

2.6.6 Services Complex

The services complex is located on the mill site adjacent to the mill and CSB. The complex includes a warehouse, the analytical lab, the heavy equipment shop, and offices for administrative personnel.



0	1000'	2000'	3000'	4000'
0	.5"	1"	1.5"	2"

SCALE : 1" = 2000'

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: SDT
DRAWN: JBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

Red Dog Mine

PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: SITE INFRASTRUCTURE

DATE: MARCH 2016

REVISION:

FIGURE NO.: 18

SRK PROJECT NO.: 329100.030

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2.6.7 Powerhouses

Powerhouses that provide electric power to the site are located on the mill site, adjacent to the mill and CSB. Eight diesel-fired generators, each rated at 5,000 kilowatts (kW) electrical output, are shared between the two powerhouses. The generators are fueled with ultra-low-sulfur diesel. Heat is supplied to mine site buildings by waste heat recovery units that utilize diesel engine cooling water and exhaust gas to heat a glycol/water mixture circulated by pumps. Three 650 kW diesel generators are installed to supply emergency power. In addition, there are three standby water/glycol heaters rated at 8,000,000 British Thermal Units (BTUs) each to provide emergency heat in the event of a power failure.

2.6.8 Maintenance Shops

Mine and mill maintenance shops service equipment used throughout the operation and by contractors. The mill maintenance shop is part of the mill complex. The mine shop, which services mobile equipment, is part of the services complex.

2.6.9 Bons Reservoir

A fresh water reservoir and pumping system are located in the Bons Creek watershed near the airport. The reservoir was created by constructing a small dam across Bons Creek. The reservoir supplies water for drinking and other domestic uses as well as peripheral uses in the mill. The reservoir is filled during the summer by snow melt and precipitation. Fresh water is collected from the reservoir and pumped to the ConPAC and mill site through insulated, heat-traced pipe.

2.6.10 Potable Water Treatment Plant

The potable water treatment plant provides drinking water for on-site personnel. The plant treats raw water from Bons Reservoir near the contractors' personnel accommodations complex and supplies potable water at an average rate of approximately 30 gpm. Treatment includes polymer (flocculent) addition, two-stage sand filtering, and calcium hypochlorite (chlorine) disinfection. From the treatment plant holding tank, treated water is pumped to the PAC, mill complex, and services complex as well as to other small buildings within the mill site.

2.6.11 Sewage Treatment Plant

The sewage treatment plant is located between the PAC and the mill. Domestic waste water is collected from the PAC, mill, and services complex, and is processed and discharged to the TSF at an average rate of approximately 16,000,000 gallons per year. Average throughput is typically 30 gpm but this rate varies depending on time of day and camp population. Waste water treatment consists of solid/liquid separation and disinfection.

2.6.12 Explosives Handling and Storage

Ammonium nitrate, emulsions, water gels, cast boosters, electric and non-electric caps, and dynamite are stored in specialized explosives storage units built at the mine site.

2.6.13 Laydown Yard

The laydown yard, also known as cold storage, is located along the east side of the TSF about one mile from the mill, and is the major bulk materials storage facility at the site. The yard is used as storage for reagents, other mill supplies, and large heavy equipment parts, drums packaged for off-site shipment, HDPE liners, and other miscellaneous supplies that can tolerate freezing conditions. All materials except oversize items are stored inside shipping Conex units, which are, by design, watertight.

2.6.14 Fuel Storage

The Mine consumes about 40,000 gallons of diesel fuel per day for power generation, equipment operation, and vehicle use. Fuel is shipped by barge to the Port site during the summer for storage and then transport to the mine site. The mine site has two 200,000-gallon fuel tanks (# 1 and #2), one 1,200,000-gallon tank (Tank #3), and one 1,140,000-gallon tank (Tank #4). The tanks are constructed on gravel pads that consist of several feet of structural fill material placed on a geotextile liner. The secondary containment and the area immediately surrounding the tanks are lined with a flexible membrane liner.

2.6.15 Natural Gas Project

Not shown on Figure 18 are facilities associated with the Natural Gas Project, which TAK may continue to evaluate the feasibility of extracting shale-hosted methane gas. The facilities include a road, five drill pads for the well casings, pump shacks, a 7,000-foot water line, and a pump station south of the North Fork of Red Dog Creek. Water from the exploration wells was pumped to the Main Dam seepage collection pond. The Natural Gas Project is in the process of being decommissioned.

2.6.16 Solid and Hazardous Waste Management

Solid waste is managed in accordance with the requirements of the Resource Conservation and Recovery Act and the Alaska Solid Waste Management Regulations (18 AAC 60).

Two incinerators are located along the east side of the TSF and north of the laydown yard, and are used for burning all putrescible wastes, drained oil filters and oily absorbent pads, paper and other combustible, non-hazardous solid waste. One active solid waste landfill is located at the mine site, in the MWD.

The landfill is used for the disposal of incinerator and burn pit ash, construction waste, and domestic garbage. The landfill is operated under permits specifying covering, grading, working face size, etc., and according to documented procedures. At the end of mine life, the landfill will be closed in accordance with 18 AAC 60 and State of Alaska Waste Management Permit No. 0132-BA002.

Hazardous wastes are disposed of offsite at permitted Treatment, Storage, and Disposal Facilities regulated for handling hazardous wastes. Most liquids wastes are shipped offsite for disposal or recycling. Glycols are cleaned and/or recycled on site where possible. Used oil from operations is mixed with diesel and burned onsite for energy recovery, where feasible. By-products of the used oil recovery process are shipped offsite as used oil. Liquid wastes are stored in Conex units prior to shipping offsite. Solid waste items shipped offsite, such as batteries, are stored in sealed containers and Conex units prior to shipping.

2.6.17 Fugitive Dust Management

Fugitive dust emissions within the air permit boundary are controlled using a variety of methods, including enclosures and stationary dust control devices for coarse ore and concentrate handling areas, addition of palliatives and control of water levels for the tailings beaches, and watering and calcium chloride application for roads and laydown areas. TAK has implemented evaluation programs and construction upgrades to facilities to improve fugitive dust control, and more improvements are in the planning stages.

3 Closure and Reclamation Methods

3.1 Mine Area

3.1.1 Overview

Figure 19 summarizes proposed closure methods for the mine area. Closure methods are based on options selected through the consultation process described in Section 1.3. Primary closure objectives are:

- Limiting safety hazards and acid generation associated with the pit walls;
- Allowing reclamation of waste rock dump areas and limiting the release of acidic drainage;
- Keeping non-contact water in the Red Dog Creek Diversion; and
- Ensuring all contact water is collected and treated prior to discharge.

3.1.2 Pits

The Main Pit will be backfilled during operations with waste from the mining of Aqqaluk and Qanaiyaq Pits. Two portions of the Main Pit highwall, a section of the southwestern highwall, and a section of the northeastern highwall would remain exposed after reclamation. Figure 19 depicts these areas.The wide and accessible benches in that area would be covered and revegetated in the same manner as the WRDs (see next section). The crest of the highwall along the eastern limit of the pit would be blasted back to a 4H:1V slope to allow snow machine operators to see the pit wall in sufficient time to stop safely.

Aqqaluk Pit will be used as a sump for contact water storage. The contact water within the pit will be maintained at an elevation of no more than 850 ft amsl. The remaining wide and accessible benches will be covered. Boulders and berms will be placed near the rim of the pit to demark the high wall as a hazard for snow machines.

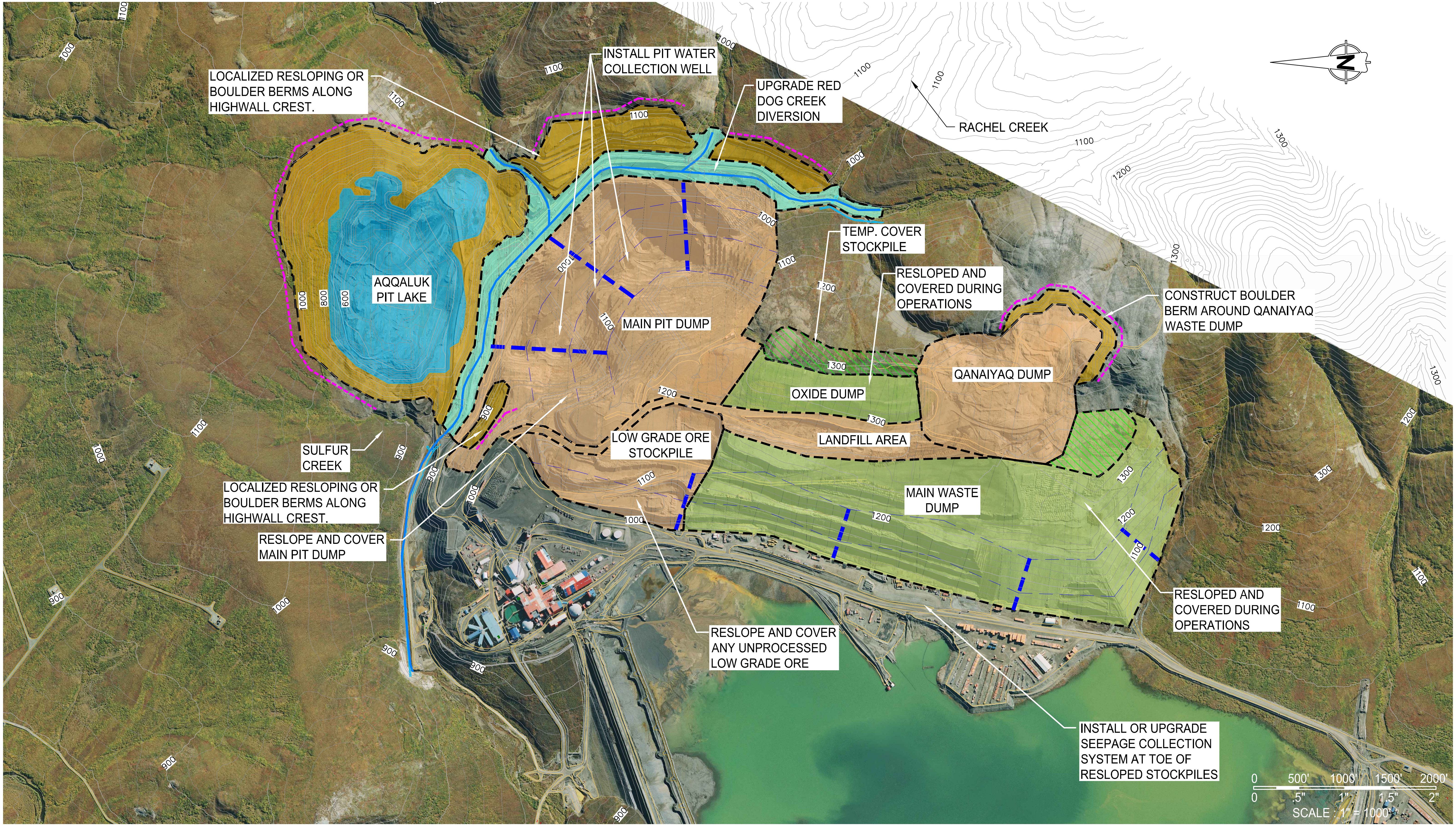
Qanaiyaq Pit will be backfilled during operations with waste rock from Aqqaluk Pit and from earlier phases of Qanaiyaq mining. The Qanaiyaq Pit is located at the top of a drainage divide, resulting in a small catchment area. The native rock is highly weathered and fractured, and at this time, it is uncertain whether water will accumulate in the backfilled pit.

3.1.3 Waste Rock Dumps and Ore Stockpiles

All stockpiles and dumps that remain uncovered at the end of mining will be covered at closure. As discussed in Section 2.1.3, the Oxide Dump and most of the MWD will be covered during operations. The remainder of the MWD, the MPD, and any unprocessed material in the Low Grade Ore Stockpile will be covered after 2030. The main haul road, truck run-out, and exposed pit benches will also be covered at that time. Figure 20 shows cover requirements for the mine and waste dump areas.

All remaining stockpile and dump faces will be flattened to an approximate overall slope angle of 3H:1V or flatter. The flatter slopes allow for better compaction of the cover material. In most cases, the dumps will be constructed in a manner that the cut to fill balance of benches will result in an overall slope of 3H:1V, so limited re-grading will be required.

Final slope angles will be varied where possible to provide more natural landforms and to promote re-establishment of natural drainage paths. Swales will be incorporated to collect surface runoff and channel it off the dump surfaces. Figures 20 and 21 show an illustration of what the re-shaped dumps may look like. Final grading surfaces cannot be specified at this time, due to uncertainties in the final volumes that will be sent to the mill or the waste dumps. A more comprehensive grading plan will be prepared toward the end of the mine life or earlier for waste management units (such as the MWD) that are expected to be closed and reclaimed prior to the end of mine life. Swale design will need to take into account site-specific factors, including snow drifting and sedimentation.



- RECLAMATION DURING OPERATION
- RESLOPE, BLAST, OR CONSTRUCT BOULDER BERM AROUND EDGE OF PIT
- RESLOPE AND COVER
- WATER
- RED DOG CREEK CHANNEL RESTORATION
- SURFACE WATER COLLECTION
- PERIMETER BERM AND BOULDERS

Red Dog Mine

DESIGN: SDT	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

FIGURE TITLE: MINE AREA CLOSURE METHODS

DATE: MARCH 2016
REVISION:
FIGURE NO.: 19
SRK PROJECT NO.: 329100.030

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

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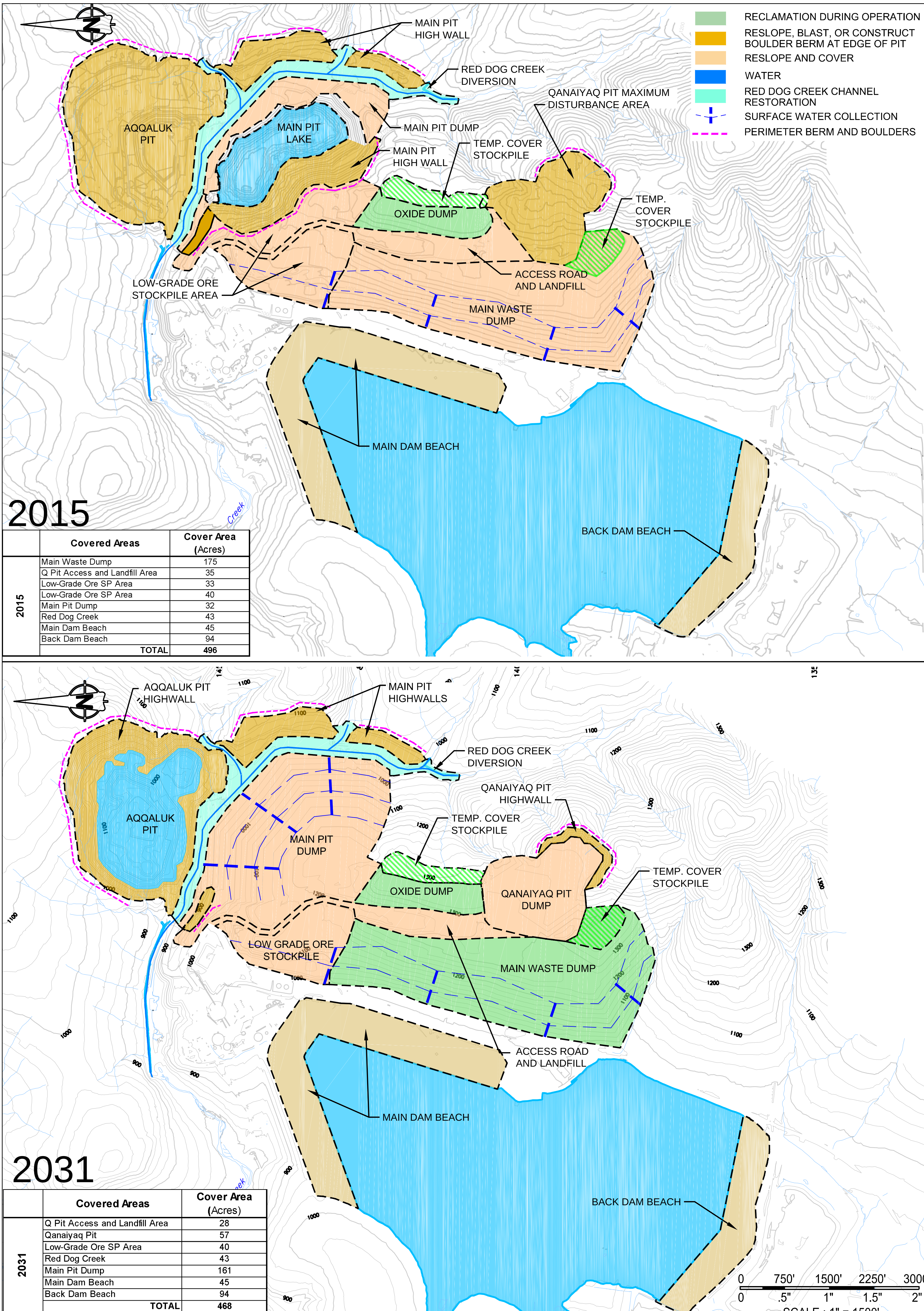

	Covered Areas	Cover Area (Acres)
2015	Main Waste Dump	175
	Q Pit Access and Landfill Area	35
	Low-Grade Ore SP Area	33
	Low-Grade Ore SP Area	40
	Main Pit Dump	32
	Red Dog Creek	43
	Main Dam Beach	45
	Back Dam Beach	94
	TOTAL	496

	Covered Areas	Cover Area (Acres)
2031	Q Pit Access and Landfill Area	28
	Qanaiyaq Pit	57
	Low-Grade Ore SP Area	40
	Red Dog Creek	43
	Main Pit Dump	161
	Main Dam Beach	45
	Back Dam Beach	94
	TOTAL	468

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: DST
DRAWN: IBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

FIGURE TITLE: EXTENT OF MINE AREA COVERS

DATE: JUNE 2015
REVISION:
FIGURE NO.: 20
SRK PROJECT NO.: 329100.030

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CURRENT VIEW OF MAIN WASTE DUMP

CONCEPTUAL VIEW OF RE-GRADED AND RECLAIMED MAIN WASTE DUMP YEAR 2040

Red Dog Mine

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: SDT	PREPARED BY: srk consulting	FIGURE TITLE: ILLUSTRATION OF MAIN WASTE DUMP LANDFORMS
DRAWN: JBM		
REVIEWED:		
APPROVED:	PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**	DATE: MARCH 2016
IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED		REVISION:
		SRK PROJECT NO.: 329100.030
		FIGURE NO.: 21

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The cover design and cost estimate assumes a cover consisting of two 20-inch layers of weathered shale (Figure 22). The design is based on investigations carried out by O'Kane Consultants using samples from the Overburden Dump (O'Kane 2004).

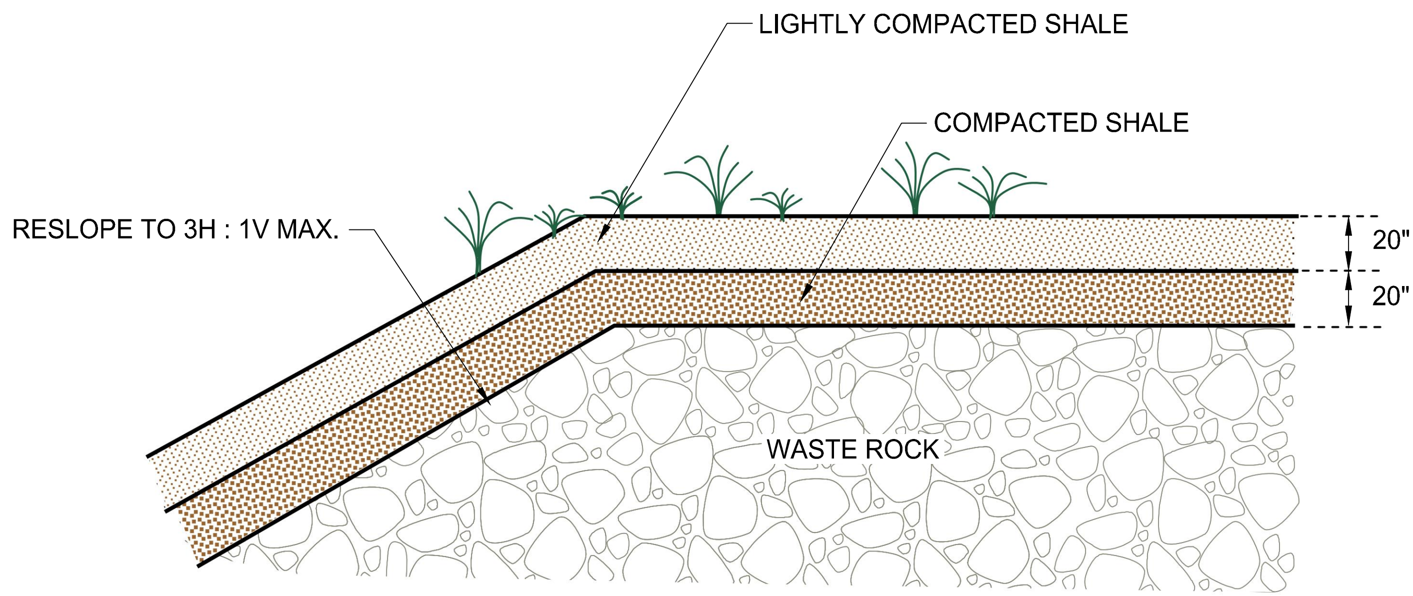
The LOM Plan includes segregation of Okpikruak and unmineralized Kivalina shale from the Main and Aqqaluk deposits to be stockpiled for use as cover material. More recently, TAK assessed the geochemical characteristics of material from the Key Creek Plate, located along the northern side of the Aqqaluk Pit; TAK developed procedures for identifying and segregating this material for use in cover construction (SRK 2016a). As of the end of the first quarter 2015, there was approximately 9.6 million tonnes of Key Creek Plate material remaining in this area of the pit under the current mine plan. Therefore, it is not expected that alternative borrow sources outside of the current mine area will be required to generate sufficient material for cover construction (Appendix F).

Cover construction will proceed as follows. An initial 20-inch layer of the cover material will be spread over the area being reclaimed. The first 20-inch layer would be graded and compacted. Depending on the level of weathering in the cover material stockpile, it may be necessary to allow further weathering time, perhaps one or two years, prior to final grading and compaction of the first layer. A second 20-inch layer of the cover material will then be placed and lightly compacted. Dust and runoff control measures will be implemented in all areas where the cover is being constructed.

The upper layer of the cover will be seeded and fertilized to promote vegetation. The proposed seed mixes are shown in Table 8. Field trials of cover construction and planting have been underway since 2007 and may lead to refinements in the seed mix. Refinements may also be made as experience is gained with the full-scale cover implemented on the Oxide Dump. Results to date from revegetation trials have not indicated that there is a need to modify the current seed mix (Cedar Creek 2013).

Covered and reclaimed areas will be monitored and, where necessary, maintained for several years after construction (O'Kane 2014). Post-closure monitoring and maintenance requirements are described further in Section 5 below.

TAK is evaluating alternatives to the currently planned two-layer cover design. Evaluation of alternative cover designs was initiated in 2015 and an update will be provided to ADNR and ADEC in the 2016 Annual Report. If the current design is not optimal, TAK will engage with interested stakeholders and propose a modification to the *Reclamation and Closure Plan*.



COVER PROFILE
NTS

Table 4: Proposed Revegetation Species for Waste Rock Facilities and Stockpile Covers

Plant Species		Planting Specifications
Native-grass cultivars Primary List Nortran hairgrass Tundra bluegrass Alpine bluegrass Spike trisetum Thickspike wheatgrass Polargrass Bluejoint	 Secondary List Bering hairgrass	Seeding Rate 20 lb/acre (final mixture). Ratio of species will depend on availability, but mix may include predominantly tundra bluegrass and alpine bluegrass for drier areas and Nortran hairgrass, polargrass, and bluejoint for mesic sites.
Native forbs Tilesy sage Alpine milkvetch Alpine sweetvetch Boreal sweetvetch Field oxytrope Boreal yarrow	Other potential species Tall fireweed Siberian aster Arctic bladderpod	Seeding rate 40 seeds/yd^2 for each species. Ratio of species will depend on availability, but mix may include alpine milkvetch, field oxytrope, Arctic bladderpod, and Siberian aster for dry areas; and tilesy sage, boreal sweetvetch, alpine sweetvetch, tall fireweed for mesic areas.

3.1.4 Red Dog Creek Diversion

The Red Dog Creek Diversion will be rebuilt as an open channel designed to handle non-contact water from a 1,000-year flood event. The alignment will be around the toe of the re-graded MPD, at a distance sufficient to allow a sediment collection ditch between the toe and the diversion ditch. Figure 23 shows a conceptual alignment and sections. By the time a final design is needed, the site will have almost forty years of experience with the Red Dog Creek Diversion. Any details needed to minimize ice formation or sediment deposition, and to minimize long-term maintenance requirements, will be incorporated into the design at that time.

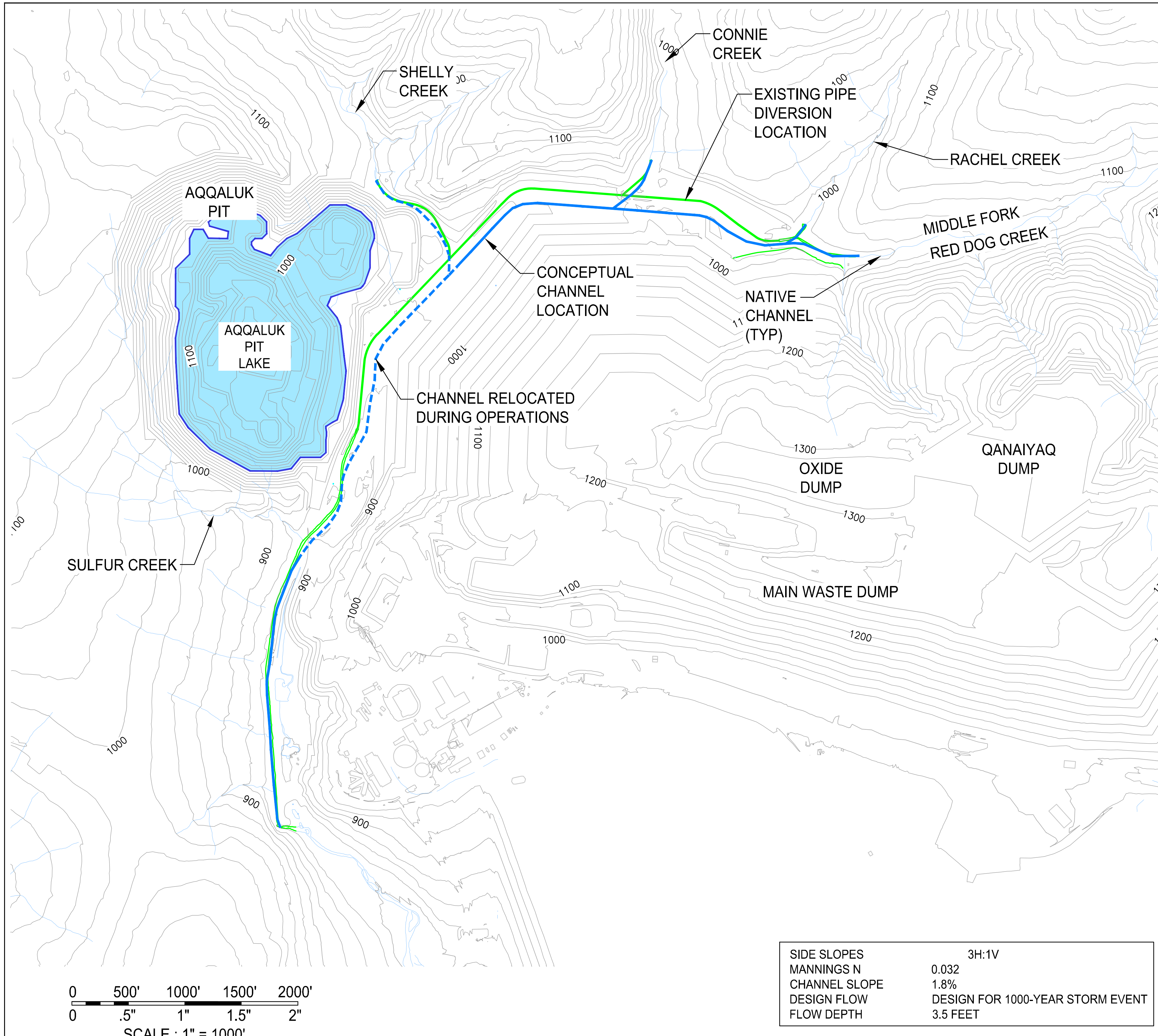
If Hilltop Creek is non-contact water after closure it would be redirected to Red Dog Creek (natural channel). Otherwise, Hilltop Creek would be directed to an infiltration basin along the toe of the backfilled Main Pit.

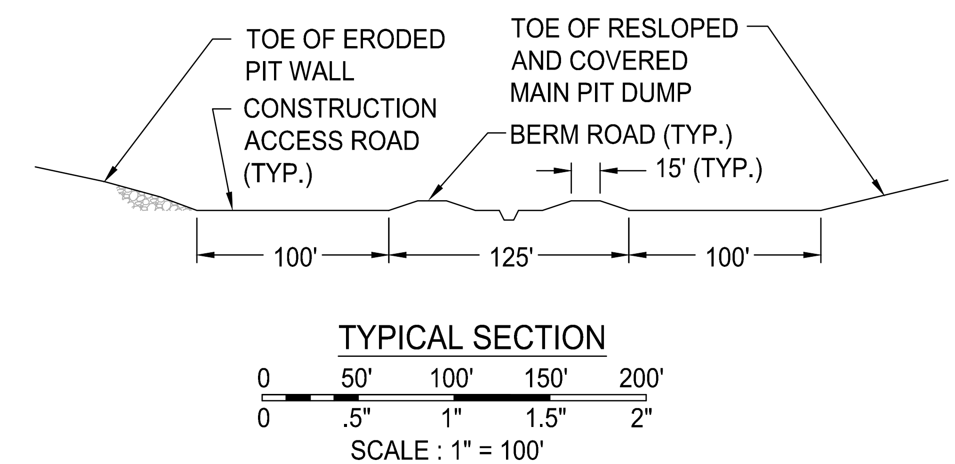
3.1.5 Mine Water and Waste Rock Facility Seepage

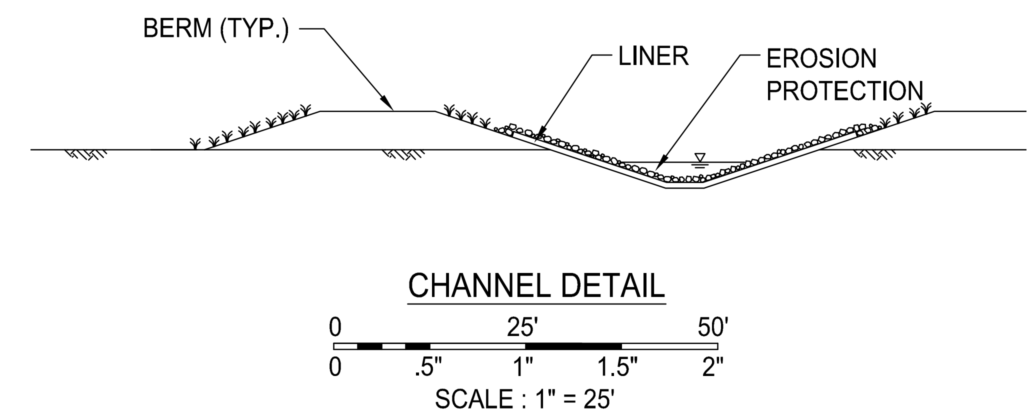
Water diversion and collection structures will be constructed adjacent to the covered dumps to collect and remove surface runoff. The water would be monitored and pumped to Aqqaluk Pit or allowed to flow into the TSF Pond until it is shown to be sufficiently good quality for direct discharge.

Cover studies to date suggest that a complex cover would reduce the infiltration of water to the underlying waste, but the amount by which infiltration would be reduced remains uncertain. The assumption herein is that approximately 25% of precipitation would infiltrate through the cover.

Water that infiltrates through the covers on the Oxide Dump and MWD will be collected in a series of wells and sumps along the toe of the MWD. From there dump seepage would flow or be pumped either directly to treatment or to the Aqqaluk Pit for storage and future treatment. Figure 24 shows a conceptual design for the seepage collection system. The conceptual design may change, depending on final construction of the TSF Wing Wall, which could include cutoff walls along a similar alignment.







SIDE SLOPES	3H:1V
MANNINGS N	0.032
CHANNEL SLOPE	1.8%
DESIGN FLOW	DESIGN FOR 1000-YEAR STORM EVENT
FLOW DEPTH	3.5 FEET

CONCEPTUAL LINED CHANNEL LOCATION

CONCEPTUAL LINED CHANNEL LOCATION RELOCATED PRIOR TO 2031

EXISTING PIPE DIVERSION

EXISTING CHANNEL DIVERSION

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: DST
DRAWN: JBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

FIGURE TITLE: CONCEPTUAL DESIGN FOR FINAL RED DOG CREEK DIVERSION

DATE: MARCH 2016
REVISION:
FIGURE NO.: 23
SRK PROJECT NO.: 329100.030

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Water infiltrating the MPD will drain downward, into the pit, where it will be collected. The water level in the MPD will be maintained no higher than 850 ft amsl by passive drainage into the Aqqaluk Pit. The water level in the backfilled Main Pit would be maintained below 850 ft amsl to keep the pit water level below the hydraulic level of the Red Dog Creek Diversion. Contact water collecting in the mine sump will be routed to treatment or to the Aqqaluk Pit. Excess water will be pumped from the Aqqaluk Pit each year and treated for discharge. As noted above, the water level in the pit will be maintained at 850 ft amsl or less. Accumulated water in the Qanaiyaq Pit Dump, if any, will be pumped to either the Aqqaluk Pit or directly to treatment.

3.2 Tailings Storage Facility Area

3.2.1 Overview

Figure 25 summarizes the proposed closure and reclamation configuration for the TSF area. Tailings area closure methods are based on the "Clean Pond" option selected through the consultation process described in Section 1.4. Primary closure objectives for closure of the TSF Pond area are:

- Covering the tailings with water to restrict oxidation and acid generation
- Managing contaminated water to keep the tailings pond as clean as possible
- Maintaining long-term stability of the dams, while minimizing seepage
- Reclaiming surface disturbances

3.2.2 Tailings

The 2014 LOM Plan indicates an average tailings elevation of 978 ft amsl by the end of production in 2030, and this estimate will be refined as mining proceeds. The struck tailings elevation assumption for this Reclamation and Closure Plan is 975 ft amsl, corresponding to a dam crest of 986 ft amsl. Further details and discussion of TSF storage capacity are presented in the *Red Dog Mine Tailings and TSF Water Management Plan* (SRK 2016c).

Tailings deposition will be managed to make the final surface as level and as close to the target elevation as possible. The tailings surface will be re-graded as necessary to provide generally level deposition of tailings and consequent water cover. Examples of tailings regrading methods include using barge-mounted dredges or boat-mounted harrows.

Water treatment capacity may need to be upgraded sometime around 2025, to allow pre-treatment of all inflows to the TSF Pond. Upgrading the treatment capacity at that time allows for the deposition of tailings into a cleaner pond.

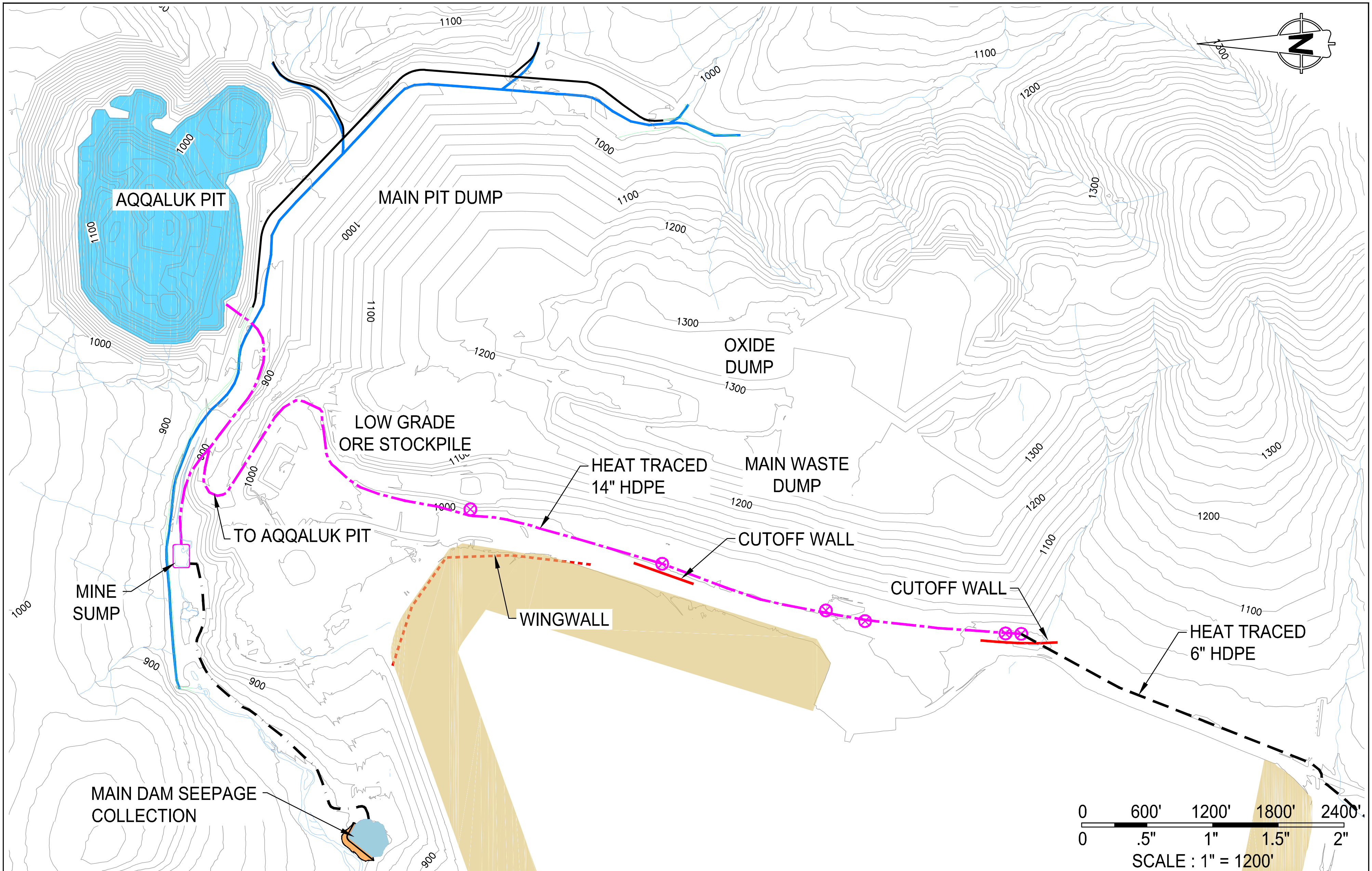
3.2.3 Water Cover

A water cover will be maintained over the tailings for the post-closure period. The beach areas will be covered with a geosynthetic liner and covered with material as described in Section 3.2.4.

Through many years of experience at other sites, it has been demonstrated that the most effective way to prevent oxidation and acid generation from sulfidic tailings is to keep the tailings underwater. Experience at the Louvicourt Mine demonstrates that minimum water cover may likely be about two feet (Ouellet 2011), which would provide a minimum pond surface elevation of

980 ft amsl. Variation in the tailings surface elevation means that a lesser depth of water cover would be unlikely to provide uniform water depth. The water would be drawn down each summer to provide storage for the next year's freshet. Depth of water in the TSF Pond will be maintained at a minimum of two feet over the tailings.

The criteria for the 986-foot dam crest are specified in the *Preliminary Spillway Design Report* (URS 2008). The 986-foot dam crest is based on a final tailings elevation of 975 ft (struck-level elevation). The proposed design includes a minimum water elevation of 977 ft, which is based on a 2-foot water cover above the tailings. This would be the target elevation to achieve at the end of each discharge season. A total of 6.5 ft of capacity is included between the minimum water elevation of 977 ft and the spillway invert elevation of 983.5 ft. This includes the estimated average inflow during freshet in May (assuming no discharge during that month) above the minimum water cover, which equates to an elevation of 978.4 ft. An additional 5.1 ft of capacity is incorporated between this 978.4-foot elevation and the spillway invert elevation, which conservatively includes the estimated probable maximum flood, 40% of another probable maximum flood, and 1-in-100 year flood volumes.



⊗ SEEPAGE COLLECTION WELLS

-·- SEEPAGE COLLECTION PIPE

Red Dog Mine

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

DESIGN: SDT
DRAWN: JBM
REVIEWED:
APPROVED:

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PREPARED BY: srk consulting

PROJECT:

RED DOG MINE
RECLAMATION AND CLOSURE PLAN

FIGURE TITLE:
CONCEPTUAL DESIGN
MAIN WASTE DUMP
SEEPAGE COLLECTION SYSTEM

DATE: MARCH 2016
REVISION:
FIGURE NO.: 24
SRK PROJECT NO.: 329100.030

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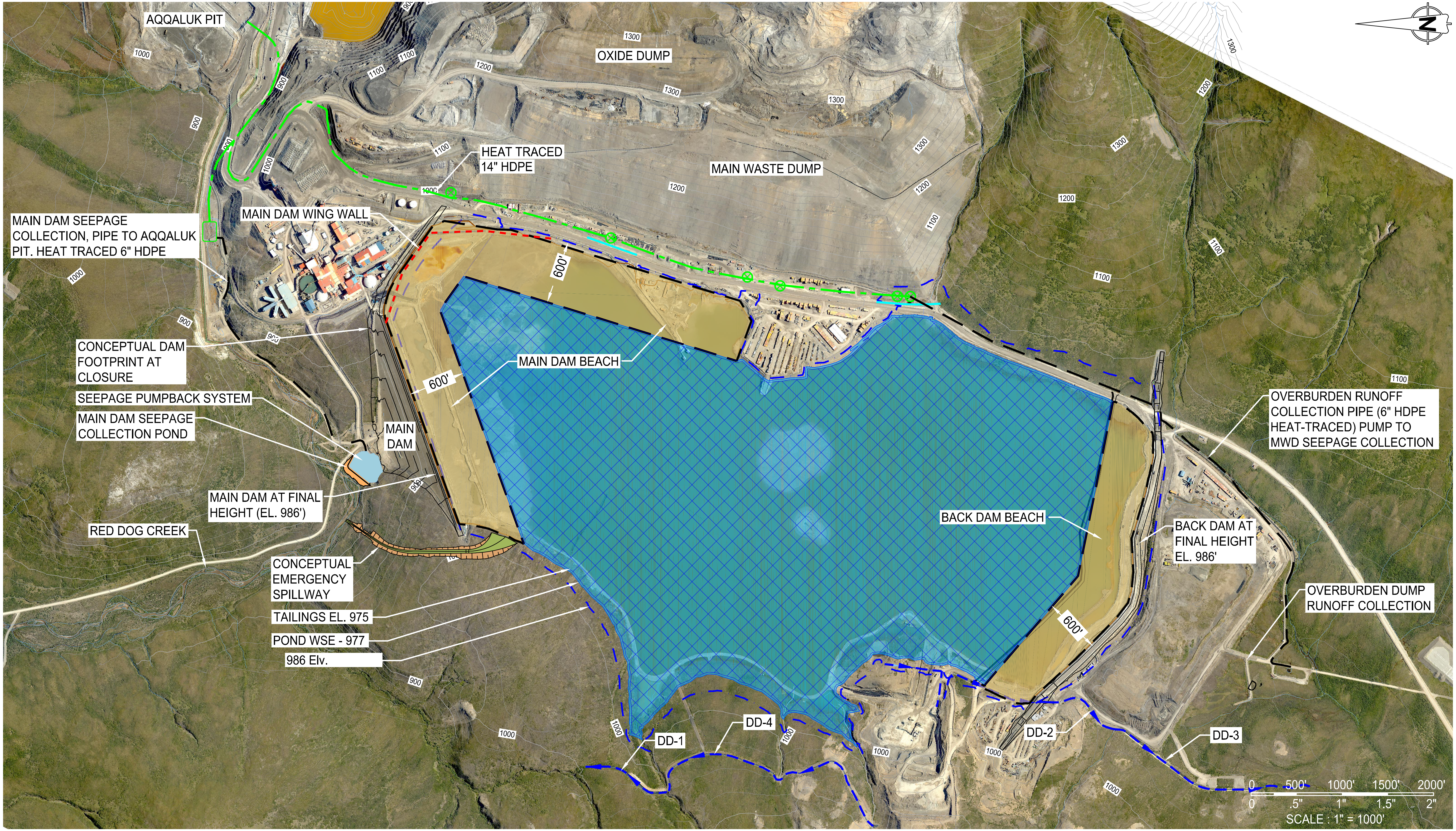

MINIMUM POND ELEV. 977 FT.

TAILINGS YR 2030 ELEV. 975 FT.

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

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DRAWN: JBM
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APPROVED:

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PREPARED BY: srk consulting

PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN

FIGURE TITLE: LIMITS OF TAILINGS AND POND AT CLOSURE

DATE: MARCH 2016
REVISION:
FIGURE NO.: 25
SRK PROJECT NO.: 329100.030

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3.2.4 Main Dam

Final Configuration

The Main Dam is currently planned to be raised to a final elevation of 986 ft amsl by 2017. Further details can be found in Section 2.3.4 and in the URS design reports (URS 2007a, 2014). Stability analyses show that the dam would be stable under long-term static, end-of-construction, and seismic conditions (URS 2014).

Spillway

To protect against overtopping of the Main Dam, a spillway will be constructed in the west abutment (URS 2008). A conceptual design for the spillway is shown in Figure 26. The conceptual design has the spillway located in bedrock. The invert elevation is 983.5 ft amsl, and the width of the channel is sufficient to pass an inflow design flood with a flow depth of 1.4 ft. The flow would therefore remain below the dam crest.

Surcharge Capacity

The volume between the assumed tailings surface elevation of 975 ft amsl and the spillway invert elevation of 983.5 ft amsl determines how much water can be stored prior to discharge via the spillway. Calculations show that even the combination of the minimum water cover of two feet, a spring freshet, a probable maximum flood (PMF) series, and a 100-year flood event could be contained between the tailings surface elevation and the level of the spillway invert (URS 2008), as shown in Figure 27.

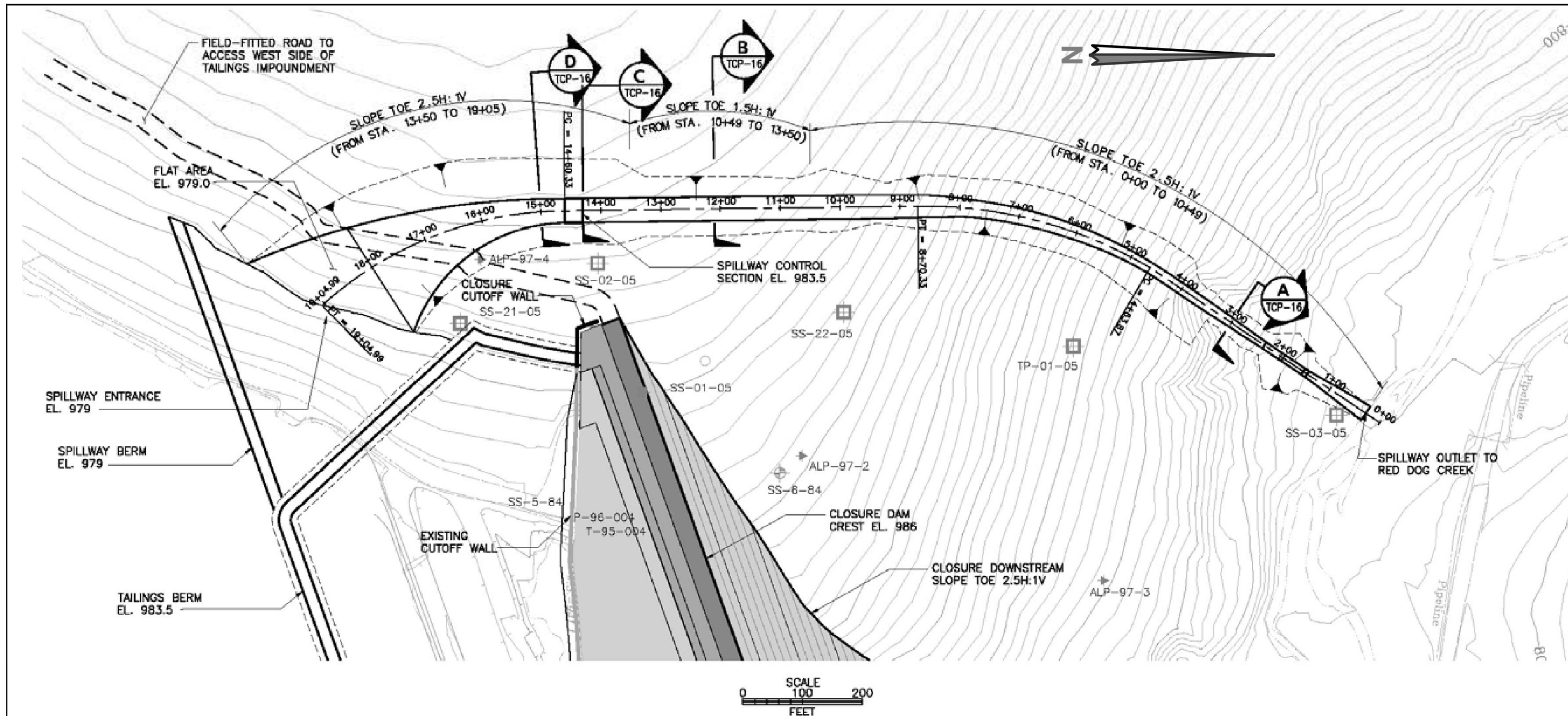
Beach

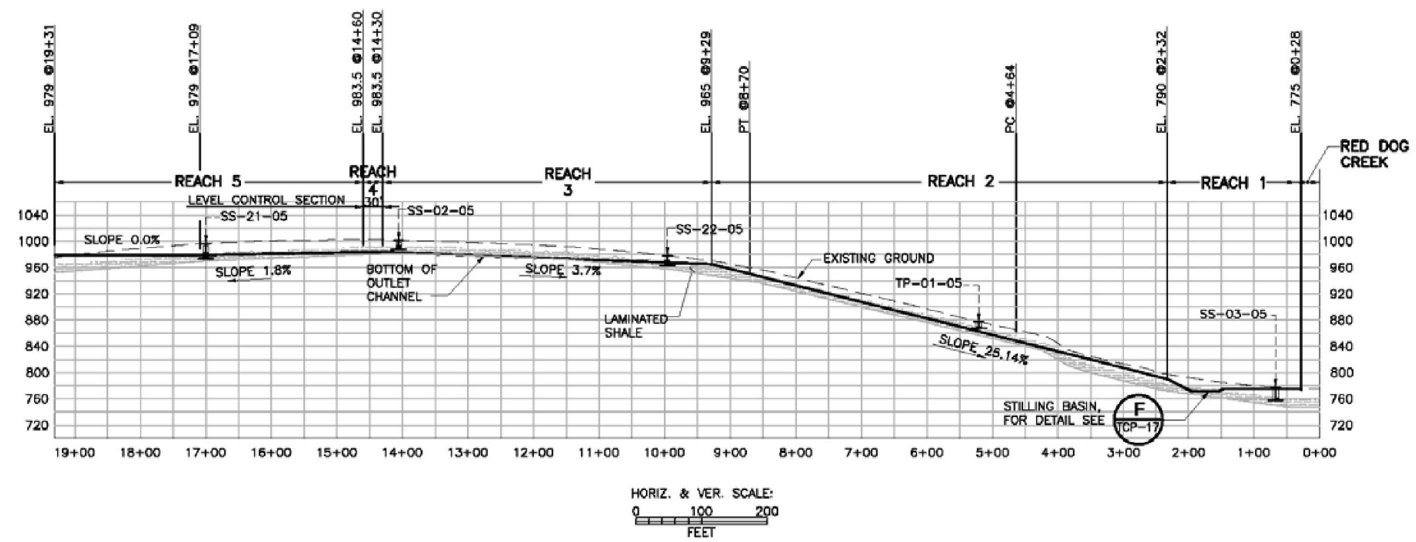
Seepage rates at the Main Dam have been assessed and a model to predict future seepage rates has been developed (URS 2007d). A key finding was seepage rates are substantially reduced when a beach is maintained in front of the dam. The beach serves to keep water away from the permeable material on the face of the dam and forces it to pass through the less permeable tailings. To reduce seepage rates after closure, a permanent beach will be constructed in front of the Main Dam. The beach will be approximately 600 ft wide, and is predicted to restrict seepage rates to about 550 gpm. The beach will be constructed of unmineralized rock, and a geosynthetic liner. The liner is intended to reduce the likelihood of oxygen reaching the underlying tailings. Figure 27 shows a typical section through the beach. The current assumption is that the beach may be extended along the eastern shore of the TSF Pond, parallel to the wing wall. Observations of seepage during operations may lead to the conclusion that a narrower beach is adequate.

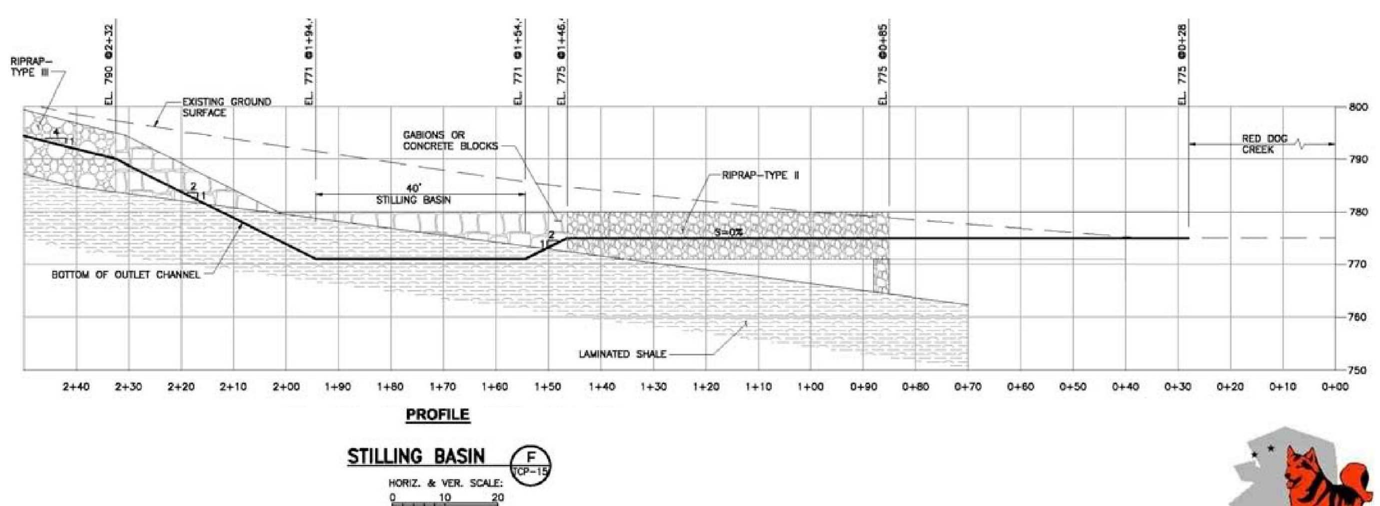
Seepage Collection

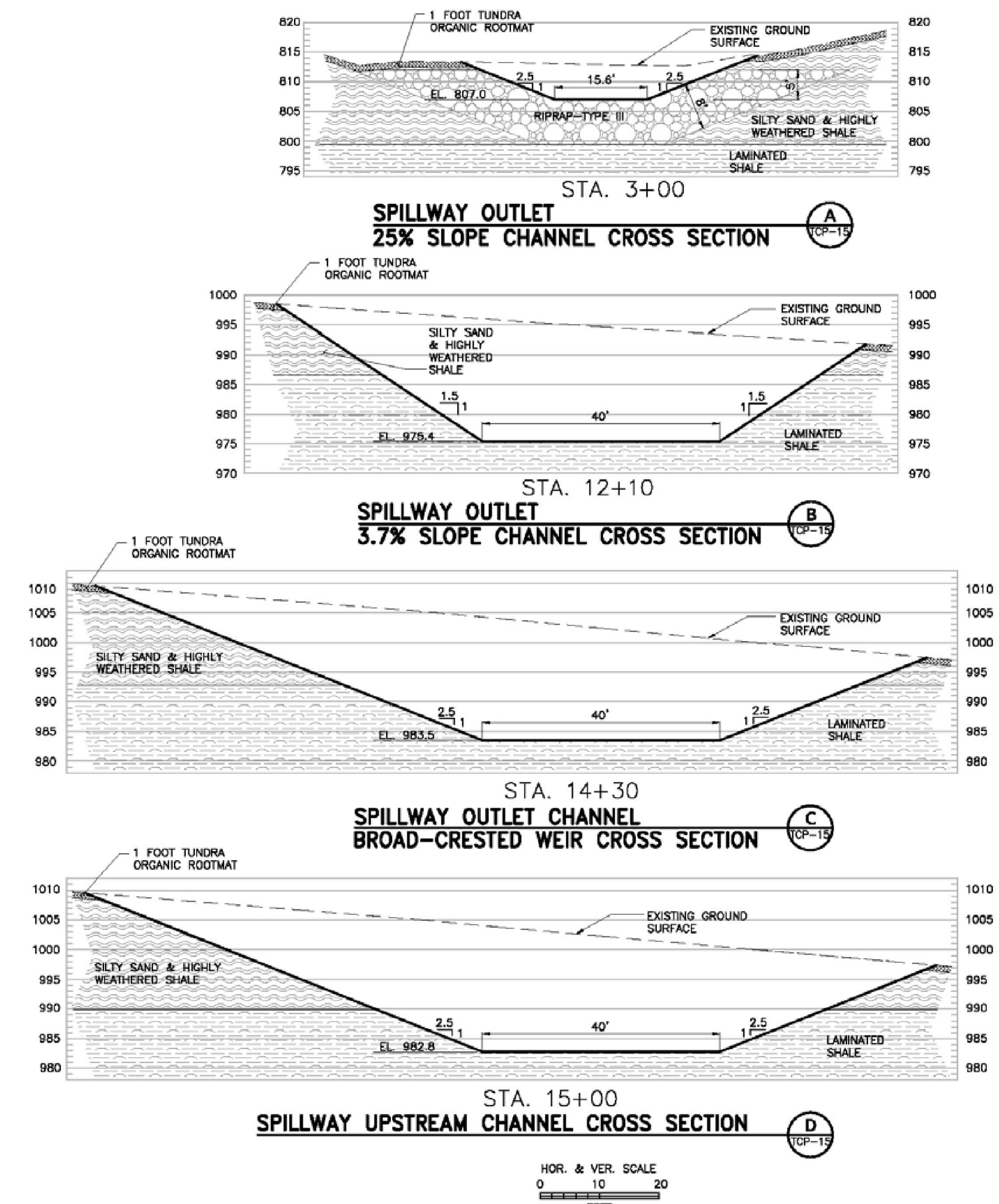
Seepage collection at the toe of the Main Dam will continue after closure, but the pumpback system will be re-configured to send the seepage to the Aqqaluk Pit (refer to Figure 25).

The seepage management system will include a seepage storage pond sufficient to contain several days of seepage. The design of the ultimate seepage pond will be provided with the conceptual design of the ultimate Main Dam, to be submitted in 2018. At the Main Dam, there is limited room for an emergency storage pond below the current seepage dam. Figure 25 shows a pond that would have a storage capacity of about 810,000 gallons. The capacity is sufficient to store seven days of seepage at the 550 gpm rate specified above.









Red Dog Mine

PLANS AND SECTIONS SHOWN ON THIS FIGURE ARE FROM URS CONCEPTUAL DESIGN OF SPILLWAY TO MAIN DAM AUTHORED ... 2014.

DESIGN: SDT	PREPARED BY: srk consulting
DRAWN: JBM	
REVIEWED:	
APPROVED:	PROJECT: RED DOG MINE RECLAMATION AND CLOSURE PLAN
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FIGURE TITLE: CONCEPTUAL DESIGN OF MAIN DAM SPILLWAY

DATE: MARCH 2016

REVISION:

FIGURE NO.: 26

SRK PROJECT NO.: 329100.030

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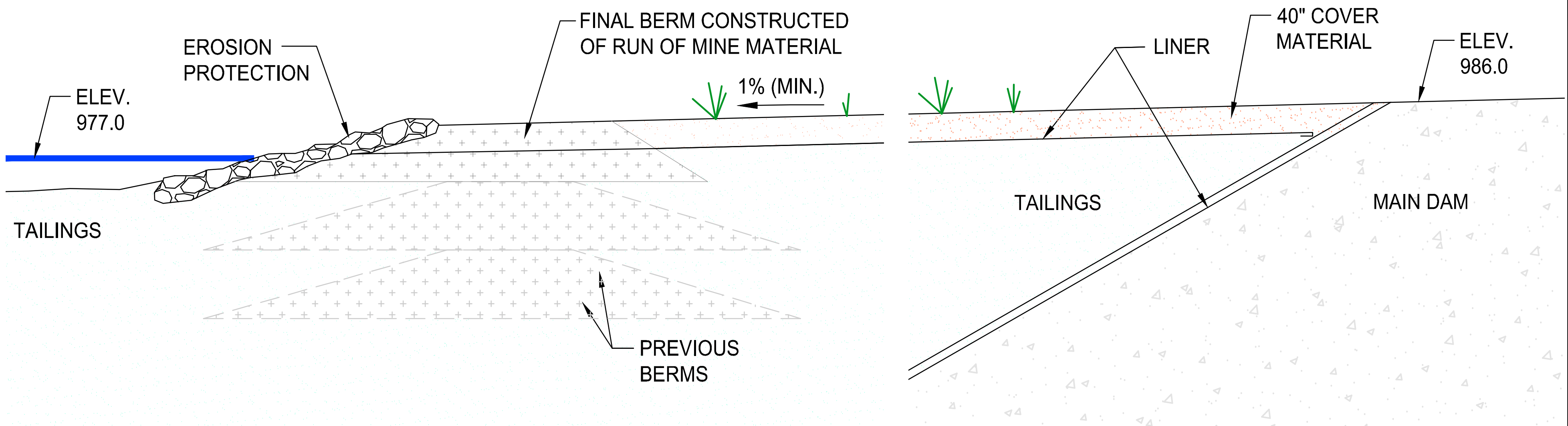
Component of Storage	Depth (feet)	Resulting Elevation (feet AMSL)
Tailings Surface	N/A	975.0
Minimum Water Cover	2.0	977.0
Spring Freshet	1.4	978.4
Probable Maximum Flood Series	4.2	982.6
100-year Flood	0.9	983.5
Spillway Crest	N/A	983.5
Inflow Design Flood	1.4	984.9
Freeboard for Wind/Wave	1.1	986.0
Dam Crest	N/A	986.0



SCALE = NONE

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PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: MAIN DAM BEACH TYPICAL SECTION

DATE: MARCH 2016

REVISION:

FIGURE NO.: 27

SRK PROJECT NO.: 329100.030

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3.2.5 Back Dam

As discussed in Section 2.3.5 above, the Back Dam is currently planned to be raised to an elevation of 986 ft amsl during operations. Any seepage from the Back Dam would be collected and pumped to the TSF. The conceptual design report for the Back Dam (Golder 2006) includes results of seepage analyses. Seepage rates through the final dam are predicted to range from about 20 to 40 gpm, for the case without a beach. The construction of a beach in front of the Back Dam would have a similar effect on seepage rates as observed at the Main Dam. A 600-foot-wide beach is predicted to reduce seepage rates at the Back Dam to less than 20 gpm. Monitoring of seepage during operations may lead to the conclusion that a narrower beach is adequate.

Upgrades to the current Overburden Dump run-off collection system, including deeper components to collect seepage, will also be re-assessed prior to final closure.

3.2.6 Overburden Dump

The Overburden Dump and any of its exposed footprint will be re-graded and revegetated. Revegetation trials on the Overburden Dump have been completed (ABR 2007). The species mix for further revegetation would be as shown in Table 4.

3.3 Water Treatment and Discharge

3.3.1 Water and Constituent Load Balance

The collection and treatment of contact water will continue during the closure period. Flows and constituent loads from each source area will transition from the operational levels discussed in Section 2.4.1 to post-closure levels. The precise timing of the transition from operational to post-closure conditions will depend on the schedule of closure activities.

3.3.2 Water Treatment

Treatment of contact water will continue during the closure period, as requirements transition from the operational to post-closure levels. It is possible that some of the excess water will be directed to the Aqqaluk Pit, in order to flood reactive pit wall surfaces more quickly.

Modifications to the treatment system will be completed during the closure period. There are several options that remain under consideration, and the final plans will depend largely on the extent of the water treatment upgrades anticipated in 2025 (Section 2.4.2). It is possible that a new treatment plant, designed specifically for post-closure conditions, will be required. Other options, such as modifications to WTP2 and WTP3, may prove to be more cost-effective. Also, once ore processing ceases, reclaim of water from the TSF Pond will no longer be necessary and WTP1 will be available for either decommissioning or incorporation into the post-closure water treatment system.

3.3.3 Discharge of Treated Water

Discharge of treated water at Outfall 001 will continue during the closure period. The quantities discharged will transition from operational levels discussed in Section 2.3.3 to the post-closure levels discussed in Section 4.2.2. Constituent concentrations in the discharge are expected to comply with the current APDES requirements.

3.4 Ore Processing Area

Assuming that no further ore production is envisaged, ore processing facilities will be decommissioned after operations end in 2030. Hazardous material will be removed and handled according to regulations specific to each material. High value components will be removed for salvage and scrap, and the remainder of the structures demolished (Denison Environmental Services 2004). Bulk demolition wastes will be disposed of in a landfill to be developed along the toe of the MWD or Low Grade Ore Stockpile.

It is assumed that metal-contaminated soils may be found below portions of the ore processing area, once the structures are removed. These soils will be removed and hauled to the MWD or Low Grade Ore Stockpiles. Further reclamation of the ore processing area is discussed in the following section.

3.5 Infrastructure

After operations cease in 2030, NANA will need to decide how much of the site infrastructure will be left in place. That decision will depend on what other activities are taking place or are reasonably foreseeable at that time.

Infrastructure that is not needed for the post-closure requirements or for other NANA plans will be decommissioned. Hazardous materials and high value components will be removed. The remainder of the facilities will be demolished and placed in the demolition landfill.

Figure 28 shows the infrastructure locations that are expected to require reclamation. The total surface area is about 225 acres. Any contaminated soil present in these areas will be removed, and areas regraded. Material that is not highly mineralized will be brought in as fill where necessary and the areas revegetated following the recommendations in Table 5.

Vegetated areas affected by fugitive dust will require further monitoring and assessment before appropriate remediation plans can be developed.

Table 5: Revegetation Recommendations for Infrastructure Areas

Area	Plant Species	Planting Specifications
Reclaim roads, laydown areas, pads and quarries	Native grass cultivars Native forbs	(see Table 4) (see Table 4)
Banks of Red Dog Creek Diversion and other wet areas	Shrub cuttings and seedlings Diamond leaf willow Felt leaf willow Richardson willows Shrub/dwarf birch	 Cuttings on one-foot centers Cuttings on one-foot centers Cuttings on one-foot centers 80 seeds/yd^2

	DESCRIPTION	AREA (ACRES)
1	CC LAYDOWN	13.7
2	KIVALINA SOUTH ROAD	1.0
3	KIVALINA EAST LAY DOWN	12.0
4	ROAD AROUND KIVALINA & DD2	11.1
5	DD2 SOUTH	22.7
6	DD2 NORTH	20.2
7	DD2 EAST (FLOODED BEFORE 2031)	SUBMERGED
8	CONEX LAYDOWN	43.0
9	WATER TREATMENT LAYDOWN AREA	SUBMERGED
10	CONTRACTOR LAYDOWN	48.3
11	PAC	10.7
12	MILL SITE	19.6

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

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APPROVED:

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PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: INFRASTRUCTURE RECLAMATION AREAS

DATE: MARCH 2016
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FIGURE NO.: 28
SRK PROJECT NO.: 329100.030

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4 Post Closure Requirements

4.1 Overview

After closure activities are completed, the site will transition to long-term post-closure status. NANA, as the land owner, will determine the post-closure uses of the site. However, a number of activities related to the closed mine will be required. Figure 29 provides an overview of the reclaimed site and Figure 30 shows typical sections.

The principal post-closure requirement will be the collection and treatment of contaminated water. Soil covers constructed on stockpiles will reduce the rate at which constituents are released from the mine area, but any water that seeps through the covers and/or contacts the exposed pit walls, will still need to be treated. In the TSF area, constituent levels in the pond water are expected to be lower than current levels and diminish over time, so that it might someday be possible to discharge pond water without treatment.

A second post-closure requirement will be the maintenance and repair of ditches, soil covers and other earthworks constructed during the closure period. Maintenance activities are expected to be substantial in the first few years post-closure, but gradually diminish as stable conditions develop.

Additional long-term requirements will include the infrastructure needed to support water treatment and maintenance, inspection and monitoring, and restriction of site access or uses.

4.2 Water Treatment and Discharge

4.2.1 Water and Constituent Load Balance

Water treatment on site is expected to continue over the long term. The operations-period water and constituent load balances introduced in Section 2.3.2 were extended to develop estimates of post-closure flows and water quality (SRK 2016b).

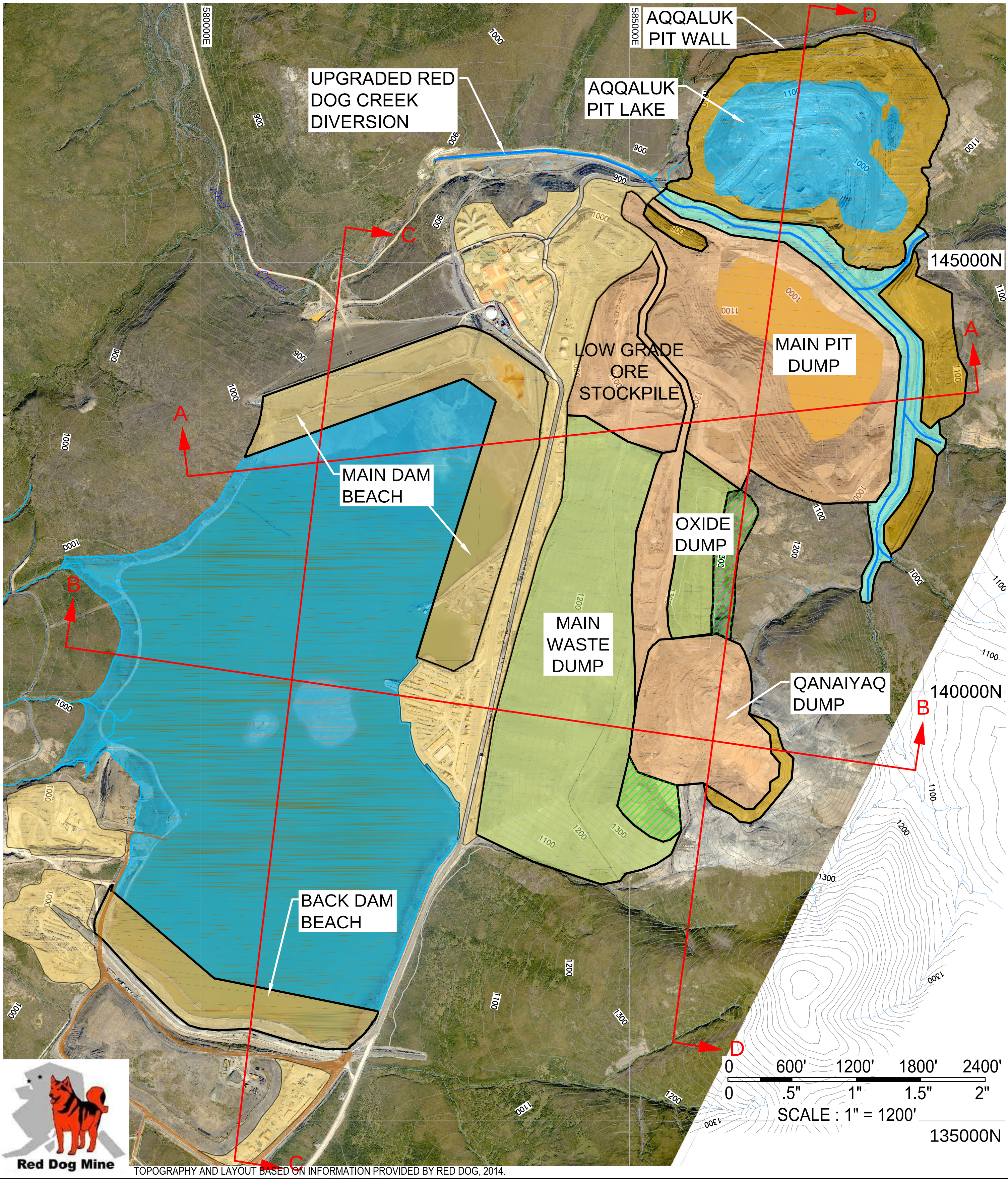
Figure 31 shows the estimated site water balance for an average year. The Aqqaluk Pit will be the primary storage area for impacted water, and will receive seepage from the MWD, Main Dam, and Back Dam, mine water from the Main Pit area, and direct runoff. Each summer, an average of about 1.2 billion gallons of water is estimated to be extracted from the Aqqaluk Pit and treated.

Runoff from the covered MWD and Oxide Dump, and from the northern portion of the Overburden Dump, will initially continue to flow into the TSF Pond. Precipitation, runoff from the west side of the TSF, grey water, seepage not captured from the MWD, and backwash water from the treatment plant(s) will also enter the TSF Pond. The outflows will be evaporation and seepage from the TSF Main Dam underdrain, leaving an excess of about 0.3 billion gallons of water to be discharged each year.

Post-closure constituent concentrations in the TSF Pond are expected to be lower than current concentrations. Two measures that will be implemented during operations, completion of the MWD seepage collection system and upgrading the WTP system, will divert or pre-treat most of the constituents. However, water remaining from earlier periods, porewater from underlying tailings, and uncaptured seepage from the MWD will continue to contribute constituents to the

TSF Pond. The first two sources are not expected to significantly impair TSF Pond water quality. The third source will be controlled by monitoring of and periodic improvements to the MWD seepage collection system, but the possibility that some seepage will remain uncaptured cannot be ruled out. The current load balance assumes that 25% of the MWD seepage will continue to enter the TSF Pond. The resulting constituent concentrations in the TSF Pond water are then estimated to be about 1,500 ppm TDS, 900 ppm sulfate, and 200 ppm zinc.

The post-closure water balance and load balance results are presented in more detail in the *Red Dog Mine Water and Load Balance Update* (SRK 2016b).



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PREPARED BY:
srk consulting

PROJECT:
RED DOG MINE
RECLAMATION AND CLOSURE PLAN

FIGURE TITLE:
OVERVIEW OF
RECLAIMED SITES

DATE:
MARCH 2016

REVISION:

SRK PROJECT NO.:
329100.030

FIGURE NO.:
29

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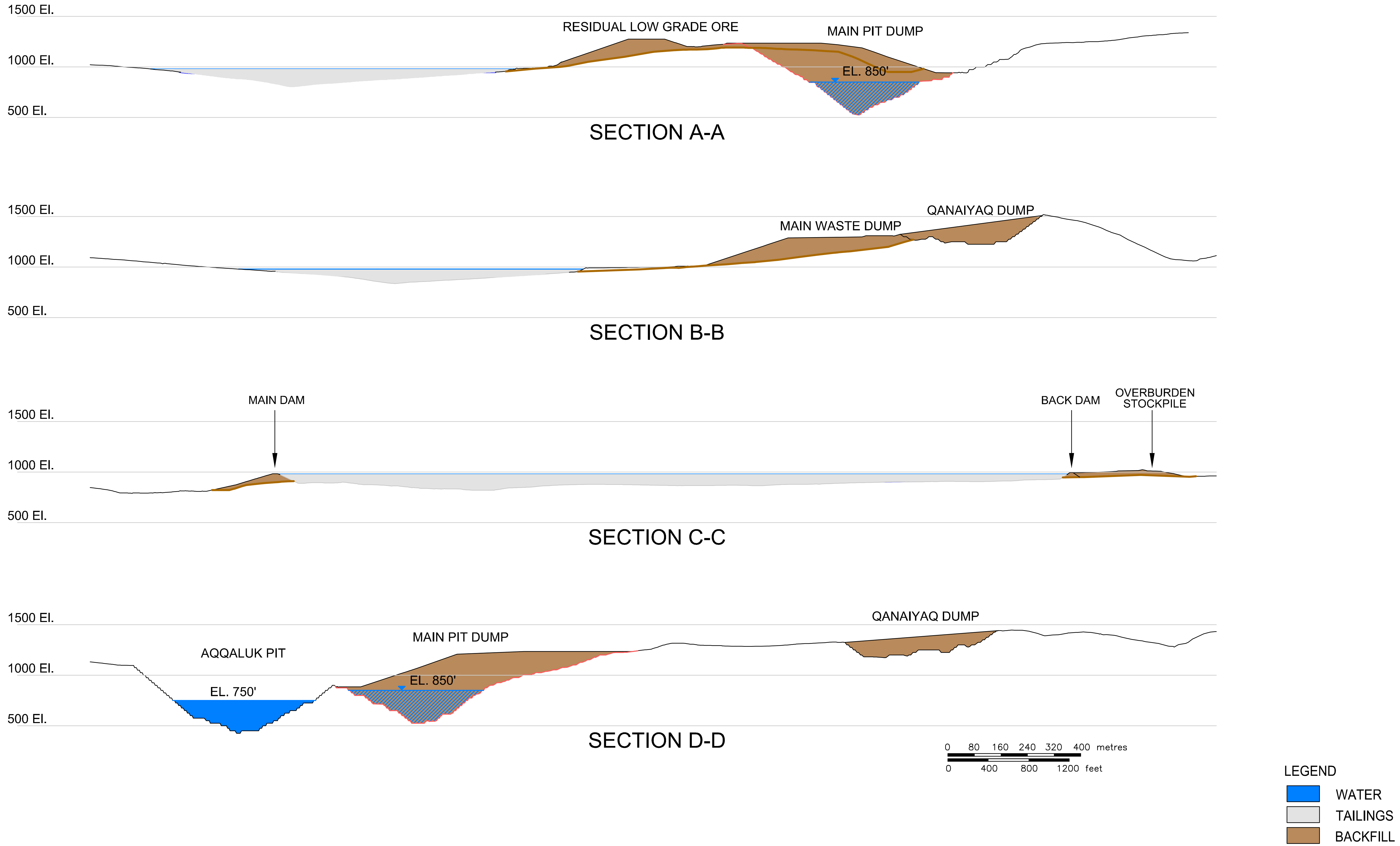

Red Dog Mine

DESIGN: SDT	
DRAWN: JBM	
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PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: SECTIONS THROUGH RECLAIMED SITES

DATE:	REVISION:	FIGURE NO.:
MARCH 2016		30
SRK PROJECT NO.: 329100.030		

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

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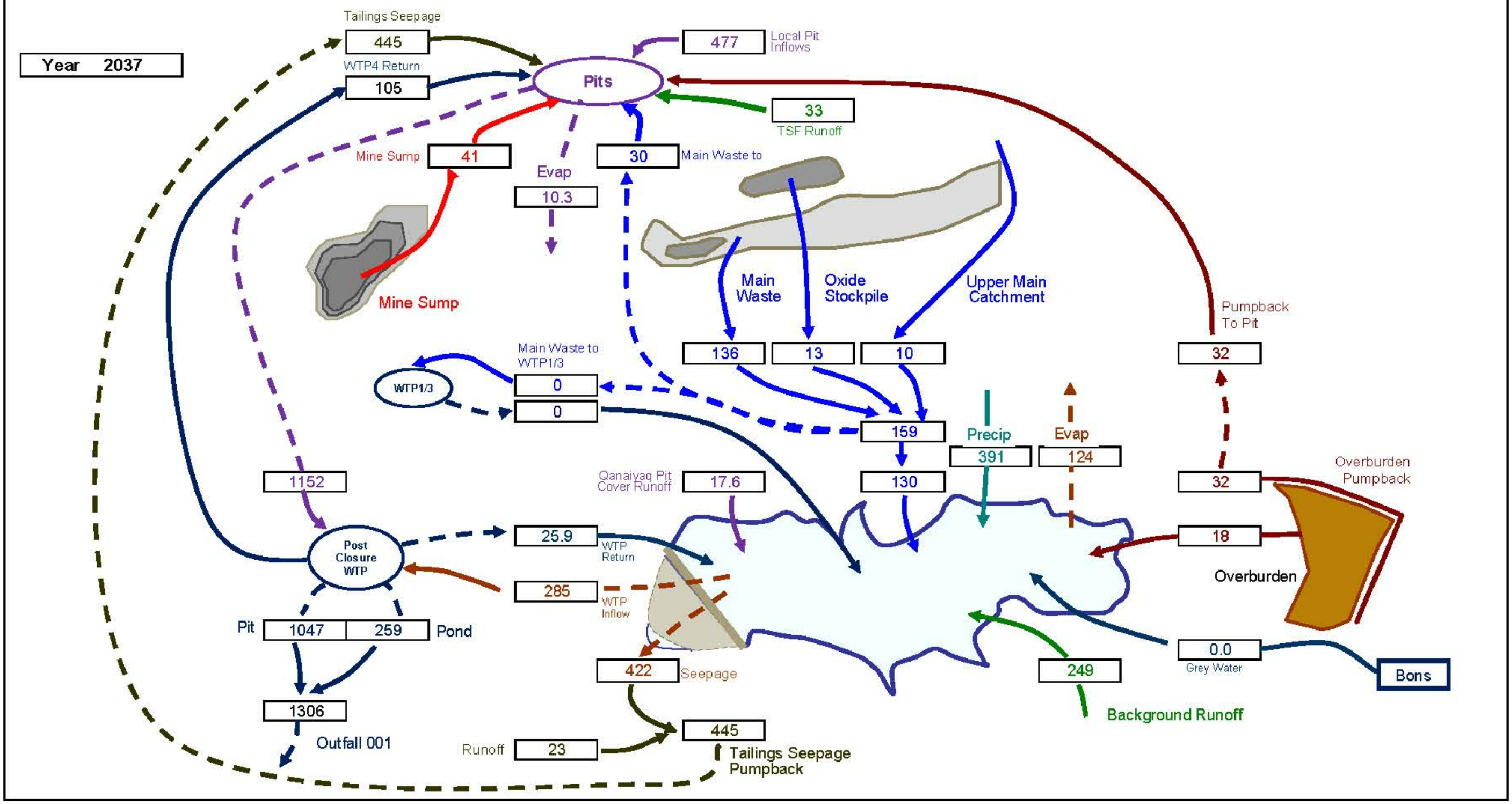
SRK Consulting

Red Dog Water Balance - Post-Closure

Flows in MGals/year

Scenario: (A) During Operations: WTP3 at Current Capacity until 2016, increased to 174 tonnes/day to 2025, then unlimited until closure, and winterized in 2018; Main Pit water treated starting in 2025; Reclaim Pre-Treated starting in 2019; Main Waste Seepage Concentrations Constant; Seepage Escape Decreased 25% by 2019; Late Implementation of Progressive Reclamation

At Closure in 2031: Main Waste Seepage Escape 25%, Cover Efficiency 75%, Mine Sump, Main Waste and Dam Seepage, Catchment 7, and Overburden Stockpile Pumpback Pumped to Pit



Red Dog Mine

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REVIEWED: BJ	
APPROVED: BJ	

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PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: SITE WATER BALANCE AFTER CLOSURE (MILLION GALLONS PER YEAR)

DATE: MARCH 2016

REVISION:

FIGURE NO.: 31

SRK PROJECT NO.: 329100.030

P:\Teck Alaska - Red_Dog\329100.030 IWMP\329100.030 IWMP\040_AutoCAD_GIS\Rec Plan Figures\Agency Draft Rev 2 -Figures SRK\FIGURE 31.dwg

4.2.2 Water Treatment

Seasonal water treatment operations will continue after closure. Impacted water stored in the Aqqaluk Pit will be withdrawn each summer for treatment and discharge. As noted in the preceding section, water from the TSF Pond is also expected to require treatment prior to discharge.

The water and load balance estimates required average annual discharges of about 1.05 billion gallons from the Aqqaluk Pit and 0.26 billion gallons from the TSF Pond, and a loss of 0.13 billion gallons to evaporation. Slightly larger volumes will need to be treated, because some of the treated water is used for backwashing the sand filters and removing the treatment sludge. Total volumes entering the treatment system each year are estimated at 1.15 billion gallons from the Aqqaluk Pit and 0.29 billion gallons from the TSF Pond. The backwash and sludge removal water could be routed either to the Aqqaluk Pit or the TSF Pond. Review of water treatment methods concluded that lime addition will remain the preferred method of water treatment after closure (SENES 2004). Given the differences in constituent concentrations, it is likely that the Aqqaluk Pit water will be treated in one set of treatment tanks, and the much cleaner TSF Pond water in another. All three of the current treatment plants will be available for use, and various configurations are possible. It may prove more cost-effective to modify one of the three plants or construct entirely new components.

The water treatment reagent requirements were estimated from the water and load balance. Table 6 shows estimates of lime consumption. They were derived by converting the estimated constituent concentrations in each source stream to a theoretical lime demand, and then increasing the theoretical values by 12.5% to account for inert and incompletely reacting lime.

Table 6: Estimated Lime Requirements for Water Treatment

Source	Annual Volume (million gallons)	Acidity (mg/L as $CaCO_3$)	Theoretical Lime Demand (tonnes per year)	Estimated Lime Requirement (tonnes per year)
TSF Pond	285	646	390	439
Aqqaluk Pit	1,152	4,128	10,080	11,340
Total	**1,437**		**10,470**	**11,779**

The lime treatment process creates a sludge consisting of gypsum and neutralized metal hydroxides. Estimates of sludge production in Table 7 are also based on the current water and load balance. The sludge generated from the Aqqaluk Pit water is expected to be much denser than sludge generated from the TSF Pond water.

TAK will continue researching options for post-closure sludge management. The current concept is that both sludge streams will initially be directed to the Aqqaluk Pit until available space in the pit is exhausted. Following the end of pit disposal, additional sludge will be directed to a series of cells, where sludge will be stored for one winter. The winter freezing and subsequent thawing is expected to increase the sludge density to about 20-40% solids. The densified sludge will be removed and deposited in an on-site sludge repository. Cost estimates for and additional information on post-closure sludge management can be found in Appendix D.

Table 7: Estimated Sludge Production

Source	Estimated Production (dry tonnes per year)	Initial Solids Content	Initial Volume[1] (cubic yards per year)	Densified Volume (cubic yards per year)
TSF Pond	800	5%	20,000	n/a
Aqqaluk Pit	42,000	10-20%	239,000-514,000	n/a
Total	42,800	n/a	260,000-534,000	104,000-244,000

[1]Total slightly different than components due to rounding

4.2.3 Discharge of Treated Water

Treated water will continue to be discharged at Outfall 001 at an average annual volume of about 1.3 billion gallons. Constituent concentrations in the discharge are expected to comply with the requirements of the current APDES permit.

4.2.4 Possible Modifications Over Long-Term

The above analyses assume that water in the TSF Pond will continue to be treated prior to discharge. This is to be expected in the years immediately after closure, but it is possible that the TSF Pond water quality will improve over time, especially if the MWD cutoff wall system can capture a high proportion of the MWD seepage. As noted above, the current water and load balance assumes that 25% of MWD seepage will bypass the cutoff system and report directly to the TSF Pond. Until the effectiveness of the MWD seepage cutoff system is demonstrated, it is prudent to continue with cautious assumptions. The post-closure cost estimate assumes that water from the TSF Pond will require treatment prior to discharge.

In the event that long-term monitoring of water quality in the closed TSF Pond shows that it consistently meets discharge requirements (without treatment), several modifications will be considered. The principal change would be deepening of the spillway so that water flows out naturally. Other modifications to be considered if water quality improves over time include breaching the clean water diversions on the west side of the TSF and diversion of any residual sources of loading such as runoff from the waste rock covers or Overburden Dump to the Aqqaluk Pit.

4.3 Maintenance Requirements

Earthworks and facilities constructed during closure will all need some level of maintenance in the post-closure period. Table 8 summarizes the expected requirements.

Requirements for maintenance of covers and ditches are expected to diminish over time. The reason is that the most significant instabilities will be noted and repaired in the first few years after closure. The development of vegetation also helps to reduce erosion problems and associated maintenance requirements. Regardless, there will still be a need for maintenance and repairs after significant storm or runoff events.

Maintenance of active facilities, such as the water treatment systems, camp, and access roads will continue as long as they remain in use.

Table 8: Post-Closure Maintenance Requirements

Area	Feature	Requirement
Mine Area	Pits	Repair of berms and cutback slopes, where necessary
	Waste Rock Dumps	Repair of erosion or settlement damage to covers; Maintenance and repair of surface water ditches and swales; Supplemental planting, seeding or fertilization
	Red Dog Creek Diversion	Maintenance and repair as needed
TSF Area	Main Dam	Maintenance and repair as needed
	Back Dam	Maintenance and repair as needed; Removal of vegetation
	Covered Beaches	Repair of wave erosion; Supplemental planting, seeding or fertilization
	Spillway	Removal of vegetation
	Overburden dump	Supplemental planting, seeding or fertilization
	Seepage Collection System	Maintenance and repair as needed
Infrastructure	Decommissioned areas	Supplemental planting, seeding or fertilization
	Access roads	Snow removal; Grading and re-surfacing
	Water treatment system	Mechanical & electrical maintenance
	Camp & support facilities	Snow removal; Structural maintenance; Mechanical & electrical maintenance
	Bons Creek reservoir and dam	Monitoring, maintenance and repair as needed

4.4 Infrastructure Requirements

The continuing water treatment and maintenance activities will create a requirement for support infrastructure, including access roads, accommodations, the water treatment plant and associated equipment, power supply, fuel storage, materials storage and equipment maintenance. Table 9 lists specific site infrastructure requirements under each category, assuming that only the required activities continue. It is assumed that barge access to the Port and access over the Port road will remain. As noted above, NANA may develop other plans for the site and those could include retention of other infrastructure.

Table 9: Infrastructure Requirements after 2030

Requirement	Infrastructure to be Retained
Site access	Airstrip and airport building Internal road system to any areas needing maintenance
Accommodations	Personnel Accommodations Complex (may be modified) Bons Creek freshwater pumphouse and supply line Potable water Sewage treatment
Water treatment	Water Treatment Plant #2 (may be modified or re-built) Reclaim barge and reclaim line Lime slaking system Sodium Sulfide mixing system Flocculant preparation system Compressed air system
Power supply	Powerhouse Emergency power supply
Fuel storage	One 1,000,000-gallon bulk fuel tank Fueling island and day tanks
Materials storage and equipment maintenance	Select storage area / Conex Trailer facilities Shop for mobile equipment and some mobile equipment

4.5 Monitoring and Inspection Requirements

Monitoring and inspections will be required in the post-closure period. Water quality monitoring will continue for the long term, i.e., as long as water collection and treatment is required. Other programs that are expected to be required in the long term include regular inspection of dams, ditches and any other earthworks that remain in use, and monitoring of caribou and other subsistence foods from the area around the site.

Several other programs will be intensive in the immediate post-closure years, but are expected to be reduced once it can be demonstrated that stable conditions have been established. These include, but may not necessarily be limited to, monitoring of cover performance and revegetation success, fugitive dust monitoring, groundwater and ground temperature monitoring and site-specific ecological risk monitoring.

Details of the monitoring and inspection plans for the post-closure period are presented in *Red Dog Mine Monitoring Plan* (SRK 2016d).

4.6 Site Use Restrictions

The mine area is currently off-limits to subsistence harvesting, and that restriction will remain in effect throughout operations. Potential for constituent intake by animals around the closed mine (Exponent 2007) was evaluated using methods developed in more extensive DeLong Mountain Regional Transportation System (DMTS) study (Exponent 2005). The study evaluated potential risks to animals living in or passing through the mine area and to the vegetation community in the mine area.

The study concluded that the closed mine is unlikely to present any significant risk of adverse effects on caribou, fox, teal or muskrat, but that individual ptarmigan, tundra vole and tundra shrew could take in enough lead or cadmium to be adversely affected. The difference is partly attributable to the small home range of the ptarmigan, shrew and vole, which were assumed to spend their entire lives in areas with the highest metals concentrations. Study conclusions also note that a number of cautious (conservative) assumptions were made in the evaluation and that more realistic assumptions would reduce uncertainties and refine the estimated potential risk.

NANA will determine post-closure uses of the site. Results of the DMTS human health risk assessment indicated that potential risks to human health would not be elevated even if harvesting were to occur in currently restricted areas of the DMTS (Exponent 2005). Because concentrations within the mine area are similar to Port area soil metals concentrations, human health risks would not be expected if subsistence harvesting were to occur within the mine area. However, the existing restrictions on subsistence harvesting will remain in effect until that conclusion can be verified by post-closure monitoring.

5 Schedule and Financial Assurance

5.1 Reclamation

The discussion of LOM operations in Section 2 above includes a number of commitments to concurrent reclamation, i.e. reclamation that will begin during operations, as well as commitments to closure-related changes in the tailings and water management systems.

Figure 32 presents a summary schedule that includes the operational period reclamation and water management activities. Other milestones are included to provide context. In many cases, the precise scheduling of activities will depend on factors that are not fully predictable. The schedule therefore shows ranges for many activities.

5.2 Closure

Closure activities described in Section 3 will begin in 2030, when production ceases. It is expected that closure measures will require at least two field seasons to complete. Figure 32 shows most of the closure activities taking place in 2030, 2031 or 2032. The detailed closure cost estimate is included in Appendix C.

5.3 Post-Closure

Post-closure activities described in Section 4 may begin in each area immediately after the closure activities are complete. Typically, however, it takes many months or even years for employment levels, equipment fleets and other practical matters to fully transition to long-term post-closure levels.

Post-closure activities are expected to be required indefinitely. However, as noted in Section 4, requirements for maintenance and monitoring are expected to be more intensive during the first few post-closure years and to diminish thereafter. The post-closure cost estimate is included in Appendix D.

5.4 Project Suspension or Temporary Closure

Project suspension or temporary closure would be the cessation of the mining and milling operations for a period of not more than five years. Temporary closure scenarios, which require modifications to the *Reclamation and Closure Plan*, solid waste permit, certificates of approval to operate a dam, or 404 Permit, will be coordinated with and submitted to the appropriate Federal and State agencies for approval.

Temporary closure may include planned and unplanned cessation of the mining and milling processes. Planned temporary closures which have specific conditions defining their beginning and end include, but are not necessarily limited to:

1. Interruptions in the active beneficiation processes to provide planned periods of quiescence for metallurgical or operating reasons;
2. Any other planned condition, which will interrupt the active beneficiation process including modification to process components or suppressed metal market conditions; and

3. Change in ownership requiring the temporary cessation of operations while operating permits are transferred to the new owner/operator.

Unplanned temporary closures may include, but are not limited to:

1. Unforeseen weather events;
2. A failure in a major system component or a process failure which causes the fluid management system or a portion thereof to shut down; or
3. The cessation of operations as a result of litigation.

TAK will notify the agencies within 10 calendar days of the first day of the temporary closure of any unanticipated suspension or cessation of operations that is expected to last more than 90 calendar days or more. The notice will state the nature and reason for the temporary closure, the anticipated duration of the temporary closure and any event that would reasonably be anticipated to result in either the resumption or abandonment of operations. Project operations must resume for not less than 90 consecutive days in order to terminate the temporary closure status. TAK will maintain the project area in a safe and stable condition during a temporary closure. TAK will continue, in full force, all water collection and treatment, monitoring and reporting required by the reclamation plan unless otherwise agreed to by the agencies.

The current LOM Plan has identified sufficient resources to support mining until 2030, based on suitably cautious assumptions about world metal prices and production costs. However, there is always a risk that prices or costs could change, leading to a requirement to suspend operations for a period of several years. Plans and cost estimates for a suspension scenario are included in Appendix E.

The plan and cost estimate for a temporary suspension of mining assume that the suspension would last approximately five years, and therefore propose measures to keep the existing facilities in a stable condition, ready for re-commissioning.

5.5 Premature Closure

The premature closure scenario provides financial assurance in the event the mine closes unexpectedly before 2031. In selecting a point in the mine life for estimating costs for a premature closure, TAK sought to select the year with maximum closure liability. During development of the closure plan in 2014, TAK estimated that 2015 had the maximum closure liability for the following reasons:

- The Aqqaluk Pit would be near full disturbance and the Main Pit would be partially backfilled;
- The Main and Back Dam tailings beaches would need to be completed through dredging;
- The MWD would need to be covered; and
- The MWD seepage cutoff system would need to be completed.

Other differences between the premature and planned closure scenario include the following:

- Qanaiyaq Pit would not be backfilled (Appendix G); and

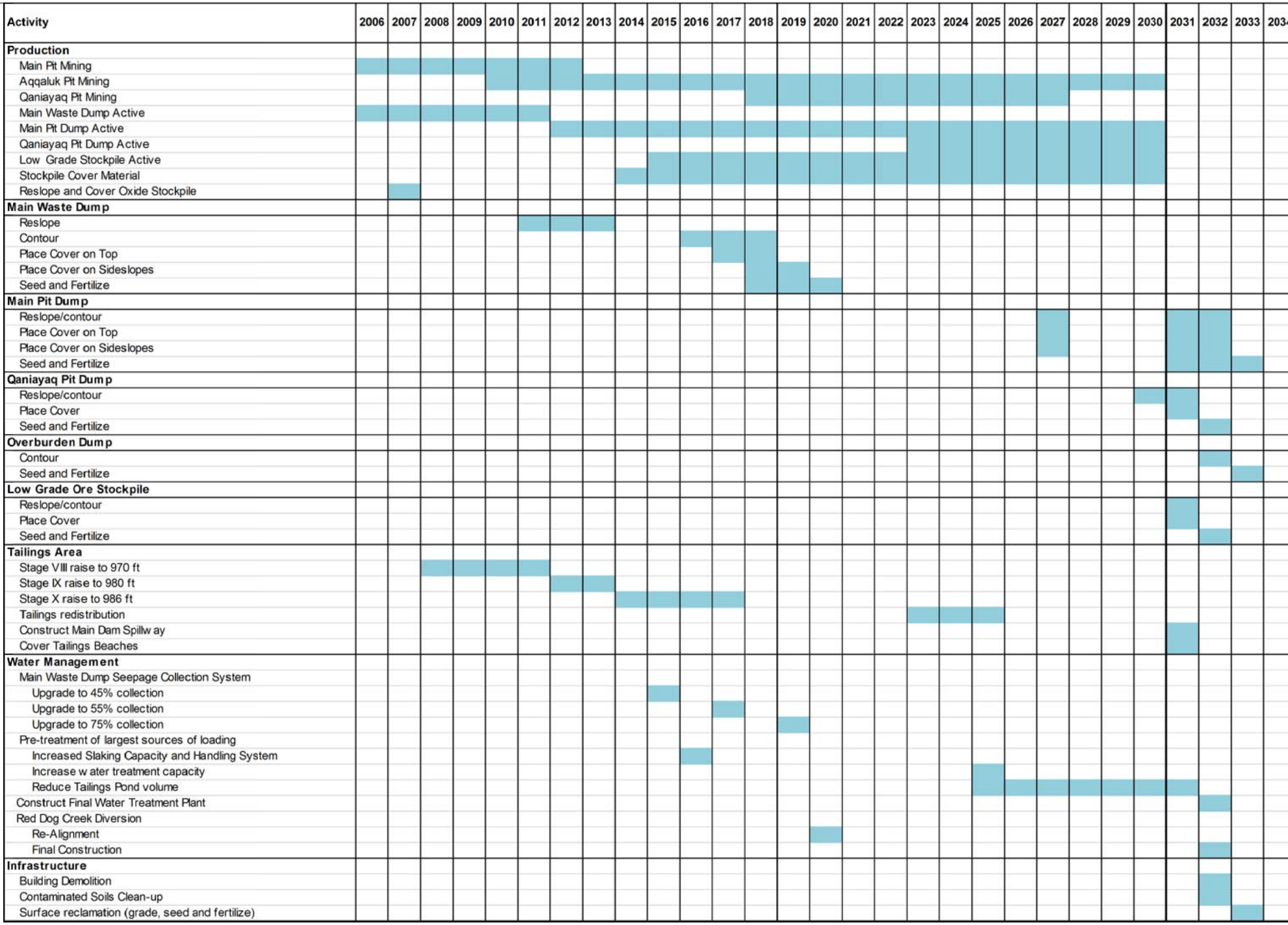
- The Main Pit would be used to store contact water (rather than Aqqaluk Pit), and the Main Pit groundwater collection system would not be required.

In addition, post-closure sludge management options differ for a premature closure scenario. The current concept is that both sludge streams will initially be directed to the Main Pit until available space in the pit is exhausted. Following the end of Main Pit disposal, additional sludge will be directed to a series of cells, where sludge will be stored for one winter. The winter freezing and subsequent thawing is expected to increase the sludge density to about 20-40% solids. The densified sludge will be removed and deposited in on-site sludge repositories, i.e., within the Aqqaluk Pit and TSF. Cost estimates for and additional information on post-closure sludge management can be found in Appendix D.

The cost estimates for a premature closure scenario are included in Appendix C and Appendix D.

5.6 Further Investigations and Plan Updates

This Plan will be updated every five years. Updates will include presentation of additional closure-related studies, as well as reports on the progress of concurrent reclamation activities.



Red Dog Mine

DESIGN: RDM
DRAWN: IJC
REVIEWED: BJ
APPROVED: BJ

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: MINE SCHEDULE

DATE: MARCH 2016

REVISION: ---

SRK PROJECT NO.: 329100.030

FIGURE NO.: 32

P:\Teck Alaska - Red_Dog\329100.030 IWMP\329100.030 IWMP\040_AutoCAD_GIS\Rec Plan Figures\Agency Draft Rev 2 -Figures SRK\FIGURE 32.dwg

5.7 Cost Estimate

Comprehensive estimates of premature closure, final closure, and post-closure costs have been prepared. Table 10 summarizes estimated costs for closure activities as described in this report, i.e., with the Mine operating until 2030, and for the premature closure scenario. Details of the closure cost estimates are presented in Appendix C.

Table 11 summarizes estimated annual costs for post-closure activities, again for the planned closure and premature closure scenarios.

Table 12 summarizes the estimated annual costs for the five-year suspension scenario, as well as the analogous annual costs for operating the camp and water management system during the two-year closure period.

5.8 Financial Security

TAK will ensure that the funding needed to implement the suspension, closure, and post-closure commitments will be available when it is needed, including over the very long term. In accordance with State requirements, the amount of financial security required must reflect the reasonable and probable costs of reclamation. While the most probable closure scenario is the planned closure in 2030, TAK and NANA have reviewed the various suspensions, premature closure, and planned closure scenarios and propose that the more conservative scenario be selected as the basis for determining the level of financial security, as follows:

- A suspension period lasting five years
- A premature closure, with ongoing water management and maintenance
- Post-closure requirements based on the premature closure scenario.

The resulting sequence of estimated annual costs is presented in Table 13.

Table 10: Summary of Estimated Closure Costs

Cost Category	Planned Closure (2031)	Premature Closure (2015)
Mine Area Direct Costs		
Pits	$800,000	$800,000
Regrade and Cover Waste and Stockpiles	$6,100,000	$7,600,000
Install Surface Water Collection	$200,000	$200,000
Upgrade Red Dog Creek	$1,100,000	$1,700,000
Install Main Pit Water Collection System (MWD Collection System for 2015 Closure)	$900,000	$2,600,000
Revegetation	$100,000	$500,000
Subtotal	*$9,200,000*	*$13,400,000*
Tailings Area Direct Costs		
Main Dam Spillway	$1,100,000	$1,100,000
Main Dam Beach	$5,800,000	$7,700,000
Back Dam Beach	$2,800,000	$4,100,000
Main Dam Seepage Collection	$700,000	$700,000
Back Dam Seepage Collection	$700,000	$700,000
Overburden Stockpile & Borrow Areas	$300,000	$300,000
Subtotal	*$11,400,000*	*$11,600,000*
Water Treatment Direct Costs		
Major Equipment and Installation	$16,700,000	$17,000,000
Subtotal	*$16,700,000*	*$17,000,000*
Ore Processing & Infrastructure Direct Costs		
Demolition	$2,900,000	$2,900,000
Contaminated Soils in Ore Processing Area	$500,000	$500,000
Contaminated Soils in Laydown Area	$1,000,000	$1,000,000
Road Decommissioning	$100,000	$100,000
Reclamation of Disturbed Areas	$200,000	$200,000
Subtotal	*$4,700,000*	*$4,700,000*
Subtotal Direct Costs	***$42,000,000***	***$49,700,000***
Indirect Costs		
Water Treatment Costs (Indirect and Contingency)	$13,400,000	$13,600,000
Mobilization and Demobilization	$4,900,000	$4,900,000
Equipment Idle and Overtime Cost	$1,900,000	$2,700,000
Administration Costs	$2,400,000	$2,700,000
Field Supervision and Support	$4,100,000	$4,100,000
Contract Administration and QA/QC	$1,900,000	$1,900,000
Insurance	$200,000	$200,000
Contractor Overhead	$1,000,000	$1,200,000
Allowance for Haul Road Maintenance and Hazardous Materials	$700,000	$700,000
Contractor Profit	$3,900,000	$4,800,000
Engineering Re-design	$1,400,000	$1,700,000
Bonding	$1,400,000	$1,700,000
State Management and Oversight	$500,000	$600,000
Subtotal Indirect Costs	*$37,700,000*	*$40,800,000*
Contingency	$5,100,000	$6,600,000
Total Costs	**$84,800,000**	**$97,100,000**

Note: Total Cost varies slightly from Summary of Estimated Cost due to rounding.

Table 11: Summary of Estimated Annual Post-Closure Costs

Cost Category	Planned Closure (2031)	Premature Closure (2015)
Manpower	$2,800,000	$2,800,000
Consumables	$5,440,000	$6,720,000
Mobile Equip	$420,000	$420,000
Maintenance Materials	$350,000	$350,000
Capital Replacement and SEP	$1,650,000	$1,650,000
Power	$2,430,000	$2,430,000
Environmental	$270,000	$270,000
Camp & Admin	$780,000	$780,000
Dam Inspection and Maintenance	$390,000	$390,000
Sludge Management	$910,000	$1,060,000
Insurance (1.6% of manpower and equip.)	$50,000	$50,000
Contractor Overhead (10% of manpower)	$1,440,000	$1,590,000
Contractor Profit (10% of manpower and equip.)	$1,440,000	$1,590,000
State Contract Mgmt. (1% of total)	$160,000	$180,000
Total Cost	**$18,550,000**	**$20,280,000**

Table 12: Summary of Estimated Annual Suspension and Closure Operating Costs

Cost Category	Suspension Period	Closure Period
Manpower	$2,700,000	$2,700,000
Consumables	$6,930,000	$6,080,000
Mobile Equip	$360,000	$360,000
Maintenance Materials	$350,000	$350,000
Capital Replacement and SEP	$1,650,000	$1,650,000
Power	$2,650,000	$2,650,000
Environmental	$270,000	$270,000
Camp & Admin	$740,000	$740,000
Dam Inspection and Maintenance	$390,000	$390,000
Insurance	$50,000	$50,000
Contractor Overhead	$1,600,000	$270,000
Contractor Profit	$1,600,000	$310,000
State Contract Mgmt.	$160,000	$160,000
Total Cost	**$19,460,000**	**$15,980,000**

Table 13: Sequence of Estimates for Financial Security

	Suspension Costs	Closure Costs	Closure Operating Costs	Post-Closure Costs
Year 1	$19,460,000			
Year 2	$19,460,000			
Year 3	$19,460,000			
Year 4	$19,460,000			
Year 5	$19,460,000			
Year 6		$48,550,000	$15,980,000	
Year 7		$48,550,000	$15,980,000	
Year 8				$20,280,000
Year 9				$20,280,000
Year 10				$20,280,000
Year 11				$20,280,000
Year 12				$20,280,000
Year 13				$20,280,000
Year 14				$20,280,000
Year 15				$20,280,000
Year 16				$20,280,000

This report, *Reclamation and Closure Plan – Red Dog Mine*, was prepared by SRK Consulting (U.S.), Inc. with data supplied by TAK.

Bill Jeffress, Principal Consultant

and reviewed by

Daryl Hockley, Corporate Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A – Legal Description of Property

1. INTRODUCTION

The boundary for the Solid Waste Permit for the Red Dog Mine, as previously approved, is identical to the 1999 Air Shed Ambient Air Quality Boundary. This boundary encompasses all the applicable facilities. In addition, it avoids duplicating the effort of determining the legal description and maintaining multiple permit boundaries.

2. LEGAL DESCRIPTION

Teck Alaska Incorporated submits this legal description of lands encompassed by the 1999 Air Shed Ambient Air Quality Boundary as the geographical boundary for the Solid Waste Permit for Red Dog Mine. It is referred to as the Solid Waste Permit Boundary and applies to the geographic area within the outline depicted on the drawing attached hereto as Figure 1 and located approximately within the following described lands:

Township 30 North, Range 18 West, Kateel River Meridian

Section 5:	NW¼NE¼, SW¼NE¼, W½, NW¼SE¼, SW¼SE¼
Section 6:	All
Section 7:	NE¼, N½NW¼, N½S½NW¼, SW¼SW¼NW¼, NE¼SE¼, NE¼NW¼SE¼
Section 8:	W½NE¼NE¼, NW¼NE¼, N½SW¼NE¼, SW¼SW¼NE¼, N½SE¼NE¼, NW¼, N½NW¼SW¼

Township 31 North, Range 18 West, Kateel River Meridian

Section 1:	SW¼SW¼
Section 2:	NW¼NW¼NE¼, S½NW¼NE¼, SW¼NE¼, SW¼SE¼NE¼, W½, SE¼
Section 3:	All
Section 4:	All
Section 5:	NE¼NE¼, NE¼NW¼NE¼, S½NW¼NE¼, S½NE¼, S½NE¼NW¼, SW¼NW¼, SE¼NW¼, S½
Section 6:	S½SE¼NE¼, E½SE¼, E½W½SE¼
Section 7:	NE¼NE¼, E½NW¼NE¼, S½NE¼, SE¼SE¼NW¼, NE¼SW¼, S½NW¼SW¼, S½SW¼, SE¼
Section 8:	All
Section 9:	All
Section 10:	All
Section 11:	All
Section 12:	W½NW¼NW¼, NW¼SW¼NW¼, W½SW¼SW¼
Section 13:	W½NW¼, N½SE¼NW¼, SW¼SE¼NW¼, SW¼NE¼NW¼, SW¼NW¼SE¼, SW¼SE¼, SW¼
Section 14:	All
Section 15:	All
Section 16:	All
Section 17:	All
Section 18:	All
Section 19:	All
Section 20:	All

Section 21: All

Section 22: N½NE¼NW¼, SW¼NE¼NW¼, W½NW¼, S½SE¼NW¼, SW¼, NW¼SE¼, W½SW¼SE¼

Section 23: N½NW¼NE¼, NE¼NE¼

Section 24: N½NW¼NE¼, SW¼NW¼NE¼, N½NW¼, N½SW¼NW¼, SE¼NW¼

Section 27: W½NW¼NE¼, W¼SW¼NE¼, NW¼, N½SW¼, N½S½SW¼

Section 28: N½, SW¼, N½SE¼, SW¼SE¼, N½SE¼SE¼, SW¼SE¼SE¼

Section 29: All

Section 30: All

Section 31: All

Section 32: N½NE, SW¼NE¼, W½, W½NW¼SE¼, SW¼SE¼

Section 33: N½N½NW¼, NW¼NW¼NE¼

Township 32 North, Range 18 West, Kateel River Meridian

Section 32: SE¼SE¼SE¼

Section 33: S½SW¼SW¼, NE¼SE¼SW¼, S½SE¼SW¼, S½SE¼

Section 34: NE¼NE¼SW¼, S½N½SW¼, S½SW¼, SE¼

Section 35: S½NW¼SW¼, SW¼SW¼, W½SE¼SW¼,

SE¼SE¼SW¼ Township 30 North, Range 19 West, Kateel River Meridian

Section 1: All

Section 2: NE¼, NE¼NW¼, E½NW¼NW¼, SE¼NW¼, NE¼SW¼, SE¼NW¼SW¼, E½SW¼SW¼, SE¼SW¼, SE¼

Section 11: NE¼, NE¼NW¼, NE¼NW¼NW¼, E½NW¼NW¼, E½SE¼NW¼, NE¼NE¼SW¼, N½SE¼, NE¼SW¼SE¼, N½SE¼SE¼

Section 12: N½, N½NE¼SW¼, SW¼NE¼SW¼, NW¼SW¼, N½SW¼SW¼, NW¼NW¼SE¼

Township 31 North, Range 19 West, Kateel River Meridian

Section 12: S½SW¼SE¼, SE¼SE¼

Section 13: E½, NE¼NW¼, NE¼NW¼NW¼, S½NW¼NW¼, S½NW¼, NE¼SW¼, N½NW¼SW¼, SE¼NW¼SW¼, SE¼SW¼

Section 24: E½, E½NW¼, E½NE¼SW¼, NE¼SE¼SW¼

Section 25: E½, E½SE¼NW¼, NE¼SW¼, S½NW¼SW¼, S½SW¼

Section 26: SE¼NE¼SW¼, E½SE¼SW¼, S½NE¼SE¼, NW¼SE¼, S½SE¼

Section 35: E½, E½NW¼, NE¼SW¼, E½SW¼SW¼, SE¼SW¼

Section 36: All

3. BOUNDARY DRAWING

The boundary for the Solid Waste Permit for the Red Dog Mine is shown on the attached drawing “Red Dog Mine Solid Waste Permit Boundary”.

162°58'0"W
162°56'0"W
162°54'0"W
162°52'0"W
162°50'0"W
162°48'0"W
162°46'0"W
162°44'0"W
162°42'0"W
68°8'0"N
68°7'0"N
68°6'0"N
68°5'0"N
68°4'0"N
68°3'0"N
68°2'0"N
68°1'0"N
68°0'0"N
Meridian Kateel River
T32N R19W
Meridian Kateel River
T32N R18W
Meridian Kateel River
T31N R19W
Meridian Kateel River
T31N R18W
Alaska State Land Boundary
NANA Land Boundary
Meridian Kateel River
T30N R19W
Meridian Kateel River
T30N R18W
Red Dod Mine Solid Waste Permit Boundary
N
W
E
S
0 2,900 5,800
Feet

Appendix B – Life of Mine Plan (2014-2030)

Red Dog Operations
Alaska, USA

LIFE OF MINE PLAN (2014-2030)

Teck

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List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ARD	Acid Rock Drainage
BMP	Best Management Practices
CFR	Code of Federal Regulations
EOY	end-of-year
EPA	Environmental Protection Agency
HSS	Higher Sulfide Sulfur
IWMP	Integrated Waste Management Plan
LG	Low Grade
LG-N	Low Grade Non-Reactive
LG-PR	Low Grade Possibly Reactive
LMPT	Large Mine Permitting Team
LOM	Life of Mine
LSS	Lower Sulfide Sulfur
MPD	Main Pit Dump
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
NPDES	National Pollution Discharge Elimination System
NPV	net present value
NSR	Net Smelter Return
PR	Possibly Reactive
QPD	Qanaiyaq Pit Dump
RDC	Red Dog Creek
SAG	semi-autogenous grinding
Se	selenium
SHC	self-heating capacity
TAK	Teck Alaska Incorporated
TDS	Total dissolved solids
TSF	Tailings Storage Facility
WMP	Waste Management Permit
WRD	Waste Rock Dump
WTP	Water Treatment Plant

Units of Measure

amsl	above mean sea level
C	Celsius
°	degree or angle
ft	foot/feet
F	Fahrenheit
Mt	Million tonnes
tpoh	tonnes per operating hour
yd^3	cubic yard

Introduction

The Life of Mine Plan 2014-2030 (LOM Plan) was developed from January to December 2013 based on revised block models, modified ultimate pit shells, modified mine phases, and a November 2013 forecast pit status for December 31, 2013. Fluctuation of metal prices, ground conditions, and other factors may result in modifications to the LOM Plan in the future.

The LOM Plan is based on two distinct block models, one for the Aqqaluk deposit and one for the Qanaiyaq deposit. Planning for the Aqqaluk Pit was based on the RED2012-BH-A model, issued in May 2013, and the Aqq12c pit shell. Planning for the Qanaiyaq Pit was based on the QAN2012-B model, issued in May 2013 with revised geology based on 2011-2012 drilling results, and the Qan12b pit shell. Main-Aqqaluk deposit metallurgy was used in both models, as metallurgical testing of Qanaiyaq ores was on-going through 2013 and unavailable prior to development of the LOM Plan. Metallurgical information arising from the analysis will be communicated in the succeeding Life of Mine or 5 Year Plans.

Preliminary geotechnical structural data from a 2011 analysis was used to redesign the shape of the ultimate Aqqaluk Pit prior to developing the LOM Plan. Geotechnical information arising from diamond drilling in 2013 and the current revision of the 2011 analysis will be communicated in the succeeding Life of Mine or 5 Year Plans.

A detailed geotechnical structural analysis report for the Qanaiyaq deposit is currently under review. It was not available for the redesign of the shape of the ultimate Qanaiyaq Pit prior to development of the LOM Plan. Geotechnical information arising from the report will be communicated in the succeeding Life of Mine or 5 Year Plans.

One mining option was analyzed based upon ore feed from the Qanaiyaq Pit starting in 2018 and ending in 2027. This start date is quite late, but was set due to the current uncertainty surrounding selenium release from the deposit. An earlier start date would improve schedule smoothing. The end date is set based on the current strip ratio of the Qanaiyaq Pit. Preliminary results from the pending geotechnical analysis indicate a reduction in slope angle is warranted due to large regions of low competency rock. This will increase the strip ratio, requiring further pulling in of the pit end date, in order to provide sufficient time for backfilling.

Information in this LOM Plan is different from the 5-Year Plan issued in October 2013 in that this Plan used a November 2013 estimate for the forecast end-of-year (EOY) pit status, updated Aqq12c and Qan12b pit shells, and updated phase pit shells, redesigned to incorporate geotechnical berms every 4±1 benches to mitigate the highwall exposure above operations personnel.

1 Executive Summary

1.1 General

The Red Dog Mine (Mine) is located 93 miles north of the city of Kotzebue, Alaska. Cominco America Incorporated developed the Mine between 1987 and 1989 under a 1982 agreement with the NANA Regional Corporation, Inc. (NANA). NANA was awarded surface and subsurface rights by Congress with the passage of the Alaska Native Claims Settlement Act of December 18th, 1971. The remaining Red Dog ore deposit consists of the Aqqaluk Deposit and Qanaiyaq Deposit. Relatively modest average mill throughput of 9,350 tonnes per day yields, on average, about 830,000 tonnes of zinc concentrate and 140,000 tonnes of lead concentrate annually. This report presents the results of an updated LOM Plan with the objectives of:

- Revising the pit shapes and the ore release based upon new geologic data.
- Deferring the start of the Qanaiyaq Pit to allow time for a better understanding of the mechanism of selenium release from the weathered cap.
- Identify permitting, exploration drilling, metallurgical testing, and infrastructure capital requirements.
- Maximizing the net present value (NPV) within the capacity of the existing Tailings Storage Facility (TSF) design.

1.2 Geology, Resources and Reserves

The Mine production from 1989 through 2009 was derived entirely from the Main deposit, which is transected by Red Dog Creek. Subsequent to the development of the Main Pit reserve, two additional open pit deposits were discovered adjacent to the Main Pit. The Aqqaluk deposit is immediately to the northeast of the Main Pit on the north side of Red Dog Creek, and the Qanaiyaq deposit is located south of the Main deposit. A small portion of the Aqqaluk deposit was mined in 2003 in order to make room for the Red Dog Creek Diversion, and mining of the Aqqaluk deposit started in May 2010 to transition with the completion of the Main Pit in 2012. Two potential underground deposits exist; Paalaaq, located northeast of the Aqqaluk deposit, and Anarraaq, located approximately 7 miles northwest of the Main Pit.

The LOM Plan is based on two distinct block models, one for the Aqqaluk deposit and one for the Qanaiyaq deposit. Planning for the Aqqaluk Pit was based on the RED2012-BH-A model which was issued in May 2013. Planning for the Qanaiyaq Pit was based on the QAN2012-B model which was also issued in May 2013. The drilling and metallurgical understanding of the Aqqaluk deposit is sufficient to classify it as a reserve. Although the drilling of the Qanaiyaq deposit is sufficient to classify it as a reserve, the understanding of metallurgy and the mechanism of selenium production is only sufficient to classify it as a resource.

1.3 Mineral Processing

The LOM Plan uses revised Universal Recovery formulas and mill throughput estimates. A revision of the Universal Recovery Model was developed by the AMIRA P843 GeM Project and has been incorporated with various revisions into the resource models since June 2009. The mill throughput estimates were developed from class based modeling; however, the Universal model was adopted, as there were insufficient samples in several of the class types to adequately span the variability in the mill feed. Mill throughput for the LOM Plan varies based on the feed zinc, barium, iron, silica, and grades, and the grain size estimate as per the GeM model. This variable throughput results in an average mill feed rate of 406 tonnes per operating hour (tpoh) with a minimum of 378 tpoh after 2028, due to the high quartz content of over 46%, and a maximum of 449 tpoh in 2014, due to the high barite grade of 11% and lower quartz content of 41%.

1.4 Mine Planning

The Mine has prepared this updated LOM Plan based on planned mine face advances. This LOM Plan uses all new pit designs. The Aqq12c pit and three new intermediate pushback phases, incorporating geotechnical catch benches every 4±1 benches, are used for the Aqqaluk deposit. The Qan12b pit and a new intermediate pushback phase are used for the Qanaiyaq deposit. The production plan is detailed by year through to the end of mine life and meets a number of predetermined constraints relating to mine production, mill throughput, and equipment fleet size.

Operating costs were developed from a combination of fixed and variable cost standards for all aspects of mine operations. Historical consumption, productivity, and cost information were modified for expected changes and then used as a basis for forecasting. Ore/Waste cutoff is based on net value per tonne.

Total annual tonnage mined is considered a function of available truck hours. The truck hours required to achieve the mill feed and required projects are determined first. These hours are then subtracted from the total available truck hours. A Utilization of 79.5% and a Physical Availability of 82.0%, giving an Effective Utilization of 65.2%, were used to calculate the total truck hours available for 2014 based on the 2014 Budget Plan. The Physical Availability is increased or decreased each subsequent year to account for the changing average age of the fleet.

The equipment required to achieve the LOM Plan decreases in stages from 2014 to the end of the Mine life. It is maintained near current levels through 2020 due to stripping of the sequential phases of the Aqqaluk Pit and the start-up of the Qanaiyaq Pit. A snapshot of the LOM Plan End-Of-Year Equipment Inventory is shown in Table 1-1. Drills need to be replaced in 2021 (1) and 2023 (1). Production loaders need to be replaced in 2015 (1), 2024 (1), and 2026 (1). Haul trucks need to be replaced in 2015 (2), 2017 (1), 2018 (3), and 2026 (1). Retired trucks are held back from shipping off-site until 2019 to be used for tailings dam construction. Dozers need to be replaced in 2015 (2) and 2017 (1).

Table 1-1: End-of-Year Equipment Schedule

Equipment	Description	2014	2020	2021	2026
Drills	Atlas-Copco DML	3	2	2	2
Loaders	Caterpillar 992/993	5	4	4	3
Trucks	Caterpillar 777	8	9	7	6
Dozers	Caterpillar D9 & D10	4	4	3	3

1.5 Mine Production

The total mine production for the LOM Plan is 154 Million tonnes (Mt) with an average strip ratio (Waste/Mill Feed) of 1.92.

The Mine is anticipating mining both the Aqqaluk and Qanaiyaq Pits simultaneously between 2018 and 2027. Overall the Aqqaluk Pit contributes 86% and the Qanaiyaq Pit 14% of the Mill Feed. Of the combined tonnage of low grade ore and waste, the Aqqaluk Pit contributes 82% and the Qanaiyaq Pit 18% due to the higher stripping ratio in Qanaiyaq. The large quantity of low grade ore is mainly attributable to the results of the recent infill drilling in the Aqqaluk deposit. It should be noted that historically only 10% of the block model estimated low and marginal grade materials from the Main Pit were recovered, most were sent to waste. This was due to the highly variable metal grades in the deposit making contiguous zones of low and marginal grade materials rare once drilled and assayed on blasthole density.

Low grade (LG) ore from the Aqqaluk and Qanaiyaq Pits was classified into two material classes: Non-Reactive (LG-N) and Possibly Reactive (LG-PR). Waste from the Aqqaluk and Qanaiyaq Pits was classified into five material classes: Possibly Reactive (PR), Higher Sulfide Sulfur (HSS), Lower Sulfide Sulfur (LSS), Construction, and Cover. PR waste was placed whenever possible below the ultimate Main Pit flood level of 840 ft elevation, but due to the timing of release, the majority was placed as mixed waste above. The very low sulfide content construction and cover waste materials will be hauled to the tailings dams or used as cover for the Main Waste Dump (MWD), respectively, depending on mineralization and rock type, on an as-produced basis.

1.6 Capital Costs

Capital cost estimates were allocated to four primary areas: infrastructure, mobile equipment, exploration, and permitting, as well as miscellaneous expenditures to maintain production. Historical cost forecasts in combination with the LOM Plan time line were used as the basis for forecasting future capital expenditures.

Infrastructure requirements were limited to maintaining the existing production plant with no planned expansions. The primary infrastructure requirements are raising the tailings dams as required by the water balance, constructing a plant to process concentrated acid rock drainage (ARD) from the waste dumps, and the relocation of Red Dog Creek, as well as other reclamation activities at the end of mine life. As they are considered expansions, neither the installation of larger motors for semi-autogenous grinding (SAG) mills #1 and #2 to counter the reduction in grinding throughput with increasing ore hardness nor replacing the lead circuit tower mills with an IsaMill™ were incorporated into the schedule.

A mobile equipment replacement schedule was established by replacing major equipment when the cumulative operating hours reach a set limit. Operating hours were determined from the LOM Plan.

Exploration expenditures to complete infill drilling for open pit planning and underground feasibility requirements were determined by the planned development sequence. Additional metallurgical testing is planned for both the Aqqaluk and Qanaiyaq deposits to refine the planning criteria.

1.7 Project List

- Main Waste Dump Re-sloping
- TSF Pond Dust Control
- Dust Control

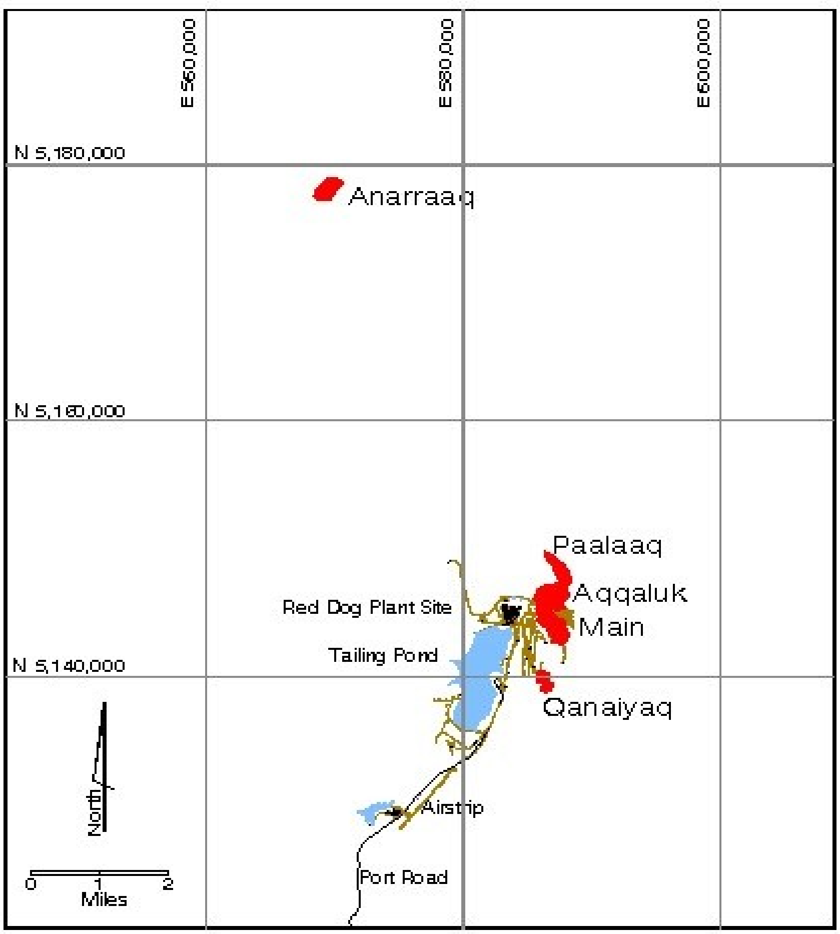
- MS-6 Site Reclamation
- Relocate West Tailings Road
- Main Waste Dump Cut Off Wall
- Mine Surface Water Management and Sediment Control
- Sulfur Creek Sediment Control
- Main Pit Dump Re-sloping
- Main Pit Pond Elevation Control
- Material Site Quarries
- Geotechnical Monitoring and Highwall Failure Mitigation
- Gas Exploration Site Reclamation
- Red Dog Creek Dirty Water Pumpback Silt Clean Out
- Main Dam Widening for Stage X
- Re-grade Mine Site Yards and Roads
- Main Dam Stage X
- Runway Resurfacing Tailings Disposal Studies
- Paalaaq Exploration
- Paalaaq Development Studies
- Anarraaq Development Studies
- Red Dog Creek Culvert Relocation
- East Tailings Pipe Bench

2 Geology

2.1 General

Mine production from 1989 through to 2011 was derived almost entirely from the Main deposit, which is transected by Red Dog Creek. Subsequent to the development of the Main Pit reserve, two additional open pit deposits were discovered adjacent to the Main Pit. The Aqqaluk deposit is immediately to the northeast of the Main Pit on the north side of Red Dog Creek. The Qanaiyaq deposit is located south of the Main deposit. A small portion of the Aqqaluk deposit was mined in 2003 in order to make room for the Red Dog Creek Diversion. Continuous mining of the Aqqaluk deposit started in May 2010 to transition with the completion of the Main Pit in April 2012. To the end of 2012, 62,296,329 tonnes of ore had been milled, yielding 18,541,267 tonnes of zinc concentrate grading 55.5% zinc and 3,496,986 tonnes of lead concentrate grading 54.7% lead. Paalaaq, to the north of Aqqaluk, and Anarraaq, seven miles northwest of the Main Pit, are mineralized areas with the potential for future development as underground mines. The Red Dog district is illustrated in Figure 2-1.

Figure 2-1: Red Dog District Deposits

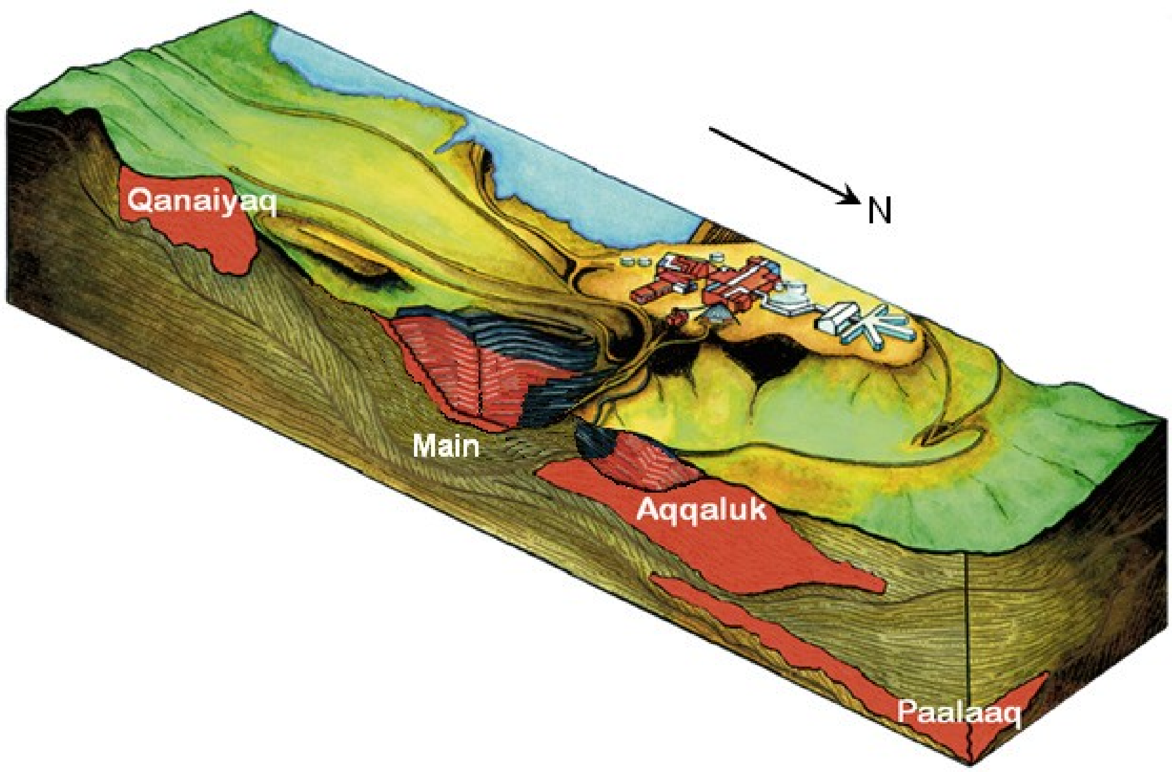


The Red Dog deposits are of a sedimentary exhalite and replacement origin. Rifting during the early Mississippian time period developed a restricted sub-basin, and block faulting associated with this event provided pathways for fluid flow to the sea floor. Syngenetic barite rock and subordinate amounts of low grade sulphide rock and silica rock were deposited as sediments. The barite rock formed a cap, which restricted and localized fluid flow, allowing for replacement by silica and sulphides. Upward migration of the vein system, through the exhalite, further upgraded the deposit which was subsequently tectonically faulted into several discreet deposits.

2.2 Deposit Geology

Four deposits occur around the original Red Dog discovery area: the Main deposit (the first to be mined), the Aqqaluk deposit (a northern extension of the Main deposit), the Qanaiyaq deposit (a southern extension of the Main deposit), and the Paalaaq deposit (a deeper zone north of Aqqaluk). All four deposits are believed to be parts of one continuous ancestral deposit, which was structurally dismembered and repeated by a series of low angle Cretaceous-aged thrust faults. A generalized isometric section of the Qanaiyaq, Main, Aqqaluk, and Paalaaq deposits is shown in Figure 2-2.

Figure 2-2: Qanaiyaq, Main, Aqqaluk, and Paalaaq deposit isometric section



In the Main, Aqqaluk and Paalaaq areas, the ancestral deposit has been structurally repeated and now occurs in four plates; upper, median, lower, and sub-lower. The upper plate, restricted to the south end of the Main deposit, is not ore bearing. The median plate starts at the south end of the Main deposit and laps over the lower plate before being truncated by erosion as it rises in the north in the Aqqaluk deposit. The majority of the ore in the Main deposit was in the median plate. Portions of the northern end of the Main deposit occur in the lower plate, but this plate is best developed north of Red Dog Creek and contains the majority of the Aqqaluk reserves and resources.

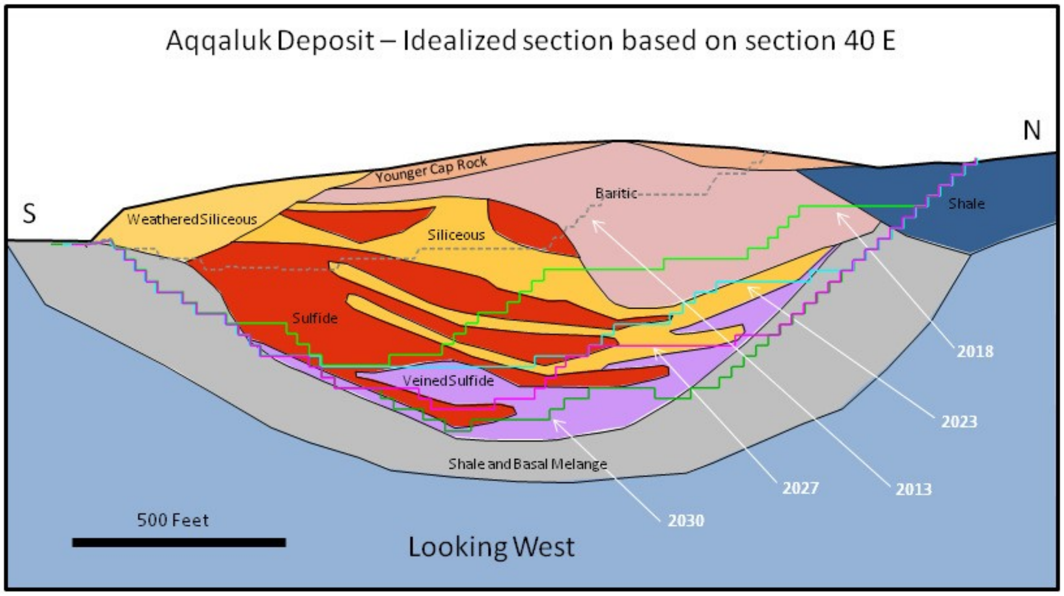
The Paalaaq resource is contained entirely in the sub-lower plate. It is a deep-seated, mineralized assemblage that occurs to the north of and below the Aqqaluk deposit. Paalaaq mineralization dips to the north, leaving Paalaaq covered by 600 to 2,000 ft of waste. The Qanaiyaq deposit is an isolated, mineralized thrust sheet, located 2,400 ft south of the Main deposit.

2.3 Aqqaluk

The Aqqaluk deposit is defined as any open pit ore north of the roughly east-west line made by Shelly Creek and Red Dog Creek downstream of the Shelly Creek intersection. To date, 483 core holes have been drilled in Aqqaluk, for 276,683 ft of core. Of these, 111 holes were drilled in 2011 and 2012, after the issue of the 2012 LOM Plan. These were incorporated into the RED2012-BH-A model used to model the Aqqaluk deposit for this LOM Plan. Drill spacing is generally 100 ft x 100 ft over most of the deposit, although there are some gaps due to the inability to drill along the path of Red Dog Creek. In the second half of 2012, thirteen geotechnical holes were drilled to help determine the optimal final pit wall placement. In addition, two infill holes were drilled in the southwest corner of the deposit. These holes are included in the total, but samples taken were not used in the RED2012-BH-A model nor were the geotechnical data used in developing the pit shell. The data from these geotechnical holes will be used once the structural modeling is complete. In 2013, nine ore delineation holes were completed on the northern and eastern edges of Aqqaluk and fourteen geotechnical holes were completed throughout the deposit. Holes from these programs are not included in the totals and results from these programs will be incorporated into future models as data becomes available. Additional perimeter drilling and holes to follow up on results of the 2013 program are planned for future drill campaigns.

There are five metallurgical ore types defined in the Aqqaluk model: low iron siliceous, high iron siliceous, baritic, veined, and median plate. The siliceous ores comprise the bulk of the Aqqaluk ore and are found in non-baritic and non-veined geologic units. The iron grade separates the low iron from the high iron siliceous ore. Zinc grades and grain sizes for siliceous ore are variable, with higher zinc grades tending to be associated with finer grained sulphides. Baritic ore is found in the Ikalukrok Barite unit and is generally fine grained sulphides disseminated in barite. Veined ore is found in the Veined Ikalukrok unit and tends to be coarse grained sulphides in a silicified black shale matrix. Median plate ore is found near the surface at the southern end of Aqqaluk and is actually a remnant of the Main Pit median plate, which contained the bulk of the Main Pit reserve. Studies comparing Main Pit and Aqqaluk metallurgy indicate that the Universal Recovery Formula is applicable to all ore types in Aqqaluk. A typical cross-section through the Aqqaluk Pit based on section 40 E showing the geology and the 2016, 2020, 2025, and 2030 (ultimate) pit shells is shown in Figure 2-3.

Figure 2-3: Typical cross-section through the Aqqaluk deposit

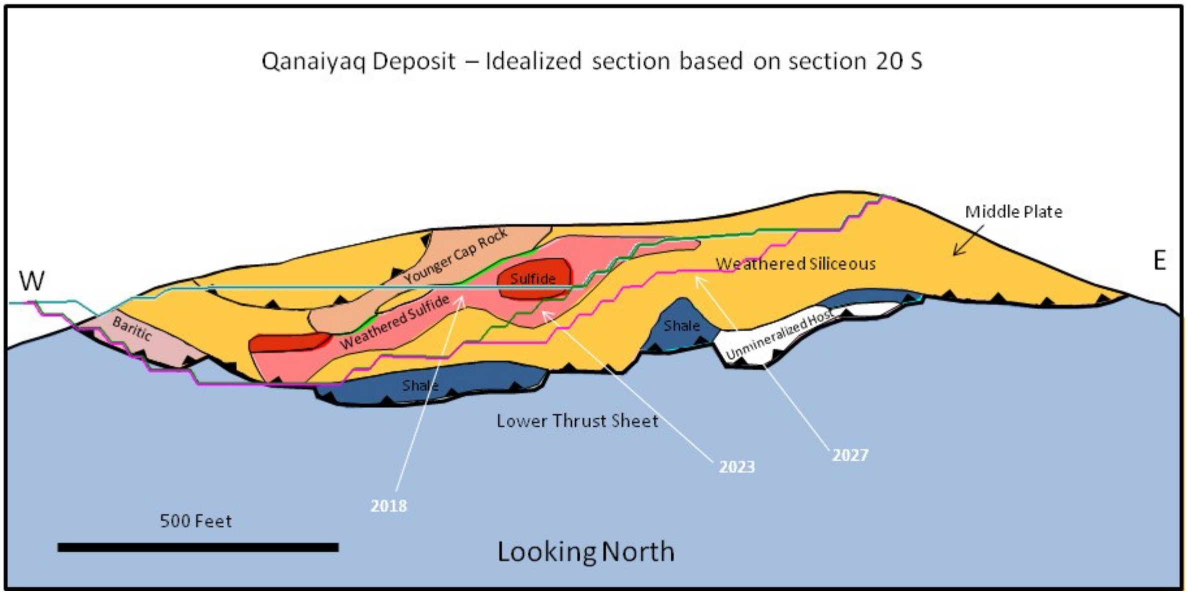


2.4 Qanaiyaq

There are 242 holes covering the Qanaiyaq deposit, 207 core totaling 52,187 ft and 35 reverse circulation totaling 9,515 ft. The bulk of the deposit was infilled with the drilling of 158 holes in 2010/11 and 2011/12 and is now drilled at 100 x 100 ft. All these holes were incorporated into the QAN2012-B model used to model the Qanaiyaq deposit for this plan. No additional drilling is planned for the Qanaiyaq deposit.

Currently there are two metallurgical ore types defined in the Qanaiyaq model, regular and weathered with low copper values. Soluble lead is used as an indicator of the degree of weathering; the higher the soluble lead assay, the greater the weathering. Regular ore with high copper values does not seem to perform in the same poor manner, so there is no copper criterion for regular ore. Limited studies based on drill core from the initial Qanaiyaq drilling campaign compared Main Pit and Qanaiyaq metallurgy. These indicated that the Universal Recovery Formula appeared to be applicable to the regular and the weathered with low copper ore types in Qanaiyaq. With the completion of infill drilling in 2012, a more extensive metallurgical study was started in 2013. The results of that study are currently being analyzed and show that a Universal Recovery Formula type model is applicable; however, it appears that the parameters will be different for the Qanaiyaq metallurgical ore types. A typical cross-section through the Qanaiyaq Pit based on section 20 S showing the geology and the 2020, 2025, and 2030 (ultimate) pit shells is shown in Figure 2-4.

Figure 2-4: Typical cross-section through the Qanaiyaq deposit



2.5 Resources and Reserves

The mineable reserves and resources for the LOM Plan based on the RED2012-A and QAN2012-B block models developed for the 2013 Ore Reserves. The LOM Plan used a forecast January 2014 status map and therefore excluded any reserves milled or planned to be milled between January 1 and December 31, 2013. Both the reserve and resource for the Aqqaluk deposit are contained in an ultimate pit designed and optimized in 2013, based on the same economic and metallurgical criteria. The reserve is roughly contained within a zone of 100 ft spaced drilling based on observed ore continuity in mining, interpreted ore continuity in core holes, and mined to milled reconciliation. The resource is generally outside the area of 100 ft spaced drilling, as well as portions of the deposit near original ground due to the inconsistent geology. The Qanaiyaq resource is contained in an ultimate pit designed and optimized in 2013 and was calculated using a three dimensional block model similar to the models used for the Main and Aqqaluk deposits.

3 Pit Optimization Parameters

Value is defined as the amount of revenue generated by the recoverable metal contained within one ton of rock. Revenue is based on metal recovery and metal prices. To balance the contribution of the valuable and the deleterious elements in the polymetallic Red Dog deposits, mill recoveries are calculated for each block based on the regression equations developed from historical geologic and mill data.

In the block model, Net Smelter Return (NSR) rather than Value is used as it is more easily compared to site costs. This is the value defined above less the costs of smelting, sales, and distribution. In conjunction with mill recoveries and metal prices, these costs are used to allocate each block in the model a net value per ton. Mine cutoffs are thus associated to the NSR value and not the total value of each block.

All blocks whose value exceeds the operating cutoff cost are routed as Ore for the LOM Plan. Of the remaining blocks, those whose value exceeds the breakeven (or mill) cutoff are routed as Low Grade Ore. This material could be stockpiled separately at the north end of the MWD for potential milling at the end of mine life, however, TSF capacity currently does not exist for this material, so it is not considered mill feed for the purposes of this LOM Plan. The remaining blocks are considered waste.

3.1 Operating Schedule

The Mine operation runs continuously, 365 days per year and 24 hours per day, with no allowance for statutory holidays. However, mine production is reduced by 4.4 weather days annually to account for snowstorms shutting down or reducing haulage to less than 10% of plan. Mill production is reduced by 6.0% to account for maintenance requirements and an additional 0.5% to account for low feed events, giving the concentrator a 93.5% average on-time. The additional day in leap years is accounted for in the schedule.

3.2 Pit Design

Each ore body has its own separately developed ultimate pit design. Pit designs and optimizations for the Aqqaluk and Qanaiyaq Pits were redone in 2013 for the 2013 Red Dog Reserves & Resources report. The pits were designed using the Mintec MineSight Economic Planner® optimization software. The software utilizes the Lerchs-Grossmann algorithm and evaluates pits by NPV. The software is not based on a static economic model, but discounts the value assigned to each block within the model to generate a series of mathematically optimal pit shells organized in order of decreasing NPV. Each shell maximizes the discounted cash flow through the mining cycle, resulting in an ordering where the most economic material is mined first. These shells can be defined to ensure a reasonable prospect of mining through the sequence by specifying minimum pushback width and bench advance. The Aqqaluk deposit is designed with four phased pushback shells to increase the NPV. The smaller Qanaiyaq pit is designed to one shell, the ultimate limit, due to its smaller size, but is divided into two pushbacks of similar tonnage and grade, for backfill haulage optimization at pit closure.

The ultimate Aqqaluk Pit shape was redone in 2013 due to the completion of the majority of the deposit infill drilling in 2012 and the issuance of a revised geological block model (Red2012-BH- A).

4 Environmental, Permitting and Closure Planning

4.1 Pits

The Main Pit will be nearly completely backfilled during operations with waste from the mining of the Aqqaluk and Qanaiyaq Pits. Only a portion of the Main Pit to the east of Red Dog Creek Diversion would remain open. The wide and accessible benches in that area would be covered and revegetated in the same manner as the waste dumps. The upper highwall along the eastern limit would be blasted back to a 4H:1V slope to allow snow machine operators to see the pit wall in sufficient time to stop safely.

Aqqaluk Pit permits have been issued. Future permits are contained within the operational permits for the entire mine site: Solid Waste, Reclamation & Closure, Water Discharge, Air (Title V), and Wetlands. At closure, the pit will be allowed to flood up to the 750 ft elevation; this will provide sufficient freeboard to store the entire volume of a 1,000-year flood. The pit lake will be used as the depository for water treatment plant sludge. A berm would be constructed to mark the highwall as a hazard for snow machines.

For the Qanaiyaq Pit, the primary permitting consideration is that its footprint is in a non-wetlands area and the drainage from the deposit is entirely within the existing water containment system. No additional infrastructure or support facility is required. The quantity of water from this development is expected to be minimal, and therefore, treatment will be accomplished by the existing treatment system. The deposit is located entirely on NANA land.

The close proximity of the Qanaiyaq Pit to the existing Main Pit and containment of its drainage minimizes the permitting requirements. No wetland permitting is anticipated. A baseline program is all that is required. The baseline data needs are as follows:

- Impact to the existing water and chemical balance; water hydrology and chemical composition characterization – currently being determined.
- Archaeological survey – completed.
- Wetlands survey – no wetland impact with current pit design.
- Material characterization of ore/tailings and waste rock – currently in progress.

The baseline data and a detailed operation and reclamation plan for mining would be submitted to the relevant agencies to meet conditions of the existing NPDES and Reclamation & Closure Approval permits. Minor facility permits for drinking water and wastewater disposal systems are not anticipated since these functions will be provided within existing infrastructure.

The Qanaiyaq Pit will be backfilled for closure so as not to leave the possibility of a pit lake. The pit is planned to be mined in two phases, with waste rock from the second phase used to fill the first phase pit. Waste from the Aqqaluk Pit will be used to fill the second phase of the pit. As the backfill will not reach the crest of the second phase pit, a berm will be constructed around the crest to denote the hazard.

4.2 Dumps and Stockpiles

The Main Waste Dump (MWD) is effectively closed and the sides have been re-sloped to a 3H:1V with the completion of the Main Pit in 2012. The re-sloped surface will be covered for revegetation as suitable cover material becomes available from the Aqqaluk Pit. The cover will consist of two 18-ft layers of weathered shale, the first weathered and compacted and the second lightly compacted. The design of the MWD may be adjusted once the geotechnical analysis for the Qanaiyaq deposit is finalized, as the ultimate pit shape is expected to change. The section of the dump closest to the Qanaiyaq Pit will thus be left uncovered and not revegetated until the Qanaiyaq Pit starts. The dump may be used for the first few years of Qanaiyaq Pit production, if the opportunity exists, with an updated Qanaiyaq Pit shape to use this area for low sulfide sulfur waste to transform the relatively planar top surface into a domed surface.

The Main Pit Dump (MPD) will be closed and the sides sloped to an average of 3.7H:1V with the completion of the Aqqaluk Pit in 2030. This would permit the re-sloped surface to be composed of engineered channels and slopes of 3H:1V varied where possible, to provide more natural looking landforms. The re-sloped surface would be covered for revegetation with stockpiled cover material using a similar cover design as for the MWD.

The Qanaiyaq Pit Dump (QPD) will be closed with the completion of the Aqqaluk Pit in 2030, as there is insufficient material from the Q2 phase pit to complete all the fills required, thus the need for waste material from the A4 phase pit. This dump is shallow and can be reclaimed in step with construction. All surfaces would be covered for revegetation with stockpiled cover material.

Portions of the Overburden Dump may be used during operations for construction of the Back Dam or as part of the cover for the MWD. At closure, additional material may be used for covering the MWD and MPD. The remainder of the dump will be regraded and revegetated.

4.3 Red Dog Creek Diversion

The Red Dog Creek Diversion will be re-built as an open channel designed to pass the 1,000-year flood. The alignment will be at the toe of the regraded MPD. The channel structure would be 125 ft wide at its base. The offset distance on the west side of the channel between the MPD toe and the channel structure toe would be sufficient to allow a sediment collection ditch and a roadway, nominally 40 ft. The offset distance on the east side of the channel would be sufficient to allow space for the Kivalina shale in the Main Pit wall to weather to a 3H:1V slope, plus the space for a similar 40 ft wide sediment collection ditch and a roadway structure between the weathered pit wall toe and the channel toe. The channel would be built above the roadway grade to further ensure sediment would not enter the channel.

4.4 Tailings Storage Facility (TSF)

The tailings deposition plan has the tailings reach the 978 ft elevation by the end of mine life. If necessary, the tailings surface will be regraded using methods developed and tested at the Teck Louvicourt Mine. A permanent pond will be maintained over the tailings, as submergence has been demonstrated as the most effective way to prevent oxidation and acid generation from sulfidic tailings. Experience at Louvicourt Mine shows that a minimum water cover to control oxidation is about 2 ft, leading to a minimum pond water elevation of 980 ft. However, the pond is also to be used as a water storage facility for the freshet inflow and would be drawn down each summer to provide room to store next year's freshet. The TSF dam is currently permitted to a final elevation of 986 ft; however, additional ore has been identified that will probably require the TSF dam to be raised above the currently permitted height of 986 ft.

Although interception of seepage from the MWD will keep contaminant concentrations much lower than current levels, they will not be low enough for the water to be discharged without treatment. Water will therefore be withdrawn from the TSF Pond each summer, treated, and discharged. To minimize the quantity of water needing to be discharged, the diversion ditches above the west side of the TSF would be maintained.

To keep seepage rates through the Main Dam low after closure, a permanent beach approximately 600 ft wide will be constructed in front of the dam. The beach will be constructed of non-mineralized rock and a geosynthetic liner to prevent oxygen from reaching the underlying tailings. Seepage collection at the toe of the dam will continue after closure, but the pumpback system will be reconfigured to send the seepage to the Aqqaluk Pit, preventing the seepage from contaminating the tailings pond.

The TSF Back Dam will be raised to the same elevation as the Main Dam during mining operations. Any seepage from the Back Dam will be collected and piped to the MWD seepage collection system from where it will be transferred to the Aqqaluk Pit. As seepage rates through the Back Dam are expected to be low, it is not clear if a beach will be required. Observations of actual seepage rates in the next few years will allow the requirement for a beach to be assessed.

4.5 Infrastructure

After operations cease in 2030, NANA and TAK will need to decide how much of the site infrastructure will be left in place. All infrastructures not needed for the post-closure requirements or for other NANA or TAK plans will be decommissioned. Hazardous material and high value components will be removed and the remainder of the facilities demolished and placed in the demolition landfills located in the existing, man-made valleys to the northeast of the mill plant. Areas where infrastructure is removed will have any metal contaminated soils removed and hauled to either the Low Grade Stockpile or the MPD prior to regrading.

4.6 Waste Dumps

4.6.1 Main Waste Dump

With the completion of the Main Pit at the beginning of 2012, the MWD will be closed and the principal dump location will be moved to the MPD. The south dipping slope of the southwest corner of the dump will be maintained to allow for the approach path of narrow body jet aircraft (e.g., Boeing 737 or similar aircraft).

4.6.2 Main Pit Dump

Dumping in the Main Pit began in 2012 and will continue through most of the Aqqaluk and Qanaiyaq Pit lives. The early plan was to segregate the waste in the MPD on the basis of total sulfide sulfur content to reduce ARD. When possible, the Higher Sulfide Sulfur waste (HSS waste) would be dumped below 850 ft elevation and the Lower Sulfide Sulfur waste (LSS waste) above 850 ft elevation. However, in the 2012 LOM Plan it was noted that the extraction of HSS waste rock from the Aqqaluk Pit is minimal in the first decade of mining and much higher near the end of pit life, thus the majority of the HSS waste would be above the 850 ft elevation.

Because it classified a smaller volume of higher risk material, sulfides subject to exothermic reaction, the Self Heating Capacity (SHC) risk criteria[1], was used in the 2012 LOM Plan to determine the waste destination. The SHC calculates the risk of the material self- heating, assigning a value between 1 and 5 as shown below. Instead of the >6% HSS criteria, waste with a SHC of 5 would be placed below the 850 ft elevation when possible.

1 Safe

2 Will not heat beyond 100 °C (212 °F)

3 Do not expose to high heat source

4 Recommend monitoring

5 Recommend preventative action

[1] Self Heating Capacity = 3.41744 + (%Pb-%sPb) / 0.866 x (-0.33539 + 0.03897 x %Zn / 0.671) - 0.81502 x Log((%Ba / 0.5886) / (%Fe / 0.4654))

The filling of the MPD is planned from south to north in a stepped sequence using 200-ft wide phases and 110-ft high lifts, giving a 3H:1V advance angle. There are approximately 13 phases per lift and the lifts are on 850, 904, 1,015, 1,125, and 1,236 ft elevations. The sequence would proceed vertically as each horizontal phase was completed. This method will maximize the available space for the possibly reactive waste (SHC = 5), optimize truck cycle times during the life of the Aqqaluk Pit, and allow phased reclamation of the MPD prior to completion of the Aqqaluk Pit. Due to the need to construct the phases with a mix of PR and low risk waste, it is planned to leave a 10 ft depth of low reactivity waste along the 3.7H:1V re-sloped, closure, dump face and the mixed waste. This will require dumping low reactivity waste on the eastern 170 ft of each MPD phase during construction.

Not all the low reactivity risk waste is placed in the dump. If it meets the low mineralization criteria for cover material it is placed on the MWD for reclamation. If it meets the criteria for construction material, whenever possible it is used as it is mined, otherwise it is stockpiled if room exists on the MWD above the stockpile pad. However, only about 25% of the block model estimated cover or construction material is actually recovered. This is due to the highly variable metal grades making contiguous zones of this low mineralization material rare once drilled and assayed on blasthole density. The MPD design incorporates space for this attrition.

Dumping will be into the Main Pit lake, maintained at the 840 ft elevation. Although originally expected to take four years to fill, due to the curtailing of discharge during the summer of 2013, the Main Pit lake water level has risen faster. It is currently at the 787 ft elevation and is expected to reach the 840 ft elevation between November 2014 and July 2015.

4.6.3 Qanaiyaq Pit Dump

Dumping in the Qanaiyaq Pit will begin in 2023 with the start of mining the second phase in the Qanaiyaq Pit and will continue through the remainder of the Aqqaluk and Qanaiyaq Pit lives. Waste in the QPD will not be segregated on the basis of SHC risk, but similar to the MPD; higher risk waste will be placed away from the outside surfaces of the dump. As with the MPD, not all LSS/low reactivity risk waste will be placed in the dump. If it meets the low mineralization criteria for cover material, it is placed on the MWD for reclamation. If it meets the criteria for construction material, whenever possible it will be used as it is mined, otherwise it will be stockpiled if room exists on the MWD above the stockpile pad.

4.6.4 Low Grade Stockpile

A Low Grade Ore Stockpile is constructed for storing material valued between the mill cutoff and the operating cutoff. The tipping location would be on top of the existing Marginal Stockpile. Depending on metal prices, oxidation, operating costs, and tailings pond capacity this material could be milled at the end of pit operations. Based on historical data, only 10% of the block model estimated low grade or marginal materials are actually recovered. This is due to the highly variable ore body grades making contiguous zones of low grade and marginal class materials rare once drilled and assayed at blasthole sampling density. In addition, approximately 60% of the material in the low grade ore category is classified as possibly reactive. It could not be stockpiled until the end of mine life and would need to be milled upon extraction or sent to the MPD, ideally for sub-aqueous disposal. This would further reduce the low grade ore material available for stockpiling down to approximately 4% of the total block model estimated low grade.

4.6.5 Solid Waste Landfill

A Solid Waste Landfill is operated to take refuse from the mining and milling operations. Current permit requirements are a maximum compacted solid waste depth of 4 ft, a minimum cover depth of 6 ft, a maximum operating width of 200 ft, and maximum operating height of 10 ft.

4.7 TSF Pond

The TSF Pond is located adjacent to the mill and is formed by the existing TSF Main Dam at the north end and Back Dam at the south end. All of the tailings will be stored subaqueously in the existing tailings pond in order to minimize metal leaching and fugitive dusting.

The crest elevation of the Main Dam is currently 976 ft, allowing for water cover, storage of runoff, waste rock seepage and mine sump flows, storage of the probable maximum flood, and wave run-up. The crest of the Main Dam may be raised to a final elevation that is above the currently permitted level of 986 ft. The impermeable portion of the Back Dam will be raised to the same final elevation of the Main Dam. The remaining dam construction is planned to be one 10 and one 14 ft lifts over the life of the mine, as required to maintain a minimum operating freeboard of 5 ft. It will be necessary to continue operation of the water treatment plant after the mine shuts down in order to maintain the TSF Pond water balance.

Although the TSF Pond capacity is considered a restriction on the current LOM Plan, the maximum NPV is achieved using an operating cutoff which utilizes the currently designed final capacity. Subsequent plans with the finalized Aqqaluk and Qanaiyaq Pit shapes and block models will reconsider whether more or less TSF Pond capacity is required for the maximum NPV schedule.

5 Mine Production

5.1 Introduction

The Mine has prepared this LOM Plan based on a revised mill throughput, a November 2013 estimate of future face advances through to the end of 2013, and updated block models. Blending is used to minimize year to year variation in mill feed grade.

The phase and the ultimate pit shells in the Aqqaluk Pit are completely new designs compared to those in the 2012 LOM Plan. They were completely redesigned in 2013 based on the new RED2012-BH-A model which included data from the 111 core holes drilled in 2011 and 2012. The new ultimate pit, 'Aqq12c', is adjusted to compensate for the findings of the preliminary geotechnical structure analysis done in 2011, particularly plate contacts on the south pit wall. Because of this structure, the primary haulage road exits from the southeast corner of the ultimate pit. The phase pit shells were redesigned to incorporate geotechnical berms every 4±1 benches to mitigate the highwall exposure above operations personnel.

The Qanaiyaq Pit is a completely new design compared to that in the 2012 LOM Plan. It was done in 2013 based on the new QAN2012-B model which included data from the 158 core holes drilled in the winters of 2010/11 and 2011/12. This pit, 'Qan12b', has one pushback to allow for staged backfilling.

5.2 Aqqaluk Pit

Mining of the Aqqulak Pit is planned in four pushbacks (A1 to A4). Mining of a low strip ratio/high zinc grade starter pit began in June of 2010. Stripping of the second Aqqaluk phase (A2) started in 2011, while mining of the third and fourth phases (A3 and A4) started in 2012. Both A3 and A4 phases release lower grade reserves with elevated iron levels.

PR waste is placed, when possible, below the 850 ft elevation in the Main Pit; however, given the distribution of waste classes in the updated block model and their exposure during the A3 and A4 pushbacks in the second half of the pit life, only 25% or 5.2 Mt of the total quantity of 21.1 Mt of possibly reactive waste from the Aqqaluk Pit can be placed below the 850 ft elevation. The 5.9 Mt will go above the 850 ft elevation and 9.0 Mt into the Qanaiyaq Pit.

In 2029, Red Dog Creek will be relocated to its ultimate alignment in an open channel slightly south and west of the current culvert alignment.

5.3 Qanaiyaq Pit

The Qanaiyaq deposit is heavily weathered with higher average zinc grades than the Aqqaluk deposit. Mining of the Qanaiyaq Pit is planned in two pushbacks in order to optimize backfilling efficiency. The schedule releases the Qanaiyaq ore over a 10 year period, finishing two years before the Aqqaluk Pit to provide time for backfilling. Qanaiyaq feed increases zinc feed grades when mining the lower grade A3 and A4 Aqqaluk Pit pushbacks.

High reactive potential waste is placed when possible below the 850 ft elevation in the Main Pit. Of the total quantity of 1.8 Mt of reactive waste from the Qanaiyaq Pit, 55% or 1.0 Mt will be exposed in the first 3 years when the weathered cap is mined, with 26% or 0.5 Mt mined in the last 2 years at the bottom of the 2^{nd} phase.

5.4 Mine Plan Production

Production schedules for the LOM Plan have been detailed by year for 2014 to 2030. The additional stripping indicated by this plan compared to the 5 Year Plan (2014-2018) is due to the need to expose sufficient Aqqaluk Pit benches for grade blending to minimize year to year variation in mill feed grade and to incorporate geotechnical berms every 4±1 benches to mitigate the highwall exposure above operations personnel. LOM Plan highlights are discussed in Section 5.4.

5.4.1 Mine Plan Production Summary

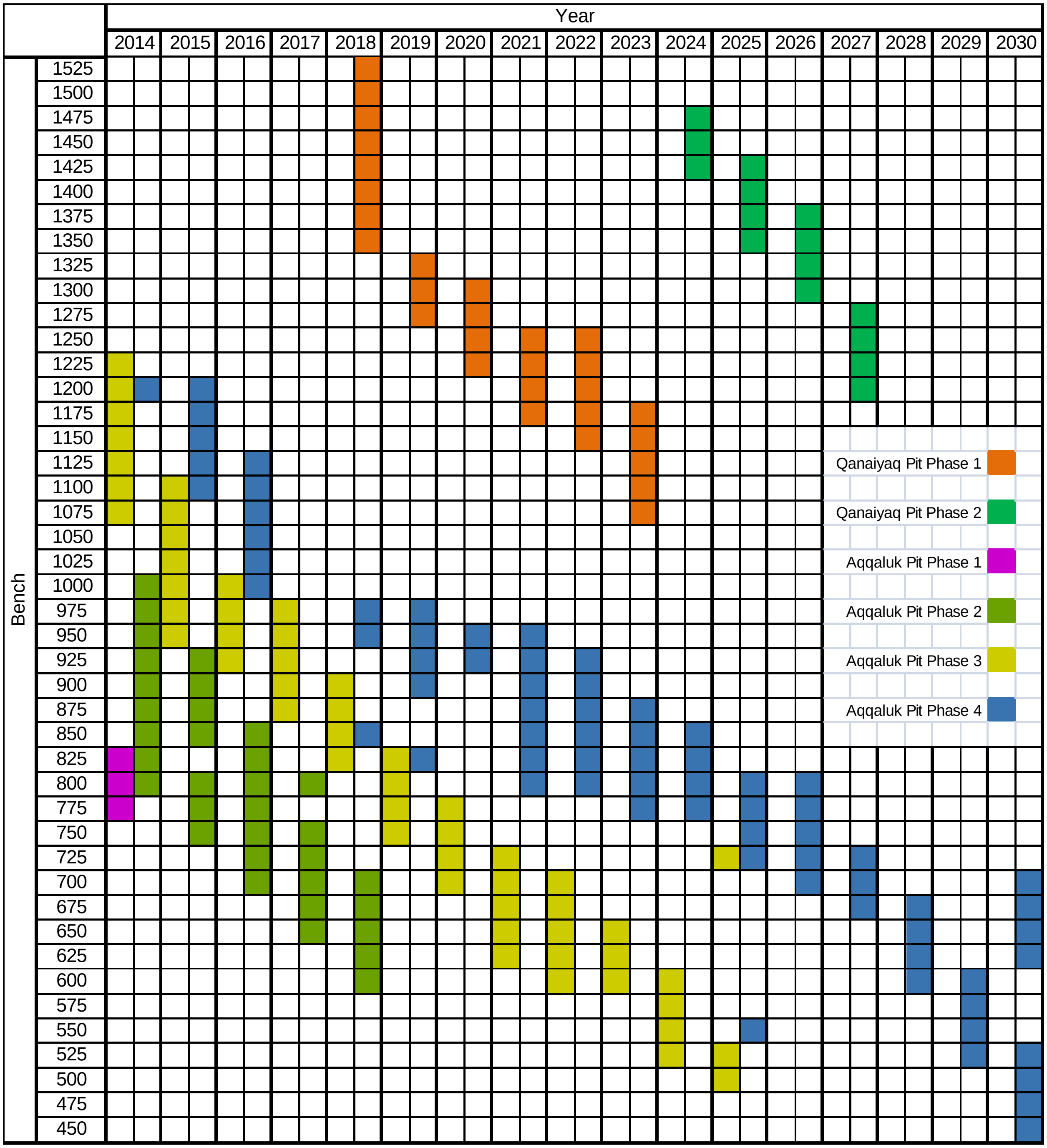
The LOM Plan production is divided into eight material classes: High Grade Ore, Low Grade Ore, Construction rock, Cover rock, Lower Sulfide Sulfur waste, Higher Sulfide Sulfur waste, Possibly Reactive waste, and Possibly Reactive Low Grade Ore. The deposits are expected to be depleted in mid-2030.

5.4.2 Phases and Benches Mined

The LOM Plan sequence schedules the Aqqaluk and Qanaiyaq deposits together in a series of pushback phases. This phasing allows for a relatively even distribution of mine production and for slightly higher grade ore in earlier production years. There are four phases in the Aqqaluk Pit, starting at the highest grade pit, A1, and ending at the ultimate pit, A4, and two phases in the Qanaiyaq Pit, the starter pit, Q1, and the ultimate pit, Q2.

Mining of the first phase in Aqqaluk, A1 started in May 2010, so it has the lowest tonnage of the four Aqqaluk phases. The high waste tonnage in the final Aqqaluk phase, A4 is due to the ultimate pit slope adjustments made to accommodate the preliminary (2011) geotechnical concerns, particularly on the south wall, and to the changes seen in the new geological block model. The Qanaiyaq Pit phases are similar to each other in size, with the first being slightly larger. A graphical summary of the benches mined by period by approximate pit phase is shown in Figure 5-1

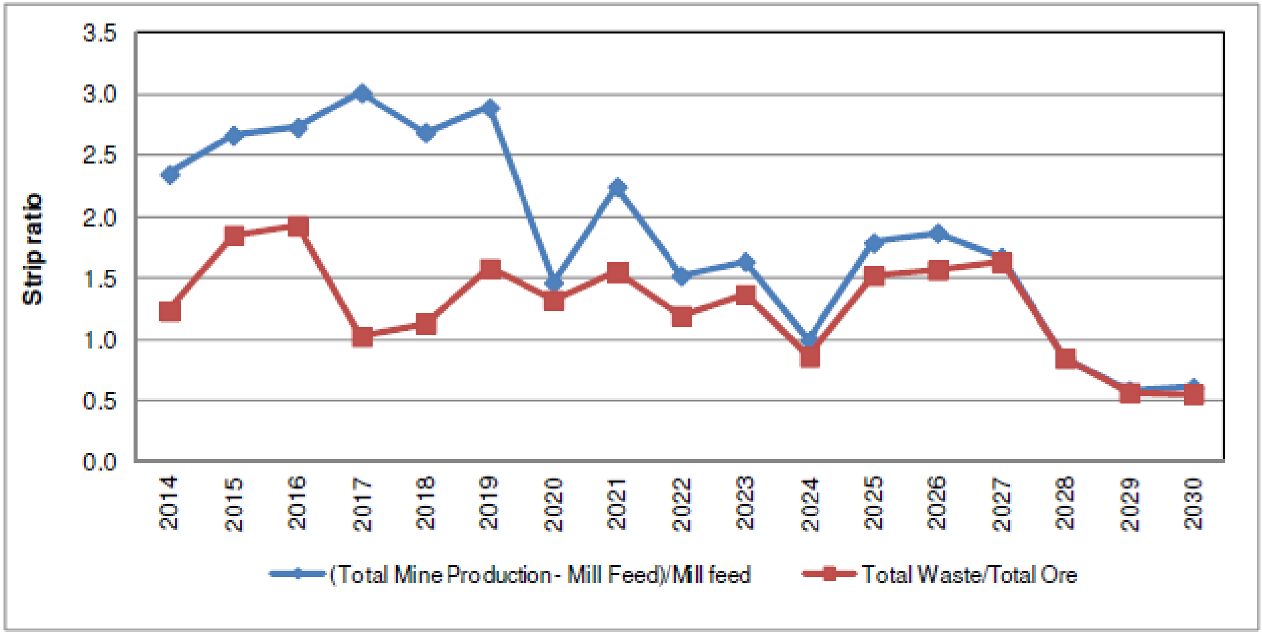
Figure 5-1: Benches Mined



5.4.3 Strip Ratio

The average strip ratio can be based on mill feed or on total ore which includes low grade ore. The mill feed based strip ratio is referred to in this report. For the LOM Plan, the average mill feed based strip ratio is 1.92. The average strip ratio for the LOM Plan based on total ore, assuming tailings capacity is increased for the low grade ore, is 1.31. The annual strip ratio, calculated with both methods, is shown in Figure 5-2

Figure 5-2: Strip Ratio

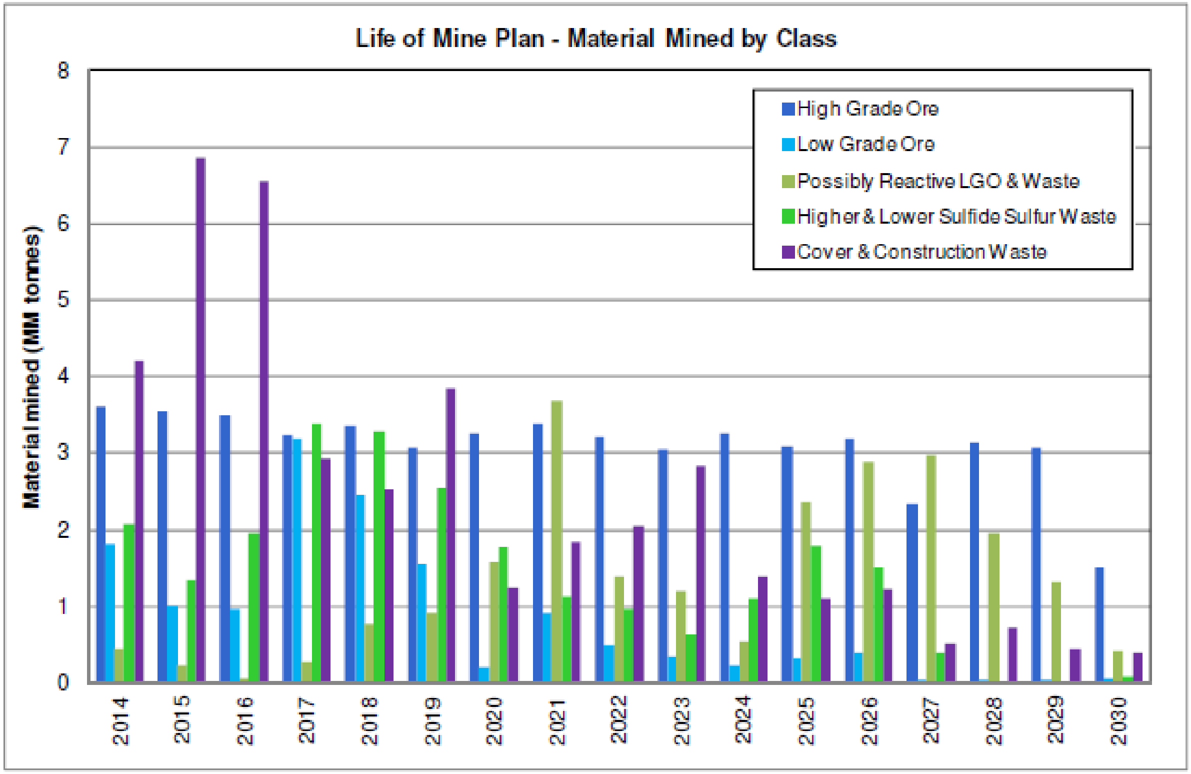


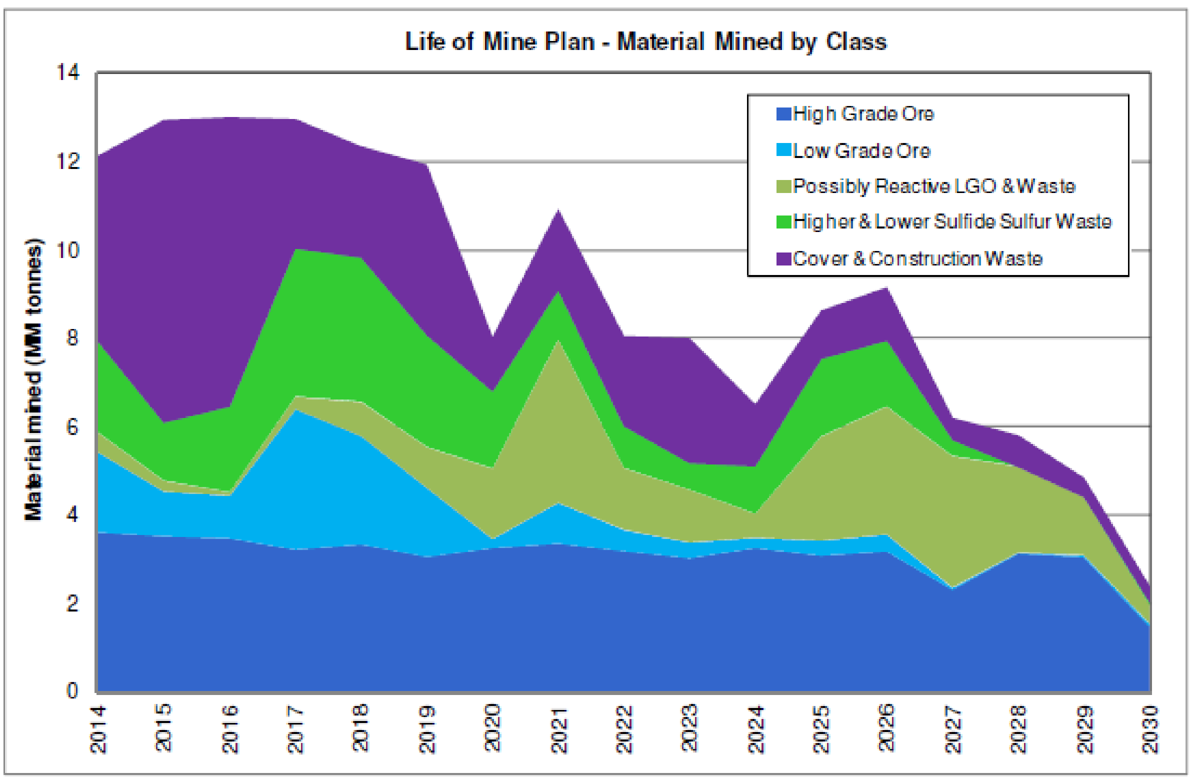
5.4.4 Total Material Movement Classification

The total material mined for the LOM Plan is 154.0 Mt. Figure 5-3 shows the material mined by class by year. It can be seen that the production of cover and construction rock spikes during the start of each phase for both the Aqqaluk and Qanaiyaq Pits and that the production of PR class material is highest between 2020 and 2029. The latter comes from the mining of Aqqaluk Phase A4.

The updated Aqqaluk Pit shell used for this plan contains 21.1 Mt of PR material, which is 30% of the total waste production from the pit. This is a substantial increase from the 2012 LOM Plan, where the Aqqaluk Pit contained only 9.2 Mt of PR materials and it was only 13% of the total waste production from the pit. The increase is due to the updates of the block models and the consequently redesigned pit shells brought about by the addition of 111 core holes in the Aqqaluk deposit and 158 core holes in the Qanaiyaq deposit. This new core information significantly changed the geologic interpretation and the grade distribution of both models.

Figure 5-3: Material Mined by Class





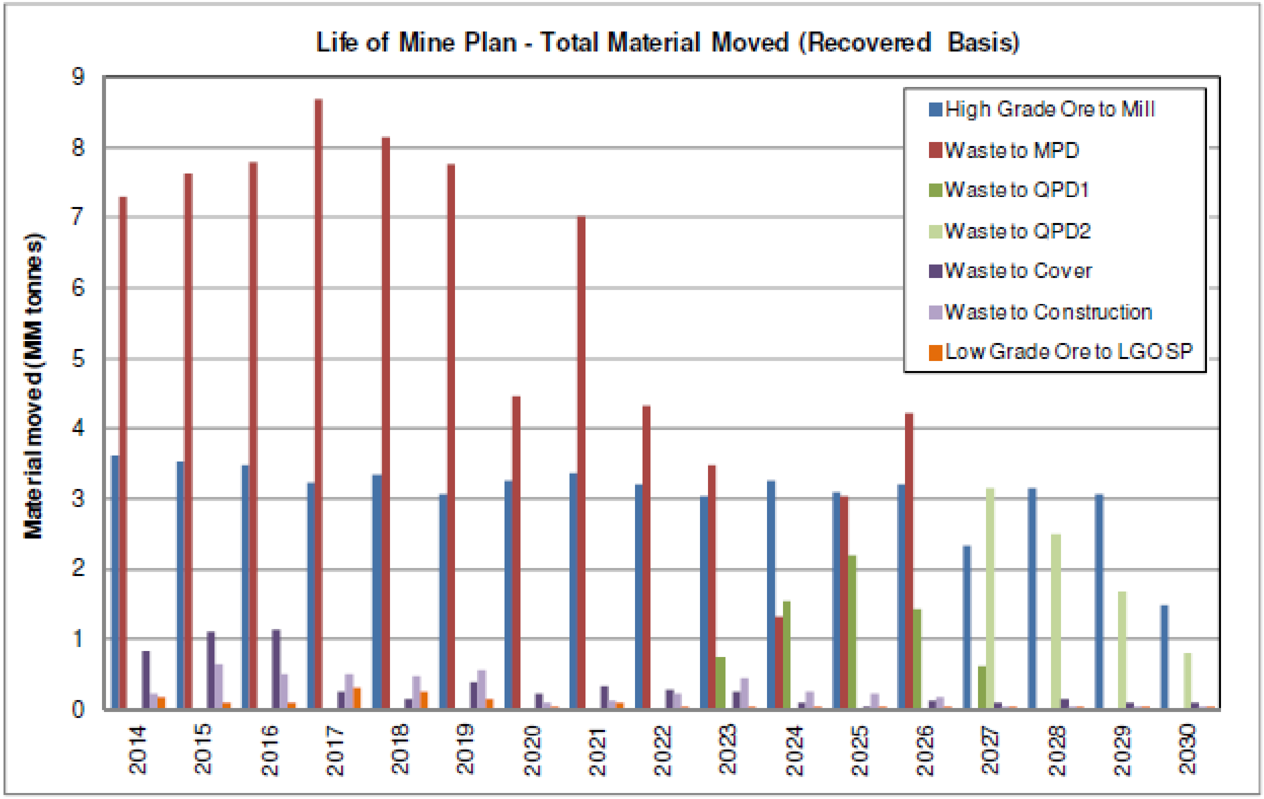
Total Material Moved is comprised of Total Mined Production (waste and ore) and Non-Production. Non-Production is primarily the re-handling of lower or marginal grade material that has been stockpiled for milling at the end of mine life. As TSF pond capacity is not currently available for this material it was not included as production in the LOM Plan. As methods to increase tailings storage capacity are evaluated, an estimate of the decrease in metallurgical performance of this material after weathering will need to be determined to better define the cutoff to be used for its construction.

Because of the wide grade range and heterogeneous distribution of metal grades in the Red Dog ore bodies, it is difficult to precisely estimate the expected blasthole pattern metal grades from the 100 ft spaced diamond drilling grid. There is a substantial difference between the quantities of Cover, Construction, and Low Grade material estimated from the block model and recoverable in the field once that area has been drilled and sampled on the blasthole pattern grid. Historically, the recovery for Cover and Construction materials has been 25% and the recovery for Low Grade Ore has been 10%. The balance of these materials is routed to the closest primary dump destination active at the time, MPD or QPD. Figure 5-4 shows the total material moved by destination by year on a recovered material basis, i.e., accounting for the historical recovery loss.

A summary of the reactivity composition of each phase for each lift of the various material destinations is shown in Table 5-1. Notwithstanding the staggered dumping sequence being used, it can be seen from the table that the initial 850 lift is mostly filled with low risk waste, making the PR waste only 33% of the total waste placed. This is due to the higher stripping in the updated Aqqaluk and Qanaiyaq Pits, causing the filling of the lower dump lifts to occur more quickly. The majority of the low risk waste, which could be stored above the water level in the Main Pit, is produced prior to 2023, whereas the majority of the PR waste, which would best be stored by submergence, is produced with the mining of the Aqqaluk Phase A4 and Qanaiyaq Pits after 2017. Thus the MPD is filled with a large quantity of low reactive possibility waste early in the mine life. Later in the mine life when the available capacity below 850 ft elevation is used up, the PR waste will be mixed and spread out with the low risk waste as a means of reducing the overall risk of exothermic activity. This gives three principal waste materials: Possibly Reactive, Low Reactive, and Mixed, a combination of the first two.

Of the total PR waste sent to the MPD, 41% is placed below the 850 ft elevation. This percentage would have been less had it not been planned to backfill the Qanaiyaq Pit, thus providing an alternative dumping location for low risk waste and slowing down the rate of MPD filling. In the 2012 LOM Plan it was possible to place 75% below the 850 ft elevation due to the lower quantity of both low reactive and PR wastes from the previous block models. It can be seen in Table 5-1 that 67% of the material sent to the QPD is classed as PR, with the 1345 Lift containing 80% PR material due to Aqqaluk Phase 4 material.

Figure 5-4: Total Material Moved by Destination (Recovered Basis)



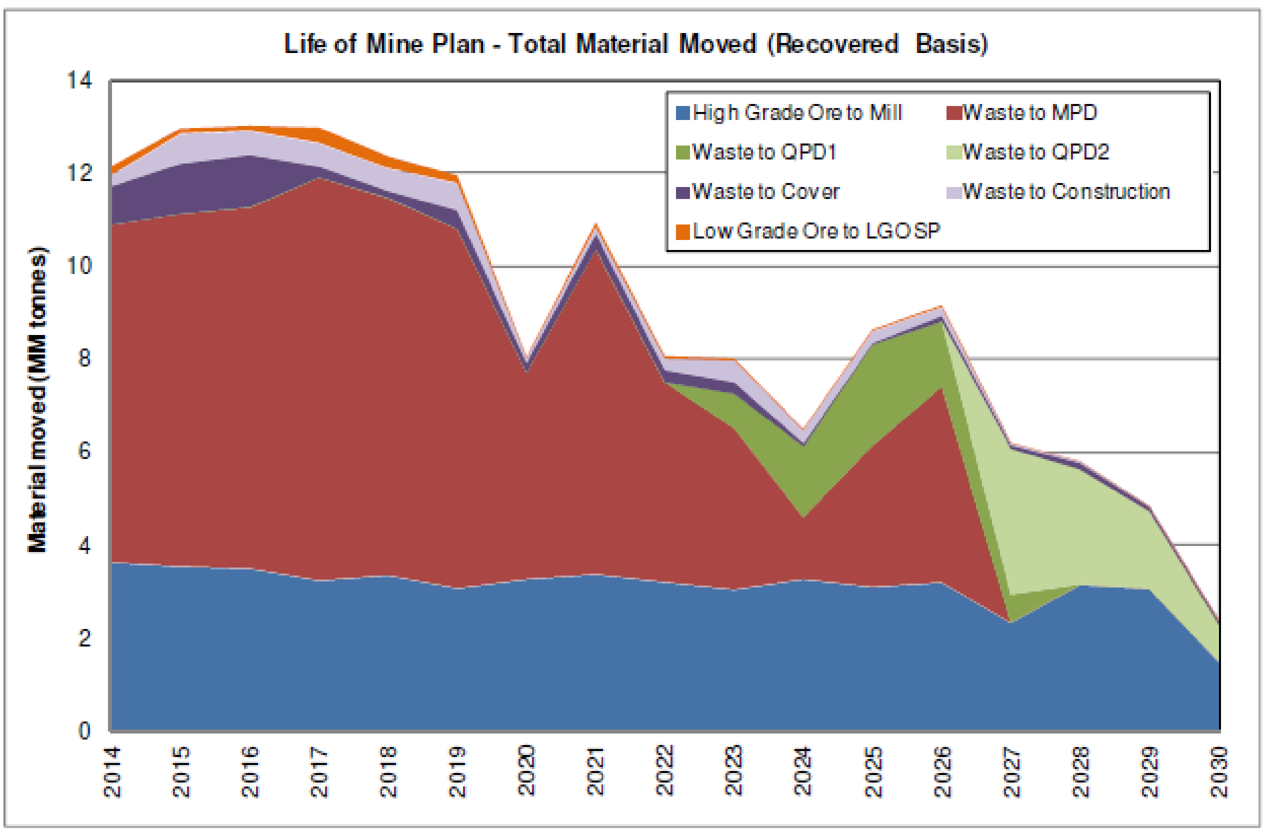


Table 5-1: Waste Destination Reactivity Summary (Recovered Basis)

			Phase																	
Lift	Material	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	15	20	21	22	Total
MPD_850	Low Risk	kt	-	-	-	-	2,272	1,298	1,454	2,197	1,906	1,181	0	0	14	-	-	-	-	10,323
	Possibly Reactive	kt	-	-	-	-	165	62	398	351	679	907	1,690	706	214	-	-	-	-	5,172
	PR content	%	-	-	-	-	7	5	21	14	26	43	100	100	94	-	-	-	-	33
MPD_904	Low Risk	kt	-	6,107	3,864	3,288	715	625	507	467	476	714	886	538	516	799	-	-	-	19,503
	Possibly Reactive	kt	-	702	443	177	0	0	0	0	34	121	0	132	42	104	-	-	-	1,756
	PR content	%	-	10	10	5	0	0	0	0	7	14	0	20	8	12	-	-	-	8
MPD_1015	Low Risk	kt	1,016	1,868	2,427	1,648	2,065	1,519	1,182	823	633	1,422	-	-	-	2,496	-	-	-	17,099
	Possibly Reactive	kt	91	68	0	0	0	0	0	26	1,244	292	-	-	-	784	-	-	-	2,504
	PR content	%	8	4	0	0	0	0	0	3	66	17	-	-	-	24	-	-	-	13
MPD_1125	Low Risk	kt	-	-	3,990	1,959	1,770	1,620	846	417	294	-	-	-	-	1,027	-	-	-	11,923
	Possibly Reactive	kt	-	-	0	0	0	0	105	1,098	396	-	-	-	-	0	-	-	-	1,599
	PR content	%	-	-	0	0	0	0	11	72	57	-	-	-	-	0	-	-	-	12
MPD_1236	Low Risk	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	666	1,120	1,185	2,971
	Possibly Reactive	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	283	1,422	1,706
	PR content	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	20	55	36
MPD Total	Low Risk	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61,819
	Possibly Reactive	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,737
	PR content	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
QPD_1305	Low Risk	kt	3,486	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,486
	Possibly Reactive	kt	4,110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,110
	PR content	%	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54
QPD_1345	Low Risk	kt	1,516	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,516
	Possibly Reactive	kt	6,066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,066
	PR content	%	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80
QPD Total	Low Risk	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,002
	Possibly Reactive	kt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,177
	PR content	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67
LG Ore	Low Risk	kt	1,394	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,394
Construction	Low Risk	kt	4,497	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,497
Cover	Low Risk	kt	5,660	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,660

5.4.5 Plan Highlights

The following Table 5-2 outlines the mine production schedule highlights.

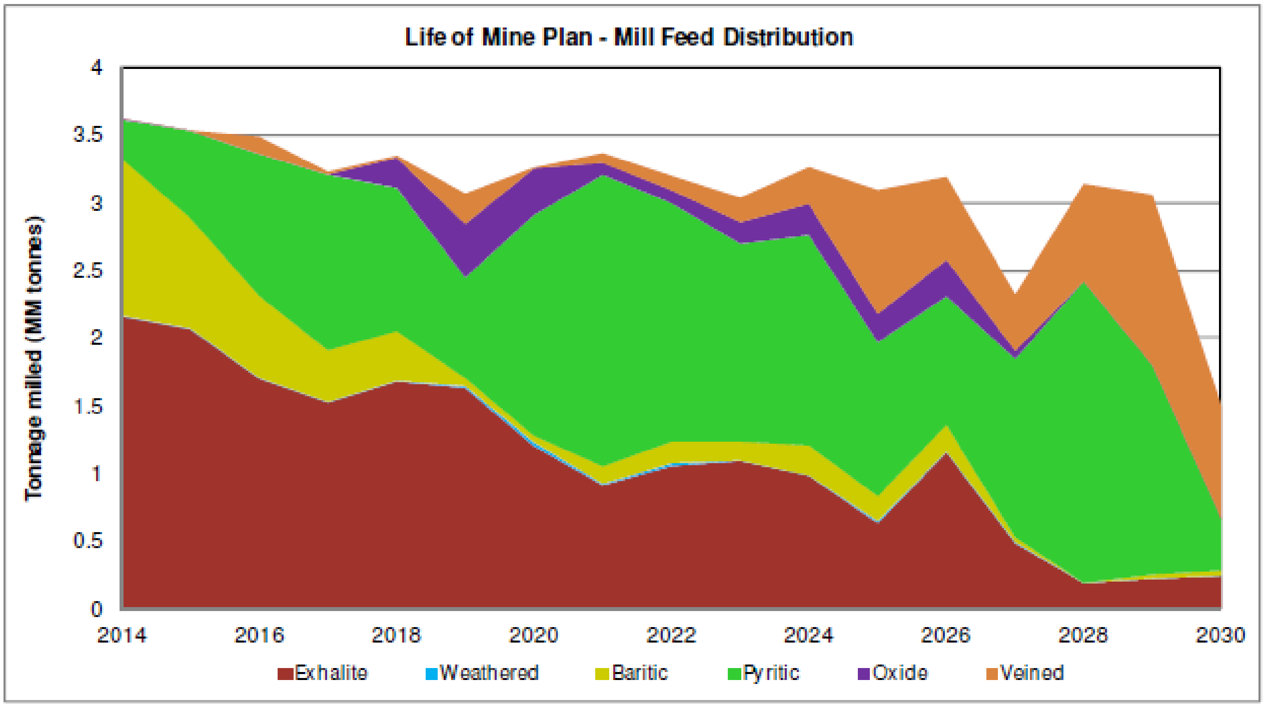
Table 5-2: Mine Production Schedule

Year	Notes
2014	Complete mining of Aqqaluk A1 pushback
2017	Pioneer access ramp for Qanaiyaq development
2018	Begin mining of Qanaiyaq Pit Complete mining of Aqqaluk A2 pushback
2023	Complete mining of Qanaiyaq Q1 pushback Begin backfill of Qanaiyaq Pit Complete 850 lift of MPD, end of storage capacity below water level
2025	Complete mining of Aqqaluk A3 pushback Complete 904 lift of MPD
2026	Complete 1015 and 1125 lifts of MPD
2027	Complete mining of Qanaiyaq Pit Begin backfill of Phase Q2 of Qanaiyaq Pit Close MPD and begin re-sloping for closure
2029	Construct open channel path for RDC
2030	Complete mining of Aqqaluk Pit Complete backfill of Qanaiyaq Pit and re-sloping of MDP End of mine life

5.5 Mill Feed

Mill throughput for the LOM Plan varies based on the feed zinc, barium, iron, silica, and grades and the grain size estimate. This results in an average mill feed rate of 406 tpoh, with a minimum of 378 tpoh, mostly due to the high quartz content of over 49%, and a maximum of 449 tpoh in 2014 mostly due to the low quartz content of 41%. Mill feed by Ore Type is shown in Figure 5-5: Mill Feed Ore Type Distribution. It can be seen that the current exhalite and baritic feeds transition to a predominantly pyritic feed over the course of the LOM Plan.

Figure 5-5: Mill Feed Ore Type Distribution



5.6 Major Mobile Equipment Performance

Foreseeable project and forecasted production hours were considered when determining the fleet requirements for the LOM Plan. The Units Available for the years that equipment is acquired or disposed of is fractional based on which sealift barge sailing the equipment is schedule to be transported.

5.6.1 Loaders

Planned Caterpillar 992 and 993 loader hours are given in Table 5-3. Physical Availability for 2014 is 80.0%, the 2011 to 2013 average (80.2%). Physical Availability is decreased as the fleet ages and increased from replacement. Use of Availability is set through the LOM Plan at 65.6%, the 2011 to 2013 average (65.4%).

5.6.2 Haul Trucks

Planned Caterpillar 777 truck hours are given in Table 5-4. Physical Availability for 2014 is 79.5%, the 2011 to 2013 average. Physical Availability is decreased as the fleet ages and increased from replacement. Use of Availability is set through the LOM Plan at 79.6%, the 2011 to 2013 average.

5.6.3 Production Drills

Planned Atlas-Copco DM-L drill hours are given in Table 5-5. Physical Availability for 2014 is 83.5%, the 2011 to 2013 average (83.3%). Physical Availability is decreased as the fleet ages and increased from replacement. Use of Availability is maintained at 64%, higher than the 2011 to 2013 average (49.7%), as per the 5-Yr Plan 2014. Use of Availability of the drills is a staffing, and not equipment, constraint and can be adjusted to the production as required.

5.6.4 Dozers

Planned Caterpillar D9 and D10 dozer hours are given in Table 5-6. Physical Availability for 2014 is 80.0%, the 2011 to 2013 average (79.9%). Physical Availability is decreased as the fleet ages and increased from replacement. Use of Availability is set through the LOM Plan at 52.0%, the 2011 to 2013 average (52.1%). Use of Availability of the dozers is a staffing and not an equipment constraint and can be adjusted to the production required.

Table 5-3: Equipment Performance Forecast (Loaders)

Loader Summary	Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
992G Loader																		
Units Available	ea	5.0	5.0	5.0	5.0	5.0	5.0	4.6	4.0	4.0	4.0	4.0	4.0	3.7	3.0	3.0	3.0	3.0
Units Required	ea	4.8	5.1	5.0	4.8	4.7	4.5	3.6	3.9	3.5	3.4	3.3	3.4	3.5	2.3	2.6	2.5	2.8
Hours Available per unit	op hrs	4,597	4,540	4,610	4,540	4,482	4,425	4,379	4,425	4,367	4,310	4,264	4,310	4,252	4,367	4,322	4,252	2,051
Hours Used per unit	op hrs	4,432	4,599	4,588	4,390	4,198	4,023	3,441	4,347	3,864	3,708	3,509	3,615	4,091	3,336	3,738	3,598	1,885
Ore Hours Required	op hrs	3,879	3,780	3,733	3,458	3,582	3,283	3,491	3,603	3,424	3,251	3,492	3,311	3,415	2,486	3,361	3,272	1,600
Reclaim Hours Required	op hrs	4,818	4,695	4,636	4,295	4,450	4,077	4,336	4,475	4,253	4,038	4,337	4,113	4,241	3,087	4,174	4,064	1,987
Waste Hours Required	op hrs	9,985	11,212	11,506	11,514	10,278	10,072	4,633	6,004	4,723	4,863	3,516	4,355	4,662	1,753	989	776	658
Non-pit Hours Required	op hrs	2,484	2,484	2,491	2,484	2,484	2,484	2,491	2,484	2,484	2,484	2,491	2,484	2,484	2,484	2,491	2,484	1,214
Project Hours Required	op hrs	994	822	572	197	197	197	822	822	572	197	197	197	197	197	197	197	197
Loading Hours Required	***op hrs***	***22,160***	***22,994***	***22,938***	***21,948***	***20,992***	***20,113***	***15,773***	***17,388***	***15,457***	***14,833***	***14,034***	***14,460***	***15,000***	***10,008***	***11,213***	***10,794***	***5,656***
Assumed Physical Availability	-	80.0%	79.0%	80.0%	79.0%	78.0%	77.0%	76.0%	77.0%	76.0%	75.0%	74.0%	75.0%	74.0%	76.0%	75.0%	74.0%	73.0%
Use of Availability	-	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%	65.6%
Efficiency	-	52.5%	51.8%	52.5%	51.8%	51.2%	50.5%	49.9%	50.5%	49.9%	49.2%	48.5%	49.2%	48.5%	49.9%	49.2%	48.5%	47.9%

Table 5-4: Equipment Performance Forecast (Haul Trucks)

Haul Truck Summary	Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
777F Haul Trucks																		
Units Available	ea	8.0	7.4	7.7	7.2	8.3	9.0	7.7	8.0	6.6	6.0	6.0	6.0	6.4	6.6	6.0	6.0	6.0
Units Required	ea	7.1	7.2	7.7	7.2	7.9	7.7	6.7	7.4	5.9	5.3	4.7	5.5	6.3	5.3	5.8	5.1	5.4
Hours Available per unit	op hrs	5,544	5,474	5,629	5,683	5,753	5,962	5,908	5,822	5,753	5,822	5,768	5,683	5,613	5,753	5,699	5,613	2,710
Hours Used per unit	op hrs	4,919	5,340	5,570	5,723	5,488	5,117	5,169	5,370	5,165	5,119	4,475	5,207	5,476	4,621	5,485	4,802	2,420
Ore Hours Required	op hrs	10,147	10,113	10,479	10,339	11,230	10,406	10,812	11,412	11,054	11,098	11,968	11,364	11,692	8,785	12,240	12,599	6,204
Reclaim Hours Required	op hrs	4,484	4,370	4,315	3,997	4,141	3,794	4,036	4,165	3,958	3,758	4,037	3,828	3,947	2,873	3,885	3,782	1,849
Waste Hours Required	op hrs	20,439	21,180	25,087	24,416	27,636	29,583	20,842	23,445	15,720	13,590	8,571	13,784	17,228	16,494	14,512	10,161	5,115
Non-pit Hours Required	op hrs	1,799	1,799	1,804	1,799	1,799	1,799	1,804	1,799	1,799	1,799	1,804	1,799	1,799	1,799	1,804	1,799	879
Project Hours Required	op hrs	2,482	2,137	1,470	470	470	470	2,137	2,137	1,470	470	470	470	470	470	470	470	470
Hauling Hours Required	***op hrs***	***39,351***	***39,599***	***43,155***	***41,021***	***45,276***	***46,052***	***39,631***	***42,957***	***34,002***	***30,715***	***26,849***	***31,245***	***35,137***	***30,422***	***32,911***	***28,811***	***14,517***
Physical Availability	-	79.5%	78.5%	80.5%	81.5%	82.5%	85.5%	84.5%	83.5%	82.5%	83.5%	82.5%	81.5%	80.5%	82.5%	81.5%	80.5%	79.5%
Use of Availability	-	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%	79.6%
Efficiency	-	63.3%	62.5%	64.1%	64.9%	65.7%	68.1%	67.3%	66.5%	65.7%	66.5%	65.7%	64.9%	64.1%	65.7%	64.9%	64.1%	63.3%

Table 5-5: Equipment Performance Forecast (Drills)

Drill Summary	Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
DM-L Drill																		
Units Available	ea	3.0	3.0	3.0	3.0	3.0	3.0	2.6	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Units Required	ea	2.5	2.8	2.9	2.8	2.6	2.5	1.6	1.8	1.5	1.6	1.3	1.5	1.6	0.9	0.9	0.9	1.0
Hours Available per unit	op hrs	4,681	4,625	4,582	4,513	4,457	4,401	4,357	4,457	4,513	4,457	4,526	4,457	4,401	4,345	4,301	4,233	**2,042**
Hours Used per unit	op hrs	3,950	4,311	4,388	4,245	3,841	3,722	2,643	3,910	3,483	3,498	2,985	3,240	3,428	1,927	1,963	1,838	1,017
Ore Drilling Hours Required	op hrs	3,216	2,890	2,839	3,378	3,207	2,681	2,375	2,668	2,420	2,237	2,413	2,303	2,347	1,624	2,278	2,227	1,100
Waste Drilling Hours Required	op hrs	7,842	9,251	9,529	8,564	7,522	7,692	3,658	4,684	3,753	3,966	2,761	3,384	3,715	1,438	853	656	546
Redrilling Hours Required	op hrs	462	462	463	462	462	462	463	462	462	462	463	462	462	462	463	462	**226**
Non-pit Hours Required	op hrs	331	331	332	331	331	331	332	331	331	331	332	331	331	331	332	331	**162**
Drilling Hours Required	***op hrs***	***11,851***	***12,934***	***13,164***	***12,735***	***11,522***	***11,165***	***6,828***	***8,145***	***6,965***	***6,996***	***5,970***	***6,479***	***6,855***	***3,855***	***3,926***	***3,676***	***2,034***
Assumed Physical Availability	-	**83.5%**	82.5%	81.5%	80.5%	79.5%	78.5%	77.5%	**79.5%**	**80.5%**	79.5%	**80.5%**	79.5%	78.5%	77.5%	76.5%	75.5%	74.5%
Use of Availability	-	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%	64.0%
Efficiency	-	53.4%	52.8%	52.2%	51.5%	50.9%	50.2%	49.6%	50.9%	51.5%	50.9%	51.5%	50.9%	50.2%	49.6%	49.0%	48.3%	47.7%

Table 5-6: Equipment Performance Forecast (Dozers)

Dozer Summary	Units	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
D9 & D10 Dozers																		
Units Available	ea	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.7	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Units Required	ea	3.4	3.4	3.3	3.2	3.0	2.9	2.6	2.9	2.5	2.4	2.3	2.4	2.5	2.0	2.1	2.1	2.5
Hours Available per unit	op hrs	3,644	3,599	3,700	3,644	3,690	3,644	3,608	3,553	3,599	3,553	3,517	3,462	3,416	3,371	3,334	3,280	***1,581***
Hours Used per unit	op hrs	3,143	3,068	3,008	2,923	2,733	2,660	2,377	2,857	3,051	2,862	2,747	2,810	2,874	2,277	2,387	2,334	1,337
Ore Hours Required	op hrs	404	394	389	360	373	342	364	375	357	339	364	345	356	259	350	341	167
Reclaim Hours Required	op hrs	1,510	1,471	1,453	1,346	1,394	1,277	1,359	1,402	1,332	1,265	1,359	1,289	1,329	967	1,308	1,273	623
COSP Hours Required	op hrs	815	794	784	727	753	690	734	757	719	683	734	696	718	522	706	688	336
Waste Hours Required	op hrs	3,900	4,379	4,494	4,497	4,015	3,934	1,810	2,345	1,845	1,900	1,374	1,701	1,821	685	386	303	257
Other Mining Hours Required	op hrs	2,410	2,410	2,417	2,410	2,410	2,410	2,417	2,410	2,410	2,410	2,417	2,410	2,410	2,410	2,417	2,410	***1,178***
Non-pit Hours Required	op hrs	1,053	1,053	1,056	1,053	1,053	1,053	1,056	1,053	1,053	1,053	1,056	1,053	1,053	1,053	1,056	1,053	***515***
Project Hours Required	op hrs	2,479	1,769	1,438	1,300	935	935	1,771	2,134	1,435	935	937	935	935	935	937	935	935
Dozing Hours Required	***op hrs***	***12,571***	***12,271***	***12,030***	***11,693***	***10,933***	***10,641***	***9,509***	***10,477***	***9,152***	***8,585***	***8,240***	***8,429***	***8,621***	***6,832***	***7,161***	***7,003***	***4,010***
Assumed Physical Availability	-	**80.0%**	79.0%	**81.0%**	80.0%	**81.0%**	80.0%	79.0%	78.0%	**79.0%**	78.0%	77.0%	76.0%	75.0%	74.0%	73.0%	72.0%	71.0%
Use of Availability	-	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%	52.0%
Efficiency	-	41.6%	41.1%	42.1%	41.6%	42.1%	41.6%	41.1%	40.6%	41.1%	40.6%	40.0%	39.5%	39.0%	38.5%	38.0%	37.4%	36.9%

5.7 Low Grade Stockpile

For the duration of this LOM Plan, a single dump location is planned for the Low Grade Stockpile in the area between the historic Solid Waste Landfill and the northern face of the MWD (Figure 5-6).

Based on historical data, only 10% of the block model estimated low grade material is actually recovered. This is due to the highly variable metal grades making contiguous zones of low grade class material rare once drilled and assayed on blasthole density. In addition, given the sulfide reactivity of some of the materials excavated, not all of the low grade ore should be stockpiled for storage until the end of mine life. Therefore, of the total 31.7 Mt of block model classified low grade ore, the Low Grade Stockpile is expected to potentially receive only 1.4 Mt with the remaining 30.3 Mt sent to the Mill Feed Stockpile, the MPD, or the QPD. Ongoing operational experience with the Aqqaluk deposit will improve the estimate of low grade recovery. In the interim, both the most likely and the maximum size of the potential Low Grade Stockpile were calculated and metallurgical recoveries for both cases are maxima, as in neither estimate was a factor applied to account for the decrease in stockpile metallurgical performance due to weathering.

5.8 Solid Waste Landfill

The Solid Waste Landfill is located on the northeast side of the MWD to the west of the Oxide Dump access road (Figure 5-6). The landfill footprint is excluded from the MWD and thus can be used for the duration of this LOM Plan. The landfill access road is off of the west side of the Oxide Dump access road and moves up the Oxide Dump access road as each lift of the landfill is completed. Marginally sufficient space is available in this footprint to handle 17 years of waste at the current fill rate of 21,000 yd^3/yr; however, more capacity would be gained by ensuring the cover fill was maintained as close to the 6 ft minimum as possible. In the last few years, cover has been maintained at 1 ft compared to being equal to the maximum allowed compacted solid waste depth of 4 ft in earlier years. This will increase the probability that this landfill location will last the duration of this LOM Plan. As the landfill is in a sulfide waste dump, alternate locations outside of the waste dump would have greater restrictions on the refuse that could be disposed, increasing waste handling costs.

5.9 TSF

The total tailings tonnage to the end of the mine life is estimated at 81.7 Mt.

Figure 5-6: Red Dog Mine Aerial Photograph (July 2013)

6 Projects

6.1 Environmental Related Projects

In conjunction with mine production, Red Dog Operations will undertake environmental related projects consistent with EPA and State of Alaska environmental standards and regulations, the latter through the Alaska Department of Environmental Conservation (ADEC) and the Alaska Department of Natural Resources (ADNR). The major projects currently foreseen over the life of the Mine, not including those related to closure at the end of mine life, are listed below.

6.1.1 Main Waste Dump Re-sloping

To reduce infiltration of precipitation into the MWD, and ultimately decrease the volume of contaminated ARD water (ARD, TDS, and Se content), the dump is being regraded and sloped. This work has been ongoing in stages since 2010. The final stage, planned for 2014, will be covering the MWD with a 3 ft lift of a fine-grained cover material. This project has also reduced the time between completion of the MWD and final reclamation.

6.1.2 TSF Pond Dust Control

A chemical palliative (LSP-1000c) is sprayed by helicopter over the TSF beach every fall before winter freeze up. It is done to control tailings beach dusting from wind scouring that often occurs in the early spring. The estimated area requiring coverage depends on the water levels and tailings discharge practice through to the winter. This work usually starts mid-August to allow the job to be completed before freeze up and lasts for 3 weeks. It is estimated that 625 man-hours are required for this task annually.

6.1.3 Relocate West TSF Road

The west TSF road will need to be relocated due to rising pond water levels. The previous road was constructed with mine haulage equipment and material produced by mine operations. It is not known if material will have to be sourced from elsewhere at this time. Recovery of topsoil and the vegetated cover are planned for 2014, with pioneering road construction scheduled for 2015. The road is expected to be constructed out of competent run of mine waste rock.

6.1.4 Main Waste Dump Cut Off Wall

A cutoff wall to intersect MWD surface and sub-surface flows before entering the TSF Pond has been proposed. This may be a continuous wall for the entire length of the waste dump toe or it may be several wall segments. Investigations indicate that the bedrock depth varies along the toe and that water flows in conforming channels. An engineering study was done in 2012 and a small drilling program was completed in 2013 to confirm the predictions of the hydrology modeling efforts from 2012. Design is planned for 2014 and the construction is scheduled for 2015 or 2016.

6.1.5 Mine Surface Water Management and Sediment Control

Mining activities are currently located within the Middle and South Forks of Red Dog Creek. The drainage system within the Red Dog Mine permit boundary and adjacent areas of the Mine are interconnected and form a single hydrologic entity that is affected by natural hydrologic, climatic, and anthropogenic factors. To ensure minimal impact to surface and ground water quality and quantity, protections to the surrounding Sulfur, Shelly, and Red Dog Creeks from storm water runoff have been put in place.

As Aqqaluk advances further in depth, it becomes increasingly difficult to maintain access to the upper benches. In 2014, the Aqqaluk Pit will reach its ultimate northern pit limit with the A4 pushback and begin its slow encroachment to the south. Eventually, the pit will cut into Sulfur Creek branches and require a relocation of Sulfur Creek in those sections. With the pit boundary exposed through mining, the majority of all rainwater that comes in contact with the pit will stay within the pit and be handled through normal mine dewatering processes. In general, it is planned to use insulated, heat- traced HDPE pipe running inside the haul road berm for maintenance access. The determination of whether to divert the entire Sulfur Creek area will be clearer as drainage experience is improved and the geotechnical analysis is finalized in 2014.

6.1.6 Sulfur Creek Sediment Control

Sulfur Creek Diversion is currently being explored in more depth, but until an adequate design and schedule can be implemented for the Aqqaluk Pit, temporary ditches and sumps will provide protection to continue Aqqaluk deposit development. These temporary ditches are realigned in tandem with the mining plan, some on an annual basis.

6.1.7 Main Pit Dump Re-sloping

In order to reduce the time between completion of the MPD and final reclamation, grading and sloping of the dump could be done in two stages. The southern half of the MPD can be re-sloped first as it will be completed in 2020. The northern half would be re-sloped after mining of the Qanaiyaq Pit was completed in 2027, allowing closure of the MPD due to the availability of a QPD waste haul destination. However, this will depend on the actual production of cover and construction rock, both of which are subject to significant estimate inaccuracy.

6.2 Other Projects

6.2.1 Main Pit Pond Elevation Control

The Main Pit will be used to store water, but will continue to be dewatered to remove volume increases from waste dumping, run off, and seepage. A recently completed water balance analysis shows water level will reach 840 ft elevation between November 2014 and July 2015 depending on precipitation. A low head, high volume pump would be installed in the northwest corner of the Main Pit at 840 ft elevation to keep the operational water level 10 ft below the nominal PR waste fill elevation of 850 ft. Discharge from the pump system will initially be free-flowing to Red Dog Creek Pumpback. Longer term plans include placing pipe for a more direct route from the Main Pit to the TSF Pond. The pumping station platform and retaining wall were completed in 2013 and installation work is planned for 2014.

6.2.2 Material Site Quarries

Quarrying and crushing are carried out from May to September. In the short term through 2016, it is expected that tailings dam construction and airport resurfacing will require approximately 250,000 yd^3 from DD-2 each year. In the longer term, it is expected that 25,000 yd^3 will be required from DD-2 each year. Some haulage may be required to remove crushed material to remote stockpiles. Drilling will be accomplished with one of the mine production drills.

6.2.3 Geotechnical Monitoring and Highwall Failure Mitigation

The Mine's geology department, in conjunction with Golder Associates Ltd., is providing hazard assessments, stability assessments/analysis, and day-to-day geotechnical support for the on-going safe operation of the open pits as required over the long term. An update to the structural interpretation is ongoing and is being used to update stability assessments, design areas of the Aqqaluk Pit, and assess highwall hazards and risks. Slope movement monitoring, using two monitoring stations containing Robotic Total Stations, are currently in use to monitor the stability of the Aqqaluk Pit walls and benches, as well as the stability of the waste dumps around the Main Pit.

6.2.4 Gas Exploration Site Reclamation

The roads that were constructed to access the Gas Exploration drill pads will be reclaimed as well as the drill pads. This is estimated at 67,000 yd^3 of material. Suitable reclaimed material will be placed at the toe of the Main Dam and built up in compacted lifts as part of the Stage X widening; the remainder can be used as crusher feed.

6.2.5 Red Dog Creek Dirty Water Pumpback Silt Clean Out

Silt and sediment build up at the Red Dog Creek Pumpback is cleaned out and stacked annually during the warmer season and removed during the colder months once the silt has solidified.

6.2.6 TSF Main Dam Widening for Stage X

Material will be placed on the TSF Main Dam downstream face as it becomes available during normal mining operations. The widened dam will be in preparation for the Stage X raise of the dam crest to elevation 986 ft. To spread the resource requirement of two additional haul trucks, dam widening will be split approximately 50/50 over 2014 and 2015.

6.2.7 Re-grade Mine Site Yards and Roads

The raised TSF Main Dam will be too high to allow gravity drainage of the mine yard; therefore mechanical assistance is needed. The mine site yard needs to be re-graded to allow drainage to flow into a detention basin where it will then be pump into the tailings pond. Re-grading the yard will occur in phases over several years.

6.2.8 Main Dam Stage X

The current elevation of the TSF Main Dam and Back Dam embankments is 976 ft. The Stage X raise of the dam crest to the 986 ft elevation is currently planned for completion in 2016 in order to maintain a 5-foot freeboard. To spread the resource demand, the widening will be partially completed in 2014, the remaining liner and embankment placed in 2015, and the completion of the wingwall/slurry wall in 2016. The 986 ft elevation lift of the Back Dam would be done in 2014.

6.2.9 Runway Resurfacing

The current plan is to do the engineering and crush approximately half the aggregate required in 2014. The remainder of the aggregate would be crushed and the resurfacing done in 2015.

6.2.10 Tailings Disposal Studies

The current TSF Pond capacity and operating procedure are insufficient for exploiting additional resources like Paalaaq or Anarraaq and milling low grade ore from the Aqqaluk Pit, as recent diamond drilling has indicated additional areas of ore grade exhalite mineralization. Studies determining the feasibility and total life cost of methods to obtain additional capacity, such as densification for the existing impoundment and alternate pond locations, are required.

6.2.11 Red Dog Creek Culvert Relocation

The south wall of Aqqaluk Pit Phase 1 pushback is directly beneath the Red Dog Creek Diversion culvert. The south wall is currently being excavated within poor quality Siksikpuk and Ikalukrok shales along the west side of the wall, and massive Ikalukrok barite along the east side. The poor quality shales that are exposed along the west side of the wall have been easily damaged by blasting. The current LOM Plan incorporates a temporary 75 ft step-in to provide a buffer zone between future blasting activity, the poor quality shale, and the culvert.

6.2.12 East Tailings Pipe Bench

This project is in support of the longer term TSF tailings deposition plan. The east tailings pipe bench will be extended further south in 2014, requiring about 4,000 yd^3 of competent waste rock from the Aqqaluk Pit.

Appendix C – Closure Cost Estimate

Red Dog Mine

Basis of Estimate – Closure Costs

Red Dog Mine, Alaska, USA

Prepared for

Teck Alaska Incorporated

Prepared by

srk consulting 1974 40 2014

SRK Consulting (U.S.), Inc.
329100.030
August 2016

Basis of Estimate – Closure Costs

Red Dog Mine, Alaska, USA

August 2016

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List of Abbreviations

ADNR	Alaska Department of Natural Resources
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
TAK	Teck Alaska Incorporated
TSF	Tailings Storage Facility

Units of Measure

m	meter
m^2	square meter
m^3	cubic meter

1 Introduction

Teck Alaska Incorporated (TAK) and NANA Regional Corporation, Inc. (NANA) are working closely with State of Alaska agencies, through the Large Mine Permitting Team, to update the *Reclamation and Closure Plan* and *Integrated Waste Management Plan* for Red Dog Mine. An objective of the process is to estimate the cost of suspension, closure, and post-closure activities. This document provides details about the estimate of closure costs. Estimates were developed for two closure cost scenarios:

- **Planned Closure:** Estimate assumes that closure will commence in 2031, and that progressive reclamation tasks will be completed, as described in the *Reclamation and Closure Plan*.
- **Premature Closure:** Estimate assumes that the mine would close prematurely (before 2031). The year 2015 was selected during closure plan development in 2014 as it was estimated to represent the worst case in terms of reclamation and closure requirements and cost. This scenario is discussed in the *Reclamation and Closure Plan*.

Both scenarios assume that closure activities would be carried out by an independent contractor working under the direction of the State. TAK and NANA fully expect all closure activities will be carried out by mine staff and equipment acting under TAK and NANA direction. However, the assumption of an independent contractor is required as a basis for setting the amount of financial security to be held by the State.

Total estimated closure costs for each scenario are as follows, in undiscounted 2016 U.S. dollars.

Scenario	Independent Contractor
Planned Closure (2031)	$84,800,000
Premature Closure (2015)	$97,100,000

2 Scope of Estimate

2.1 Estimate Structure

The estimate was prepared in an Excel workbook organized as follows:

- A summary worksheet presents total costs.
- Seven separate activity worksheets present estimated Direct Costs for activities in the "2031 Mine", "2015 Mine", "2031 Tailings", "2015 Tailings" "WTP Estimate 2031", "WTP Estimate 2015", and "Ore Processing & Infrastructure". Direct cost estimates are broken down into tasks, and the cost of each task is calculated on the basis of a quantity estimate multiplied by a unit cost estimate.
- Eleven worksheets provide detail behind quantity estimates used in the activity worksheets. Activity worksheets provide quantities for "Pit Walls", "Stockpile Resloping", "Cover Volumes", "Cover Compaction", "Ditches", "Seepage Collection", "Tailings Beaches", "Borrow Sources", "Contaminated Soils & Roads", "Demolition", and "Revegetation". The large number of worksheets is necessary because of the variety of quantity types. Section 3 below provides details of each calculation.
- Three worksheets provide the basis for the unit cost estimates in the activity worksheets. The first of these provides "Unit Cost Inputs" including rates for labor, equipment, and supplies. The second provides "Relocation Unit Costs" which translate the unit cost inputs into estimates of cost per unit volume of material in each of the major excavation, load, haul, dump, spread, and compact operations. The third provides "Task Unit Costs" where the unit cost inputs are translated to costs per production unit for other tasks. Section 4 below presents details of unit cost calculations.
- Two additional worksheets, "Mob Demob" and "No Plot Fleet Hours Summary", are included to clarify calculations for mobilization and demobilization as well as equipment schedule auditing.
- Each activity worksheet also includes an estimate of the associated Indirect Costs. Two worksheets provide inputs to indirect costs, and are discussed in Section 5 below.

Estimates were prepared for both the "Planned Closure (2031)" and "Premature Closure (2015)" scenarios, as described in the Red Dog Mine *Reclamation and Closure Plan*. Major differences between the two scenarios are located in the Mine and Tailings areas, and the workbook includes separate sheets for Mine, Tailings, and WTP Estimate for the 2031 and 2015 scenarios. Differences in costs for the other areas are expected to be relatively small, so separate estimates were not prepared for those areas.

2.2 Mine Area Activities

2.2.1 Planned Closure (2031)

Planned closure activities in the Mine area are described in Section 3 of the *Red Dog Mine Reclamation and Closure Plan*. Anticipated major reclamation activities are described in the following sections.

Pit Rims

Inadvertent access to the rim of the Aqqaluk, Qanaiyaq, and Main Pits will be discouraged by boulder berms. In addition, the remnant of the Main Pit high wall east of Red Dog Creek will be cut back to improve visibility for snow machine or ATV drivers. For the cost estimate, it was assumed boulder berms would be constructed along the final pit crests, and the rim would be resloped as noted above.

Waste Dumps

Areas which have not been regraded, such as the Low Grade Ore Stockpile and the Main Pit Dump, will be graded to varying slopes ranging between 2.5H:1V to 4H:1V, with an overall average of 3H:1V.

A 20-inch layer of unmineralized shale will be placed on the dumps, graded and compacted. A second 20-inch layer of unmineralized shale will then be placed over the compacted layer.

Cover material will be sourced from cover stockpiles located on the south end of the MWD and adjacent to the Oxide Dump. Current stockpile volumes are less than the required cover volume for the 2015 closure scenario. The additional cover material will be sourced from the Key Creek Plate, located on the upper benches of Aqqaluk Pit. Sufficient cover is anticipated to be stockpiled and available for all 2031 closure activities. The anticipated cover stockpiles for the 2031 scenario are located on the south end of the MWD, adjacent to the Oxide Dump, and near the Overburden Dump. Haulage routes and costs reflect these source locations.

Dumps will be shaped during regrading to develop a ‘trellis’ pattern to direct surface water flow into the surface water collection system. Where necessary, ditches and swales would be constructed to collect and remove overflow.

Red Dog Creek

The Red Dog Creek Diversion will be rebuilt as a high-density polyethylene (HDPE) lined open channel designed for a 1000-year flood event. The alignment will be around the toe of the regraded Main Pit Dump, at a distance sufficient to allow space for sediment collection between the toe and the diversion ditch. A conceptual section of the diversion design can be found in Figure 23 of the *Reclamation and Closure Plan.*

Main Pit Water Collection System

For the final closure scenario, a system of wells will be installed in the backfilled Main Pit to keep contact groundwater below the level of the pit rim, and prevent seepage into the Red Dog Creek

Diversion. Aqqaluk Pit will function as a sump for the mine contact water collection at closure. For the premature closure scenario, the Main Pit will function as a sump for mine contact water.

Revegetation

All covered and disturbed areas will be seeded and fertilized. Shrub cuttings will be applied over 10% of the surface.

2.2.2 Premature Closure (2015)

The premature closure scenario differs from the planned closure in the following ways:

- The Main Pit would be partially backfilled;
- Qanaiyaq Pit would not be backfilled (see *Qanaiyaq Pit Addendum*, SRK 2016);
- The Main and Back Dam tailings beaches would need to be completed through dredging;
- The Main Waste Dump must be covered (scheduled for 2017-2019);
- The Main Pit is used to store contact water (rather than Aqqaluk Pit), and the Main Pit water collection system is not required; and
- The seepage collection system between the Main Waste Dump and the TSF must be completed to include: cut-off wall, additional pumps, etc. (scheduled for 2015-2028).

2.3 Tailings Area Activities

Closure activities in the Tailings areas are described in Section 3.2 of the *Red Dog Mine Reclamation and Closure Plan*. Major activities are as follows.

Spillway

A spillway will be constructed around the Main Dam; refer to Figure 26 of the *Reclamation and Closure Plan*. For additional details, refer to the *Preliminary Spillway Design, Red Dog Tailings Main Dam, Ultimate Closure Configuration* (2008) prepared by URS for Red Dog's 2009 *Closure and Reclamation Plan*.

Main Dam and Back Dam Beaches

A 600-foot (180m) wide beach will be constructed of tailings upstream of the dams. The beaches will be covered with a geosynthetic liner and unmineralized cover material, similar to covers on the dump. The type of geosynthetic will depend on economics at the time. A geosynthetic clay liner is assumed for the cost estimate. Unmineralized cover material is assumed to be obtained from Aqqaluk Pit in the 2015 scenario, and from a stockpile located near the Overburden Dump in the 2031 scenario. A berm will be constructed to act as a coffer dam during deposition of the beach material, and faced with riprap for erosion protection.

In the event of premature closure, tailings will be dredged and placed to form the beaches. As of 2015, a conservative estimate of five feet (1.5m) of tailings must be placed to form the proposed final beach surfaces. The estimate assumes a volume of dredged tailings to form the beaches is equal to the length of the beaches by 600 feet by 5 feet in depth. At final closure (2030), tailings to form the beaches would be in place, and only the liner and cover material will be required.

Overburden Dump

The Overburden Dump will be re-sloped to an average 3H:1V, seeded and fertilized. Shrub cuttings will be applied over 10% of the surface.

Seepage Collection

Seepage collection systems at both the Main Dam and Back Dam will be re-configured to send water to Aqqaluk Pit (or Main Pit in 2015) via heat-traced pipe. Emergency storage ponds will be constructed at the Main Dam to prevent the escape of seepage in the event of short-term shutdowns/interruptions of the piping system.

Borrow Areas

The DD-2 and MS-14 borrow pits will be resloped, where practical, and revegetated.

2.4 Water Treatment Activities

Closure activities related to water treatment and discharge are described in Section 4.2 of the *Reclamation and Closure Plan*. Major activities are described below.

Water Treatment System Upgrades

Uncertainty exists about the extent to which the water treatment system will need to be upgraded at closure. Minor modifications could be sufficient, especially if they can be coordinated with the changes that will be required in the last few years of operations. See Section 4.2.4 of the *Closure and Reclamation Plan* for further information.

To provide a conservative estimate of the cost of upgrades, the following steps were taken:

- A worst-case scenario was developed by assuming that all existing water treatment facilities will be replaced by a system equivalent to two entirely new plants, one to treat Aqqaluk Pit water and one to treat TSF water. However, we assume that 50% of the existing infrastructure can be reused for each plant; therefore, the total capital outlay is 50% of an entirely new plant.
- The cost of constructing the two plants was estimated using a treatment plant HDS simulation model.

These assumptions are roughly equivalent to the construction of one new treatment plant at closure. It is unlikely that two new plants would be constructed, given that water treatment is ongoing during operation.

Ongoing Water Treatment and Discharge

The cost of water treatment operations during the closure period is uncertain. It is expected to take 2.5 years to fill the Aqqaluk Pit to its long-term level, meaning that water treatment and discharge could completely cease during the two-year closure period. There is also uncertainty about the length of time in which the water quality and flow rates from each contaminant source will transition from operating to post-closure conditions.

To avoid bringing these uncertainties into the closure cost estimate, water treatment operating costs are not included in the closure cost estimate. Instead, they are included in the suspension cost estimate, provided under separate cover. A similar approach has been taken to the cost of infrastructure operations during closure (see next section).

2.5 Ore Processing Area and Infrastructure Activities

Closure activities related to the ore processing area and infrastructure are described in Sections 3.4 and 3.5 of the *Reclamation and Closure Plan*. Major activities include:

Demolition

Infrastructure not required for long-term use will be decommissioned. Hazardous materials will be removed, high value components may be salvaged, and the remainder demolished and placed in the landfill at the top of the Main Waste Dump. Further details regarding demolition methods are provided in a report providing demolition costs for infrastructure (DES 2004).

Contaminated Soil Removal

Contaminated soil will be removed and the areas backfilled with unmineralized material. Known or likely future areas of soil contamination are shown in Figure 28 of the Red Dog Mine *Reclamation and Closure Plan*. It is assumed that the depth of soil removal and backfilling will average two feet.

Road Decommissioning

Site roads no longer required will be reshaped to integrate with the surrounding topography and drainage.

Limestone Quarry Reclamation

The limestone quarry will be reclaimed by regrading the steep slopes, seeded and fertilized.

Revegetation

All contaminated soil areas and decommissioned roads will be seeded and fertilized. Shrub cuttings will be applied over 10% of the surface.

Infrastructure Operations

Camp-related costs are covered in the indirect portion of the closure cost estimate. Other costs for operating the site facilities during the closure period are <u>not</u> included in the closure cost estimate. They are included in the suspension cost estimate.

3 Quantities

Quantity estimates needed as input to closure cost estimates were derived using standard engineering calculations. The worksheets provide the details for different types of quantities. Calculations are straightforward with additional information provided below.

Pit Walls

Pit berms were estimated to be constructed around the perimeter of the pits where highwalls are present. Pit berms were assumed to be 3.3 feet high with a 1 foot wide crest width and 1H:1V side slopes. Pit perimeters were obtained from topographic plans showing conditions at closure.

Pit rims were estimated to be re-sloped around the eastern remnant of the Main Pit. The rims will be blasted back 150 feet to a slope of 4H:1V to improve visibility for snow machine or ATV drivers.

Stockpile Re-Sloping

The duration of re-sloping activities on the Waste and Overburden Dumps was estimated using the Caterpillar® Handbook 43. Re-sloping was assumed to be completed by a CAT D11 dozer. Dump heights and initial slope angles were obtained from topographic plans showing conditions at closure. Volumes of material pushed were estimated by computing the sectional area of each bench to be cut and multiplying by the length of the bench.

Cover Volumes

Cover volumes for waste dumps were estimated from using areas calculated in AutoCAD by comparing available topographic surveys and aerial photography. An average depth of cover was assumed for all waste rock covers and beaches. A depth of 3.3 feet (1m) was assumed for all quantity volumes.

Cover Compaction

Durations of compaction activities on the covered areas were estimated by a simplified productivity calculation. Compaction was assumed to be completed by a CAT D9 with a sheepsfoot roller and two passes at estimated speeds calculated for both sloped (e.g., 33%) and flat (e.g., 3%) surfaces.

Ditches

Quantities for the ditches to convey water off the covered dumps were estimated based on the following assumptions:

- Contouring of the trellis pattern for surface water collection will be completed during operations and regrading;
- Excavation of the surface water collection channels to a channel depth of 3.3 feet with 2H:1V side slopes;
- Channel locations and lengths determined from topographic plans; and
- Drop structures in the channels with excavation depths of 5.5 feet, bedding and rip-rap thicknesses of 1 foot each, and a layer of geotextile in between.

Quantities for the Red Dog Creek Diversion Channel upgrade were estimated based on the following assumptions:

- Clearing and grading over 10% of the overall channel length over a width of 100 feet;
- Channel design based on a flow of 500 ft^3/s and a grade of 1.8%;
- Channel excavation optimized to have the excavation quantity equal the berm quantities on each side of the channel;
- A channel width of 6.5 feet and side slopes of 3H:1V with 15 foot wide berms on each side of the diversion channel; and
- A channel bedding thickness of 0.5 feet and a rip-rap thickness of 1.2 feet.

Seepage Collection

Quantities for the Main Waste seepage collection system were estimated based on the following assumptions:

- Groundwater wells will be installed along the Main Dump at known seep locations. The depths to bedrock were estimated based on borehole data from nearby locations.
- Piping and pump sizes were estimated based on historical data from existing seeps.
- Bentonite cut-off walls were included around seeps with high flows (MWD-24 and MWD-18). The cut-off wall around MWD-24 was assumed to be 650 feet long, 5 feet wide with a 50 foot average depth to bedrock. The cut-off wall around MWD-18 was assumed to be 650 feet long, 5 feet wide with a 50 foot average depth to bedrock.

New piping systems for seepage from the Main and Back Dams were assumed to be buried, at an average depth of 6.5 feet.

Tailings Beaches

Material quantities for tailings beaches were determined from topographic plans and an assumed beach width of 600 feet. Estimates of liner area, cover material volume, and revegetation area were derived for both a beach at the Main Dam and the Back Dam.

Contaminated Soils and Roads

Areas with contaminated soils are shown in Figure 28 of the *Reclamation and Closure Plan* and were estimated from 2015 site topography.

Demolition

Demolition quantities were estimated by Denison Environmental Services, (DES 2004). Demolition quantities for two new structures, the Jameson Cell and the ISA Mill, were incorporated in the cost estimate. Estimates in the DES report assumed hauling demolished materials to the port for salvage. Due to the economics of salvaging material and not accounting for the actual salvage value (credit) in the estimate, all materials were assumed to be placed in the landfill. During actual closure activities, salvage of materials may be economically viable to remove from the site. However, at this time, we assume that all material will remain on site and will be placed in the landfill, and thus assume no credit for the salvaged material. The hours calculated in the DES report are greatly reduced due to the time required to move salvaged material to the port versus placing it in the nearby landfill.

Revegetation

Revegetation areas were estimated in AutoCAD using current topography and aerial photography.

4 Unit Costs

4.1 Unit Cost Inputs

Equipment Rates

Equipment rates were based on estimates developed by SRK using monthly rental rates provided by NC Machinery. Rates for equipment not available through NC Machinery were obtained from Construction Machinery Industrial (CMI), Delta Leasing, and Airport Equipment Rentals. The construction schedule assumes two construction seasons, with a complete mobilization and demobilization to occur each construction season. Rental rates were provided in terms of 4-week increments. Each construction season is assumed to span five 4-week terms.

The rental rate is based on a 4-week term and a 10hr/day, 5 day/week schedule. This results in 200 hours per 4-week term. The rental price is divided by 200 hours to derive the estimated hourly equipment rate. However, it is anticipated that equipment would operate 7 days per week, for approximately 10 hours per day, which would result in an additional 80 hours of overtime per 4-week term. The cost for the additional 80 hours, and up to 100 hours per 4-week term, is billed with an overtime charge of 1.5x the hourly rate.

Overhead costs for equipment, such as GET, tires, and major maintenance, are included in the average wear and tear clause of the rental terms. The maximum time any one piece of equipment is scheduled per season is 1500 hours (5 terms, 300 hours each). The expected lifespan of a tire, for instance, is 4,500-5,000 hours; the anticipated GET rebuild for dozers, loaders, etc. is approximately 7,000-9,000 hours. Therefore, including costs associated with GET or tire replacement is negligible and not required. A separate “No Plot Fleet Hours Summary” worksheet is provided to show total hours for each piece of equipment. Since equipment will be demobilized each season, “wear and tear” would start again at the beginning of the next season under a new rental agreement. An additional 15% of the hourly rate is included for general and incidental maintenance, and an additional 10% of fuel cost is included for lube and preventative maintenance.

This method of calculating equipment costs is consistent with the standard reclamation cost estimator (SRCE) method for calculating hourly rates, and Caterpillar Handbook for calculating ownership costs. Closure activities are estimated to be performed over the course of two constructions seasons. Equipment idle time, for time in which the equipment is on-site, but not engaged, is calculated at 100% of the base hourly rental rate, and is included in the estimate as an indirect cost.

Equipment rates include ownership and maintenance (less labor) but exclude overhead and profit. Maintenance labor, overhead, and profit are included in the indirect section of the estimate.

Fuel

A fuel unit cost of $3.08 per gallon was used throughout the cost estimate. The estimate is based on the 5-year average (2011-2015) price of fuel delivered to Red Dog Port.

Equipment fuel rates were derived based on the equipment horsepower, obtained from the Caterpillar® Performance Handbook 43. The equation used to calculate the fuel rate is:

$$\text{Fuel Rate (\$/hr)} = \text{HP} \times \text{FF} \times \text{fuel cost per liter}$$

where: HP = horsepower
FF = Fuel Factor (liter/hr/HP)

Fuel factors account for actual hours of operation, and operating capacity is accounted for in the productivity of the equipment. Fuel consumption is directly tied to hours of operation, which is linked to productivity. The fuel factor uses the medium fuel consumption rate shown in the CAT Handbook divided by the gross horsepower. Fuel factors for each type of equipment represent the average fuel consumed per hour per horsepower. Fuel factors used in determining fuel costs were as follows:

Equipment Type	Fuel Factor (L/hr/HP)	Source
Backhoes	0.110	CAT Handbook
Excavators	0.130	CAT Handbook
Lifting Equipment	0.100	Estimated
Loaders	0.121	CAT Handbook
Dozers	0.135	CAT Handbook
Graders	0.140	CAT Handbook
Trucks	0.065	CAT Handbook
Compactors	0.130	CAT Handbook
Drills	0.130	Estimated

Labor Rates

Labor rates for an independent contractor were built up from base hourly rates presented in Issue 31 (effective September 1, 2015) of the *Laborers' & Mechanics' Minimum Rates of Pay* (Pamphlet 600), published by the Alaska Department of Labor and Workforce Development. Labor rates not available in Pamphlet 600 were built up from wages available on the Alaska Department of Labor's website (Research and Analysis, May 2014 Wages in Alaska). Base hourly rates include standard overtime, benefits, and payroll burden. Labor rates do not include the costs of camp accommodation or flights, which are included as indirect costs.

Material Costs

Estimates of material costs were obtained from the following sources:

- Specific vendor quotes;
- RSMeans 2014 *Heavy Construction Cost Data*; and
- Recent SRK experience on other projects.

4.2 Relocation Unit Costs

The “Relocation Unit Cost” spreadsheet follows standard estimation procedures, routinely used by earthwork contractors. Calculations make use of equipment specifications obtained from manufacturer’s data, in this case, the Caterpillar Handbook 43, Caterpillar DozSim 2.0, and Caterpillar Fleet Production and Cost Analysis, V5.2.

Equipment Selection

Equipment models used in the cost estimate were chosen to match existing Red Dog equipment as much as possible. Equipment fleets were selected, depending on the size of the task. For smaller relocation tasks, CAT 740 rock trucks were assumed to be used and loaded by either a CAT 988 loader or a CAT 325 excavator. For larger relocation tasks, CAT 777 trucks were assumed to be used and loaded by a CAT 992 loader. Where appropriate, CAT D9 dozers were assumed to assist the loader, with CAT CP563 or walk-behind vibrating plate compactors for compaction.

In general, relocation unit costs are optimized when enough trucks are used to keep the loader at constant operation with no stand-by time. In some cases, this may result in an optimized truck number greater than the amount of trucks available on-site. For the purpose of this cost estimate, both truck fleets (CAT 777 and CAT 740) were capped at five trucks. Use of larger equipment or greater numbers of trucks could reduce the cost of some activities.

Material Properties

The materials involved vary from one task to another, and material properties needed in productivity calculations were varied accordingly, as follows.

	Bulk Density tonne/m^3	Bulking Factor	Excavated Density tonne/m^3	Shrinkage Factor	Compacted Density tonne/m^3	Compacted Density ton/yd^3
Earth	1.90	1.25	1.52	0.95	2.00	1.68
Misc.	2.00	1.00	2.00	1.00	2.00	1.68
Rip-Rap	2.61	1.40	1.86	1.00	2.61	2.19
Shale	2.61	1.35	1.93	0.90	2.35	1.97
Top Soil	1.37	1.40	0.98	1.10	1.25	1.05
Till	1.84	1.20	1.53	0.90	2.04	1.71
Waste Rock	3.00	1.35	2.22	.9	2.70	2.70

Haul Routes

Distances and grades used in haul time calculations were obtained from topographic plans. Reasonable assumptions were made as to where roads would be located at the time of closure. A haul route map can be found the “Relocation Unit Costs” tab of the workbook.

Relocation Unit Rate Calculations

Relocation productivities were calculated using material properties, haul route characteristics, and equipment performance data from the current version of Caterpillar® Fleet Production and Cost

Analysis software. Calculations used to convert productivity estimates and unit rate inputs into relocation unit rates for each category are:

- Equipment cost ($/Bank-m^3) is calculated as the sum of equipment hourly rates divided by the bank material productivity (Bm^3/hr).
- Fuel cost ($/Bm^3) is calculated as the sum of hourly fuel costs for each piece of equipment divided by the bank material productivity (Bm^3/hr).
- Labor cost ($/Bm^3) is calculated as the sum of operator rates for each piece of equipment divided by the bank material productivity (Bm^3/hr).
- Man-hours per bank-volume of material moved assumes one operator per piece of equipment and is equal to the sum of pieces equipment used divided by the bank material productivity (Bm^3/hr).

The Total Bank Unit Rate ($/Bm^3) is equal to the sum of the equipment, fuel and operator costs.

4.3 Task Unit Costs

The “Task Unit Costs” worksheet calculates labor, material, equipment, and fuel costs per unit quantity for various other tasks. The methodology also provides an estimate of man-hours required for each unit of production.

Productivity Selection

Productivities for each task were obtained from the following sources:

- Equipment specifications obtained from manufacturer’s data, in this case, the Caterpillar® Handbook 43;
- Caterpillar® Equipment Training Solutions, STB Suite Software;
- RSMeans 2014 *Heavy Construction Cost Data*; and
- Recent SRK experience on other projects.

Task Unit Rate Calculations

Calculations used to estimate unit rates for each task are summarized below:

- Equipment cost ($/Unit) is calculated as the sum of equipment hourly rates divided by the task productivity (Unit/hr).
- Fuel cost ($/Unit) is calculated as the sum of hourly fuel costs for each piece of equipment divided by the task productivity (Unit/hr).
- Material cost ($/Unit) is calculated as the sum of material unit rates times the materials’ multiplier factor.
- Labor cost ($/Unit) is calculated as the sum of operator rates for each piece of equipment divided by the unit productivity (Unit/hr).
- Man-hours per unit are calculated to the sum of equipment operators, tradesman and laborers divided by the unit productivity (Unit/hr).
- The Total Unit Rate ($/Unit) is equal to the sum of the equipment, fuel, material, and labor costs.

5 Indirect Costs

General Structure

Indirect costs were defined as any costs that cannot be directly associated with individual tasks.

Separate estimates were prepared for indirect costs associated with activities in the “2031 Mine”, “2015 Mine”, “2031 Tailings”, “2015 Tailings”, “WTP Estimate 2031”, “WTP Estimate 2015”, and “Ore Processing & Infrastructure” tabs. Indirect costs are therefore included in the respective activity spreadsheets.

Many indirect costs depend on the project duration. The project was assumed to span two 140-day construction seasons. The project duration was estimated by dividing the total man-hours by the estimated crew size for each activity total, with equipment operating 10 hours per day. Field support staff and engineers were assumed to work 12 hours per day.

Indirect cost categories include all of those that SRK would normally consider, as well as others specified in the State of Alaska “Financial Assurance Guidelines”. Input factors that are common to many of the indirect cost estimates are collected in the “Indirect Cost Inputs” spreadsheet.

Mobilization and Demobilization

Mobilization and demobilization costs were included as a lump sum allocated to the “2031 Mine” and “2015 Mine” worksheets. A summary of mobilization and demobilization costs can be found in Table 22, with additional detail and assumptions found in the “Mob Demob” tab of the Excel workbook. The estimate allows for two complete mobilization and demobilization events of the entire equipment fleet. The estimate also allows for shipping construction materials on the barges with the equipment fleet. An air cargo contingency was provided for materials that are not shipped via barge; in addition, materials can be shipped air cargo when crews change out each rotation. The estimate was developed using a method provided by the State of Alaska Department of Natural Resources (personal communication from Steve J. McGroarty, P.E.), which incorporates quotes from Alaskan barge operators, and also includes the cost of moving equipment and materials from Red Dog Port to the mine site.

Unutilized and Overtime Equipment Costs

Equipment is rented on a term basis, and once on site, the contractor is liable for the full rental fee regardless of usage. Equipment hourly rates are based on a term rate of 4 weeks divided by 200 hours of usage allowed per term, as provided in the rental agreement. The estimate is based on an hourly rate and equipment scheduled per task. When a piece of equipment is not scheduled for 200 hours per term, idle time is incurred and must be accounted for to equal, at a minimum, the rental cost for the term. When equipment is scheduled for more than 200 hours per term, the result is overtime charges.

An audit was performed on all tasks in the estimate, the hours were summed for each piece of equipment and resulting idle or overtime hours were accounted. This time is accounted for as “overhead” charges for the equipment.

All hours in the estimate are billed as “regular” hours, or rental rate per term divided by 200 hours. In order to capture the cost of overtime, the maximum hours allowed per term is subtracted from the total hours scheduled. The overtime is billed out at regular time plus an additional 50% of the regular rate, and multiplied by the calculated overtime hours (NC Machinery bills an overtime rate of 1.5 the regular rate for hours scheduled between 200 and 300 in a rental term). Calculations showing the equipment audit can be found in each activity tab, with a summary of all hours, overtime hours, and idle time found in the “No Plot Fleet Summary” tab. The resulting lost overtime and idle charges are included as an indirect cost in the “2031 Mine” and “2015 Mine” tabs, below the Mobilization cost.

Administration Costs

Workers’ Compensation costs were included in the labor unit costs. Additional administration costs included office and communication costs. Office supplies were included at a rate of $100/month. Communication costs were included at a rate of $570/month, based on satellite internet and VOIP, plus one Iridium satellite phone for back-up, for both voice and data communications.

Camp operation costs were included at a rate of $111 per day per person. Heating fuel for office operations was included at a rate of 360 gallons/month. Heating for the camp is supplied by waste heat from the diesel generators.

Miscellaneous administrative supplies were included at a rate of $600/month to capture potential supply costs not included under office supplies.

Field Support

It was assumed that a supervisor, administrative assistant, foreman, and mechanic would be on-site throughout the project duration. A survey field manager and crew were assumed to be on-site for half of the project duration.

Field support staff wages were obtained from Issue 31 (effective September 1, 2015) of the *Laborers’ & Mechanics’ Minimum Rates of Pay*, published by the Alaska Department of Labor and Workforce Development (Pamphlet 600). Labor rates not available in Pamphlet 600 were built up from wages available on the Alaska Department of Labor’s website (Research and Analysis, May 2014 Wages in Alaska).

Field support staff vehicle rates were based on the estimates discussed in Section 4.1.

Turnaround quantities were estimated assuming a 2 week in, 2 week out work schedule for both crew and field support staff.

Turnaround costs were included at a rate of $357 per person, assuming a rotating workforce of approximately 90 people. This cost assumes a round trip charter flight on an Alaska Air 737-800 plane, with service from Anchorage to Red Dog. Crew and support staff were estimated to be on a 2 week in, 2 week out schedule.

Contract Administration and QA/QC

It was assumed that an independent engineer would act as the State's representative throughout the duration of each activity, with technician and laboratory testing support, and vehicles.

Water Treatment

Indirect costs for water treatment plant construction includes the following percentages as a percent of all direct costs:

- 15% for contractor profit and overhead;
- 15% for engineering and procurement;
- 30% for a remote site premium for northern construction; and
- 20% construction contingency.

Other

Miscellaneous costs are incurred for the project and are considered indirect costs. These include:

- Insurance costs were estimated as 1.6% of labor cost.
- Contractor overhead was included at a rate of 10% of labor and insurance costs.
- Cost of shipping equipment and materials to site was included with the mobilization and demobilization cost, and includes a contingency for air shipping.
- Haul road maintenance costs were included at a rate of $600,000 per year, based on recent site experience.
- Contractor profit was included at a rate of 10% of direct and above indirect costs.
- Bonding costs were estimated as 3% of direct and above indirect costs.
- An engineering re-design cost was included in the independent contractor's case, to cover the cost of design review and revisions by the State. The cost was estimated as 3% of direct and above indirect costs.
- State management and oversight costs were included at a rate of 1% of direct and above indirect costs.
- These indirect cost percentages were derived for the site during development of the 2009 closure cost estimate.

Contingency

A contingency of 20% of direct costs was added to each estimate. The 20% contingency is presumed to be conservative because of the level of detail for costs and is consistent with the 2009 closure cost estimate.

This report, *Basis of Estimate – Closure Costs – Red Dog Mine*, was prepared by SRK Consulting (U.S.), Inc. with data supplied by TAK.

Ivan Clark, Senior Consultant

and reviewed by

Dan Neuffer, Senior Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

6 References

Alaska Department of Labor (AK DOL). Laborers' & Mechanics' Minimum Rates of Pay. Effective September 1, 2015. Issue 31.

Caterpillar ® Handbook 43.

Denison Environmental Services (DES). Demolition Cost Estimate: Red Dog Mine, Alaska. Report prepared for SRK Consulting and SENES Consultants. October 2004.

RSMeans. 2014 Heavy Construction Cost Data. 28th Annual Edition.

SRK 2016. Qanaiyaq Pit Addendum. Memorandum prepared for Teck Alaska, Inc. August 2016.

SUMMARY OF ESTIMATED CLOSURE COSTS
ALASKAN CONTRACTOR RATES

		Direct	Indirect	Total	Total
Mine Area				**2031**	**2015**
	Planned Closure (2031)	$9,300,000	$15,600,000	$ 24,900,000	
	Premature Closure (2015)	$13,500,000	$18,500,000		$ 32,000,000
Tailings Area					
	Planned Closure (2031)	$11,300,000	$7,900,000	$ 19,200,000	
	Premature Closure (2015)	$14,500,000	$9,400,000		$ 23,900,000
Ore Processing & Infrastructure		$4,900,000	$5,700,000	$ 10,600,000	$ 10,600,000
Water Treatment Plant Construction					
	Planned Closure (2031)	$16,700,000	$13,400,000	$ 30,100,000	
	Premature Closure (2015)	$17,000,000	$13,600,000		$ 30,600,000
				$84,800,000	$ 97,100,000

Table 1. Mine Area Closure Costs - Planned Closure (2031)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - DIRECT CAPITAL																					
Install Berms and Regrade Pit Rims																					**$774,165**
1	1	1	-	Aqqaluk: Pit berm (boulder fence)	6,847	Bm3	R.001	0.06	431	$ 3.83	$ 26,255	$ -	$ -	$ 7.61	$ 52,100	$ 2.07	17,361	$ 14,146	$ 13.51	$ 92,501	
1	1	2	-	Qanaiyaq: Pit berm (boulder fence)	2,921	Bm3	R.002	0.05	137	$ 2.85	$ 8,319	$ -	$ -	$ 5.65	$ 16,508	$ 1.53	5,501	$ 4,482	$ 10.03	$ 29,310	
1	1	3	-	Main Pit: Drill and blast highwall along eastern limit (4H:1V)	230,400	Bm3	C2.09	0.01	1,613	$ 0.41	$ 95,012	$ 1.22	$ 281,292	$ 0.37	$ 85,744	$ 0.04	11,740	$ 9,566	$ 2.05	$ 471,614	
1	1	4	-	Main Pit: Push blasted material into pit	358	hrs	C2.23	1.00	358	$ 61.23	$ 21,899	$ -	$ -	$ 314.10	$ 112,338	$ 93.50	41,040	$ 33,440	$ 468.83	$ 167,677	
1	1	5	-	Main Pit: Pit berm (boulder fence)	1,028	Bm3	R.003	0.06	61	$ 3.61	$ 3,708	$ -	$ -	$ 7.16	$ 7,357	$ 1.94	2,452	$ 1,998	$ 12.71	$ 13,062	
Regrade and Cover Waste and Stockpiles																					**$6,129,098**
Regrade and Compact Main Pit and Stockpiles																					
1	2	1	-	Regrade slopes and flat areas using D11 Dozer	3,618	hrs	C2.23	1.00	3,618	$ 61.23	$ 221,500	$ -	$ -	$ 314.10	$ 1,136,258	$ 93.50	415,109	$ 338,237	$ 468.83	$ 1,695,995	
1	2	2	-	D9 with impact roller (all surfaces)	293	hrs	C2.06	2.00	586	$ 120.97	$ 35,456	$ -	$ -	$ 222.87	$ 65,323	$ 77.94	28,036	$ 22,844	$ 421.78	$ 123,623	
Complex Soil Cover - First layer, high compaction (0.5m) from Stockpiles																					
1	3	1	-	Load, haul, dump, spread material (MPD, Area: 12)	325,600	Bm3	R.009	0.01	2,548	$ 0.49	$ 158,321	$ -	$ -	$ 2.10	$ 682,160	$ 0.43	173,591	$ 141,445	$ 3.02	$ 981,926	
1	3	2	-	Load, haul, dump, spread material (Red Dog Creek, Area: 15)	86,000	Bm3	R.019	0.02	1,802	$ 1.28	$ 110,227	$ -	$ -	$ 2.37	$ 203,703	$ 0.62	65,176	$ 53,106	$ 4.27	$ 367,036	
1	3	3	-	Load, haul, dump, spread material (QPit and HR, Areas: 5,6,10)	254,250	Bm3	R.017	0.01	2,113	$ 0.51	$ 130,731	$ -	$ -	$ 1.97	$ 501,214	$ 0.44	137,481	$ 112,021	$ 2.93	$ 743,967	
1	3	4	-	Compact material D9 with sheepsfoot roller (all surfaces)	293	hrs	C2.06	2.00	586	$ 120.97	$ 35,456	$ -	$ -	$ 222.87	$ 65,323	$ 77.94	28,036	$ 22,844	$ 421.78	$ 123,623	
Complex Soil Cover - Second layer, light compaction (0.5m) from Stockpiles																					
1	4	1	-	Load, haul, dump, spread material (MPD, Area: 12)	325,600	Bm3	R.009	0.01	2,548	$ 0.49	$ 158,321	$ -	$ -	$ 2.10	$ 682,160	$ 0.43	173,591	$ 141,445	$ 3.02	$ 981,926	
1	4	2	-	Load, haul, dump, spread material (Red Dog Creek, Area: 15)	86,000	Bm3	R.019	0.02	1,802	$ 1.28	$ 110,227	$ -	$ -	$ 2.37	$ 203,703	$ 0.62	65,176	$ 53,106	$ 4.27	$ 367,036	
1	4	3	-	Load, haul, dump, spread material (QPit and HR, Area: 5,6,10)	254,250	Bm3	R.017	0.01	2,113	$ 0.51	$ 130,731	$ -	$ -	$ 1.97	$ 501,214	$ 0.44	137,481	$ 112,021	$ 2.93	$ 743,967	
Install Surface Water Collection																					**$211,670**
1	5	1	-	Excavate trellis pattern	9,600	Bm3	C2.11	0.04	427	$ 2.70	$ 25,942	$ -	$ -	$ 4.99	$ 47,907	$ 1.35	15,879	$ 12,939	$ 9.04	$ 86,788	
1	5	2	-	Excavate drop structures	7,480	Bm3	C2.11	0.04	332	$ 2.70	$ 20,213	$ -	$ -	$ 4.99	$ 37,328	$ 1.35	12,373	$ 10,081	$ 9.04	$ 67,623	
1	5	3	-	Bedding material (load, haul, dump, place, 0.5m shale)	1,800	Bm3	R.005	0.04	71	$ 2.39	$ 4,310	$ -	$ -	$ 3.99	$ 7,176	$ 1.02	2,260	$ 1,841	$ 7.40	$ 13,328	
1	5	4	-	Place riprap: Drill, blast, stockpile	1,800	Bm3	C2.24	0.05	81	$ 2.67	$ 4,814	$ 8.14	$ 14,651	$ 2.80	$ 5,038	$ 0.68	1,499	$ 1,222	$ 14.29	$ 25,724	
1	5	5	-	Place riprap: Load, haul, dump	1,800	Bm3	R.006	0.04	81	$ 2.74	$ 4,933	$ -	$ -	$ 4.63	$ 8,343	$ 1.20	2,641	$ 2,152	$ 8.57	$ 15,427	
1	5	6	-	Place riprap: Place and secure	1,800	Bm3	C2.27	0.01	23	$ 0.77	$ 1,378	$ -	$ -	$ 0.56	$ 1,010	$ 0.22	483	$ 393	$ 1.54	$ 2,781	
Upgrade Red Dog Creek (1:1000yr)																					**$1,139,084**
1	6	1	-	Additional clearing and grading	31,250	m2	C2.05	0.01	455	$ 0.89	$ 27,702	$ -	$ -	$ 1.88	$ 58,776	$ 0.51	19,675	$ 16,032	$ 3.28	$ 102,511	
1	6	2	-	Excavation and placement of creek berms	16,678	Bm3	C2.17	0.12	2,001	$ 7.19	$ 119,909	$ -	$ -	$ 9.74	$ 162,363	$ 3.16	64,681	$ 52,703	$ 20.08	$ 334,976	
1	6	3	-	Bedding layer: Screen and stockpile	2,938	Bm3	C2.02	0.01	29	$ 0.62	$ 1,825	$ -	$ -	$ 2.29	$ 6,728	$ 0.62	2,235	$ 1,821	$ 3.53	$ 10,373	
1	6	4	-	Bedding layer: Load, haul, dump, place 150mm layer (25mm minus)	2,938	Bm3	R.019	0.02	62	$ 1.28	$ 3,765	$ -	$ -	$ 2.37	$ 6,958	$ 0.62	2,226	$ 1,814	$ 4.27	$ 12,538	
1	6	5	-	Supply and place geotextile	21,383	m2	C3.06	0.07	1,527	$ 4.01	$ 85,688	$ 1.53	$ 32,617	$ 1.09	$ 23,366	$ 0.33	8,686	$ 7,078	$ 6.96	$ 148,749	
1	6	6	-	Supply and place HDPE liner	21,383	m2	C3.11	0.14	3,055	$ 8.73	$ 186,759	$ 5.47	$ 116,962	$ 2.19	$ 46,732	$ 0.66	17,373	$ 14,156	$ 17.05	$ 364,609	
1	6	7	-	Place riprap: Drill, blast, stockpile	6,224	Bm3	C2.24	0.05	280	$ 2.67	$ 16,643	$ 8.14	$ 50,656	$ 2.80	$ 17,421	$ 0.68	5,184	$ 4,224	$ 14.29	$ 88,944	
1	6	8	-	Place riprap: Load, haul, dump	6,224	Bm3	R.020	0.05	289	$ 2.84	$ 17,685	$ -	$ -	$ 5.22	$ 32,463	$ 1.35	10,283	$ 8,379	$ 9.40	$ 58,527	
1	6	9	-	Place riprap: Place and secure	6,224	Bm3	C2.27	0.01	78	$ 0.77	$ 4,763	$ -	$ -	$ 0.56	$ 3,491	$ 0.22	1,669	$ 1,360	$ 1.54	$ 9,614	
1	6	10	-	Revegetation: Willow cuttings/birch seeding	1	hec	C4.02	93.75	100	$ 5,215.00	$ 5,582	$ 1,800.00	$ 1,927	$ 356.53	$ 382	$ 330.94	435	$ 354	$ 7,702.47	$ 8,244	
Install Main Pit Water Collection System																					**$912,252**
1	7	1	-	GW Wells: Drill wells (Air Rotary Drill Rig)	276	m	C2.10	2.00	552	$ 134.97	$ 37,253	$ -	$ -	$ 124.05	$ 34,238	$ 13.84	4,688	$ 3,820	$ 272.86	$ 75,310	
1	7	2	-	GW Wells: Install 6" stainless steel well casing and screen	276	m	C3.20	0.15	41	$ 10.12	$ 2,794	$ 3.29	$ 908	$ 9.30	$ 2,568	$ 1.04	352	$ 286	$ 23.75	$ 6,556	
1	7	3	-	GW Wells: Install 6" submersible pump with controls (59-95 GPM)	3	ea.	C3.08	12.00	36	$ 691.48	$ 2,074	$ 7,434.00	$ 22,302	$ -	$ -	$ -	0	$ -	$ 8,125.48	$ 24,376	
1	7	4	-	GW Wells: Install protective housing (shack)	3	ea.	C3.19	26.67	80	$ 1,542.07	$ 4,626	$ 1,472.15	$ 4,416	$ 76.06	$ 228	$ 70.60	260	$ 212	$ 3,160.88	$ 9,483	
1	7	5	-	Piping System: Excavate piping trench	9,000	Bm3	C2.14	0.02	180	$ 1.22	$ 11,021	$ -	$ -	$ 0.90	$ 8,077	$ 0.35	3,861	$ 3,146	$ 2.47	$ 22,245	
1	7	6	-	Piping System: Supply and install insulated 350mm HDPE pipe	1,500	m	C3.13	0.23	346	$ 12.65	$ 18,976	$ 210.00	$ 315,000	$ -	$ -	$ -	0	$ -	$ 222.65	$ 333,976	
1	7	7	-	Piping System: Backfill ditches	9,000	Bm3	C2.01	0.03	270	$ 1.71	$ 15,378	$ -	$ -	$ 0.53	$ 4,743	$ 0.18	2,001	$ 1,631	$ 2.42	$ 21,752	
1	7	8	-	Heat Tracing: Supply and install heat trace in HDPE pipe	1,500	m	C3.14	0.08	120	$ 4.81	$ 7,214	$ 90.00	$ 135,000	$ 0.23	$ 342	$ 0.21	390	$ 318	$ 95.25	$ 142,874	
1	7	9	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
1	7	10	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
1	7	11	-	Power Supply: Supply and install treated power poles	20	ea.	C3.03	4.55	91	$ 318.41	$ 6,368	$ 10,500.00	$ 210,000	$ 133.40	$ 2,668	$ 27.17	667	$ 543	$ 10,978.97	$ 219,579	
1	7	12	-	Power Supply: Supply and install overhead conductor	1,500	m	C3.02	0.03	48	$ 2.27	$ 3,405	$ 23.05	$ 34,571	$ 0.70	$ 1,057	$ 0.14	264	$ 215	$ 26.16	$ 39,247	
1	7	13	-	Power Supply: Supply and install transformers	1	ea.	C3.04	20.00	20	$ 1,418.65	$ 1,419	$ 442.75	$ 443	$ 440.22	$ 440	$ 89.65	110	$ 90	$ 2,391.26	$ 2,391	
Revegetation																					**$93,229**
1	8	1	-	Native seed, application by helicopter	35	hec	C4.01	1.61	56	$ 93.55	$ 3,283	$ 437.95	$ 15,372	$ 343.36	$ 12,052	$ 68.07	2,932	$ 2,389	$ 942.93	$ 33,097	
1	8	2	-	Live plants - shrub cuttings (10% of surface area)	4	hec	C4.02	93.75	329	$ 5,215.00	$ 18,305	$ 1,800.00	$ 6,318	$ 356.53	$ 1,251	$ 330.94	1,426	$ 1,162	$ 7,702.47	$ 27,036	
1	8	3	-	Fertilizer pellets, application by helicopter	35	hec	C4.01	1.61	56	$ 93.55	$ 3,283	$ 437.95	$ 15,372	$ 343.36	$ 12,052	$ 68.07	2,932	$ 2,389	$ 942.93	$ 33,097	
Subtotal Direct Costs - Mine Area Planned Closure (2031)									**31,442**		**$ 1,914,138**		**$ 1,271,605**		**$ 4,860,304**			**$ 1,213,452**			**$9,259,498**

Table 1. Mine Area Closure Costs - Planned Closure (2031)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - INDIRECT																					
Mobilization & Demobilization																					**$ 6,801,767**
-	1	1	-	Idle Equipment Cost and Equipment OT	1	ls													$ 1,932,971	$1,932,971	
-	1	2	-	Mob/Demob - Entire Project	1	ls													$ 4,868,796	$4,868,796	
Administration Costs																					**$ 572,436**
-	2	1	-	Office Supplies	9	months	x	$100	/month											$901	
-	2	2	-	Communications	9	months	x	$570	/month											$5,130	
-	2	3	-	Heating Fuel (avg. 360 gal per month)	9	months	x	360	gal/month	x	$ 3.08	/gallon								$9,979	
-	2	4	-	Misc. Supplies	9	months	x	$600	/month											$5,400	
-	2	5	-	Camp Operation	4,964	Man-days	x	$111	per day per person											$551,026	
Field Support												Turnarounds									**$ 1,367,280**
-	3	1	-	Supervisor #1	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	2	-	Supervisor #2	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	3	-	Administrative Assistant #1	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	4	-	Administrative Assistant #2	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	5	-	Foreman #1	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	6	-	Foreman #2	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	7	-	Mechanic #1	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	8	-	Mechanic #2	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	9	-	Survey Field Manager	130	days	x	12	hrs/day			4					1560	hr	$ 63.88	$99,653	
-	3	10	-	Survey Crew (surveyor + helper)	130	days	x	12	hrs/day			4					1560	hr	$ 116.21	$181,288	
-	3	11	-	Field Support Vehicles	130	days	x	3	trucks												
-	3	12	-	Turnaround Costs - Admin	43	trips	x	$357	per trip	+	10 %									$17,032	
-	3	13	-	Turnaround Costs - Crew	56	trips	x	$357	per trip	+	10 %									$22,142	
Contract Administration and QA/QC												Turnarounds									**$ 626,013**
-	4	1	-	Resident Engineer #1	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	2	-	Resident Engineer #2	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	3	-	Engineering Technician #1	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	4	-	Engineering Technician #2	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	5	-	Laboratory and Material Testing Costs	9	months	x	$1,200	/month											$10,800	
-	4	6	-	Field Support Vehicles	130	days	x	1	trucks												
-	4	7	-	Turnaround Costs - QA/QC	17	trips	x	$357	/trip	+	10 %									$6,813	
Other Indirect Allocations																					**$ 4,405,902**
-	5	1	-	Insurance (1.6% of labor cost)	2	%	of	$3,242,244	Direct Labor Cost+Field Support Labor											$51,876	
-	5	2	-	Contractor Overhead	10	%	of	$3,294,119	Direct Labor Cost+Field Support Labor+ Insurance											$329,412	
-	5	3	-	Allowance for Haul Road Maintenance	2	yr													$ 300,000	$600,000	
-	5	4	-	Contractor Profit	10	%	of	$19,057,256	Total Direct Cost+mob/demob+site admin-CAMP OPERATION+field support+Insurance+OH+Freight+Haul Road Maint.											$1,905,726	
-	5	5	-	Engineering Re-Design	3	%	of	$21,514,008	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$645,420	
-	5	6	-	Bonding	3	%	of	$21,514,008	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$645,420	
-	5	7	-	State Management and Oversight	1	%	of	$22,804,848	Total Project Cost EXCLUDING State Contract Admin, Contingency											$228,048	
Subtotal Indirect Costs																					**$13,773,398**
CLOSURE COSTS - CONTINGENCY																					
				Contingency	20	%	of	$9,259,498	Direct Cost											$1,851,900	**$1,851,900**
CLOSURE COSTS - TOTAL																					
				Total Direct and Indirect Costs																	**$24,884,796**

Table 2. Mine Area Closure Costs - Premature Closure (2015)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - DIRECT CAPITAL																					
Install Berms and Regrade Pit Rims																					$826,801
1	1	1	-	Aqqaluk: Pit berm (boulder fence)	6,847	Bm3	R.001	0.06	431	$ 3.83	$ 26,255	$ -	$ -	$ 7.61	$ 52,100	$ 2.07	17,361	$ 14,146	$ 13.51	$ 92,501	
1	1	2	-	Qanaiyaq: Pit berm (boulder fence)	2,921	Bm3	R.002	0.05	137	$ 2.85	$ 8,319	$ -	$ -	$ 5.65	$ 16,508	$ 1.53	5,501	$ 4,482	$ 10.03	$ 29,310	
1	1	3	-	Main Pit: Pit berm (boulder fence)	5,169	Bm3	R.003	0.06	306	$ 3.61	$ 18,648	$ -	$ -	$ 7.16	$ 37,004	$ 1.94	12,330	$ 10,047	$ 12.71	$ 65,699	
1	1	4	-	Main Pit: Drill and blast highwall along eastern limit (4H:1V)	230,400	Bm3	C2.09	0.01	1,613	$ 0.41	$ 95,012	$ 1.22	$ 281,292	$ 0.37	$ 85,744	$ 0.04	11,740	$ 9,566	$ 2.05	$ 471,614	
1	1	5	-	Main Pit: Push blasted material into pit	358	hrs	C2.23	1.00	358	$ 61.23	$ 21,899	$ -	$ -	$ 314.10	$ 112,338	$ 93.50	41,040	$ 33,440	$ 468.83	$ 167,677	
Regrade and Cover Waste and Stockpiles																					$ 7,587,973
Regrading, Compaction and Material Stockpiling																					
1	2	1	-	Regrade slopes and flat areas using D11 Dozer	1,040	hrs	C2.23	1.00	1,040	$ 61.23	$ 63,676	$ -	$ -	$ 314.10	$ 326,649	$ 93.50	119,335	$ 97,236	$ 468.83	$ 487,561	
1	2	2	-	D9 with impact roller (all surfaces)	326	hrs	C2.06	2.00	653	$ 120.97	$ 39,487	$ -	$ -	$ 222.87	$ 72,750	$ 77.94	31,223	$ 25,441	$ 421.78	$ 137,677	
1	2	3	-	Drill and blast cover material sourced in Aqqaluk Pit	706,749	Bm3	C2.09	0.01	4,947	$ 0.41	$ 291,449	$ 1.22	$ 862,859	$ 0.37	$ 263,018	$ 0.04	36,013	$ 29,344	$ 2.05	$ 1,446,670	
Complex Soil Cover - First layer, high compaction (0.5m) from stockpiles																					
1	3	1	-	Load, haul, dump, spread material (MWD SP to Area: 4)	353,850	Bm3	R.004	0.01	3,702	$ 0.65	$ 229,114	$ -	$ -	$ 2.52	$ 892,310	$ 0.55	238,745	$ 194,533	$ 3.72	$ 1,315,957	
1	3	2	-	Load, haul, dump, spread material (A-Pit to MPD, Area: 12)	64,400	Bm3	R.007	0.01	684	$ 0.66	$ 42,331	$ -	$ -	$ 2.56	$ 164,863	$ 0.56	44,110	$ 35,942	$ 3.78	$ 243,136	
1	3	3	-	Load, haul, dump, spread material (A-Pit to Red Dog Creek, Area: 15)	86,000	Bm3	R.019	0.02	1,802	$ 1.28	$ 110,227	$ -	$ -	$ 2.37	$ 203,703	$ 0.62	65,176	$ 53,106	$ 4.27	$ 367,036	
1	3	4	-	Load, haul, dump, spread material (A-Pit to LGO & Road, Areas: 5,9,10)	212,200	Bm3	R.013	0.01	2,091	$ 0.61	$ 129,385	$ -	$ -	$ 2.40	$ 509,789	$ 0.51	133,892	$ 109,097	$ 3.53	$ 748,271	
1	3	5	-	Compact material D9 with sheepsfoot roller (all surfaces)	326	hrs	C2.06	2.00	653	$ 120.97	$ 39,487	$ -	$ -	$ 222.87	$ 72,750	$ 77.94	31,223	$ 25,441	$ 421.78	$ 137,677	
Complex Soil Cover - Second layer, light compaction (0.5m) from stockpiles																					
1	4	1	-	Load, haul, dump, spread material (MWD SP to Area: 4)	379,301	Bm3	R.004	0.01	3,969	$ 0.65	$ 245,593	$ -	$ -	$ 2.52	$ 956,490	$ 0.55	255,917	$ 208,525	$ 3.72	$ 1,410,608	
1	4	2	-	Load, haul, dump, spread material (A-Pit to MPD, Area: 12)	64,400	Bm3	R.007	0.01	684	$ 0.66	$ 42,331	$ -	$ -	$ 2.56	$ 164,863	$ 0.56	44,110	$ 35,942	$ 3.78	$ 243,136	
1	4	3	-	Load, haul, dump, spread material (A-Pit to Red Dog Creek, Area: 15)	86,000	Bm3	R.019	0.02	1,802	$ 1.28	$ 110,227	$ -	$ -	$ 2.37	$ 203,703	$ 0.62	65,176	$ 53,106	$ 4.27	$ 367,036	
1	4	4	-	Load, haul, dump, spread material (A-Pit to LGO & Road, Areas: 5,9,10)	193,749	Bm3	R.013	0.01	1,909	$ 0.61	$ 118,134	$ -	$ -	$ 2.40	$ 465,462	$ 0.51	122,250	$ 99,611	$ 3.53	$ 683,208	
Install Surface Water Collection																					$199,675
1	5	1	-	Excavate trellis pattern	10,800	Bm3	C2.11	0.04	480	$ 2.70	$ 29,185	$ -	$ -	$ 4.99	$ 53,896	$ 1.35	17,864	$ 14,556	$ 9.04	$ 97,637	
1	5	2	-	Excavate drop structures	5,984	Bm3	C2.11	0.04	266	$ 2.70	$ 16,171	$ -	$ -	$ 4.99	$ 29,862	$ 1.35	9,898	$ 8,065	$ 9.04	$ 54,098	
1	5	3	-	Bedding material (load, haul, dump, place, shale)	1,728	Bm3	R.005	0.04	69	$ 2.39	$ 4,138	$ -	$ -	$ 3.99	$ 6,889	$ 1.02	2,169	$ 1,768	$ 7.40	$ 12,795	
1	5	4	-	Place riprap: Drill, blast, stockpile	1,440	Bm3	C2.24	0.05	65	$ 2.67	$ 3,851	$ 8.14	$ 11,720	$ 2.80	$ 4,031	$ 0.68	1,199	$ 977	$ 14.29	$ 20,579	
1	5	5	-	Place riprap: Load, haul, dump	1,440	Bm3	R.006	0.04	65	$ 2.74	$ 3,946	$ -	$ -	$ 4.63	$ 6,674	$ 1.20	2,112	$ 1,721	$ 8.57	$ 12,342	
1	5	6	-	Place riprap: Place and secure	1,440	Bm3	C2.27	0.01	18	$ 0.77	$ 1,102	$ -	$ -	$ 0.56	$ 808	$ 0.22	386	$ 315	$ 1.54	$ 2,224	
Upgrade Red Dog Creek (1:1000yr)																					$1,703,977
1	6	1	-	Additional clearing and grading	31,250	m2	C2.05	0.01	455	$ 0.89	$ 27,702	$ -	$ -	$ 1.88	$ 58,776	$ 0.51	19,675	$ 16,032	$ 3.28	$ 102,511	
1	6	2	-	Excavation and placement of creek berms	25,840	Bm3	C2.17	0.12	3,101	$ 7.19	$ 185,779	$ -	$ -	$ 9.74	$ 251,554	$ 3.16	100,212	$ 81,654	$ 20.08	$ 518,988	
1	6	3	-	Bedding layer: Screen and stockpile	4,552	Bm3	C2.02	0.01	46	$ 0.62	$ 2,827	$ -	$ -	$ 2.29	$ 10,424	$ 0.62	3,462	$ 2,821	$ 3.53	$ 16,072	
1	6	4	-	Bedding layer: Load, haul, dump, place 150mm layer (25mm minus)	4,552	Bm3	R.019	0.02	95	$ 1.28	$ 5,834	$ -	$ -	$ 2.37	$ 10,781	$ 0.62	3,449	$ 2,811	$ 4.27	$ 19,425	
1	6	5	-	Supply and place geotextile	33,129	m2	C3.06	0.07	2,366	$ 4.01	$ 132,759	$ 1.53	$ 50,534	$ 1.09	$ 36,202	$ 0.33	13,458	$ 10,966	$ 6.96	$ 230,461	
1	6	6	-	Supply and place HDPE liner	33,129	m2	C3.11	0.14	4,733	$ 8.73	$ 289,352	$ 5.47	$ 181,212	$ 2.19	$ 72,404	$ 0.66	26,916	$ 21,932	$ 17.05	$ 564,900	
1	6	7	-	Place riprap: Drill, blast, stockpile	9,643	Bm3	C2.24	0.05	434	$ 2.67	$ 25,786	$ 8.14	$ 78,483	$ 2.80	$ 26,991	$ 0.68	8,032	$ 6,544	$ 14.29	$ 137,803	
1	6	8	-	Place riprap: Load, haul, dump	9,643	Bm3	R.020	0.05	448	$ 2.84	$ 27,400	$ -	$ -	$ 5.22	$ 50,296	$ 1.35	15,933	$ 12,982	$ 9.40	$ 90,677	
1	6	9	-	Place riprap: Place and secure	9,643	Bm3	C2.27	0.01	121	$ 0.77	$ 7,380	$ -	$ -	$ 0.56	$ 5,409	$ 0.22	2,586	$ 2,107	$ 1.54	$ 14,896	
1	6	10	-	Revegetation: Willow cuttings/birch seeding	1	hec	C4.02	93.75	100	$ 5,215.00	$ 5,582	$ 1,800.00	$ 1,927	$ 356.53	$ 382	$ 330.94	435	$ 354	$ 7,702.47	$ 8,244	
Install Main Waste Stockpile Seepage Collection System																					$2,616,816
1	7	1	-	GW Wells: Drill wells (Air Rotary Drill Rig)	120	m	C2.10	2.00	240	$ 134.97	$ 16,197	$ -	$ -	$ 124.05	$ 14,886	$ 13.84	2,038	$ 1,661	$ 272.86	$ 32,744	
1	7	2	-	GW Wells: Install 6" stainless steel well casing and screen	120	m	C3.20	0.15	18	$ 10.12	$ 1,215	$ 3.29	$ 395	$ 9.30	$ 1,116	$ 1.04	153	$ 125	$ 23.75	$ 2,850	
1	7	3	-	GW Wells: Install 6" submersible pump with controls (59-95 GPM)	6	ea.	C3.08	12.00	72	$ 691.48	$ 4,149	$ 7,434.00	$ 44,604	$ -	$ -	$ -	0	$ -	$ 8,125.48	$ 48,753	
1	7	4	-	GW Wells: Install 6" submersible pump w/ controls (681-1400 GPM)	2	ea.	C3.09	12.00	24	$ 691.48	$ 1,383	$ 9,114.00	$ 18,228	$ -	$ -	$ -	0	$ -	$ 9,805.48	$ 19,611	
1	7	5	-	GW Wells: Install protective housing (shack)	8	ea.	C3.19	26.67	213	$ 1,542.07	$ 12,337	$ 1,472.15	$ 11,777	$ 76.06	$ 608	$ 70.60	693	$ 565	$ 3,160.88	$ 25,287	
1	7	6	-	Pumping Stations: Excavate sump for manholes	200	Bm3	C2.12	0.01	2	$ 0.68	$ 136	$ -	$ -	$ 0.50	$ 100	$ 0.19	48	$ 39	$ 1.37	$ 275	
1	7	7	-	Pumping Stations: Supply and place precast concrete manhole	2	ea.	C3.17	16.00	32	$ 1,003.48	$ 2,007	$ 3,760.30	$ 7,521	$ 179.49	$ 359	$ 69.92	172	$ 140	$ 5,013.19	$ 10,026	
1	7	8	-	Pumping Stations: Backfill and compact around manhole	200	Bm3	C2.01	0.03	6	$ 1.71	$ 342	$ -	$ -	$ 0.53	$ 105	$ 0.18	44	$ 36	$ 2.42	$ 483	
1	7	9	-	Pumping Stations: Install primary pump	2	ea.	C3.18	12.00	24	$ 683.48	$ 1,367	$ 2,547.30	$ 5,095	$ -	$ -	$ -	0	$ -	$ 3,230.78	$ 6,462	
1	7	10	-	Piping System: Excavate piping trench	21,630	Bm3	C2.14	0.02	433	$ 1.22	$ 26,488	$ -	$ -	$ 0.90	$ 19,412	$ 0.35	9,280	$ 7,562	$ 2.47	$ 53,462	
1	7	11	-	Piping System: Supply and install insulated 350mm HDPE pipe	3,605	m	C3.13	0.23	832	$ 12.65	$ 45,606	$ 210.00	$ 757,050	$ -	$ -	$ -	0	$ -	$ 222.65	$ 802,656	
1	7	12	-	Piping System: Backfill ditches	21,630	Bm3	C2.01	0.03	649	$ 1.71	$ 36,959	$ -	$ -	$ 0.53	$ 11,399	$ 0.18	4,810	$ 3,919	$ 2.42	$ 52,277	
1	7	13	-	Heat Tracing: Supply and install heat trace in HDPE pipe	3,605	m	C3.14	0.08	288	$ 4.81	$ 17,337	$ 90.00	$ 324,450	$ 0.23	$ 823	$ 0.21	937	$ 764	$ 95.25	$ 343,373	
1	7	14	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
1	7	15	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
1	7	16	-	Power Supply: Supply and install treated power poles	24	ea.	C3.03	4.55	109	$ 318.41	$ 7,642	$ 10,500.00	$ 252,000	$ 133.40	$ 3,202	$ 27.17	800	$ 652	$ 10,978.97	$ 263,495	
1	7	17	-	Power Supply: Supply and install overhead conductor	1,800	m	C3.02	0.03	58	$ 2.27	$ 4,086	$ 23.05	$ 41,485	$ 0.70	$ 1,268	$ 0.14	317	$ 258	$ 26.16	$ 47,096	
1	7	18	-	Power Supply: Supply and install transformers	4	ea.	C3.04	20.00	80	$ 1,418.65	$ 5,675	$ 442.75	$ 1,771	$ 440.22	$ 1,761	$ 89.65	440	$ 359	$ 2,391.26	$ 9,565	
1	7	19	-	Cut-off Wall: Install bentonite slurry wall by MWD-18 and MWD-24	6,000	m2	C2.08	0.50	3,000	$ 33.73	$ 202,368	$ 74.03	$ 444,204	$ 30.52	$ 183,101	$ 9.04	66,597	$ 54,264	$ 147.32	$ 883,937	
Revegetation																					$517,940
1	8	1	-	Native seed, application by helicopter	195	hec	C4.01	1.61	313	$ 93.55	$ 18,242	$ 437.95	$ 85,401	$ 343.36	$ 66,955	$ 68.07	16,290	$ 13,273	$ 942.93	$ 183,871	
1	8	2	-	Live plants - shrub cuttings (10% of surface area)	20	hec	C4.02	93.75	1,828	$ 5,215.00	$ 101,693	$ 1,800.00	$ 35,100	$ 356.53	$ 6,952	$ 330.94	7,920	$ 6,453	$ 7,702.47	$ 150,198	
1	8	3	-	Fertilizer pellets, application by helicopter	195	hec	C4.01	1.61	313	$ 93.55	$ 18,242	$ 437.95	$ 85,401	$ 343.36	$ 66,955	$ 68.07	16,290	$ 13,273	$ 942.93	$ 183,871	
Subtotal Direct Costs - Mine Area Premature Closure (2015)									**48,186**		**$ 2,924,498**		**$ 3,596,307**		**$ 5,604,423**			**$ 1,327,954**			**$13,453,182**

Table 2. Mine Area Closure Costs - Premature Closure (2015)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - INDIRECT																					
Mobilization & Demobilization																					**$ 7,606,567**
-	1	1	-	Idle Equipment Cost and Equipment OT	1	ls													$ 2,737,771	$2,737,771	
-	1	2	-	Mob/Demob - Entire Project	1	ls													$ 4,868,796	$4,868,796	
Administration Costs																					**$ 758,292**
-	2	1	-	Office Supplies	9	months	x	$100	/month											$901	
-	2	2	-	Communications	9	months	x	$570	/month											$5,130	
-	2	3	-	Heating Fuel (avg. 360 gal per month)	9	months	x	360	gal/month	x	$ 3.08	/gallon								$9,979	
-	2	4	-	Misc. Supplies	9	months	x	$600	/month											$5,400	
-	2	5	-	Camp Operation	6,639	Man-days	x	$111	per day per person											$736,883	
Field Support												Turnarounds									**$ 1,377,500**
-	3	1	-	Supervisor #1	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	2	-	Supervisor #2	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	3	-	Administrative Assistant #1	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	4	-	Administrative Assistant #2	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	5	-	Foreman #1	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	6	-	Foreman #2	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	7	-	Mechanic #1	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	8	-	Mechanic #2	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	9	-	Survey Field Manager	130	days	x	12	hrs/day			4					1560	hr	$ 63.88	$99,653	
-	3	10	-	Survey Crew (surveyor + helper)	130	days	x	12	hrs/day			4					1560	hr	$ 116.21	$181,288	
-	3	11	-	Field Support Vehicles	130	days	x	3	trucks												
-	3	12	-	Turnaround Costs - Admin	43	trips	x	$357	per trip	+	10	%								$17,032	
-	3	13	-	Turnaround Costs - Crew	82	trips	x	$357	per trip	+	10	%								$32,361	
Contract Administration and QA/QC												Turnarounds									**$ 626,013**
-	4	1	-	Resident Engineer #1	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	2	-	Resident Engineer #2	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	3	-	Engineering Technician #1	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	4	-	Engineering Technician #2	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	5	-	Laboratory and Material Testing Costs	9	months	x	$1,200	/month											$10,800	
-	4	6	-	Field Support Vehicles	130	days	x	1	trucks												
-	4	7	-	Turnaround Costs - QA/QC	17	trips	x	$357	/trip	+	10	%								$6,813	
Other Indirect Allocations																					**$ 5,448,798**
-	5	1	-	Insurance (1.6% of labor cost)	2	%	of	$4,252,604	Direct Labor Cost+Field Support Labor											$68,042	
-	5	2	-	Contractor Overhead	10	%	of	$4,320,646	Direct Labor Cost+Field Support Labor+ Insurance											$432,065	
-	5	3	-	Allowance for Haul Road Maintenance	2	yr													$ 300,000	$600,000	
-	5	4	-	Contractor Profit	10	%	of	$24,184,778	Total Direct Cost+mob/demob+site admin-CAMP OPERATION+field support+Insurance+OH+Freight+Haul Road Maint.											$2,418,478	
-	5	5	-	Engineering Re-Design	3	%	of	$27,340,138	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$820,204	
-	5	6	-	Bonding	3	%	of	$27,340,138	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$820,204	
-	5	7	-	State Management and Oversight	1	%		$28,980,546	Total Project Cost EXCLUDING State Contract Admin, Contingency											$289,805	
Subtotal Indirect Costs																					**$15,817,170**
CLOSURE COSTS - CONTINGENCY																					
				Contingency	20	%	of	$13,453,182	Direct Cost											$2,690,636	**$2,690,636**
CLOSURE COSTS - TOTAL																					
				Total Direct and Indirect Costs																	**$31,960,988**

Table 3. Tailings Area Closure Costs (2031)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - DIRECT CAPITAL																					
Construct Spillway																					**$1,053,319**
2	1	1	-	Clear and grub	22,000	m2	C2.05	0.01	320	$ 0.89	$ 19,502	$ -	$ -	$ 1.88	$ 41,379	$ 0.51	13,851	$ 11,286	$ 3.28	$ 72,167	
2	1	2	-	Strip topsoil	6,600	Bm3	C2.13	0.02	155	$ 1.43	$ 9,442	$ -	$ -	$ 2.64	$ 17,437	$ 0.71	5,780	$ 4,709	$ 4.79	$ 31,588	
2	1	3	-	Excavate channel/energy dissipation	63,673	Bm3	C2.11	0.04	2,830	$ 2.70	$ 172,065	$ -	$ -	$ 4.99	$ 317,748	$ 1.35	105,321	$ 85,817	$ 9.04	$ 575,630	
2	1	4	-	Drill and blast for spillway excavation	31,836	Bm3	C2.09	0.01	223	$ 0.41	$ 13,129	$ 1.22	$ 38,869	$ 0.37	$ 11,848	$ 0.04	1,622	$ 1,322	$ 2.05	$ 65,167	
2	1	5	-	Place riprap: Drill, blast, stockpile	9,684	Bm3	C2.24	0.05	436	$ 2.67	$ 25,896	$ 8.14	$ 78,817	$ 2.80	$ 27,106	$ 0.68	8,066	$ 6,572	$ 14.29	$ 138,391	
2	1	6	-	Place riprap: Load, haul, dump	9,684	Bm3	R.008	0.04	381	$ 2.40	$ 23,258	$ -	$ -	$ 4.06	$ 39,334	$ 1.05	12,450	$ 10,144	$ 7.51	$ 72,737	
2	1	7	-	Place riprap: Place and secure	9,684	Bm3	C2.27	0.01	121	$ 0.77	$ 7,412	$ -	$ -	$ 0.56	$ 5,432	$ 0.22	2,597	$ 2,116	$ 1.54	$ 14,959	
2	1	8	-	Channel/Energy Dissipation: Place geotextile	6,841	m2	C3.06	0.07	489	$ 4.01	$ 27,414	$ 1.53	$ 10,435	$ 1.09	$ 7,476	$ 0.33	2,779	$ 2,264	$ 6.96	$ 47,589	
2	1	9	-	Energy Dissipation: Riprap - Drill, blast, stockpile	1,503	Bm3	C2.24	0.05	68	$ 2.67	$ 4,019	$ 8.14	$ 12,233	$ 2.80	$ 4,207	$ 0.68	1,252	$ 1,020	$ 14.29	$ 21,479	
2	1	10	-	Energy Dissipation: Riprap - Load, haul, dump	1,503	Bm3	R.008	0.04	59	$ 2.40	$ 3,610	$ -	$ -	$ 4.06	$ 6,105	$ 1.05	1,932	$ 1,574	$ 7.51	$ 11,289	
2	1	11	-	Energy Dissipation: Riprap - Place and secure	1,503	Bm3	C2.27	0.01	19	$ 0.77	$ 1,150	$ -	$ -	$ 0.56	$ 843	$ 0.22	403	$ 328	$ 1.54	$ 2,322	
Construct Main Dam Beach																					**$5,789,305**
2	2	1	-	Coffer Dam: Load, haul, dump, place, compact berm material	35,100	Bm3	R.011	0.01	487	$ 0.85	$ 29,741	$ -	$ -	$ 3.02	$ 105,926	$ 0.64	27,752	$ 22,613	$ 4.51	$ 158,280	
2	2	2	-	Final berm: Load, haul, dump, place, compact run-of-mine material	58,500	Bm3	R.013	0.01	576	$ 0.61	$ 35,669	$ -	$ -	$ 2.40	$ 140,540	$ 0.51	36,912	$ 30,076	$ 3.53	$ 206,286	
2	2	3	-	Beach: Supply and place GCL liner	382,100	m2	C3.07	0.04	15,284	$ 2.45	$ 934,433	$ 5.69	$ 2,175,720	$ 0.61	$ 233,821	$ 0.19	86,923	$ 70,826	$ 8.94	$ 3,414,800	
2	2	4	-	Beach: Load, haul, dump, place cover of shale from Ovb. Dump	382,100	Bm3	R.012	0.01	5,424	$ 0.88	$ 334,392	$ -	$ -	$ 3.14	$ 1,200,481	$ 0.68	320,773	$ 261,371	$ 4.70	$ 1,796,243	
2	2	5	-	Erosion Protection: Riprap - Drill, blast, stockpile	3,900	Bm3	C2.24	0.05	176	$ 2.67	$ 10,429	$ 8.14	$ 31,743	$ 2.80	$ 10,917	$ 0.68	3,249	$ 2,647	$ 14.29	$ 55,736	
2	2	6	-	Erosion Protection: Riprap - Load, haul, dump	3,900	Bm3	R.014	0.04	147	$ 2.31	$ 8,991	$ -	$ -	$ 4.23	$ 16,504	$ 1.09	5,228	$ 4,260	$ 7.63	$ 29,755	
2	2	7	-	Erosion Protection: Riprap - Place and secure	3,900	Bm3	C2.27	0.01	49	$ 0.77	$ 2,985	$ -	$ -	$ 0.56	$ 2,188	$ 0.22	1,046	$ 852	$ 1.54	$ 6,025	
2	2	8	-	Revegetate: Native seed, application by helicopter	46	hec	C4.01	1.61	74	$ 93.55	$ 4,303	$ 437.95	$ 20,146	$ 343.36	$ 15,795	$ 68.07	3,843	$ 3,131	$ 942.93	$ 43,375	
2	2	9	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	5	hec	C4.02	93.75	431	$ 5,215.00	$ 23,989	$ 1,800.00	$ 8,280	$ 356.53	$ 1,640	$ 330.94	1,868	$ 1,522	$ 7,702.47	$ 35,431	
2	2	10	-	Revegetate: Fertilizer pellets, application by helicopter	46	hec	C4.01	1.61	74	$ 93.55	$ 4,303	$ 437.95	$ 20,146	$ 343.36	$ 15,795	$ 68.07	3,843	$ 3,131	$ 942.93	$ 43,375	
Reclaim Overburden Stockpile																					**$95,226**
2	3	1	-	Reslope steep slopes to 3H:1V	75	hrs	C2.23	1.00	75	$ 61.23	$ 4,562	$ -	$ -	$ 314.10	$ 23,404	$ 93.50	8,550	$ 6,967	$ 468.83	$ 34,933	
2	3	2	-	Revegetate: Native seed, application by helicopter	23	hec	C4.01	1.61	36	$ 93.55	$ 2,124	$ 437.95	$ 9,942	$ 343.36	$ 7,794	$ 68.07	1,896	$ 1,545	$ 942.93	$ 21,404	
2	3	3	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	2	hec	C4.02	93.75	213	$ 5,215.00	$ 11,838	$ 1,800.00	$ 4,086	$ 356.53	$ 809	$ 330.94	922	$ 751	$ 7,702.47	$ 17,485	
2	3	4	-	Revegetate: Fertilizer pellets, application by helicopter	23	hec	C4.01	1.61	36	$ 93.55	$ 2,124	$ 437.95	$ 9,942	$ 343.36	$ 7,794	$ 68.07	1,896	$ 1,545	$ 942.93	$ 21,404	
Upgrade Main Dam Seepage Collection																					**$666,975**
2	4	1	-	Pumping Stations: Excavate sump for manholes	200	Bm3	C2.12	0.01	2	$ 0.68	$ 136	$ -	$ -	$ 0.50	$ 100	$ 0.19	48	$ 39	$ 1.37	$ 275	
2	4	2	-	Pumping Stations: Supply and place precast concrete manhole	1	ea.	C3.17	16.00	16	$ 1,003.48	$ 1,003	$ 3,760.30	$ 3,760	$ 179.49	$ 179	$ 69.92	86	$ 70	$ 5,013.19	$ 5,013	
2	4	3	-	Pumping Stations: Backfill and compact around manhole	200	Bm3	C2.01	0.03	6	$ 1.71	$ 342	$ -	$ -	$ 0.53	$ 105	$ 0.18	44	$ 36	$ 2.42	$ 483	
2	4	4	-	Pumping Stations: Install primary pump	1	ea.	C3.18	12.00	12	$ 683.48	$ 683	$ 2,547.30	$ 2,547	$ -	$ -	$ -	0	$ -	$ 3,230.78	$ 3,231	
2	4	5	-	Piping System: Excavate piping trench	11,142	Bm3	C2.14	0.02	223	$ 1.22	$ 13,644	$ -	$ -	$ 0.90	$ 9,999	$ 0.35	4,781	$ 3,895	$ 2.47	$ 27,539	
2	4	6	-	Piping System: Supply and install insulated 150mm HDPE pipe	1,857	m	C3.12	0.21	384	$ 11.34	$ 21,062	$ 95.00	$ 176,415	$ -	$ -	$ -	0	$ -	$ 106.34	$ 197,477	
2	4	7	-	Piping System: Backfill ditches	11,142	Bm3	C2.01	0.03	334	$ 1.71	$ 19,038	$ -	$ -	$ 0.53	$ 5,872	$ 0.18	2,478	$ 2,019	$ 2.42	$ 26,929	
2	4	8	-	Heat Tracing: Supply and install heat trace in HDPE pipe	1,857	m	C3.14	0.08	149	$ 4.81	$ 8,931	$ 90.00	$ 167,130	$ 0.23	$ 424	$ 0.21	483	$ 393	$ 95.25	$ 176,878	
2	4	9	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
2	4	10	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
2	4	11	-	Power Supply: Supply and install treated power poles	7	ea.	C3.03	4.55	32	$ 318.41	$ 2,229	$ 10,500.00	$ 73,500	$ 133.40	$ 934	$ 27.17	233	$ 190	$ 10,978.97	$ 76,853	
2	4	12	-	Power Supply: Supply and install overhead conductor	500	m	C3.02	0.03	16	$ 2.27	$ 1,135	$ 23.05	$ 11,524	$ 0.70	$ 352	$ 0.14	88	$ 72	$ 26.16	$ 13,082	
2	4	13	-	Power Supply: Supply and install transformers	1	ea.	C3.04	20.00	20	$ 1,418.65	$ 1,419	$ 442.75	$ 443	$ 440.22	$ 440	$ 89.65	110	$ 90	$ 2,391.26	$ 2,391	
2	4	14	-	Emergency Storage Pond: Clear and grub retention dam area	3,450	m2	C2.05	0.01	50	$ 0.89	$ 3,058	$ -	$ -	$ 1.88	$ 6,489	$ 0.51	2,172	$ 1,770	$ 3.28	$ 11,317	
2	4	15	-	Supply and place HDPE liner	3,450	m2	C3.10	0.03	115	$ 2.04	$ 7,031	$ 5.47	$ 18,871	$ 0.51	$ 1,759	$ 0.15	654	$ 533	$ 8.17	$ 28,194	
2	4	16	-	Supply and place geotextile on each side of liner	6,900	m2	C3.05	0.02	110	$ 0.90	$ 6,229	$ 1.53	$ 10,525	$ 0.31	$ 2,111	$ 0.09	785	$ 639	$ 2.83	$ 19,505	
2	4	17	-	Emergency Storage Pond: Load, haul, dump, place overburden	13,475	Bm3	R.012	0.01	191	$ 0.88	$ 11,793	$ -	$ -	$ 3.14	$ 42,336	$ 0.68	11,312	$ 9,217	$ 4.70	$ 63,346	
Construct Back Dam Beach																					**$2,804,987**
2	5	1	-	Coffer Dam: Load, haul, dump, place, compact berm material	21,240	Bm3	R.011	0.01	295	$ 0.85	$ 17,997	$ -	$ -	$ 3.02	$ 64,099	$ 0.64	16,794	$ 13,684	$ 4.51	$ 95,780	
2	5	2	-	Final berm: Load, haul, dump, place, compact run-of-mine material	35,400	Bm3	R.013	0.01	349	$ 0.61	$ 21,584	$ -	$ -	$ 2.40	$ 85,045	$ 0.51	22,336	$ 18,200	$ 3.53	$ 124,829	
2	5	3	-	Beach: Supply and place GCL liner	180,200	m2	C3.07	0.04	7,208	$ 2.45	$ 440,683	$ 5.69	$ 1,026,079	$ 0.61	$ 110,271	$ 0.19	40,993	$ 33,402	$ 8.94	$ 1,610,434	
2	5	4	-	Beach: Load, haul, dump, place cover of shale from Ovb. Dump	180,200	Bm3	R.012	0.01	2,558	$ 0.88	$ 157,701	$ -	$ -	$ 3.14	$ 566,152	$ 0.68	151,278	$ 123,264	$ 4.70	$ 847,116	
2	5	5	-	Erosion Protection: Riprap - Drill, blast, stockpile	2,360	Bm3	C2.24	0.05	106	$ 2.67	$ 6,311	$ 8.14	$ 19,209	$ 2.80	$ 6,606	$ 0.68	1,966	$ 1,602	$ 14.29	$ 33,727	
2	5	6	-	Erosion Protection: Riprap - Load, haul, dump	2,360	Bm3	R.014	0.04	89	$ 2.31	$ 5,441	$ -	$ -	$ 4.23	$ 9,987	$ 1.09	3,164	$ 2,578	$ 7.63	$ 18,006	
2	5	7	-	Erosion Protection: Riprap - Place and secure	2,360	Bm3	C2.27	0.01	30	$ 0.77	$ 1,806	$ -	$ -	$ 0.56	$ 1,324	$ 0.22	633	$ 516	$ 1.54	$ 3,646	
2	5	8	-	Revegetate: Native seed, application by helicopter	27	hec	C4.01	1.61	43	$ 93.55	$ 2,516	$ 437.95	$ 11,781	$ 343.36	$ 9,236	$ 68.07	2,247	$ 1,831	$ 942.93	$ 25,365	
2	5	9	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	3	hec	C4.02	93.75	252	$ 5,215.00	$ 14,028	$ 1,800.00	$ 4,842	$ 356.53	$ 959	$ 330.94	1,093	$ 890	$ 7,702.47	$ 20,720	
2	5	10	-	Revegetate: Fertilizer pellets, application by helicopter	27	hec	C4.01	1.61	43	$ 93.55	$ 2,516	$ 437.95	$ 11,781	$ 343.36	$ 9,236	$ 68.07	2,247	$ 1,831	$ 942.93	$ 25,365	

Table 3. Tailings Area Closure Costs (2031)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
Upgrade Back Dam Seepage Collection																					**$710,622**
2	6	1	-	Pumping Stations: Excavate sump for manholes	200	Bm3	C2.12	0.01	2	$ 0.68	$ 136	$ -	$ -	$ 0.50	$ 100	$ 0.19	48	$ 39	$ 1.37	$ 275	
2	6	2	-	Pumping Stations: Supply and place precast concrete manhole	1	ea.	C3.17	16.00	16	$ 1,003.48	$ 1,003	$ 3,760.30	$ 3,760	$ 179.49	$ 179	$ 69.92	86	$ 70	$ 5,013.19	$ 5,013	
2	6	3	-	Pumping Stations: Backfill and compact around manhole	200	Bm3	C2.01	0.03	6	$ 1.71	$ 342	$ -	$ -	$ 0.53	$ 105	$ 0.18	44	$ 36	$ 2.42	$ 483	
2	6	4	-	Pumping Stations: Install primary pump	1	ea.	C3.18	12.00	12	$ 683.48	$ 683	$ 2,547.30	$ 2,547	$ -	$ -	$ -	0	$ -	$ 3,230.78	$ 3,231	
2	6	5	-	Piping System: Excavate piping trench	13,200	Bm3	C2.14	0.02	264	$ 1.22	$ 16,165	$ -	$ -	$ 0.90	$ 11,846	$ 0.35	5,664	$ 4,615	$ 2.47	$ 32,626	
2	6	6	-	Piping System: Supply and install insulated 150mm HDPE pipe	2,200	m	C3.12	0.21	455	$ 11.34	$ 24,953	$ 95.00	$ 209,000	$ -	$ -	$ -	0	$ -	$ 106.34	$ 233,953	
2	6	7	-	Piping System: Backfill ditches	13,200	Bm3	C2.01	0.03	396	$ 1.71	$ 22,555	$ -	$ -	$ 0.53	$ 6,956	$ 0.18	2,935	$ 2,392	$ 2.42	$ 31,903	
2	6	8	-	Heat Tracing: Supply and install heat trace in HDPE pipe	2,200	m	C3.14	0.08	176	$ 4.81	$ 10,580	$ 90.00	$ 198,000	$ 0.23	$ 502	$ 0.21	572	$ 466	$ 95.25	$ 209,548	
2	6	9	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
2	6	10	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
2	6	11	-	Power Supply: Supply and install treated power poles	7	ea.	C3.03	4.55	32	$ 318.41	$ 2,229	$ 10,500.00	$ 73,500	$ 133.40	$ 934	$ 27.17	233	$ 190	$ 10,978.97	$ 76,853	
2	6	12	-	Power Supply: Supply and install overhead conductor	500	m	C3.02	0.03	16	$ 2.27	$ 1,135	$ 23.05	$ 11,524	$ 0.70	$ 352	$ 0.14	88	$ 72	$ 26.16	$ 13,082	
2	6	13	-	Power Supply: Supply and install transformers	1	ea.	C3.04	20.00	20	$ 1,418.65	$ 1,419	$ 442.75	$ 443	$ 440.22	$ 440	$ 89.65	110	$ 90	$ 2,391.26	$ 2,391	
2	6	14	-	Emergency Storage Pond: Clear and grub retention dam area	3,650	m2	C2.05	0.01	53	$ 0.89	$ 3,236	$ -	$ -	$ 1.88	$ 6,865	$ 0.51	2,298	$ 1,873	$ 3.28	$ 11,973	
2	6	15	-	Supply and place HDPE liner	3,650	m2	C3.10	0.03	122	$ 2.04	$ 7,438	$ 5.47	$ 19,965	$ 0.51	$ 1,861	$ 0.15	692	$ 564	$ 8.17	$ 29,829	
2	6	16	-	Supply and place geotextile on each side of liner	7,300	m2	C3.05	0.02	117	$ 0.90	$ 6,590	$ 1.53	$ 11,135	$ 0.31	$ 2,234	$ 0.09	830	$ 677	$ 2.83	$ 20,635	
2	6	17	-	Emergency Storage Pond: Load, haul, dump, place overburden	6,600	Bm3	R.016	0.01	76	$ 0.71	$ 4,709	$ -	$ -	$ 2.42	$ 16,002	$ 0.55	4,483	$ 3,653	$ 3.69	$ 24,365	
Reclaim Borrow Areas																					**$158,462**
2	7	1	-	Decommission Borrow Sources: Regrade slopes	153	hrs	C2.23	1.00	153	$ 61.23	$ 9,365	$ -	$ -	$ 314.10	$ 48,039	$ 93.50	17,550	$ 14,300	$ 468.83	$ 71,703	
2	7	2	-	Revegetate: Native seed, application by helicopter	48	hec	C4.01	1.61	77	$ 93.55	$ 4,490	$ 437.95	$ 21,022	$ 343.36	$ 16,481	$ 68.07	4,010	$ 3,267	$ 942.93	$ 45,261	
2	7	3	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	5	hec	C4.02	93.75	450	$ 5,215.00	$ 25,032	$ 1,800.00	$ 8,640	$ 356.53	$ 1,711	$ 330.94	1,950	$ 1,589	$ 7,702.47	$ 36,972	
2	7	4	-	Revegetate: Fertilizer pellets, application by helicopter	5	hec	C4.01	1.61	8	$ 93.55	$ 449	$ 437.95	$ 2,102	$ 343.36	$ 1,648	$ 68.07	401	$ 327	$ 942.93	$ 4,526	
Subtotal Direct Costs - Tailings Area									**43,285**		**$ 2,628,933**		**$ 4,548,001**		**$ 3,312,594**			**$ 789,370**			**$11,278,898**
CLOSURE COSTS - INDIRECT																					
Administration Costs																					**$ 704,887**
-	1	1	-	Office Supplies	9	months	x	$100	/month											$901	
-	1	2	-	Communications	9	months	x	$570	/month											$5,130	
-	1	3	-	Heating Fuel (avg. 360 gal per month)	9	months	x	360	gal/month	x	$ 3.08	/gallon								$9,979	
-	1	4	-	Misc. Supplies	9	months	x	$600	/month											$5,400	
-	1	5	-	Camp Operation	6,157	Man-days	x	$111	per day per person											$683,477	
Field Support												Turnarounds									**$ 1,374,093**
-	2	1	-	Supervisor #1	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	2	2	-	Supervisor #2	130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	2	3	-	Administrative Assistant #1	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	2	4	-	Administrative Assistant #2	130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	2	5	-	Foreman #1	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	2	6	-	Foreman #2	130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	2	7	-	Mechanic #1	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	2	8	-	Mechanic #2	130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	2	9	-	Survey Field Manager	130	days	x	12	hrs/day			4					1560	hr	$ 63.88	$99,653	
-	2	10	-	Survey Crew (surveyor + helper)	130	days	x	12	hrs/day			4					1560	hr	$ 116.21	$181,288	
-	2	11	-	Field Support Vehicles	130	days	x	3	trucks												
-	2	12	-	Turnaround Costs - Admin	43	trips	x	$357	/trip	+	10 %									$17,032	
-	2	13	-	Turnaround Costs - Crew	74	trips	x	$357	/trip	+	10 %									$28,955	
Contract Administration and QA/QC												Turnarounds									**$ 626,013**
-	4	1	-	Resident Engineer #1	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	2	-	Resident Engineer #2	130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	3	-	Engineering Technician #1	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	4	-	Engineering Technician #2	130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	5	-	Laboratory and Material Testing Costs	9	months	x	$1,200	/month											$10,800	
-	4	6	-	Field Support Vehicles	130	days	x	1	trucks												
-	4	7	-	Turnaround Costs - QA/QC	17	trips	x	$357	/trip	+	10 %									$6,813	
Other Indirect Allocations																					**$ 2,959,227**
-	5	1	-	Insurance (1.6% of equipment cost)	2	%	of	$3,957,039	Direct Labor Cost+Field Support Labor											$63,313	
-	5	2	-	Contractor Overhead	10	%	of	$4,020,352	Direct Labor Cost+Field Support Labor+ Insurance											$402,035	
-	5	3	-	Allowance for Haul Road Maintenance	-	yr													$ 300,000	$0	
-	5	4	-	Contractor Profit	10	%	of	$13,765,762	Total Direct Cost+mob/demob+site admin-CAMP OPERATION+field support+Insurance+OH+Freight+Haul Road Maint.											$1,376,576	
-	5	5	-	Engineering Re-Design	3	%	of	$15,825,815	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$474,774	
-	5	6	-	Bonding	3	%	of	$15,825,815	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit											$474,774	
-	5	7	-	State Management and Oversight	1	%	of	$16,775,364	Total Project Cost EXCLUDING State Contract Admin, Contingency											$167,754	
Subtotal Indirect Costs																					**$5,664,220**
CLOSURE COSTS - CONTINGENCY																					
				Contingency	20	%	of	$11,278,898	Direct Costs											$2,255,780	**$2,255,780**
CLOSURE COSTS - TOTAL																					
				Total Direct and Indirect Costs																	**$19,198,898**

Table 4. Tailings Area Closure Costs (2015)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - DIRECT CAPITAL																					
Construct Spillway																					**$1,053,319**
2	1	1	-	Clear and grub	22,000	m2	C2.05	0.01	320	$ 0.89	$ 19,502	$ -	$ -	$ 1.88	$ 41,379	$ 0.51	13,851	$ 11,286	$ 3.28	$ 72,167	
2	1	2	-	Strip topsoil	6,600	Bm3	C2.13	0.02	155	$ 1.43	$ 9,442	$ -	$ -	$ 2.64	$ 17,437	$ 0.71	5,780	$ 4,709	$ 4.79	$ 31,588	
2	1	3	-	Excavate channel/energy dissipation	63,673	Bm3	C2.11	0.04	2,830	$ 2.70	$ 172,065	$ -	$ -	$ 4.99	$ 317,748	$ 1.35	105,321	$ 85,817	$ 9.04	$ 575,630	
2	1	4	-	Drill and blast for spillway excavation	31,836	Bm3	C2.09	0.01	223	$ 0.41	$ 13,129	$ 1.22	$ 38,869	$ 0.37	$ 11,848	$ 0.04	1,622	$ 1,322	$ 2.05	$ 65,167	
2	1	5	-	Place riprap: Drill, blast, stockpile	9,684	Bm3	C2.24	0.05	436	$ 2.67	$ 25,896	$ 8.14	$ 78,817	$ 2.80	$ 27,106	$ 0.68	8,066	$ 6,572	$ 14.29	$ 138,391	
2	1	6	-	Place riprap: Load, haul, dump	9,684	Bm3	R.008	0.04	381	$ 2.40	$ 23,258	$ -	$ -	$ 4.06	$ 39,334	$ 1.05	12,450	$ 10,144	$ 7.51	$ 72,737	
2	1	7	-	Place riprap: Place and secure	9,684	Bm3	C2.27	0.01	121	$ 0.77	$ 7,412	$ -	$ -	$ 0.56	$ 5,432	$ 0.22	2,597	$ 2,116	$ 1.54	$ 14,959	
2	1	8	-	Channel/Energy Dissipation: Place geotextile	6,841	m2	C3.06	0.07	489	$ 4.01	$ 27,414	$ 1.53	$ 10,435	$ 1.09	$ 7,476	$ 0.33	2,779	$ 2,264	$ 6.96	$ 47,589	
2	1	9	-	Energy Dissipation: Riprap - Drill, blast, stockpile	1,503	Bm3	C2.24	0.05	68	$ 2.67	$ 4,019	$ 8.14	$ 12,233	$ 2.80	$ 4,207	$ 0.68	1,252	$ 1,020	$ 14.29	$ 21,479	
2	1	10	-	Energy Dissipation: Riprap - Load, haul, dump	1,503	Bm3	R.008	0.04	59	$ 2.40	$ 3,610	$ -	$ -	$ 4.06	$ 6,105	$ 1.05	1,932	$ 1,574	$ 7.51	$ 11,289	
2	1	11	-	Energy Dissipation: Riprap - Place and secure	1,503	Bm3	C2.27	0.01	19	$ 0.77	$ 1,150	$ -	$ -	$ 0.56	$ 843	$ 0.22	403	$ 328	$ 1.54	$ 2,322	
Construct Main Dam Beach																					**$7,652,572**
2	2	1	-	Dredge tailings, place on beach	497,250	Bm3	C2.32	0.01	4,420	$ 0.58	$ 287,300	$ -	$ -	$ 1.00	$ 495,402	$ 0.25	150,368	$ 122,522	$ 1.82	$ 905,224	
2	2	2	-	Source cover and construction materials: Drill and blast	475,700	Bm3	C2.09	0.01	3,330	$ 0.41	$ 196,169	$ 1.22	$ 580,775	$ 0.37	$ 177,033	$ 0.04	24,240	$ 19,751	$ 2.05	$ 973,728	
2	2	3	-	Coffer Dam: Load, haul, dump, place, compact berm material	35,100	Bm3	R.011	0.01	487	$ 0.85	$ 29,741	$ -	$ -	$ 3.02	$ 105,926	$ 0.64	27,752	$ 22,613	$ 4.51	$ 158,280	
2	2	4	-	Final berm: Load, haul, dump, place, compact run-of-mine material	58,500	Bm3	R.011	0.01	811	$ 0.85	$ 49,569	$ -	$ -	$ 3.02	$ 176,543	$ 0.64	46,253	$ 37,688	$ 4.51	$ 263,800	
2	2	5	-	Beach: Supply and place GCL liner	382,100	m2	C3.07	0.04	15,284	$ 2.45	$ 934,433	$ 5.69	$ 2,175,720	$ 0.61	$ 233,821	$ 0.19	86,923	$ 70,826	$ 8.94	$ 3,414,800	
2	2	6	-	Beach: Load, haul, dump, place cover of shale from A-Pit	382,100	Bm3	R.011	0.01	5,299	$ 0.85	$ 323,766	$ -	$ -	$ 3.02	$ 1,153,114	$ 0.64	302,109	$ 246,163	$ 4.51	$ 1,723,043	
2	2	7	-	Erosion Protection: Riprap - Drill, blast, stockpile	3,900	Bm3	C2.24	0.05	176	$ 2.67	$ 10,429	$ 8.14	$ 31,743	$ 2.80	$ 10,917	$ 0.68	3,249	$ 2,647	$ 14.29	$ 55,736	
2	2	8	-	Erosion Protection: Riprap - Load, haul, dump	3,900	Bm3	R.014	0.04	147	$ 2.31	$ 8,991	$ -	$ -	$ 4.23	$ 16,504	$ 1.09	5,228	$ 4,260	$ 7.63	$ 29,755	
2	2	9	-	Erosion Protection: Riprap - Place and secure	3,900	Bm3	C2.27	0.01	49	$ 0.77	$ 2,985	$ -	$ -	$ 0.56	$ 2,188	$ 0.22	1,046	$ 852	$ 1.54	$ 6,025	
2	2	10	-	Revegetate: Native seed, application by helicopter	46	hec	C4.01	1.61	74	$ 93.55	$ 4,303	$ 437.95	$ 20,146	$ 343.36	$ 15,795	$ 68.07	3,843	$ 3,131	$ 942.93	$ 43,375	
2	2	11	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	5	hec	C4.02	93.75	431	$ 5,215.00	$ 23,989	$ 1,800.00	$ 8,280	$ 356.53	$ 1,640	$ 330.94	1,868	$ 1,522	$ 7,702.47	$ 35,431	
2	2	12	-	Revegetate: Fertilizer pellets, application by helicopter	46	hec	C4.01	1.61	74	$ 93.55	$ 4,303	$ 437.95	$ 20,146	$ 343.36	$ 15,795	$ 68.07	3,843	$ 3,131	$ 942.93	$ 43,375	
Reclaim Overburden Stockpile																					**$95,226**
2	3	1	-	Reslope steep slopes to 3H:1V	75	hrs	C2.23	1.00	75	$ 61.23	$ 4,562	$ -	$ -	$ 314.10	$ 23,404	$ 93.50	8,550	$ 6,967	$ 468.83	$ 34,933	
2	3	2	-	Revegetate: Native seed, application by helicopter	23	hec	C4.01	1.61	36	$ 93.55	$ 2,124	$ 437.95	$ 9,942	$ 343.36	$ 7,794	$ 68.07	1,896	$ 1,545	$ 942.93	$ 21,404	
2	3	3	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	2	hec	C4.02	93.75	213	$ 5,215.00	$ 11,838	$ 1,800.00	$ 4,086	$ 356.53	$ 809	$ 330.94	922	$ 751	$ 7,702.47	$ 17,485	
2	3	4	-	Revegetate: Fertilizer pellets, application by helicopter	23	hec	C4.01	1.61	36	$ 93.55	$ 2,124	$ 437.95	$ 9,942	$ 343.36	$ 7,794	$ 68.07	1,896	$ 1,545	$ 942.93	$ 21,404	
Upgrade Main Dam Seepage Collection																					**$666,975**
2	4	1	-	Pumping Stations: Excavate sump for manholes	200	Bm3	C2.12	0.01	2	$ 0.68	$ 136	$ -	$ -	$ 0.50	$ 100	$ 0.19	48	$ 39	$ 1.37	$ 275	
2	4	2	-	Pumping Stations: Supply and place precast concrete manhole	1	ea.	C3.17	16.00	16	$ 1,003.48	$ 1,003	$ 3,760.30	$ 3,760	$ 179.49	$ 179	$ 69.92	86	$ 70	$ 5,013.19	$ 5,013	
2	4	3	-	Pumping Stations: Backfill and compact around manhole	200	Bm3	C2.01	0.03	6	$ 1.71	$ 342	$ -	$ -	$ 0.53	$ 105	$ 0.18	44	$ 36	$ 2.42	$ 483	
2	4	4	-	Pumping Stations: Install primary pump	1	ea.	C3.18	12.00	12	$ 683.48	$ 683	$ 2,547.30	$ 2,547	$ -	$ -	$ -	0	$ -	$ 3,230.78	$ 3,231	
2	4	5	-	Piping System: Excavate piping trench	11,142	Bm3	C2.14	0.02	223	$ 1.22	$ 13,644	$ -	$ -	$ 0.90	$ 9,999	$ 0.35	4,781	$ 3,895	$ 2.47	$ 27,539	
2	4	6	-	Piping System: Supply and install insulated 150mm HDPE pipe	1,857	m	C3.12	0.21	384	$ 11.34	$ 21,062	$ 95.00	$ 176,415	$ -	$ -	$ -	0	$ -	$ 106.34	$ 197,477	
2	4	7	-	Piping System: Backfill ditches	11,142	Bm3	C2.01	0.03	334	$ 1.71	$ 19,038	$ -	$ -	$ 0.53	$ 5,872	$ 0.18	2,478	$ 2,019	$ 2.42	$ 26,929	
2	4	8	-	Heat Tracing: Supply and install heat trace in HDPE pipe	1,857	m	C3.14	0.08	149	$ 4.81	$ 8,931	$ 90.00	$ 167,130	$ 0.23	$ 424	$ 0.21	483	$ 393	$ 95.25	$ 176,878	
2	4	9	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
2	4	10	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
2	4	11	-	Power Supply: Supply and install treated power poles	7	ea.	C3.03	4.55	32	$ 318.41	$ 2,229	$ 10,500.00	$ 73,500	$ 133.40	$ 934	$ 27.17	233	$ 190	$ 10,978.97	$ 76,853	
2	4	12	-	Power Supply: Supply and install overhead conductor	500	m	C3.02	0.03	16	$ 2.27	$ 1,135	$ 23.05	$ 11,524	$ 0.70	$ 352	$ 0.14	88	$ 72	$ 26.16	$ 13,082	
2	4	13	-	Power Supply: Supply and install transformers	1	ea.	C3.04	20.00	20	$ 1,418.65	$ 1,419	$ 442.75	$ 443	$ 440.22	$ 440	$ 89.65	110	$ 90	$ 2,391.26	$ 2,391	
2	4	14	-	Emergency Storage Pond: Clear and grub retention dam area	3,450	m2	C2.05	0.01	50	$ 0.89	$ 3,058	$ -	$ -	$ 1.88	$ 6,489	$ 0.51	2,172	$ 1,770	$ 3.28	$ 11,317	
2	4	15	-	Supply and place HDPE liner	3,450	m2	C3.10	0.03	115	$ 2.04	$ 7,031	$ 5.47	$ 18,871	$ 0.51	$ 1,759	$ 0.15	654	$ 533	$ 8.17	$ 28,194	
2	4	16	-	Supply and place geotextile on each side of liner	6,900	m2	C3.05	0.02	110	$ 0.90	$ 6,229	$ 1.53	$ 10,525	$ 0.31	$ 2,111	$ 0.09	785	$ 639	$ 2.83	$ 19,505	
2	4	17	-	Emergency Storage Pond: Load, haul, dump, place overburden	13,475	Bm3	R.012	0.01	191	$ 0.88	$ 11,793	$ -	$ -	$ 3.14	$ 42,336	$ 0.68	11,312	$ 9,217	$ 4.70	$ 63,346	
Construct Back Dam Beach																					**$4,116,940**
2	5	1	-	Dredge tailings, prepare beach surface	300,900	Bm3	C2.32	0.01	2,675	$ 0.58	$ 173,853	$ -	$ -	$ 1.00	$ 299,782	$ 0.25	90,992	$ 74,142	$ 1.82	$ 547,777	
2	5	2	-	Source cover and construction materials: Drill and blast	236,840	Bm3	C2.09	0.01	1,658	$ 0.41	$ 97,668	$ 1.22	$ 289,154	$ 0.37	$ 88,140	$ 0.04	12,069	$ 9,834	$ 2.05	$ 484,796	
2	5	3	-	Coffer Dam: Load, haul, dump, place, compact berm material	21,240	Bm3	R.015	0.02	365	$ 1.06	$ 22,490	$ -	$ -	$ 3.80	$ 80,740	$ 0.83	21,574	$ 17,579	$ 5.69	$ 120,809	
2	5	4	-	Final berm: Load, haul, dump, place, compact run-of-mine material	35,400	Bm3	R.015	0.02	608	$ 1.06	$ 37,483	$ -	$ -	$ 3.80	$ 134,567	$ 0.83	35,957	$ 29,298	$ 5.69	$ 201,349	
2	5	5	-	Beach: Supply and place GCL liner	180,200	m2	C3.07	0.04	7,208	$ 2.45	$ 440,683	$ 5.69	$ 1,026,079	$ 0.61	$ 110,271	$ 0.19	40,993	$ 33,402	$ 8.94	$ 1,610,434	
2	5	6	-	Beach: Load, haul, dump, place cover of shale from A-Pit	180,200	Bm3	R.015	0.02	3,095	$ 1.06	$ 190,806	$ -	$ -	$ 3.80	$ 685,000	$ 0.83	183,035	$ 149,140	$ 5.69	$ 1,024,946	
2	5	7	-	Erosion Protection: Riprap - Drill, blast, stockpile	2,360	Bm3	C2.24	0.05	106	$ 2.67	$ 6,311	$ 8.14	$ 19,209	$ 2.80	$ 6,606	$ 0.68	1,966	$ 1,602	$ 14.29	$ 33,727	
2	5	8	-	Erosion Protection: Riprap - Load, haul, dump	2,360	Bm3	R.014	0.04	89	$ 2.31	$ 5,441	$ -	$ -	$ 4.23	$ 9,987	$ 1.09	3,164	$ 2,578	$ 7.63	$ 18,006	
2	5	9	-	Erosion Protection: Riprap - Place and secure	2,360	Bm3	C2.27	0.01	30	$ 0.77	$ 1,806	$ -	$ -	$ 0.56	$ 1,324	$ 0.22	633	$ 516	$ 1.54	$ 3,646	
2	5	10	-	Revegetate: Native seed, application by helicopter	27	hec	C4.01	1.61	43	$ 93.55	$ 2,516	$ 437.95	$ 11,781	$ 343.36	$ 9,236	$ 68.07	2,247	$ 1,831	$ 942.93	$ 25,365	
2	5	11	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	3	hec	C4.02	93.75	252	$ 5,215.00	$ 14,028	$ 1,800.00	$ 4,842	$ 356.53	$ 959	$ 330.94	1,093	$ 890	$ 7,702.47	$ 20,720	
2	5	12	-	Revegetate: Fertilizer pellets, application by helicopter	27	hec	C4.01	1.61	43	$ 93.55	$ 2,516	$ 437.95	$ 11,781	$ 343.36	$ 9,236	$ 68.07	2,247	$ 1,831	$ 942.93	$ 25,365	

Table 4. Tailings Area Closure Costs (2015)

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
Upgrade Back Dam Seepage Collection																					**$710,622**
2	6	1	-	Pumping Stations: Excavate sump for manholes	200	Bm3	C2.12	0.01	2	$ 0.68	$ 136	$ -	$ -	$ 0.50	$ 100	$ 0.19	48	$ 39	$ 1.37	$ 275	
2	6	2	-	Pumping Stations: Supply and place precast concrete manhole	1	ea.	C3.17	16.00	16	$ 1,003.48	$ 1,003	$ 3,760.30	$ 3,760	$ 179.49	$ 179	$ 69.92	86	$ 70	$ 5,013.19	$ 5,013	
2	6	3	-	Pumping Stations: Backfill and compact around manhole	200	Bm3	C2.01	0.03	6	$ 1.71	$ 342	$ -	$ -	$ 0.53	$ 105	$ 0.18	44	$ 36	$ 2.42	$ 483	
2	6	4	-	Pumping Stations: Install primary pump	1	ea.	C3.18	12.00	12	$ 683.48	$ 683	$ 2,547.30	$ 2,547	$ -	$ -	$ -	0	$ -	$ 3,230.78	$ 3,231	
2	6	5	-	Piping System: Excavate piping trench	13,200	Bm3	C2.14	0.02	264	$ 1.22	$ 16,165	$ -	$ -	$ 0.90	$ 11,846	$ 0.35	5,664	$ 4,615	$ 2.47	$ 32,626	
2	6	6	-	Piping System: Supply and install insulated 150mm HDPE pipe	2,200	m	C3.12	0.21	455	$ 11.34	$ 24,953	$ 95.00	$ 209,000	$ -	$ -	$ -	0	$ -	$ 106.34	$ 233,953	
2	6	7	-	Piping System: Backfill ditches	13,200	Bm3	C2.01	0.03	396	$ 1.71	$ 22,555	$ -	$ -	$ 0.53	$ 6,956	$ 0.18	2,935	$ 2,392	$ 2.42	$ 31,903	
2	6	8	-	Heat Tracing: Supply and install heat trace in HDPE pipe	2,200	m	C3.14	0.08	176	$ 4.81	$ 10,580	$ 90.00	$ 198,000	$ 0.23	$ 502	$ 0.21	572	$ 466	$ 95.25	$ 209,548	
2	6	9	-	Heat Tracing: Supply and install heat tracing power feed kit	2	ea.	C3.15	4.00	8	$ 294.32	$ 589	$ 2,400.00	$ 4,800	$ -	$ -	$ -	0	$ -	$ 2,694.32	$ 5,389	
2	6	10	-	Heat Tracing: Supply and install electrical thermostat for heat tracing	1	ea.	C3.16	1.00	1	$ 73.58	$ 74	$ 9,000.00	$ 9,000	$ -	$ -	$ -	0	$ -	$ 9,073.58	$ 9,074	
2	6	11	-	Power Supply: Supply and install treated power poles	7	ea.	C3.03	4.55	32	$ 318.41	$ 2,229	$ 10,500.00	$ 73,500	$ 133.40	$ 934	$ 27.17	233	$ 190	$ 10,978.97	$ 76,853	
2	6	12	-	Power Supply: Supply and install overhead conductor	500	m	C3.02	0.03	16	$ 2.27	$ 1,135	$ 23.05	$ 11,524	$ 0.70	$ 352	$ 0.14	88	$ 72	$ 26.16	$ 13,082	
2	6	13	-	Power Supply: Supply and install transformers	1	ea.	C3.04	20.00	20	$ 1,418.65	$ 1,419	$ 442.75	$ 443	$ 440.22	$ 440	$ 89.65	110	$ 90	$ 2,391.26	$ 2,391	
2	6	14	-	Emergency Storage Pond: Clear and grub retention dam area	3,650	m2	C2.05	0.01	53	$ 0.89	$ 3,236	$ -	$ -	$ 1.88	$ 6,865	$ 0.51	2,298	$ 1,873	$ 3.28	$ 11,973	
2	6	15	-	Supply and place HDPE liner	3,650	m2	C3.10	0.03	122	$ 2.04	$ 7,438	$ 5.47	$ 19,965	$ 0.51	$ 1,861	$ 0.15	692	$ 564	$ 8.17	$ 29,829	
2	6	16	-	Supply and place geotextile on each side of liner	7,300	m2	C3.05	0.02	117	$ 0.90	$ 6,590	$ 1.53	$ 11,135	$ 0.31	$ 2,234	$ 0.09	830	$ 677	$ 2.83	$ 20,635	
2	6	17	-	Emergency Storage Pond: Load, haul, dump, place overburden	6,600	Bm3	R.016	0.01	76	$ 0.71	$ 4,709	$ -	$ -	$ 2.42	$ 16,002	$ 0.55	4,483	$ 3,653	$ 3.69	$ 24,365	
Reclaim Borrow Areas																					**$158,462**
2	7	1	-	Decommission Borrow Sources: Regrade slopes	153	hrs	C2.23	1.00	153	$ 61.23	$ 9,365	$ -	$ -	$ 314.10	$ 48,039	$ 93.50	17,550	$ 14,300	$ 468.83	$ 71,703	
2	7	2	-	Revegetate: Native seed, application by helicopter	48	hec	C4.01	1.61	77	$ 93.55	$ 4,490	$ 437.95	$ 21,022	$ 343.36	$ 16,481	$ 68.07	4,010	$ 3,267	$ 942.93	$ 45,261	
2	7	3	-	Revegetate: Live plants - shrub cuttings (10% of surface area)	5	hec	C4.02	93.75	450	$ 5,215.00	$ 25,032	$ 1,800.00	$ 8,640	$ 356.53	$ 1,711	$ 330.94	1,950	$ 1,589	$ 7,702.47	$ 36,972	
2	7	4	-	Revegetate: Fertilizer pellets, application by helicopter	5	hec	C4.01	1.61	8	$ 93.55	$ 449	$ 437.95	$ 2,102	$ 343.36	$ 1,648	$ 68.07	401	$ 327	$ 942.93	$ 4,526	
Subtotal Direct Costs - Tailings Area									**56,343**		**$ 3,440,695**		**$ 5,417,930**		**$ 4,546,600**			**$ 1,048,892**			**$14,454,117**

Work Area Code	Item	Task	Estimate Type	Activity	Quantity	Unit										Activity Total	Subtotals
CLOSURE COSTS - INDIRECT																	
Administration Costs																	**$ 849,836**
-	1	1	-	Office Supplies	9	months	x	$100	/month							$901	
-	1	2	-	Communications	9	months	x	$570	/month							$5,130	
-	1	3	-	Heating Fuel (avg. 360 gal per month)	9	months	x	360	gal/month	x	$ 3.08	/gallon				$9,979	
-	1	4	-	Misc. Supplies	9	months	x	$600	/month							$5,400	
-	1	5	-	Camp Operation	7,463	Man-days	x	$111	per day per person							$828,426	
Field Support												Turnarounds					**$ 1,382,610**
-	2	1	-	Supervisor #1	130	days	x	12	hrs/day			4	1560	hr	$ 119.76	$186,826	
-	2	2	-	Supervisor #2	130	days	x	12	hrs/day			4	1560	hr	$ 119.76	$186,826	
-	2	3	-	Administrative Assistant #1	130	days	x	12	hrs/day			4	1560	hr	$ 66.38	$103,553	
-	2	4	-	Administrative Assistant #2	130	days	x	12	hrs/day			4	1560	hr	$ 66.38	$103,553	
-	2	5	-	Foreman #1	130	days	x	12	hrs/day			4	1560	hr	$ 88.26	$137,686	
-	2	6	-	Foreman #2	130	days	x	12	hrs/day			4	1560	hr	$ 88.26	$137,686	
-	2	7	-	Mechanic #1	130	days	x	12	hrs/day			4	1560	hr	$ 61.23	$95,519	
-	2	8	-	Mechanic #2	130	days	x	12	hrs/day			4	1560	hr	$ 61.23	$95,519	
-	2	9	-	Survey Field Manager	130	days	x	12	hrs/day			4	1560	hr	$ 63.88	$99,653	
-	2	10	-	Survey Crew (surveyor + helper)	130	days	x	12	hrs/day			4	1560	hr	$ 116.21	$181,288	
-	2	11	-	Field Support Vehicles	130	days	x	3	trucks								
-	2	12	-	Turnaround Costs - Admin	43	trips	x	$357	/trip	+	10	%				$17,032	
-	2	13	-	Turnaround Costs - Crew	95	trips	x	$357	/trip	+	10	%				$37,471	
Contract Administration and QA/QC												Turnarounds					**$ 626,013**
-	3	1	-	Resident Engineer #1	130	days	x	12	hrs/day			4	1560	hr	$ 115.00	$179,400	
-	3	2	-	Resident Engineer #2	130	days	x	12	hrs/day			4	1560	hr	$ 115.00	$179,400	
-	3	3	-	Engineering Technician #1	130	days	x	12	hrs/day			4	1560	hr	$ 80.00	$124,800	
-	3	4	-	Engineering Technician #2	130	days	x	12	hrs/day			4	1560	hr	$ 80.00	$124,800	
-	3	5	-	Laboratory and Material Testing Costs	9	months	x	$1,200	/month							$10,800	
-	3	6	-	Field Support Vehicles	130	days	x	1	trucks								
-	3	7	-	Turnaround Costs - QA/QC	17	trips	x	$357	/trip	+	10	%				$6,813	
Other Indirect Allocations																	**$ 3,647,506**
-	4	1	-	Insurance (1.6% of equipment cost)	2	%	of	$4,768,801	Direct Labor Cost+Field Support Labor							$76,301	
-	4	2	-	Contractor Overhead	10	%	of	$4,845,102	Direct Labor Cost+Field Support Labor+ Insurance							$484,510	
-	4	3	-	Allowance for Haul Road Maintenance	-	yr									$ 300,000	$0	
-	4	4	-	Contractor Profit	10	%	of	$17,044,960	Total Direct Cost+mob/demob+site admin-CAMP OPERATION+field support+Insurance+OH+Freight+Haul Road Maint.							$1,704,496	
-	4	5	-	Engineering Re-Design	3	%	of	$19,577,883	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit							$587,336	
-	4	6	-	Bonding	3	%	of	$19,577,883	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haul Road Maint.+Profit							$587,336	
-	4	7	-	State Management and Oversight	1	%	of	$20,752,555	Total Project Cost EXCLUDING State Contract Admin, Contingency							$207,526	
Subtotal Indirect Costs																	**$6,505,964**
CLOSURE COSTS - CONTINGENCY																	
				Contingency	20	%	of	$14,454,117	Direct Costs							$2,890,823	**$2,890,823**
CLOSURE COSTS - TOTAL																	
				Total Direct and Indirect Costs													**$23,850,904**

Table 5A. Water Treatment Closure Costs (2031)

Aqqaluk Pit
Treatment Flowrates

Volume	4,360,000	m3/year
Maximum Flow Rate	0.417	m3/s
Duration	121	days/year
Surge Capacity	0	m3
High Flow Rate	36,033	m3/day
Storage	0	days
Surge Flow Rate	0.417	m3/s
Nominal Flow Rate	0.417	m3/s
Design Flow Rate	20	% excess capacity
	0.5	m3/s
	1,802	m3/h
	7,933	GPM

TSF
Treatment Flowrates

Volume	2,560,000	m3/year
Maximum Flow Rate	0.245	m3/s
Duration	121	days/year
Surge Capacity	0	m3
High Flow Rate	21,157	m3/day
Storage	0	days
Surge Flow Rate	0.245	m3/s
Nominal Flow Rate	0.245	m3/s
Design Flow Rate	25	% excess capacity
	0.306	m3/s
	1,102	m3/h
	4,852	GPM

Capital Cost Estimates

Plant sized for seasonal operation (121 days/year)

		TSF	Aqqaluk Pit	Total	50% New Construction
Plant Feed, Sump and Recycle Pumps		$ 142,000	$ 201,000		
Package Flocculant Preparation and Dosage		$ 290,000	$ 611,000		
Lime Storage, Slaker and Dosage		$ 389,000	$ 1,271,000		
Process and Instrument Control Compressors		$ 59,000	$ 59,000		
Clarifier		$ 1,986,000	$ 2,527,000		
Reactor and Rapid Mix Tanks (complete with agitators)		$ 474,000	$ 785,000		
Buildings and Services		$ 1,166,000	$ 2,012,000		
Pipelines		$ 324,803	$ 324,803		
Equipment Total		$ 4,830,803	$ 7,790,803	**$ 12,621,606**	**$ 6,310,803**
Equipment Installation	100%	$ 4,830,803	$ 7,790,803		
Process Piping	30%	$ 1,449,241	$ 2,337,241		
Electrical	20%	$ 966,161	$ 1,558,161		
Instrumentation	15%	$ 724,620	$ 1,168,620		
Total Direct Costs		$ 12,801,628	$ 20,645,628	**$ 33,447,256**	**$ 16,723,628**
Construction Overhead and Profit	15%	$ 1,920,244	$ 3,096,844		
Engineering and Procurement	15%	$ 1,920,244	$ 3,096,844		
Contingency	20%	$ 2,560,326	$ 4,129,126		
Remote Alaskan Premium	30%	$ 3,840,489	$ 6,193,688		
Total Indirect Costs		$ 10,241,303	$ 16,516,502	**$ 26,757,805**	**$ 13,378,903**
TOTAL ESTIMATED CAPITAL COSTS		**$ 23,042,931**	**$ 37,162,130**	**$ 60,205,061**	**$ 30,102,531**

* Note - The HDS-SIM models were calculated using costs from the 2014 CostMine book, as well as operating costs from several Canadian and US mines. As a result, some of the dollar amounts in the HDS-SIM models are Canadian, and some are US. The costing on the capital costs is heavily biased towards US dollars. Due to that fact, and because the value of the Canadian dollar was close to the US dollar in 2014, the final dollar amounts in the HDS-SIM models generated in the capital and operating costs are considered conservative in US dollars, and those amounts are used in the WTP Estimates. Converting all Canadian dollars to US dollars would actually decrease the WTP Estimates (based on the decreased value of the CDN dollar).

Table 5B. Water Treatment Closure Costs (2015)

Main Pit
Treatment Flowrates

Volume	4,840,000	m3/year
Maximum Flow Rate	0.463	m3/s
Duration	121	days/year
Surge Capacity	0	m3
High Flow Rate	40,000	m3/day
Storage	0	days
Surge Flow Rate	0.463	m3/s
Nominal Flow Rate	0.463	m3/s
Design Flow Rate	20	% excess capacity
	0.556	m3/s
	2,000	m3/h
	8,806	GPM

TSF
Treatment Flowrates

Volume	2,200,000	m3/year
Maximum Flow Rate	0.21	m3/s
Duration	121	days/year
Surge Capacity	0	m3
High Flow Rate	18,182	m3/day
Storage	0	days
Surge Flow Rate	0.21	m3/s
Nominal Flow Rate	0.21	m3/s
Design Flow Rate	25	% excess capacity
	0.263	m3/s
	947	m3/h
	4,169	GPM

Capital Cost Estimates

Plant sized for seasonal operation (121 days/year)

		TSF	Main Pit	Total	50% New Construction
Plant Feed, Sump and Recycle Pumps		$ 134,000	$ 213,000		
Package Flocculant Preparation and Dosage		$ 328,000	$ 586,000		
Lime Storage, Slaker and Dosage		$ 585,000	$ 1,161,000		
Process and Instrument Control Compressors		$ 59,000	$ 59,000		
Clarifier		$ 1,854,000	$ 2,655,000		
Reactor and Rapid Mix Tanks (complete with agitators)		$ 439,000	$ 841,000		
Buildings and Services		$ 1,044,000	$ 2,196,000		
Pipelines		$ 324,803	$ 324,803		
Equipment Total		$ 4,767,803	$ 8,035,803	**$ 12,803,606**	**$ 6,401,803**
Equipment Installation	100%	$ 4,767,803	$ 8,035,803		
Process Piping	30%	$ 1,430,341	$ 2,410,741		
Electrical	20%	$ 953,561	$ 1,607,161		
Instrumentation	15%	$ 715,170	$ 1,205,370		
Total Direct Costs		$ 12,634,678	$ 21,294,878	**$ 33,929,556**	**$ 16,964,778**
Construction Overhead and Profit	15%	$ 1,895,202	$ 3,194,232		
Engineering and Procurement	15%	$ 1,895,202	$ 3,194,232		
Contingency	20%	$ 2,526,936	$ 4,258,976		
Remote Alaskan Premium	30%	$ 3,790,403	$ 6,388,463		
Total Indirect Costs		$ 10,107,742	$ 17,035,902	**$ 27,143,645**	**$ 13,571,822**
TOTAL ESTIMATED CAPITAL COSTS		**$ 22,742,420**	**$ 38,330,780**	**$ 61,073,201**	**$ 30,536,600**

* Note - The HDS-SIM models were calculated using costs from the 2014 CostMine book, as well as operating costs from several Canadian and US mines. As a result, some of the dollar amounts in the HDS-SIM models are Canadian, and some are US. The costing on the capital costs is heavily biased towards US dollars. Due to that fact, and because the value of the Canadian dollar was close to the US dollar in 2014, the final dollar amounts in the HDS-SIM models generated in the capital and operating costs are considered conservative in US dollars, and those amounts are used in the WTP Estimates. Converting all Canadian dollars to US dollars would actually decrease the WTP Estimates (based on the decreased value of the CDN dollar).

Table 6. Ore Processing and Infrastructure Closure Costs

Work Area Code	Item	Task	Sub Area	Description	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - DIRECT CAPITAL																					
Water Treatment Plant #1 Area																					**$27,075**
2000-1	1	1	Clarifier (steel bottom/wall)	Excavator: CAT 345 w/ shear	30	hrs	C1.04	1.00	30	$ 61.23	$ 1,837	$ -	$ -	$ 95.40	$ 2,862	$ 34.00	1,252	$ 1,020	$ 190.63	$ 5,719	
2000-1	1	2		Excavator: CAT 345 w/ grapple	20	hrs	C1.02	1.00	20	$ 61.23	$ 1,225	$ -	$ -	$ 112.65	$ 2,253	$ 34.00	835	$ 680	$ 207.88	$ 4,158	
2000-1	1	3		Truck: CAT 740	-	hrs	C1.06	1.00	-	$ 60.66	$ -	$ -	$ -	$ 106.03	$ -	$ 25.32	0	$ -	$ 192.01	$ -	
2000-1	1	4	Clarifier Cover	Excavator: CAT 345 w/ grapple	15	hrs	C1.02	1.00	15	$ 61.23	$ 918	$ -	$ -	$ 112.65	$ 1,690	$ 34.00	626	$ 510	$ 207.88	$ 3,118	
2000-1	1	5		Truck: CAT 740	-	hrs	C1.06	1.00	-	$ 60.66	$ -	$ -	$ -	$ 106.03	$ -	$ 25.32	0	$ -	$ 192.01	$ -	
2000-1	1	6	Drive Support	Excavator: CAT 345 w/ shear	10	hrs	C1.04	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 95.40	$ 954	$ 34.00	417	$ 340	$ 190.63	$ 1,906	
2000-1	1	7	Walkway	Excavator: CAT 345 w/ grapple	10	hrs	C1.02	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 112.65	$ 1,127	$ 34.00	417	$ 340	$ 207.88	$ 2,079	
2000-1	1	8		Truck: CAT 740	-	hrs	C1.06	1.00	-	$ 60.66	$ -	$ -	$ -	$ 106.03	$ -	$ 25.32	0	$ -	$ 192.01	$ -	
2000-1	1	9	WTP#1 MCC's, tunnels, foundations	Excavator: CAT 345	30	hrs	C1.01	1.00	30	$ 61.23	$ 1,837	$ -	$ -	$ 92.53	$ 2,776	$ 34.00	1,252	$ 1,020	$ 187.76	$ 5,633	
2000-1	1	10	Emergency Exit Tunnel	Excavator: CAT 345 w/ grapple	15	hrs	C1.02	1.00	15	$ 61.23	$ 918	$ -	$ -	$ 112.65	$ 1,690	$ 34.00	626	$ 510	$ 207.88	$ 3,118	
2000-1	1	11	Underflow Tunnel	Truck: CAT 740	7	hrs	C1.06	1.00	7	$ 60.66	$ 425	$ -	$ -	$ 106.03	$ 742	$ 25.32	218	$ 177	$ 192.01	$ 1,344	
Jaw Crusher Area																					**$76,675**
2001	2	1	Incl. building, foundation, retaining wall	Excavator: CAT 345 w/ grapple	80	hrs	C1.02	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 112.65	$ 9,012	$ 34.00	3,338	$ 2,720	$ 207.88	$ 16,630	
2001	2	2		Excavator: CAT 345 w/ hammer	50	hrs	C1.03	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 106.90	$ 5,345	$ 34.00	2,086	$ 1,700	$ 202.13	$ 10,107	
2001	2	3		Excavator: CAT 345 w/ shear	30	hrs	C1.04	1.00	30	$ 61.23	$ 1,837	$ -	$ -	$ 95.40	$ 2,862	$ 34.00	1,252	$ 1,020	$ 190.63	$ 5,719	
2001	2	4		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2001	2	5		Truck: CAT 740	6	hrs	C1.06	1.00	6	$ 60.66	$ 364	$ -	$ -	$ 106.03	$ 636	$ 25.32	186	$ 152	$ 192.01	$ 1,152	
2001	2	6		Dozer: CAT D9	100	hrs	C1.05	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 174.14	$ 17,414	$ 45.10	5,535	$ 4,510	$ 280.47	$ 28,047	
Coarse Ore Storage Area																					**$202,672**
2002	3	1	2C to 3C Transfer Tower	Excavator: CAT 345 w/ grapple	45	hrs	C1.02	1.00	45	$ 61.23	$ 2,755	$ -	$ -	$ 112.65	$ 5,069	$ 34.00	1,878	$ 1,530	$ 207.88	$ 9,355	
2002	3	2	Existing Conveyor & Conveyors 2A,2B,2C	Excavator: CAT 345 w/ grapple	60	hrs	C1.02	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 112.65	$ 6,759	$ 34.00	2,504	$ 2,040	$ 207.88	$ 12,473	
2002	3	3		Excavator: CAT 345 w/ hammer	50	hrs	C1.03	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 106.90	$ 5,345	$ 34.00	2,086	$ 1,700	$ 202.13	$ 10,107	
2002	3	4		Excavator: CAT 345 w/ shear	50	hrs	C1.04	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 95.40	$ 4,770	$ 34.00	2,086	$ 1,700	$ 190.63	$ 9,532	
2002	3	5		Excavator: CAT 345	30	hrs	C1.01	1.00	30	$ 61.23	$ 1,837	$ -	$ -	$ 92.53	$ 2,776	$ 34.00	1,252	$ 1,020	$ 187.76	$ 5,633	
2002	3	6		Truck: CAT 740	23	hrs	C1.06	1.00	23	$ 60.66	$ 1,395	$ -	$ -	$ 106.03	$ 2,439	$ 25.32	715	$ 582	$ 192.01	$ 4,416	
2002	3	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2002	3	8	Coarse Ore Storage Building	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2012	3	9	Conveyor 1	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
2012	3	10		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2012	3	11		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2012	3	12		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2012	3	13		Truck: CAT 740	2	hrs	C1.06	1.00	2	$ 60.66	$ 121	$ -	$ -	$ 106.03	$ 212	$ 25.32	62	$ 51	$ 192.01	$ 384	
2012	3	14		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2012	3	15		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Primary Grinding & Mill Maintenance Facility Module																					**$222,695**
2003	4	1	PG & MM Addition	Excavator: CAT 345 w/ grapple	150	hrs	C1.02	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 112.65	$ 16,898	$ 34.00	6,259	$ 5,100	$ 207.88	$ 31,182	
2003	4	2	Mill Module & Cyclone Addition	Excavator: CAT 345 w/ grapple	300	hrs	C1.02	1.00	300	$ 61.23	$ 18,369	$ -	$ -	$ 112.65	$ 33,795	$ 34.00	12,518	$ 10,200	$ 207.88	$ 62,364	
2003	4	3		Excavator: CAT 345 w/ hammer	150	hrs	C1.03	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 106.90	$ 16,035	$ 34.00	6,259	$ 5,100	$ 202.13	$ 30,320	
2003	4	4		Excavator: CAT 345 w/ shear	300	hrs	C1.04	1.00	300	$ 61.23	$ 18,369	$ -	$ -	$ 95.40	$ 28,620	$ 34.00	12,518	$ 10,200	$ 190.63	$ 57,189	
2003	4	5		Excavator: CAT 345	100	hrs	C1.01	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 92.53	$ 9,253	$ 34.00	4,173	$ 3,400	$ 187.76	$ 18,776	
2003	4	6		Truck: CAT 740	41	hrs	C1.06	1.00	41	$ 60.66	$ 2,487	$ -	$ -	$ 106.03	$ 4,347	$ 25.32	1,274	$ 1,038	$ 192.01	$ 7,872	
2003	4	7		Dozer: CAT D9	30	hrs	C1.05	1.00	30	$ 61.23	$ 1,837	$ -	$ -	$ 174.14	$ 5,224	$ 45.10	1,661	$ 1,353	$ 280.47	$ 8,414	
2003	4	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Grinding Area																					**$128,897**
2004	5	1	Grinding Module	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2004	5	2	Equipment	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2004	5	3		Excavator: CAT 345 w/ hammer	120	hrs	C1.03	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 106.90	$ 12,828	$ 34.00	5,007	$ 4,080	$ 202.13	$ 24,256	
2004	5	4		Excavator: CAT 345 w/ shear	120	hrs	C1.04	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 95.40	$ 11,448	$ 34.00	5,007	$ 4,080	$ 190.63	$ 22,876	
2004	5	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2004	5	6		Truck: CAT 740	17	hrs	C1.06	1.00	17	$ 60.66	$ 1,031	$ -	$ -	$ 106.03	$ 1,803	$ 25.32	528	$ 430	$ 192.01	$ 3,264	
2004	5	7		Dozer: CAT D9	25	hrs	C1.05	1.00	25	$ 61.23	$ 1,531	$ -	$ -	$ 174.14	$ 4,353	$ 45.10	1,384	$ 1,128	$ 280.47	$ 7,012	
2004	5	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Zinc Regrind Area																					**$180,295**
2005	6	1	Zinc Regrind Module	Excavator: CAT 345 w/ grapple	400	hrs	C1.02	1.00	400	$ 61.23	$ 24,492	$ -	$ -	$ 112.65	$ 45,060	$ 34.00	16,691	$ 13,600	$ 207.88	$ 83,152	
2005	6	2		Excavator: CAT 345 w/ hammer	150	hrs	C1.03	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 106.90	$ 16,035	$ 34.00	6,259	$ 5,100	$ 202.13	$ 30,320	
2005	6	3		Excavator: CAT 345 w/ shear	150	hrs	C1.04	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 95.40	$ 14,310	$ 34.00	6,259	$ 5,100	$ 190.63	$ 28,595	
2005	6	4		Excavator: CAT 345	100	hrs	C1.01	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 92.53	$ 9,253	$ 34.00	4,173	$ 3,400	$ 187.76	$ 18,776	
2005	6	5		Truck: CAT 740	15	hrs	C1.06	1.00	15	$ 60.66	$ 910	$ -	$ -	$ 106.03	$ 1,590	$ 25.32	466	$ 380	$ 192.01	$ 2,880	
2005	6	6		Dozer: CAT D9	20	hrs	C1.05	1.00	20	$ 61.23	$ 1,225	$ -	$ -	$ 174.14	$ 3,483	$ 45.10	1,107	$ 902	$ 280.47	$ 5,609	
2005	6	7		General Labor	200	hrs	C1.07	1.00	200	$ 54.82	$ 10,964	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 10,964	
Ball Mill Addition Area																					**$148,757**
2006	7	1	Ball Mill Addition	Excavator: CAT 345 w/ grapple	320	hrs	C1.02	1.00	320	$ 61.23	$ 19,594	$ -	$ -	$ 112.65	$ 36,048	$ 34.00	13,353	$ 10,880	$ 207.88	$ 66,522	
2006	7	2		Excavator: CAT 345 w/ hammer	120	hrs	C1.03	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 106.90	$ 12,828	$ 34.00	5,007	$ 4,080	$ 202.13	$ 24,256	
2006	7	3		Excavator: CAT 345 w/ shear	120	hrs	C1.04	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 95.40	$ 11,448	$ 34.00	5,007	$ 4,080	$ 190.63	$ 22,876	
2006	7	4		Excavator: CAT 345	100	hrs	C1.01	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 92.53	$ 9,253	$ 34.00	4,173	$ 3,400	$ 187.76	$ 18,776	
2006	7	5		Truck: CAT 740	13	hrs	C1.06	1.00	13	$ 60.66	$ 789	$ -	$ -	$ 106.03	$ 1,378	$ 25.32	404	$ 329	$ 192.01	$ 2,496	
2006	7	6		Dozer: CAT D9	20	hrs	C1.05	1.00	20	$ 61.23	$ 1,225	$ -	$ -	$ 174.14	$ 3,483	$ 45.10	1,107	$ 902	$ 280.47	$ 5,609	
2006	7	7		General Labor	150	hrs	C1.07	1.00	150	$ 54.82	$ 8,223	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 8,223	

Table 6. Ore Processing and Infrastructure Closure Costs

Work Area Code	Item	Task	Sub Area	Description	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
Lead Flotation Area																					$153,269
2007	8	1	Floatation Module	Excavator: CAT 345 w/ grapple	350	hrs	C1.02	1.00	350	$ 61.23	$ 21,431	$ -	$ -	$ 112.65	$ 39,428	$ 34.00	14,605	$ 11,900	$ 207.88	$ 72,758	
2007	8	2		Excavator: CAT 345 w/ hammer	100	hrs	C1.03	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 106.90	$ 10,690	$ 34.00	4,173	$ 3,400	$ 202.13	$ 20,213	
2007	8	3		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2007	8	4		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2007	8	5		Truck: CAT 740	21	hrs	C1.06	1.00	21	$ 60.66	$ 1,274	$ -	$ -	$ 106.03	$ 2,227	$ 25.32	653	$ 532	$ 192.01	$ 4,032	
2007	8	6		Dozer: CAT D9	40	hrs	C1.05	1.00	40	$ 61.23	$ 2,449	$ -	$ -	$ 174.14	$ 6,965	$ 45.10	2,214	$ 1,804	$ 280.47	$ 11,219	
2007	8	7		General Labor	200	hrs	C1.07	1.00	200	$ 54.82	$ 10,964	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 10,964	
Zinc Flotation Module Area																					$147,225
2008	9	1	Mill Module	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2008	9	2	Lead Thickener	Excavator: CAT 345 w/ grapple	200	hrs	C1.02	1.00	200	$ 61.23	$ 12,246	$ -	$ -	$ 112.65	$ 22,530	$ 34.00	8,345	$ 6,800	$ 207.88	$ 41,576	
2008	9	3		Excavator: CAT 345 w/ hammer	100	hrs	C1.03	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 106.90	$ 10,690	$ 34.00	4,173	$ 3,400	$ 202.13	$ 20,213	
2008	9	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2008	9	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2008	9	6		Truck: CAT 740	22	hrs	C1.06	1.00	22	$ 60.66	$ 1,335	$ -	$ -	$ 106.03	$ 2,333	$ 25.32	684	$ 557	$ 192.01	$ 4,224	
2008	9	7		Dozer: CAT D9	40	hrs	C1.05	1.00	40	$ 61.23	$ 2,449	$ -	$ -	$ 174.14	$ 6,965	$ 45.10	2,214	$ 1,804	$ 280.47	$ 11,219	
2008	9	8		General Labor	200	hrs	C1.07	1.00	200	$ 54.82	$ 10,964	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 10,964	
Compressor Building Area																					$134,713
2009	10	1	Compressor Building	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2009	10	2	Pipe Bridge & Equipment	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
2009	10	3		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2009	10	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2009	10	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2009	10	6		Truck: CAT 740	4	hrs	C1.06	1.00	4	$ 60.66	$ 243	$ -	$ -	$ 106.03	$ 424	$ 25.32	124	$ 101	$ 192.01	$ 768	
2009	10	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2009	10	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Grinding Building Addition Area																					$74,152
2010	11	1	Grinding Building Addition	Excavator: CAT 345 w/ grapple	50	hrs	C1.02	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 112.65	$ 5,633	$ 34.00	2,086	$ 1,700	$ 207.88	$ 10,394	
2010	11	2	Conveyors 3A, 3B & 3C	Excavator: CAT 345 w/ grapple	100	hrs	C1.02	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 112.65	$ 11,265	$ 34.00	4,173	$ 3,400	$ 207.88	$ 20,788	
2010	11	3		Excavator: CAT 345 w/ hammer	50	hrs	C1.03	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 106.90	$ 5,345	$ 34.00	2,086	$ 1,700	$ 202.13	$ 10,107	
2010	11	4		Excavator: CAT 345 w/ shear	60	hrs	C1.04	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 95.40	$ 5,724	$ 34.00	2,504	$ 2,040	$ 190.63	$ 11,438	
2010	11	5		Excavator: CAT 345	40	hrs	C1.01	1.00	40	$ 61.23	$ 2,449	$ -	$ -	$ 92.53	$ 3,701	$ 34.00	1,669	$ 1,360	$ 187.76	$ 7,510	
2010	11	6		Truck: CAT 740	9	hrs	C1.06	1.00	9	$ 60.66	$ 546	$ -	$ -	$ 106.03	$ 954	$ 25.32	280	$ 228	$ 192.01	$ 1,728	
2010	11	7		Dozer: CAT D9	20	hrs	C1.05	1.00	20	$ 61.23	$ 1,225	$ -	$ -	$ 174.14	$ 3,483	$ 45.10	1,107	$ 902	$ 280.47	$ 5,609	
2010	11	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Dewatering																					$128,513
2011	12	1	Pressure Filters	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2011	12	2	Air Receivers	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2011	12	3		Excavator: CAT 345 w/ hammer	120	hrs	C1.03	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 106.90	$ 12,828	$ 34.00	5,007	$ 4,080	$ 202.13	$ 24,256	
2011	12	4		Excavator: CAT 345 w/ shear	120	hrs	C1.04	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 95.40	$ 11,448	$ 34.00	5,007	$ 4,080	$ 190.63	$ 22,876	
2011	12	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2011	12	6		Truck: CAT 740	15	hrs	C1.06	1.00	15	$ 60.66	$ 910	$ -	$ -	$ 106.03	$ 1,590	$ 25.32	466	$ 380	$ 192.01	$ 2,880	
2011	12	7		Dozer: CAT D9	25	hrs	C1.05	1.00	25	$ 61.23	$ 1,531	$ -	$ -	$ 174.14	$ 4,353	$ 45.10	1,384	$ 1,128	$ 280.47	$ 7,012	
2011	12	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Gyratory Crushing Plant Area																					$182,561
2012	13	1	Gyratory Crusher Pit Shelter	Excavator: CAT 345 w/ grapple	80	hrs	C1.02	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 112.65	$ 9,012	$ 34.00	3,338	$ 2,720	$ 207.88	$ 16,630	
2012	13	2	Foundation/Retaining Wall/Conveyor 1A	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2012	13	3		Excavator: CAT 345 w/ hammer	150	hrs	C1.03	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 106.90	$ 16,035	$ 34.00	6,259	$ 5,100	$ 202.13	$ 30,320	
2012	13	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2012	13	5		Excavator: CAT 345	150	hrs	C1.01	1.00	150	$ 61.23	$ 9,185	$ -	$ -	$ 92.53	$ 13,879	$ 34.00	6,259	$ 5,100	$ 187.76	$ 28,163	
2012	13	6		Truck: CAT 740	4	hrs	C1.06	1.00	4	$ 60.66	$ 243	$ -	$ -	$ 106.03	$ 424	$ 25.32	124	$ 101	$ 192.01	$ 768	
2012	13	7		Dozer: CAT D9	200	hrs	C1.05	1.00	200	$ 61.23	$ 12,246	$ -	$ -	$ 174.14	$ 34,827	$ 45.10	11,070	$ 9,020	$ 280.47	$ 56,093	
2012	13	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Reagent Handling																					$136,249
2016	14	1	RH Building	Excavator: CAT 345 w/ grapple	290	hrs	C1.02	1.00	290	$ 61.23	$ 17,757	$ -	$ -	$ 112.65	$ 32,669	$ 34.00	12,101	$ 9,860	$ 207.88	$ 60,285	
2016	14	2		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2016	14	3		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2016	14	4		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2016	14	5		Truck: CAT 740	12	hrs	C1.06	1.00	12	$ 60.66	$ 728	$ -	$ -	$ 106.03	$ 1,272	$ 25.32	373	$ 304	$ 192.01	$ 2,304	
2016	14	6		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2016	14	7		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Mill Concentrate Storage																					$138,554
2018	15	1	Mill Concentrate Storage Building	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2018	15	2	Truck Loading/Conveyor 10	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
2018	15	3		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2018	15	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2018	15	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2018	15	6		Truck: CAT 740	24	hrs	C1.06	1.00	24	$ 60.66	$ 1,456	$ -	$ -	$ 106.03	$ 2,545	$ 25.32	746	$ 608	$ 192.01	$ 4,608	
2018	15	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2018	15	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	

Table 6. Ore Processing and Infrastructure Closure Costs

Work Area Code	Item	Task	Sub Area	Description	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
Lead Flotation																					**$135,097**
2025	16	1	Lead Flotation Addition	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2025	16	2	Lead Flotation Addition #2	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
2025	16	3		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2025	16	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2025	16	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2025	16	6		Truck: CAT 740	6	hrs	C1.06	1.00	6	$ 60.66	$ 364	$ -	$ -	$ 106.03	$ 636	$ 25.32	186	$ 152	$ 192.01	$ 1,152	
2025	16	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2025	16	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Zinc Rougher / Cleaner Flotation Area																					**$136,249**
2030	17	1	Zinc Thickener (steel bottom)	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
2030	17	2	Cover, drive support, tunnel, building additio	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
2030	17	3		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
2030	17	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
2030	17	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
2030	17	6		Truck: CAT 740	12	hrs	C1.06	1.00	12	$ 60.66	$ 728	$ -	$ -	$ 106.03	$ 1,272	$ 25.32	373	$ 304	$ 192.01	$ 2,304	
2030	17	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
2030	17	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
PAC																					**$140,666**
6003	18	1	Accommodations	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
6003	18	2	PAC, WTPs, Wood Shop, Emerg. Serv. Bld	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
6003	18	3		Excavator: CAT 345 w/ hammer	80	hrs	C1.03	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 106.90	$ 8,552	$ 34.00	3,338	$ 2,720	$ 202.13	$ 16,170	
6003	18	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
6003	18	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
6003	18	6		Truck: CAT 740	35	hrs	C1.06	1.00	35	$ 60.66	$ 2,123	$ -	$ -	$ 106.03	$ 3,711	$ 25.32	1,088	$ 886	$ 192.01	$ 6,720	
6003	18	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
6003	18	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Process Water Plant																					**$15,557**
6017	19	1	Process Water Pumphouse	Excavator: CAT 345 w/ grapple	10	hrs	C1.02	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 112.65	$ 1,127	$ 34.00	417	$ 340	$ 207.88	$ 2,079	
6017	19	2	Incinerator	Excavator: CAT 345 w/ grapple	15	hrs	C1.02	1.00	15	$ 61.23	$ 918	$ -	$ -	$ 112.65	$ 1,690	$ 34.00	626	$ 510	$ 207.88	$ 3,118	
6017	19	3	Reclaim Barge #2	Excavator: CAT 345 w/ hammer	10	hrs	C1.03	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 106.90	$ 1,069	$ 34.00	417	$ 340	$ 202.13	$ 2,021	
6017	19	4		Excavator: CAT 345 w/ shear	10	hrs	C1.04	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 95.40	$ 954	$ 34.00	417	$ 340	$ 190.63	$ 1,906	
6017	19	5		Excavator: CAT 345	10	hrs	C1.01	1.00	10	$ 61.23	$ 612	$ -	$ -	$ 92.53	$ 925	$ 34.00	417	$ 340	$ 187.76	$ 1,878	
6017	19	6		Truck: CAT 740	5	hrs	C1.06	1.00	5	$ 60.66	$ 303	$ -	$ -	$ 106.03	$ 530	$ 25.32	155	$ 127	$ 192.01	$ 960	
6017	19	7		Dozer: CAT D9	5	hrs	C1.05	1.00	5	$ 61.23	$ 306	$ -	$ -	$ 174.14	$ 871	$ 45.10	277	$ 226	$ 280.47	$ 1,402	
6017	19	8		General Labor	40	hrs	C1.07	1.00	40	$ 54.82	$ 2,193	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 2,193	
Original Power House Area																					**$145,472**
6022	20	1	Power House	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
6022	20	2	Power House Addition	Excavator: CAT 345 w/ grapple	170	hrs	C1.02	1.00	170	$ 61.23	$ 10,409	$ -	$ -	$ 112.65	$ 19,151	$ 34.00	7,094	$ 5,780	$ 207.88	$ 35,340	
6022	20	3		Excavator: CAT 345 w/ hammer	100	hrs	C1.03	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 106.90	$ 10,690	$ 34.00	4,173	$ 3,400	$ 202.13	$ 20,213	
6022	20	4		Excavator: CAT 345 w/ shear	100	hrs	C1.04	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 95.40	$ 9,540	$ 34.00	4,173	$ 3,400	$ 190.63	$ 19,063	
6022	20	5		Excavator: CAT 345	100	hrs	C1.01	1.00	100	$ 61.23	$ 6,123	$ -	$ -	$ 92.53	$ 9,253	$ 34.00	4,173	$ 3,400	$ 187.76	$ 18,776	
6022	20	6		Truck: CAT 740	8	hrs	C1.06	1.00	8	$ 60.66	$ 485	$ -	$ -	$ 106.03	$ 848	$ 25.32	249	$ 203	$ 192.01	$ 1,536	
6022	20	7		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
6022	20	8		General Labor	160	hrs	C1.07	1.00	160	$ 54.82	$ 8,771	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 8,771	
Jameson Cell																					**$76,731**
-	21	1	Jameson Cell	Excavator: CAT 345 w/ grapple	175	hrs	C1.02	1.00	175	$ 61.23	$ 10,715	$ -	$ -	$ 112.65	$ 19,714	$ 34.00	7,302	$ 5,950	$ 207.88	$ 36,379	
-	21	2		Excavator: CAT 345 w/ hammer	50	hrs	C1.03	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 106.90	$ 5,345	$ 34.00	2,086	$ 1,700	$ 202.13	$ 10,107	
-	21	3		Excavator: CAT 345 w/ shear	50	hrs	C1.04	1.00	50	$ 61.23	$ 3,062	$ -	$ -	$ 95.40	$ 4,770	$ 34.00	2,086	$ 1,700	$ 190.63	$ 9,532	
-	21	4		Excavator: CAT 345	40	hrs	C1.01	1.00	40	$ 61.23	$ 2,449	$ -	$ -	$ 92.53	$ 3,701	$ 34.00	1,669	$ 1,360	$ 187.76	$ 7,510	
-	21	5		Truck: CAT 740	11	hrs	C1.06	1.00	11	$ 60.66	$ 667	$ -	$ -	$ 106.03	$ 1,166	$ 25.32	342	$ 279	$ 192.01	$ 2,112	
-	21	6		Dozer: CAT D9	20	hrs	C1.05	1.00	20	$ 61.23	$ 1,225	$ -	$ -	$ 174.14	$ 3,483	$ 45.10	1,107	$ 902	$ 280.47	$ 5,609	
-	21	7		General Labor	100	hrs	C1.07	1.00	100	$ 54.82	$ 5,482	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 5,482	
ISA Mill																					**$128,897**
-	22	1	ISA Mill	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
-	22	2	Equipment	Excavator: CAT 345 w/ grapple	120	hrs	C1.02	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 112.65	$ 13,518	$ 34.00	5,007	$ 4,080	$ 207.88	$ 24,946	
-	22	3		Excavator: CAT 345 w/ hammer	120	hrs	C1.03	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 106.90	$ 12,828	$ 34.00	5,007	$ 4,080	$ 202.13	$ 24,256	
-	22	4		Excavator: CAT 345 w/ shear	120	hrs	C1.04	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 95.40	$ 11,448	$ 34.00	5,007	$ 4,080	$ 190.63	$ 22,876	
-	22	5		Excavator: CAT 345	80	hrs	C1.01	1.00	80	$ 61.23	$ 4,898	$ -	$ -	$ 92.53	$ 7,402	$ 34.00	3,338	$ 2,720	$ 187.76	$ 15,020	
-	22	6		Truck: CAT 740	17	hrs	C1.06	1.00	17	$ 60.66	$ 1,031	$ -	$ -	$ 106.03	$ 1,803	$ 25.32	528	$ 430	$ 192.01	$ 3,264	
-	22	7		Dozer: CAT D9	25	hrs	C1.05	1.00	25	$ 61.23	$ 1,531	$ -	$ -	$ 174.14	$ 4,353	$ 45.10	1,384	$ 1,128	$ 280.47	$ 7,012	
-	22	8		General Labor	120	hrs	C1.07	1.00	120	$ 54.82	$ 6,578	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 6,578	
Service Complex																					**$65,210**
6025	23	1	Truck Scales	Excavator: CAT 345 w/ hammer	120	hrs	C1.03	1.00	120	$ 61.23	$ 7,348	$ -	$ -	$ 106.90	$ 12,828	$ 34.00	5,007	$ 4,080	$ 202.13	$ 24,256	
6025	23	2	Assay Lab	Truck: CAT 740	40	hrs	C1.06	1.00	40	$ 60.66	$ 2,426	$ -	$ -	$ 106.03	$ 4,241	$ 25.32	1,243	$ 1,013	$ 192.01	$ 7,680	
6025	23	3		Dozer: CAT D9	60	hrs	C1.05	1.00	60	$ 61.23	$ 3,674	$ -	$ -	$ 174.14	$ 10,448	$ 45.10	3,321	$ 2,706	$ 280.47	$ 16,828	
6025	23	4		General Labor	300	hrs	C1.07	1.00	300	$ 54.82	$ 16,446	$ -	$ -	$ -	$ -	$ -	0	$ -	$ 54.82	$ 16,446	
Cleanup of Contaminated Soils in Mill Area & Fuel Pad																					**$549,922**
-	24	1	Excavate, haul, dump contaminated soils		47,592	Bm3	R.021	0.03	1,560	$ 2.00	$ 94,950	$ -	$ -	$ 3.99	$ 189,665	$ 1.05	61,192	$ 49,860	$ 7.03	$ 334,475	
-	24	2	Backfill excavated rockfill areas		47,592	Bm3	R.022	0.02	1,010	$ 1.30	$ 61,656	$ -	$ -	$ 2.58	$ 122,915	$ 0.65	37,893	$ 30,876	$ 4.53	$ 215,447	
Cleanup of Other Laydown & Borrow Areas																					**$1,040,326**
-	25	1	Excavate, haul, dump contaminated soils		90,033	Bm3	R.021	0.03	2,952	$ 2.00	$ 179,624	$ -	$ -	$ 3.99	$ 358,803	$ 1.05	115,760	$ 94,323	$ 7.03	$ 632,750	
-	25	2	Backfill excavated rockfill areas		90,033	Bm3	R.022	0.02	1,910	$ 1.30	$ 116,639	$ -	$ -	$ 2.58	$ 232,527	$ 0.65	71,685	$ 58,410	$ 4.53	$ 407,576	
Road Decommissioning																					**$111,191**
-	26	1	Roads: Reshape and scarify shoulders		24,509	m	C2.30	0.02	490	$ 1.22	$ 30,013	$ -	$ -	$ 2.81	$ 68,875	$ 0.50	15,100	$ 12,303	$ 4.54	$ 111,191	
Reclamation of RDM (Limestone) Quarry Site																					**$9,816**
-	27	1	Regrade steep slopes (rip & push)	Dozer: CAT D9	35	hrs	C1.05	1.00	35	$ 61.23	$ 2,143	$ -	$ -	$ 174.14	$ 6,095	$ 45.10	1,937	$ 1,579	$ 280.47	$ 9,816	
Reclamation of Contaminated Soil, Other Laydown & Borrow Areas and Decommissioned Roads																					**$217,292**
-	28	1	Revegetate - Native seed, application by helicopter		82	ha	C4.01	1.61	131	$ 93.55	$ 7,653	$ 437.95	$ 35,828	$ 343.36	$ 28,090	$ 68.07	6,834	$ 5,569	$ 942.93	$ 77,140	
-	28	2	Revegetate - Live plants - shrub cuttings (10% of area)		8	ha	C4.02	93.75	767	$ 5,215	$ 42,663	$ 1,800.00	$ 14,726	$ 356.53	$ 2,917	$ 330.94	3,323	$ 2,707	$ 7,702.47	$ 63,013	
-	28	3	Revegetate - Fertilizer pellets, application by helicopter		82	ha	C4.01	1.61	131	$ 93.55	$ 7,653	$ 437.95	$ 35,828	$ 343.36	$ 28,090	$ 68.07	6,834	$ 5,569	$ 942.93	$ 77,140	
Subtotal Direct Costs - Demolition, Contaminated Soils & Road Decommissioning									**25,241**		**$ 1,519,364**		**$ 86,382**		**$ 2,524,308**			**$ 724,675**			**$ 4,854,728**

Table 6. Ore Processing and Infrastructure Closure Costs

Work Area Code	Item	Task	Sub Area	Description	Quantity	Unit	Cost Code	Unit Mhrs	Total Mhrs	Labor Rate	Labor Cost	Unit Matl	Material Cost	Unit Equip.	Equipment Cost	Unit Fuel	Fuel Consumed (L)	Fuel Cost	Total Unit Cost	Activity Total	Subtotals
CLOSURE COSTS - INDIRECT																					
Mobilization & Demobilization																					$ -
-	1	1	Mobilization			ls														$0	
-	1	2	Demobilization			ls														$0	
Administration Costs																					**$ 1,080,802**
-	2	1	Office Supplies		9	months	x	$100	/month											$901	
-	2	2	Communications		9	months	x	$570	/month											$5,130	
-	2	3	Heating Fuel (avg. 360 gal per month)		9	months	x	360	gal/month	x	$ 3.08	/gallon								$9,979	
-	2	4	Misc. Supplies		9	months	x	$600	/month											$5,400	
-	2	5	Camp Operation		9,544	Man-days	x	$111	per day per person											$1,059,392	
Field Support												Turnarounds									**$ 1,362,171**
-	3	1	Supervisor #1		130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	2	Supervisor #2		130	days	x	12	hrs/day			4					1560	hr	$ 119.76	$186,826	
-	3	3	Administrative Assistant #1		130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	4	Administrative Assistant #2		130	days	x	12	hrs/day			4					1560	hr	$ 66.38	$103,553	
-	3	5	Foreman #1		130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	6	Foreman #2		130	days	x	12	hrs/day			4					1560	hr	$ 88.26	$137,686	
-	3	7	Mechanic #1		130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	8	Mechanic #2		130	days	x	12	hrs/day			4					1560	hr	$ 61.23	$95,519	
-	3	9	Survey Field Manager		130	days	x	12	hrs/day			4					1560	hr	$ 63.88	$99,653	
-	3	10	Survey Crew (surveyor + helper)		130	days	x	12	hrs/day			4					1560	hr	$ 116.21	$181,288	
-	3	11	Field Support Vehicles		130	days	x	3	trucks												
-	3	12	Turnaround Costs - Admin		43	trips	x	$357	/trip	+	10	%								$17,032	
-	3	13	Turnaround Costs - Crew		43	trips	x	$357	/trip	+	10	%								$17,032	
Contract Administration and QA/QC												Turnarounds									**$ 626,013**
-	4	1	Resident Engineer #1		130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	2	Resident Engineer #2		130	days	x	12	hrs/day			4					1560	hr	$ 115.00	$179,400	
-	4	3	Engineering Technician #1		130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	4	Engineering Technician #2		130	days	x	12	hrs/day			4					1560	hr	$ 80.00	$124,800	
-	4	5	Laboratory and Material Testing Costs		9	months	x	$1,200	/month											$10,800	
-	4	6	Field Support Vehicles		130	days	x	2	trucks												
-	4	7	Turnaround Costs - QA/QC		17	trips	x	$357	/trip	+	10	%								$6,813	
Other Indirect Allocations																					**$ 1,701,471**
-	5	1	Insurance (1.6% of labor)		2	%	of	$2,847,470	Direct Labor Cost+Field Support Labor											$45,560	
-	5	2	Contractor Overhead		10	%	of	$2,893,029	Direct Labor Cost+Field Support Labor+ Insurance											$289,303	
-	5	3	Hazardous Materials		1	ls													$ 100,000	$100,000	
-	5	4	Contractor Profit		10	%	of	$6,673,171	Total Direct Cost+mob/demob+site admin-CAMP OPERATION+field support+Insurance+OH+Freight+Haz Mat											$667,317	
-	5	5	Engineering Re-Design		3	%	of	$8,399,880	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haz Mat											$251,996	
-	5	6	Bonding		3	%	of	$8,399,880	Total Direct Cost+mob/demob+site admin+field support+Insurance+OH+Freight+Haz Mat											$251,996	
-	5	7	State Management and Oversight		1	%	of	$9,529,886	Total Project Cost EXCLUDING State Contract Admin, Contingency											$95,299	
Subtotal Indirect Costs																					**$4,770,457**
CLOSURE COSTS - CONTINGENCY																					
			Contingency		20	%	of	$4,854,728	Direct Cost											$970,946	**$970,946**
CLOSURE COSTS - TOTAL																					
			Total Direct and Indirect Costs																		**$10,596,131**

Table 7. Pit Wall Quantities

Item	Option	Area	Task	Qnty	Unit	Length (m)	Width (m)	Height (m)	Side Slope	Area (m2)	Volume (m3)	Source / Comments
High Wall Safety	Mine Area	Qanaiyaq	Clear (grub access road)			0						
			Construct access road			0						
			LHD material (highwall perimeter, from DD-2)			730	3	1	2	4	**2921**	Final Closure
			Shape material into berm			730	3	1	2	4	**2921**	Final Closure
			Drill and blast dangerous slopes			0	30	12		180	**0**	Use berms and boulders
		Aqqaluk	Clear (grub access road)			0	0			0		
			Construct access road			0						
			LHD material (highwall perimeter, from DD-2)			1712	3	1	2	4	**6847**	Final Closure
			Shape material into berm			1712	3	1	2	4	**6847**	Final Closure
		Main Pit - East Highwalls	Drill and blast dangerous slopes			300	48	12	4:1	288	**86400**	
			Drill and blast dangerous slopes			500	48	12	4:1	288	**144000**	
		Main Pit (2031)	LHD material at pit rim			257	3	1	2	4	**1028**	Premature Closure
			Shape material into berm			257	3	1	2	4	**1028**	Premature Closure
		Main Pit (2015)	LHD material at pit rim			1292	3	1	2	4	**5169**	Premature Closure
			Shape material into berm			1292	3	1	2	4	**5169**	Premature Closure

Table 8. Stockpile Re-sloping Quantities

		Bubble Dumps	Flattened
Dozer:	**D11**		
Minutes Worked per Hour:			
Estimated Operating Speed (km/hr):			

3618 Total Hours at Closure
1040 Total Hours at Premature Closure

Area	Option	Zone	Flat Surfaces: Bubble Dump Area (m2)	Flat Surfaces: Flattened Area (m2)	Flat Surfaces: Estimated Avg. Dozing Distance (m)	Sloped Areas: Height (m)	Sloped Areas: Bench Length (m)	Sloped Areas: Initial Slope x:1	Sloped Areas:	Sloped Areas: Final Slope x:1	Theoretical Production: Actual* Production Lm3/hr	Theoretical Production: Estimated Volume**	Theoretical Production: Total Time Required (hrs)	Sources/Comments
Waste Rock	**A: 2031**	A			91	30	305	1.5		4.5	644	106,188	165	main pit dump, regrade benches
		B			91	30	1280	1.5		4.5	644	445,990	692	main pit dump, regrade benches
		C			91	30	975	1.5		4.5	644	339,802	527	main pit dump, regrade benches
		D			137	34	671	1.5		7	403	518,233	1287	main pit dump, regrade benches
		E			46	30	457	1.5		3	1145	79,641	70	Low grade ore stockpile, bench regrade
		F			46	30	305	1.5		3	1145	53,094	46	Low grade ore stockpile, bench regrade
		G			46	30	152	1.5		3	1145	26,547	23	Low grade ore stockpile, bench regrade
		H			46	30	152	1.5		3	1145	26,547	23	Low grade ore stockpile, bench regrade
	TOTALS HOURS REQUIRED:												**2834**	
	B: Concurrent													
	TOTALS HOURS REQUIRED:												**0**	
	C: 2015 (Premature)	I			69	23	152	4.5		4.5	787	29,865	38	main pit dump, regrade benches
		J			69	23	122	4.5		4.5	787	23,892	30	main pit dump, regrade benches
		K			69	23	244	4.5		4.5	787	47,785	61	main pit dump, regrade benches
		E			46	30	457	3.0		3	1145	79,641	70	main pit dump, regrade benches
		F			46	30	305	3.0		3	1145	53,094	46	Low grade ore stockpile, bench regrade
		G			46	15	152	3.0		3	1145	6,637	6	Low grade ore stockpile, bench regrade
		H			46	15	152	3.0		3	1145	6,637	6	Low grade ore stockpile, bench regrade
	TOTALS HOURS REQUIRED:												**256**	
Main Pit Highwalls		1								3	644	230,400		Pushing Blasted material into pits
	TOTALS HOURS REQUIRED:												**358**	
Qanaiyaq		1		221200	60					20	787	44,240		Backfill plan does not require bench grading
	TOTALS HOURS REQUIRED:												**56**	assume minor grading (20%) for both pre/post
Overburden Dump		1			70	20	250	45	24.23	33	587	43,750	75	
	TOTALS HOURS REQUIRED:												**75**	
Landfill		1		142800	40					33	484	142,800		Assume 1m deep across area for drainage
	TOTALS HOURS REQUIRED:												**295**	

* Production based information shown in D11 Production Table.

**See sketch (Main Pit Dump Stockpile Resloping) this sheet for estimated volume calculations and dump layout.

Table 9. Cover Volumes

Note: all volumes bulk in place.

								Placement and Compaction Conditions [1]				Cover	Total Required	
Area	**Option**	**Area**	**Area Description**	**Material Source Location**	**Lift #**	**Compactive Effort**	**Area (m^2)**	**Approx % Area (grade <5%)**	**Area (grade <5%) M^2**	**Approx % Area (grade >5%)**	**Area (grade >5%) M^2**	**Thickness (m)**	**Cover Volume (m^3)**	**Cover volume used in relocation calculations by source (m^3)**
Waste Rock Cover	**A: 2031**													
		5	Q Pit Access and Landfill Area	MWD Stockpile	1	Highly Compacted	113,400	60%	68040	40%	45360	0.5	56,700	56,700
		6	Qanaiyaq Pit	MWD Stockpile	1	Highly Compacted	232,000	80%	185600	20%	46400	0.5	116,000	116,000
		10	Low-Grade Ore SP Area	Oxide Stockpile	1	Highly Compacted	163,100	50%	81550	50%	81550	0.5	81,550	81,550
		15	Red Dog Creek	Oxide Stockpile	1	Highly Compacted	172,000	90%	154800	10%	17200	0.5	86,000	86,000
		12	Main Pit Dump	Oxide Stockpile	1	Highly Compacted	651,200	20%	130240	80%	520960	0.5	325,600	325,600
		TOTAL:					**1,331,700**		**620,230**		**711,470**		**665,850**	
		5	Q Pit Access and Landfill Area	MWD Stockpile	2	Loosely Compacted	113,400	60%	68040	40%	45360	0.5	56,700	56,700
		6	Qanaiyaq Pit	MWD Stockpile	2	Loosely Compacted	232,000	80%	185600	20%	46400	0.5	116,000	116,000
		10	Low-Grade Ore SP Area	Oxide Stockpile	2	Loosely Compacted	163,100	50%	81550	50%	81550	0.5	81,550	81,550
		15	Red Dog Creek	Oxide Stockpile	2	Loosely Compacted	172,000	90%	154800	10%	17200	0.5	86,000	86,000
		12	Main Pit Dump	Oxide Stockpile	2	Loosely Compacted	651,200	20%	130240	80%	520960	0.5	325,600	325,600
		TOTAL:					**1,331,700**		**620,230**		**711,470**		**665,850**	
Waste Rock Cover	**B: Concurrent**													
		7	Oxide Dump		1	Complete	100,800					0	0	
		TOTAL:					**0**						**0**	
		7	Oxide Dump		2	Complete	100,800					0	0	
		TOTAL:					**0**						**0**	
Waste Rock Cover	**C: 2015**													
		4	Main Waste Dump	MWD Stockpile	1	Highly Compacted	707,700	20%	141540	80%	566160	0.5	353,850	353,850
		5	Q Pit Access and Landfill Area	Aqqaluk Pit	1	Highly Compacted	142,800	60%	85680	40%	57120	0.5	71,400	71,400
		9	Low-Grade Ore SP Area	Aqqaluk Pit	1	Highly Compacted	132,500	50%	66250	50%	66250	0.5	66,250	66,250
		10	Low-Grade Ore SP Area	Aqqaluk Pit	1	Highly Compacted	163,100	50%	81550	50%	81550	0.5	81,550	81,550
		12	Main Pit Dump	Aqqaluk Pit	1	Highly Compacted	128,800	50%	64400	50%	64400	0.5	64,400	64,400
		15	Red Dog Creek	Aqqaluk Pit	1	Highly Compacted	172,000	90%	154,800	10%	17,200	0.5	86,000	86,000
		TOTAL:					**1,446,900**		**594,220**		**852,680**		**723,450**	
		4	Main Waste Dump	MWD/OX Stockpile	2	Loosely Compacted	707,700	20%	141,540	80%	566,160	0.5	353,850	***379,301***
		5	Q Pit Access and Landfill Area	Aqqaluk Pit	2	Loosely Compacted	142,800	60%	85,680	40%	57,120	0.5	71,400	71,400
		9	Low-Grade Ore SP Area	Aqqaluk Pit	2	Loosely Compacted	132,500	50%	66,250	50%	66,250	0.5	66,250	66,250
		10	Low-Grade Ore SP Area	Aqqaluk Pit	2	Loosely Compacted	163,100	50%	81,550	50%	81,550	0.5	81,550	***56,099***
		12	Main Pit Dump	Aqqaluk Pit	2	Loosely Compacted	128,800	50%	64,400	50%	64,400	0.5	64,400	64,400
		15	Red Dog Creek	Aqqaluk Pit	2	Loosely Compacted	172,000	90%	154,800	10%	17,200	0.5	86,000	86,000
		TOTAL:					**1,446,900**		**594,220**		**852,680**		**723,450**	

1- Placement and Compaction Conditions - Assumes approximate percentage of area greater than or less than 5% grade. This area is used for productivity estimation for compaction (see Cover Compaction tab).

Table 10. Cover Compaction Quantities

Area	Option	Segment	Area (m2)	D9 /w Roller Productivity (flat Surface) (m2/hr/pass)	# of Passes*	Grade Factor	Actual D9 /w Roller Productivity (flat Surface) (m2/hr)	Time Required (hrs)	Notes
Waste Rock Dumps	A. Complete	Top (<5%)	620,230	12,000	2	1	6000	103.4	Flat slopes from cover volumes
		Sloped	711,470	7,500	2	1	3750	189.7	Bench areas from cover volumes
Total Hours Required:								**293.1**	
Waste Rock Dumps	B: Concurrent	Top (<5%)		12,000	2	1	6000	-	
		Sloped	-	7,500	2	1	3750	-	Includes Main Dump
Total Hours Required:								**-**	
Waste Rock Dumps	C: 2015	Top (<5%)	594,220	12,000	2	1	6000	99.0	
		Sloped	852,680	7,500	2	1	3750	227.4	Includes Main Dump
Total Hours Required:								**326.4**	
Total Hours Required:								**-**	

Table 11. Ditch Construction Quantities

A: Channels

		Ditch Parameters								X-Section Quantities					Total Quantities				
Area	**Segment**	Final Average Ditch Bottom Width (m)	Ditch Side Slope (:1)	Channel Depth (m) (exc. surf to top of riprap)	Designed Flow Depth of Channel Depth (m)	Rip-Rap Thickness (m)	Bedding Thickness (m)	Excavation Depth (incl. over exc. for riprap) (m)	Ditch Length (m)	Total Excavated Area (m2)	Exc Area for Channel (m2)	Rip-Rap Area (m2)	Bedding Area (m2)	Filter Fabric/Liner Width (m)	Excavation Volume (m3)	Drill/Blast Volume (m3) 50% of exc	Bedding Volume (m3)	Rip-Rap Volume (m3)	Filter Fabric/Liner Area (m2)
Main Pit Dump 2031	Trellis pattern	1	2	1	1	0	0	1	3200	3.0	3.0	0.0	0.0	0.0	9600		0	0	0
	Drop structures (3)	1	2	1.1	1.1	0.3	0.3	1.7	1000	7.5	7.5	1.8	2.2	8.6	7480		2160	1800	8603
Main Dump 2015	Trellis pattern	1	2	1	1	0	0	1	3600	3.0	3.0	0.0	0.0	0.0	10800		0	0	0
	Drop structures (4)	1	2	1.1	1.1	0.3	0.3	1.7	800	7.5	7.5	1.8	2.2	8.6	5984		1728	1440	6882
Red Dog Creek 2031		2	3	0.83	0.83	0.38	0.15	1.36	2017	8.3	8.3	3.1	1.5	10.6	16678		2938	6224	21383
Red Dog Creek 2015		2	3	0.83	0.83	0.38	0.15	1.36	3125	8.3	8.3	3.1	1.5	10.6	25840		4552	9643	33129
Spillway (Main Dam)	Sta: 19+00 - 15+00	30.5	2.5	5	1.5	0	0	5	92	215.0	51.4	0.0	0.0	0.0	19780	9890	0	0	0
Spillway (Main Dam)	Sta: 15+00 - 13+25	12.2	2.5	5	1.5	0	0	5	51	123.5	23.9	0.0	0.0	0.0	6299	3149	0	0	0
Spillway (Main Dam)	Sta: 13+25 - 11+00	12.2	1.5	3.5	1.5	0	0	3.5	69	61.1	21.7	0.0	0.0	0.0	4214	2107	0	0	0
Spillway (Main Dam)	Sta: 11+00 - 9+29	12.2	1.5	3.5	1.5	1.25	0	4.75	52	91.8	44.9	23.2	0.0	22.1	4773	2387	0	1207	1150
Spillway (Main Dam)	Sta: 9+29 - 6+00	8.5	2.5	3.5	1.5	2.5	0	6	100	141.0	74.0	55.6	0.0	30.0	14100	7050	0	5563	3004
Spillway (Main Dam)	Sta: 6+00 - 4+40	8.5	2.5	3.5	1.5	0	0	3.5	49	60.4	18.4	0.0	0.0	0.0	2958	1479	0	0	0
Spillway (Main Dam)	Sta: 4+40 - 2+32	4.75	2.5	3.5	1.5	2.5	0	6	63	118.5	59.0	46.3	0.0	26.3	7466	3733	0	2914	1656
	TOTAL Sta: 19+00 - 2+32								**476**						**59590**	**29795**	**0**	**9684**	**5810**

Riprap, bedding, fabric and liner is assumed to be in flow areas only of excavations. Flow depth is assumed as 1m unless otherwise noted.
Spillway stationing in feet.

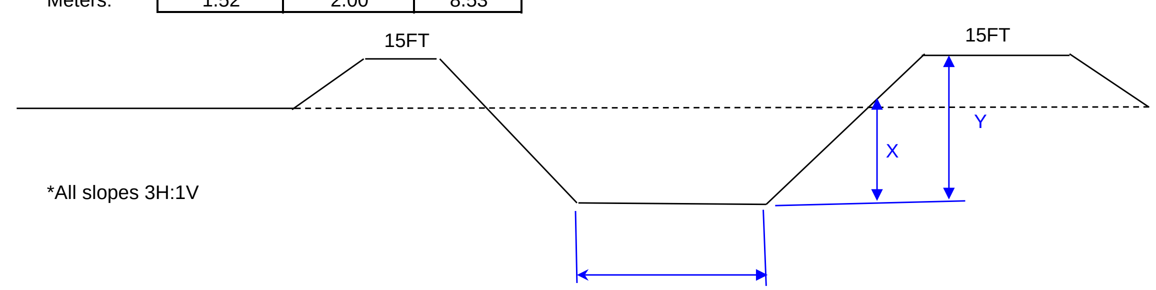
Note: Table B (sediment ponds) was removed from estimate, as it was not used.

C: Energy Dissipation Structures

		Ditch Parameters								X-Section Quantities					Total Quantities				
Area	**Segment**	Final Average Ditch Bottom Width (m)	Ditch Side Slope (:1)	Channel Depth (m) (exc. surf to top of riprap)	Designed Flow Depth of Channel Depth (m)	Rip-Rap Thickness (m)	Bedding Thickness (m)	Excavation Depth (incl. over exc. for riprap) (m)	Ditch Length (m)	Total Excavated Area (m2)	Exc Area for Channel (m2)	Rip-Rap Area (m2)	Bedding Area (m2)	Filter Fabric/Liner Length (m)	Excavation Volume (m3)	Drill/Blast Volume (m3) 50% of exc	Bedding Volume (m3)	Rip-Rap Volume (m3)	Filter Fabric/Liner Area (m2)
Spillway (Main Dam)	Stilling Basin Inlet 2+32 - 1+46	3.7	2.5	3.8	1.5	2.5	0	6.3	26	122.5	54.8	43.6	0.0	25.2	3185.9	1593	0.0	1134.3	656.3
	Stilling Basin Apron 1+46 - 0+85	4.9	2.5	1.5	1.5	1.25	0	2.75	19	32.4	32.4	19.4	0.0	19.7	615.2	308	0.0	368.7	374.5
	Stilling Basin Apron 0+85 - 0+28	7.3	2.5	1.5	1.5	0	0	1.5	17	16.6	16.6	0.0	0.0	0.0	281.8	141	0.0	0.0	0.0
	TOTAL														**4083**	**2041**	**0**	**1503**	**1031**

D: Red Dog Creek Diversion - Typical Section

	x	y	w
Feet:	5.00	6.56	28
Meters:	1.52	2.00	8.53



*All slopes 3H:1V

Typical Design based on largest flow at outlet (513ft3/s), with the shallowest slope along channel (1.81%)
Depth of flow for Q500 = 1.05m

Table 12. Seepage Collection System Quantities

A. Groundwater/Seepage Pipeline Collection Systems

Option	Access Road Length (m)	Sumps, Wells, Pumps: Well #	Name	Estimated Pumping Well Depth (m)	6" Submersible Pump (56-95 GPM)	6" Submersible Pump (681-1400 GPM)	# of Sumps	Sump Depth (m)	Associated Monitoring Wells: # of Monitoring Wells	Well Depth (m)
Mine Dump Seepage Collection	0	1	MWD 21	15	1					
		2	MWD 17	15	1					
		3	MWD 18	15		1				
		4	MWD 7	15	1					
		5	MWD 22	15	1					
		6	MWD 23	15	1					
		7	MWD 20	15	1					
		8	MWD 24	15		1				
TOTAL:	**0**	**8**		**120**	**6**	**2**	**2**	**4**	**0**	**0**
Main Dam Seepage Collection							1	4		
Overburden Dump Runoff Collection							1	4		
Main Pit Water Collection	0	3	-	92	3		0	0		

Option	Ditch Parameters: Ditch/Pipe Length (m)	Ditch Bottom Width (m)	Ditch Side Slope (:1)	Average Channel Depth (m)	Bedding Sand Depth (m)	Heat Trace Requirements: # of Power Feed Kits	# of Thermostats	Electricity Requirements: Distance to Power Source (m)	Power Pole Distance (m)	Power Poles Required	# of Transformers	X-Section Quantities: Average Excavated Area (m2)	Bedding Sand Area (m2)	Total Quantities: Sump Excavation Volume (m3)	Pipeline Excavation Volume (m3)	Bedding Sand Volume (m3)
Mine Dump Seepage Collection																
TOTAL:	**3605**	**1**	**1**	**2**	**0**	**2**	**1**	**1800**	**77**	**24**	**4**	**6.0**	**0.0**	**200.0**	**21630.0**	**0.0**
Main Dam Seepage Collection	1857	1	1	2	0	2	1	500	77	**7**	**1**	6.0	0.0	200.0	11142.0	0.0
Overburden Dump Runoff Collection	2200	1	1	2	0	2	1	500	77	**7**	**1**	6.0	0.0	200.0	13200.0	0.0
Main Pit Water Collection	1500	1	1	2	0	2	1	1500	77	**20**	**1**	6.0	0.0	8.0	9000.0	0.0

B. Cut-off Walls

Option	Area	Length (m)	Parameters: Avg Depth to Bedrock (m)	Wall Area (m2)	Wall Thickness (m)	Wall Volume (m3)	Working Surface Width (m)	Level Working Surface (m3)	Comments
Main Waste Dump Seepage Collection	**MWD 24**	200	15.0	3000	1.5	4500			
	MWD 18	200	15.0	3000	1.5	4500			
TOTAL:		400		6000		9000			

Table 13. Tailings Beach Quantities

Area	Option	Item	Task	Qnty	Unit	Length (m)	Width (m)	Height (m)	Side Slope	Area (m2)	Volume (m3)	Source / Comments
Main Dam	Tailings Area	Coffer Dam				1950	3	2	2	18	**35100**	
		Run-of-mine berm				1950	5	2	2	30	**58500**	
		Dredge tails for beach				1950	170	1.5			**497250**	Premature closure only
		Beach cover						1.0		**382100**	**382100**	
		Liner								**382100**		
		Erosion protection				1950	1	2	2	**2**	**3900**	
		Emergency Storage Pond	Clear/grub pond dam area							**3450**		
			Load, haul, dump, place, compact			110		7	2.5		**13475**	
Back Dam	Tailings Area	Coffer Dam				1180	3	2	2	18	**21240**	
		Run-of-mine berm				1180	5	2	2	30	**35400**	
		Dredge tails for beach				1180	170	1.5			**300900**	Premature closure only
		Beach cover						1.0		**180200**	**180200**	
		Liner								**180200**		
		Erosion protection				1180	1	2	2	**2**	**2360**	
		Emergency Storage Pond	Clear/grub pond dam area							**3650**		
			Load, haul, dump, place, compact			165		4	2.5		**6600**	

See Figure 27 of the 2015 Reclamation and Closure Plan

Table 14. Borrow Source Reclamation

	Flat Surfaces			Sloped Areas					Theoretical Production (from Dozer Spreadsheet)				
Zone	Bubble Dump Area (m2)	Flattened Area (m2)	Estimated Avg. Dozing Distance	Height (m)	Length (m)	Initial Slope (%)	Initial Slope	Final Slope (%)	Actual Production	Estimated Volume**	Benches	Total Time Required (hrs)	**Sources/Comments**
DD-2		20000	40	15	300	75.0	36.87	33	850	45000	1	53	Borrow Size Estimated
MS-14		20000	40	15	300	75.0	36.87	33	850	45000	1	53	Borrow Size Estimated
TOTALS HOURS REQUIRED:		**47**										**106**	

Table 15. Contaminated Soil Area and Road Quantities

A. Areas from Figure 3.5.1

	Area (acres)	(hectares)	Road	Cont. Soil	Other		Revised Estimates of Areas (per 2015 topography)				
			hectares					feet 2	m2	ha	acre
1 CC Laydown	13.7	5.5			5.5		1	597019	55465	5.55	13.7
2 Kivalina South Road	1.0	0.4	0.4				2	41596	3864	0.39	1.0
3 Kivalina East Laydown	12.0	4.8			4.8		3	521367	48437	4.84	12.0
4 Road around Kivalina & DD2	11.1	4.5	4.5				4	482032	44782	4.48	11.1
5 DD2 South	22.7	9.2			9.2		5				22.7
6 DD2 North	20.2	8.2			8.2		6	877934	81563	8.16	20.2
7 DD2 East (flooded before 2031)							7	160355	14897	1.49	3.7
8 Conex Laydown	43.0	17.4	3.5		13.9		8				43.0
9 Water Treatment Laydown Area (submerged)							9				0.0
10 Contractor Laydown/Fuel Pad	48.3	19.5	3.9	1.6	14.0		10	1180416	109664	10.97	48.3
11 PAC	10.7	4.3			4.3						10.7
12 Mill Site	19.6	7.9		7.9			12	2047605	190229	19.02	19.6
Total	202.1	82	12	10	60	**82**					

B. Summary Quantities for Cost Estimate

Road Reshaping		
	12	ha
	122544	m2
	10	m width
	12254	m road length
	24509	m shoulder length
Contaminated Soils		
Mill area	7.9	ha
Fuel pad	0.0	ha
Total	7.9	ha
	79320	m2
Assumed depth of soil removal and backfill	0.6	m
Volume	**47592**	m3
Other Areas		
Total area	60	ha
	25%	assumed to be contaminated
	15	ha
	150055	m2
Assumed depth of soil removal and backfill	0.6	m
Volume	**90033**	m3

SEE FIGURE 28 Reclamation Plan for Detail

Table 16. Demolition Quantities

Area/Item	Sub Component/Building/Section	Status	Qnty	Building Size: Length (ft.)	Building Size: Width (ft.)	Building Size: Avg. Height (ft.)	Material Quantities: Steel Thickness	No. 1 Steel (tons)	No. 1 Steel (CYD)	Scrap Steel (CYD)	Wood (CYD)	Concrete (CYD)	Other (CYD)	Hydrocarbons (liters)	Relocated to Landfill: All Materials (CYD)	All Materials (m3)	All Materials (tonnes)	CAT 740: Trips ($24m^3$/trip)	Hours (4.3trip/hr)[1]	Total Hours	Total Hours Rounded up
Mine Sump Collection System	Retaining Wall	Retain		150	1	30					200	4	10		214	163	38	7	1.63	2.09	3
	Pumphouse & Gen. Trailer	Retain		20	20	15		5	10	2	33		2	500	47	36	11	2	0.47		
Water Treatment Plant #1 Area	Clarifier (steel bottom/wall)				120	21	0.04166667	180	360	50			100		510	390	233	17	3.95	6.28	7
	Clarifier Cover				120	20				50			20		70	53	30	3	0.70		
	Drive Support							5	10	2				100	12	9	5	1	0.23		
	Walkway (Steel)			97		10		7	14	2					16	12	7	1	0.23		
	WTP#1 MCC's							1	2	2					4	3	2	1	0.23		
	Emergency Exit Tunnel (CSP)			92	7					5					5	4	2	1	0.23		
	Underflow Tunnel (CSP)			102	8					15					15	11	6	1	0.23		
	Ring Wall Foundation											50			50	38	35	2	0.47		
Water Treatment Plant #2 Area	Tank Wall	Retain			200	17	0.04166667	99	198	50			75		323	247	147	11	2.56	4.19	5
	Clarifier Cover	Retain			200	20				20			50		70	53	33	3	0.70		
	Drive Support	Retain						8	16	5		10			31	24	16	1	0.23		
	Walkway (Steel)	Retain		102		10		10	20	2					22	17	10	1	0.23		
	Underflow Pumphouse	Retain								2		10			12	9	8	1	0.23		
	Pipe Trench	Retain								20					20	15	8	1	0.23		
Sand Filter Plant (does not include pipes)	Lime Sludge Tank	Retain	1							2					2	2	1	1	0.23	2.56	3
	Rapid Mix Tank	Retain	1							2					2	2	1	1	0.23		
	Lime Reactor	Retain	1							2					2	2	1	1	0.23		
	Floc Day Tank	Retain	1							2					2	2	1	1	0.23		
	Floc Mix Tank	Retain	1							2					2	2	1	1	0.23		
	Clarifier	Retain	1							2					2	2	1	1	0.23		
	Sand Filters	Retain	3							2					2	2	1	1	0.23		
	Tent Enclosure	Retain	1	120	60								30		30	23	15	1	0.23		
	Potable Water Plant		1							2					2	2	1	1	0.23		
	Sewage Treatment Plant		1							2					2	2	1	1	0.23		
	Emergency Generator		1							2				500	2	2	1	1	0.23		
Jaw Crusher Area	Shell/Building			60	35	43		103	206	50			20	200	276	211	123	9	2.09	5.35	6
	Pit Cover			15	35	30		18	36	20					56	43	24	2	0.47		
	Rock Breaker							2	4						4	3	2	1	0.23		
	Foundation											25			25	19	18	1	0.23		
	Retaining Wall (Concrete)			200	2	30						300			300	229	210	10	2.33		
Coarse Ore Storage Area	2C to 3C Transfer Tower			42	25	30		36	72	5		40			117	89	63	4	0.93	22.09	23
	Existing Conveyor			30						7					7	5	3	1	0.23		
	Conveyor 2A (36")		9'	310	7	7		17	34	70		10			114	87	50	4	0.93		
	Conveyor 2B (36")		9'	310	7	7		17	34	70		10			114	87	50	4	0.93		
	Conveyor 2C (36")		9'	210	7	7		12	24	50		15			89	68	41	3	0.70		
	Course Ore Storage Building (Part buried)			215	160	85		1108	2216	150		100			2466	1884	1135	79	18.37		
	Conveyor 1 (36")		9'	450	7	7		25	50	50		50			150	115	78	5	1.16	1.16	2
Primary Grinding & Mill Maintenance Facility Modu	PG & MM Addition			100	60	75		818	1636	739					2375	1815	1038	76	17.67	40.23	41
	Mill Module			130	80	75		1418	2836						2836	2167	1286	91	21.16		
	Cyclone Addition			30	20	75		82	164						164	125	74	6	1.40		
Grinding Area	Grinding Module			100	80	75		1091	2182						2182	1667	990	70	16.28	16.28	17
	Equipment																				
Zinc Regrind Area	Zinc Regrind Module			100	70	75		955	1910						1910	1459	866	61	14.19	14.19	15
Ball Mill Addition Area	Ball Mill Addition			80	75	75		818	1636						1636	1250	742	53	12.33	12.33	13
Lead Flotation Area	Floatation Module			145	70	75		1384	2768						2768	2115	1256	89	20.70	20.70	21
Zinc Flotation Module Area	Mill Module			145	70	75		1384	2768						2768	2115	1256	89	20.70	21.40	22
	Lead Thickener			200	3	35		38	76						76	58	34	3	0.70		
Compressor Building Area	Compressor Building			40	75	70		239	478						478	365	217	16	3.72	3.95	4
	Pipe Bridge			70	10	10		8	16						16	12	7	1	0.23		
	Equipment																				
Grinding Building Addition Area	Grinding Building Addition			105	75	60		537	1074						1074	821	487	35	8.14	8.14	9
	Conveyor 3A			40	36"																
	Conveyor 3B			40	36"																
	Conveyor 3C			275	36"	9'															
Dewatering	Pressure Filters			95	75	75		972	1944						1944	1485	882	62	14.42	14.42	15
	Air Receivers																				

Table 16. Demolition Quantities

				Building Size			Material Quantities								Relocated to Landfill			CAT 740			
Area/Item	Sub Component/Building/Section	Status	Qnty	Length (ft.)	Width (ft.)	Avg. Height (ft.)	Steel Thickness	No. 1 Steel (tons)	No. 1 Steel (CYD)	Scrap Steel (CYD)	Wood (CYD)	Concrete (CYD)	Other (CYD)	Hydrocarbons (liters)	All Materials (CYD)	All Materials (m3)	All Materials (tonnes)	Trips ($24m^3$/trip)	Hours (4.3trip/hr)[1]	Total Hours	Total Hours Rounded up
Gyratory Crushing Plant Area	Gyratory Crusher Pit Shelter			80	30	40		109	218						218	167	99	7	1.63	3.02	4
	Foundation			30	25	70															
	Lower Building			80	30	40															
	Retaining Wall			500		45															
	Conveyor 1A (36")		9'	723	10	10		82	164						164	125	74	6	1.40		
Reagent Handling	RH Building	Retain		200	65	50		739	1478						1478	1129	670	48	11.16	11	12
Mill Concentrate Storage	Mill Concentrate Storage Building			325	134	70		1155	2310			300			2610	1994	1258	84	19.53	23.02	24
	Truck Loading			325	18	20		133	266			200			466	356	261	15	3.49		
	Conveyor 10			395	30"																
Lime Slaking	Lime Slaking Module	Retain		66	63	55		416	832						832	636	377	27	6.28	6.28	7
Lead Flotation	Lead Flotation Addition			62	40	60		169	338						338	258	153	11	2.56	5.12	6
	Lead Flotation Addition 2			62	40	60		169	338						338	258	153	11	2.56		
Zinc Rougher/Cleaner Flotation Area	Zinc Thickener (steel bottom)				140	15	0.04166667	60	120						120	92	54	4	0.93	11.16	12
	Zinc Thickener Cover				140	15															
	Zinc Drive Support			140	10	10															
	Zinc Underflow Tunnel			100	8	8															
	Building Addition			100	70	85		676	1352						1352	1033	613	44	10.23		
Airport and Connex	Airport	Retain						4000	8000		400	200	1000		9600	7334	4329	306	71.16	71.16	72
	Connex Storage	Retain																			
	Rebar Bending	Retain																			
	Equipment Repair (tent)	Retain																			
	Construction Camp	Retain																			
	Bone Yards	Retain																			
PAC	Accommodations (Wing)	Retain	5	150	35	35		1045	2090				400		2490	1902	1148	80	18.60	34.65	35
	PAC	Retain		276	111	25		870	1740				400		2140	1635	989	69	16.05		
	PAC Extension	Retain																			
	Sewage Treatment Plant	Retain																			
	Potable Water Treatment	Retain	1	32	18	22															
	Wood Shop	Retain																			
	Emergency Services Building (Addition)	Retain																			
Freshwater and Overburden Seepage Recovery	Freshwater Tank	Retain																		0.47	1
	Freshwater Pumphouse (mill)	Retain		40	15	18		12	24						24	18	11	1	0.23		
	Bons Creek Freshwater Pumphouse	Retain	1	40	15	18		12	24						24	18	11	1	0.23		
	Kivalina Overburden Pumps and Pipe	Retain																			
Fuels Distribution	Fuels Tanks	Retain	2		80'	32'		195	390						390	298	177	13	3.02	4.19	5
	Piping to Fuel Island	Retain																			
	Fuel Island	Retain	2		44	30		70	140						140	107	64	5	1.16		
	2 x 1,000,000 US gals.	Retain																			
	Decontamination of Steel and Pipe removal	Retain																			
Process Water Plant	Process Water Pumphouse	Retain																			5
	Incinerator	Retain																			
	Reclaim Barge #1	Retain																			
Original Power House Area	Power House			74	113	45		428	856						856	654	388	28	6.51	7.67	8
	Power House Addition			74	20	45		76	152						152	116	69	5	1.16		
Service Complex	Vehicle Shop			215	100	45		1099	2198						2198	1679	997	70	16.28	39.53	40
	Support Facility			290	105	45		1557	3114						3114	2379	1412	100	23.26		
	Truck Scales																				
	Emergency Generators																				
	Power House Support																				
	Assay Lab																				
New Power House	New Power House	Retain		75	70	50		477	954	150		10		500	1114	851	500	36	8.37	9.53	10
	Utilidor E	Retain								150					150	115	60	5	1.16		
Jameson Cell	Jameson Cell			44	44	75		700	1400			30			1430	1093	656	46	10.70	10.70	11
ISA Mill	Isa Mill			146	60	50		1091	2182			25			2207	1686	1007	71	16.51	16.51	17
HDPE Pipelines	Reclaim Barge Line 1	Retain	1	2400	24"																
	Reclaim Barge Line 2	Retain	1	2400	16"																
	Freshwater	Retain	1		6"																
	WTP#2 Over Flow	Retain	1																		
	WTP#1 Over Flow	Retain	1																		
	Red Dog Creek Interception	Retain	3		10"																
	Main Dam Seepage Return Line	Retain	1																		
	Seepage Seepage Return Line	Retain	1																		
	Tailings Discharge	Retain	1	5000	16"																
	Red Dog Creek Mine Line		1	5000	12"																
Cleanup of Contaminated Rockfill	Dozer time covered																				
	Estimated Quantity		92000	yd3																	
	Rock Backfill - Haulage		37500	yd3																	
Hydrocarbon Remediation	estimated quantity		240	yd3																	
TOTALS								**26737**	53474	**1758**	**633**	**1389**	**2107**	**1800**	59361	45352	27079	1933	449.53	449.53	475

[1] - 4.3 trips per hour is based on the productivity rate for R.021 (relocation tab) for moving material from the mill site to the landfill

Table 17. Revegetation Quantities

			Areas (hec)			
Site	**Area**	**Option**	**Native Seed**	**Fertilizer Pellets**	**Live Plants (Shrub Cuttings)**	**Source/Comments**
Mine	Waste Rock Covers	A: Complete 2031	195.0	195.0	19.5	ACAD
		B: Progressive 2031	35.1	35.1	3.5	Low Grade Ore Stockpile +NW end of the Main Pit Stockpile
		C: 2015	113.0	113.0	11.3	ACAD <site layout 2012.dwg>
	Red Dog Creek Div.				1.1	Length-ACAD, width (45ft) from Figure 3.1.5 (Closure and Reclamation Plan) - x .25 (25% of total area planted)
Overburden Dump			22.7	22.7	2.3	(from ACAD)
Back Dam			26.9	26.9	2.7	Includes beach and dam (from ACAD)
Main Dam			46.0	46.0	4.6	Includes beach and dam (from ACAD)
Roads			24.1	24.1	2.4	Includes beach and dam (from ACAD)
Borrow Areas	DD-2		24.0	24.0	2.4	Figure 3.5.1 (Closure & Reclamation Plan)
	MS-14		24.0	24.0	2.4	Estimated

Table 18. Unit Rate Inputs

A. Equipment Rates

Adjustment Factors			
Adjustment Factor for ownership/maintenance cost vs Blue Book	1.00		
Equipment Rates Used:	**AlaskanContractor**		
Include Operator?	No	Avg. Wage ($/hr)	
Include Equipment Owner Overhead?	No	Contractor OH Rate:	10%
Include Equipment Owner Profit?	No	Profit Rate:	10%
Include Fuel Cost?	No	Fuel Cost per Liter:	$0.815

Fuel ($/gal)	
$ 3.08	5-Year Average Price Delivered to RDM (2011-2015)

							Rates Used in Estimate		January 2016 Rates (NC Machinery, Delta, CMI)				
Total Equipment Weight (lbs)	**Individual Equipment Weight (lbs)**	**Model**	**HP**	**# of Operators**	**Operator Type**	**Operator Rate ($/hr)**	**Equipment Rate Includes Maint./lube/etc ($/hr)**	**Fuel Rate ($/hr)[1]**	**Rental Rate Per 4-week period (10 hours/day 5 days/week)**	**Hourly Equipment Rate ($/hr)2**	**Hourly Rate Maint. and Lube ($/hr)[3] (maint = 15%) (lube=10%)**	**Equipment Operating Cost ($/hr)**	**Fleet Size**
		Compactor											
25,000	25,000	CAT CP563	153	1	Power Equipment Operator - Group 3	$59.74	**$41.15**	**$16.21**	$6,875	$34.38	$6.78	$41.15	1
30,000	30,000	Sheepsfoot (72 in, 2 drums)	310	1	Power Equipment Operator - Group 3	$59.74	**$48.74**	**$32.84**	$7,905	$39.53	$9.21	$48.74	1
200	200	Walk-behind vibrating (30 in)	6	1	Labourers - Group 1	$54.82	**$7.83**	**$0.64**	$1,350	$6.75	$1.08	$7.83	1
		Dozer											
0	57,000	CAT D7	240	1	Power Equipment Operator - Group 1	$61.23	**$88.89**	**$26.40**	$15,000	$75.00	$13.89	$88.89	
0	85,000	CAT D8	310	1	Power Equipment Operator - Group 1	$61.23	**$115.54**	**$34.10**	$19,500	$97.50	$18.04	$115.54	
432,000	108,000	CAT D9	410	1	Power Equipment Operator - Group 1	$61.23	**$174.14**	**$45.10**	$29,500	$147.50	$26.64	$174.14	4
0	150,000	CAT D10	570	1	Power Equipment Operator - Group 1	$61.23	**$224.77**	**$62.70**	$38,000	$190.00	$34.77	$224.77	
460,000	230,000	CAT D11	850	1	Power Equipment Operator - Group 1	$61.23	**$314.10**	**$93.50**	$53,000	$265.00	$49.10	$314.10	2
		Drill											
45,000	45,000	Air track rig (900cfm)	215	2	Power Equipment Operator - Group 1	$61.23	**$105.78**	**$22.77**	$18,000	$90.00	$15.78	$105.78	1
130,000	130,000	Air Rotary, 200 cfm compressor	196	2	Power Equipment Operator - Group 1	$61.23	**$186.08**	**$20.76**	$32,000	$160.00	$26.08	$186.08	1
		Excavator											
50,000	50,000	CAT 325	165	1	Power Equipment Operator - Group 1	$61.23	**$44.87**	**$17.48**	$7,500	$37.50	$7.37	$44.87	1
110,000	110,000	CAT 350	428	1	Power Equipment Operator - Group 1	$61.23	**$131.03**	**$45.34**	$22,000	$110.00	$21.03	$131.03	1
120,000	120,000	CAT 345	321	1	Power Equipment Operator - Group 1	$61.23	**$92.53**	**$34.00**	$15,500	$77.50	$15.03	$92.53	1
260,000	130,000	CAT 345 Grapple	321	1	Power Equipment Operator - Group 1	$61.23	**$112.65**	**$34.00**	$19,000	$95.00	$17.65	$112.65	2
130,000	130,000	CAT 345 Hammer	321	1	Power Equipment Operator - Group 1	$61.23	**$106.90**	**$34.00**	$18,000	$90.00	$16.90	$106.90	1
130,000	130,000	CAT 345 Shear	321	1	Power Equipment Operator - Group 1	$61.23	**$95.40**	**$34.00**	$16,000	$80.00	$15.40	$95.40	1
		Grader											
60,000	60,000	CAT 16H	220	1	Power Equipment Operator - Group 1	$61.23	**$140.51**	**$25.10**	$24,000	$120.00	$20.51	$140.51	1
		Lifting											
200,000	200,000	Crane (Cable Boom), 100T	220	1	Power Equipment Operator - Group 1A	$62.99	**$88.04**	**$17.93**	$15,000	$75.00	$13.04	$88.04	1
0	260,000	Crane (Cable Boom), 150T	220	1	Power Equipment Operator - Group 1A	$62.99	**$122.54**	**$17.93**	$21,000	$105.00	$17.54	$122.54	
0	20,000	Forklift CAT 924G	114	1	Power Equipment Operator - Group 3	$59.74	**$25.08**	**$9.29**	$4,200	$21.00	$4.08	$25.08	
		Loader											
100,000	50,000	CAT 966F	235	1	Power Equipment Operator - Group 1	$61.23	**$76.49**	**$23.17**	$12,900	$64.50	$11.99	$76.49	2
100,000	100,000	CAT 988F	430	1	Power Equipment Operator - Group 1A	$62.99	**$147.99**	**$42.39**	$25,000	$125.00	$22.99	$147.99	1
200,000	200,000	CAT 992K	800	1	Power Equipment Operator - Group 1A	$62.99	**$283.89**	**$78.87**	$48,000	$240.00	$43.89	$283.89	1
		Truck											
84,000	7,000	Light Truck (3/4T) 4x2	200	1	Truck Drivers - Group 5	$57.24	**$11.41**	**$10.59**	$1,800	$9.00	$2.41	$11.41	12
375,000	75,000	CAT 740	478	1	Truck Drivers - Group 1	$60.66	**$106.03**	**$25.32**	$18,000	$90.00	$16.03	$106.03	5
650,000	130,000	CAT 777G	938	1	Truck Drivers - Group 1A	$61.93	**$263.72**	**$49.68**	$45,000	$225.00	$38.72	$263.72	5
15,000	15,000	Service Truck	300	1	Mechanic (Power Equipment Operator Group 1)	$61.23	**$25.74**	**$15.89**	$4,200	$21.00	$4.74	$25.74	1
70,000	35,000	Tractor and Lowboy	400	1	Truck Drivers - Group 1	$60.66	**$41.79**	**$21.19**	$6,900	$34.50	$7.29	$41.79	2
15,000	15,000	Fuel Truck	400	1	Mechanic (Power Equipment Operator Group 1)	$61.23	**$36.04**	**$21.19**	$5,900	$29.50	$6.54	$36.04	1
15,000	15,000	Water Truck	400	1	Truck Drivers - Group 1	$60.66	**$36.04**	**$21.19**	$5,900	$29.50	$6.54	$36.04	1
		Dredge											
104,000	52,000	IMS 7012 HP Versi-Dredge	18gal/hr	2	Specialist	$65.00	**$224.16**	**$55.44**	$36,500	$190.10	$34.06	$224.16	2
3,806,200	2,502,200												

1. Fuel consumption is based on a fuel consumption rate/HP found in Caterpillar Handbook

2. Hourly rate calculated based on NC Machinery rental rate is 10hrs/day 5 days per week or 200 hours per 4 week rental period. Rental rate = 4-week rate/200

3. Maintenance, lube, tires etc is calculated based on % of fuel and hourly base rates, per Caterpillar Handbook. Tire rate is considered to be negligable due to project duration and estimated tire life.

Misc. Equipment	**Equipment Rate ($/hr)**	**Est. Fuel Rate ($/hr)**	**Operator Rate ($/hr)**	**Source**
Helicopter, MD500	**$950.00**	**$180.00**		**Soloy Helicopters, Avgas is $6/gal**
IMS Model 7012 HP Versi-Dredge	**$224.16**	**$55.44**	**$65.00**	**IMS Dredges**

Table 18. Unit Rate Inputs

B. Labor Rates

Cost Code	Category	Rate Used in Estimate	Unit	Basic Hourly Rate	Fringes + Burden + OT Adjustment	Contractor Total Unit Cost	Contractor Source
P.01	Asbestos Workers (Labourer Group 2)	$55.82	$/hr	$30.79	$25.03	$55.82	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.02	Carpenter	$62.43	$/hr	$38.09	$24.34	$62.43	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.03	Electrician	$73.58	$/hr	$45.70	$27.88	$73.58	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.04	Engineer	$115.00	$/hr			$115.00	Standard SRK Field Engineer rate for 2015
P.05	Engineering Technician	$80.00	$/hr			$80.00	Standard SRK Engineering Technician rate for 2015
P.06	Foreman	$88.26	$/hr	$44.13	$44.13	$88.26	Alaska Dept. of Labor - Research and Analysis, May 2014 Wages in Alaska (SOC 47-1011, mean wage)
P.07	Hazardous Material Handler (Painter Group 1)	$52.15	$/hr	$32.07	$20.08	$52.15	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.08	Health and Safety Supervisor	$80.02	$/hr	$40.01	$40.01	$80.02	Alaska Dept. of Labor - Research and Analysis, May 2014 Wages in Alaska (SOC 29-9011, mean wage)
P.09	Labourers - Group 1	$54.82	$/hr	$29.79	$25.03	$54.82	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.10	Labourers - Group 2	$55.82	$/hr	$30.79	$25.03	$55.82	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.11	Labourers - Group 3	$56.72	$/hr	$31.69	$25.03	$56.72	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.12	Labourers - Group 3A	$60.00	$/hr	$34.97	$25.03	$60.00	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.13	Labourers - Group 4	$44.39	$/hr	$19.36	$25.03	$44.39	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.14	Mechanic (Power Equipment Operator Group 1)	$61.23	$/hr	$40.03	$21.20	$61.23	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.15	Millwright	$58.98	$/hr	$36.49	$22.49	$58.98	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.16	Power Equipment Operator - Group 1	$61.23	$/hr	$40.03	$21.20	$61.23	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.17	Power Equipment Operator - Group 1A	$62.99	$/hr	$41.79	$21.20	$62.99	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.18	Power Equipment Operator - Group 2	$60.46	$/hr	$39.26	$21.20	$60.46	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.19	Power Equipment Operator - Group 3	$59.74	$/hr	$38.54	$21.20	$59.74	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.20	Power Equipment Operator - Group 4	$53.53	$/hr	$32.33	$21.20	$53.53	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.21	Site Clerk / Medic	$66.38	$/hr	$33.19	$33.19	$66.38	Alaska Dept. of Labor - Research and Analysis, May 2014 Wages in Alaska (SOC 29-9012, mean wage)
P.22	Superintendent	$119.76	$/hr	$59.88	$59.88	$119.76	Alaska Dept. of Labor - Research and Analysis, May 2014 Wages in Alaska (SOC 11-9021, mean wage)
P.23	Survey Field Manager	$63.88	$/hr	$42.51	$21.37	$63.88	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.24	Survey Crew (Surveyor and Helper)	$116.21	$/hr	$73.47	$42.74	$116.21	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.25	Truck Drivers - Group 1A	$61.93	$/hr	$40.56	$21.37	$61.93	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.26	Truck Drivers - Group 1	$60.66	$/hr	$39.29	$21.37	$60.66	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.27	Truck Drivers - Group 2	$59.40	$/hr	$38.03	$21.37	$59.40	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.28	Truck Drivers - Group 3	$58.58	$/hr	$37.21	$21.37	$58.58	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.29	Truck Drivers - Group 4	$58.00	$/hr	$36.63	$21.37	$58.00	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)
P.30	Truck Drivers - Group 5	$57.24	$/hr	$35.87	$21.37	$57.24	Alaska Dept. of Labor - Laborers' & Mechanics' Min. Rate of Pay (Effective Sept 1, 2015)

Labor rates (basic hourly rate) sourced from the AK DOL May 2014 Wages were doubled for the contractor total unit cost to ensure that fringes and benefits were covered. Comparison of the DOL Laborers' & Mechanics' Min Rate of Pay to the AK DOL May 2014 Wages shows that fringes and benefits are approximately 40% of the total unit cost; we increased fringes and benefits to 50% for these rates to be conservative.
SRK standard rates used for total contractor unit cost include fringes and benefits.

C. Material Costs

Cost Code	Item	Unit Cost ($)	Unit	Source
M.01	Bentonite	$457.00	tonnes	Polar Supply, Anchorage - FOB Anchorage, $414.55/ton
M.04	Electricity: Overhead Electrical Conductors	$23.05	m	RSMeans 2014, Heavy Construction (Pg 380) (2 conductors)
M.05	Electricity: Pole-mounted Transformer	$10,500.00	each	RSMeans 2014, Heavy Construction (Pg 379)
M.06	Electricity: Treated Power Poles (40' class 3)	$442.75	each	RSMeans 2014, Heavy Construction (Pg 376)
M.07	Explosives and Blasting Caps (for rip-rap production)	$8.14	each	RSMeans 2014, Heavy Construction (Pg 229)
M.08	Fertilizer (dry, granular 4#)	$0.04	m2	RSMeans 2014, Heavy Construction (Pg 299)
M.09	Flocculant	$4,500	tonne	Current RD price, FOB Seattle
M.10	Fuel: Diesel	$0.81	liter	
M.11	Fuel: Diesel	$3.08	gallon	5-year average price delivered to RDM (2011-2015)
M.12	Geosynthetic Clay Liner (60 mil, textured)	$5.69	m2	Quotes (mean value): GSE Environmental, AGRU America, and Titan
M.13	Geotextile (8 oz.)	$1.53	m2	Quotes (mean value): GSE Environmental, AGRU America, and Titan
M.14	Groundwater Pump: 6" Submersible Pump (weighted average of two pumps: TDH=6	$7,434.00	each	Delta Pump Quote (weighted average of two pumps)
M.15	Groundwater Pump: 6" Submersible Pump (TDH=60', Flow Rate 700-1400 gpm)	$9,114.00	each	Delta Pump Quote
M.16	HDPE liner (60 mil, textured)	$5.47	m2	Quotes (mean value): GSE Environmental, AGRU America, and Titan
M.19	HDPE pipe: 150 mm (6"), insulated	$95.00	m	Ferguson Supply - comes with heat trace channel and includes cost for joint kits, FOB Seattle
M.21	HDPE pipe: 350 mm (14"), insulated	$210.00	m	Ferguson Supply - comes with heat trace channel and includes cost for joint kits, FOB Seattle
M.23	Heat trace electrical thermostat	$9,000.00	each	Municipality of Anchorage 2014 bid (average)
M.24	Heat trace Power Feed Kit	$2,400.00	each	Municipality of Anchorage 2014 bid (average)
M.25	Heat trace: constant watt cables	$90.00	m	Municipality of Anchorage 2014 bid (average)
M.26	Lime	$197.19	tonne	2015 RD price, FOB Seattle
M.27	Lumber: 2x4x8 Studs (Doug-Fir)	$4.16	each	Lowe's (website)
M.28	Native seed	$7.00	kg	Estimated - USDA Plant Material Center
M.29	Plants: live shrub cuttings	$1,800.00	hec	Estimated - USDA Plant Material Center
M.30	Plywood: 1/2"x4x8 (Fir Sheathing)	$23.47	each	Lowe's (website)
M.31	Precast Concrete Manhole: 4' ID, 4' Deep	$940.08	each	RSMeans 2014, Heavy Construction (Pg 365)
M.32	Pump: 250PSI pump with motor	$2,547.30	each	RSMeans 2014, Heavy Construction (pg 353)
M.37	Riparian Area vegetation (willow)	$12.00	kg	Estimated - USDA Plant Material Center
M.38	Sodium Sulfide	$908	tonne	2015 RD price, FOB Delta Tug terminal, BC (appx. same cost as FOB Seattle per TAK)
M.44	Well Casing: Steel	$3.29	kg	RSMeans 2014, Heavy Construction (Pg 352)

Table 19. Relocation Unit Costs

Relocation Tables

Relocation Productivity (Lm3/hr) obtained from Caterpillar Fleet Production and Cost Analysis (FPC) Simulator 5.2.0.0

Cost Code	Area	Activity	Material	Source	Destination	Distance (1-way) (km)	Loose (Lm^3/hr)	Bank (Bm^3/hr)	Total Loose Unit Rate ($/Bm3)	Total Bank Unit Rate ($/Bm3)	Manhours (hrs/Bm3)	Labor Cost ($/Bm3)	Equipment Cost ($/Bm3)	Fuel Cost ($/Bm3)
R.001	Aqqaluk Pit	Load, haul, dump, place	Rip-Rap	DD-2	Aqqaluk Pit Perimeter	6.34	91	127	$9.65	**$13.51**	0.063	$ 3.83	$ 7.61	$ 2.07
R.002	Qanaiyaq Pit	Load, haul, dump, place	Rip-Rap	DD-2	Qanaiyaq Pit Perimeter	5.62	122	171	$7.91	**$10.03**	0.047	$ 2.85	$ 5.65	$ 1.53
R.003	Main Pit	Load, haul, dump, place	Rip-Rap	DD-2	Main Pit Perimeter	7.27	96	135	$10.02	**$12.71**	0.059	$ 3.61	$ 7.16	$ 1.94
R.004	MWD (2015)	Load, haul, dump, place	Shale	MWD Cover Stockpile	MWD Cover	0.73	496	669	$3.40	**$3.72**	0.010	$ 0.65	$ 2.52	$ 0.55
R.005	MWD	Load, haul, dump, place	Shale	Aqqaluk Pit	MWD channels	2.85	168	227	$5.38	**$7.40**	0.040	$ 2.39	$ 3.99	$ 1.02
R.006	MWD	Load, haul, dump	Rip-Rap	DD-2	MWD channels	6.29	111	156	$6.49	**$8.57**	0.045	$ 2.74	$ 4.63	$ 1.20
R.007	MPD Area (2015)	Load, haul, dump, place	Shale	Aqqaluk Pit	MPD Cover	1.07	488	659	$3.46	**$3.78**	0.011	$ 0.66	$ 2.56	$ 0.56
R.008	Spillway	Load, haul, dump	Rip-Rap	DD-2	Spillway	5.37	127	178	$5.69	**$7.51**	0.039	$ 2.40	$ 4.06	$ 1.05
R.009	MPD Area (2031)	Load, haul, dump, place	Shale	Oxide Dump Cover Stockpile	MPD Cover	0.82	473	639	$2.83	**$3.02**	0.008	$ 0.49	$ 2.10	$ 0.43
R.010	Tailing Water Ditches	Load, haul, dump, place	Shale	DD-2	Tailings Water control ditches	1.5	199	269	$3.44	**$4.59**	0.022	$ 1.37	$ 2.55	$ 0.67
R.011	Main Dam (2015)	Load, haul, dump, place, compact	Shale	Aqqaluk Pit	Main Dam (beach const.)	3.01	481	649	$4.07	**$4.51**	0.014	$ 0.85	$ 3.02	$ 0.64
R.012	Main Dam (2031)	Load, haul, dump, place, compact	Shale	Overburden Cover Stockpile	Main Dam (beach cover)	3.96	470	634	$4.24	**$4.70**	0.014	$ 0.88	$ 3.14	$ 0.68
R.013	LGO & Q-Pit Access	Load, haul, dump, place	Shale	Aqqaluk Pit	LGO Area	2.43	601	812	$3.24	**$3.53**	0.010	$ 0.61	$ 2.40	$ 0.51
R.014	Main Dam	Load, haul, dump	Rip-Rap	DD-2	Main Dam (erosion pro.)	5.09	151	212	$5.92	**$7.63**	0.038	$ 2.31	$ 4.23	$ 1.09
R.015	Back Dam (2015)	Load, haul, dump, place, compact	Shale	Aqqaluk Pit	Back Dam (beach const.)	5.21	388	524	$5.13	**$5.69**	0.017	$ 1.06	$ 3.80	$ 0.83
R.016	Back Dam (2031)	Load, haul, dump, place, compact	Shale	Overburden Cover Stockpile	Back Dam (beach cover)	0.6	447	604	$3.27	**$3.69**	0.012	$ 0.71	$ 2.42	$ 0.55
R.017	LGO & Q-Pit Areas	Load, haul, dump, place	Shale	Oxide Dump Cover Stockpile	LGO Area	0.67	535	722	$2.66	**$2.93**	0.008	$ 0.51	$ 1.97	$ 0.44
R.018	Back Dam	Load, haul, dump	Rip-Rap	DD-2	Back Dam (erosion pro.)	1.52	253	354	$3.55	**$4.57**	0.023	$ 1.38	$ 2.53	$ 0.65
R.019	Red Dog Creek	Load, haul, dump, place	Shale	Aqqaluk Pit	Red Dog Creek	1.07	247	334	$3.20	**$4.27**	0.021	$ 1.28	$ 2.37	$ 0.62
R.020		Load, haul, dump	Rip-Rap	DD-2	Red Dog Creek	6.55	123	172	$7.30	**$9.40**	0.047	$ 2.84	$ 5.22	$ 1.35
R.021	Mill Area	Load, haul, dump, place	Waste Rock	Mill Area	MWD Landfill	2.08	136	183	$5.38	**$7.03**	0.033	$ 2.00	$ 3.99	$ 1.05
R.022		Load, haul, dump, place	Shale	Overburden Cover Stockpile	Mill Area	2.13	244	330	$3.49	**$4.53**	0.021	$ 1.30	$ 2.58	$ 0.65
R.023		Load, haul, dump, place	Earth	Mill Area	MWD Landfill	2.08	129	161	$5.66	**$7.99**	0.037	$ 2.27	$ 4.53	$ 1.19

Material Properties

Assumed Material Properties	Bulk Density Mg/m3	Bulking Factor	Excavated Density Mg/m3	Shrinkage Factor	Compacted Density Mg/m3
Clay - Natural	2.02	1.20	1.68	0.90	1.82
Earth	1.90	1.25	1.52	0.95	1.81
Gravels	2.17	1.10	1.97	0.97	2.10
Misc.	2.00	1.00	2.00	1.00	2.00
Rip-Rap	2.61	1.40	1.86	1.00	2.61
Sands	1.90	1.10	1.73	0.90	1.71
Sand & Gravel	2.23	1.10	2.02	1.00	2.23
Shale	2.61	1.35	1.93	0.90	2.35
Top Soil	1.37	1.40	0.98	1.10	1.51
Till	1.84	1.20	1.53	0.90	1.66
Waste Rock	3.00	1.35	2.22	0.90	2.70

Material properties were updated to match current mine production densities

Haul Route Segments

From	To		Elev change (ft)	Dist (ft)	Grade	Dist (km)
DD2	Mill		20	13800	0%	4.21
Mill	Crusher		40	2230	2%	0.68
Crusher	End RDC div		-100	1150	-9%	0.35
End RDC div	MP entrance		-40	1300	-3%	0.40
MP entrance	A pit rim		230	2300	10%	0.70
MP entrance	RDC		50	2600	2%	0.79
Crusher	main pit rim		170	2400	7%	0.73
Crusher	MWD		240	4600	5%	1.40
MWD	QP Rim		165	3200	5%	0.98
MWD	Q Pit		100	1500	7%	0.46
MWD SP	MWD		-100	2400	-4%	0.73
MWD SP	Q Pit		-20	1400	-1%	0.43
Ox SP	LGO SP		-140	2200	-6%	0.67
Ox SP	MPD		-30	2700	-1%	0.82
A-Pit Borrow	MPD 2015		-100	3500	-3%	1.07
MP Ent	A-Pit Borrow		125	2300	5%	0.70
Mill	Spillway		-10	2100	0%	0.64
			-165	1700	-10%	0.52
DD2	TSF Ditches		20	5000	0%	1.52
Mill	Main Dam Beach		-10	2900	0%	0.88
OVB SP	Mill		0	10100	0%	3.08
OVB SP	BDB		-20	1000	-2%	0.30
			0	1000	0%	0.30
DD2	BDB		0	5000	0%	1.52
A-Pt Borrow	RDC		-100	2000	-5%	0.61
			0	1500	0%	0.46
MP entrance	RDC		50	3000	2%	0.91

Table19. Relocation Unit Costs

	Equipment Used																								
	Loader					Excavator					Truck					Dozer 1					Compactor				
Cost Code	Qnty	Model	Equipment Rate ($/hr)	Fuel Cost ($/hr)	Operator Wage ($/hr)	Qnty	Model	Equipment Rate ($/hr)	Fuel Cost ($/hr)	Operator Wage ($/hr)	Qnty	Model	Equipment Rate ($/hr)	Fuel Cost ($/hr)	Operator Wage ($/hr)	Qnty	Model	Equipment Rate ($/hr)	Fuel Cost ($/hr)	Operator Wage ($/hr)	Qnty	Model	Equipment Rate ($/hr)	Fuel Cost ($/hr)	Operator Wage ($/hr)
R.001						2	CAT 350	$131.03	$45.34	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.002						2	CAT 350	$131.03	$45.34	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.003						2	CAT 350	$131.03	$45.34	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.004	1	CAT 992K	$283.89	$78.87	$62.99						4	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23					
R.005	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23	1	Walk-behind vib	$7.83	$0.64	$54.82
R.006	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66										
R.007	1	CAT 992K	$283.89	$78.87	$62.99						4	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23					
R.008	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66										
R.009	1	CAT 992K	$283.89	$78.87	$62.99						4	CAT 777G	$263.72	$49.68	$61.93										
R.010	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	3	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.011	1	CAT 992K	$283.89	$78.87	$62.99						5	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23	1	Walk-behind vib	$7.83	$0.64	$54.82
R.012	1	CAT 992K	$283.89	$78.87	$62.99						5	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23	1	CAT CP563	$41.15	$16.21	$59.74
R.013	1	CAT 992K	$283.89	$78.87	$62.99						5	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23					
R.014	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.015	1	CAT 992K	$283.89	$78.87	$62.99						5	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23	1	CAT CP563	$41.15	$16.21	$59.74
R.016	1	CAT 992K	$283.89	$78.87	$62.99						3	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23	1	CAT CP563	$41.15	$16.21	$59.74
R.017	1	CAT 992K	$283.89	$78.87	$62.99						3	CAT 777G	$263.72	$49.68	$61.93	2	CAT D9	$174.14	$45.10	$61.23					
R.018	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.019	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	4	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.020	1	CAT 988F	$147.99	$42.39	$62.99	1	CAT 325	$44.87	$17.48	$61.23	5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.021						1	CAT 350	$131.03	$45.34	$61.23	4	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.022	1	CAT 988F	$147.99	$42.39	$62.99						5	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					
R.023						1	CAT 350	$131.03	$45.34	$61.23	4	CAT 740	$106.03	$25.32	$60.66	1	CAT D9	$174.14	$45.10	$61.23					

Haul Route Information - update this table

	Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Segment 6		Segment 7		
Cost Code	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Grade (%)	Distance (km)	Total (km)
R.001	0	4.21	2	0.68	-9	0.35	-3	0.4	10	0.7					6.34
R.002	0	4.21	2	0.68	7	0.73									5.62
R.003	0	4.21	2	0.68	5	1.4	5	0.98							7.27
R.004	-4	0.73													0.73
R.005	-5	0.7	3	0.4	9	0.35	5	1.4							2.85
R.006	0	4.21	2	0.68	5	1.4									6.29
R.007	-3	1.07													1.07
R.008	0	4.21	0	0.64	-10	0.52									5.37
R.009	-1	0.82													0.82
R.010	0	1.5													1.5
R.011	-5	0.7	3	0.4	9	0.35	-2	0.68	0	0.88					3.01
R.012	0	3.08	0	0.88											3.96
R.013	-5	0.7	3	0.4	9	0.35	5	0.98							2.43
R.014	0	4.21	0	0.88											5.09
R.015	-5	0.7	3	0.4	9	0.35	-2	0.68	0	3.08					5.21
R.016	-2	0.3	0	0.3											0.6
R.017	-6	0.67													0.67
R.018	0	1.52													1.52
R.019	-5%	0.61	0	0.46											1.07
R.020	0	4.21	2	0.68	-9	0.35	-3	0.4	2	0.91					6.55
R.021	2	0.68	5	1.4											2.08
R.022	-5	0.7	3	0.4	9	0.35	-2	0.68							2.13
R.023	2	0.68	5	1.4											2.08

Table below is a snapshot from Caterpillar Fleet Production & Cost Analysis (FPC) 5.2.0.0

File name containing full output: CAT SIM Fleet Productivity_20160310_IJC.xls

Model name : Eqipment_productivities_20160310_ijc.fpc4

Course	Fleet	Material Qty BCM	Haul meters	Return meters	Scheduled Hrs. Req.	BCM per Sched Hr
R.001	350 - 5x 740	10,000	6,340	6,340	79	127
R.002	350 - 5x 740	10,000	5,620	5,620	58	171
R.003	350 - 5x 740	10,000	7,270	7,270	74	135
R.004	992K - 4x 777G	10,000	730	730	15	669
R.005	988 - 5x 740	10,000	2,850	2,850	44	227
R.006	988 - 5x 740	10,000	6,290	6,290	64	156
R.007	992K - 4x 777G	10,000	1,070	1,070	15	659
R.008	988 - 5x 740	10,000	5,370	5,370	56	178
R.009	992K - 4x 777G	10,000	820	820	16	639
R.010	988 - 3x 740	10,000	1,500	1,500	37	269
R.011	992K - 5x 777G	10,000	3,010	3,010	15	649
R.012	992K - 5x 777G	10,000	3,960	3,960	16	634
R.013	992K - 5x 777G	10,000	1,548	1,548	12	812
R.014	988 - 5x 740	10,000	5,090	5,090	47	212
R.015	992K - 5x 777G	10,000	5,210	5,210	19	524
R.016	992K - 3x 777G	10,000	600	600	17	604
R.017	992K - 3x 777G	10,000	670	670	14	722
R.018	988 - 5x 740	10,000	1,520	1,520	28	354
R.019	988 - 4x 740	10,000	1,070	1,070	30	334
R.020	988 - 5x 740	10,000	6,550	6,550	58	172
R.021	350 - 4x 740	10,000	2,080	2,080	55	183
R.022	988 - 5x 740	10,000	2,130	2,130	30	330
R.023	350 - 4x 740	10,000	2,080	2,080	62	161

Table 20. Tasks Unit Costs

Cost Code	Item	Unit	Productivity (unit/hr)	Total Unit Cost	Manhours per Unit (hrs/Unit)	Labor Cost Per Unit ($/Unit)	Material Cost Per Unit ($/Unit)	Equipment Cost Per Unit ($/Unit)	Fuel Cost Per Unit ($/Unit)	Power Cost Per Unit
Demolition										
C1.01	**Excavator: CAT 345 w/ bucket**	**hrs**	**1**	**$ 187.76**	1.000	$ 61.23	$ -	$ 92.53	$ 34.00	
C1.02	**Excavator: CAT 345 w/ grapple attachment**	**hrs**	**1**	**$ 207.88**	1.000	$ 61.23	$ -	$ 112.65	$ 34.00	
C1.03	**Excavator: CAT 345 w/ hammer attachment**	**hrs**	**1**	**$ 202.13**	1.000	$ 61.23	$ -	$ 106.90	$ 34.00	
C1.04	**Excavator: CAT 345 w/ shear attachment**	**hrs**	**1**	**$ 190.63**	1.000	$ 61.23	$ -	$ 95.40	$ 34.00	
C1.05	**Dozer: CAT D9**	**hrs**	**1**	**$ 280.47**	1.000	$ 61.23	$ -	$ 174.14	$ 45.10	
C1.06	**Truck: CAT 740**	**hrs**	**1**	**$ 192.01**	1.000	$ 60.66	$ -	$ 106.03	$ 25.32	
C1.07	**General Labor**	**hrs**	**1**	**$ 54.82**	1.000	$ 54.82	$ -	$ -	$ -	
Earthworks										
C2.01	**Backfill excavated ditches**	**m3**	**100**	**$ 2.42**	0.030	$ 1.71	$ -	$ 0.53	$ 0.18	
C2.02	**Bedding: Produce and stockpile**	**m3**	**200**	**$ 3.53**	0.010	$ 0.62	$ -	$ 2.29	$ 0.62	
C2.03	**Berm: Shaping material**	**m**	**50**	**$ 5.61**	0.020	$ 1.22	$ -	$ 3.48	$ 0.90	
C2.04	**Clearing land**	**m2**	**275**	**$ 1.02**	0.004	$ 0.22	$ -	$ 0.63	$ 0.16	
C2.05	**Clearing and grubbing**	**m2**	**275**	**$ 3.28**	0.015	$ 0.89	$ -	$ 1.88	$ 0.51	
C2.06	**Compaction: D9 with Impact Roller**	**hrs**	**1**	**$ 421.78**	2.000	$ 120.97	$ -	$ 222.87	$ 77.94	
C2.07	**Crusher: Crush materials**	**m3**	**125**	**$ 3.86**	0.032	$ 1.93	$ -	$ 1.32	$ 0.62	
C2.08	**Cut-off Wall: Install (all-inclusive)**	**m2**	**10**	**$ 147.32**	0.500	$ 33.73	$ 74.03	$ 30.52	$ 9.04	
C2.09	**Drilling and blasting**	**m3**	**500**	**$ 2.05**	0.007	$ 0.41	$ 1.22	$ 0.37	$ 0.04	
C2.10	**Drilling: Air Rotary 8" dia.**	**m**	**1.5**	**$ 272.86**	2.000	$ 134.97	$ -	$ 124.05	$ 13.84	
C2.11	**Excavation: Large channel (short haul)**	**m3**	**90**	**$ 9.04**	0.044	$ 2.70	$ -	$ 4.99	$ 1.35	
C2.12	**Excavation: Common (no haul)**	**m3**	**90**	**$ 1.37**	0.011	$ 0.68	$ -	$ 0.50	$ 0.19	
C2.13	**Excavation: Common (short haul)**	**m3**	**170**	**$ 4.79**	0.024	$ 1.43	$ -	$ 2.64	$ 0.71	
C2.14	**Excavation: Shallow trench (no haul)**	**m3**	**50**	**$ 2.47**	0.020	$ 1.22	$ -	$ 0.90	$ 0.35	
C2.15	**Excavation: Deep trench (short haul)**	**m3**	**35**	**$ 17.76**	0.086	$ 5.22	$ -	$ 9.80	$ 2.74	
C2.16	**Excavation: Rock**	**m3**	**15**	**$ 23.50**	0.173	$ 10.60	$ -	$ 10.48	$ 2.43	
C2.17	**Excavate and create berms (Red Dog Creek)**	**m3**	**50**	**$ 20.08**	0.120	$ 7.19	$ -	$ 9.74	$ 3.16	
C2.18	**Foundation Preparation**	**m2**	**22**	**$ 44.44**	0.318	$ 19.70	$ -	$ 19.59	$ 5.15	
C2.19	**Grading: Roads, ramps, etc.**	**m2**	**460**	**$ 0.49**	0.002	$ 0.13	$ -	$ 0.31	$ 0.05	
C2.20	**Grouting: Setting Packers**	**each**	**14**	**$ 23.64**	0.214	$ 14.46	$ -	$ 7.56	$ 1.63	
C2.21	**Landfarm: Operate**	**hrs**	**1**	**$ 335.29**	2.000	$ 116.05	$ -	$ 174.14	$ 45.10	
C2.22	**Level and compact working surface (nominal compaction)**	**m3**	**80**	**$ 3.51**	0.013	$ 0.77	$ -	$ 2.18	$ 0.56	
C2.23	**Regrading**	**hrs**	**1**	**$ 468.83**	1.000	$ 61.23	$ -	$ 314.10	$ 93.50	
C2.24	**Rip-Rap: Drill, blast and stockpile**	**m3**	**100**	**$ 14.29**	0.045	$ 2.67	$ 8.14	$ 2.80	$ 0.68	
C2.25	**Rip-Rap (rounded, low quality): Screen and Stockpile**	**m3**	**50**	**$ 14.12**	0.040	$ 2.48	$ -	$ 9.16	$ 2.48	
C2.26	**Rip-Rap (angular, high quality): Screen and Stockpile**	**m3**	**35**	**$ 20.18**	0.057	$ 3.55	$ -	$ 13.09	$ 3.54	
C2.27	**Rip-Rap rock placement**	**m3**	**80**	**$ 1.54**	0.013	$ 0.77	$ -	$ 0.56	$ 0.22	
C2.28	**Road: Construct access road**	**m**	**40**	**$ 29.06**	0.131	$ 8.01	$ -	$ 16.80	$ 4.26	
C2.29	**Road: Construct haul road**	**m**	**18**	**$ 143.85**	0.375	$ 22.28	$ -	$ 97.72	$ 23.85	
C2.30	**Road: Reshape and scarify shoulders**	**m**	**50**	**$ 4.54**	0.020	$ 1.22	$ -	$ 2.81	$ 0.50	
C2.31	**Tailings: Spilled tailings cleanup**	**m3**	**75**	**$ 13.07**	0.067	$ 4.06	$ -	$ 7.16	$ 1.85	
C2.32	**Dredge and place tailings**	**m3**	**450**	**$ 1.83**	0.009	$ 0.58	$ -	$ 1.00	$ 0.25	
Materials										
C3.01	**Dust Suppressant - Supply and Apply**	**m2**	**1000**	**$ 0.17**	0.003	$ 0.15	$ -	$ 0.01	$ 0.01	
C3.02	**Electricity - Overhead electrical conductors**	**m**	**125**	**$ 26.16**	0.032	$ 2.27	$ 23.05	$ 0.70	$ 0.14	
C3.03	**Electricity - Treated Power Poles (40' class 3)**	**each**	**0.66**	**$ 10,978.97**	4.545	$ 318.41	$ 10,500.00	$ 133.40	$ 27.17	
C3.04	**Electricity - Pole mounted transformer**	**each**	**0.2**	**$ 2,391.26**	20.000	$ 1,418.65	$ 442.75	$ 440.22	$ 89.65	
C3.05	**Geotextile: Supply and Install (large areas)**	**m2**	**250**	**$ 2.83**	0.016	$ 0.90	$ 1.53	$ 0.31	$ 0.09	
C3.06	**Geotextile: Supply and Install (channels)**	**m2**	**70**	**$ 6.96**	0.071	$ 4.01	$ 1.53	$ 1.09	$ 0.33	
C3.07	**Geosynthetic Clay Liner: Supplied & Installed**	**m2**	**125**	**$ 8.94**	0.040	$ 2.45	$ 5.69	$ 0.61	$ 0.19	
C3.08	**Groundwater Pump: 6" Submersible Pump (60-100 gpm)**	**m2**	**0.25**	**$ 8,125.48**	12.000	$ 691.48	$ 7,434.00	$ -	$ -	
C3.09	**Groundwater Pump: 6" Submersible Pump (700-1400 gpm)**	**m2**	**0.25**	**$ 9,805.48**	12.000	$ 691.48	$ 9,114.00	$ -	$ -	
C3.10	**HDPE liner: Supplied & Installed (large areas)**	**m2**	**150**	**$ 8.17**	0.033	$ 2.04	$ 5.47	$ 0.51	$ 0.15	
C3.11	**HDPE liner: Supplied & Installed (channels)**	**m2**	**35**	**$ 17.05**	0.143	$ 8.73	$ 5.47	$ 2.19	$ 0.66	
C3.12	**HDPE pipe: 150mm, insulated; supplied and installed**	**m**	**14.5**	**$ 106.34**	0.207	$ 11.34	$ 95.00	$ -	$ -	
C3.13	**HDPE pipe: 350mm, insulated; supplied and installed**	**m**	**13**	**$ 222.65**	0.231	$ 12.65	$ 210.00	$ -	$ -	
C3.14	**Heat trace: Constant watt cables, installed**	**m**	**50**	**$ 95.25**	0.080	$ 4.81	$ 90.00	$ 0.23	$ 0.21	
C3.15	**Heat trace Power Feed Kit**	**each**	**0.5**	**$ 2,694.32**	4.000	$ 294.32	$ 2,400.00	$ -	$ -	
C3.16	**Heat trace electrical thermostat**	**each**	**2**	**$ 9,073.58**	1.000	$ 73.58	$ 9,000.00	$ -	$ -	
C3.17	**Manholes: Precast 12' deep: supplied and installed**	**each**	**0.25**	**$ 5,013.19**	16.000	$ 1,003.48	$ 3,760.30	$ 179.49	$ 69.92	
C3.18	**Pump: Install large seepage pump**	**each**	**0.25**	**$ 3,230.78**	12.000	$ 683.48	$ 2,547.30	$ -	$ -	
C3.19	**Pumping well protective housing**	**each**	**0.15**	**$ 3,160.88**	26.667	$ 1,542.07	$ 1,472.15	$ 76.06	$ 70.60	
C3.20	**Well Casing, 150mm Stainless Steel, supplied and installed**	**m**	**20**	**$ 23.75**	0.150	$ 10.12	$ 3.29	$ 9.30	$ 1.04	
C3.21	**Well Cover: Steel protective well cover**	**each**	**1.5**	**$ 219.53**	1.333	$ 81.64	$ -	$ 124.05	$ 13.84	
Revegetation										
C4.01	**Seeding/Fertilizing: Application by Helicopter**	**hec**	**2.8**	**$ 942.93**	1.607	$ 93.55	$ 437.95	$ 343.36	$ 68.07	
C4.02	**Planting (shrubs, seedlings, etc.): By hand**	**hec**	**0.032**	**$ 7,702.47**	93.750	$ 5,215.00	$ 1,800.00	$ 356.53	$ 330.94	
Relocations										
C5.01	**See Unit Cost Relocations Worksheet**									

Table 20. Tasks Unit Costs

		Manhour Details					
		Laborers/Trades			Equipment Operators		
Cost Code	Item	Qnty	Description	Rate ($/hr)	Qnty	Description	Rate ($/hr)
Demolition							
C1.01	**Excavator: CAT 345 w/ bucket**				1.0	Power Equipment Operator - Group 1	$61.23
C1.02	**Excavator: CAT 345 w/ grapple attachment**				1.0	Power Equipment Operator - Group 1	$61.23
C1.03	**Excavator: CAT 345 w/ hammer attachment**				1.0	Power Equipment Operator - Group 1	$61.23
C1.04	**Excavator: CAT 345 w/ shear attachment**				1.0	Power Equipment Operator - Group 1	$61.23
C1.05	**Dozer: CAT D9**				1.0	Power Equipment Operator - Group 1	$61.23
C1.06	**Truck: CAT 740**				1.0	Truck Drivers - Group 1	$60.66
C1.07	**General Labor**	1.0	Labourers - Group 1	$54.82			
Earthworks							
C2.01	**Backfill excavated ditches**	1.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
					1.0	Labourers - Group 1	$54.82
C2.02	**Bedding: Produce and stockpile**				1.0	Power Equipment Operator - Group 1A	$62.99
					1.0	Power Equipment Operator - Group 1	$61.23
C2.03	**Berm: Shaping material**				1.0	Power Equipment Operator - Group 1	$61.23
C2.04	**Clearing land**				1.0	Power Equipment Operator - Group 1	$61.23
C2.05	**Clearing and grubbing**				1.0	Power Equipment Operator - Group 1	$61.23
					1.0	Power Equipment Operator - Group 1	$61.23
					2.0	Truck Drivers - Group 1	$60.66
C2.06	**Compaction: D9 with Impact Roller**				1.0	Power Equipment Operator - Group 1	$61.23
					1.0	Power Equipment Operator - Group 3	$59.74
C2.07	**Crusher: Crush materials**				1.0	Power Equipment Operator - Group 1	$61.23
					2.0	Power Equipment Operator - Group 1	$61.23
					1.0	Truck Drivers - Group 5	$57.24
C2.08	**Cut-off Wall: Install (all-inclusive)**	1.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
		2.0	Engineering Technician	$80.00	1.0	Power Equipment Operator - Group 1	$61.23
C2.09	**Drilling and blasting**	1.5	Labourers - Group 2	$55.82	2.0	Power Equipment Operator - Group 1	$61.23
C2.10	**Drilling: Air Rotary 8" dia.**	1.0	Engineering Technician	$80.00	2.0	Power Equipment Operator - Group 1	$61.23
C2.11	**Excavation: Large channel (short haul)**				1.0	Power Equipment Operator - Group 1	$61.23
					3.0	Truck Drivers - Group 1	$60.66
C2.12	**Excavation: Common (no haul)**				1.0	Power Equipment Operator - Group 1	$61.23
C2.13	**Excavation: Common (short haul)**				1.0	Power Equipment Operator - Group 1	$61.23
					3.0	Truck Drivers - Group 1	$60.66
C2.14	**Excavation: Shallow trench (no haul)**				1.0	Power Equipment Operator - Group 1	$61.23
C2.15	**Excavation: Deep trench (short haul)**				1.0	Power Equipment Operator - Group 1	$61.23
					2.0	Truck Drivers - Group 1	$60.66
C2.16	**Excavation: Rock**				2.0	Power Equipment Operator - Group 1	$61.23
					0.2	Power Equipment Operator - Group 1	$61.23
					0.4	Truck Drivers - Group 1	$60.66
C2.17	**Excavate and create berms (Red Dog Creek)**	1.0	Labourers - Group 1	$54.82	2.0	Power Equipment Operator - Group 1	$61.23
					2.0	Power Equipment Operator - Group 1	$61.23
					1.0	Power Equipment Operator - Group 3	$59.74
C2.18	**Foundation Preparation**	2.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
		1.0	Engineering Technician	$80.00	1.0	Power Equipment Operator - Group 1	$61.23
					2.0	Truck Drivers - Group 1	$60.66
C2.19	**Grading: Roads, ramps, etc.**				1.0	Power Equipment Operator - Group 1	$61.23
C2.20	**Grouting: Setting Packers**	1.0	Engineering Technician	$80.00	2.0	Power Equipment Operator - Group 1	$61.23
C2.21	**Landfarm: Operate**	1.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
C2.22	**Level and compact working surface (nominal compaction)**				1.0	Power Equipment Operator - Group 1	$61.23
C2.23	**Regrading**				1.0	Power Equipment Operator - Group 1	$61.23
C2.24	**Rip-Rap: Drill, blast and stockpile**	1.5	Labourers - Group 2	$55.82	2.0	Power Equipment Operator - Group 1	$61.23
					1.0	Power Equipment Operator - Group 1	$61.23
C2.25	**Rip-Rap (rounded, low quality): Screen and Stockpile**				1.0	Power Equipment Operator - Group 1A	$62.99
					1.0	Power Equipment Operator - Group 1	$61.23
C2.26	**Rip-Rap (angular, high quality): Screen and Stockpile**				1.0	Power Equipment Operator - Group 1A	$62.99
					1.0	Power Equipment Operator - Group 1	$61.23
C2.27	**Rip-Rap rock placement**				1.0	Power Equipment Operator - Group 1	$61.23
C2.28	**Road: Construct access road**				1.0	Power Equipment Operator - Group 1	$61.23
					2.0	Truck Drivers - Group 1	$60.66
					2.0	Power Equipment Operator - Group 1	$61.23
					0.3	Power Equipment Operator - Group 1	$61.23
C2.29	**Road: Construct haul road**				1.0	Power Equipment Operator - Group 1A	$62.99
					3.0	Truck Drivers - Group 1A	$61.93
					2.0	Power Equipment Operator - Group 1	$61.23
					0.5	Power Equipment Operator - Group 3	$59.74
					0.3	Power Equipment Operator - Group 1	$61.23
C2.30	**Road: Reshape and scarify shoulders**				1.0	Power Equipment Operator - Group 1	$61.23
C2.31	**Tailings: Spilled tailings cleanup**				1.0	Power Equipment Operator - Group 1	$61.23
					1.0	Power Equipment Operator - Group 1	$61.23
					3.0	Truck Drivers - Group 1	$60.66
C2.32	**Dredge and place tailings**				4.0	Specialist	$65.00
Materials							
C3.01	**Dust Suppressant - Supply and Apply**	2.0	Labourers - Group 4	$44.39	1.0	Truck Drivers - Group 5	$57.24
C3.02	**Electricity - Overhead electrical conductors**	3.0	Electrician	$73.58	1.0	Power Equipment Operator - Group 1A	$62.99
C3.03	**Electricity - Treated Power Poles (40' class 3)**	2.0	Electrician	$73.58	1.0	Power Equipment Operator - Group 1A	$62.99
C3.04	**Electricity - Pole mounted transformer**	3.0	Electrician	$73.58	1.0	Power Equipment Operator - Group 1A	$62.99
C3.05	**Geotextile: Supply and Install (large areas)**	3.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
C3.06	**Geotextile: Supply and Install (channels)**	4.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
C3.07	**Geosynthetic Clay Liner: Supplied & Installed**	3.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
		1.0	Engineering Technician	$80.00			
C3.08	**Groundwater Pump: 6" Submersible Pump (60-100 gpm)**	1.0	Mechanic (Power Equipment Operator Group 1)	$61.23			
		2.0	Labourers - Group 2	$55.82			
C3.09	**Groundwater Pump: 6" Submersible Pump (700-1400 gpm)**	1.0	Mechanic (Power Equipment Operator Group 1)	$61.23			
		2.0	Labourers - Group 2	$55.82			
C3.10	**HDPE liner: Supplied & Installed (large areas)**	3.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
		1.0	Engineering Technician	$80.00			
C3.11	**HDPE liner: Supplied & Installed (channels)**	3.0	Labourers - Group 1	$54.82	1.0	Power Equipment Operator - Group 1	$61.23
		1.0	Engineering Technician	$80.00			
C3.12	**HDPE pipe: 150mm, insulated; supplied and installed**	3.0	Labourers - Group 1	$54.82			
C3.13	**HDPE pipe: 350mm, insulated; supplied and installed**	3.0	Labourers - Group 1	$54.82			
C3.14	**Heat trace: Constant watt cables, installed**	1.0	Electrician	$73.58	1.0	Truck Drivers - Group 5	$57.24
		2.0	Labourers - Group 1	$54.82			
C3.15	**Heat trace Power Feed Kit**	2.0	Electrician	$73.58			
C3.16	**Heat trace electrical thermostat**	2.0	Electrician	$73.58			
C3.17	**Manholes: Precast 12' deep: supplied and installed**	1.0	Engineering Technician	$80.00	1.0	Power Equipment Operator - Group 1	$61.23
		2.0	Labourers - Group 1	$54.82			
C3.18	**Pump: Install large seepage pump**	1.0	Mechanic (Power Equipment Operator Group 1)	$61.23			
		2.0	Labourers - Group 1	$54.82			
C3.19	**Pumping well protective housing**	1.0	Carpenter	$62.43	1.0	Truck Drivers - Group 5	$57.24
		2.0	Labourers - Group 2	$55.82			
C3.20	**Well Casing, 150mm Stainless Steel, supplied and installed**	1.0	Engineering Technician	$80.00	2.0	Power Equipment Operator - Group 1	$61.23
C3.21	**Well Cover: Steel protective well cover**				2.0	Power Equipment Operator - Group 1	$61.23
Revegetation							
C4.01	**Seeding/Fertilizing: Application by Helicopter**	1.5	Labourers - Group 1	$54.82	2.0	Power Equipment Operator - Group 1	$61.23
					1.0	Truck Drivers - Group 5	$57.24
C4.02	**Planting (shrubs, seedlings, etc.): By hand**	2.0	Labourers - Group 1	$54.82	1.0	Truck Drivers - Group 5	$57.24
Relocations							
C5.01	**See Unit Cost Relocations Worksheet**						

Table 20. Tasks Unit Costs

		Equipment Details				
Cost Code	**Item**	**Equipment Type**	**Equipment Model**	**# of Equipment**	**Equipment Rate ($/hr)**	**Fuel Cost ($/hr)**
Demolition						
C1.01	**Excavator: CAT 345 w/ bucket**	Excavator	CAT 345	1	$92.53	$34.00
C1.02	**Excavator: CAT 345 w/ grapple attachment**	Excavator	CAT 345 Grapple	1	$112.65	$34.00
C1.03	**Excavator: CAT 345 w/ hammer attachment**	Excavator	CAT 345 Hammer	1	$106.90	$34.00
C1.04	**Excavator: CAT 345 w/ shear attachment**	Excavator	CAT 345 Shear	1	$95.40	$34.00
C1.05	**Dozer: CAT D9**	Dozer	CAT D9	1	$174.14	$45.10
C1.06	**Truck: CAT 740**	Truck	CAT 740	1	$106.03	$25.32
C1.07	**General Labor**				$0.00	$0.00
Earthworks						
C2.01	**Backfill excavated ditches**	Excavator	CAT 325	1	$44.87	$17.48
		Compactor	Walk-behind vibrating (30 in)	1	$7.83	$0.64
C2.02	**Bedding: Produce and stockpile**	Loader	CAT 992K	1	$283.89	$78.87
		Dozer	CAT D9	1	$174.14	$45.10
C2.03	**Berm: Shaping material**	Dozer	CAT D9	1	$174.14	$45.10
C2.04	**Clearing land**	Dozer	CAT D9	1	$174.14	$45.10
C2.05	**Clearing and grubbing**	Dozer	CAT D9	1	$174.14	$45.10
		Excavator	CAT 350	1	$131.03	$45.34
		Truck	CAT 740	2	$106.03	$25.32
C2.06	**Compaction: D9 with Impact Roller**	Dozer	CAT D9	1	$174.14	$45.10
		Compactor	Sheepsfoot (72 in, 2 drums)	1	$48.74	$32.84
C2.07	**Crusher: Crush materials**	Other	Crusher	1	$0.00	$20.00
		Loader	CAT 966F	2	$76.49	$23.17
		Truck	Light Truck (3/4T) 4x2	1	$11.41	$10.59
C2.08	**Cut-off Wall: Install (all-inclusive)**	Excavator	CAT 350	1	$131.03	$45.34
		Dozer	CAT D9	1	$174.14	$45.10
C2.09	**Drilling and blasting**	Drill	Air Rotary, 200 cfm compressor	1	$186.08	$20.76
C2.10	**Drilling: Air Rotary 8" dia.**	Drill	Air Rotary, 200 cfm compressor	1	$186.08	$20.76
C2.11	**Excavation: Large channel (short haul)**	Excavator	CAT 350	1	$131.03	$45.34
		Truck	CAT 740	3	$106.03	$25.32
C2.12	**Excavation: Common (no haul)**	Excavator	CAT 325	1	$44.87	$17.48
C2.13	**Excavation: Common (short haul)**	Excavator	CAT 350	1	$131.03	$45.34
		Truck	CAT 740	3	$106.03	$25.32
C2.14	**Excavation: Shallow trench (no haul)**	Excavator	CAT 325	1	$44.87	$17.48
C2.15	**Excavation: Deep trench (short haul)**	Excavator	CAT 350	1	$131.03	$45.34
		Truck	CAT 740	2	$106.03	$25.32
C2.16	**Excavation: Rock**	Drill	Air track rig (900cfm)	1	$105.78	$22.77
		Excavator	CAT 325	0.2	$44.87	$17.48
		Truck	CAT 740	0.4	$106.03	$25.32
C2.17	**Excavate and create berms (Red Dog Creek)**	Excavator	CAT 325	2	$44.87	$17.48
		Dozer	CAT D9	2.0	$174.14	$45.10
		Compactor	Sheepsfoot (72 in, 2 drums)	1.0	$48.74	$32.84
C2.18	**Foundation Preparation**	Dozer	CAT D9	1	$174.14	$45.10
		Excavator	CAT 325	1	$44.87	$17.48
		Truck	CAT 740	2	$106.03	$25.32
C2.19	**Grading: Roads, ramps, etc.**	Grader	CAT 16H	1	$140.51	$25.10
C2.20	**Grouting: Setting Packers**	Drill	Air track rig (900cfm)	1	$105.78	$22.77
C2.21	**Landfarm: Operate**	Dozer	CAT D9	1	$174.14	$45.10
C2.22	**Level and compact working surface (nominal compaction)**	Dozer	CAT D9	1	$174.14	$45.10
C2.23	**Regrading**	Dozer	CAT D11	1	$314.10	$93.50
C2.24	**Rip-Rap: Drill, blast and stockpile**	Drill	Air track rig (900cfm)	1	$105.78	$22.77
		Dozer	CAT D9	1	$174.14	$45.10
C2.25	**Rip-Rap (rounded, low quality): Screen and Stockpile**	Loader	CAT 992K	1	$283.89	$78.87
		Dozer	CAT D9	1	$174.14	$45.10
C2.26	**Rip-Rap (angular, high quality): Screen and Stockpile**	Loader	CAT 992K	1	$283.89	$78.87
		Dozer	CAT D9	1	$174.14	$45.10
C2.27	**Rip-Rap rock placement**	Excavator	CAT 325	1	$44.87	$17.48
C2.28	**Road: Construct access road**	Loader	CAT 966F	1	$76.49	$23.17
		Truck	CAT 740	2	$106.03	$25.32
		Dozer	CAT D9	2	$174.14	$45.10
		Grader	CAT 16H	0.25	$140.51	$25.10
C2.29	**Road: Construct haul road**	Loader	CAT 992K	1	$283.89	$78.87
		Truck	CAT 777G	3	$263.72	$49.68
		Dozer	CAT D11	2	$314.10	$93.50
		Compactor	CAT CP563	0.5	$41.15	$16.21
		Grader	CAT 16H	0.3	$140.51	$25.10
C2.30	**Road: Reshape and scarify shoulders**	Grader	CAT 16H	1	$140.51	$25.10
C2.31	**Tailings: Spilled tailings cleanup**	Excavator	CAT 325	1	$44.87	$17.48
		Dozer	CAT D9	1.0	$174.14	$45.10
		Truck	CAT 740	3.0	$106.03	$25.32
C2.32	**Dredge and place tailings**	Misc	IMS Dredge	2	$224.16	55.44
Materials						
C3.01	**Dust Suppressant - Supply and Apply**	Truck	Light Truck (3/4T) 4x2	1	$11.41	$10.59
C3.02	**Electricity - Overhead electrical conductors**	Lifting	Crane (Cable Boom), 100T	1	$88.04	$17.93
C3.03	**Electricity - Treated Power Poles (40' class 3)**	Lifting	Crane (Cable Boom), 100T	1	$88.04	$17.93
C3.04	**Electricity - Pole mounted transformer**	Lifting	Crane (Cable Boom), 100T	1	$88.04	$17.93
C3.05	**Geotextile: Supply and Install (large areas)**	Loader	CAT 966F	1	$76.49	$23.17
C3.06	**Geotextile: Supply and Install (channels)**	Loader	CAT 966F	1	$76.49	$23.17
C3.07	**Geosynthetic Clay Liner: Supplied & Installed**	Loader	CAT 966F	1	$76.49	$23.17
C3.08	**Groundwater Pump: 6" Submersible Pump (60-100 gpm)**					
C3.09	**Groundwater Pump: 6" Submersible Pump (700-1400 gpm)**					
C3.10	**HDPE liner: Supplied & Installed (large areas)**	Loader	CAT 966F	1	$76.49	$23.17
C3.11	**HDPE liner: Supplied & Installed (channels)**	Loader	CAT 966F	1	$76.49	$23.17
C3.12	**HDPE pipe: 150mm, insulated; supplied and installed**					
C3.13	**HDPE pipe: 350mm, insulated; supplied and installed**					
C3.14	**Heat trace: Constant watt cables, installed**	Truck	Light Truck (3/4T) 4x2	1	$11.41	$10.59
C3.15	**Heat trace Power Feed Kit**					
C3.16	**Heat trace electrical thermostat**					
C3.17	**Manholes: Precast 12' deep: supplied and installed**	Excavator	CAT 325	1	$44.87	$17.48
C3.18	**Pump: Install large seepage pump**				$0.00	$0.00
C3.19	**Pumping well protective housing**	Truck	Light Truck (3/4T) 4x2	1	$11.41	$10.59
C3.20	**Well Casing, 150mm Stainless Steel, supplied and installed**	Drill	Air Rotary, 200 cfm compressor	1	$186.08	$20.76
C3.21	**Well Cover: Steel protective well cover**	Drill	Air Rotary, 200 cfm compressor	1	$186.08	$20.76
Revegetation						
C4.01	**Seeding/Fertilizing: Application by Helicopter**	Other	Helicopter	1.0	$950.00	$180.00
		Truck	Light Truck (3/4T) 4x2	1.0	$11.41	$10.59
C4.02	**Planting (shrubs, seedlings, etc.): By hand**	Truck	Light Truck (3/4T) 4x2	1.0	$11.41	$10.59
Relocations						
C5.01	**See Unit Cost Relocations Worksheet**					

Table 20. Tasks Unit Costs

Cost Code	Item	Cost Code	Item	Unit Rate	Unit	Multiplier	Multiplier Comments
Demolition							
C1.01	**Excavator: CAT 345 w/ bucket**						
C1.02	**Excavator: CAT 345 w/ grapple attachment**						
C1.03	**Excavator: CAT 345 w/ hammer attachment**						
C1.04	**Excavator: CAT 345 w/ shear attachment**						
C1.05	**Dozer: CAT D9**						
C1.06	**Truck: CAT 740**						
C1.07	**General Labor**						
Earthworks							
C2.01	**Backfill excavated ditches**						
C2.02	**Bedding: Produce and stockpile**						
C2.03	**Berm: Shaping material**						
C2.04	**Clearing land**						
C2.05	**Clearing and grubbing**						
C2.06	**Compaction: D9 with Impact Roller**						
C2.07	**Crusher: Crush materials**						
C2.08	**Cut-off Wall: Install (all-inclusive)**	M.01	Bentonite	$457.00	Polar S	0.162	Assumes 1.5m wide trench, 6% b
C2.09	**Drilling and blasting**	M.07	Explosives and Blasting Caps (for rip-rap production)	$8.14	RSMea	0.15	
C2.10	**Drilling: Air Rotary 8" dia.**						
C2.11	**Excavation: Large channel (short haul)**						
C2.12	**Excavation: Common (no haul)**						
C2.13	**Excavation: Common (short haul)**						
C2.14	**Excavation: Shallow trench (no haul)**						
C2.15	**Excavation: Deep trench (short haul)**						
C2.16	**Excavation: Rock**						
C2.17	**Excavate and create berms (Red Dog Creek)**						
C2.18	**Foundation Preparation**						
C2.19	**Grading: Roads, ramps, etc.**						
C2.20	**Grouting: Setting Packers**						
C2.21	**Landfarm: Operate**						
C2.22	**Level and compact working surface (nominal compaction)**						
C2.23	**Regrading**						
C2.24	**Rip-Rap: Drill, blast and stockpile**	M.07	Explosives and Blasting Caps (for rip-rap production)	$8.14	RSMea	1	
C2.25	**Rip-Rap (rounded, low quality): Screen and Stockpile**						
C2.26	**Rip-Rap (angular, high quality): Screen and Stockpile**						
C2.27	**Rip-Rap rock placement**						
C2.28	**Road: Construct access road**						
C2.29	**Road: Construct haul road**						
C2.30	**Road: Reshape and scarify shoulders**						
C2.31	**Tailings: Spilled tailings cleanup**						
C2.32	**Dredge and place tailings**						
Materials							
C3.01	**Dust Suppressant - Supply and Apply**	M.02	Dust Suppressant		Not use	1	
C3.02	**Electricity - Overhead electrical conductors**	M.04	Electricity: Overhead Electrical Conductors	$23.05	RSMea	1	
C3.03	**Electricity - Treated Power Poles (40' class 3)**	M.05	Electricity: Pole-mounted Transformer	$10,500.00	RSMea	1	
C3.04	**Electricity - Pole mounted transformer**	M.06	Electricity: Treated Power Poles (40' class 3)	$442.75	RSMea	1	
C3.05	**Geotextile: Supply and Install (large areas)**	M.13	Geotextile (8 oz.)	$1.53	Quotes	1	
C3.06	**Geotextile: Supply and Install (channels)**	M.13	Geotextile (8 oz.)	$1.53	Quotes	1	
C3.07	**Geosynthetic Clay Liner: Supplied & Installed**	M.12	Geosynthetic Clay Liner (60 mil, textured)	$5.69	Quotes	1	
C3.08	**Groundwater Pump: 6" Submersible Pump (60-100 gpm)**	M.14	Groundwater Pump: 6" Submersible Pump (weighted ave	$7,434.00	Delta P	1	
C3.09	**Groundwater Pump: 6" Submersible Pump (700-1400 gpm)**	M.15	Groundwater Pump: 6" Submersible Pump (TDH=60', Flo	$9,114.00	Delta P	1	
C3.10	**HDPE liner: Supplied & Installed (large areas)**	M.16	HDPE liner (60 mil, textured)	$5.47	Quotes	1	
C3.11	**HDPE liner: Supplied & Installed (channels)**	M.16	HDPE liner (60 mil, textured)	$5.47	Quotes	1	
C3.12	**HDPE pipe: 150mm, insulated; supplied and installed**	M.19	HDPE pipe: 150 mm (6"), insulated	$95.00	Fergus	1	
C3.13	**HDPE pipe: 350mm, insulated; supplied and installed**	M.21	HDPE pipe: 350 mm (14"), insulated	$210.00	Fergus	1	
C3.14	**Heat trace: Constant watt cables, installed**	M.25	Heat trace: constant watt cables	$90.00	Municip	1	
C3.15	**Heat trace Power Feed Kit**	M.24	Heat trace Power Feed Kit	$2,400.00	Municip	1	
C3.16	**Heat trace electrical thermostat**	M.23	Heat trace electrical thermostat	$9,000.00	Municip	1	
C3.17	**Manholes: Precast 12' deep: supplied and installed**	M.31	Precast Concrete Manhole: 4' ID, 4' Deep	$940.08	RSMea	4	Assumes 4m deep manhole
C3.18	**Pump: Install large seepage pump**	M.32	Pump: 250PSI pump with motor	$2,547.30	RSMea	1	
C3.19	**Pumping well protective housing**	M.27	Lumber: 2x4x8 Studs (Doug-Fir)	$4.16	Lowe's	100	
		M.30	Plywood: 1/2"x4x8 (Fir Sheathing)	$23.47	Lowe's	45	
C3.20	**Well Casing, 150mm Stainless Steel, supplied and installed**	M.44	Well Casing: Steel	$3.29	RSMea	1	
C3.21	**Well Cover: Steel protective well cover**	M.45	Well Cover: Steel, Protective		Estimat	1	
Revegetation							
C4.01	**Seeding/Fertilizing: Application by Helicopter**	M.28	Native seed	$7.00	Estimat	60	60kg per hectare
		M.08	Fertilizer (dry, granular 4#)	$0.04	RSMea	500	500kg per hectare
C4.02	**Planting (shrubs, seedlings, etc.): By hand**	M.29	Plants: live shrub cuttings	$1,800.00	Estimat	1	
Relocations							
C5.01	**See Unit Cost Relocations Worksheet**						

Table 21. Indirect Cost Inputs

Cost Code	Category	Rate Used in Estimate	Unit	Source/Comments
I.01	**Bonding**	3.0	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.02	**Camp Operation**	$111.00	$/day/man	Estimated camp cost reviewed by Nana Management Services, Camps Division; rate is still valid in 2016
I.03	**Communications**	$570.00	month	Estimate assumes most expensive Exede internet and VOIP package, plus most expensive Iridium sat phone package
I.04	**Contractor Profit**	10	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.05	**Contingency**	20	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.06a	**Engineering Re-Design 1**	3.0	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.06b	**Engineering Re-Design 2**	3.0	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.06c	**Engineering Re-Design 3**	3.0	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.08	**Office Heating Fuel**	360	gal/month	2015 heating fuel usage for site fabrication shop: 2 office trailers, 40 ft fabrication tent. Camp heating from generator waste heat.
I.09	**Insurance**	1.6	%	See "Red Dog Closure Cost Estimate - Indirect Cost Allocations 3-5-09.xls" for more detail on indirect allocation
I.10	**Laboratory/Material Testing**	$1,200.00	month	Estimated, for field laboratory testing (cost increased 20% from Rev1)
I.11	**Misc. Admin Supplies**	$600.00	month	Estimated, for general office supply contingency (cost increased 20% from Rev1)
I.12	**Office Supplies**	$100.07	month	RSMeans 2014, Heavy Construction (Pg 17)
I.13	**Turnaround Costs**	$357.32	$/trip	Alaska Air, Charter Flights (737-800 plane, includes fuel and all fees) (round trip ANC to RD, estimate assumes 90 ppl/flight)
I.15	**Mob/Demob**	$4,868,796	each	Assumes two full mob/demob trips, plus shipping materials. See Mob Demob tab for detail.
I.17	**Contract Oversight**	1	%	of Total Project Cost EXCLUDING State Contract Admin, Contingency
I.18	**Contractor Overhead**	10	%	of Direct Labor Cost+Field Support Labor + Insurance

Table 22. Mobilization and Demobilization Costs

Mobilization Summary

Event	Cost	Notes
1st Year, Mob Equipment/Supplies (barge)	$ 1,100,000	Equipment and Materials
1st Year, Demob Equipment (barge)	$ 1,100,000	Equipment and Materials
2nd Year, Mob Equipment/Supplies (barge)	$ 1,100,000	Equipment and Materials
2nd Year, Demob Equipment (barge)	$ 1,100,000	Equipment and Materials
Freight Contingency (air cargo)	$ 100,000	Special delivery of materials; additional delivery is available during shift change-out
Red Dog Port to Mine Transport - Equipment	$ 109,360	Transporting equipment from RD Port to Mine and Mine back to RD Port
Red Dog Port to Mine Transport - Supplies	$ 259,436	Transporting Materials from RD Port to Mine, and empty containers back to RD Port
TOTAL MOB/DEMOB COST	**$ 4,868,796**	

Appendix D – Post-Closure Cost Estimate

Basis of Cost Estimate – Post Closure Costs

Red Dog Mine, Alaska, USA

Prepared for

Teck Alaska Incorporated

Prepared by

SRK Consulting (U.S.), Inc.

329100.030

August 2016

Basis of Cost Estimate – Post Closure Costs

Red Dog Mine, Alaska, USA

August 2016

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File Name: BasisofEstimate_PostClosureCosts_RedDogMine_329100.030_20160805

srk consulting 1974 40 2014

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List of Abbreviations

ADNR	Alaska Department of Natural Resources
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
TAK	Teck Alaska Incorporated
TSF	Tailings Storage Facility

Units of Measure

m	meter
m^2	square meter
m^3	cubic meter

1 Introduction

Teck Alaska Incorporated and NANA are working closely with State of Alaska agencies, through the Large Mine Permitting Team, to update the *Reclamation and Closure Plan* and *Integrated Waste Management Plan* for Red Dog Mine. One objective of the process is to estimate the cost of suspension, closure, and post-closure activities. This document provides details about the estimate of post-closure costs.

Estimates of the long-term average annual post-closure cost were developed for two different scenarios:

- **Planned Closure:** This estimate assumes that the post-closure period will commence in 2033, after all of the closure measures described in the *Reclamation and Closure Plan* have been implemented.
- **Premature Closure:** This estimate assumes that the mine would close prematurely sometime before 2031. The year 2015 was selected during closure plan development in 2014, as it was estimated to represent the worst case scenario in terms of reclamation and closure requirements, as discussed in the *Reclamation and Closure Plan*. The post-closure period in this case is assumed to commence in 2017.

The total estimated annual post-closure cost for each case is as follows, in undiscounted 2016 dollars.

Scenario	Annual Post-Closure Cost*
Planned Closure (2031)	$18,550,000
Premature Closure (2015)	$20,280,000

2 Scope of Estimate

2.1 Estimate structure

The estimate was prepared in an Excel workbook organized as follows:

- A summary worksheet presents the total annual post-closure costs for both the planned and premature closure scenarios;
- A direct-indirect summary worksheet presents the estimated direct and indirect post-closure costs;
- Nine separate worksheets estimate costs under the headings “Manpower”, “Consumables (2031)”, “Consumables (2015)”, “Mobile Equipment”, “Maintenance Materials”, “Capital Replacement”, “Power”, “Camp Admin & Enviro”, and “Dam Inspection”;
- Supporting calculations are provided in the worksheets labeled “Environmental Costs”, “Winter Power Consumption”, and “Summer Power Consumption”; and
- Twelve worksheets include cost estimates for three different sludge disposal alternatives and the supporting calculations for the construction and lifecycle operation of a sludge management facility for one hundred years.

As previously stated, estimates were prepared for both the 2031 planned closure and the 2015 premature closure scenarios described in the *Reclamation and Closure Plan*. The main difference between the two scenarios is reflected in the long-term water treatment costs, specifically the reagents needed to treat the differing flows and levels of acidity. The workbook therefore includes separate sheets for “Consumables (2031)” and “Consumables (2015)”. In addition to the long-term water treatment costs, estimates for managing water treatment sludge vary between the two closure scenarios, as discussed in Section 3.6 below. Differences in costs for other areas, such as capital replacement and power consumption, were expected to be very small between the two scenarios, so separate estimates were not prepared.

In both scenarios, it was assumed that the site would be operated by a long-term contractor managed by the State of Alaska. This assumption is required for all estimates of financial security provided to the State.

2.2 General Assumptions

Requirements for the post-closure period are described in Section 4 of the *Reclamation and Closure Plan*. The primary activities include:

- Storage of contact water in the Aqqaluk Pit or Main Pit, with seasonal treatment and discharge;
- Seasonal treatment and discharge of excess water from the Tailings Storage Facility (TSF);
- Year-round collection of seepage from the Main Dam, Back Dam (if necessary), toe of the Main Waste Dump (MWD), and piping to the Aqqaluk Pit or Main Pit;

- Maintenance of earthworks constructed during the closure period;
- Operation and maintenance of remaining site infrastructure;
- Environmental monitoring and inspections; and
- Sludge produced by the water treatment process will be deposited on site.

For the purposes of this estimate, it is conservatively assumed that the site will be staffed year-round with daily 12-hour shifts. The use of remote systems for monitoring facilities during low activity periods is becoming more common, and could be explored in later revisions of the plan and estimate.

3 Assumptions by Cost Item

3.1 Manpower

Year-round staffing will consist of the following staff:

- One site/property manager;
- One environmental coordinator;
- One environmental technician;
- One mechanic;
- One electrician;
- One equipment operator; and
- Two camp support staff.

Taking into account shift changes, there will be seven or eight people on site during the winter.

In the summer, additional staff will be on site to operate the two water treatment plants, haul consumables and fuel from the port to the mine, and carry out the earthworks maintenance. Additional summer staffing will consist of the following staff:

- One water treatment plant operator;
- One water treatment plant operator assistant;
- One technician;
- One additional mechanic;
- One additional electrician;
- Two truck drivers; and
- Two additional equipment operators.

Taking shift changes into account, there will be sixteen or seventeen people on site for most of the summer.

Labor rates were estimated using the Alaska Department of Labor's rates as listed in Issue 31 of the *Laborers' & Mechanics' Minimum Rates of Pay* (Pamphlet 600). Labor rates not available in Pamphlet 600 were sourced from wages available on the Alaska Department of Labor's website (Research and Analysis, May 2014 Wages in Alaska). Base hourly rates include standard overtime, benefits, and payroll burden. Labor rates do not include the costs of camp accommodation or flights, which are included as indirect costs.

3.2 Consumables

The major consumables will be those used in the water treatment system, specifically lime, flocculant, sodium sulfide, and antiscalant.

A post-closure water and load balance is described in the *Red Dog* Mine *Reclamation and Closure Plan*, Section 4, and the *Red Dog Water and Load Balance Update* Memo. The water and load balance provides estimates of the annual treatment flows and the lime demand from the Aqqaluk Pit (2031 scenario) or the Main Pit (2015 scenario) and from the TSF, also referred to as the Tailings Pond. Estimates of post-closure water quality were derived using the September 2014 (version 68) water and load balance. The flows and lime demands vary slightly over the first few years after closure. The long-term steady state values, which are generally reached about 5-10 years after closure, were used for the estimate.

It was assumed that actual lime demand would be 12.5% greater than the theoretical lime demand provided by the water and load balance. The difference accounts for grit content and unreactive lime.

The amounts of flocculant, sodium sulfide, and antiscalant were assumed to be proportional to the lime demand. The ratios of the amount of each consumable to the lime tonnage were estimated from site records. The resulting estimates of treated flows, lime demand, and consumable requirements were as follows for steady state conditions.

	Units	Planned Closure (2031)	Premature Closure (2015)
Annual Flows to Treatment Plant			
Tailings Pond	million gallons	285	581
Aqqaluk Pit	million gallons	1,152	n/a
Main Pit	million gallons	n/a	1,147
Total	**million gallons**	**1,437**	**1,728**
Theoretical Lime Demand			
Tailings Pond	tonnes/year	390	2,569
Aqqaluk Pit	tonnes/year	10,080	
Main Pit	tonnes/year		10,356
Total	tonnes/year	10,470	12,925
Flocculant	tonnes/year	118	145
Actual Lime Demand	tonnes/year	11,779	14,540
Sodium Sulfide	tonnes/year	307	380
Antiscalant	tonnes/year	49	61

The unit cost for lime was estimated at $373 per tonne, which is the current (2015) price as delivered to the Red Dog Port.

Unit costs for the other water treatment consumables (flocculant, sodium sulfide, and antiscalant) were based on the 2015 price for each consumable as delivered to the Red Dog Port.

3.3 Mobile Equipment

A small fleet of mobile equipment that is owned by the site is assumed to be used in post-closure activities. Equipment sizes were assumed to be similar to the equipment presently on site or used to transport consumables to site:

- One 16M Grader
- One 966 Loader
- Two Articulated Haul Trucks (35 ton)
- One Excavator (2.3 cy)
- One 988 Loader
- Two Forklifts
- One Portable Generator (20 kW)
- One D6 Dozer
- One Field Service Truck
- Two Semi Tractors
- Two Flatbed Trailers
- One Heavy Equipment Trailer
- Two Fuel Tankers
- One Van-mounted Steam Generator
- One Snowblower
- Four Pick-up Trucks

Hourly equipment rates were based on the 2015 CostMine *Mine and Mill Equipment Costs*. The equipment rates include fuel, maintenance and overhaul parts, lube and oil, tires, and GET costs. Equipment operator rates are included separately in the estimate.

Usage of the equipment (hours per month) was estimated from historical Red Dog data, with an allowance for increased use of the grader for road maintenance activities. Hours were increased for the forklifts, semi tractors, trailers, and fuel tankers to transport and unload fuel and consumables from the port to the mine.

The addition of a sludge management facility increased the hours of operation for both the haul trucks and the 988 loader. This fleet is utilized in transporting densified sludge from freeze thaw beds to the final repository.

3.4 Maintenance Materials

Maintenance material costs were estimated based on historical site maintenance department records. Generally, maintenance costs are relatively low, with the pumpback systems requiring a majority of the maintenance costs. Specific maintenance items vary between maintenance areas, which prevents updating costs from vendor quotations with any accuracy. As a result, estimated costs from 2009 were increased by 30% as a conservative measure to cover freight and any material cost increases. Sand filter maintenance was reduced from the current twice per season to once per season, because the combined effluent streams from the post-closure water treatment plants are expected to generate significantly less scaling than the current effluent. Maintenance labor costs were included in Manpower, except for the sand filter maintenance, as it is carried out by contract labor.

3.5 Capital Replacement

An annual capital replacement cost of $1,650,000 was included to account for replacement of major capital items and Supplementary Environmental Project (SEP) reporting. The amount is sufficient to provide for:

- Replacement of 25% of the water treatment system in years 15, 45, 75, 105, etc., and replacement of the other 75% in years 30, 60, 90, 120 etc. (the total capital cost for new water treatment infrastructure was estimated in the closure cost estimate as $61,100,000, including indirect costs for contingency, engineering, procurement, overhead, and remote site premium, as detailed in the *Basis of Cost Estimate - Closure Costs*;
- Replacement of pick-up trucks, field service truck, and steam generator every 10 years;
- Replacement of semi tractors and trailers every 15 years;
- Replacement of heavy equipment fleet every 25 years;
- Replacement of generators and switch gear every 20 years;
- Replacement of monitoring equipment (thermistors) every 15 years;
- Quarterly, annual, and 5-year SEP reporting for a 30-year period; and
- Borehole (well) abandonment costs for all thermistors and piezometers after monitoring has ceased.

Actual capital expenditures likely will not correspond directly to the above. But comparison of the annual allowance to the above shows that it is conservative. For example, there are many examples of water treatment plants that have been in operation for more than thirty years without complete replacement. Considering the plants will only be in operation 5 months per year may also increase the life of the plants. Replacement capital costs were obtained from current vendor quotations or current online pricing. Borehole abandonment costs were sourced from the SRCE model.

3.6 Sludge Management

This cost estimate provides capital and operating cost estimates for long-term, post-closure sludge management. A period of 100 years was selected to provide long-term financial assurance for sludge management while also acknowledging that requirements and technologies for water treatment and sludge management will change with time.

This cost estimate assumes the post-closure water treatment plants will generate approximately 561,000 cy of high density sludge at 10% solids from Aqqaluk Pit water and 5% solids from the TSF water. The current concept is for water treatment plant sludge to initially be pumped to excess storage within the pits while densification infrastructure and storage for densified sludge are prepared or constructed. Sludge in the pits is assumed to have the same density as sludge from the WTP. Following disposal of sludge in available pit storage, sludge would be densified by freeze-thaw densification beds, sized to store 1.5 years of sludge production at a maximum depth of 4.6 feet to provide sufficient area to load, freeze, and thaw sludge and provide for full sludge freezing over one winter. Disturbed areas, such as laydown yards, construction material quarries, and/or waste dump surfaces, may be used for freeze-thaw densification. Once placed in the densification beds, the sludge will be allowed to freeze and thaw over the course of a seasonal cycle, which will densify the sludge to an estimated 30% solids. This densified sludge will be transported by truck and loader to a repository for final placement.

The sludge management concept for the 2015 closure scenario is as follows:

- Sludge would be placed, undensified, in the Main Pit from Years 1-9;
- Freeze-thaw densification beds would be constructed in Years 8-9 and begin operating in Year 10;
- Densified sludge would be placed in Aqqaluk Pit from Years 10-19;
- A repository would be constructed in the TSF in Years 18 and 19 for densified sludge placement from Years 20-90; and
- A new repository would be constructed on site in Years 89 and 90 for densified sludge placement from Years 91-100, although refinements in sludge management processes, facility design, or sludge consolidation may make a new repository unnecessary for the 2015 closure scenario.

The sludge management concept for the 2031 closure scenario is as follows:

- Sludge would be placed, undensified, in the Aqqaluk Pit from Years 1-42
- Freeze-thaw densification beds would be constructed in Years 41-42 and begin operating in Year 43; and
- A new repository would be constructed on-site in Years 41 and 42 for densified sludge placement from Years 43-100, although refinements in sludge management processes, facility design, or sludge consolidation may make adjust the timing and size of a new repository for the 2031 closure scenario.

A new repository location has not yet been selected; however, a generic location within a narrow valley immediately east of the mine area was selected for costing purposes. The repository includes a rockfill dam, HDPE liner, and required appurtenances. A cost curve was developed at various elevations and storage volumes to develop an overall capital cost for a sludge repository.

Detailed construction and operational estimates can be found in Tables 14-25. Future evaluation may refine the post-closure sludge management assumptions as follows:

- Sludge density: from WTP, in pit, densified, in repositories
- Optimal pit disposal methods
- Optimal methods and geometrics for freeze-thaw densification

- Water management constraints

To estimate indirect costs associated with the construction of sludge management infrastructure, the ratio of indirect to direct costs from the Closure Cost Estimate (0.9) was applied to direct construction costs and added to the total sludge management cost. See the *Basis of Estimate – Closure Costs* for further detail on indirect closure costs.

3.7 Power

Power requirements were estimated based on a detailed listing of the equipment needed to operate in the both the winter and summer months.

During the winter, power will be required primarily to operate the pumps and heat tracing systems on the tailings seepage and seepage-seepage system and the overburden seepage system. Heat and power will also be provided for a stand-alone office and living area for the small crew that will be accommodated on site. Winter power consumption was estimated to be 500 kW.

During the summer, water treatment will increase the power requirements. In addition to the plant, the operation of water treatment requires operation of the reclaim pumps, Bons Creek pumps, process water distribution pumps, lime, flocculant, and sulfide mixing and distribution systems, and a compressor. Summer power consumption was estimated to be 2,000 kW.

The power costs were based on:

- Three generators optimally sized for the winter and summer seasons, producing power at an efficiency of 14.2 kW-hours per gallon;
- Maintenance costs of $0.01 per kW-hour; and
- A fuel cost of $3.08 per gallon. The estimated fuel cost is based on the 5-year average price of fuel delivered to Red Dog Port from 2011-2015.

3.8 Camp and Administration

The estimate of camp and administration costs included:

- Camp operation at $111 per person per day;
- Turnaround costs of $610 per person per trip; and
- An annual port maintenance fee of $100,000.

The estimated camp fee of $111 per person day was provided by a current vendor quotation, based upon a camp housing 20-30 people. The turnaround cost was estimated by using current Alaska Air flight costs from Anchorage to Kotzebue, plus a current vendor quotation for a charter flight from Kotzebue to Red Dog.

3.9 Environmental Monitoring

Environmental monitoring costs include all external sample analysis requirements, sampling and preparation supplies, and external consulting and contracted services.

The sampling and analytical requirements were based on sampling the following locations: Outfall 001, Station 2, Station 9, Station 10, Station 12, Station 20, Station 73, Station 140, Station 150, Station 160, and Red Dog Creek above Qanaiyaq, Shelly Creek, Connie Creek, Rachel Creek, and Sulfur Creek. All analyses were assumed to be completed by external laboratories. Monthly WET (toxicity) testing was assumed to continue during the summer. Costs of sample shipping and data manipulation were included. The bioassessment program was assumed to continue to be carried out by a consultant. Helicopter time for accessing the remote sampling sites was also included.

Monitoring requirements over time may be reduced in the future. This estimate assumes all monitoring needed at closure will be needed throughout the life of the project.

Monitoring costs were obtained from vendor quotations, where possible, or site cost data.

3.10 Dam Inspections and Maintenance

Dam inspections are required on a periodic basis as well as an annual basis. The estimate includes the following assumptions:

- Annual dam inspections for each dam by a licensed and qualified engineer, as per Alaska Statute 46.17, to inspect all dams for obvious deficiencies;
- Provides $50,000 per year for dam instrumentation replacement;
- Provides $700,000 for Periodic Dam Safety Inspections allocated over 3 years at $233,000 per year;
- Provides $32,000 for repair of potential surface erosion on the Main Dam, as well as the Main Dam and Back Dam beach armoring, allocated over 20 years at $1,600 per year;
- Provides $1,500,000 for Main Dam rock drain reconstruction and repair, allocated over 20 years at $75,000 per year; and
- Dam inspection and maintenance for the sludge repository is included in the sludge worksheet. The cost is estimated to be $97,000 per year, per repository.

Post-closure maintenance of dam spillways is assumed to be provided by on-site staff and equipment, and the cost is included with the scheduled manpower and equipment hours.

3.11 Other Indirect Costs

Other indirect costs added to the estimate include:

- Insurance at 1.6% of manpower and mobile equipment costs;
- Contractor overhead at 10% of direct plus camp and administration indirect costs;
- Contractor profit at 10% of direct plus camp and administration indirect costs; and
- State contract management based on 1% of the total project cost minus contractor overhead and profit on costs other than manpower and equipment.

These indirect cost percentages were derived for the site during development of the 2009 post-closure cost estimate except for contractor overhead and profit, which were set by the Alaska Department of Environmental Conservation.

In addition, the following indirect costs are included in the post-closure cost estimate, as discussed above:

- Indirect costs included in the water treatment capital replacement cost from the closure cost estimate;
- Indirect costs applied to direct construction costs of sludge management infrastructure at a ratio of 0.9;
- Indirect costs applied to direct erosion repair costs for the Main Dam and tailings beaches at a ratio of 0.9; and
- Indirect costs applied to direct borehole abandonment costs for the SEP thermistors and piezometers at a ratio of 0.9.

4 Summary – Annual Costs

The total annual post-closure costs under the Planned and Premature Closure scenarios are as follows:

Cost Category	Planned Closure (2031)	Premature Closure (2015)
Manpower	$ 2,800,000	$ 2,800,000
Consumables	$ 5,440,000	$ 6,720,000
Mobile Equip	$ 420,000	$ 420,000
Maintenance Materials	$ 350,000	$ 350,000
Capital Replacement and SEP	$ 1,650,000	$ 1,650,000
Power	$ 2,430,000	$ 2,430,000
Environmental	$ 270,000	$ 270,000
Camp & Admin	$ 780,000	$ 780,000
Dam Inspection and Maintenance	$ 390,000	$ 390,000
Sludge Management	$ 910,000	$ 1,060,000
Insurance (1.6% of manpower and equip.)	$ 50,000	$ 50,000
Contractor Overhead (10% of directs)	$ 1,440,000	$ 1,590,000
Contractor Profit (10% of directs)	$ 1,440,000	$ 1,590,000
State Contract Mgmt. (1% of total)	$ 160,000	$ 180,000
Total Cost	**$ 18,550,000**	**$ 20,280,000**

This report, *Basis of Estimate – Post Closure Costs*, was prepared by SRK Consulting (U.S.), Inc. with data supplied by TAK.

Ivan Clark, Senior Consultant

and reviewed by

Dan Neuffer, Senior Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Tables

Table 1a: Summary of Estimated Post-Closure Costs

Planned Closure (2031)

Annual Water Treatment Cost

	Annual Cost
Manpower	$710,000
Consumables	$5,440,000
Maintenance Materials	$170,000
Capital Replacement	$1,260,000
Sludge Management	$910,000
Power	$1,430,000
Subtotal	**$9,930,000**

Annual Camp, Site Maintenance, Environmental & Administration Costs

	Annual Cost
Manpower	$2,090,000
Maintenance Materials	$180,000
Mobile Equip	$420,000
Capital Replacement and SEP	$390,000
Power	$1,000,000
Environmental	$270,000
Camp & Admin	$780,000
Dam Inspection and Maintenance	$390,000
Subtotal	**$5,520,000**

Total Annual Post-Closure Operating Cost

	Annual Cost
Manpower	$2,800,000
Consumables	$5,440,000
Mobile Equip	$420,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,430,000
Environmental	$270,000
Camp & Admin	$780,000
Dam Inspection and Maintenance	$390,000
Sludge Management	$910,000
Insurance (1.6% of manpower and equip.)	$50,000
Contractor Overhead (10% of directs+camp&admin indirects)	$1,440,000
Contractor Profit (10% of directs+camp&admin indirects)	$1,440,000
State Contract Mgmt. (1% of total-portion of contractor O&P)	$160,000
Total Cost	**$18,550,000**

Premature Closure (2015)

Annual Water Treatment Cost

	Annual Cost
Manpower	$710,000
Consumables	$6,720,000
Maintenance Materials	$170,000
Capital Replacement	$1,260,000
Sludge Management	$1,060,000
Power	$1,430,000
Subtotal	**$11,350,000**

Annual Camp, Site Maintenance, Environmental & Administration Costs

	Annual Cost
Manpower	$2,090,000
Maintenance Materials	$180,000
Mobile Equip	$420,000
Capital Replacement and SEP	$390,000
Power	$1,000,000
Environmental	$270,000
Camp & Admin	$780,000
Dam Inspection and Maintenance	$390,000
Subtotal	**$5,520,000**

Total Annual Post-Closure Operating Cost

	Annual Cost
Manpower	$2,800,000
Consumables	$6,720,000
Mobile Equip	$420,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,430,000
Environmental	$270,000
Camp & Admin	$780,000
Dam Inspection and Maintenance	$390,000
Sludge Management	$1,060,000
Insurance (1.6% of manpower and equip.)	$50,000
Contractor Overhead (10% of directs+camp&admin indirects)	$1,590,000
Contractor Profit (10% of directs+camp&admin indirects)	$1,590,000
State Contract Mgmt. (1% of total-portion of contractor O&P)	$180,000
Total Cost	**$20,280,000**

Table 1b: Summary of Estimated Direct and Indirect Post-Closure Costs

Total Annual Post-Closure Operating Cost (Planned Closure)

	Direct Costs	Indirect Costs	Total Cost
Manpower	$2,799,094	$0	$2,799,094
Consumables	$5,443,500	$0	$5,443,500
Mobile Equip	$416,329	$0	$416,329
Maintenance Materials	$352,593	$0	$352,593
Capital Replacement and SEP	$992,041	$660,435	$1,652,476
Power	$2,431,450	$0	$2,431,450
Environmental	$268,468	$0	$268,468
Camp & Admin	$120,000	$664,329	$784,329
Dam Inspection and Maintenance	$389,919	$0	$389,919
Sludge Management	$545,556	$364,722	$910,278
Insurance (1.6% of manpower and equip.)	$0	$51,447	$51,447
Contractor Overhead (10% of directs+camp&admin indirects)	$0	$1,442,328	$1,442,328
Contractor Profit (10% of directs+camp&admin indirects)	$0	$1,442,328	$1,442,328
State Contract Mgmt. (1% of total-portion of contractor O&P)	$0	$161,013	$161,013
Total Cost	**$13,758,949**	**$4,786,602**	**$18,545,551**

Total Annual Post-Closure Operating Cost (Premature Closure)

	Direct Costs	Indirect Costs	Annual Cost
Manpower	$2,799,094	$0	$2,799,094
Consumables	$6,716,850	$0	$6,716,850
Mobile Equip	$416,329	$0	$416,329
Maintenance Materials	$352,593	$0	$352,593
Capital Replacement and SEP	$992,041	$660,435	$1,652,476
Power	$2,431,450	$0	$2,431,450
Environmental	$268,468	$0	$268,468
Camp & Admin	$120,000	$664,329	$784,329
Dam Inspection and Maintenance	$389,919	$0	$389,919
Sludge Management	$755,764	$307,762	$1,063,526
Insurance (1.6% of manpower and equip.)	$0	$51,447	$51,447
Contractor Overhead (10% of directs+camp&admin indirects)	$0	$1,590,684	$1,590,684
Contractor Profit (10% of directs+camp&admin indirects)	$0	$1,590,684	$1,590,684
State Contract Mgmt. (1% of total-portion of contractor O&P)	$0	$175,279	$175,279
Total Cost	**$15,242,507**	**$5,040,619**	**$20,283,126**

Table 2: Post-Closure Manpower Schedule

	On Roll	On Site	Coverage	Turnaround	* Total Hourly Wage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Year-Round Ops						31	28	31	30	31	30	31	31	30	31	30	31	365
Summer Ops						0	0	0	15	31	30	31	31	30	2	0	0	170
Year-Round																		
Site Manager	1	1			175,000	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	175,000
Enviro. Coordinator	1	1	12/7	2x2	99.10	36,865	33,298	36,865	35,676	36,865	35,676	36,865	36,865	35,676	36,865	35,676	36,865	434,058
Enviro. Tech.	1	1	12/8	2x3	56.76	21,115	19,071	21,115	20,434	21,115	20,434	21,115	21,115	20,434	21,115	20,434	21,115	248,609
Mechanic	2	1	12/7	2x2	61.23	22,778	20,573	22,778	22,043	22,778	22,043	22,778	22,778	22,043	22,778	22,043	22,778	268,187
Electrician	2	1	12/7	2x2	73.58	27,372	24,723	27,372	26,489	27,372	26,489	27,372	27,372	26,489	27,372	26,489	27,372	322,280
Equip. Operator Group 1A	2	1	12/7	2x2	62.99	23,432	21,165	23,432	22,676	23,432	22,676	23,432	23,432	22,676	23,432	22,676	23,432	275,896
Camp Support	0	2	12/7	2x2	33.17					included in camp costs in supplies and services								0
Nightshift Coverage	0		12/7	2x2		0	0	0	0	0	0	0	0	0	0	0	0	0
	9	8				$146,145	$133,413	$146,145	$141,901	$146,145	$141,901	$146,145	$146,145	$141,901	$146,145	$141,901	$146,145	$1,724,031
Summer																		
WTP Operator	2	1	12/7	2x2	62.99	0	0	0	11,338	23,432	22,676	23,432	23,432	22,676		0	0	126,988
Operator Assistant	2	1	12/7	2x2	59.74	0	0	0	10,753	22,223	21,506	22,223	22,223	21,506		0	0	120,436
PowerHouse Operator											included in power cost							0
Technicians	2	1	12/7	2x2	56.76	0	0	0	10,217	21,115	20,434	21,115	21,115	20,434		0	0	114,428
Mechanic	2	1	12/7	2x2	61.23	0	0	0	11,021	22,778	22,043	22,778	22,778	22,043		0	0	123,440
Electrician	2	1	12/7	2x2	73.58	0	0	0	13,244	27,372	26,489	27,372	27,372	26,489		0	0	148,337
Truck Driver	4	2	12/7	2x2	62.99	0	0	0	0	0	45,353	46,865	46,865	45,353	3,024	0	0	187,458
Equip. Operator Group 1A	4	2	12/7	2x2	62.99	0	0	0	22,676	46,865	45,353	46,865	46,865	45,353		0	0	253,976
	18	9				$0	$0	$0	$79,250	$163,784	$203,854	$210,649	$210,649	$203,854	$3,024	$0	$0	$1,075,063
Total - Manpower Cost						**$146,145**	**$133,413**	**$146,145**	**$221,151**	**$309,929**	**$345,755**	**$356,794**	**$356,794**	**$345,755**	**$149,168**	**$141,901**	**$146,145**	**$2,799,094**

Table 3: Water Treatment Consumables for Planned Closure (2031)

Red Dog Post-Closure Water Treatment Costs - 2031 Scenario (N)

				2031		2032		2033		2034		2035		2036		2037	
Supply	**Cost/Tonne FOB Seattle**	**Freight**	**Cost/Tonne Delivered**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**	**Tonnes***	**Total Cost**
Flocculant	$4,500	$176	$4,676	69	$322,597	54	$253,159	14	$63,547	14	$63,313	118	$550,739	118	$550,786	118	$550,786
Lime	$197	$176	$373	6899	$2,574,638	5414	$2,020,451	1359	$507,165	1354	$505,299	11778	$4,395,432	11779	$4,395,805	11779	$4,395,805
Sodium Sulfide	$908	$176	$1,084	180	$195,189	141	$153,175	35	$38,449	35	$38,308	307	$333,228	307	$333,256	307	$333,256
Antiscalant	$3,042	$266	$3,308	29	$95,852	23	$75,220	6	$18,881	6	$18,812	49	$163,639	49	$163,653	49	$163,653
					$3,188,276		$2,502,004		$628,043		$625,732		$5,443,038		$5,443,500		$5,443,500

*Ratios of consumption of flocculant, sodium sulfide and antiscalant from Susp Study Consumables sheet
*Flocculent, Lime, Antiscalant, and Sodium Sulfide costs are the current 2015 RD prices, FOB Seattle

Calculation of Lime Requirement (to steady state)

	Year	Flow 10^6 USGal	Acidity mg/L as CaCO3	Acidity Load t/Year	Theoretical Lime Demand t/Y	Lime Requirement t/Y
Tailings Pond		677	716.1	1834	1027	1155
Aqqaluk Pit	2031	583	4128	9117	5106	5744
Total Load		1260		10951	6133	6899
Tailings Pond		285	672.8	726	407	458
Aqqaluk Pit	2032	503	4128	7868	4406	4957
Total Load		789		8594	4813	5414
Tailings Pond		285	655.9	708	397	446
Aqqaluk Pit	2033	93	4128	1448	811	913
Total Load		378		2157	1208	1359
Tailings Pond		285	649.3	701	393	442
Aqqaluk Pit	2034	93	4128	1448	811	913
Total Load		378		2149	1204	1354
Tailings Pond		284	646.7	695	389	438
Aqqaluk Pit	2035	1152	4128	17999	10080	438
Total Load		1436		18695	10469	11778
Tailings Pond		285	645.7	697	390	439
Aqqaluk Pit	2036	1152	4128	17999	10080	11340
Total Load		1437		18696	10470	11779
Tailings Pond		285	645.7	697	390	439
Aqqaluk Pit	2037	1152	4128	17999	10080	11340
Total Load		1437		18696	10470	11779
Tailings Pond		285	645.7	697	390	439
Aqqaluk Pit	2038	1152	4128	17999	10080	11340
Total Load		1437		18696	10470	11779
Tailings Pond		285	645.7	697	390	439
Aqqaluk Pit	2039	1152	4128	17999	10080	11340
Total Load		1437		18696	10470	11779
Tailings Pond		285	645.7	697	390	439
Aqqaluk Pit	2040	1152	4128	17999	10080	11340
Total Load		1437		18696	10470	11779

Pit Inputs

Filling Period Calcs	2031	2032	2033	2034	2035	Steady State
Load to Pit	27117	25867	19448	19448	19478	17999
Load to Storage	17999	17999	17999	17999	17999	0
Excess Load to be treated	9117	7868	1448	1448	1478	17999
Flow to Treatment (Mgal/yr)	0.0	0.0	0.0	0.0	331.4	1151.8
Flow to Storage (Mgal/yr)	1065	1055	1055	1055	755	0

In the W&L balance, it was assumed that these would be flushed out over several years
For costing purposes, assume that this excess would be treated during the filling period

Tailings Pond						
Load (t/yr)	1834	726	708	701	695	697
Flow (Mm3/yr)	2.6	1.1	1.1	1.1	1.1	1.1
Flow (Mgal/yr	677	285	285	285	284	285
Conc (mg/L)	716	673	656	649	647	646

m3toUSGals	264

Annual SO4 load from Pit	23629
Annual SO4 from Pond	696

1) Assumes actual demand : theoretical demand = 1.125
2) Based on water and load balance model update as of Sept 2014 — Red Dog Load Balance_Avg Precip_Update_329100 030_rev68

Table 4: Water Treatment Consumables for Premature Closure (2015)

Red Dog Post-Closure Water Treatment Costs - 2015 Scenario

Supply	Cost/Tonne FOB Seattle	Freight Cost/Tonne	Cost/Tonne Delivered	2015 Tonnes*	2015 Total Cost	2016 Tonnes*	2016 Total Cost	2017 Tonnes*	2017 Total Cost	2018 Tonnes*	2018 Total Cost	2019 Tonnes*	2019 Total Cost	2020 Tonnes*	2020 Total Cost
Flocculant	$4,500	$176	$4,676	150	$700,834	113	$528,911	125	$585,978	123	$577,131	151	$706,530	145	$679,906
Lime	$197	$176	$373	14988	$5,590,483	11311	$4,219,070	12532	$4,674,289	12342	$4,603,717	15110	$5,635,924	14540	$5,423,545
Sodium Sulfide	$908	$176	$1,084	391	$424,043	295	$320,020	327	$354,549	322	$349,196	394	$427,490	380	$411,381
Antiscalant	$3,042	$266	$3,308	63	$208,236	48	$157,153	53	$174,109	52	$171,480	63	$209,928	61	$202,018
					$6,923,596		$5,225,155		$5,788,926		$5,701,524		$6,979,873		$6,716,850

*Ratios of consumption of flocculant, sodium sulfide and antiscalant from Susp Study Consumables sheet

Calculation of Lime Requirement (to steady state)

	Year	Flow 10^6 USGal	Acidity mg/L as CaCO3	Acidity Load t/Year	Theoretical Lime Demand t/Y	Lime Requirement t/Y
Tailings Pond		548	2480	5147	2883	3243
Main Pit	2015	1113	4425	18643	10440	11745
Total Load		1661		23790	13323	14988
Tailings Pond		283	2936	3141	1759	1979
Main Pit	2016	1109	3529	14813	8295	9332
Total Load		1391		17954	10054	11311
Tailings Pond		450	2982	5078	2844	3199
Main Pit	2017	1109	3529	14813	8295	9332
Total Load		1559		19891	11139	12532
Tailings Pond		450	2806	4778	2676	3010
Main Pit	2018	1109	3529	14813	8295	9332
Total Load		1559		19591	10971	12342
Tailings Pond		427	2466	3988	2233	2512
Main Pit	2019	1301	4061	19996	11198	12597
Total Load		1728		23984	13431	15110
Tailings Pond		581	2086	4587	2569	2890
Main Pit	2020	1147	4259	18492	10356	11650
Total Load		1728		23080	12925	14540
Tailings Pond						
Main Pit						
Total Load						
Tailings Pond						
Main Pit						
Total Load						
Tailings Pond						
Main Pit						
Total Load						
Tailings Pond						
Main Pit						
Total Load						

Pit Inputs

	2015	2016	2017	2018	2019	2020
Total lime demand	18643	14813	14813	14813	19996	18492
New flow to WTP	1113	1109	1109	1109	1301	1147

Tailings Pond

Load (t/yr)	5147	3141	5078	4778	3988	4587
Flow (Mm3/yr)	2.08	1.07	1.70	1.70	1.62	2.20
Flow (Mgal/yr	548	283	450	450	427	581
Conc (mg/L)	2480	2936	2982	2806	2466	2086

m3toUSGals	264.172051

1) Assumes actual demand : theoretical demand = 1.125

2) Based on water and load balance model update as of Sept 2014 Red Dog Load Balance_Avg Precip_Update_329100 030_rev68

Table 5: Post-Closure Mobile Equipment Schedule

	$/hr	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
16M Grader	$ 64.44	$ 32,863	30	30	30	30	60	60	60	60	60	30	30	30	510
966 Loader (CAT 966K)	$ 45.08	$ 81,151	125	125	125	125	125	200	200	200	200	125	125	125	1800
Haul Truck (CAT 735B)	$ 54.14	$ 77,964	10	10	10	10	10	340	340	340	340	10	10	10	1440
Excavator (CAT 349E L)	$ 65.10	$ 33,201				10	100	100	100	100	100				510
988 Loader (CAT 988K)	$ 94.78	$ 11,373	20	20	20							20	20	20	120
Forklift (CAT TH514C)	$ 22.11	$ 14,372						300	110	110	110	20			650
Portable Generator, 20 kW	$ 6.37	$ 765	10	10	10	10	10	10	10	10	10	10	10	10	120
D6 Dozer (D6T)	$ 46.30	$ 22,224	10	10	10	10	10	100	100	100	100	10	10	10	480
Field Service Truck (33K lb)	$ 11.13	$ 20,034	150	150	150	150	150	150	150	150	150	150	150	150	1800
Semi Tractor 6x4 (80K lb)	$ 28.00	$ 81,318						720	720	720	720	24			2904
Flatbed Trailer	$ 3.01	$ 7,766						396	720	720	720	24			2580
Heavy Equipment Trailer	$ 3.01	$ 151						50							50
Fuel Tanker (9300 gal)	$ 1.31	$ 346						264							264
Van-Mounted Steam Generator (16 hp	$ 31.31	$ 5,010			20	60	60	20							160
Snowblower (350 hp)	$ 42.72	$ 4,272	20	20	20	10							10	20	100
SUBTOTALS		$ 392,809	375	375	395	415	525	2710	2510	2510	2510	423	365	375	13488
Pick-ups (3/4 ton, 4x4)	$ 9.80	$ 23,520	200	200	200	200	200	200	200	200	200	200	200	200	2400
Total - Mobile Equipment		**$ 416,329**													
	Maint. Hrs	5,645													

Table 6: Post-Closure Maintenance Material Costs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	30	28	31	30	31	30	31	31	30	31	30	31	
Water Treatment Plant Maintenance													
Non-exempt													
Stores	$0	$0	$0	$1,000	$500	$500	$500	$500	$500	$0	$0	$0	$3,500
Equipment													$0
Other	$0	$0	$0	$5,000	$500	$500	$500	$500	$500	$0	$0	$0	$7,500
Total				$6,000	$1,000	$1,000	$1,000	$1,000	$1,000	$0			$11,000
Sand Filter Maintenance													
Filter 1							$0			$30,000			
Filter 2							$0			$30,000			
Filter 3							$0			$30,000			
Total							$0			$90,000			$90,000
Reagent Systems Maintenance													
Non-exempt													$0
Stores				$1,000	$250	$250	$250	$250	$250				$2,250
Equipment													$0
Other				$250	$100	$100	$100	$100	$100				$750
Total	$0	$0	$0	$1,250	$350	$350	$350	$350	$350	$0	$0	$0	$3,000
Lime Slaking Maintenance													
Non-exempt													$0
Stores				$2,000	$500	$500	$500	$500	$500				$4,500
Equipment				$2,000									$2,000
Other				$500	$100	$100	$100	$100	$100				$1,000
Total	$0	$0	$0	$4,500	$600	$600	$600	$600	$600	$0	$0	$0	$7,500
Red Dog Creek Pumpback													
Non-exempt													$0
Stores	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$54,000
Equipment													$0
Other	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$12,000
Total	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$66,000
Tailings Seepage Pumpback													
Non-exempt													$0
Stores	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$12,000
Equipment													$0
Other	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Total	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$18,000
Overburden Pumpback													
Non-exempt													$0
Stores	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$13,200
Equipment	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Other	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$19,200
Total	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$38,400
Sullaire Compressor													
Non-exempt													$0
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment													$0
Other	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Total	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$7,200

Table 6: Post-Closure Maintenance Material Costs

	Jan 30	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	Total
#1 Reclaim Barge													
Non-exempt													$0
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$600
Other	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Total	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$7,800
Bons Creek Pumps													
Non-exempt													$0
Stores					$1,200	$250	$250	$250	$250	$500			$2,700
Equipment													$0
Other													$0
Total	$0	$0	$0	$0	$1,200	$250	$250	$250	$250	$500	$0	$0	$2,700
Temporary Facilities													
Non-exempt													
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment													
Other	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$2,400
Total	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$8,400
Building and Camp Maintenance													
Supplies	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$9,600
Total	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$9,600
Miscellaneous													
lubricants	$25	$25	$25	$25	$50	$50	$50	$50	$50	$25	$25	$25	$425
supplies	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Total	$125	$125	$125	$125	$150	$150	$150	$150	$150	$125	$125	$125	$1,625
Total Maint. Cost (2015 inflation and freight)	**$16,998**	**$16,998**	**$16,998**	**$32,273**	**$21,125**	**$19,890**	**$19,890**	**$19,890**	**$19,890**	**$134,648**	**$16,998**	**$16,998**	**$352,593**

Table 7: Capital Replacement Allowances

Water Treatment Equipment					
Total Capital Cost for new water treatment infrastructure	$61,073,201		verif. 3/30/16	See 2015 Water Treatment Capital Estimate in Red Dog Closure Cost Estimate	
Annual Capital Replacement Cost	$1,263,229				
Equipment		Pick-ups, Service Truck, Steam Generator	Tractor and Trailers	Heavy Equipment	
Total capital cost for replacement fleet	$5,770,800	$614,400	$742,800	$ 4,413,600	
Annual capital replacement cost	$287,504				
Generator/Power Equipment					
Total capital cost for replacement	$1,365,600				
Annual capital replacement cost	$44,450				
SEP Monitoring Equipment (thermistor installations)					
Total capital cost for new installations	$250,000		Assume replacement and install for 15 thermistors		
Annual capital replacement cost	$57,293				
Total Annual Capital Replacement (less Water Treatment)					
Equipment, Generator/Power, and Monitoring	$389,247				
SEP Reporting					
Total reporting cost over 30-year period	$2,100,000				
Annual reporting cost	$70,000				

Equipment Capital Costs

Equipment	Capex per Unit 2015	Units	Total Capital	Total Capital with Freight and Assembly (20% capital cost)
16 Grader	$ 500,000	1	$ 500,000	$ 600,000
966 Loader	$ 365,000	1	$ 365,000	$ 438,000
35 ton Haul Truck	$ 475,000	2	$ 950,000	$ 1,140,000
2.3 cy Excavator	$ 262,000	1	$ 262,000	$ 314,400
988 Loader	$ 695,000	1	$ 695,000	$ 834,000
Forklift	$ 150,000	2	$ 300,000	$ 360,000
Portable Generator, 20 kW	$ 25,000	1	$ 25,000	$ 30,000
D6 Dozer	$ 231,000	1	$ 231,000	$ 277,200
Snowblower	$ 350,000	1	$ 350,000	$ 420,000
Van-mounted Steam Generator, Stainl	$ 115,000	1	$ 115,000	$ 138,000
Field Service Truck	$ 137,000	1	$ 137,000	$ 164,400
Semi Tractor 6x4, 80K lb	$ 175,000	2	$ 350,000	$ 420,000
Flatbed Trailer	$ 33,000	2	$ 66,000	$ 79,200
Heavy Equipment Trailer, 50t	$ 45,000	1	$ 45,000	$ 54,000
Fuel Tanker, 9300 gal	$ 79,000	2	$ 158,000	$ 189,600
Pick-ups	$ 65,000	4	$ 260,000	$ 312,000
Total Fleet			*$ 4,809,000*	*$ 5,770,800*
Power Equipment				$ -
500 kW Generator	$ 298,000	2	$ 596,000	$ 715,200
1000 kW Generator	$ 467,000	1	$ 467,000	$ 560,400
Switchgear	$ 25,000	3	$ 75,000	$ 90,000
Total Power			*$ 1,138,000*	*$ 1,365,600*
Total Capital Cost			$ 5,947,000	$ 7,136,400

Capital Replacement Schedule 2031 (Table 7 Cont.)

NPV at net discount per year 4.30%

	Cost Component								
	Water Treatment	**Pick-ups, Service Truck, Steam Generator**	**Tractor and Trailers**	**Heavy Equipment**	**Generator / Power**	**SEP Reporting**	**Monitoring - Thermistors (SEP)**	**Total NPV**	**Annual Equivalent**
Total Capital Replacement	$61,073,201	$614,400	$742,800	$4,413,600	$1,365,600	$2,100,000	$250,000		
Replacement time (years)	30	10	15	25	20	30	15		
Total NPV:	**$29,370,945**	**$1,428,522**	**$1,151,374**	**$4,104,770**	**$1,033,488**	**$1,140,063**	**$192,050**	**$38,421,213**	**$38,421,213**
Year									
1	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
2	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
3	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
4	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
5	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
6	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
7	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
8	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
9	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
10	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
11	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
12	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
13	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
14	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
15	$15,268,300	$61,440	$49,520	$176,544	$0	$150,000	$250,000	$15,955,804	$1,652,476
16	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
17	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
18	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
19	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
20	$0	$61,440	$49,520	$176,544	$1,365,600	$150,000	$0	$1,803,104	$1,652,476
21	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
22	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
23	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
24	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
25	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
26	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
27	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
28	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
29	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
30	$45,804,900	$61,440	$49,520	$176,544	$0	$150,000	$209,000	$46,451,404	$1,652,476
31	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
32	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
33	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
34	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
35	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
36	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
37	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
38	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
39	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
40	$0	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$1,653,104	$1,652,476
41	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
42	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
43	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
44	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
45	$15,268,300	$61,440	$49,520	$176,544	$0	$0	$0	$15,555,804	$1,652,476
46	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
47	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
163	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
164	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
165	$15,268,300	$61,440	$49,520	$176,544	$0	$0	$0	$15,555,804	$1,652,476
166	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
167	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
168	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
169	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
170	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
171	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
172	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
173	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
174	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
175	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
176	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
177	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
178	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
179	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
180	$45,804,900	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$47,458,004	$1,652,476
181	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
182	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
183	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
184	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
185	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
186	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
187	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
188	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
189	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
190	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
191	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
192	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
193	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
194	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
195	$15,268,300	$61,440	$49,520	$176,544	$0	$0	$0	$15,555,804	$1,652,476
196	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
197	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
198	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
199	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
200	$0	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$1,653,104	$1,652,476

Table 8: Post-Closure Power Costs

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New		515	31	28	31	30	0	0	0	0	0	31	30	31	
New		2014	0	0	0	0	31	30	31	31	30	0	0	0	
kWh Produced			383,154	346,074	383,154	370,794	1,498,440	1,450,103	1,498,440	1,498,440	1,450,103	383,154	370,794	383,154	10,015,802
Fuel Cost			$ 82,957	$ 74,929	$ 82,957	$ 80,281	$ 324,429	$ 313,964	$ 324,429	$ 324,429	$ 313,964	$ 82,957	$ 80,281	$ 82,957	
500 kW op hrs			744	672	744	720	0	0	0	0	0	744	720	744	
500 kW Maintenance and Supplies $/hr	no labor		$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	$ 2.83	
1000 kW op hrs			0	0	0	0	744	720	744	744	720	0	0	0	
1000 kW Maintenance and Supplies $/hr	no labor		$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	$ 4.69	
Fuel Consumed (gal)			26,934	24,328	26,934	26,065	105,334	101,936	105,334	105,334	101,936	26,934	26,065	26,934	704,070
Powerhouse Operator	$	62.99	$ -	$ -	$ -	$ -	$ 46,865	$ 45,353	$ 46,865	$ 46,865	$ 45,353	$ -	$ -	$ -	
500 kW Maintenance Cost			$ 2,104	$ 1,901	$ 2,104	$ 2,037	$ -	$ -	$ -	$ -	$ -	$ 2,104	$ 2,037	$ 2,104	
1000 kW Maintenance Cost			$ -	$ -	$ -	$ -	$ 3,490	$ 3,377	$ 3,490	$ 3,490	$ 3,377	$ -	$ -	$ -	
Total Cost			**$ 85,062**	**$ 76,830**	**$ 85,062**	**$ 82,318**	**$ 374,784**	**$ 362,694**	**$ 374,784**	**$ 374,784**	**$ 362,694**	**$ 85,062**	**$ 82,318**	**$ 85,062**	**$ 2,431,450**
500 kW Labor			47.3	42.7	47.3	45.8	0.0	0.0	0.0	0.0	0.0	47.3	45.8	47.3	
1000 kW Labor			0.0	0.0	0.0	0.0	115.9	112.2	115.9	115.9	112.2	0.0	0.0	0.0	
Maint. Labor hours needed			47.3	42.7	47.3	45.8	115.9	112.2	115.9	115.9	112.2	47.3	45.8	47.3	
$/kWhr			0.23	0.23	0.23	0.23	0.50	0.50	0.50	0.50	0.50	0.23	0.23	0.23	
Maint. Cost / kWh			$ 0.01	$ 0.01	$ 0.01	$ 0.01	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.01	$ 0.01	$ 0.01	

Average Fuel Cost $/gal $ 3.08 5-year average cost of fuel delivered to RD Port (2011-2015)

Powerhouse Operator (Grp 1A) Hourly
$ 62.99

Table 9: Post-Closure Camp & Administration Costs

	Basis	Jan. 31	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	Total
Administration														
Worker Compensation	11% of labor cost						covered in labor burden							$0
Insurance	Covered on Summary Tab													$0
Office Supplies	Allow $100/mo	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Communications	Exede internet + Iridium phone	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$6,840
Office Heating Fuel	500/200 gal/mo	$1,540	$1,540	$1,540	$1,540	$616	$616	$616	$616	$1,540	$1,540	$1,540	$1,540	$14,784
Misc. Supplies	Allow $600/mo	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$7,200
Camp Operation	$111 per person-day	$27,528	$24,864	$27,528	$49,950	$51,615	$56,610	$58,497	$58,497	$56,610	$27,528	$26,640	$27,528	$493,395
Turnaround Costs	$610/trip x 231 trips	$7,862	$7,101	$7,862	$14,265	$14,741	$16,167	$16,706	$16,706	$16,167	$7,862	$7,608	$7,862	$140,910
Subtotal - Administration		$38,200	$34,775	$38,200	$67,025	$68,242	$74,663	$77,089	$77,089	$75,587	$38,200	$37,058	$38,200	$664,329
Port Maintenance														
Additional Maintenance		$0	$0	$0	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$0	$0	$120,000
Subtotal - Port Maintenance		$0	$0	$0	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$0	$0	$120,000
Total - Supplies and Services		**$38,200**	**$34,775**	**$38,200**	**$67,025**	**$88,242**	**$94,663**	**$97,089**	**$97,089**	**$95,587**	**$58,200**	**$37,058**	**$38,200**	**$784,329**

Table 10: Post-Closure Environmental Monitoring Costs

Analyte	Unit Cost	Used Oil and Fuel Samples	Used Oil and Fuel Cost	APDES Samples	APDES Cost
Aluminum Total EPA 200.8 (W)	$20.00			160	$3,200
Ammonia-N by EPA 350.2 (W)	$25.00			95	$2,375
Arsenic, SW7060 GF (O)	$20.00	1	$20		
Biochemical Oxygen Demand 5	$40.00			6	$240
Cadmium by SW6010 ICP (O)	$10.00	1	$10		
Cadmium Total EPA 200.8 (W)	$20.00			240	$4,800
Calcium Total EPA 200.8 (W)	$20.00			145	$2,900
Chloride by Ion Chrom. (W)	$20.00			150	$3,000
Chromium by SW6010 ICP (O)	$10.00	1	$10		
Chromium Total EPA 200.8 (W)	$20.00			160	$3,200
Cobalt Total EPA 200.8 (W)	$20.00			65	$1,300
Copper Total EPA 200.8 (W)	$20.00			235	$4,700
Cyanide, Total (W)	$45.00			60	$2,700
Fecal Coliform (MF)	$50.00			8	$400
Flash Point by ASTM D-3828	$33.00	1	$33		
Hardness CaCO3 ICP-MS (W)	$25.00			125	$3,125
Iron Total EPA 200.8 (W)	$20.00			155	$3,100
Lead by SW6010 ICP (O)	$10.00	1	$10		
Lead Total EPA 200.8 (W)	$20.00			240	$4,800
Manganese Total EPA 200.8 (W)	$20.00			150	$3,000
Mercury by EPA 245.1 CV (DW)	$35.00			85	$2,975
Metals Acid Digestion	$20.00			250	$5,000
Nickel Total EPA 200.8 (W)	$20.00			160	$3,200
Selenium Total EPA 200.8 (W)	$20.00			150	$3,000
Silver Total EPA 200.8 (W)	$20.00			140	$2,800
Total Dissolved Solids (W)	$20.00			190	$3,800
Total Halogens	$150.00	1	$150		
Total Sulfur	$110.00	2	$220		
Total Suspended Solids	$20.00			45	$900
VOC, EPA 624 (W)	$125.00			4	$500
Zinc Total EPA 200.8 (W)	$20.00			240	$4,800
Monthly WET Tests	$1,910.00			12	$22,920
Courier					$4,080
SEWRM Fees					$5,000
Total Analytical			**$453**		**$101,815**

Bioassessment Program	$90,000	
Fish Population and Diversity		
Fish Tissue Sampling		
Benthic Invertebrate Sampling		
Dolly Varden Aerial Surveys		
Equipment	$4,200	
Miscellaneous Sampling Supplies	$4,000	
Sampling Equipment	$5,000	
Telemetry/MET Station Maintenance	$50,000	
Helicopter Time	$3,000	
Backup Telemetry Contract	$10,000	
Equipment Maintenance		
Total	**$166,200**	
Grand Total	**$268,468**	**$268,468**

Table 11: Post-Closure Winter Power Consumption

		Number Available	Connected Power	Number Operating	Power kW	
Red Dog Pumpback	pumps	3	140		0.0	
	pumps	4	87	1	65	
	heat tracing				18	
Waste Pile Seepage	pumps	2				
	heat tracing					
Tailings Seepage	pumps	3	100	2	149	
	heat tracing				2	
Seepage-Seepage	pumps		5	1	4	
	heat tracing				0.5	
Overburden Pumpback	pumps		50	1	37	
	heat tracing				8	
Pumping Systems					283	283
Temporary Heat	heat tracing				19	
	compressor				15	
	lime plant				15	
	flocculant system				15	
	Reclaim Barge#1				20	
	Generator				25	
	6016 MCC				10	
	2021 MCC				10	
	2020 MCC				10	
	6030 MCC				10	
Barge De-Icing	pump		25	1	19	
Temporary Heat					167	167
Potable Water Plant					15	
Temporary Accommodation	misc heating				30	
	appliances				10	
	lighting				10	
Temporary Accommodation					65	65
Total						**515**

Table 12: Post-Closure Summer Power Consumption

			Number Available	Connected Power	Number Operating	Power kW	Standalone Power
Red Dog Pumpback	pumps		3	140	2	146.2	
			4	87	2	90.8	
	heat tracing			17.6	0	0.0	
Tailings Seepage	pumps		3	100	2	104.4	
						0.0	
	heat tracing			1.9	0	0.0	
Seepage-Seepage	pumps			10	2	10.4	
						0.0	
	heat tracing			0.475	0	0.0	
Overburden Pumpback	pumps			50	1	26.1	
						0.0	
	heat tracing			7.64	0	0.0	
						0.0	
Potable Water Plant						15.0	
						0.0	
Subtotal - Water Collection Pumps						393	393
Reclaim Barge #1	pumps		4	300	4	626.4	
	misc.					0.0	
Subtotal - Reclaim Barge						626	626
WTP#2	Lime/sludge Agitator	2021-1901	1	15	1	7.8	
	Rapid Mix Agitator	2021-1902	1	25	1	13.0	
	Lime Reactor Agitator	2021-1903	1	100	1	52.2	
	Floc Mix Agitator	2021-1904	1	5	1	2.6	
	Clarifier - rake drive	2006-3301	2	7.5	2	7.8	
	Clarifier - lift drive		1	2	1	1.0	
	Sludge recycle pumps	2005-1509	2	150	2	156.6	
	Overflow bypass pump	2020-1540	1	75	1	39.1	
	Emergency spill pump	2021-1503	1	10	1	5.2	
Subtotal - WTP2						286	286
Lime Mixing System	Screw Conveyor	2020-2004	1	3	1	1.6	
	Lime slaker	2020-2101	1	5	1	2.6	
	MOL transfer pump	2020-1510	1	7.5	1	3.9	
	MOL storage tank agitator	2020-1920	1	7.5	1	3.9	
	Lime feed pumps	2020-1511	2	25	1	13.0	
	Overhead crane	2020-1002	1	5	1	2.6	
	Sump pump	2020-1521	1	10	1	5.2	
	Dust Collection Filter	2020-2905	1	5	1	2.6	
Subtotal - Lime Slaking System						35	35
Flocculant System	Flocculant Transfer Pump	2025-1507	2	5	1	2.6	
	Flocculant Area Sump Pump	2025-1510	1	7.5	1	3.9	
	Flocculant Feed Pump	2025-1512	2	1	1	0.5	
	Flocculant Transfer Blower		1	2.5	1	1.3	
	Flocculant Screw Feeder		1	0.5	1	0.3	
	Flocculant Day Tank Agitator	2025-1902	1	1	1	0.5	
	Flocculant Mix Tank Agitator		1	5	1	2.6	
	Flocculant Hoist	2025-1004	1	1	1	0.5	
Subtotal - Flocculant System						12	12
Sodium Sulfide System	Mix tank agitator	2016-2407	1	2	1	1.0	
	Transfer pump	2016-1511	2	5	1	2.6	
	Day tank agitator	2016-24__	1	1.5	1	0.8	
	Head tank feed pumps	2016-1517	2	5	1	2.6	
	Overhead Crane	2016-1002	1	25	1	13.0	
	Exhaust fan	2016-2903	1	2	1	1.0	
	Spill sump pump					0.0	
Subtotal - Sulfide System						21	21

Table 12: Post-Closure Summer Power Consumption

			Number Available	Connected Power	Number Operating	Power kW	Standalone Power
Air Compressor	Sullair compressor	2021-1801	4	200	1	104.4	
	Cooling circulating pumps	2021-1510	2	5	1	2.6	
	Mechanical room sump pump	2021-1508	1	2	1	1.0	
	Air Dryer	2021-2801	1	25	1	13.0	
Subtotal - Air Compressor						121	121
Fresh Water Supply	Bon's Creek pumps		2	50	1	26.1	
	Fresh water transfer pumps	2020-1522	2	5	1	2.6	
	Reagent water supply pumps	2016-1513	2	10	1	5.2	
	Potable Water Plant					0.0	
Subtotal - Fresh Water Supply						34	34
Process Water Distribution	Cooling Water Standby pump	2025-1513	1	75	1	39.1	
Subtotal - Process Water Distribution						39.1	39
Generator	Fuel Feed Pump Skid		2	3	1	1.6	
	Fuel Return Skid		1	1	1	0.5	
	Fuel Treatment Feed Pump No.1		2	15	1	7.8	
	Fuel Treatment Heater No.1 (24 kW)		2	24	1	12.5	
	Fuel Treatment Sludge Tank Heater		1	1	1	0.5	
	Lube Oil Reclaim Skid Separator Motor		1	20	1	10.4	
	Lube Oil Reclaim Skid Feed Pump		1	3	1	1.6	
	Lube Oil Reclaim Skid Electric Heater		1	64	1	33.4	
	Waste Oil Centrifuge		1	5	1	2.6	
	25t / 5t Powerhouse Bridge Crane		1	30	1	15.7	
	Water Pre-Heater (15 kW)		2	15	1	7.8	
	Portable Clean Lube Oil Transfer Pump		2	2	1	1.0	
	Pre-Lube Circulation Oil Pump		1	20	1	10.4	
	Engine Water Jacket Pre-Heating Pump		2	1	1	0.5	
	Oil/Water Separator Sump Pump		1	7.5	1	3.9	
	Spill Trays Sump Pump		1	7.5	1	3.9	
	Heat Recovery Circulating Pump		2	40	1	20.9	
	Starting Air Compressor (Electric) Skid		1	10	1	5.2	
	Starting Air Compressor (Diesel) Skid		1	10	1	5.2	
	Door Heater		1	0.5	1	0.3	
	Electric Unit Heater		1	0.5	1	0.3	
	Control Room HVAC Unit		1	5	1	2.6	
	Switchroom Ventilation (AC) Unit		1	10	1	5.2	
	Mechanical Bay Area Ventilation Unit		1	5	1	2.6	
	Powerhouse Make-Up Air Unit		2	30	1	15.7	
	Mechanical Bay Area Exhaust Fan		1	0.5	1	0.3	
	Vertical Lift Door		1	2	1	1.0	
	Modulating Motorized Relief Damper		3	1	1	0.5	
Subtotal - Generator						174	174
Misc. Heating & Lighting						30	
Temporary Accommodation	Heating					30.0	
	appliances					10.0	
	lighting					10.0	
Subtotal - Temporary & Miscellaneous						80	80
Contingency							192
Total							**2014**

Table 13: Dam Inspection and Maintenance

	Per Item		Item		Yearly Cost
Yearly Dam Inspection	$7,500	Each dam	4	Dams	$30,000
Dam Instrumentation Replacement	$12,500	Each dam	4	Dams	$50,000
Periodic Dam Safety Inspection (4 dams)	$700,000	Each period	3	Years	$233,333
Repair erosion on dam face and beach armoring (20-year interval)	$31,716	Each period	20	Years	$1,586
Repair Main Dam Drain (20-year interval)	$1,500,000	Each period	20	Years	$75,000
Total Inspection and Maintenance					**$389,919**

Erosion repair calcs
Main Dam face

Slope length (ft):	501	986' dam crest to 800' toe, 2.5H:1V slope
Slope length (m):	153	
Rip-rap quantity (m3):	85	Assume 3 runnels full length of dam face, each runnel is 1' deep with 2H:1V side slopes
Unit cost ($/m3):	$23.47	Quarry, haul, place (Rev 2 closure cost estimate)
Direct cost:	$2,000	
Indirect cost (0.9 x direct cost):	$1,800	Indirect:direct ratio for Rev 2 closure cost estimate
Total cost:	**$3,800**	

Main and Back Dam Beach armoring

Rip-rap quantity (m3):	626	Assume 10% of rip-rap needs to be replaced (Rev 2 closure cost estimate)
Unit cost ($/m3):	$23.47	Quarry, haul, place (Rev 2 closure cost estimate)
Direct cost:	$14,692	
Indirect cost (0.9 x direct cost):	$13,223	Indirect:direct ratio for Rev 2 closure cost estimate
Total cost:	**$27,915**	

Table 14: 2015 Sludge Management Annual Cost

2015 Closure Scenario Sludge Management		
Densification:	Freeze-thaw	
Primary Disposal:	Main Pit, Aqqaluk Pit	@ Year 1-19
Secondary Disposal:	TSF Repository, New Repository	@ Year 20-100
TSF Dam Height (ft.)	976	
Real Rate of Return:	4.3%	
	NPV $24,366,000	NPV $24,366,000
Year	**Cash flow by year**	**Equivalent Annual Cost**
1	$53,908	$1,063,526
2	$53,908	$1,063,526
3	$53,908	$1,063,526
4	$53,908	$1,063,526
5	$53,908	$1,063,526
6	$53,908	$1,063,526
7	$53,908	$1,063,526
8	$7,310,793	$1,063,526
9	$7,310,793	$1,063,526
10	$470,486	$1,063,526
11	$470,486	$1,063,526
12	$470,486	$1,063,526
13	$470,486	$1,063,526
14	$470,486	$1,063,526
15	$470,486	$1,063,526
16	$470,486	$1,063,526
17	$470,486	$1,063,526
18	$4,392,950	$1,063,526
19	$4,392,950	$1,063,526
20	$476,656	$1,063,526
21	$476,656	$1,063,526
56	$476,656	$1,063,526
57	$476,656	$1,063,526
58	$7,733,541	$1,063,526
59	$7,733,541	$1,063,526
60	$476,656	$1,063,526
61	$476,656	$1,063,526
90	$11,868,948	$1,063,526
91	$816,527	$1,063,526
92	$816,527	$1,063,526
93	$816,527	$1,063,526
94	$816,527	$1,063,526
95	$816,527	$1,063,526
96	$816,527	$1,063,526
97	$816,527	$1,063,526
98	$816,527	$1,063,526
99	$816,527	$1,063,526
100	$816,527	$1,063,526

Capital Costs	**Start Year**	**End Year**	**Annual Cost**
TSF repository - cofferdam	18	19	$ 3,922,464
New densification infrastructure	8	9	$ 7,256,885
Replace densification infrastructure	58	59	$ 7,256,885
New repository	89	90	$ 11,392,292
Operating Costs			
Pumping WTP sludge to Main Pit	1	9	$ 53,908
Pumping WTP sludge to densification	10	100	$ 18,816
Densification operating and maintenance costs	10	100	$ 169,801
Trucking densified sludge to TSF repository	20	90	$ 190,559
Dam inspection and maintenance of TSF repository	20	90	$ 97,480
Trucking densified sludge to Aqqaluk repository	10	19	$ 281,869
Trucking densified sludge to new repository	91	100	$ 432,950
Dam inspection and maintenance of TSF/new repository	91	100	$ 194,960

Table 15: 2031 Sludge Management Annual Cost

2031 Closure Scenario Sludge Management		
Densification:	Freeze-thaw	
Primary Disposal:	Aqqaluk Pit	@ Year 1-42
Secondary Disposal:	New Repository	@Year 43-100
TSF Dam Height (ft)	986	
Real Rate of Return:	4.3%	
	NPV $20,855,000	NPV $20,855,000
Year	**Cash flow by year**	**Equivalent Annual Cost**
1	$45,357	$910,278
2	$45,357	$910,278
3	$45,357	$910,278
39	$45,357	$910,278
40	$45,357	$910,278
41	$46,571,922	$910,278
42	$46,571,922	$910,278
43	$719,048	$910,278
44	$719,048	$910,278
89	$719,048	$910,278
90	$719,048	$910,278
91	$7,698,744	$910,278
92	$7,698,744	$910,278
93	$719,048	$910,278
94	$719,048	$910,278
95	$719,048	$910,278
96	$719,048	$910,278
97	$719,048	$910,278
98	$719,048	$910,278
99	$719,048	$910,278
100	$719,048	$910,278

Capital Costs	**Start Year**	**End Year**	**Annual Cost**
New repository	41	42	$ 39,546,869
New densification infrastructure	41	42	$ 6,979,697
Replacement of densification infrastructure	91	92	$ 6,979,697
Operating Costs			
Pumping WTP sludge to Aqqaluk Pit	1	42	$ 45,357
Pumping WTP sludge to densification	43	100	$ 18,816
Densification operating and maintenance costs	43	100	$ 169,801
Trucking densified sludge to new repository	43	100	$ 432,950
Dam inspection and maintenance of new repository	43	100	$ 97,480

Table 16: Sludge Management Freeze/Thaw Bed Construction and Operation

Cost Estimate for Sludge Dewatering / Freeze-Thaw infrastructure and Operating Cost

Note: Costs were updated to Rev2 costs where applicable

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 5/14/2015
By: CAM
Checked By: DPN, 6/10/15

2015 Scenario

Item	Quantity	Units	Production Rate (BCY/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)	Cost per acre ($)	Cost for 114 acres ($)
Earthwork (D11 Dozer)	1,603,683	cy	368	4,363		$ 469	$ 2,045,729	$ 12,324	$ 1,404,898
Liner Bedding (load, haul, dump, place, compact)	93,548	cy	829	113		$ 3.59	$ 336,157	$ 2,025	$ 230,855
Overliner Gravel (load, haul, dump, place)	280,645	cy	829	338		$ 3.59	$ 1,008,470	$ 6,075	$ 692,564
Produce and Screen Bedding and Overliner	374,193	cy				$ 2.70	$ 1,009,900	$ 6,084	$ 693,546
HDPE Liner (60-mil) - Installed	5,051,601	sf				$ 0.73	$ 3,684,077	$ 22,193	$ 2,530,028
HDPE Pipe (10", uninsulated) - material and labor	31,543	lf				$ 90	$ 2,838,870	$ 17,102	$ 1,949,585
Portable Pump and Pipe (for effluent water to TSF)	2	each			100,000	$ 100,000	$ 200,000	$ 1,205	$ 137,349
TOTALS							**$ 11,123,203**	**$ 67,007**	**$ 7,638,826**

Table 16: Sludge Management Freeze/Thaw Bed Construction and Operation

Cost Estimate for Sludge Dewatering / Freeze-Thaw infrastructure and Operating Cost

Note: Costs were updated to Rev2 costs where applicable

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 5/14/2015
By: CAM
Checked By: DPN, 6/10/15

2031 Scenario

Item	Quantity	Units	Production Rate (BCY/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)	Cost per acre ($)	Cost for 114 acres ($)
Earthwork (D11 Dozer)	1,786,659	cy	368	4,861		$ 469	$ 2,279,141	$ 12,320	$ 1,404,444
Liner Bedding (load, haul, dump, place, compact)	104,222	cy	829	126		$ 3.59	$ 374,511	$ 2,024	$ 230,780
Overliner Gravel (load, haul, dump, place)	312,665	cy	829	377		$ 3.59	$ 1,123,533	$ 6,073	$ 692,340
Produce and Screen Bedding	416,887	cy				$ 2.70	$ 1,125,127	$ 6,082	$ 693,322
HDPE Liner (60-mil) - labor and material	5,627,975	sf				$ 0.73	$ 4,104,420	$ 22,186	$ 2,529,210
HDPE Pipe (10", uninsulated) - material and labor	30,179	lf				$ 90	$ 2,716,110	$ 14,682	$ 1,673,711
Portable Pump and Pipe (for effluent water to TSF)	2	each			100,000	$ 100,000	$ 200,000	$ 1,081	$ 123,243
TOTALS							**$ 11,922,843**	**$ 64,448**	**$ 7,347,049**

Operating Costs

Water released from 10% to 30% solids (m3/yr)	293,316	
Water released from 10% to 30% solids (m3/s)	0.021	161 days/yr
Head loss (m)	6	Static head to start siphon + friction loss + minor loss
Pump efficiency	60%	
Power (kW)	2.1	
Power usage (kWh)	7,993	161 days/yr

OPEX

Operating Costs:	Unit Cost ($/hr)	Total ($/year)	
Service truck	$ 11.13	$ 24,375	
Maintenance (valves, pumps)	$ 2.78	$ 10,000	5% capital costs
Decant pumping (per kWh)	$ 0.50	$ 4,026	
Labor (1 man x 12 hr @ $60/hr)	$ 60.00	$ 131,400	
Total Costs:	**$ 74.41**	**$ 169,801**	

Note: CAPEX and OPEX costs were derived from Red_Dog_Estimate_Closure_Costs_329100.030_Rev1
Note: Productivities and unit rates were updated with REV2 figures on 3/15/2016. CAM

Table 17: Sludge Management Freeze/Thaw Bed Construction Volumes

Sludge Dewatering / Freeze-Thaw Alternative   Note: Assumptions are listed below

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 5/7/2015
By: CAM
Checked By: DPN

2015 Scenario

Facility	Available Area (sf)	Available Area (acres)	Earthwork Volume (cf)	Earthwork Volume (cy)	Sludge Storage Volume (cf)	Sludge Storage Volume (cy)	Liner Area (sf)	Liner Area (acres)	Gravel Fill Volume (cf)	Gravel Fill Volume (cy)	Pipe Network Length (ft)
Main Waste Dump Surface	1,336,051	30.7	8,016,306	296,900	3,006,115	111,338	935,236	21.5	1,870,471	69,277	
Oxide Dump Surface	539,571	12.4	3,237,426	119,905	1,214,035	44,964	377,700	8.7	755,399	27,978	
Low-Grade Ore Stockpile Surface	475,365	10.9	2,852,190	105,637	1,069,571	39,614	332,756	7.6	665,511	24,649	
Lay Down Yard by East Beach (above 976')	754,377	17.3	4,526,262	167,639	1,697,348	62,865	528,064	12.1	1,056,128	39,116	
Lay Down Yard by DD2 (above 976')	935,166	21.5	5,610,996	207,815	2,104,124	77,931	654,616	15.0	1,309,232	48,490	
Quarry by DD2 (above 976')	799,265	18.3	4,795,590	177,614	1,798,346	66,605	559,486	12.8	1,118,971	41,443	
Sloped area in DD2 Quarry	367,490	8.4	2,204,940	81,664	826,853	30,624	257,243	5.9	514,486	19,055	
Lay Down Yard by Back Dam	552,466	12.7	3,314,796	122,770	1,243,049	46,039	386,726	8.9	773,452	28,646	
Organic Stockpile behind Back Dam	1,456,822	33.4	8,740,932	323,738	3,277,850	121,402	1,019,775	23.4	2,039,551	75,539	
TOTALS	**7,216,573**	**166**	**43,299,438**	**1,603,683**	**16,237,289**	**601,381**	**5,051,601**	**116**	**10,103,202**	**374,193**	**31,543**

2031 Scenario

Facility	Available Area (sf)	Available Area (acres)	Earthwork Volume (cf)	Earthwork Volume (cy)	Sludge Storage Volume (cf)	Sludge Storage Volume (cy)	Liner Area (sf)	Liner Area (acres)	Gravel Fill Volume (cf)	Gravel Fill Volume (cy)	Pipe Network Length (ft)
Main Waste Dump Surface	1,336,051	30.7	8,016,306	296,900	3,006,115	111,338	935,236	21.5	1,870,471	69,277	
Qanaiyaq Pit Dump Surface	1,458,144	33.5	8,748,864	324,032	3,280,824	121,512	1,020,701	23.4	2,041,402	75,607	
Main Pit Dump Surface	472,789	10.9	2,836,734	105,064	1,063,775	39,399	330,952	7.6	661,905	24,515	
Oxide Dump Surface	539,571	12.4	3,237,426	119,905	1,214,035	44,964	377,700	8.7	755,399	27,978	
Low-Grade Ore Stockpile Surface	475,365	10.9	2,852,190	105,637	1,069,571	39,614	332,756	7.6	665,511	24,649	
Lay Down Yard by East Beach (if above 986')	754,377	17.3	4,526,262	167,639	1,697,348	62,865	528,064	12.1	1,056,128	39,116	
Lay Down Yard by DD2 (above 986')	626,889	14.4	3,761,334	139,309	1,410,500	52,241	438,822	10.1	877,645	32,505	
Sloped area in DD2 Quarry	367,490	8.4	2,204,940	81,664	826,853	30,624	257,243	5.9	514,486	19,055	
Lay Down Yard by Back Dam	552,466	12.7	3,314,796	122,770	1,243,049	46,039	386,726	8.9	773,452	28,646	
Organic Stockpile behind Back Dam	1,456,822	33.4	8,740,932	323,738	3,277,850	121,402	1,019,775	23.4	2,039,551	75,539	
TOTALS	**8,039,964**	**185**	**48,239,784**	**1,786,659**	**18,089,919**	**669,997**	**5,627,975**	**129**	**11,255,950**	**416,887**	**30,179**

Assumptions:

Available areas are in disturbed footprint, above TSF limits (elevation), and are approximate
Areas and pipe lengths are from ACAD
Sludge storage depth/thickness is 4.5 ft
50% of each available area can be used for sludge storage after earthwork grading
Average cut/fill earthwork over each entire area is 6 ft
60-mil HDPE liner covers sludge storage area + 20% for berms and slope (70% of available area)
0.5 ft of gravel below liner, and 1.5 ft of gravel above liner for liner protection

We have more available area than necessary for 1.5 years of sludge storage (114 acres), so cost estimate will be adjusted to reflect 114 acres. However, since we assume that only half of the area in each cell will actually store sludge, we will provide a cost estimate for the total available area in case it is needed.

Table 18: Sludge Management Repository Construction Cost Curve Estimate

Scenario	Elev w fb (ft)	Storage Vol (cy)	Capital Cost	Storage Vol (M cy)	Capital Cost (1e6 $)
1250'	1240	10,300,000	$ 44,305,458	10.30	44.31
1200'	1190	4,450,000	$ 23,838,345	4.45	23.84
1150'	1140	1,600,000	$ 11,331,806	1.60	11.33
Estimated Volume Required		**9,490,000**	**$ 41,628,283**	9.49	41.63
Estimated Volume Required		**1,580,000**	**$ 11,991,886**	1.58	11.99

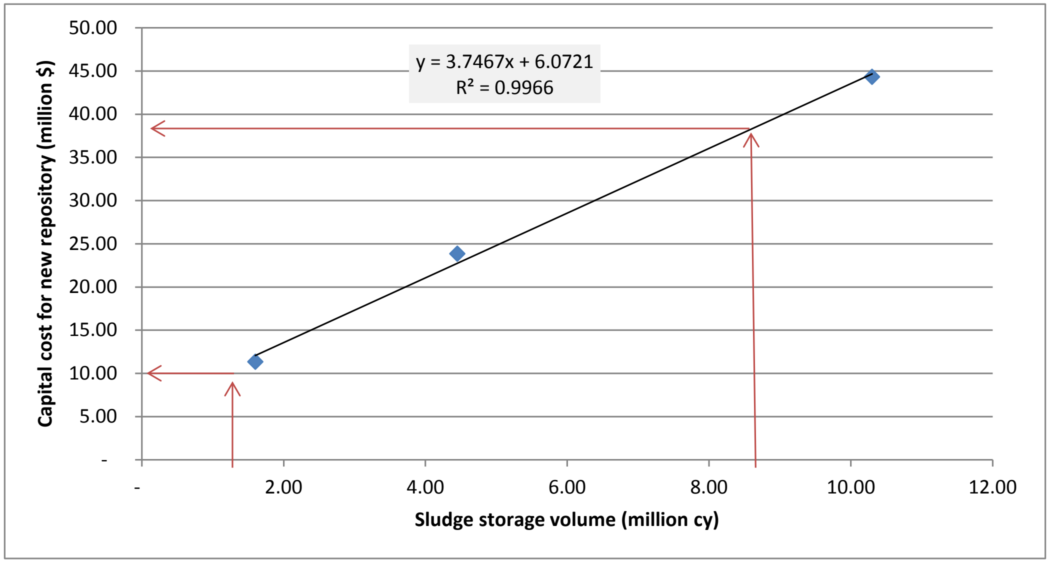

Table 19: Sludge Management Generic Repository Construction Estimate

Assumed location for costing purposes: Connie Creek

Note: Costs were updated to Rev2 costs where applicable

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 6/12/2015
By: CAM/IJC
Checked By: DPN, 6/12/15

1250' Scenario

Item	Quantity	Units	Production Rate (unit/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)
Grubbing and Stripping	5,164,168	sf	2,960	1,745		$0.30	$1,573,635
Stockpiling Organics (load, haul, dump)	159,388	cy	233	685		$5.74	$915,174
Div Channels and Road - cut side (excavator)	34,417	cy	118	292		$6.91	$237,873
Channel Excavation	9,637	cy	118	82		$6.91	$66,605
Drill, Blast, and Stockpile Rip-Rap	3,450	cy	131	26		$10.93	$37,697
Haul Rip-Rap	3,450	cy	204	17		$6.55	$22,607
Place Rip-Rap	3,450	cy	105	33		$1.18	$4,062
Div Channels and Road - fill side (load, haul, dump, place, compact)	34,417	cy	239	144		$5.37	$184,983
Produce and Screen Gravel for Channel Roads	6,883	cy	262	26		$2.70	$18,577
Road Gravel (load, haul, dump, place, compact)	6,883	cy	829	8		$3.59	$24,735
Repository Earthwork (D11 Dozer)	796,939	cy	368	2,168		$438.71	$951,299
Produce and Screen Liner Bedding	87,663	cy	262	335		$2.70	$236,593
Liner Bedding (load, haul, dump, place, compact)	87,663	cy	829	106		$3.59	$315,010
HDPE Liner (60-mil) - labor and material	5,164,168	sf			0.73	$0.73	$3,769,842
Construct Haul Road from valley floor to dam crest	3,000	ft	59	51		$43.85	$131,537
Produce and Screen Gravel for Haul Road	3,333	cy	262	13		$2.70	$8,996
Haul Road Gravel (load, haul, dump, place, compact)	3,333	cy	829	4		$3.59	$11,978
Dam Construction (cost from Dam Construction at RDM)	4,377,719	cy				$6.00	$26,266,311
Borrow Source Development (grubbing and stripping, access road)	1	ls				$2,000,000	$2,000,000
Contact Water Management (pumps and pipeline from repository to WTP)	1	ls				$2,000,000	$2,000,000
Monitoring Wells	4	ea				$500,000	$2,000,000
Spillway	1	ls				$300,000	$300,000
Underliner Drain	513,000	cy				$6.29	$3,227,942
Total Cost							**$44,305,458**

Table 19: Sludge Management Generic Repository Construction Estimate

Assumed location for costing purposes: Connie Creek

Note: Costs were updated to Rev2 costs where applicable

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 6/12/2015
By: CAM/IJC
Checked By: DPN, 6/12/15

1200' Scenario Item	Quantity	Units	Production Rate (unit/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)
Grubbing and Stripping	2,934,456	sf	2,960	991		$0.30	$894,193
Stockpiling Organics (load, haul, dump)	90,570	cy	233	389		$5.74	$520,033
Channel Excavation	7,860	cy	118	67		$6.91	$54,327
Drill, Blast, and Stockpile Rip-Rap	2,562	cy	131	20		$10.93	$27,992
Haul Rip-Rap	2,562	cy	204	13		$6.55	$16,787
Place Rip-Rap	2,562	cy	105	24		$1.18	$3,017
Div Channels and Road - cut side (excavator)	28,072	cy	118	238		$6.91	$194,023
Div Channels and Road - fill side (load, haul, dump, place, compact)	28,072	cy	239	117		$5.37	$150,883
Produce and Screen Gravel for Channel Roads	5,614	cy	262	21		$2.70	$15,153
Road Gravel (load, haul, dump, place, compact)	5,614	cy	829	7		$3.59	$20,175
Repository Earthwork (D11 Dozer)	452,848	cy	368	1,232		$438.71	$540,561
Produce and Screen Liner Bedding	49,813	cy	262	190		$2.70	$134,440
Liner Bedding (load, haul, dump, place, compact)	49,813	cy	829	60		$3.59	$178,999
HDPE Liner (60-mil) - labor and material	2,934,456	sf			$0.73	$0.73	$2,142,153
Construct Haul Road from valley floor to dam crest	3,000	ft	59	51		$43.85	$131,537
Produce and Screen Gravel for Haul Road	3,333	cy	262	13		$2.70	$8,996
Haul Road Gravel (load, haul, dump, place, compact)	3,333	cy	829	4		$3.59	$11,978
Dam Construction (cost from dam construction RDM)	1,727,880	cy				$6.00	$10,367,280
Borrow Source Development (grubbing and stripping, access road)	1	ls				$1,500,000	$1,500,000
Contact Water Management (pumps and pipeline from repository to WTP)	1	ls				$2,000,000	$2,000,000
Monitoring Wells	4	ea				$500,000	$2,000,000
Spillway	1	ls				$200,000	$200,000
Underliner Drain	433,200	cy				$6.29	$2,725,818
Total Cost							**$23,838,345**

Table 19: Sludge Management Generic Repository Construction Estimate

Assumed location for costing purposes: Connie Creek

Note: Costs were updated to Rev2 costs where applicable

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 6/12/2015
By: CAM/IJC
Checked By: DPN, 6/12/15

1150' Scenario Item	Quantity	Units	Production Rate (unit/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)
Grubbing and Stripping	1,533,773	sf	2,960	518		$0.30	$467,374
Stockpiling Organics (load, haul, dump)	47,339	cy	233	203		$5.74	$271,809
Channel Excavation	5,262	cy	118	45		$6.91	$36,372
Drill, Blast, and Stockpile Rip-Rap	1,706	cy	131	13		$10.93	$18,638
Haul Rip-Rap	1,706	cy	204	8		$6.55	$11,178
Place Rip-Rap	1,706	cy	105	16		$1.18	$2,009
Div Channels and Road - cut side (excavator)	18,794	cy	118	160		$6.91	$129,899
Div Channels and Road - fill side (load, haul, dump, place, compact)	18,794	cy	239	79		$5.37	$101,017
Produce and Screen Gravel for Channel Roads	3,759	cy	262	14		$2.70	$10,145
Road Gravel (load, haul, dump, place, compact)	3,759	cy	829	5		$3.59	$13,507
Repository Earthwork (D11 Dozer)	236,693	cy	368	644		$438.71	$34,448
Produce and Screen Liner Bedding	26,036	cy	262	100		$2.70	$70,269
Liner Bedding (load, haul, dump, place, compact)	26,036	cy	829	31		$3.59	$93,559
HDPE Liner (60-mil) - labor and material	1,533,773	sf			0.73	$0.73	$1,119,654
Construct Haul Road from valley floor to dam crest	3,000	ft	59	51		$43.85	$131,537
Produce and Screen Gravel for Haul Road	3,333	cy	262	13		$2.70	$8,996
Haul Road Gravel (load, haul, dump, place, compact)	3,333	cy	829	4		$3.59	$11,978
Dam Construction (cost from dam construction RDM)	281,820	cy				$6.00	$1,690,920
Borrow Source Development (grubbing and stripping, access road)	1	ls				$1,000,000	$1,000,000
Contact Water Management (pumps and pipeline from repository to WTP)	1	ls				$2,000,000	$2,000,000
Monitoring Wells	4	ea				$500,000	$2,000,000
Spillway	1	ls				$100,000	$100,000
Underliner Drain	319,200	cy				$6.29	$2,008,497
Total Cost							**$11,331,806**

Table 20: Sludge Management Generic Repository Construction Volume Estimates

New Repository Areas, Volumes, and Channel Lengths

Channels and Road (does not include material moved from channel, which can be used to construct berm)

Scenario		Cross-Sectional Area (sf)	Channel/Road Length (ft)	Earthwork Vol (cf)	Earthwork Vol (cy)
1250'	Cut Slope side only	75	12,390	929,250	34,417
1250'	Fill Slope side only	75	12,390	929,250	34,417
1200'	Cut Slope side only	75	10,106	757,950	28,072
1200'	Fill Slope side only	75	10,106	757,950	28,072
1150'	Cut Slope side only	75	6,766	507,450	18,794
1150'	Fill Slope side only	75	6,766	507,450	18,794

Channel Only - this is only for the material removed from the actual channel

Scenario	Cross-Sectional Area (sf)	Channel Length (ft)	Earthwork Vol (cf)	Earthwork Vol (cy)
1250'	21	12,390	260,190	9,637
1200'	21	10,106	212,226	7,860
1150'	21	6,766	142,086	5,262

End of channels - for rip-rap only

Scenario	Channel Width (ft)	Channel Length (ft)	Rip-Rap Depth (ft)	Earthwork Vol (cf)	Earthwork Vol (cy)
1250'	16.5	3,764	1.5	93,159	3,450
1200'	16.5	2,795	1.5	69,176	2,562
1150'	16.5	1,861	1.5	46,060	1,706

Haul Road from Valley Floor to Dam Crest

Scenario	Road Width (ft)	Road Length (ft)	Gravel Depth (ft)	Earthwork Vol (cf)	Earthwork Vol (cy)
1250'	30	3,000	1.0	90,000	3,333
1200'	30	3,000	1.0	90,000	3,333
1150'	30	3,000	1.0	90,000	3,333

Organic Material

Scenario	Area (sf)	Est Depth (ft)	Stockpile Vol (cf)	Stockpile Vol (cy)
1250'	4,303,473	1	4,303,473	159,388
1200'	2,445,380	1	2,445,380	90,570
1150'	1,278,144	1	1,278,144	47,339

Repository Earthwork (D11)

Scenario	Area (sf)	Est Depth (ft)	Vol (cf)	Vol (Cy)
1250'	4,303,473	5	21,517,365	796,939
1200'	2,445,380	5	12,226,900	452,848
1150'	1,278,144	5	6,390,720	236,693

Repository Gravel Bedding

Scenario	Area (sf)	Est Depth (ft)	Vol (cf)	Vol (cy)
1250'	4,303,473	0.5	2,151,737	79,694
1200'	2,445,380	0.5	1,222,690	45,285
1150'	1,278,144	0.5	639,072	23,669

Channel Access Road Gravel

Scenario	Road Width (ft)	Channel Length (ft)	Gravel Depth (ft)	Earthwork Vol (cf)	Earthwork Vol (cy)
1250'	15	12,390	1.0	185,850	6,883
1200'	15	10,106	1.0	151,590	5,614
1150'	15	6,766	1.0	101,490	3,759

Haul Road to Dam Crest

	Road Length (ft)
all scenarios	3000

Table 21: Sludge Management Generic Repository Dam Construction Volume Estimates

Conceptual Dam Geometrics

	1250' Scenario			1200' Scenario			1150' Scenario	
Dam Design			Dam Design			Dam Design		
	Dam Crest Elev (ft)	1250		Dam Crest Elev (ft)	1200		Dam Crest Elev (ft)	1150
	Dam Crest Width (ft)	34		Dam Crest Width (ft)	34		Dam Crest Width (ft)	34
	Dam Crest Length (ft)	1718		Dam Crest Length (ft)	1386		Dam Crest Length (ft)	693
	Avg Vertical Depth (ft)	160		Avg Vertical Depth (ft)	110		Avg Vertical Depth (ft)	60
	Left Rock Slope Width (ft)	396		Left Rock Slope Width (ft)	272		Left Rock Slope Width (ft)	149
	Right Rock Slope Width (ft)	396		Right Rock Slope Width (ft)	272		Right Rock Slope Width (ft)	149
Areas			Areas			Areas		
	Left Rock Slope Area (sf)	31,680		Left Rock Slope Area (sf)	14,960		Left Rock Slope Area (sf)	4,470
	Center Area (sf)	5,440		Center Area (sf)	3,740		Center Area (sf)	2,040
	Right Rock Slope Area (sf)	31,680		Right Rock Slope Area (sf)	14,960		Right Rock Slope Area (sf)	4,470
	Total Area (sf)	68,800		Total Area (sf)	33,660		Total Area (sf)	10,980
Volumes			Volumes			Volumes		
	Total Volume (cf)	118,198,400		Total Volume (cf)	46,652,760		Total Volume (cf)	7,609,140
	Total Volume (cy)	**4,377,719**		**Total Volume (cy)**	**1,727,880**		**Total Volume (cy)**	**281,820**

Table 22: Sludge Management TSF Coffer Dam Construction Estimate

TSF Repository Coffer Dam Volumes and Cost Estimate

Project: Red Dog IWMP/RPA Renewal
PN: 329100.030
Date: 6/2/2015
By: CAM
Checked By: DPN, 6/10/15

Note: Costs were updated to Rev2 costs where applicable

976 Scenario

Item	Quantity	Units	Production Rate (unit/hr)	Hours	Material Cost ($/unit)	Cost per unit ($/hr or $/unit)	Total Cost ($)
Rock Fill (load, haul, dump, place)	311,389	cy	463	673		$ 3.49	$ 1,087,999
Soil-Bentonite Core	82,500	ft^2	108	766		$ 13.69	$ 1,129,097
Drill and Blast DD-2 material	311,389	cy	654	476		$ 1.57	$ 488,052
Total Cost							**$ 2,705,148**

Table 23: Sludge Management TSF Coffer Dam Construction Estimate Volumes

TSF Repository Coffer Dam Volumes and Cost

976 Scenario

TSF			TSF
	Dam Crest (ft)	976	
	Top of Tailings (ft)	949	
Dam Design			Dam Design
	Vertical Elevation Difference (ft)	27	
	Left Rock Slope Base Width (ft)	81	
	Left Berm Width (ft)	9	
	Road Width (ft)	17	
	Center Core Width (ft)	5	
	Right Berm Width (ft)	9	
	Right Rock Slope Base Width (ft)	81	
	Length Across Center of TSF (ft)	3,300	
Areas			Areas
	Left Rock Slope Area (sf)	1,094	
	Left Berm Area (sf)	13	
	Road Area (sf)	334	
	Center Core Area (sf)	125	
	Right Berm Area (sf)	13	
	Right Rock Slope Area (sf)	1,094	
	Total Area (sf)	2,673	
	Total DD-2 Rock Area (sf)	2,548	
	Total Core Area (sf)	125	
Volumes			Volumes
	Total Volume (cf)	8,820,009	
	Total Volume (cy)	326,667	
DD-2 Pit	Total DD-2 Rock Volume (cf)	8,407,509	
TSF North	Total Core Volume (cf)	412,500	
DD-2 Pit	**Total DD-2 Rock Volume (cy)**	**311,389**	
TSF North	**Total Core Volume (cy)**	**15,278**	
TSF North	**Total Core Area (depth of wall x length) ft^2**	**82,500**	
	Total Core Volume (m3)	**11,681**	

Note: Dam embankment slopes are 3:1

Table 24: Sludge Management Sludge Pumping Cost Estimate

Checked by DPN, 6/10/15

Yearly Sludge Production @10%	560,895	CY	
Yearly Sludge Production @30%	158,086	CY	
Operational Year	161	Days	
WTP Operational Availability	100%		
WTP Operating Hours	3864	total hours	
Sludge Generation/day @10%	3484	CY/Day	(Pumped)
Sludge Generation/day @10%	703627	GPD	(Pumped)
Sludge Generation/day @10%	489	GPM	(Pumped)
Sludge Generation/day @10%	65.33	CFM	(Pumped)

Pipe = DR11	
Outside dia	Inside dia
6	5.35
8	6.95
10	8.68
12	10.29

@XX% = percent solids in sludge

1 cy	201.97	gal
1 cy H2o	1685.6	lbs
	1.1	Sludge Specific Gravity @10%
	1.3	Sludge Specific Gravity @30%
1 cy @ 10%	1854.16	lbs
1 cy @ 30%	2191.28	lbs
1 gpm	0.1337	CFM

Power required

C = 0.746 Q h c / (3960 µp µm)

where

	C = cost per hour
488.6	Q = volume flow (gpm)
varies	h = head (ft)
0.50	c = cost rate per kWh
0.6	µp = pump efficiency
0.9	µm= motor efficiency

Pipe Route	Dist ft	Change in Elevation ft	Flow Rate gpm	Hazen-Williams H-W Roughness c	Pipe Size outside dia	Pipe Size inside dia	Friction Head Loss (per 100')	Friction Head Loss (ft)	Friction Head Loss (psi)	Velocity ft/s	Misc Head Loss	Total Head	Pumping Cost Cost/ kWh	Total OPEX $
WTP to Aqqaluk Pit	3563	115	488.6	140	10.0	8.68	0.29	10.3	4.4	2.65	2.06	127	11.74	$ 45,357
WTP to Main Pit	3280	140	488.6	140	10.0	8.68	0.29	9.5	4.1	2.65	1.90	151	13.95	$ 53,908
WTP to Densification	6575	30	488.6	140	10.0	8.68	0.29	19.0	8.2	2.65	3.81	53	4.87	$ 18,816

Table 25: Sludge Management Densified Sludge Haulage Cost Estimate

@XX% = percent solids in sludge

Yearly Sludge Production @10%	560,895	CY	
Yearly Sludge Production @30%	158,086	CY	
Operational Year	161	Days	
WTP Operational Availability	100%		
Sludge Generation/day @10%	3484	CY/Day	(Pumped)
Sludge Generation/day @30%	982	CY/Day	(Hauled)
Sludge Generation/day @30%	1076	tons/day	(Hauled)

Sludge Specific Gravity @30%	1.3	
Sludge Weight	2192	lbs/CY
Sludge Weight	1.096	tons/CY

Fleet	Capacity		Fleet size
CAT 735B with Tailgate	19.9	CY - struck	2
CAT 966	4.5	CY - struck	1

Total truck cycles @30% 50 per day

Operating Cost

Haul Route	Description	Dist. (ft)	Fleet Productivity (ton/hr)	Hours	Fleet ($/ton)	Production (ton/day)	Total Cost ($/day)	Production (ton/yr)	Total Cost ($/yr)
2015-1a-FT	Freeze/Thaw to New Repository	18246	125	8.6	2.74	1076	$ 2,947	158085.9	$ 432,950
2015-1c-FT	Freeze/Thaw to Aqqaluk Pit Repository	10138	192	5.6	1.78	1076	$ 1,919	158085.9	$ 281,869
2015-1b-FT	Freeze/Thaw to TSF Repository	3146	284	3.8	1.21	1076	$ 1,297	158085.9	$ 190,559

Note: Cost estimate based on Caterpillar Haulage Simulator (Fleet Production and Cost V4), Equipment rates based on Post-Closure Cost Estimate values

Appendix E – Suspension Cost Estimate

Basis of Estimate – Suspension Costs

Red Dog Mine, Alaska, USA

Prepared for

Teck Alaska Incorporated

Prepared by

SRK Consulting (U.S.), Inc.
329100.030
August 2016

Basis of Estimate – Suspension Costs
Red Dog Mine, Alaska, USA

August 2016

Prepared for

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Project No: 329100.030
File Name: BasisofEstimate_Suspension_Costs_RedDogMine_329100.030_20160805.docx

srk consulting 1974 40 2014

Table of Contents

List of Tables

List of Abbreviations

ADNR	Alaska Department of Natural Resources
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
TAK	Teck Alaska Incorporated
TSF	Tailings Storage Facility

Units of Measure

m	meter
m^2	square meter
m^3	cubic meter

1 Introduction

Teck Alaska Incorporated and NANA are working closely with State of Alaska agencies, through the Large Mine Permitting Team, to update the *Reclamation and Closure Plan* and *Integrated Waste Management Plan* for Red Dog Mine. One objective of the process is to estimate the cost of suspension, closure, and post-closure activities. This document provides details about the estimates of suspension costs.

Estimates of the annual suspension costs were developed for two different scenarios:

- **Suspension:** All site costs during a hypothetical five-year period after mining and milling cease unexpectedly, but before closure is implemented.
- **Closure Period:** Water treatment and related costs for the two-year period during which closure is implemented.

The estimated annual cost for each case is as follows, in undiscounted 2016 dollars.

Scenario	Annual Cost
Suspension	$19,460,000
During Closure	$15,980,000

2 Scope of Estimate

The estimates were prepared using the post-closure estimate as a basis, so the structure of the estimate is as described in the *Basis of Estimate – Post-Closure Costs*.

3 Assumptions by Cost Item

General and specific assumptions described in the *Basis of Estimate – Post-Closure Costs* were adopted for the suspension estimate, with the following exceptions only.

3.1 Consumables

3.1.1 Suspension

During a short-term suspension of operations, the waste rock piles and pit walls would remain uncovered, and water treatment reagent costs would be higher than in the post-closure case.

The water and load balance model presented in the *Reclamation and Closure Plan* was used to estimate the total amount of acidity that would need to be treated in order to prevent deterioration of the Tailings Storage Facility (TSF) water quality. Under the further assumption that current treatment and discharge rates would be maintained, it was possible to estimate the average annual lime requirement for the treatment systems. Over a hypothetical five-year suspension period, the average annual lime requirement would be approximately 14,990 tonnes per year. Estimates of the annual requirements for the other treatment consumables (flocculant, sodium sulfide, and antiscalant) were increased in proportion to the lime demand. Unit costs were assumed to be the same as in the post-closure cost estimate.

The increases in lime and reagent demand increased the total consumables cost in comparison with the post-closure cost estimate.

3.1.2 During Closure

In contrast, during the two years in which closure is implemented, water treatment costs will be less than in the post-closure period. The reason is that excess water will be transferred to either the Aqqaluk Pit or Main Pit. Water treatment would only be required to prevent the build-up of additional acidity in the transferred water.

Calculations with the water and load balance model show that, during the closure period, it would only be necessary to treat about 300 million gallons of water per year, with an associated lime requirement of about 13,150 tonnes per year. Requirements for other consumables would reduce proportionately.

As a result, estimates of consumables costs during closure are lower than in either the suspension period or the post-closure period.

3.2 Power

3.2.1 Suspension

During the suspension period, the site would continue to use the current generators.
Estimates of fuel consumption for power generation were therefore based on current Red Dog rates. The current generator set produces power at an efficiency of 12.9 kW-hours per gallon, slightly lower than the efficiency assumed for the post-closure period.

3.2.2 During Closure

The limited level of water treatment during the closure period could allow a decrease in power consumption. However, water would be pumped from the TSF to either Aqqaluk Pit or Main Pit, and the additional power for pumping would partially compensate for the savings in water treatment power. As a simple but conservative assumption, the overall power cost was assumed to be the same as in the suspension period.

3.3 Other Indirect Costs

Other indirect costs added to the estimate include:

- Insurance at 1.6% of manpower and mobile equipment costs;
- Contractor overhead at 10% of direct plus camp-administration and capital replacement indirect costs;
- Contractor profit at 10% of direct plus camp-administration and capital replacement indirect costs; and
- State contract management based on 1% of the total project cost minus insurance, contractor overhead, and contractor profit.

These indirect cost percentages were derived for the site during development of the 2009 suspension cost estimate, except for contractor overhead, contractor profit, and state contract management, which were set by the Alaska Department of Environmental Conservation.

4 Summary – Suspension Costs

The estimated total annual cost during a suspension is as follows:

	Annual Cost
Manpower	$2,700,000
Consumables	$6,930,000
Mobile Equip	$360,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,650,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Insurance	$50,000
Contractor Overhead	$1,600,000
Contractor Profit	$1,600,000
State Contract Mgmt.	$160,000
Total Cost	**$19,460,000**

5 Summary – Closure Period

The estimated annual cost during closure is as follows:

	Annual Cost
Manpower	$2,700,000
Consumables	$6,080,000
Mobile Equip	$360,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,650,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Insurance	$50,000
Contractor Overhead	$270,000
Contractor Profit	$310,000
State Contract Mgmt.	$160,000
Total Cost	**$15,980,000**

This report, *Basis of Estimate – Suspension Costs*, was prepared by SRK Consulting (U.S.), Inc. with data supplied by TAK.

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Ivan Clark, Senior Consultant

and reviewed by

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Dan Neuffer, Senior Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Tables

Table 1a: Summary of Estimated Suspension Costs

Annual Water Treatment Cost

	Annual Cost
Manpower	$730,000
Consumables	$6,930,000
Maintenance Materials	$170,000
Capital Replacement	$1,260,000
Power	$1,560,000
Subtotal	**$10,650,000**

Annual Camp, Site Maintenance, Environmental & Administration Costs

	Annual Cost
Manpower	$1,970,000
Maintenance Materials	$180,000
Mobile Equip	$360,000
Capital Replacement	$390,000
Power	$1,100,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Subtotal	**$5,010,000**

Total Annual Suspension Operating Cost

	Annual Cost
Manpower	$2,700,000
Consumables	$6,930,000
Mobile Equip	$360,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,650,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Insurance	$50,000
Contractor Overhead	$1,600,000
Contractor Profit	$1,600,000
State Contract Mgmt	$160,000
Total Cost	**$19,460,000**

Table 1b: Summary of Estimated Camp and Water Treatment Costs during Closure

Annual Water Treatment Cost

	Annual Cost
Manpower	$730,000
Consumables	$6,080,000
Maintenance Materials	$170,000
Capital Replacement	$1,260,000
Power	$1,560,000
Subtotal	**$9,800,000**

Annual Camp, Site Maintenance, Environmental & Administration Costs

	Annual Cost
Manpower	$1,970,000
Maintenance Materials	$180,000
Mobile Equip	$360,000
Capital Replacement	$390,000
Power	$1,100,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Subtotal	**$5,400,000**

Total Annual Camp and Water Treatment Costs during Closure

	Annual Cost
Manpower	$2,700,000
Consumables	$6,080,000
Mobile Equip	$360,000
Maintenance Materials	$350,000
Capital Replacement and SEP	$1,650,000
Power	$2,650,000
Environmental	$270,000
Camp & Admin	$740,000
Dam Inspection and Maintenance	$390,000
Insurance	$50,000
Contractor Overhead	$270,000
Contractor Profit	$310,000
State Contract Mgmt	$160,000
Total Cost	**$15,980,000**

Table 2a: Summary of Estimated Direct and Indirect Suspension Costs

Total Annual Suspension Operating Cost

	Direct Costs	Indirect Costs	Total Cost
Manpower	$2,697,806	$0	$2,697,806
Consumables	$6,926,444	$0	$6,926,444
Mobile Equip	$363,490	$0	$363,490
Maintenance Materials	$352,593	$0	$352,593
Capital Replacement and SEP	$992,041	$660,435	$1,652,476
Power	$2,654,285	$0	$2,654,285
Environmental	$268,468	$0	$268,468
Camp & Admin	$120,000	$616,932	$736,932
Dam Inspection and Maintenance	$389,919	$0	$389,919
Insurance (1.6% of manpower and equip.)	$0	$48,981	$48,981
Contractor Overhead (10% of directs+camp&admin and cap repl indirects)	$0	$1,604,241	$1,604,241
Contractor Profit (10% of directs+camp&admin and cap repl indirects)	$0	$1,604,241	$1,604,241
State Contract Mgmt. (1% of total-insurance and contractor O&P)	$0	$160,424	$160,424
Total Cost	**$14,765,046**	**$4,695,254**	**$19,460,300**

Table 2b: Summary of Estimated Direct and Indirect Camp and Water Treatment Costs during Closure

Total Annual Camp and Water Treatment Costs during Closure

	Direct Costs	Indirect Costs	Total Cost
Manpower	$2,697,806	$0	$2,697,806
Consumables	$6,076,874	$0	$6,076,874
Mobile Equip	$363,490	$0	$363,490
Maintenance Materials	$352,593	$0	$352,593
Capital Replacement and SEP	$992,041	$660,435	$1,652,476
Power	$2,654,285	$0	$2,654,285
Environmental	$268,468	$0	$268,468
Camp & Admin	$120,000	$616,932	$736,932
Dam Inspection and Maintenance	$389,919	$0	$389,919
Insurance (1.6% of manpower and equip.)	$0	$48,981	$48,981
Contractor Overhead (10% of manpower)	$0	$269,781	$269,781
Contractor Profit (10% of manpower and equip.)	$0	$306,130	$306,130
State Contract Mgmt. (1% of total)	$0	$158,177	$158,177
Total Cost	**$13,915,476**	**$2,060,435**	**$15,975,911**

Table 3: Suspension Manpower Schedule

	On Roll	On Site	Coverage	Turnaround	Total Hourly Wage*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Year-Round Ops						31	28	31	30	31	30	31	31	30	31	30	31	365
Summer Ops						0	0	0	15	31	30	31	31	30	19	0	0	187
Year-Round																		
Site Manager	1	1			175,000	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	14,583	175,000
Enviro. Coordinator	1	1	12/7	2x2	99.10	36,865	33,298	36,865	35,676	36,865	35,676	36,865	36,865	35,676	36,865	35,676	36,865	434,058
Enviro. Tech.	1	1	12/8	2x3	56.76	21,115	19,071	21,115	20,434	21,115	20,434	21,115	21,115	20,434	21,115	20,434	21,115	248,609
Mechanic	2	1	12/7	2x2	61.23	22,778	20,573	22,778	22,043	22,778	22,043	22,778	22,778	22,043	22,778	22,043	22,778	268,187
Electrician	2	1	12/7	2x2	73.58	27,372	24,723	27,372	26,489	27,372	26,489	27,372	27,372	26,489	27,372	26,489	27,372	322,280
Equip. Operator Group 1A	2	1	12/7	2x2	62.99	23,432	21,165	23,432	22,676	23,432	22,676	23,432	23,432	22,676	23,432	22,676	23,432	275,896
Camp Support	0	2	12/7	2x2	33.17					included in camp costs in supplies and services								0
Nightshift Coverage	0		12/7	2x2		0	0	0	0	0	0	0	0	0	0	0	0	0
	9	8				$146,145	$133,413	$146,145	$141,901	$146,145	$141,901	$146,145	$146,145	$141,901	$146,145	$141,901	$146,145	$1,724,031
Summer																		
WTP Operator	2	1	12/7	2x2	62.99	0	0	0	11,338	23,432	22,676	23,432	23,432	22,676		0	0	126,988
Operator Assistant	2	1	12/7	2x2	59.74	0	0	0	10,753	22,223	21,506	22,223	22,223	21,506		0	0	120,436
Powerhouse Operator											included in power cost							0
Technicians	2	1	12/7	2x2	56.76	0	0	0	10,217	21,115	20,434	21,115	21,115	20,434		0	0	114,428
Mechanic	2	1	12/7	2x2	61.23	0	0	0	11,021	22,778	22,043	22,778	22,778	22,043		0	0	123,440
Electrician	2	1	12/7	2x2	73.58	0	0	0	13,244	27,372	26,489	27,372	27,372	26,489		0	0	148,337
Truck Driver	4	2	12/7	2x2	62.99	0	0	0	0	0	45,353	46,865	46,865	45,353	28,723	0	0	213,158
Equip. Operator Group 1A	2	1	12/7	2x2	62.99	0	0	0	11,338	23,432	22,676	23,432	23,432	22,676		0	0	126,988
	16	8				$0	$0	$0	$67,912	$140,352	$181,177	$187,216	$187,216	$181,177	$28,723	$0	$0	$973,775
Total Manpower Cost						**$146,145**	**$133,413**	**$146,145**	**$209,813**	**$286,497**	**$323,078**	**$333,361**	**$333,361**	**$323,078**	**$174,868**	**$141,901**	**$146,145**	**$2,697,806**
Workers On-site		16				8	8	8	14	14	14	14	14	14	8	8	8	

*Hourly rate per AK DOL, Laborers and Mechanics Minimum Rates of Pay, Sept 1, 2015, or estimated yearly salary.

Table 4: Water Treatment Consumables for Suspension and Closure Periods

Supply	Cost/Tonne FOB Seattle	Freight Cost/Tonne	Cost/Tonne Delivered	Suspension[1]		Closure[2]	
				Tonnes*	Total Cost	Tonnes*	Total Cost
Flocculant	$4,500	$176	$4,676	150	$700,834	131	$614,872
Lime	$197	$176	$373	14988	$5,593,331	13150	$4,907,275
Sodium Sulfide	$908	$176	$1,084	391	$424,043	343	$372,032
Antiscalant	$3,042	$266	$3,308	63	$208,236	55	$182,694
					$6,926,444		$6,076,874

2015	2016
150	113
14988	11311
391	295
63	48

*Flocculant, Lime, Antiscalant, and Sodium Sulfide are current 2015 RD prices, FOB Seattle

*Ratios of consumption of flocculent, sodium sulfide and antiscalant from Susp Study Consumables sheet

[1]Suspension assumes consumables rate at year 2015 from Water and Load Balance Model

[2]Closure assumes an average of consumables during years 2015 and 2016 from Water and Load Balance Model

Table 5: Suspension Mobile Equipment Schedule

	$/hr	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
16M Grader	$ 64.44	$ 32,863	30	30	30	30	60	60	60	60	60	30	30	30	510
966 Loader (CAT 966K)	$ 45.08	$ 67,626	125	125	125	125	125	125	125	125	125	125	125	125	1500
Haul Truck (CAT 735B)	$ 54.14	$ 25,988	10	10	10	10	10	100	100	100	100	10	10	10	480
Excavator (CAT 349E L)	$ 65.10	$ 33,201				10	100	100	100	100	100				510
988 Loader (CAT 988K)	$ 94.78	$ 11,373	20	20	20							20	20	20	120
Forklift (CAT TH514C)	$ 22.11	$ 14,372						300	110	110	110	20			650
Portable Generator, 20 kW	$ 6.37	$ 765	10	10	10	10	10	10	10	10	10	10	10	10	120
D6 Dozer (D6T)	$ 46.30	$ 22,224	10	10	10	10	10	100	100	100	100	10	10	10	480
Field Service Truck (33K lb)	$ 11.13	$ 20,034	150	150	150	150	150	150	150	150	150	150	150	150	1800
Semi Tractor 6x4 (80K lb)	$ 28.00	$ 93,415						720	720	720	720	456			3336
Flatbed Trailer	$ 3.01	$ 7,766						300	384	720	720	456			2580
Heavy Equipment Trailer	$ 3.01	$ 151						50							50
Fuel Tanker (9300 gal)	$ 1.31	$ 912						360	336						696
Van-Mounted Steam Generator (16 hp)	$ 31.31	$ 5,010			20	60	60	20							160
Snowblower (350 hp)	$ 42.72	$ 4,272	20	20	20	10							10	20	100
SUBTOTALS		$ 339,970	375	375	395	415	525	2395	2195	2195	2195	1287	365	375	13092
Pick-ups (3/4 ton, 4x4)	$ 9.80	$ 23,520	200	200	200	200	200	200	200	200	200	200	200	200	2400
Total - Mobile Equipment		**$ 363,490**													
	Maint. Hrs	4929													

Fuel Price 3.08 — 5-year average price delivered to RD port (2011-2015)

Hourly Op Cost Components	Total $/hr Maint. Parts and Consumables	Fuel Consumption (gal/hr)	Maint. Parts	Overhaul Parts	Fuel	Lube	Tires	GET
16M Grader	$ 64.44	9.9	$ 10.31	$ 10.31	$ 30.34	$ 10.00	$ 2.13	$ 1.35
966 Loader (CAT 966K)	$ 45.08	5.3	$ 4.35	$ 2.32	$ 16.32	$ 6.09	$ 15.50	$ 0.50
Haul Truck (CAT 735B)	$ 54.14	9.9	$ 4.59	$ 2.47	$ 30.49	$ 10.31	$ 6.28	$ -
Excavator (CAT 349E L)	$ 65.10	14.0	$ 6.65	$ 4.44	$ 43.12	$ 8.12	$ -	$ 2.77
988 Loader (CAT 988K)	$ 94.78	13.2	$ 8.21	$ 4.42	$ 40.66	$ 12.12	$ 28.67	$ 0.70
Forklift (CAT TH514C)	$ 22.11	4.5	$ 2.70	$ 1.75	$ 13.86	$ 2.80	$ 1.00	$ -
Portable Generator, 20 kW	$ 6.37	1.8	$ 0.24	$ 0.20	$ 5.54	$ 0.39	$ -	$ -
D6 Dozer (D6T)	$ 46.30	8.3	$ 3.80	$ 2.53	$ 25.41	$ 5.40	$ -	$ 9.16
Field Service Truck (33K lb)	$ 11.13	2.5	$ 0.96	$ 0.52	$ 7.70	$ 1.37	$ 0.58	$ -
Semi Tractor 6x4 (80K lb)	$ 28.00	6.4	$ 0.49	$ 0.16	$ 19.71	$ 4.32	$ 3.32	$ -
Flatbed Trailer	$ 3.01	0.0	$ 0.88	$ 0.29	$ -	$ 0.37	$ 1.47	$ -
Heavy Equipment Trailer	$ 3.01	0.0	$ 0.88	$ 0.29	$ -	$ 0.37	$ 1.47	$ -
Fuel Tanker (9300 gal)	$ 1.31	0.0	$ 0.49	$ 0.16	$ -	$ 0.20	$ 0.46	$ -
Van-Mounted Steam Generator (16 hp)	$ 31.31	7.0	$ 0.75	$ 3.00	$ 21.56	$ 6.00	$ -	$ -
Snowblower (350 hp)	$ 42.72	9.0	$ 4.00	$ 3.00	$ 27.72	$ 6.00	$ -	$ 2.00
Pick-ups (3/4 ton, 4x4)	$ 9.80	2.0	$ 0.48	$ 0.26	$ 6.16	$ 2.66	$ 0.24	$ -

Costs taken from *Mine and Mill Equipment Costs (2015) Surface Equipment* , Published by InfoMine USA, Inc
and from *Mine and Mill Equipment Costs (2015) Miscellaneous Equipment* , Published by InfoMine USA, Inc
Fuel consumption per CAT Handbook 44 (average of High Range) Tier 4 engines

Table 6: Suspension Maintenance Material Costs

	Jan 30	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	Total
Water Treatment Plant Maintenance													
Non-exempt													
Stores	$0	$0	$0	$1,000	$500	$500	$500	$500	$500	$0	$0	$0	$3,500
Equipment													$0
Other	$0	$0	$0	$5,000	$500	$500	$500	$500	$500	$0	$0	$0	$7,500
Total				$6,000	$1,000	$1,000	$1,000	$1,000	$1,000	$0			$11,000
Sand Filter Maintenance													
Filter 1							$0			$30,000			
Filter 2							$0			$30,000			
Filter 3							$0			$30,000			
Total							$0			$90,000			$90,000
Reagent Systems Maintenance													
Non-exempt													$0
Stores				$1,000	$250	$250	$250	$250	$250				$2,250
Equipment													$0
Other				$250	$100	$100	$100	$100	$100				$750
Total	$0	$0	$0	$1,250	$350	$350	$350	$350	$350	$0	$0	$0	$3,000
Lime Slaking Maintenance													
Non-exempt													$0
Stores				$2,000	$500	$500	$500	$500	$500				$4,500
Equipment				$2,000									$2,000
Other				$500	$100	$100	$100	$100	$100				$1,000
Total	$0	$0	$0	$4,500	$600	$600	$600	$600	$600	$0	$0	$0	$7,500
Red Dog Creek Pumpback													
Non-exempt													$0
Stores	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$4,500	$54,000
Equipment													$0
Other	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$12,000
Total	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$5,500	$66,000
Tailings Seepage Pumpback													
Non-exempt													$0
Stores	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$12,000
Equipment													$0
Other	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Total	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$18,000
Overburden Pumpback													
Non-exempt													$0
Stores	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$1,100	$13,200
Equipment	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Other	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$19,200
Total	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$3,200	$38,400
Sullaire Compressor													
Non-exempt													$0
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment													$0
Other	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200

Table 6: Suspension Maintenance Material Costs

	Jan 30	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	Total
Total	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$7,200
#1 Reclaim Barge													
Non-exempt													$0
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	$600
Other	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Total	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$7,800
Bonns Creek Pumps													
Non-exempt													$0
Stores					$1,200	$250	$250	$250	$250	$500			$2,700
Equipment													$0
Other													$0
Total	$0	$0	$0	$0	$1,200	$250	$250	$250	$250	$500	$0	$0	$2,700
Temporary Facilities													
Non-exempt													
Stores	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$6,000
Equipment													
Other	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$2,400
Total	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700	$8,400
Building and Camp Maintenance													
Supplies	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$9,600
Total	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$800	$9,600
Miscellaneous													
Lubricants	$25	$25	$25	$25	$50	$50	$50	$50	$50	$25	$25	$25	$425
Supplies	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Total	$125	$125	$125	$125	$150	$150	$150	$150	$150	$125	$125	$125	$1,625
Total Maint. Cost (2015 inflation and freight)	**$16,998**	**$16,998**	**$16,998**	**$32,273**	**$21,125**	**$19,890**	**$19,890**	**$19,890**	**$19,890**	**$134,648**	**$16,998**	**$16,998**	**$352,593**

Table 7: Capital Replacement Allowances

Water Treatment Equipment

Total Capital Cost for new water treatment infrastructure	$61,073,201		verif. 3/30/2016	See 2015 Water Treatment Capital Estimate in Red Dog Closure Cost Estimate	
Annual Capital Replacement Cost	$1,263,229				
Equipment		Pick-ups, Service Truck, Steam Generator	Tractor and Trailers	Heavy Equipment	
Total capital cost for replacement fleet	$5,770,800	$614,400	$742,800	$	4,413,600
Annual capital replacement cost	$287,504				
Generator/Power Equipment					
Total capital cost for replacement	$1,365,600				
Annual capital replacement cost	$44,450				
SEP Monitoring Equipment (thermistor installations)					
Total capital cost for new installations	$250,000		Assume replacement and install for 15 thermistors		
Annual capital replacement cost	$57,293				
Total Annual Capital Replacement (less Water Treatment)					
Equipment, Generator/Power, and Monitoring	$389,247				
SEP Reporting					
Total reporting cost over 30-year period	$2,100,000				
Annual reporting cost	$70,000				

Equipment Capital Costs

Equipment	Capex per Unit 2015	# of Units	Total Capital	Total Capital with Freight and Assembly (20% capital cost)
16 Grader	$ 500,000	1	$ 500,000	$ 600,000
966 Loader	$ 365,000	1	$ 365,000	$ 438,000
35 ton Haul Truck	$ 475,000	2	$ 950,000	$ 1,140,000
2.3 cy Excavator	$ 262,000	1	$ 262,000	$ 314,400
988 Loader	$ 695,000	1	$ 695,000	$ 834,000
Forklift	$ 150,000	2	$ 300,000	$ 360,000
Portable Generator, 20 kW	$ 25,000	1	$ 25,000	$ 30,000
D6 Dozer	$ 231,000	1	$ 231,000	$ 277,200
Snowblower	$ 350,000	1	$ 350,000	$ 420,000
Van-Mounted Steam Generator, Stainl	$ 115,000	1	$ 115,000	$ 138,000
Field Service Truck	$ 137,000	1	$ 137,000	$ 164,400
Semi Tractor 6x4, 80K lb	$ 175,000	2	$ 350,000	$ 420,000
Flatbed Trailer	$ 33,000	2	$ 66,000	$ 79,200
Heavy Equipment Trailer, 50t	$ 45,000	1	$ 45,000	$ 54,000
Fuel Tanker, 9300 gal	$ 79,000	2	$ 158,000	$ 189,600
Pick-ups	$ 65,000	4	$ 260,000	$ 312,000
Total Fleet			*$ 4,809,000*	*$ 5,770,800*
Power Equipment				$ -
500 kW Generator	$ 298,000	2	$ 596,000	$ 715,200
1000 kW Generator	$ 467,000	1	$ 467,000	$ 560,400
Switchgear	$ 25,000	3	$ 75,000	$ 90,000
Total Power			*$ 1,138,000*	*$ 1,365,600*
Total Capital Cost			**$ 5,947,000**	**$ 7,136,400**

Capital Replacement Schedule

NPV at net discount per year 4.30%

	Cost Component								
	Water Treatment	**Pick-ups, Service Truck, Steam Generator**	**Tractor and Trailers**	**Heavy Equipment**	**Generator / Power**	**SEP Reporting**	**Monitoring - Thermistors (SEP)**	**Total Annual Cost**	**Annual Equivalent**
Total Capital Replacement	$61,073,201	$614,400	$742,800	$4,413,600	$1,365,600	$2,100,000	$250,000		
Replacement Time (years)	30	10	15	25	20	30	15		
Total NPV:	**$29,370,945**	**$1,428,522**	**$1,151,374**	**$4,104,770**	**$1,033,488**	**$1,140,063**	**$192,050**	**$38,421,213**	**$38,421,213**
Year									
1	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
2	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
3	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
4	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
5	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
6	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
7	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
8	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
9	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
10	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
11	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
12	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
13	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
14	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
15	$15,268,300	$61,440	$49,520	$176,544	$0	$150,000	$250,000	$15,955,804	$1,652,476
16	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
17	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
18	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
19	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
20	$0	$61,440	$49,520	$176,544	$1,365,600	$150,000	$0	$1,803,104	$1,652,476
21	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
22	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
23	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
24	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
25	$0	$61,440	$49,520	$176,544	$0	$150,000	$0	$437,504	$1,652,476
26	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
27	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
28	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
29	$0	$61,440	$49,520	$176,544	$0	$50,000	$0	$337,504	$1,652,476
30	$45,804,900	$61,440	$49,520	$176,544	$0	$150,000	$209,000	$46,451,404	$1,652,476
31	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
32	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
33	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
34	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
35	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
36	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
37	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
38	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
39	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
40	$0	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$1,653,104	$1,652,476
41	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
42	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
43	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
44	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
45	$15,268,300	$61,440	$49,520	$176,544	$0	$0	$0	$15,555,804	$1,652,476
46	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
178	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
179	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
180	$45,804,900	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$47,458,004	$1,652,476
181	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
182	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
183	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
184	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
185	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
186	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
187	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
188	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
189	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
190	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
191	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
192	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
193	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
194	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
195	$15,268,300	$61,440	$49,520	$176,544	$0	$0	$0	$15,555,804	$1,652,476
196	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
197	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
198	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
199	$0	$61,440	$49,520	$176,544	$0	$0	$0	$287,504	$1,652,476
200	$0	$61,440	$49,520	$176,544	$1,365,600	$0	$0	$1,653,104	$1,652,476

Table 8: Suspension Power Costs

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
New		515	31	28	31	30	0	0	0	0	0	31	30	31	
New		2014	0	0	0	0	31	30	31	31	30	0	0	0	
kWh Produced			383,154	346,074	383,154	370,794	1,498,440	1,450,103	1,498,440	1,498,440	1,450,103	383,154	370,794	383,154	10,015,802
			$91,482	$82,629	$91,482	$88,531	$357,767	$346,226	$357,767	$357,767	$346,226	$91,482	$88,531	$91,482	
500 kW op hrs			744	672	744	720	0	0	0	0	0	744	720	744	
Maintenance and Supplies $/hr	no labor		2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	
1000 kW op hrs			0	0	0	0	744	720	744	744	720	0	0	0	
Maintenance and Supplies $/hr	no labor		4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69	
Powerhouse Operator	$	62.99	$ -	$ -	$ -	$ -	$ 46,865	$ 45,353	$ 46,865	$ 46,865	$ 45,353	$ -	$ -	$ -	
500 kW Cost			$ 2,104	$ 1,901	$ 2,104	$ 2,037	$ -	$ -	$ -	$ -	$ -	$ 2,104	$ 2,037	$ 2,104	
1000 kW Cost			$ -	$ -	$ -	$ -	$ 3,490	$ 3,377	$ 3,490	$ 3,490	$ 3,377	$ -	$ -	$ -	
Total Cost			**$ 93,586**	**$ 84,529**	**$ 93,586**	**$ 90,567**	**$ 408,121**	**$ 394,956**	**$ 408,121**	**$ 408,121**	**$ 394,956**	**$ 93,586**	**$ 90,567**	**$ 93,586**	**$ 2,654,285**
500 kW Labor			47.3	42.7	47.3	45.8	0.0	0.0	0.0	0.0	0.0	47.3	45.8	47.3	
1000 kW Labor			0.0	0.0	0.0	0.0	115.9	112.2	115.9	115.9	112.2	0.0	0.0	0.0	
Maint. Labor hours needed			47.3	42.7	47.3	45.8	115.9	112.2	115.9	115.9	112.2	47.3	45.8	47.3	
$/kWhr			0.25	0.25	0.25	0.25	0.55	0.55	0.55	0.55	0.55	0.25	0.25	0.25	

Average Fuel Cost $/gal $ 3.08 5-year average price delivered to RD Port (2011-2015)

Powerhouse Operator (Grp 1A) Hourly $ 62.99

Fuel Consumption Rates

	12.9	kW-hr per gal	**Consumption from current Red Dog rates**
$	0.24	per kW-hr	

Water Treatment Power Cost

New HDS Plant 600 KW in use for 150 days		2,160,000	KWh - covered by available power
Summer power with one treatment plant treating 1.9 B gallons	7,395,526		KWh
Factored power for 1.3 B gallons		5,060,097	KWh
		7,220,097	

Total Power Cost		$2,654,285
Winter	7	$640,008
Summer	5	$2,014,277
Treatment Power Cost		$1,557,128

Other Power Cost $1,097,157

Table 9: Suspension Camp & Administration Costs

	Basis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
		31	28	31	30	31	30	31	31	30	31	30	31	
Administration														
Office Supplies	Allow $100/month	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$1,200
Communications	Exede internet + Iridium phone	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$570	$6,840
Office Heating Fuel	500/200 gal/month	$1,540	$1,540	$1,540	$1,540	$616	$616	$616	$616	$1,540	$1,540	$1,540	$1,540	$14,784
Misc. Supplies	Allow $600/month	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$7,200
Camp Operation	$111 per person-day	$27,528	$24,864	$27,528	$46,620	$48,174	$46,620	$48,174	$48,174	$46,620	$27,528	$26,640	$27,528	$445,998
Turnaround Costs	$610/trip x 231 trips	$8,697	$7,856	$8,697	$14,729	$15,220	$14,729	$15,220	$15,220	$14,729	$8,697	$8,417	$8,697	$140,910
Subtotal - Administration		$39,035	$35,530	$39,035	$64,159	$65,280	$63,235	$65,280	$65,280	$64,159	$39,035	$37,867	$39,035	$616,932
Port Maintenance														
Maintenance		$0	$0	$0	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$0	$0	$120,000
Subtotal - Port Maintenance		$0	$0	$0	$0	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$0	$0	$120,000
Total - Supplies and Services		**$39,035**	**$35,530**	**$39,035**	**$64,159**	**$85,280**	**$83,235**	**$85,280**	**$85,280**	**$84,159**	**$59,035**	**$37,867**	**$39,035**	**$736,932**

Table 10: Suspension Environmental Monitoring Costs					
Analyte	**Unit Cost**	**Used Oil and Fuel Samples**	**Used Oil and Fuel Cost**	**APDES Samples**	**APDES Cost**
Aluminum Total EPA 200.8 (W)	$20.00			160	$3,200
Ammonia-N by EPA 350.2 (W)	$25.00			95	$2,375
Arsenic, SW7060 GF (O)	$20.00	1	$20		
Biochemical Oxygen Demand 5	$40.00			6	$240
Cadmium by SW6010 ICP (O)	$10.00	1	$10		
Cadmium Total EPA 200.8 (W)	$20.00			240	$4,800
Calcium Total EPA 200.8 (W)	$20.00			145	$2,900
Chloride by Ion Chrom. (W)	$20.00			150	$3,000
Chromium by SW6010 ICP (O)	$10.00	1	$10		
Chromium Total EPA 200.8 (W)	$20.00			160	$3,200
Cobalt Total EPA 200.8 (W)	$20.00			65	$1,300
Copper Total EPA 200.8 (W)	$20.00			235	$4,700
Cyanide, Total (W)	$45.00			60	$2,700
Fecal Coliform (MF) (9222D)	$50.00			8	$400
Flash Point by ASTM D-3828 (1020A)	$33.00	1	$33		
Hardness CaCO3 ICP-MS (W)	$25.00			125	$3,125
Iron Total EPA 200.8 (W)	$20.00			155	$3,100
Lead by SW6010 ICP (O)	$10.00	1	$10		
Lead Total EPA 200.8 (W)	$20.00			240	$4,800
Manganese Total EPA 200.8 (W)	$20.00			150	$3,000
Mercury by EPA 245.1 CV (DW)	$35.00			85	$2,975
Metals Acid Digestion	$20.00			250	$5,000
Nickel Total EPA 200.8 (W)	$20.00			160	$3,200
Selenium Total EPA 200.8 (W)	$20.00			150	$3,000
Silver Total EPA 200.8 (W)	$20.00			140	$2,800
Total Dissolved Solids (W)	$20.00			190	$3,800
Total Halogens (9076)	$150.00	1	$150		
Total Sulfur (5050/300.0)	$110.00	2	$220		
Total Suspended Solids	$20.00			45	$900
VOC, EPA 624 (W)	$125.00			4	$500
Zinc Total EPA 200.8 (W)	$20.00			240	$4,800
Monthly WET Tests	$1,910.00			12	$22,920
Courier					$4,080
SEWRM Fees					$5,000
Total Analytical			**$453**		**$101,815**
Bioassessment Program					$90,000
Fish Population and Diversity					
Fish Tissue Sampling					
Benthic Invertebrate Sampling					
Dolly Varden Aerial Surveys					
Equipment					
Miscellaneous Sampling Supplies					$4,200
Sampling Equipment					$4,000
Telemetry/MET Station Maintenance					$5,000
Helicopter Time					$50,000
Backup Telemetry Contract					$3,000
Equipment Maintenance					$10,000
Total					**$166,200**
Grand Total					**$268,468**

Table 11: Suspension Winter Power Consumption

		Number Available	Connected Power	Number Operating	Power kW	
Red Dog Pumpback	pumps	3	140		0	
	pumps	4	87	1	65	
	heat tracing				18	
Waste Pile Seepage	pumps	2				
	heat tracing					
Tailings Seepage	pumps	3	100	2	149	
	heat tracing				2	
Seepage-Seepage	pumps		5	1	4	
	heat tracing				0	
Overburden Pumpback	pumps		50	1	37	
	heat tracing				8	
Pumping Systems					283	283
Temporary Heat	heat tracing				19	
	compressor				15	
	lime plant				15	
	flocculant system				15	
	Reclaim Barge#1				20	
	Generator				25	
	6016 MCC				10	
	2021 MCC				10	
	2020 MCC				10	
	6030 MCC				10	
Barge De-Icing	pump		25	1	19	
Temporary Heat					167	167
Potable Water Plant					15	
Temporary Accommodation	misc heating				30	
	appliances				10	
	lighting				10	
Temporary Accommodation					65	65
Total						**515**

Table 12: Suspension Summer Power Consumption

		Number Available	Connected Power	Number Operating	Power kW	Standalone Power
Red Dog Pumpback	pumps	3	140	2	146.2	
		4	87	2	90.8	
	heat tracing		17.6	0	0.0	
Tailings Seepage	pumps	3	100	2	104.4	
					0.0	
	heat tracing		1.9	0	0.0	
Seepage-Seepage	pumps		10	2	10.4	
					0.0	
	heat tracing		0.475	0	0.0	
Overburden Pumpback	pumps		50	1	26.1	
					0.0	
	heat tracing		7.64	0	0.0	
					0.0	
Potable Water Plant					15.0	
					0.0	
Subtotal - Water Collection Pumps					393	393
Reclaim Barge #1	pumps	4	300	4	626.4	
	misc.				0.0	
Subtotal - Reclaim Barge					626	626
WTP#2	Lime/sludge Agitator	1	15	1	7.8	
	Rapid Mix Agitator	1	25	1	13.0	
	Lime Reactor Agitator	1	100	1	52.2	
	Floc Mix Agitator	1	5	1	2.6	
	Clarifier - rake drive	2	7.5	2	7.8	
	Clarifier - lift drive	1	2	1	1.0	
	Sludge Recycle pumps	2	150	2	156.6	
	Overflow Bypass pump	1	75	1	39.1	
	Emergency Spill Pump	1	10	1	5.2	
Subtotal - WTP2					286	286
Lime Mixing System	Screw Conveyor	1	3	1	1.6	
	Lime slaker	1	5	1	2.6	
	MOL transfer pump	1	7.5	1	3.9	
	MOL storage tank agitator	1	7.5	1	3.9	
	Lime feed pumps	2	25	1	13.0	
	Overhead crane	1	5	1	2.6	
	Sump pump	1	10	1	5.2	
	Dust Collection Filter	1	5	1	2.6	
Subtotal - Lime Slaking System					35	35
Flocculant System	Flocculant Transfer Pump	2	5	1	2.6	
	Flocculant Area Sump Pump	1	7.5	1	3.9	
	Flocculant Feed Pump	2	1	1	0.5	
	Flocculant Transfer Blower	1	2.5	1	1.3	
	Flocculant Screw Feeder	1	0.5	1	0.3	
	Flocculant Day Tank Agitator	1	1	1	0.5	
	Flocculant Mix Tank Agitator	1	5	1	2.6	
	Flocculant Hoist	1	1	1	0.5	
Subtotal - Flocculant System					12	12
Sodium Sulfide System	Mix tank agitator	1	2	1	1.0	
	Transfer pump	2	5	1	2.6	
	Day tank agitator	1	1.5	1	0.8	
	Head tank feed pumps	2	5	1	2.6	
	Overhead Crane	1	25	1	13.0	
	Exhaust fan	1	2	1	1.0	
	Spill sump pump				0.0	
Subtotal - Sulfide System					21	21

Table 12: Suspension Summer Power Consumption

		Number Available	Connected Power	Number Operating	Power kW	Standalone Power
Air Compressor	Sullair compressor	4	200	1	104.4	
	Cooling circulating pumps	2	5	1	2.6	
	Mechanical room sump pump	1	2	1	1.0	
	Air Dryer	1	25	1	13.0	
Subtotal - Air Compressor					121	121
Fresh Water Supply	Bon's Creek Pumps	2	50	1	26.1	
	Fresh water transfer pumps	2	5	1	2.6	
	Reagent water supply pumps	2	10	1	5.2	
	Potable Water Plant				0.0	
Subtotal - Fresh Water Supply					34	34
Process Water Distribution	Cooling Water Standby pump	1	75	1	39.1	
Subtotal - Process Water Distribution					39.1	39
Generator	Fuel Feed Pump Skid	2	3	1	1.6	
	Fuel Return Skid	1	1	1	0.5	
	Fuel Treatment Feed Pump No.1	2	15	1	7.8	
	Fuel Treatment Heater No.1 (24 kW)	2	24	1	12.5	
	Fuel Treatment Sludge Tank Heater	1	1	1	0.5	
	Lube Oil Reclaim Skid Separator Motor	1	20	1	10.4	
	Lube Oil Reclaim Skid Feed Pump	1	3	1	1.6	
	Lube Oil Reclaim Skid Electric Heater	1	64	1	33.4	
	Waste Oil Centrifuge	1	5	1	2.6	
	25t / 5t Powerhouse Bridge Crane	1	30	1	15.7	
	Water Pre-Heater (15 kW)	2	15	1	7.8	
	Portable Clean Lube Oil Transfer Pump	2	2	1	1.0	
	Pre-Lube Circulation Oil Pump	1	20	1	10.4	
	Engine Water Jacket Pre-Heating Pump	2	1	1	0.5	
	Oil/Water Separator Sump Pump	1	7.5	1	3.9	
	Spill Trays Sump Pump	1	7.5	1	3.9	
	Heat Recovery Circulating Pump	2	40	1	20.9	
	Starting Air Compressor (Electric) Skid	1	10	1	5.2	
	Starting Air Compressor (Diesel) Skid	1	10	1	5.2	
	Door Heater	1	0.5	1	0.3	
	Electric Unit Heater	1	0.5	1	0.3	
	Control Room HVAC Unit	1	5	1	2.6	
	Switchroom Ventilation (AC) Unit	1	10	1	5.2	
	Mechanical Bay Area Ventilation Unit	1	5	1	2.6	
	Powerhouse Make-Up Air Unit	2	30	1	15.7	
	Mechanical Bay Area Exhaust Fan	1	0.5	1	0.3	
	Vertical Lift Door	1	2	1	1.0	
	Modulating Motorized Relief Damper	3	1	1	0.5	
Subtotal - Generator					174	174
Misc. Heating & Lighting					30	
Temporary Accommodation	Heating				30.0	
	Appliances				10.0	
	Lighting				10.0	
Subtotal - Temporary & Miscellaneous					80	80
Contingency						192
Total						**2014**

Table 13: Dam Inspection and Maintenance

	Per Item		Item		Yearly Cost
Yearly Dam Inspection	$7,500	Each dam	4	Dams	$30,000
Dam Instrumentation Replacement	$12,500	Each dam	4	Dams	$50,000
Periodic Dam Safety Inspection (4 dams)	$700,000	Each period	3	Years	$233,333
Repair erosion on dam face and beach armoring (20-year interval)	$31,716	Each period	20	Years	$1,586
Repair Main Dam Drain (20-year interval)	$1,500,000	Each period	20	Years	$75,000
Total Inspection and Maintenance					**$389,919**

Erosion repair calcs

Main Dam face

Slope length (ft):	501	986' dam crest to 800' toe, 2.5H:1V slope
Slope length (m):	153	
Rip-rap quantity (m3):	85	Assume 3 runnels full length of dam face, each runnel is 1' deep with 2H:1V side slopes
Unit cost ($/m3):	$23.47	Quarry, haul, place (Rev 2 closure cost estimate)
Direct cost:	$2,000	
Indirect cost (0.9 x direct cost):	$1,800	Indirect:direct ratio for Rev 2 closure cost estimate
Total cost:	**$3,800**	

Main and Back Dam Beach armoring

Rip-rap quantity (m3):	626	Assume 10% of rip-rap needs to be replaced (Rev 2 closure cost estimate)
Unit cost ($/m3):	$23.47	Quarry, haul, place (Rev 2 closure cost estimate)
Direct cost:	$14,692	
Indirect cost (0.9 x direct cost):	$13,223	Indirect:direct ratio for Rev 2 closure cost estimate
Total cost:	**$27,915**	

Appendix F – Evaluation of Borrow Sources

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Memo

To:	Chris Eckert, TAK	**Client:**	Teck Alaska Incorporated
From:	Christine McCabe	**Project No:**	329100.030
Cc:	Dan Neuffer, SRK	**Date:**	August 5, 2016
Subject:	Evaluation of Borrow Sources		

1 Introduction

Teck Alaska Incorporated's (TAK) Red Dog Mine is expected to close permanently in the year 2031 (SRK 2016a). The following areas are anticipated to require cover material for closure:

1. Main Waste Dump (cover placement during operations);
2. Qanaiyaq Pit Dump (some cover placement during operations);
3. Landfill Area;
4. Low-Grade Ore Stockpile Area;
5. Main Pit Dump;
6. Red Dog Creek Area;
7. Main Dam Tailings Beach; and
8. Back Dam Tailings Beach.

Attachment 1 shows the areas that will require cover material for closure. The cover design requires 3.3 feet of cover material over the areas above. Approximately 6.8 million tonnes (3.4 million cubic yards) of cover material will be required for closure during and after mine operations.

This memo summarizes potential borrow sources that TAK has considered for cover material, and outlines TAK's plan for sourcing cover material. TAK has considered sources of unmineralized shale, existing coarse rock quarries, and unconsolidated material sources for cover material. TAK intends to use waste rock generated from current and future mining activities within the upper benches of the Aqqaluk Pit. This material consists of unmineralized shale within the Key Creek Plate Formation. The source contains sufficient unmineralized shale for use as cover material at mine closure. Additionally, the source is being mined as part of the mining operation, and no additional land disturbance is required.

1.1 Sources of Unmineralized Shale

1.1.1 Waste Rock from Future Mining

The cover material that TAK has selected is within a distinct thrust sheet identified as the Key Creek Plate Formation, located in the northeast portion of the Aqqaluk Pit (SRK 2016b). Approximately 9.6 million tonnes of Key Creek Plate material resides within the area identified in the mine plan, and approximately 1.9 million tonnes of the material has been stockpiled for use in cover construction as of March 2016. Material in the Key Creek Plate is fully accessible, and could be extracted for use in cover construction, both now and in the future. Therefore, an alternative borrow source outside the mine footprint is not anticipated to be required for sourcing cover material.

The Key Creek Plate overlies the Red Dog Plate, which is the host for all the deposits at the Red Dog Mine. Rocks in the Key Creek Plate formed many miles from the Red Dog deposit at the time of formation; therefore, rocks in the Key Creek Plate do not contain the high concentrations of zinc and lead mineralization that are found in the Red Dog Plate. Rocks in the Key Creek Plate are structurally complex, similar to rocks in the Red Dog Plate, with minor thrust faulting and folding, resulting in a blocky mixture of rock types with a wide range of non-distinctive geochemical characteristics. Drilling data indicates that the majority of the rocks in the Key Creek Plate are comprised of Kivalina Shale or Kayak Shale. Volcanic intrusives are present within some of the Kivalina Shale.

Figure 1 shows estimated production for Key Creek Plate material between the years 2015 and 2031. The figure also shows the estimated requirements for cover material with time. Based upon the volumes shown, sufficient cover material will be available at closure for the waste rock dumps, tailings beaches, and other areas.

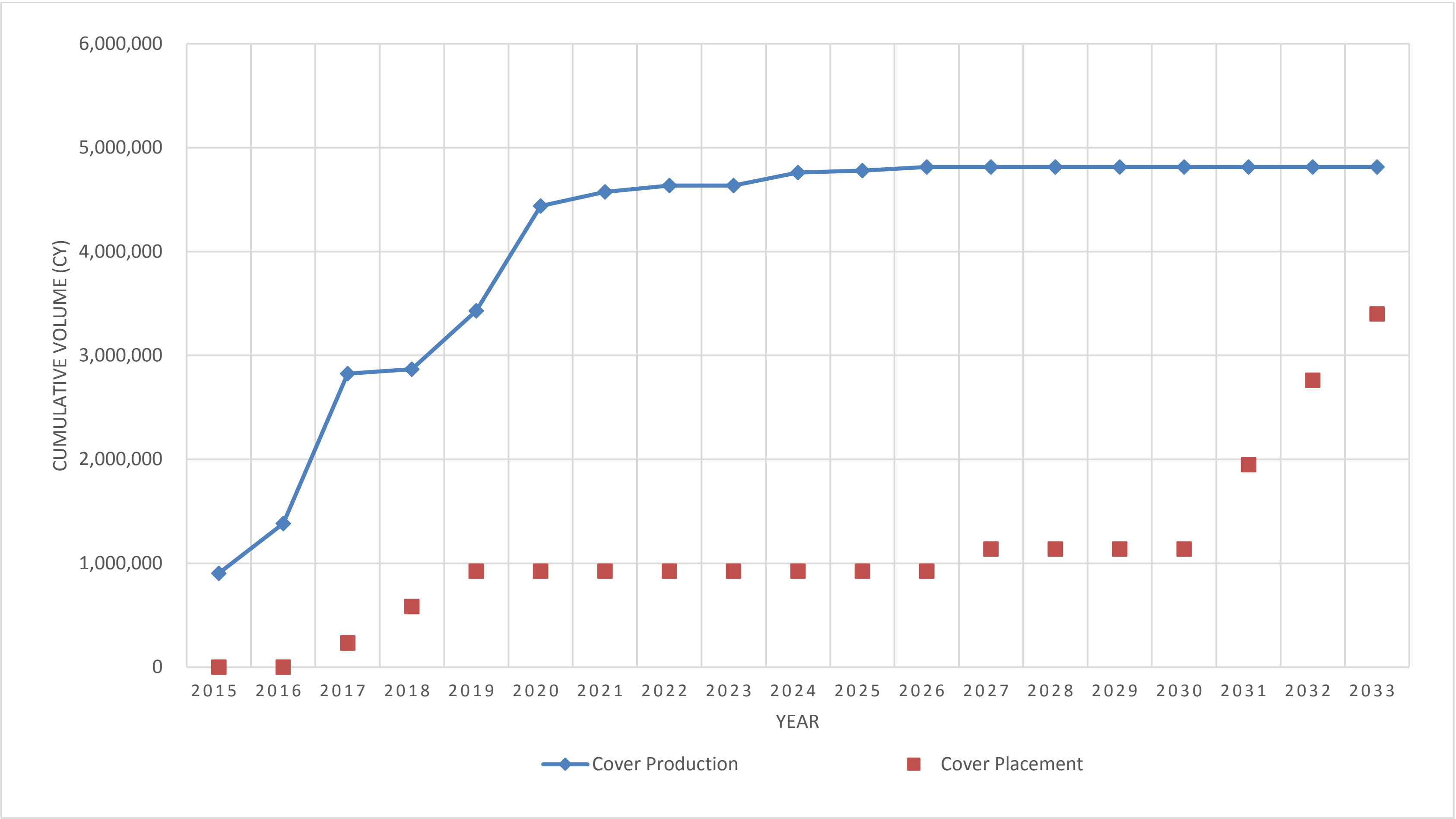


Figure 1: Planned Cover Production Rates and Material Requirements[1]

[1] 2015 cover production is actual cover stockpile volume from TAK

1.1.2 Overburden Dump

The Overburden Dump is located at the south end of the Tailings Storage Facility (TSF). Kivalina Shale is the dominant material in the stockpile; however, a mixture of mineralized materials is present. The material within this stockpile is not used in the *Reclamation and Closure Plan* (SRK 2016a). At this time, TAK plans to leave the Overburden Dump in place, regrade to promote drainage, and revegetate.

1.1.3 Potential Quarry Sites

Two geologic formations in the vicinity of the mine could also provide cover material that will weather and break down into relatively fine-grained soil. The Kivalina Formation is calcareous shale with acid neutralization potential. It is highly sheared and does not require crushing for coarse cover purposes. The Kivalina Shale contains traces of orange sphalerite and may have a slight potential for metal leaching. The Okpikruak Formation is shale with traces of pyrite, with a neutral acid generating/consuming potential. The material is also expected to quarry without crushing for coarse cover purposes.

At the head of Sulfur Creek, just north of the Aqqaluk Pit, is an area which could provide the required cover material from the Kivalina Formation. The potential borrow source, which is located on NANA land, is labeled Kivalina Pit in Figure 2. The potential borrow source for the Okpikruak Formation, which is also on NANA land, is located just south of the Qanaiyaq Pit, and is labeled Okpikruak Pit in Figure 2.

In 2003 and 2004, O'Kane Consultants collected samples and performed sieve analyses and compared the physical properties of the two shale formations. Sieve analyses results showed that the particle size distribution of the Okpikruak Shale falls within the coarse and fine limits of the Kivalina Shale. The median particle size of both materials is approximately the same (7 mm). The Okpikruak Shale is slightly more uniform and generally coarser, particularly below the 1 mm particle size, than the Kivalina Shale. From a hydraulic performance perspective, the Okpikruak Shale may have a slightly higher saturated hydraulic conductivity (estimated to be less than a half order of magnitude difference) and slightly less moisture retention under suction conditions compared to the Kivalina Shale (O'Kane 2005).

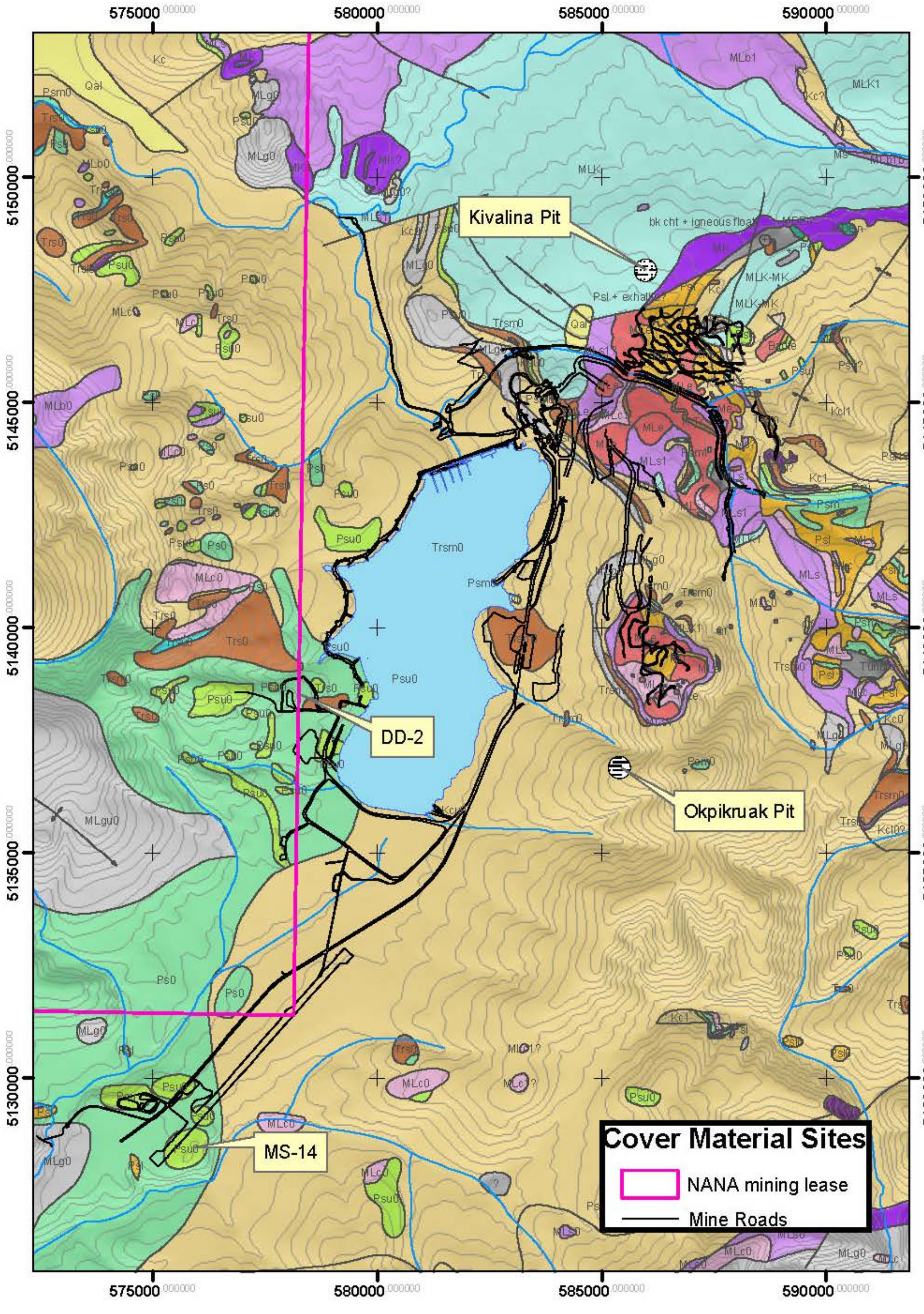


Figure 2: Potential and Existing Quarry Sites

1.2 Existing Rock Quarry Sites

The Red Dog Mine has two existing rock quarries that could provide cover material. The quarries are labeled MS-14 and DD-2, and are displayed in Figure 2. MS-14 is located at the southern end of the airstrip, on NANA land, and DD-2 is located on the west side of the TSF, on NANA and State land.

Both potential borrow sites are located in the Middle Siksikpuk Formation. The Middle Siksikpuk Formation is siliceous shale, and contains a trace of iron sulfide and minor iron carbonate. The material is not acid generating and has low acid neutralization potential. Blasting yields material that may be usable as coarse cover material without crushing.

Rock from the DD-2 quarry is coarse in nature, and is also more resistant to erosion than other rocks in the area. As a result, material used to construct dam raises is quarried from the DD-2 Pit. However, the same characteristics that deem the DD-2 rock suitable for dam construction also make the rock less favorable for cover material. DD-2 material does not weather to clay fast enough to provide adequate fines for compaction, water retention, and plant growth, and is therefore more permeable than other available cover materials in the area. Other alternate cover materials discussed in this memo weather to clay and residual soil relatively quickly, and are therefore more suitable for use as cover material.

1.3 Unconsolidated Sources

Typically, unconsolidated material sources are used for cover materials. Two types of unconsolidated material are located within close proximity to the Red Dog Mine: sand and gravel on river floodplains and talus material. Other typical unconsolidated cover materials are glacial outwash and till; however, since the area did not experience glaciation, these materials are not available.

Digital Elevation Models (DEM) and Geographic Information System (GIS) software were used by TAK staff to develop the slope map shown in Figure 3. Slopes of about 30-35° indicate areas of potential talus material at angles of repose. However, the only areas within two miles of the mine that may contain the required amount of talus material are located high on the slopes of Deadlock Mountain.

Slopes less than 3° indicate areas of stream floodplains. Two floodplains with potential gravel deposits were identified: Ikalukrok Creek and Robinson Creek. Ikalukrok Creek has potential for gravel deposits near the junction with Red Dog Creek; however, the creek contains lead and zinc-bearing detritus from the Red Dog deposit erosion. Robinson Creek, which is located approximately five miles east of the mine, is probably the closest source of unconsolidated sand and gravel. Developing either of these areas for potential cover material could cause significant disturbance to the streams and surrounding areas. Additionally, the construction of new haul roads for site access would also create new land disturbance.

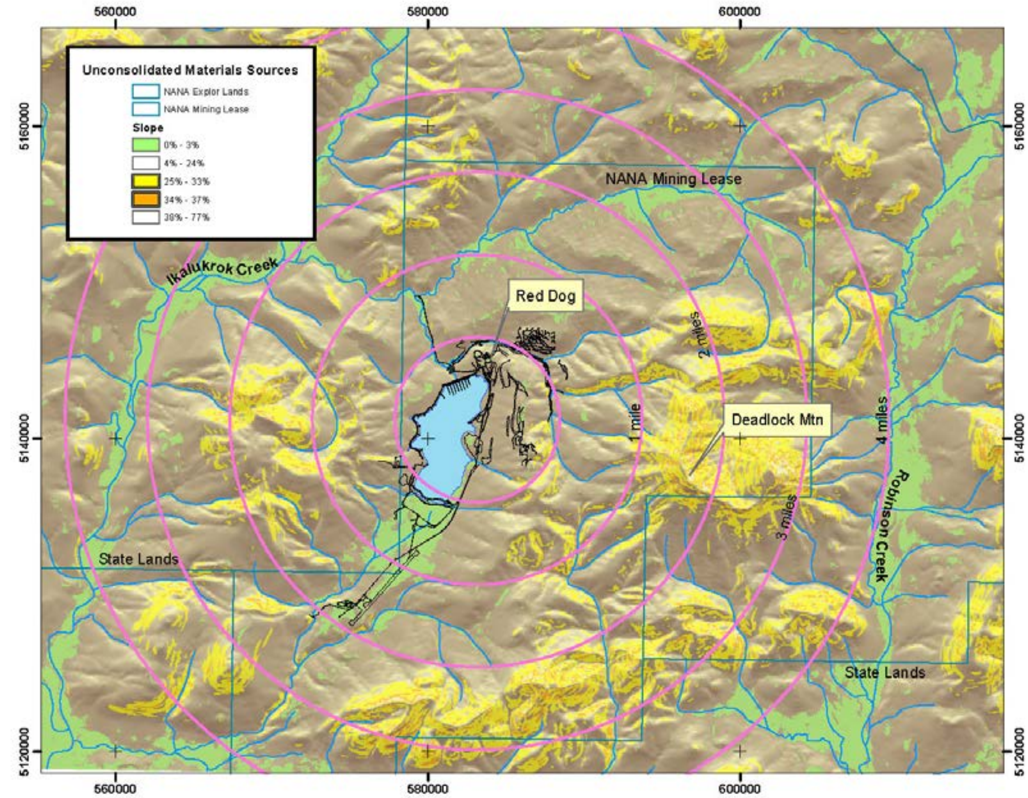


Figure 3: Slope Map

1.4 Conclusion

At closure, TAK will need approximately 6.8 million tonnes (3.4 million cubic yards) of cover material to place a 3.3-foot-thick cover over waste rock dumps, tailings beaches, and other mine areas. TAK intends to use waste rock generated from current and future mining activities within the upper benches of the Aqqaluk Pit. This material consists of unmineralized shale within the Key Creek Plate Formation. As shown in Figure 1, the Key Creek Plate has sufficient cover material available for closure of these disturbed areas.

SRK appreciates the opportunity to work with TAK on this important project. Please contact us at (907) 677-3520 with questions or comments.

SRK Consulting (U.S.), Inc.

Christine McCabe, EIT
Staff Consultant

2 References

O'Kane Consulting Inc. Red Dog Waste Rock Cover Design Project – Comparison of Particle Size Distribution of the Kivalina and Okpikruak Shale Formation Materials. Memorandum to Red Dog Operations, Teck Cominco Alaska Inc. February 2005.

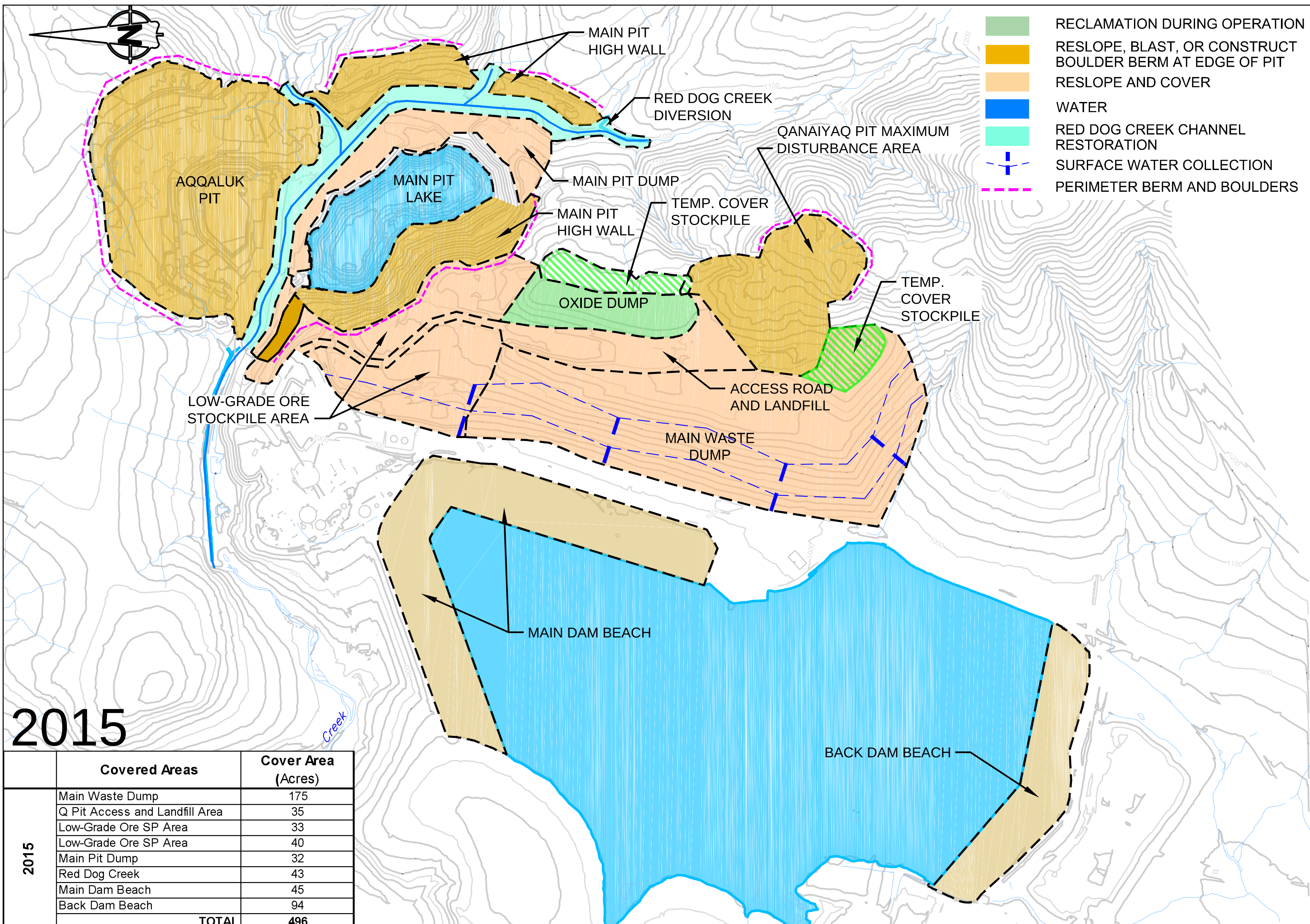
SRK Consulting Inc. Red Dog Mine Closure and Reclamation Plan, Appendix SD F2: Evaluation of Borrow Sources. Memorandum to file. November 2005.

SRK Consulting Inc. Red Dog Mine Reclamation and Closure Plan. August 2016a.

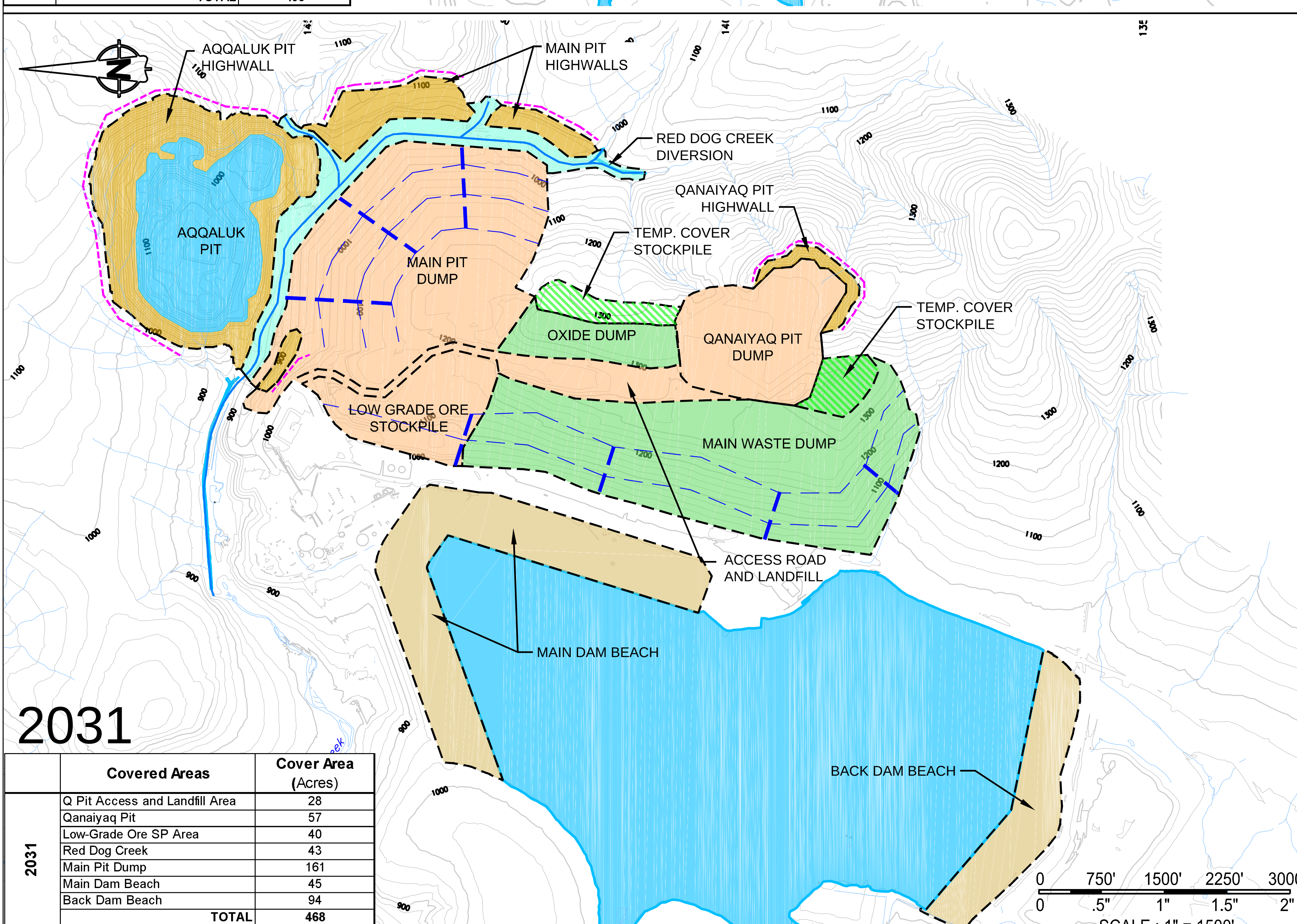
SRK Consulting Inc. Segregation Plan for Cover Material at the Red Dog Mine, Alaska. March August 2016b.

Teck Cominco Alaska. Red Dog Mine Site Current Conditions – Waste Management Permitting Program Tasks B-04, C-02, and D-02. December 2005.

Attachment 1: Areas Requiring Cover for Closure (from SRK 2016a)



	Covered Areas	Cover Area (Acres)
2015	Main Waste Dump	175
	Q Pit Access and Landfill Area	35
	Low-Grade Ore SP Area	33
	Low-Grade Ore SP Area	40
	Main Pit Dump	32
	Red Dog Creek	43
	Main Dam Beach	45
	Back Dam Beach	94
	TOTAL	496



	Covered Areas	Cover Area (Acres)
2031	Q Pit Access and Landfill Area	28
	Qanaiyaq Pit	57
	Low-Grade Ore SP Area	40
	Red Dog Creek	43
	Main Pit Dump	161
	Main Dam Beach	45
	Back Dam Beach	94
	TOTAL	468

TOPOGRAPHY AND LAYOUT BASED ON INFORMATION PROVIDED BY RED DOG, 2014.

Red Dog Mine

DESIGN: DST
DRAWN: IBM
REVIEWED:
APPROVED:

IF THE ABOVE BAR DOES NOT MEASURE 1 INCH, THE DRAWING SCALE IS ALTERED

PREPARED BY: srk consulting

PROJECT: **RED DOG MINE RECLAMATION AND CLOSURE PLAN**

FIGURE TITLE: EXTENT OF MINE AREA COVERS

DATE: JUNE 2015
REVISION:
FIGURE NO.: 20
SRK PROJECT NO.: 329100.030

P:\Teck Alaska - Red_Dog\329100.030 IWMP\329100.030 IWMP\040_AutoCAD_GIS\Rec Plan Figures\Agency Draft Rev 2 -Figures SRK\2238-F20.dwg

Appendix G – Qanaiyaq Pit Addendum

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Memo

To:	Chris Eckert, TAK	**Client:**	Teck Alaska Incorporated
From:	Dan Neuffer	**Project No:**	329100.030
Cc:	Kelly Sexsmith, SRK Bill Jeffress, SRK Daryl Hockley, SRK	**Date:**	August 5, 2016
Subject:	Qanaiyaq Pit Addendum		

1 Introduction

Teck Alaska Incorporated (TAK) provides this addendum to the *Reclamation and Closure Plan* (SRK 2016a) to incorporate a recent change in the Red Dog Mine plan relative to the *Life of Mine Plan (2014-2030)* (TAK 2014). Early in 2016, TAK initiated development and mining of Qanaiyaq Pit, two years earlier than the planned start of mining in 2018 (TAK 2014). The advance of the Qanaiyaq Pit mining schedule affects the Premature Closure Scenario in the *Reclamation and Closure Plan* and *Water and Load Balance Update* (SRK 2016b). This memo summarizes the effects of the change in Qanaiyaq Pit schedule on the load balance and closure plan, as well as the post-closure, suspension, and closure cost estimates.

2 Effects on Load Balance and Closure Plan

The primary effect of advancing the Qanaiyaq Pit schedule on the load balance and closure plan is advancing chemical loading from the pit walls into the Premature Closure Scenario, i.e., an immediate unplanned closure. The worst case for Qanaiyaq Pit in the load balance within the next five years, is a case where the Qanaiyaq Pit is fully disturbed with no waste rock backfill, as backfill is not scheduled until year seven of Qanaiyaq Pit mining. Accordingly, the maximum chemical load from the Qanaiyaq Pit walls prior to backfill was extracted from the load balance; in the *Water and Load Balance Update*, this corresponds to the chemical loading during years 2018 through 2022[1], which now correspond approximately with years 2016 through 2021 in the current Qanaiyaq Pit mine plan. The increased loading from Qanaiyaq Pit during a Premature Closure Scenario would increase long-term water treatment requirements as follows:

1. Increase acidity load reporting to the Main Pit by 1,160 tonnes per year, resulting in an additional 730 tonnes per year of lime demand, a 5% increase; and

2. Increase water treatment sludge production by about 5% per year.

[1] Dashboard in load balance must be set to 2031 Closure, as Qanaiyaq Pit was not included in 2015 Closure due to 2018 start date.

For a Premature Closure Scenario where Qanaiyaq Pit would not be backfilled, closure actions would consist of the following:

1. Construction of berms around pit highwall for safety; and
2. Minor surface grading within the pit bottom to maintain gravity drainage to the Main Pit.

3 Effects on Post-Closure, Suspension, and Closure Cost Estimates

The Premature Closure Scenario of the *Post-Closure Cost Estimate* (SRK 2016c) was updated as follows:

1. Usage of lime and other water treatment consumables were updated with the increased acidity load, as shown in Table 1; the *Suspension Cost Estimate* (SRK 2016d) was updated accordingly, as shown in Table 2; and
2. Sizes and costs of the new sludge repository and new densification infrastructure, sludge hauling and pumping costs, and schedules for capital and operating expenditures were updated to account for the increased sludge production, as summarized in Tables 3 and 4.

Table 1: Updated Post-Closure Water Treatment Consumables Estimate

Consumable	Unit Cost Delivered (US$/tonne)	Long-Term Annual Usage (tonnes)	Total Annual Cost (US$)
Flocculant	$4,676	145	$679,906
Lime	$373	14,540	$5,423,545
Sodium Sulfide	$1,084	380	$411,381
Antiscalant	$3,308	61	$202,018
Total			**$6,716,850**

Table 2: Updated Suspension Water Treatment Consumables Estimate

		Suspension Water Treatment		Closure Water Treatment	
Consumable	Unit Cost Delivered (US$/tonne)	Annual Usage (tonnes)	Total Annual Closure Cost (US$)	Annual Usage (tonnes)	Total Annual Closure Cost (US$)
Flocculant	$4,676	150	$700,834	131	$614,872
Lime	$373	14,988	$5,593,331	13,150	$4,907,275
Sodium Sulfide	$1,084	391	$424,043	343	$372,032
Antiscalant	$3,308	63	$208,236	55	$182,694
Total			**$6,926,444**		**$6,076,874**

Table 3: Updated Post-Closure Sludge Management Estimate – Capital Costs

Capital Cost	Start Year	End Year	Total Annual Cost (2016 US$)
TSF repository - cofferdam	18	19	$3,922,464
New densification infrastructure	8	9	$7,256,885
Replace densification infrastructure	58	59	$7,256,885
New repository	89	90	$11,392,292

Table 4: Updated Post-Closure Sludge Management Estimate – Operating Costs

Operating Cost	Start Year	End Year	Total Annual Cost (2016 US$)
Pumping WTP sludge to Main Pit	1	9	$53,908
Pumping WTP sludge to densification	10	100	$18,816
Densification operating and maintenance costs	10	100	$169,801
Trucking densified sludge to TSF repository	20	90	$190,559
Dam inspection and maintenance of TSF repository	20	90	$97,480
Trucking densified sludge to Aqqaluk repository	10	19	$281,869
Trucking densified sludge to new repository	91	100	$432,950
Dam inspection and maintenance of TSF/new repository	91	100	$194,960

The following costs were added to the Premature Closure Scenario of the *Closure Cost Estimate* (SRK 2016e):

1. Construction of approximately 2,400 feet of berm around the Qanaiyaq Pit highwall, totalling an estimated $29,300 in direct costs; and

2. An allowance for dozing approximately 57,800 cubic yards of material within the Qanaiyaq Pit bottom to promote drainage to Hilltop Creek and the Main Pit, totalling an estimated $26,300 in direct costs.

Water treatment plant construction costs are not expected to change, as the 5% increase in lime usage is within the range of the equipment specified in the *Closure Cost Estimate*.

Please contact me with any questions or comments.

SRK Consulting (U.S.), Inc.

Dan Neuffer
Senior Consultant

Disclaimer—SRK Consulting (U.S.), Inc. has prepared this document for Teck Alaska Incorporated. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this document by a third party.

The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

4 References

SRK. (2016a). Red Dog Reclamation and Closure Plan. Prepared for Teck Alaska, Inc.

SRK. (2016b). Red Dog Mine Water and Load Balance Update. Memo prepared for Teck Alaska, Inc.

SRK. (2016c). Red Dog Mine Post-Closure Cost Estimate. Prepared for Teck Alaska, Inc.

SRK. (2016d). Red Dog Mine Suspension Cost Estimate. Prepared for Teck Alaska, Inc.

SRK. (2016e). Red Dog Mine Closure Cost Estimate. Prepared for Teck Alaska, Inc.

Teck Alaska, Inc. (2014). Red Dog Mine Life of Mine (2014-2030).