95 Wellington Street
Suite 1010
Toronto, Ontario
M5J 2N7
416-628-0216

April 27, 2015

Phyllis Beaulieu
Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0
licensing@nwb-oen.ca

Dear Phyllis,

Re: Request for Approval under Part G Item 19 of 2AM-DOH1323

TMAC Resources Inc. (TMAC) operates the Hope Bay project under water license 2AM-DOH1323, issued by the Nunavut Water Board (the Board, NWB). The project has been in care and maintenance since 2012 and during that time TMAC has been re-evaluating various aspects of the mine plans and license provisions. Now, following these deliberations, TMAC intends to commence construction of a mill building and mill to process ore from the Doris Mine under the currently approved water license. Foundation construction for the mill and underground development of access ways is scheduled to commence in the second quarter of 2015. Delivery, installation and start-up of mill components is scheduled for the third quarter of 2016 with first gold to be poured at approximately the end of 2016.

Based on TMAC's re-examination of the current mine plan, and in consideration of planned near-term commencement of development, TMAC views Pad T as the optimal location for waste rock storage. With the proposed mill in-feed crusher location and ore stockpile configuration, it is considered to be unsafe and inefficient to place waste rock on pads F and G, as currently approved. It is safer for ore haul traffic exiting the portal to proceed straight to the ore storage pads (Pads Q, H and J). Waste rock haulers emerging from the portal would turn right (north) and proceed to Pad T, immediately north of the portal entrance. This avoids crossing traffic, thereby reducing collision potential.

To facilitate this path to production schedule, TMAC is seeking approval from The Board for a revision to the current *Waste Rock and Ore Management Plan (2010)* under Part G Item 19 of 2AM-DOH1323 water license. The proposed revision would permit construction and operation of a waste rock storage pad in the area identified as Pad T. Features of this pad are presented in Table 1.

Table 1. Design features of Pad T waste rock storage area, Doris North.

Feature	**Value**
Footprint area	42,600 m^2
Peak waste rock on surface	506,000 t
Contingency	10 % 50,000 t
Maximum design capacity	828,000 t
Waste rock on surface at closure (incl. contingency)	188,000 t

Based on TMAC's review of the procedural history (summarized below) associated with water license 2AM-DOH1323 and Project Certificate 003, the area of Pad T:

- Lies outside of an existing land use planning area,
- Has been previously reviewed by both the Nunavut Impact Review Board (NIRB) and the NWB,
- Is a reasonable modification of waste rock storage practices at the Doris North Mine which have similarly been reviewed and approved by the NWB, and
- Is within the boundaries of the commercial lease (KTCL 308D003) held with the Kitikmeot Inuit Association (KIA).

Currently approved water management practices will remain in place and unchanged for construction and operation of Pad T.

Key references pertaining to previous reviews of Pad T are summarized below and included in the attached procedural history (Attachment 1):

- **Final Environmental Impact Statement (FEIS)** supporting document:
  - A7 *Surface Infrastructure Preliminary Design* (SRK 2005) describes and illustrates a temporary waste rock pile generally consistent with the proposed footprint of Pad T.
  - *Preliminary Closure Plan* (AMEC 2005) presents the waste rock pad in the same location, Pad T_1.
- **Approved *Interim Water Management Plan* (SRK 2012**) illustrates Pad T, and describes it as located within the contact area, wherein runoff originating at Pad T would flow to existing water management infrastructure including the pollution control pond.
- **Approved *Waste Rock and Ore Management Plan* (SRK 2010)** describes current waste rock management practices on site.

A previous submission to the NWB and the NIRB in November 2013 included Pad T as part of a larger change in scope, requesting an amendment to 2AM-DOH1323 and Project Certificate 003. Collectively, the proposed site changes were of such magnitude that it was most appropriate and efficient to examine all proposed changes together, as an application for an amendment. As previously discussed, TMAC is currently revising the amendment application in order to reflect TMAC's updated mine plan. In undertaking that work, TMAC identified that Pad T does not require amendment to the license and that it should not properly have been included in the November 2013 amendment package. The Pad T area is part of the current approved Doris North Project and is not part of the changes to the project that are the subject of the amendment application. Given the imminent need under currently approved mine and waste rock management plans, specific scope and historical review of the Pad T area, TMAC is requesting The Board's approval of the revised *Waste Rock and Ore Management Plan* (SRK 2015; Attachment 2) and establishment of Pad T separately from the previously mentioned amendment. This change will greatly facilitate the early production schedule for the Doris Mine and will result in no unassessed impacts on the site footprint.

Should the Board decide that approval under Part G Item 19 is not the appropriate mechanism to review and approve the *Waste Rock and Ore Management Plan* (2015), TMAC respectfully requests that it be notified of this decision as soon as possible.

To support the NWB in a focused review of the revised *Waste Rock and Ore Management Plan* (2015), a document control table is included in the attached report identifying where changes to the approved Plan have been made. A design brief and a stability assessment have also been compiled and accompany this submission (see Attachments 3 & 4).

Further, TMAC would like to highlight our approach to underground drilling. It is understood that historic underground drilling involved substantial brine use resulting in salt-laden waste rock and saline runoff associated with surface storage of waste rock. TMAC plans to minimize salt use in underground drilling, and instead employ a compressed air and water mist system. This approach will mitigate permafrost degradation and water management issues arising from salt-laden waste rock storage and saline run-off. This procedure has proven effective where it is in use at Glencore's Raglan Mine in northern Quebec. Please find attached TMAC's draft *Low Salt Underground Drilling Procedure* (2014) summarizing this procedure (Attachment 5).

Finally, it is expected that the addition of the Pad T to site infrastructure will require an adjustment of the security furnished under Part C Item 1 of 2AM-DOH1323. Based on calculations provided in the attached document (Attachment 6), TMAC is prepared to furnish an additional $6,000 security upon receipt of approval for construction and operation of Pad T.

Feel free to contract the undersigned with any questions or comments you may have regarding this request for approval.

Yours sincerely,

M. John Roberts
Vice President, Environmental Affairs
Hope Bay Project
(416) 628-0216
john.roberts@tmacresources.com.

encl.: Attachment 1 *Procedural History*

Attachment 2 *Waste Rock and Ore Management Plan* (SRK 2015)

Attachment 3 *Design Brief: Pad T* (SRK 2015)

Attachment 4 *Stability Assessment: Pad T* (SRK 2015)

Attachment 5 *Low Salt Underground Drilling Procedure* (TMAC 2014)

Attachment 6 *Revised security estimate calculation, Pad T* (SRK 2015)

MEMORANDUM

DATE: March 6, 2015

TO: File

FROM: Sharleen Hamm, John Roberts

SUBJECT: **Summary of Procedural History for Pad T**

The following points provide a summary of waste rock pad review and approvals, focussing on a regulatory review of Pad T.

- Supporting documentation for the 2005 FEIS includes delineation of the temporary waste rock pile. This is consistent with a portion of Pad T, Pad T_1.
  - Ref.: FEIS Supporting document A7 Surface Infrastructure Preliminary Design, SRK 2005, Figure 5.6.). Figure 5.6 and reference to the temporary waste rock pile are to be consistent with that presented throughout the FEIS [Attachment 1].
  - Ref.: Closure Plan (AMEC 2005) presents the waste rock pad in the same location, Pad T_1 [Attachment 2].
- ***Project Certificate 003 awarded subsequent to review of FEIS, indicating approval of location and use.***
- 2AM-DOH0713-2007
  - Application submitted in 2007 in response to NWB comments, superseding that submitted in 2006.
  - Licence issued, requiring revised *Waste Rock Management Plan* due April 2008.
  - Revised *Waste Rock Management Plan* submitted in 2010 along with a request for approval under Part G Item 17. Revision addressed rock placement on Pad I as planned, and requested use of Pads F&G for waste rock, use of clean waste rock for construction, and establishment of an approach to managing waste rock in a flexible manner (seek approvals of WROMP, not amendments to WL).
  - The ask for use of clean waste rock for construction triggered an amendment (Amendment 3).
  - *Waste Rock and Ore Management Plan* (SRK 2010) addresses waste rock on Pads I, F & G. This plan is referenced in the current licence.
  - *Waste Rock and Ore Management Plan* (SRK 2010) approved in 2012.
- 2AM-DOH1323 "approves the project as outlined in the August 2012 application". The Aug 2012 application states that the location has not changed, nor have any of the main components of the undertaking, nor have the quantity and quality of wastes deposited.
  - *Interim Water Management* (SRK 2012) approved in licence [Attachment 3]. This Plan identifies Pad T as:
    - Located within the contact water management area; and
    - To be constructed if the project moves to operations.

Attachment 1

MIRAMAR MINING CORPORATION

Preliminary Surface Infrastructure Design

Doris North Project, Hope Bay
Nunavut, Canada

Prepared for:

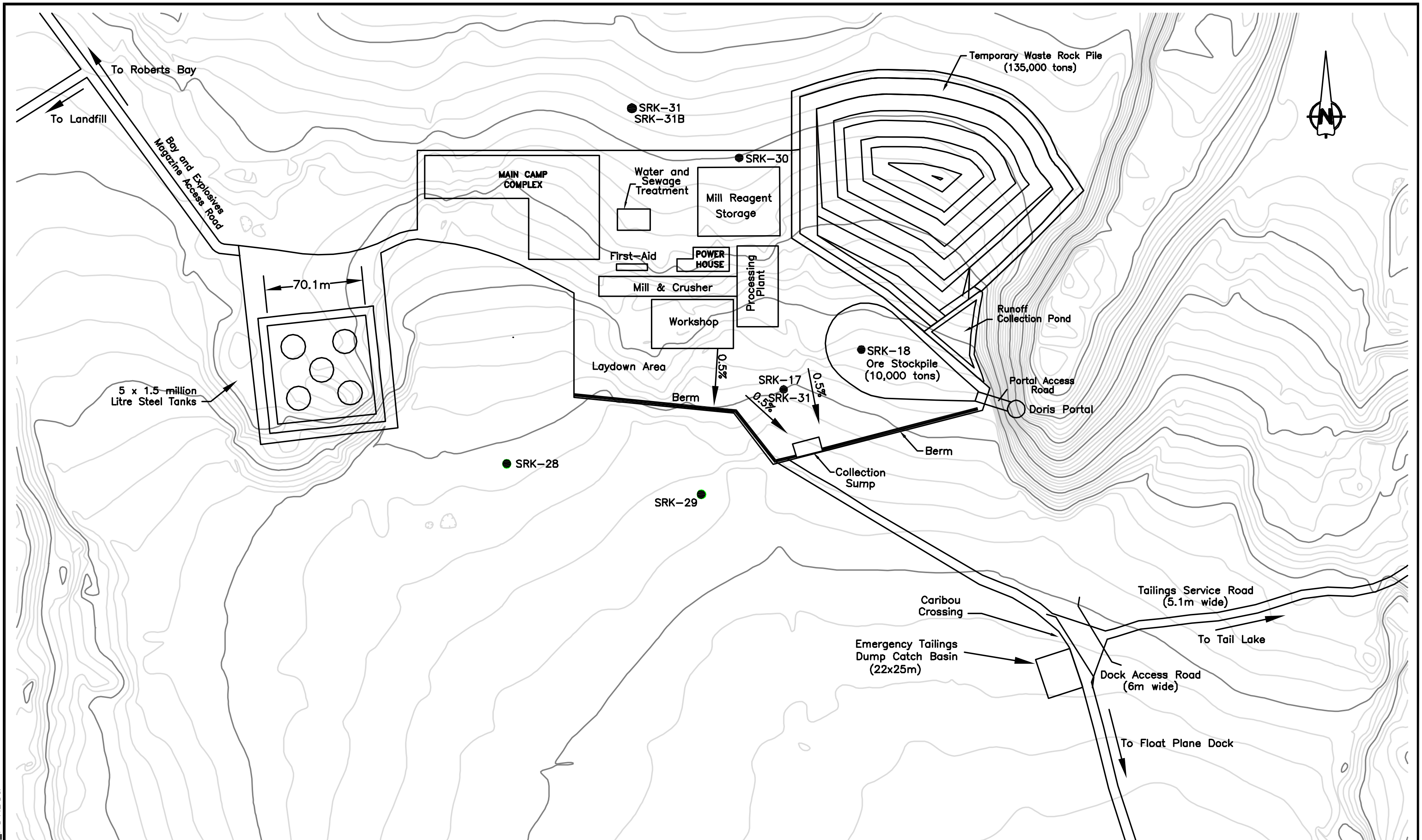
Miramar Hope Bay Limited
Suite 300, 889 Harbourside Drive
North Vancouver, BC
CANADA V7P 3S1

Prepared by:

SRK Consulting
Engineers and Scientists

Project No. 1CM014.006

October 2005



Dwg Ref: DETAIL-MILL-SITE_revised

0 20 40 60 80 100 metres
0 100 200 300 feet

Contour Interval = 1m
UTM Projection: NAD83 Zone 13

SRK Consulting
Engineers and Scientists

MIRAMAR HOPE BAY LIMITED

DORIS NORTH PROJECT
Preliminary Surface Infrastructure Design

Detailed Plan Layout of Mill/Camp

PROJECT NO.	DATE	APPROVED	FIGURE
1CM014.006	Sept 2005	EMR	5.6

Attachment 2

Miramar
MINING CORPORATION

Preliminary Mine Closure and Reclamation Plan
Doris North Project – Hope Bay Belt
Nunavut, Canada

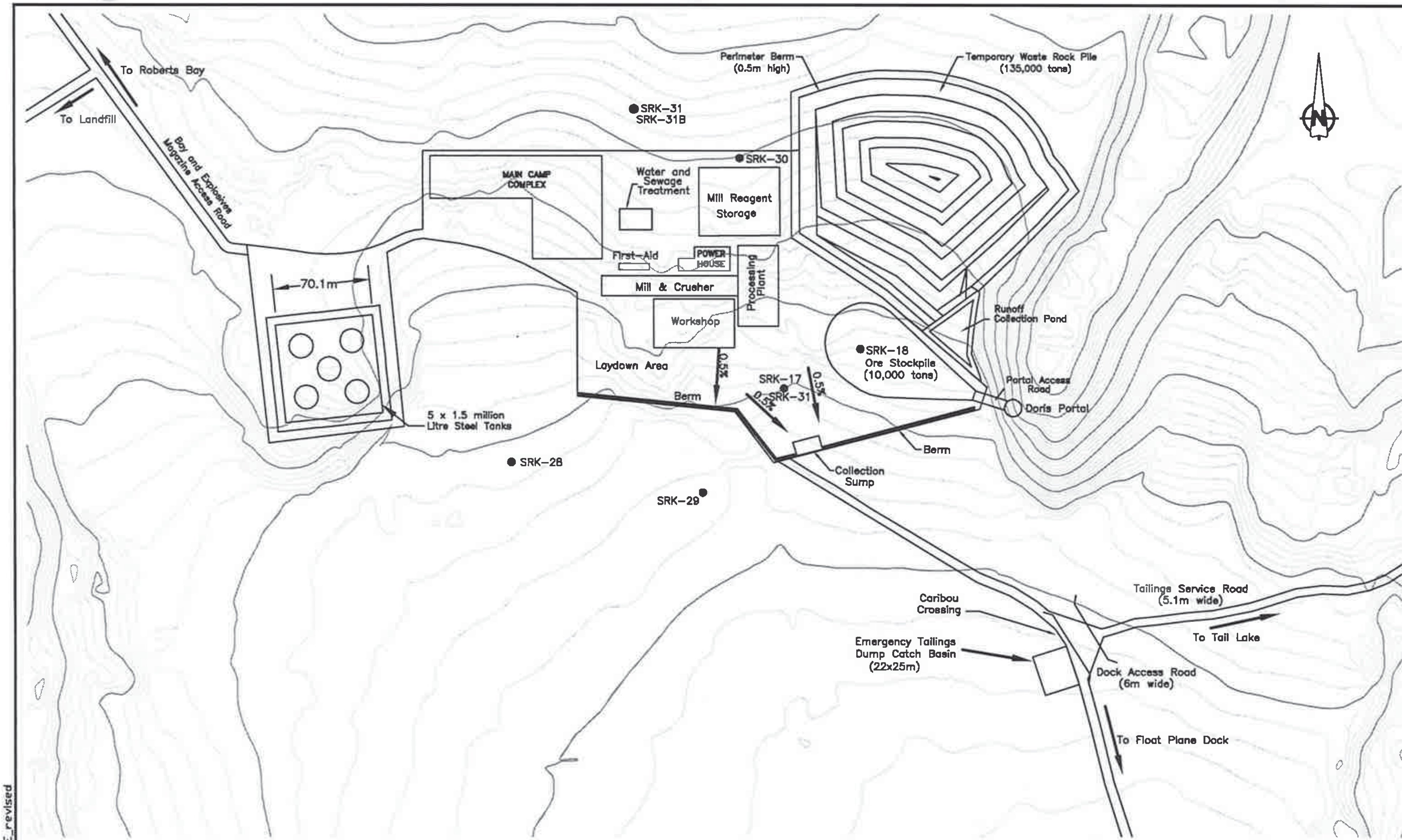
Prepared for:

Miramar Hope Bay Limited
889 Harbourside Drive
North Vancouver, BC
V7P 3S1

Prepared by:

AMEC Earth & Environmental,
a division of AMEC Americas Limited
2227 Douglas Road
Burnaby, BC
V5C 5A9

amec



Contour Interval = 1m
UTM Projection: NAD83 Zone 13

Dwg Ref: DETAIL-MILL-SITE_revised

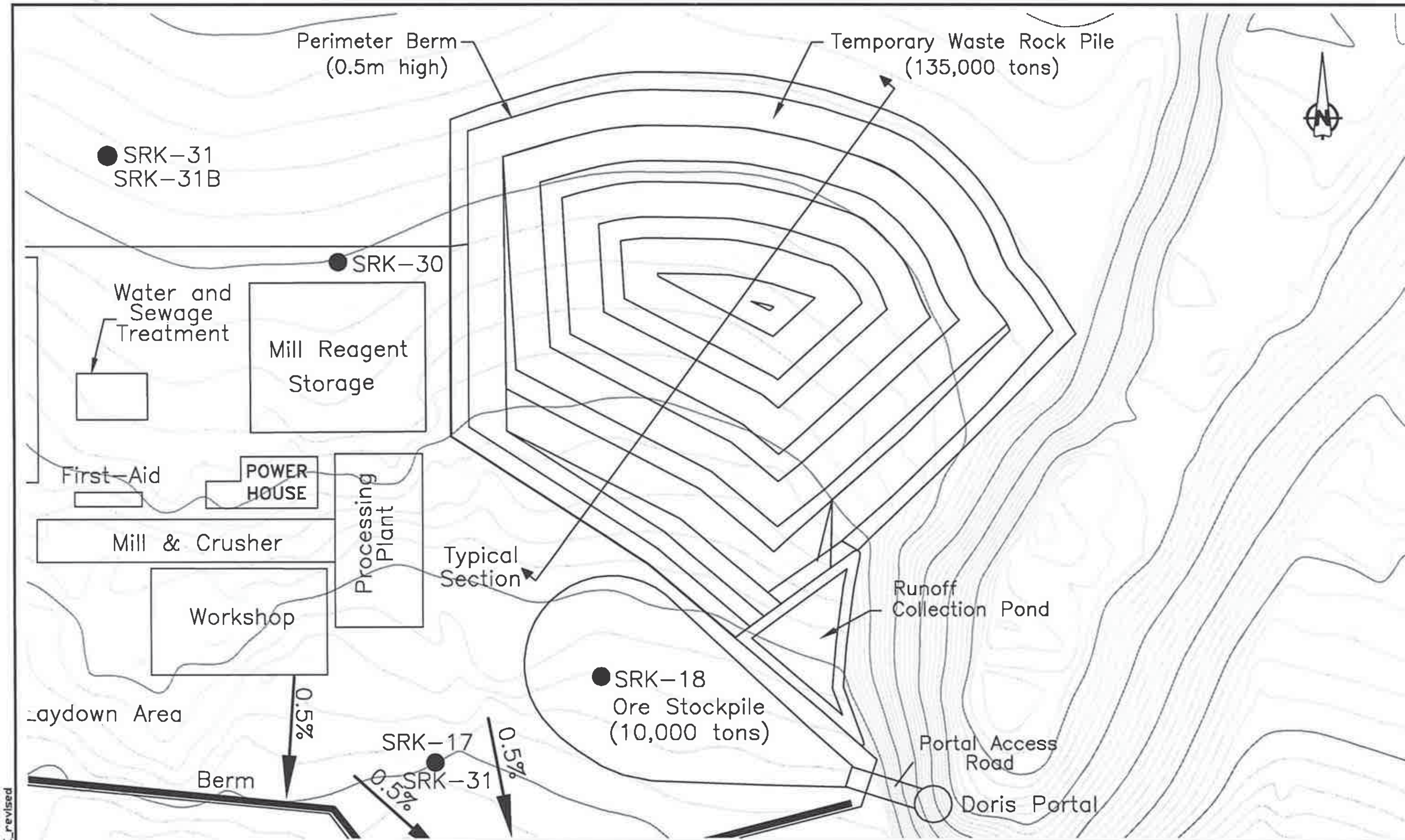
SRK Consulting
Engineers and Scientists

MIRAMAR HOPE BAY LIMITED

DORIS NORTH PROJECT
Preliminary Surface Infrastructure Design

Detailed Plan Layout of Mill/Camp

PROJECT NO.	DATE	APPROVED	FIGURE
1CM014.006	Sept 2005	EMR	4.3



Contour Interval = 1m
UTM Projection: NAD83 Zone 13

Dwg Ref: DETAIL-MILL-SITE_revised

SRK Consulting
Engineers and Scientists

MIRAMAR HOPE BAY LIMITED

DORIS NORTH PROJECT
Preliminary Surface Infrastructure Design

Plan Layout of Temporary Waste Rock Pile

PROJECT NO.	DATE	APPROVED	FIGURE
1CM014.006	Oct. 2005	EMR	4.6

Attachment 3

Doris North Project
Interim Water Management Plan

Revision 5

Report Prepared for

Hope Bay Mining Ltd.

Report Prepared by

srk consulting

SRK Consulting (Canada) Inc.
1CH008.069
December 2012
HBML Document Number: HB-WM-OPS-MP-001

2.5 Facilities

Mine and mine support facilities are built on pads below the Diversion Berm. These facilities are listed in Table 1 and are shown on Figure 2. Additional new facilities may be constructed, but these would not change the Plan.

The area below the Diversion Berm where these facilities are constructed can be divided further into two parts based on the type of material the runoff will encounter. Figure 1 shows these two areas downgradient of the Diversion Berm. The grading of individual camp pads was designed such that surface runoff from the pads is directed to either the Sedimentation Pond or the Pollution Control Pond.

Runoff and underflow from the eastern portion of the area below the Diversion Berm (Area 3 on Figure 1) is contact water as it may be affected by the waste rock or the brine mixing area for the underground mining operation.

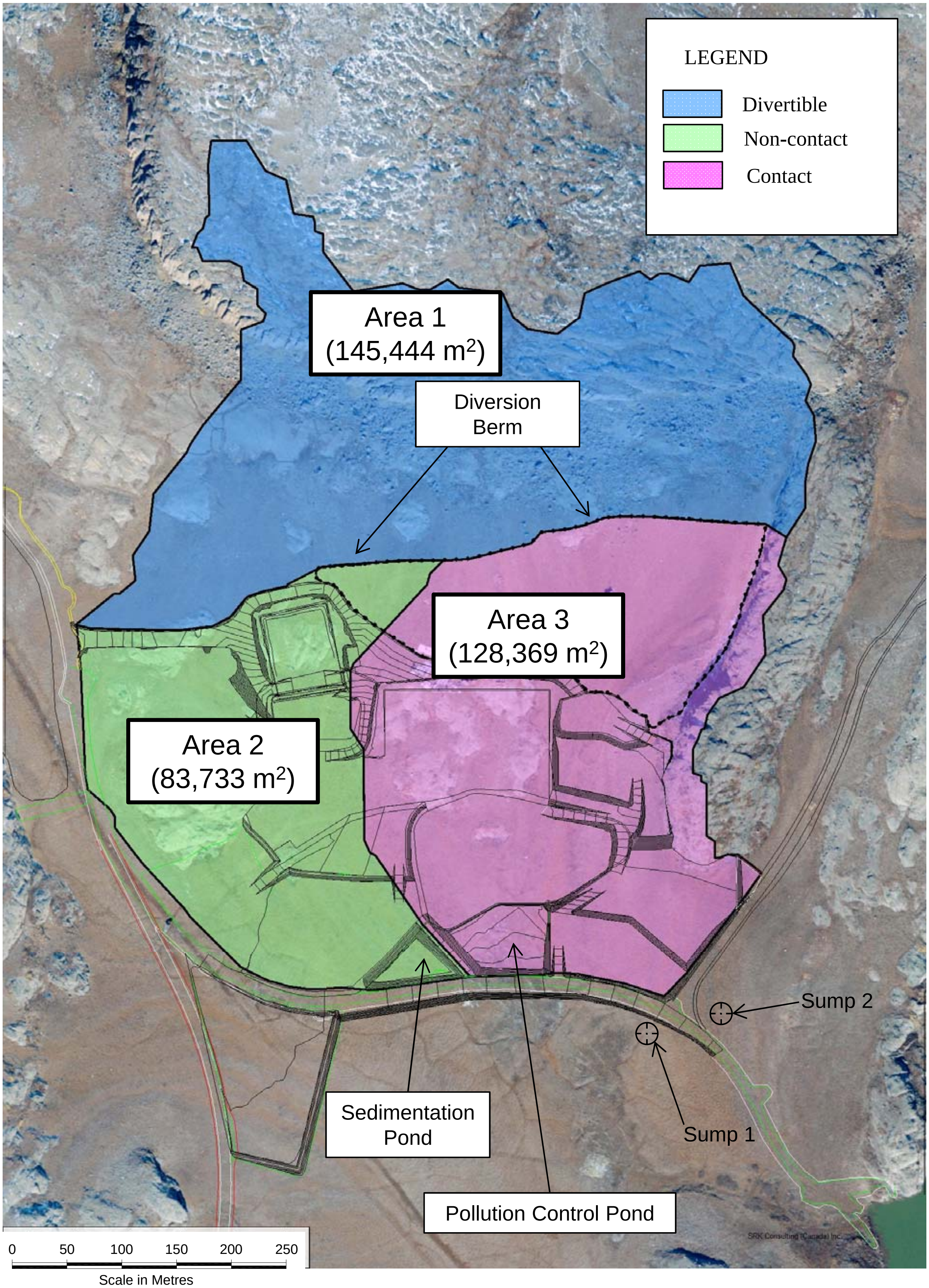
Runoff and underflow from the western portion of the area below the diversion berm (Area 2 on Figure 1) is non-contact water.

Table 1: Facilities within the Mine Area

Facilities in Area 2 (non-contact water)	Facilities in Area 3 (contact water)
Doris North Tank Farm (Pad R)	Mill Terrace (Pad D)
Lay Down Area (Pad B)	Ore Storage Pad (Pads Q, H/J)
Administrative Buildings/Dry (Pad C)	Waste Rock Storage (Pad I)
Warehouse/Laydown Area (Pad Y)	Waste Rock Storage (Pad F/G)
Lay Down Area (Pad E/P)	Pad T (to be constructed if the project moves to operations)
Main Camp (Pad X)	

Pad R (Fuel Storage Area) is enclosed by a containment berm that prevents water from flowing to the Sedimentation Pond or the Pollution Control Pond. Water contained within this berm is sampled and compared to the licence discharge criteria. If the water is impacted by hydrocarbons, the water will first be treated using an oil water separator, and if treatment does not result in compliant water quality, the water may be transferred to the Sedimentation Pond (Surge Pond) for transfer to Tail Lake.

\Hope.Bay\1CH008.033 Infras. Design Support Services 2011\210_Doris North Camp Water Management Structures\Water Management Post-mortem\Global Mapper



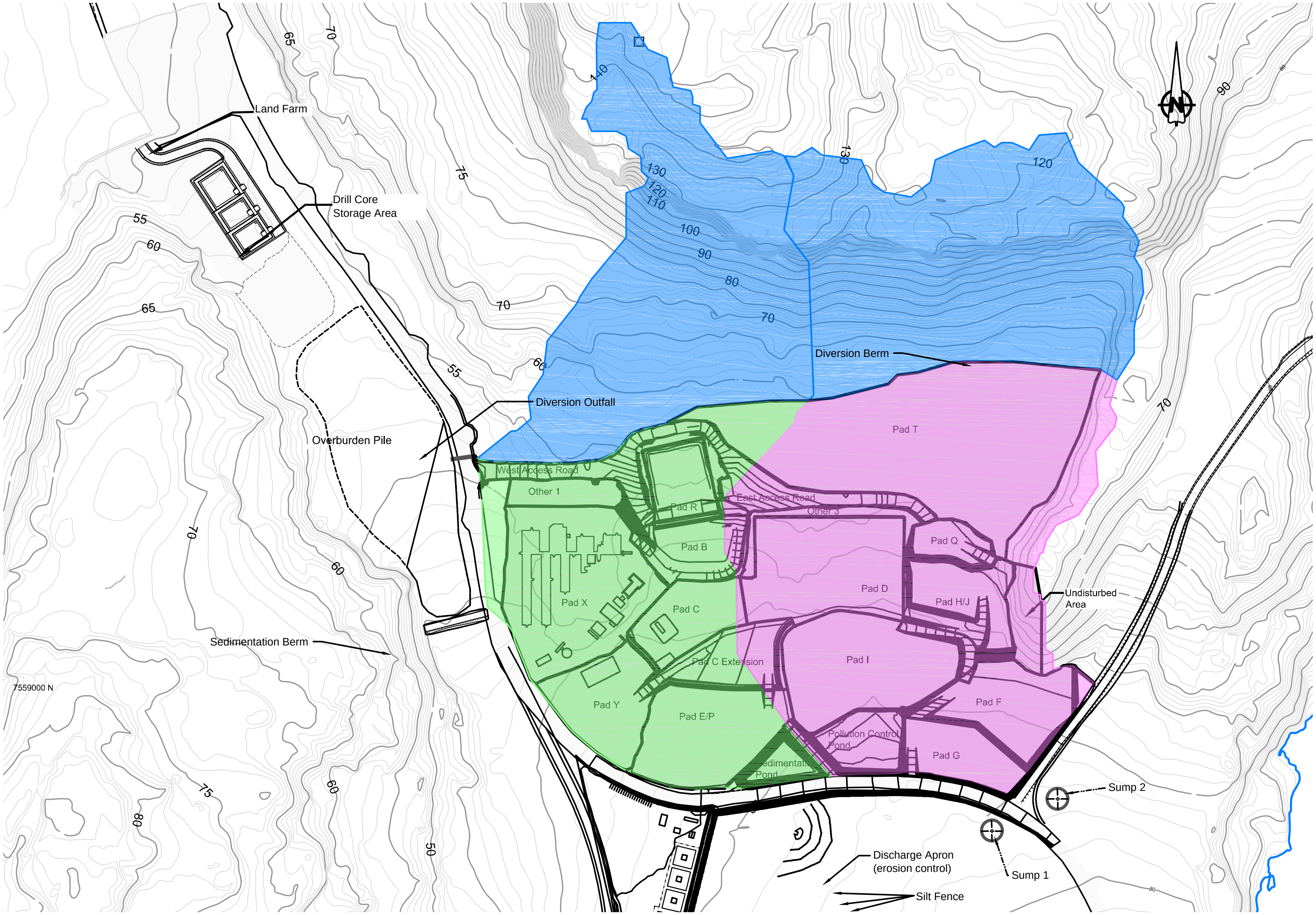
srk consulting

NEWMONT NORTH AMERICA

Doris North Camp

Water Management Areas

Job No: 1CH008.050 Filename:DorisNorth_WaterManagementFigure1…Rev10.pptx	HOPE BAY MINING LTD.	Date: Dec. 5, 2012	Approved: TS	Figure: **1**



0 20 40 60 80 100
Scale in Metres

srk consulting	NEWMONT NORTH AMERICA	Doris North Camp
		Doris North Mine Area and Land Farm
SRK JOB NO.: 1CH008.050	HOPE BAY MINING LTD.	DATE: Dec. 2011
FILE NAME: 1CH008.050-WMP_Figure2_wjm_IM_rev04.dwg		APPROVED: TS
		FIGURE: 2

Hope Bay Project
Doris North Waste Rock and Ore Management Plan – Revision 02

Prepared for

TMAC Resources Inc.

Prepared by

SRK Consulting (Canada) Inc.
1CT022.002.100
April 2015

Hope Bay Project
Doris North Waste Rock and Ore Management Plan – Revision 02

April 2015

Prepared for

TMAC Resources Inc.
Suite 1010 – 95 Wellington St. W.
Toronto, ON M5J 2N7
Canada

Tel: +1 416 628 0216
Web: www.tmacresources.com

Prepared by

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2
Canada

Tel: +1 604 681 4196
Web: www.srk.com

Project No: 1CT022.002.100

File Name: Doris_UGWasteRockManagmentPlan_Report_1CT022.002_kss_lw_20150424.doc

Table of Contents

1 Introduction ... 1

2 Background ... 2

2.1 Mine Development Plans ... 2

2.2 Surface Facilities ... 4

2.3 Ongoing Construction Requirements ... 5

2.4 Water Licence Terms and Conditions ... 5

2.5 Management Issues ... 6

2.5.1 ML/ARD Potential ... 6

2.5.2 Nutrient Release ... 12

2.5.3 Underground Brine Water ... 12

2.5.4 Fuel and Lubricants ... 13

2.5.5 Dust ... 13

2.5.6 Management of Additional Materials ... 13

2.5.7 Geotechnical Stability ... 13

3 Waste Rock Management ... 14

3.1 Pad T Construction ... 14

3.2 Stockpile Configuration and Construction Sequence ... 14

3.3 Waste Classification and Segregation ... 15

3.3.1 Overview ... 15

3.3.2 Classification Procedures ... 15

3.3.3 Confirmatory Sampling and Testing ... 16

3.3.4 Data Management and Evaluation ... 17

3.4 Procedures for Using Non-Mineralized Rock for Construction ... 18

3.5 Water Management ... 18

3.6 Management of Residual ANFO ... 20

3.7 Low Salt Underground Brine Water Use Procedure ... 20

3.8 Spill Prevention ... 21

3.9 Dust Management ... 21

4 Management of Ore Stockpiles ... 22

5 Inspections and Monitoring ... 23

5.1 Waste Rock Pile ... 23

5.1.1 Period of Waste Rock Deposition and Backfilling (Operations) ... 23

5.1.2 Period Following Backfilling ... 25

5.2 Ore Stockpile ... 25

5.3 Infrastructure Areas ... 25

5.3.1 Construction 25
5.3.2 Post-construction 25
6 Documentation and Reporting 28
7 Concordance with Water Licence 29
8 References 31

List of Tables

Table 1: Production Schedule 3
Table 2: Geochemical Classification and Management Recommendations for Proposed Waste Management Units 11
Table 3: Hope Bay Doris Waste Rock Monitoring Summary 27
Table 4: Concordance Table 29

List of Figures

Figure 1: Schematic of Underground Mine Workings (looking east) 2
Figure 2: Surface Facilities – Current Site Configuration 4
Figure 3: Surface Facilities – Planned Site Configuration 5
Figure 4: 3D View of Doris North Deposit and Mine Workings 7
Figure 5: Plan View of the Doris North Deposits with Locations of Static Test Samples 8
Figure 6: Water Management Areas 19
Figure 7: Ore Stockpile Configuration 22

List of Appendices

Appendix 1 – Summary of Static Testing

1 Introduction

This Hope Bay Project *Doris North Waste Rock and Ore Management Plan - Revision 02* (the Plan) has been prepared for TMAC Resources Inc. (TMAC) in accordance with Type A Water Licence No. 2AM-DOH1323, (the Water Licence), issued by the Nunavut Water Board in August 2013 (the Board).

The Plan is intended primarily for use by TMAC and its contractors to ensure that best practices for minimizing potential environmental impacts and liabilities associated with waste rock and ore storage are understood and managed, and that the conditions of the Water Licence are met.

This plan supersedes the 2010 Doris North Waste Rock and Ore Management Plan (SRK 2010a), which was prepared for Hope Bay Mining Ltd. (HBML). The only substantial change to the management plan is that TMAC would like to develop and use a new waste rock pad (Pad T) to store waste rock. The new location is expected to improve traffic flow and minimize re-handling requirements associated with using the existing waste rock storage location on Pads I, F and G. Areas of this document that have been materially revised to reflect the addition of Pad T or other minor changes have been highlighted with gray, to promote ease of review.

This new pad is within the original development area, and is located within the existing Pollution Containment System. TMAC is requesting Board approval to place waste rock on this new location through review and approval of this Plan. Other minor changes to this Plan include updated information from related management plans, updated production schedule (based on the current approved mine plan), updated geochemical information, addition of a low salt underground brine water procedure to reduce soluble salts in the waste rock pile, updated information on roles and responsibilities key to Plan execution and an updated concordance table to reflect the terms and conditions of the renewed Doris water licence, 2AM-DOH1323. Waste rock segregation and sampling procedures remain unchanged from that already approved by the NWB under the previous version of the Plan.

2 Background

2.1 Mine Development Plans

A schematic of the underground workings is shown in Figure 1. Access is provided via the Doris North Portal situated to the east of the mill area, an approximately 1,800 metre long decline tunnel, and then a series of tunnels, cross cuts and spiral ramps that provide access to the ore. The ore is extracted by both long-hole and cut and fill methods from a series of stopes that follow the gold-bearing quartz veins.

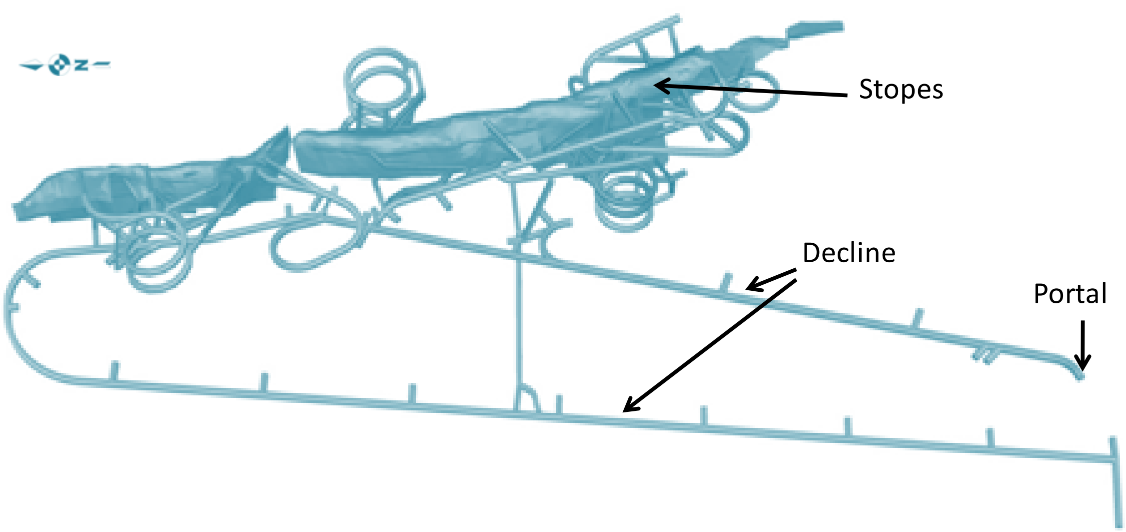


Figure 1: Schematic of Underground Mine Workings (looking east)

In 2010 and 2011, approximately 2,670 m of lateral and 76 m of vertical development were completed at the Doris North Mine by HBML. This development resulted in production of approximately 183,000 t of waste rock, including 86% non-mineralized and 14% mineralized waste rock. Additionally, 329 m of ore development occurred resulting in the production of 9,400 t of ore.

The current production schedule showing production rates for waste rock and ore, backfill rates for waste rock, and requirements for waste rock storage over time is provided in Table 1. As shown, the majority of the waste rock will be produced during the next two years of mining. Once the mill is operating, the rate of ore production and backfill rates will increase, and there will be relatively low volumes of new waste rock produced.

Prior to completion of the mill, approximately 25,000 to 30,000 t of ore will be produced and stored in a temporary stockpile. Once ore processing starts, the ore stockpile will be maintained at this size to smooth out variations in production.

The total waste rock production from the underground mine is approximately 506,000 t, most of which will need to be stored in a surface waste rock pad. There is also a need for additional storage space in case potentially acid generating (PAG) rock is encountered in any of the quarries. To address this requirement, a contingency for an additional 10% or 50,000 t of rock has been considered in the design of the waste rock pad. Overall, the waste rock pad has been designed to accommodate 556,000 t of waste rock and quarry rock.

Approximately 398,000 t of material will be required for backfill, including 368,000 t of waste rock and 30,000 t of detoxified tailings. Therefore, 188,000 t of waste rock will remain at the end of the mine life. Priority will be given to backfilling detoxified tailings, mineralized waste rock and any PAG quarry rock. As discussed in Section 2.5.1, the majority of the waste rock has been classified as having a low-risk for metal leaching/acid rock drainage (ML/ARD), and will be managed as non-mineralized rock. Therefore, it is expected that all of the waste rock remaining on surface at the end of the mine life will be non-mineralized.

As with any mine plan, these production volumes may change in response to changing conditions in the underground mine.

Table 1: Production Schedule

Year	**Waste Rock**		**Ore**		**Backfill**		**Waste Rock Storage Requirement at Closure**
	t	**cumulative t**	**t**	**cumulative t**	**t**	**cumulative t**	
Existing		183,000		9,400		0	183,000
Year 1	138,000	321,000	7,900	17,000	0	0	321,000
Year 2	178,000	499,000	34,000	51,000	0	0	499,000*
Year 3	7,200	506,000	472,000	523,000	320,000	320,000	186,000
Year 4	0	506,000	63,000	586,000	78,000	398,000	108,000
Totals		506,000		586,000		398,000	108,000
+10% contingency*		50,000					50,000
detoxified tailings**					(30,000)*	368,000	30,000
		556,000*				368,000	188,000**

Notes: * a 10% contingency is included for storage of any PAG material encountered during quarry operations.

** as described in Section 2.5.6 approximately 30,000 t detoxified tailings will need to be backfilled, which will displace some of the waste rock that can be used for backfill.

2.2 Surface Facilities

The site is currently divided into a series of adjoining rock pads that provide a foundation for all of the facilities in this area. The location of the permitted existing and planned surface facilities in the camp and mill area are shown in Figures 2 and 3. The pads on the eastern half of this area (Pads D, F, G, H/J, I, and Q) are located within the Pollution Containment System, which drains to a Pollution Collection Pond at the southern edge of the pad complex, and collection sumps located at the southeast corner of the pad area. Water collected at these locations is discharged to the tailings impoundment area (TIA).

The mill will be located on Pad D. Consistent with previous plans, Pads Q and H/J will be used to stockpile ore prior to milling. In previous designs, Pads I, F and G were designated as the Temporary Waste Rock Pad. TMAC is proposing to construct a new pad, Pad T, as shown in Figure 3, and to use this area as the Waste Rock Pad. The new location is expected to improve traffic flow and minimize re-handling requirements associated with storing waste rock on Pads I, F and G. No changes to any other waste management facilities are required. Further details on the design and sequencing of the Waste Rock Pad are provided in Section 3.

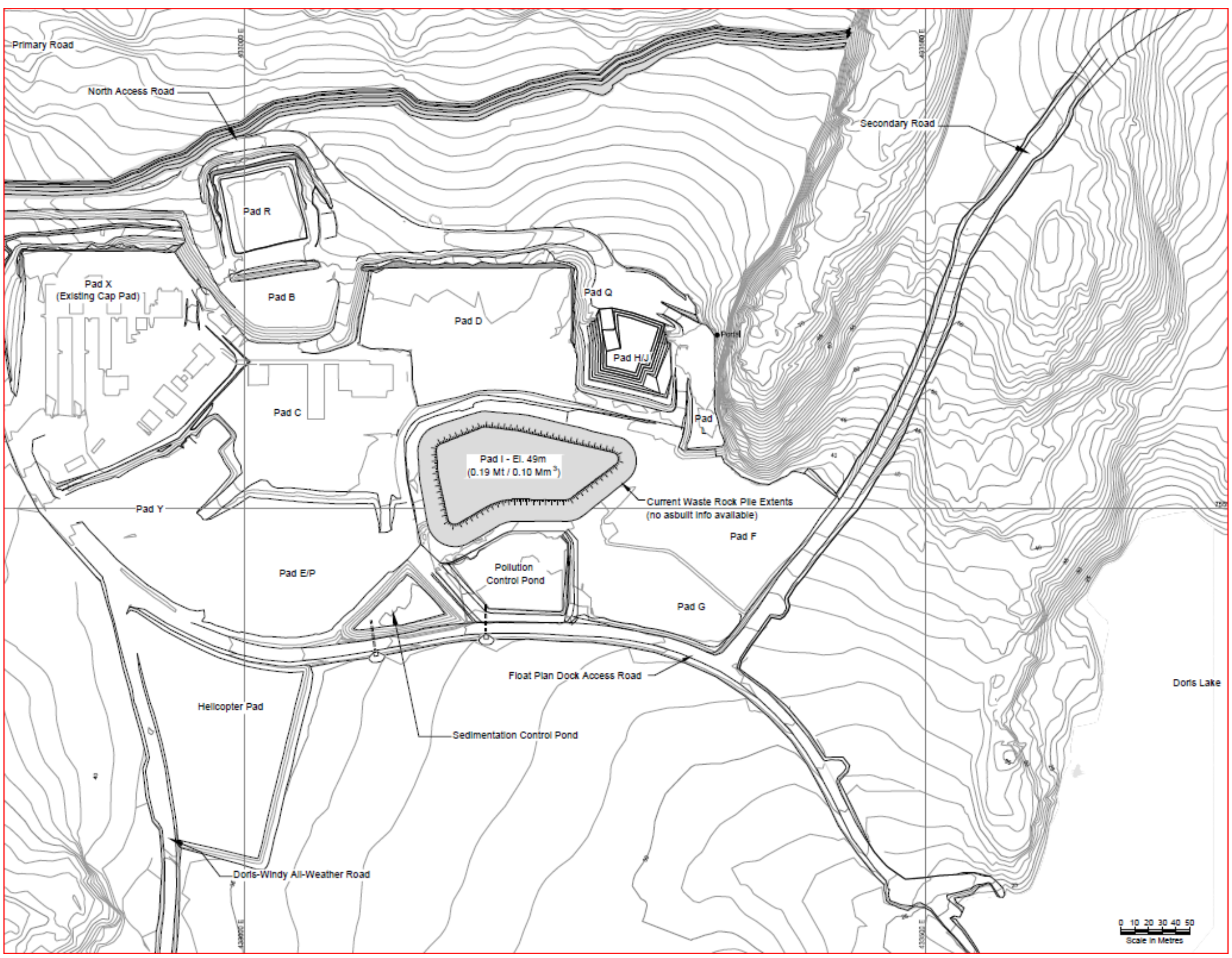


Figure 2: Surface Facilities – Current Site Configuration

Figure 3: Surface Facilities – Planned Site Configuration

2.3 Ongoing Construction Requirements

There is a possibility that ongoing construction activities could make use of non-mineralized waste rock from the underground mine workings. Use of excess non-mineralized waste rock from the underground mine for construction would offset the amount of quarry rock that would be required from surface quarries.

2.4 Water Licence Terms and Conditions

The Water Licence sets out a number of terms and conditions related to the management of waste rock at the Doris North mine, including:

- Part D Items 10, 22, 23 and 27;
- Part G Items 14, 15, 16, 17, 18, 19 and 20;
- Part J, Items 12d and e;

- Part K, Item 6;
- Part L, Items 6j; and
- Provisions in Schedule B and Schedule D.

All of these terms and conditions were considered in developing this Plan.

2.5 Management Issues

2.5.1 ML/ARD Potential

Geological Context

The Doris ore deposits consist of a series of gold-bearing quartz veins hosted by Archean age folded and metamorphosed mafic volcanic rocks. The main gold bearing veins form a tight anticline, with steeply dipping limbs that have a roughly north-south strike. The anticline plunges towards the north and south. At Doris North, the high-grade ore that is amenable to underground mining methods is located primarily in the hinge of the anticline. The quartz veins are surrounded by a narrow envelope of intense dolomite-sericite alteration.

The surrounding volcanic rocks have been broadly classified as iron- and magnesium-rich tholeiites. This suite of rocks includes basalt, “low NP basalt”, and mafic dykes with a range of textural and compositional variations. There is a large diabase intrusive located in the vicinity of the Doris deposits. This forms the prominent mesa above the camp, and then dips toward the east, crosscutting the deposit at a depth of approximately 150 metres. The diabase post-dates both the main phases of regional metamorphism and the mineralization associated with the gold deposits.

Figure 4 shows the location of the Doris North Mine workings relative to the diabase dyke and the ore veins. The portal is collared in the diabase.

Geochemical Characterization

There have been a number of studies characterizing the ML/ARD potential of rocks at Doris, including Rescan (1997), Rescan (2001), Knight Piesold (2001), Knight Piesold (2002), AMEC (2005), and SRK (2007). The findings of these studies were reported in the Environmental Impact Statement and in the Water Licence Application for the project submitted by Miramar Hope Bay Ltd. (MHBL). More recently, Newmont Metallurgical Services and SRK completed additional static and kinetic testing to provide improved spatial geochemical coverage of the deposit area and to obtain additional information required to support future development plans in this area (unpublished). Additionally, in accordance with previous versions of this Plan, geochemical monitoring was completed during the 2010/2011 underground mining activities (reported in SRK 2012a and submitted to NWB as part of annual reporting for Doris North). The results of these programs have been used as a basis for developing this updated Waste Rock Management Plan, and are briefly summarized here.

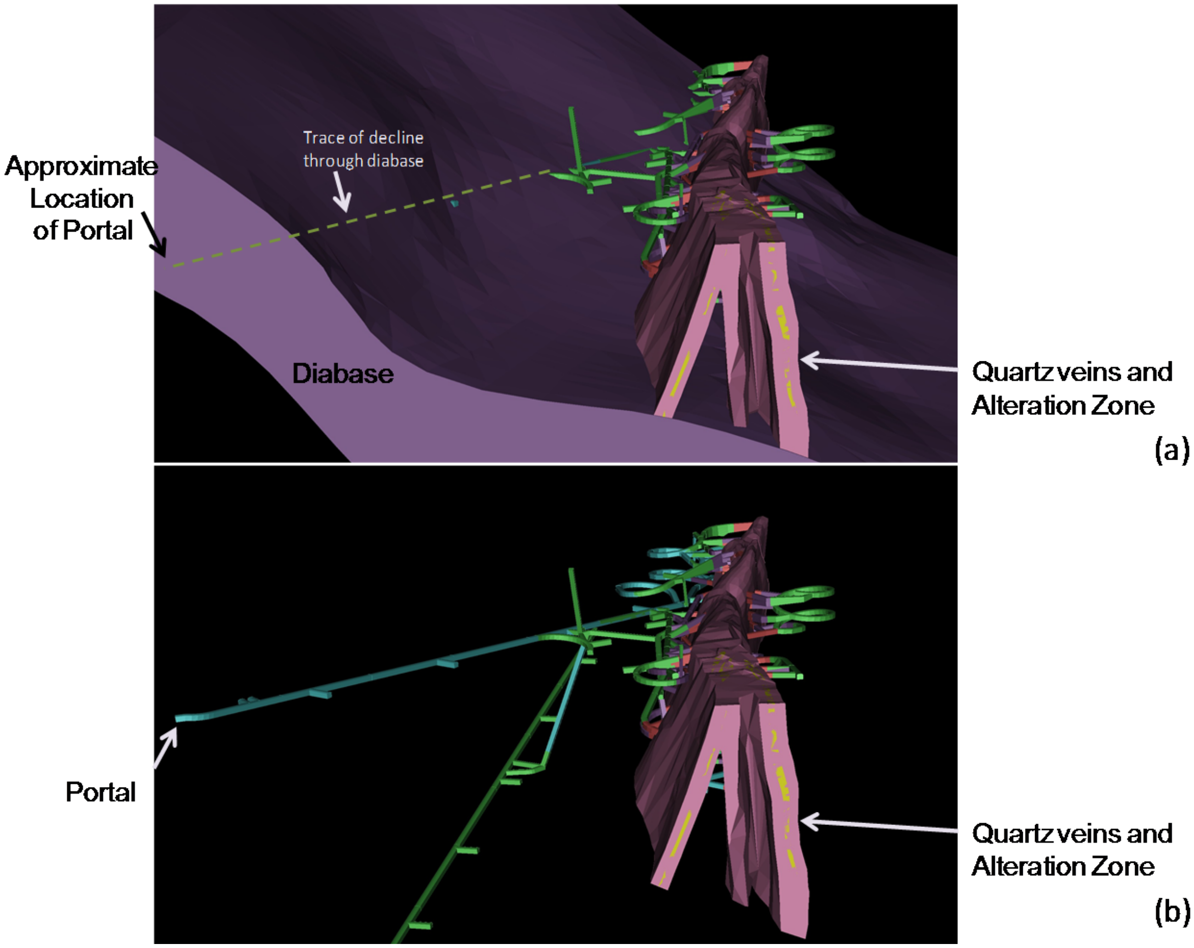


Figure 4: 3D View of Doris North Deposit and Mine Workings.

For clarity, the figure is shown a) with diabase solid, and b) without diabase solid (workings in diabase are shown in blue).

Static testing data representing pre-mine data for the immediate area of the Doris North mine workings includes acid base accounting (ABA) or net carbonate value (NCV)[1] testing on 308 samples, elemental analyses on 224 samples, and semi quantitative x-ray diffraction (XRD) analyses on 77 samples. The locations of these samples are shown in Figure 3. Kinetic tests results are available for 21 humidity cell and five barrel test samples from the Doris area.

[1] NCV tests are a type of ABA tests used by Newmont Metallurgical Services. Acid potential is quantified on the basis of sulphide sulphur, and NP is quantified using TIC.

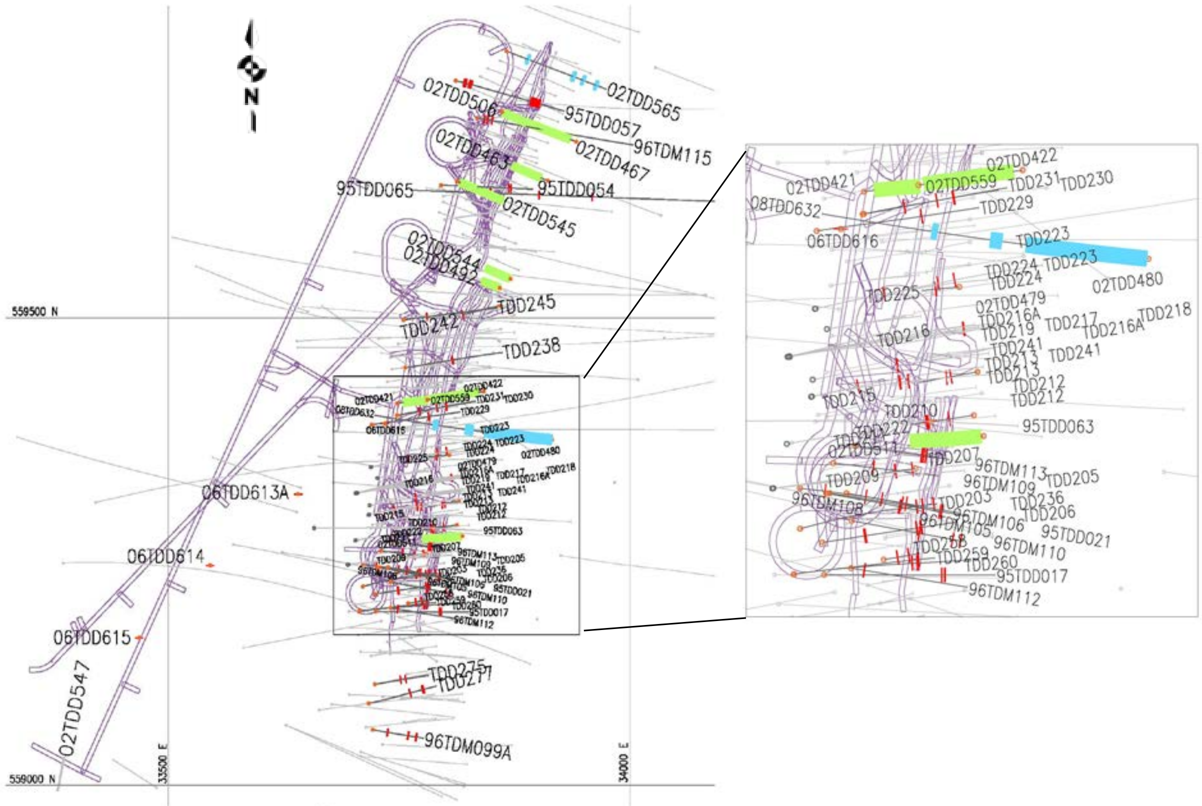


Figure 5: Plan View of the Doris North Deposits with Locations of Static Test Samples

Key findings of the testing programs completed to date are summarized as follows:

- The majority of the samples were classified as non-potentially acid generating (non-PAG) by both NP/AP and TIC/AP ratios[2]. Most of the samples classified as PAG or uncertain were classified as ore or as a mixture of ore and waste rock. Diabase and some of the "gabbro" (now re-classified as "low NP basalt") had low sulphide, NP and TIC content, and were classified as PAG or uncertain on the basis of low NP/TIC ratios, but contained such low concentrations of sulphide that buffering by silicate minerals is likely to be sufficient to maintain neutral pH conditions in these rocks.

- Ferroan dolomite is the most abundant carbonate mineral, and is a major component of most of the basalt samples. In contrast, carbonate minerals were absent in the diabase and "gabbro". Pyrite is the most abundant sulphide mineral, and is present in trace to minor amounts in most samples.

[2] NP = neutralization potential, AP = Acid Potential, TIC = total inorganic carbon, all expressed in units of $CaCO_3$ eq/tonne. These ratios are frequently used to classify the ARD potential of rock or tailings samples.

- Concentrations of arsenic, cadmium, antimony, and selenium were elevated in comparison to average crustal abundance, indicating some potential for leaching of these elements under neutral or alkaline pH conditions.
- Results of the kinetic tests demonstrated neutral pH conditions in all of the Doris samples.
- Depletion calculations based on release rates from the kinetic tests indicated that, with the exception of one of the quartz vein samples, it would be many decades to centuries before neutralization potential or sulphides would be depleted. All samples with NP/AP ratios above 3 were either predicted to remain neutral, or had extremely low sulphide oxidation rates.
- In general, both sulphate and arsenic loading rates measured in the kinetic tests were low in comparison to other sites in Canada and Internationally.

A geological block model was used to define and estimate quantities of proposed waste management units within the mine. These include basalt, diabase, a ten metre wide buffer zone around the alteration zone, the alteration zone, and the ore stopes, as presented in Table 2. In the previous version of the Plan, the basalt was further subdivided on the basis of geological logs into basalt and “gabbro”. The “gabbro” was considered to be a relatively minor unit within the metavolcanic suite of rocks, and was not modelled separately. New data from the waste rock monitoring programs (SRK 2012a) suggests that pre-mine samples identified as “gabbro” in the geological logs are actually part of the basalt unit, but that it has distinct physical and geochemical properties resulting from contact metamorphism (heat) from the diabase dyke. Notably, this material tends to have much lower TIC and NP in comparison to more typical basalt. This unit has now been re-classified as “low NP basalt”. As in the previous Plan (SRK 2010a), this unit was classified as having a moderate risk for ML/ARD, and will continue to be managed as mineralized waste on the basis that even minor amounts of sulphide could result in potentially acid generating material.

Key features of the waste rock management units are summarized in Table 2. A series of box and whisker plots showing the distribution of key ABA parameters in each of the units is provided in Appendix 1. The results show that the majority of the samples from all zones except the ore stopes can be classified as non-PAG on the basis of NP/AP ratios, but there is a slightly higher proportion of samples that could be classified as uncertain or PAG in the alteration zone. On the basis of TIC/AP ratios, the basalt, buffer zone and alteration zones showed similar high percentages of non-PAG material. However, the majority of the diabase and “low NP basalt” samples were classified as PAG or uncertain. In the case of diabase, the sulphide content was consistently below 0.1%, indicating that ARD is unlikely, and this material can be considered as having negligible risks from an ARD perspective. In the case of “low NP basalt”, there are enough samples with elevated sulphur that this material should be managed as mineralized waste.

The material from the stopes is classified as ore, and will be processed in the mill. This material tends to have a higher sulphide content and lower NP and TIC. A substantial proportion of the stope samples were classified as uncertain or PAG. However, there is sufficient NP present that the development of acidic conditions is unlikely to occur during the short time that this material will be stockpiled on surface.

Overall, these results indicate that all of the diabase, and large proportion of the basalt and buffer zone material, is non-acid generating and is not expected to result in any long-term ARD management issues. As such, it could be used for construction material, or stored in surface stockpiles indefinitely without ML/ARD issues. Any underground waste used in surface construction would be subject to the same long-term monitoring required for rock quarried on the surface expressly for construction as per Part D, Items 9, 20, 21 and 22, and Schedule D, Item 1f of the water licence. However, if the basalt and buffer material are to be used for construction, further confirmatory testing will be needed to ensure that the small amount of more mineralized material present can be effectively identified and segregated from the non-mineralized rock. Diabase requires minimal confirmation, but proper identification by a geologist is required, particularly in areas where the diabase solid in the block model is not well defined. Gabbro and alteration zone material should be managed as mineralized waste.

Detailed procedures for the classification, segregation and management of waste rock to prevent ML/ARD are provided in Sections 3.2, 3.3 and 3.4. Procedures for managing water associated with the waste rock and ore stockpiles are provided in Section 3.5.

Table 2: Geochemical Classification and Management Recommendations for Proposed Waste Management Units

Unit	Quantity (t)	Sample Set	Classification Based on NP/AP (% of samples)				Classification Based on TIC/AP (% of samples)				Notes	Management
			No. of Samples	non-PAG	uncertain	PAG	No. of Samples	non-PAG	uncertain	PAG		
Basalt	203,000	2011 2012	122 6	94% 67%	4% 33%	2% 0%	115 31	93% 52%	3% 39%	4% 10%	Descriptions for all uncertain and PAG samples noted elevated sulphides. Samples from monitoring were in close proximity to the diabase.	Low Risk: separate any high sulphide material.
Low-NP Basalt	a minor subunit within basalt*	2011 2012	46 8	89% 100%	9% 0%	4% 0%	39 35	15% 89%	23% 11%	62% 0%	Data set is biased toward the spatially clustered samples from 06TDD614.	Moderate Risk due to low NP: store in mineralized pile.
Diabase	143,000	2011 2012	34 8	100% 100%	0% 0%	0% 0%	34 17	15% 100%	62% 0%	24% 0%	Given the consistently low AP, should be managed as non-PAG.	Low Risk: confirm lithology then store in non-mineralized pile.
Buffer Zone	58,000	2011 2012	17 3	94% 100%	6% 0%	0% 0%	13 8	100% 75%	0% 25%	0% 0%	Most PAG or uncertain samples contained sulphide or were logged as quartz veins.	Low Risk: separate any high sulphide material.
Alteration Zone	102,000	2011 2012	56 1	79% 100%	18% 0%	4% 0%	39 4	79% 100%	15% 0%	5% 0%	Most PAG or uncertain samples contained sulphide or were logged as quartz veins.	Moderate Risk: store in mineralized pile.
Stopes	n/a**	2011 2012***	6	33%	17%	50%	6	33%	17%	50%	Most PAG or uncertain samples contained or were logged as quartz veins.	n/a: all material from the stopes will be processed.

Notes: * The low NP basalt (formerly gabbro) is not defined in the geological model but is considered a minor component of the zone defined as basalt
** all of the rock in the stopes is ore and will be processed.
*** ore is not part of monitoring program

2.5.2 Nutrient Release

The majority of the waste rock will be blasted using a bulk form of ammonium nitrate and fuel oil mixture to make the blasting product ANFO. From a blasting perspective, ANFO is only ideally suited for dry hole application. In the event that ANFO is inadvertently loaded into a wet blast hole, an incomplete detonation of the product may occur. Further, spills can occur during loading of the holes. In such instances residual ANFO in the waste rock and spilled ANFO would potentially be a source of soluble ammonia, nitrate and nitrite.

The residual ammonia, nitrate and nitrite in the waste rock are highly soluble, and they are flushed out of the rock during snowmelt and precipitation events, potentially resulting in short-term release of nutrients to water coming into contact with this material. All direct discharges to the environment associated with the waste rock must meet the licence discharge criteria for ammonia nitrogen ($NH4$) of 2 or 4 mg/L (as N) (for average monthly and grab samples respectively).

The approved Interim Water Management Plan (SRK 2012b) provides details of the site-wide water management plan, including plans for collection of any non-compliant seepage and runoff from the Pollution Containment System and discharge to the TIA. Key information from this plan is summarized in Section 3.5. Measures for minimizing the potential for nutrient release from blasting activities are discussed in Section 3.6.

2.5.3 Underground Brine Water

Water is used as a lubricant for drilling, as a means of cleaning off the face and walls for geological mapping, and for dust suppression in the underground mine. Calcium chloride salt is added to the make-up water to lower the freeze point and thereby keep the water supply lines from freezing. This water is called underground brine water. Any excess brine water that ends up at the mine face is pumped to a settling sump and is recycled for use at the face. However, some of the water is absorbed by the blasted rock which is hauled to the surface stockpiles.

Excessive use of salt and improper salt management can limit the use of waste rock for construction and pose problems for rock storage, such as impacts to the structural integrity of infrastructure components arising from ground thaw, increased or alternative requirements for wastewater treatment and disposal, increased challenges associated with waste rock and tailings disposal and stabilization, and limited volume of non-mineralised waste rock available for use as construction material. Accordingly, implementing salt management practices are key to ensure ongoing use of clean rock for construction on site.

As discussed previously, the Water Management Plan (SRK 2012b) provides details on the collection and fate of seepage and runoff from this area. A summary of these details is provided in Section 3.6. TMAC have also developed procedures for reducing the concentration and amount of brine that is used in the underground mine, as documented in the "Low Salt Underground Brine Water Use Procedure" (TMAC 2014). A summary of this procedure is presented in Section 3.7.

2.5.4 Fuel and Lubricants

Any fuel or lubricants spills, including leaks from mobile equipment, have the potential to become mixed with the waste rock, and therefore any water that is in contact with the waste rock once it has been placed in its ultimate storage location. Any discharges associated with the waste rock must meet the licence discharge criteria for oil and grease concentrations of 5 or 10 mg/L (for average monthly and grab samples, respectively), and “no visible sheen”. Therefore, prevention and management of spills is particularly important for ensuring that the waste rock can be used for construction activities outside of the pollution containment system.

The Spill Contingency Plan (SRK 2010b) provides detailed procedures for the prevention and clean-up of spills. These plans encompass all of the activities in the underground mine. A summary of the spill contingency plans is provided in Section 3.8.

2.5.5 Dust

Fugitive dust can arise from blasting, haul traffic and end dumping. Fugitive dust poses a potential risk to human and ecological health through both ingestion and deposition. Of particular importance is the potential risk posed by fibrous forms of actinolite, which have been found at a few locations in the Doris area.

The current Air Quality Management Plan (HBML 2012) outlines procedures for managing fugitive dust. Air quality monitoring is ongoing throughout site and is reported semi-annually to the NWB in an Air Quality Compliance Report. A summary of fugitive dust management procedures that are relevant to the waste rock is provided in Section 3.9 of this document.

2.5.6 Management of Additional Materials

As specified in Part D Item 10 of Water Licence, “*the Licensee shall tag any potentially acid generating rock identified through the Quarry Rock Construction Monitoring program for removal to the Temporary Waste Rock Pile, for ultimate disposal underground*”. Therefore, the Waste Rock Pad must also have sufficient capacity to accommodate any PAG rock from these areas. To date, none of the quarry monitoring programs or characterization data from the quarry sites has identified PAG rock. The contingency plan for storage of an extra 10% of the total volume expected from the underground mine should be adequate to handle future requirements from these areas. This has been considered in waste rock pad design and closure planning.

The milling operations are expected to produce approximately 30,000 t of detoxified tailings. As per Part G Item 27g of the Water Licence, this material will be used as backfill in the underground mine. Therefore, some of the space in the mine that is allocated for backfill must be reserved for the detoxified tailings.

2.5.7 Geotechnical Stability

The stability of the Waste Rock Pile is an important consideration traffic safety and for containment of the waste rock. An evaluation of stability is provided in SRK 2015b, and summarized in Section 3.2.

3 Waste Rock Management

3.1 Pad T Construction

Design details for Pad T and the associated waste rock stockpile are provided in SRK (2015a) and summarized herein. The pad will be constructed using a minimum of 1 m of quarry rock or non-mineralized waste rock. The pad will be constructed in accordance to SRK's Technical Specifications (SRK 2011), which include measures such as timing of construction, ground preparation methods, placement methods, and compaction requirements. 80,000 t (44,000 m^3) of quarry rock or non-mineralized diabase from the underground mine will be required to build Pad T.

3.2 Stockpile Configuration and Construction Sequence

The waste rock piles have been designed such that the foundation pad extends 2.5 to 3 m beyond the toe of the waste rock pile. The outer edge of the pads also has a safety berm that will prevent any large boulders from rolling off of the pad during construction. The waste rock piles have been designed with slopes of 2H:1V, and will be constructed in lifts, which will result in a configuration that provides a high degree of geotechnical stability. Stability calculations (SRK 2015b) confirm that there are no stability concerns. Notwithstanding, the results of these slope stability and bearing capacity analyses indicate a minimum safe distance from the crest of the waste rock pile of 1.2 m should be maintained for haul trucks dumping waste rock close to the crest of the waste rock pile. This minimum distance is based on a factor of safety of 1.0 and does not take into consideration any additional distance from the crest of the waste rock pile that should be maintained for operational safety.

All of the waste rock will be directed to Pad T. The waste rock will be placed by dumping on the pad using underground haul trucks, and the individual end dumped piles will be reworked once the pad level is full. A dozer will be used periodically to shape the waste rock piles to maintain stable angles, reduce overhangs and over steepened slopes, and to maintain a safe haul truck access ramp.

Mineralized waste rock will be placed on the eastern end of Pad T, while non-mineralized rock will be placed on the western end of Pad T. The procedures for classifying and segregating these materials are described in Sections 3.3 and 3.4. The spatial boundary between these materials will vary depending on the relative amounts of mineralized and non-mineralized waste rock. Where there is sufficient space, inter-layering of mineralized waste rock with non-mineralized waste rock will be avoided by building up a mineralized waste rock pile within the established mineralized waste rock area rather than advancing over the non-mineralized waste rock area (or vice-versa). The boundary between non-mineralized and mineralized waste rock will be surveyed after each lift has been completed.

Backfilling will be sequenced throughout the mine life, with priority given to detoxified tailings and then to mineralized waste rock. A total of approximately 368,000 t of waste rock and 30,000 t of detoxified tailings are expected to be backfilled in the mine, leaving up to 188,000 t of excess waste rock on surface). At closure, the final surface will be contoured and reclaimed in place, effectively creating a thicker pad at closure. As discussed in Section 2.5.1, the majority of the waste rock has been classified as having a low-risk for metal leaching/acid rock drainage (ML/ARD), and will be managed as non-mineralized rock. Therefore, it is expected that all of the waste rock remaining on surface at the end of the mine life will be non-mineralized.

3.3 Waste Classification and Segregation

3.3.1 Overview

The waste rock will be classified as "mineralized" or "non-mineralized" based on a combination of information from the geological block models and mine planning software, and geological inspections. These materials will then be segregated during mining, and directed to separate locations on the waste rock pile as described in Section 3.2. Confirmatory testing will be used to verify the accuracy of the classification and segregation methods, and pending the results of this testing, non-mineralized rock may be classified as suitable for use in construction. The Mine Geologist will be responsible for the classification and segregation of the rock, and executing the confirmatory sampling program.

3.3.2 Classification Procedures

As discussed in Section 2.5.1, rock within the alteration zone surrounding the ore deposit (approximately 102,000 t), and "low NP basalt" (a portion of the approximately 203,000 t of basalt), have a somewhat increased potential for ML/ARD, and will be managed as mineralized waste. The remainder of the basalt and buffer zone material (approximately 58,000 t) may contain small amounts of more mineralized waste, which will need to be identified and segregated from non-mineralized basalt during mining. Diabase (approximately 148,000 t) is expected to be uniform, with low sulphides, and will be managed as non-mineralized waste.

With the exception of "low NP basalt", each of these management units has been represented in the geological block model of the deposit area. The "low NP basalt" is not included in the geological model, but it is expected to occur in the vicinity of the diabase, and it can be readily identified by the site geologists. Using the block models and information obtained during inspection and mapping of the workings, the mine geologists will work with the mine planners to prepare mine plans that show the rock types likely to be encountered during each mining shift. They will also inspect the working face or muck pile to confirm the lithology and to identify mineralized zones within the basalt and buffer zone. The frequency of inspection will be at least once per day in the diabase, and will increase to at least once per shift when the mining is in basalt, "low NP basalt", or the buffer zone. Geological inspections are likely to be even more frequent when mining in the alteration zone. However, since this material will be managed as mineralized rock, daily inspections are considered sufficient for the purposes of this management plan.

The geological inspections will include a detailed examination of the working face or muck pile to identify the rock type, the quantity of sulphide minerals, quartz veining, carbonate mineralization, and the presence of fibrous minerals. If the visual inspections indicate that there is more than trace amounts (>0.5%) of disseminated sulphides or any sulphide veining, waste rock would be designated as mineralized, and would be directed to the appropriate location on the waste rock pad. If the rock does not contain an appreciable quantity of sulphides (i.e. more than trace amounts), it would be classified as non-mineralized and would be directed to the appropriate storage location as described in Section 3.2. The geologists will be instructed to classify the materials conservatively. If there are any doubts as the amount of sulphide mineralization, the rock will be designated as mineralized. The results of the geological inspections will be recorded in a daily log. This information will also be used to update the geological models.

In the unlikely event that fibrous minerals are identified, the rock would be flagged for special handling within the mineralized storage area. This material would be placed in a location where there is minimal traffic, and where the rock would not be exposed on the outer face of the pile. Dust suppressants would be used as an extra control for dust emissions, and the location would be surveyed such that it can be handled appropriately when it is excavated for backfill. Again, dust suppressants would be used as required to minimize any dust emissions.

The mine geologist will be responsible for tagging all waste rock with the intended waste designation, and instructing the mucking crew regarding waste placement on surface. The mucking crew will be instructed not to remove any waste that has not been clearly tagged. The mucking crew will be responsible for placing the waste rock in the intended location on the Waste Rock Pad, as described in Section 3.2. The mine engineer will record the number of truckloads of material sent to each of the waste stockpiles and will record this information in the daily record as per Part J Item 12d and e of the Water Licence.

3.3.3 Confirmatory Sampling and Testing

Confirmatory samples will be collected from within the mine, either from the blast hole drill cuttings or the blasted muck pile. The samples will be submitted to a commercial testing laboratory for full ABA (including total sulphur, sulphur speciation, inorganic carbon, and modified Sobek NP), or total sulphur and TIC only.

The confirmatory sampling will focus on the rock that is located in zones that have a low potential for ML/ARD. However, the mineralized units will also be sampled to determine the actual range of geochemical characteristics that will be present in the mineralized part of the waste pile. The sampling and testing frequency will be as follows:

- In the diabase, one sample for every 60 metres of mining (approximately 5,000 t of rock) will be collected and submitted for full ABA tests.
- In the basalt and buffer zone, samples will be collected at intervals of approximately one sample per 12 metres of mining (approximately 1,000 t of rock). A minimum of one in five samples will be submitted for full ABA tests. The other four samples will be submitted for total sulphur and TIC analyses only. Once the on-site testing laboratory is constructed, it will be used to complete the total sulphur and TIC analyses on these extra samples.
- Where encountered, “low NP basalt” will be sampled and submitted for full ABA tests at least once per 5,000 t of rock. However, since this unit is not expected to be spatially extensive, the frequency of sampling may be increased to capture spatially distinct

occurrences of the "low NP basalt" until its characteristics are more completely understood. These samples would be submitted for total sulphur and TIC analyses.

- In the alteration zone, there are relatively few long sections of tunnel; therefore, samples will be collected at intervals of approximately one sample per 5,000 t of rock. Efforts will be made to ensure that these are spatially distributed throughout the alteration area.

The samples will represent a random composite of material from the individual blast. Samples will be approximately 1 to 2 kg in size. The following information will be recorded at the time of sampling:

- Description of the sample location (blast cuttings or underground muck pile) ;
- Sample location (coordinates);
- The name of the person who collected the sample;
- Date and time of sampling;
- Geological description, including rock type, estimated sulphide and carbonate content; and
- Sample classification (mineralized or non-mineralized).

Three samples from the first six months of renewed mining activities, and then one in ten samples from the confirmatory testing (representing one sample per 50,000 t of rock will be subjected to a shake flask extraction test to assess the amount of soluble salt, nutrients and metals present in the rock.

3.3.4 Data Management and Evaluation

The results of the confirmatory testing program will be checked to ensure that they meet data quality objectives, and will be maintained in an on-site database. The results will be used to update the geological models and improve the predictive value of those models in defining ML/ARD potential in other nearby working areas.

The results will be reviewed on an annual basis by a geochemical specialist and will be included in the annual Waste Rock and Quarry Monitoring Report. After sufficient data has been collected to evaluate the effectiveness of the geological inspections in identifying rock that has an increased potential for ML/ARD potential, the frequency of sampling and testing will be re-evaluated. If any changes in the sampling frequency are warranted, justification for the change will be presented to the Board for consideration at least sixty days prior to implementation.

If any of the non-mineralized rock is used for construction, results representing accessible areas of non-mineralized rock will be reviewed on a more regular basis and used to delineate areas where the rock can be released for use in construction. A geochemical specialist will provide training and guidance during the initial assessments to ensure that the data is used in an appropriate manner.

3.4 Procedures for Using Non-Mineralized Rock for Construction

To use non-mineralized waste rock from the underground workings for construction, data from the confirmatory sampling will be reviewed to confirm whether the non-mineralized rock meet the criteria for use in construction. Additionally, further testing will be required to demonstrate that salt and ammonia levels are within acceptable limits.

The additional testing will include field contact tests and shake flask extraction tests to assess the amount of soluble salt, nutrients and metals present in the rock. Samples will be collected at a frequency of one sample composite for every 20,000 t of rock. The composites will be prepared by mixing a minimum of five 1 kg samples over an area of 100 m^2, and then sieving to recover the -1 cm size fraction. A 1 kg split of the -1 cm material will be submitted to a commercial testing laboratory for shake flask extraction tests. A portion of the remaining -1 cm material will be further sieved to recover the -2 mm fines, and the fines will be subjected to field contact tests.

The criteria for using non-mineralized diabase for construction will be as follows:

- Non-mineralized diabase would need to have sulphur contents of less than 0.2%.
- Non-mineralized basalt would need to have sulphur contents of less than 0.5% and TIC/AP and NP/AP ratios greater than 3.
- Ammonia and metal levels in the shake flask extraction tests would need to be below discharge criteria for the sedimentation pond, as specified in the water licence (Part G, item 23).
- Shake Flask Extraction tests would need to show chloride levels below 150 mg/L.

The site geologist would be responsible for delineating areas of the pile that have been adequately characterized and confirm that these criteria are met. The construction contractor will then be allowed to load and move the material to areas that have been approved for construction. The Mine Manager will be responsible for ensuring that the contractor stays within the bounds of the non-mineralized waste rock pile area designated for construction.

3.5 Water Management

Key elements of the water management plan include diversion of non-contact water around the mine site, seepage collection and discharge to the TIA.

The diversion berm has been constructed along the northern extent of the mine site (as illustrated in Figure 6), to divert non-contact water around the mine site.

By design, all seepage and runoff from the waste rock pile areas is directed to the Pollution Control Pond and sumps (Figure 6), and is managed according to the protocols outlined in the Doris North Project Interim Water Management Plan (SRK 2012b). The Pollution Control Pond is designed to contain all surface runoff and melt water from the Waste Rock Pad. The pond is designed for full containment of the 1:100 year storm event of 24-hour duration, plus an additional freeboard of 0.3 m. Containment is provided, to the full supply level of 35.3 m by an HDPE liner sandwiched between two geotextiles. The water that accumulates within the Pollution Control Pond is to be pumped to the tailings pump box within the mill so that it can be transferred to the TIA. The pond pumps are designed to completely empty the pond within six hours. No water is discharged onto the surrounding tundra unless it meets discharge criteria.

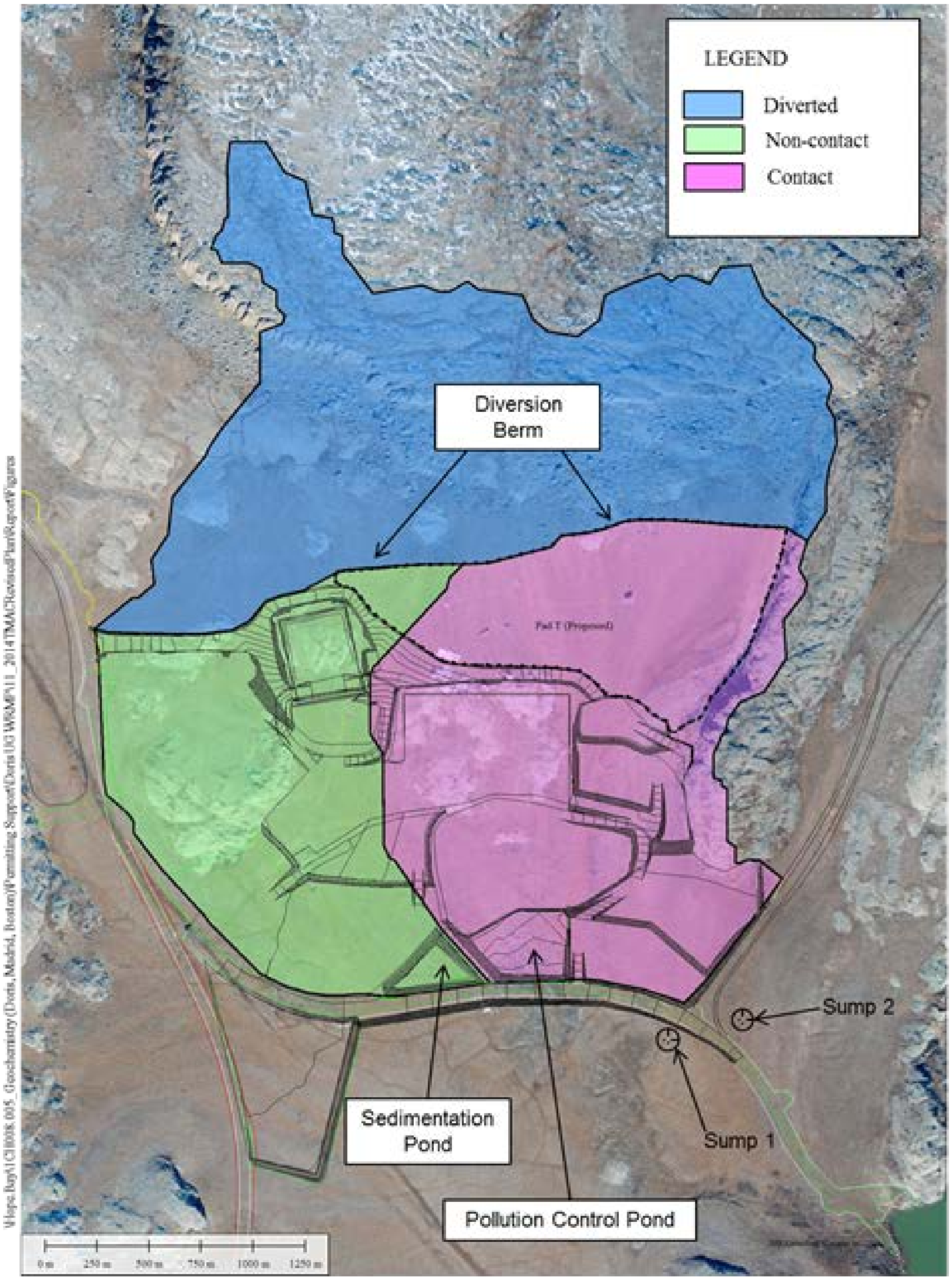


Figure 6: Water Management Areas

3.6 Management of Residual ANFO

As mentioned previously, incomplete detonation of explosives resulting from wet holes and spills are the two main issues contributing to residual ANFO and therefore nutrient leaching from the waste rock.

The potential for wet holes in the mine is considered to be low due to the land-based nature of the underground workings and the presence of permafrost. Any wet holes will be evident at the time of drilling and during the cleaning of each blast hole. The blaster is responsible for the loading and firing of the holes, and begins the loading process by checking the actual depth of each hole and will record unusual conditions, such as water in the blast-holes.

In the event that a wet hole is encountered, one of two charging methods will be employed to ensure complete detonation of the explosives:

- The hole is dewatered using compressed air.
- If the hole cannot be dewatered, or if it is seeping water, the hole will be loaded with an alternative explosive that is effective under wet conditions.

When using ANFO, the hole is loaded with a pneumatic loading device. A detonator is placed at the end of the hole, then the loader hose is pushed to the end of the hole and is slowly withdrawn as the ANFO is blown into the hole, thereby filling the hole. Once the end of the loading hose is near the top (collar) of the hole, the loader is stopped to prevent spillage of ANFO.

After blasting, the blaster is required by regulations to inspect the blasted area, make note of blast holes that may have experienced incomplete detonation, and mark those locations with paint. Information from the blaster’s inspection will be noted in the daily operations shift log and will be communicated to all underground supervision personnel.

Contingency - Identification of Un-detonated or High ANFO Residue Areas

Material considered un-detonated or high in ANFO residue, which will contain potentially elevated level of nutrients (primarily ammonia) will be hauled to the mineralized area of the waste rock pile, and will eventually be used as backfill in the mine.

Contingency - Spill of ANFO

In the unlikely event that a spill of ANFO occurs during charging of the blast holes, the ANFO will be cleaned-up immediately upon the completion of all loading operations. This material will be hauled to the mineralized area of the waste rock pile, and will eventually be used as backfill in the mine.

3.7 Low Salt Underground Brine Water Use Procedure

TMAC will follow the Low Salt Underground Brine Water Use Procedure developed to minimize the amount of calcium chloride use in the mine, and therefore minimize the amount of salt that is entrained in waste rock and ore. The procedure includes:

- locating brine mixing tanks in the mine or within an enclosure to control temperatures, and thereby limit the amount of salt used in the brine;
- use of hose nozzle atomizers and/or foggers to reduce the amount of water used for dust suppression; and
- recycling of brine water during drilling activities, bolt inflation, and washing activities.

3.8 Spill Prevention

If re-fuelling of mobile equipment is required in the mining or waste deposition areas, it will be conducted at a location and time that will ensure that any spill of fuel or lubricants will be effectively contained and clean-up can be easily accomplished.

Every operator is required to inspect their light or heavy equipment at the beginning of every shift. This inspection is designed to discover potential safety concerns as well as potential environmental risks such as oil, fuel and hydraulic fluid leaks. In the event that leaks are detected, the vehicle will be taken out of service and must be repaired prior to resuming use.

In accordance with the Spill Contingency Plan (SRK 2010b), all employees are trained as first responders to spills. During re-fuelling, all employees will have access to a Spill Kit suitable for the materials being handled. In addition, each vehicle is equipped with a 20 pound, fully charged, ABC fire extinguisher, as set out in the Hope Bay Health Safety and Loss Prevention Management system.

Contingency – Spill During Refuelling or Equipment Malfunction

In the unlikely event that a spill occurs during re-fuelling activities, clean-up of the spilled material will be initiated immediately and all activities within the immediate area will be suspended until the clean-up is complete and the material is disposed of in an appropriate manner, as per the requirements specified in the Spill Contingency Plan (SRK 2010b). Waste rock that has been contaminated with hydrocarbons will be placed in the area designated for storage of mineralized waste rock where it will be eventually used as backfill in the mine.

3.9 Dust Management

The current Air Quality Management Plan (HBML 2012) outlines the management procedures that will be used to control dust from the waste rock and ore stockpiles. These include:

- watering traffic surfaces and active end dumping areas;
- controlling vehicle speeds; and
- application of approved dust suppressants, such as EK35 or DL10 to high traffic areas.

Air quality monitoring is ongoing throughout site and is reported semi-annually to the NWB in an Air Quality Compliance Report.

4 Management of Ore Stockpiles

All of the ore extracted from the underground mine will be placed in a Temporary Ore Stockpile located on Pad Q. The ore stockpile will have a live storage capacity of approximately 25,000 t. The maximum configuration of this stockpile is shown in Figure 6.

All of the ore will be processed in the mill. Therefore, geochemical monitoring is not required. If any waste rock is inadvertently placed in the ore stockpile, it must be directed to the mineralized area of the waste rock storage area.

The ore stockpiles are located within the Pollution Containment System. Therefore, the water management procedures described in Section 3.5 will also address management of runoff from the ore stockpiles.

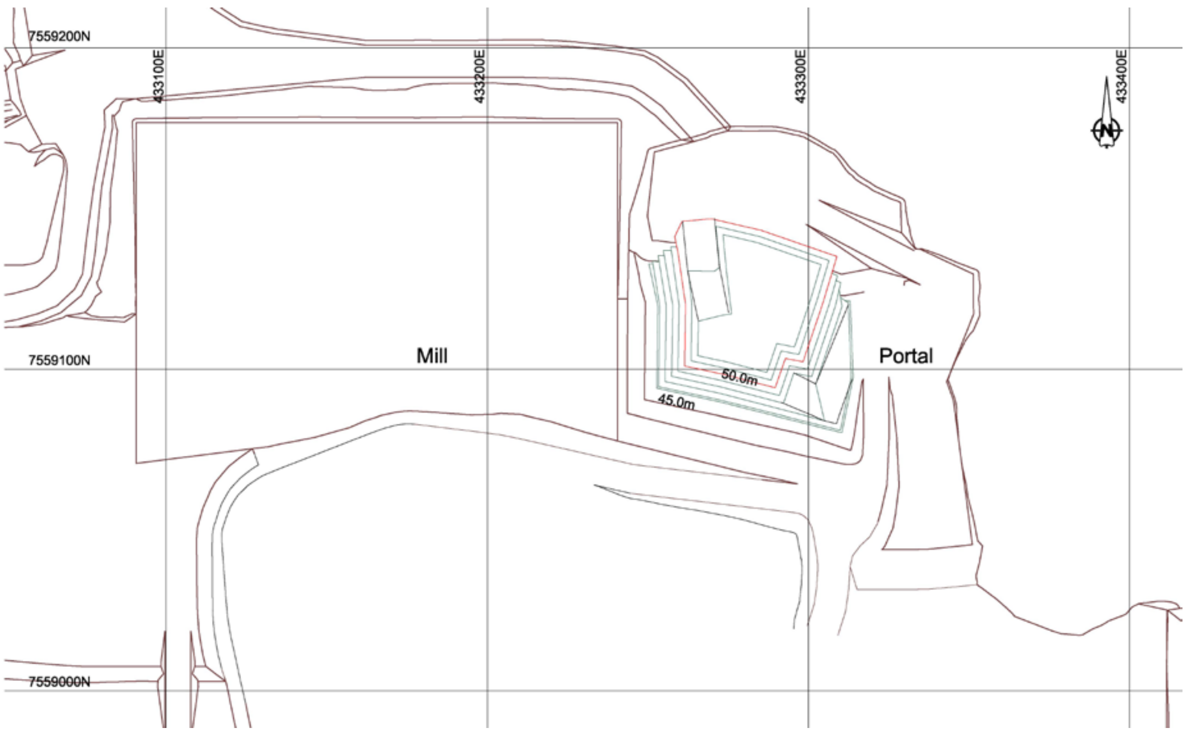


Figure 7: Ore Stockpile Configuration

5 Inspections and Monitoring

5.1 Waste Rock Pile

5.1.1 Period of Waste Rock Deposition and Backfilling (Operations)

The operational monitoring program will include routine visual inspections and sampling used to classify and segregate rock (Section 3.3), annual inspection of material in the waste rock piles and review of the routine monitoring program by a qualified geochemist, spring seep surveys, and routine monitoring of water quality in the Pollution Control Pond, described as follows:

Annual Inspections and Review

Material in the waste rock piles will be inspected by a qualified geochemist on an annual basis. The geochemist will establish a transect that crosses through an inactive area of the non-mineralized part of the pile. They will walk along this transect, examining the rock for rock types and rock with elevated sulphides that should not have been placed in this area of the pile, and noting the relative abundance of such material. The mineralized pile will also be examined for signs of sulphide oxidation and weathering. The results of this inspection will be discussed with the mine geologist to ensure there is clarity on the classification and segregation procedures. Additionally, if there are any areas deemed unacceptable for use in construction, these will be surveyed to ensure that they can be avoided during excavation. Results of the inspections will be provided in an annual waste rock and quarry monitoring report as per Schedule B, Item 3 of the Water Licence.

The geochemist will also review the results of the ongoing monitoring program described in Section 3.3 to evaluate the success of the segregation program for ensuring material in the non-mineralized pile is consistently meeting the target criteria for potential use in construction and to determine whether the sampling frequency is appropriate. The geochemist will provide feedback to the mine geologist on any aspects that could be improved.

Seep Surveys

Starting in 2011, spring seep surveys will be completed along all safely accessible areas along the down-gradient toe of the waste rock pile and below the Pollution Control Pond and access road. The surveys will be completed during the latter part of the spring freshet, and will be completed at the same time using the same general methods that have been established for the seep surveys completed in other infrastructure areas at the site. The objective of this program is to confirm that an environmentally-significant level of metal leaching is not occurring from the rock. The seep surveys will be completed annually during freshet for at least 2 years following the period of waste rock deposition and backfilling activities.

Seeps will be identified by walking along the down-gradient toe of the facility looking and listening for signs of flowing water. A survey stake will be installed to mark the location of each seep sampled and the following information will be recorded:

- Description of the seep location;

- GPS location of the seep;
- A photographic record of the seep;
- A description of the flow pattern and magnitude of flow; and
- Field pH, EC, ORP[3] and temperature readings.

Field pH, EC, ORP and temperature measurements will also be established at reference sites located in a similar geological, and physiographic setting, but away from the influence of the rock or other mine related activities. These reference stations will also be shared with the quarry monitoring program.

In the immediate area of the waste rock pile, water samples will be collected from all distinct seepage locations. Where there are clusters of seeps within 50 metres of each other, the one with the dominant flow will be sampled, appropriately preserved, labelled, and submitted to an accredited laboratory for analysis. The following information will be recorded:

- The name of the person who collected the sample;
- Date and time of sampling;
- Date of analysis;
- Name of person who completed the analysis;
- Analytical methods or techniques used;
- Results of the analyses, including pH, TDS, acidity and/or alkalinity, sulphate, total ammonia, nitrate, and a full suite of metals by ICP-MS4; and
- The results of the seep survey will be reported in an annual seepage and waste rock monitoring reporting submitted by March 31 of the year following the seep survey, as per Part D Item 22, and Schedule B Item 3 of the Water Licence.

Routine Water Quality Monitoring

A surveillance monitoring station ST-2 has been established to monitor discharges from the Pollution Control Pond. Water that accumulates within the pond will be sampled at a depth of approximately 0.25 metres on a monthly basis during periods of open water and will be sent for analyses of pH, TSS, total ammonia, total sulphate, total CN, total oil and grease, alkalinity, chloride, aluminum, arsenic, copper, iron, lead, nickel and zinc. The results will be reported to the Board under the Surveillance Network Program (SNP) contained within the Water Licence. TMAC Environmental and Social Responsibility (ESR) staff will use this data to calibrate and update the TIA water quality model.

---

[3] ORP = oxidation reduction potential, a measure of the redox of the water

[4] ICP-MS = inductively coupled plasma - mass spectrometry, a laboratory method used to measure low-level concentrations of elements in water.

5.1.2 Period Following Backfilling

Once backfilling is complete and the pile has reached its final configuration, there will be one final inspection of the pad area to ensure that all of the mineralized waste has been removed.

The spring seep surveys and routine monitoring of water quality in the Pollution Control Pond will continue for a minimum of two years following backfilling of the waste rock, following the methods established during operations.

5.2 Ore Stockpile

There are no specific monitoring requirements for the ore stockpile. The seepage and routine monitoring programs also address the monitoring of seepage and runoff from this area.

5.3 Infrastructure Areas

5.3.1 Construction

If any of the non-mineralized waste rock is used for construction, additional inspection and sampling will be completed in the areas where this rock is placed. The procedures will be the same as those established for infrastructure areas that have been constructed using quarry rock, and will include visual inspections, confirmatory sampling, and seep surveys.

During construction, the Mine Manager will be responsible for ensuring that any waste rock that has been removed from the non-mineralized area of the waste rock pile has been released for construction by the mine geologist prior to use. The Mine Manger will also be responsible for tracking the amount of waste rock that is extracted for use in construction, and the specific destination of that rock so that it can be tracked and monitored as part of the Quarry Management Plans (SRK 2010c).

5.3.2 Post-construction

Once construction is complete, and the infrastructure areas can be safely accessed, an inspection of any newly constructed areas will be conducted by a qualified geochemist to check the geochemical characteristics of the rock used in construction. The inspection will include collection of one sample per 10,000 t of rock. The samples will be collected from pre-determined locations that reflect the progression of construction over time. Where sufficient fines are present, the samples will consist of a whole sample (a randomly selected composite of rock particles from the local sample area), and a sample sieved to pass a 2 mm (10 mesh) screen. Where no fines are present, the samples will consist of a whole sample.

All of the samples will be submitted to an accredited external laboratory for total sulphur analysis. In the event that the sulphur concentration is greater than 0.1 %, the samples will be submitted for ABA analysis. Analyses will be completed on both the fines and the whole sample. Shake flask extraction tests will be completed on a representative subset of samples, at a frequency of one sample per 50,000 t of rock.

The following information will be recorded for each sample collected:

- Description of the sample point;
- GPS Coordinates of sample point;
- The source of the rock fill (i.e. the non-mineralized area of the pile or the quarry that the rock came from);
- The name of the person who collected the sample;
- Date and time of sampling;
- Date of analysis;
- Name of person who completed the analysis;
- Analytical methods or techniques used; and
- Results of analysis.

The results will be reported in the annual waste rock and quarry monitoring report.

Contingency - Inappropriate Construction Material Identified

In the unlikely event that the results of the seep monitoring program or the confirmatory sampling program indicate the presence of material with an elevated potential for ML/ARD, further investigations will be undertaken to define the extent and assess the potential impacts of the material. If warranted, and after discussion with the appropriate regulatory agencies, the material will be excavated and hauled to the waste rock pile for eventual disposal underground.

Table 3: Hope Bay Doris Waste Rock Monitoring Summary

Aspect	Monitoring Activity	Monitoring Type	Data Management & Reporting
Mining Operations, including Waste Rock Deposition and Backfill	Pre-blast inspection	Identify “wet holes” and clean spilled ANFO.	Maintain field notes.
	Post-blast inspection	Confirm there were no misfires.	Maintain field notes.
	Daily visual inspection of face and muck pile by field geologist	Confirm rock types, and mineralogical characteristics, classify the rock as mineralized or non-mineralized and tag for deposition as appropriate.	Maintain field notes. Report results in annual Waste Rock and Quarry Monitoring Report.
	Sampling of underground waste rock	ABA on a minimum of one sample per 5,000 t of rock, additional analysis of total sulphur and TIC in some rock units as per Section 3.3, shake flask extraction tests on one sample per 50,000 t of rock.	Maintain field notes. Manage data. Assess material for suitability in construction. Report findings in the Annual Waste Rock and Quarry Monitoring Report.
	Amount of material mined and placed in mineralized and non-mineralized areas of the pile, amount of material used for construction, and amount of material used for backfill	Material quantities (cubic metres and t).	Maintain record for annual reporting to the Board.
	Annual inspections and review of regular monitoring program	Visual inspections.	Maintain field notes. Discuss findings with site geologists. Report findings in Annual Waste Rock and Quarry Monitoring Report.
	Annual seep survey	Water samples submitted for pH, total sulphate, total ammonia, nitrate, alkalinity, and metals by ICP-MS.	Maintain field notes. Report findings in Annual Waste Rock and Quarry Monitoring Report.
	Monthly SNP monitoring of ST-2	Water samples submitted for pH, TSS, total ammonia, total sulphate, total CN, total oil and grease, alkalinity, chloride, aluminum, arsenic, copper, iron, lead, nickel and zinc.	Maintain field notes. Report findings in Annual Waste Rock and Quarry Monitoring Report.
Infrastructure Construction and Post-Construction	Amount of non-mineralized rock used for construction, and location of placement	Material quantities (t).	Maintain records for annual reporting to NWB.
	Geochemical inspections and sampling of infrastructure areas constructed using waste rock.	Sulphur analysis on a minimum of one sample per 10,000 t of non-mineralized rock. Full ABA tests on all samples with >0.1% sulphur. Shake flask extraction tests on one sample per 50,000 t of rock.	Maintain field notes. Report findings in Annual Waste Rock and Quarry Monitoring Report.
	Annual seep survey	Water samples submitted for pH, total sulphate, total ammonia, nitrate, alkalinity, and metals by ICP-MS.	Maintain field notes. Report findings in Annual Waste Rock and Quarry Monitoring Report.

6 Documentation and Reporting

All documentation related to waste rock classification, segregation, confirmatory sampling, material hauled from underground, and post-blast inspection records area maintained on site. Annual reporting required under the water licence will include reporting of mineralized and non-mineralized waste rock tonnages placed on the Waste Rock Pile in the annual Geochemical Monitoring and Waste Rock Storage Assessment.

TMAC will combine all other results from the inspections and monitoring programs related to waste rock and quarry rock in an annual “Waste Rock and Quarry Monitoring Report”. The monitoring report would be prepared and submitted no later than March 31 of the year following the monitoring activities, and would include all data collected prior to December 31 of the preceding year (i.e. within six months of the collection of samples, as prescribed in the Water Licence).

This brief factual report will address the requirements specified in the Water Licence (2AM-DOH1323) and Quarry Permit Agreement KT307Q010. The report will include, but not necessarily be limited to:

- A summary of the geochemical inspections;
- Results of the seep surveys;
- Results of geochemical sampling and analysis; and
- A summary of all mitigation activities undertaken as a result of monitoring.

The ESR department is responsible for compiling this report.

7 Concordance with Water Licence

Table 4 provides a concordance table to demonstrate where the applicable conditions of the Water Licence been incorporated into this management plan.

Table 4: Concordance Table

Licence Condition	Document Reference
Part D, Items 9, 20, 21	Section 5.3 addresses the rock and seepage monitoring that would be completed if the waste rock was used in construction.
Part D, Item 10	Section 2.5.6 addresses the requirement to provide contingency for storage of PAG rock from the quarries.
Part D, Items 22, 23,	Sections 3.3 and 3.4 provide information on how waste rock would be segregated and tested to confirm that non-mineralized rock from the underground mine would be non-PAG and therefore suitable for construction. The updated plan includes additional restrictions on the levels of soluble ammonia and chloride that would be acceptable in this material, but retains the limitations on sulphur content that were approved in an earlier version of the Plan (SRK 2010a). However, it is recognized that these additions may require further approval under the provisions in Part G, Item 15.
Part D, Item 27	Section 3.5 addresses management of water from the waste rock storage areas.
Part G, Item 14	This report addresses the requirement for an updated plan.
Part G, Item 15	60 days notification to the Board any changes to the sampling and testing or the criteria for using rock for construction.
Part G, Item 16	Sections 3.2 and 3.3 presents management plans for segregation of mineralized waste rock within Pad T. The Plan assumes that Pad T will be approved as the new Waste Rock Pad.
Part G, Item 17	Section 6 addresses the requirements to report the results of geochemical and seepage monitoring in an annual report.
Part G, Item 18, 19, 20	Section 3.3 addresses how mineralized and non-mineralized waste rock will be segregated, while Section 3.2 addresses separate storage of these materials.
Part J, Items 12d and e	Section 3.3.2 addresses the requirement to record quantities of mineralized and non-mineralized waste rock deposited in the piles, and quantities of backfill returned to the mine.
Part K, Item 6	Section 5.1.1 addresses the plans to confirm the absence of seepage below the Pollution Control Pond.
Part L, Item 6j	Section 3.2 addresses the requirement to backfill mineralized waste rock unless otherwise approved by the Board in writing.
Schedule B, Item 3c	Section 3.3.2 addresses the requirement to record quantities of mineralized and non-mineralized waste rock deposited in the piles, and quantities of backfill returned to the mine.
Schedule D, Items 1f, 1k and 1n	Section 6 addresses the requirements to report the results of geochemical and seepage monitoring in an annual report.

This report, Hope Bay Project Doris North Waste Rock and Ore Management Plan – Revision 02, was prepared by SRK Consulting (Canada) Inc.

ORIGINAL SIGNED BY

Kelly Sexsmith, PGeo
Principal Consultant (Geochemistry)

and reviewed by

ORIGINAL SIGNED BY

Lowell Wade, PGeo
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.

8 References

AMEC, 2005. ARD and Metal Leaching Characterization Studies in 2003 – 2005, Doris North Project, Nunavut, Canada. Report prepared for Miramar Hope Bay Ltd. by AMEC Earth & Environmental (Burnaby), October 2005.

Knight Piésold, 2001. Preliminary ARD and Metal Leaching Assessment for the Doris and Naartok Mineralized Zones, The Hope Bay Project (Ref. No. 11843/3-1). Prepared for Hope Bay Joint Venture by Knight Piésold, November 2001.

Knight Piésold, 2002. Hope Bay Project – Integrated ARD Characterization Report, Vol 1 and 2 (Ref. No. VA101-00007/1-1). Prepared for Hope Bay Joint Venture by Knight Piésold, June 2002.

Hope Bay Mining Ltd., 2012. Air Quality Management Plan (Revision 2). Report prepared for the Nunavut Impact Review Board. Report Number: HB-AT-ENV-MP-001. October 2012.

Rescan, 1997. Environmental Baseline Studies Report 1996, Hope Bay Belt Project. Report prepared for BHP World Minerals (San Francisco, CA) by Rescan Environmental Services Ltd., February 1997.

Rescan, 2001. 2000 Supplemental Environmental Baseline Data Report, Hope Bay Belt Project, Nunavut, Canada. Report prepared for Hope Bay Joint Venture by Rescan Environmental Services, March 2001.

SRK Consulting (Canada) Inc., 2007. Geochemical Characterization of Portal Development Rock, Doris North Project, Hope Bay, Nunavut, Canada (Revised March 2007). In Supporting Document S8 Supplemental to Revised Water Licence Application Support Document, Doris North Project, Nunavut, Canada. Prepared by Miramar Hope Bay Ltd. for Nunavut Water Board, April 2007.

SRK Consulting (Canada) Inc., 2010a. Hope Bay Project Doris North Waste Rock and Ore Management Plan. Prepared for Hope Bay Mining Ltd. December 2010.

SRK Consulting (Canada) Inc., 2010b. Spill Contingency Plan, Hope Bay, Nunavut Canada. Prepared for Hope Bay Mining Ltd. January 2010.

SRK Consulting (Canada) Inc., 2010c. Hope Bay Project - Quarry A, B & D Management and Monitoring Plan – Revision 01. Prepared for Hope Bay Mining Ltd.., October 2010.

SRK Consulting (Canada) Inc., 2011. Technical Specifications Earthworks and Geotechnical Engineering. Hope Bay Project, Nunavut, Canada. Revision G – Issued for Construction. Report Prepared for Hope Bay Mining Ltd. Project Number: 1CH008.027. March 2011.

SRK Consulting (Canada) Inc., 2012a. Geochemical Monitoring of Waste Rock from the Underground Decline. Prepared for Hope Bay Mining Ltd. March 29, 2012.

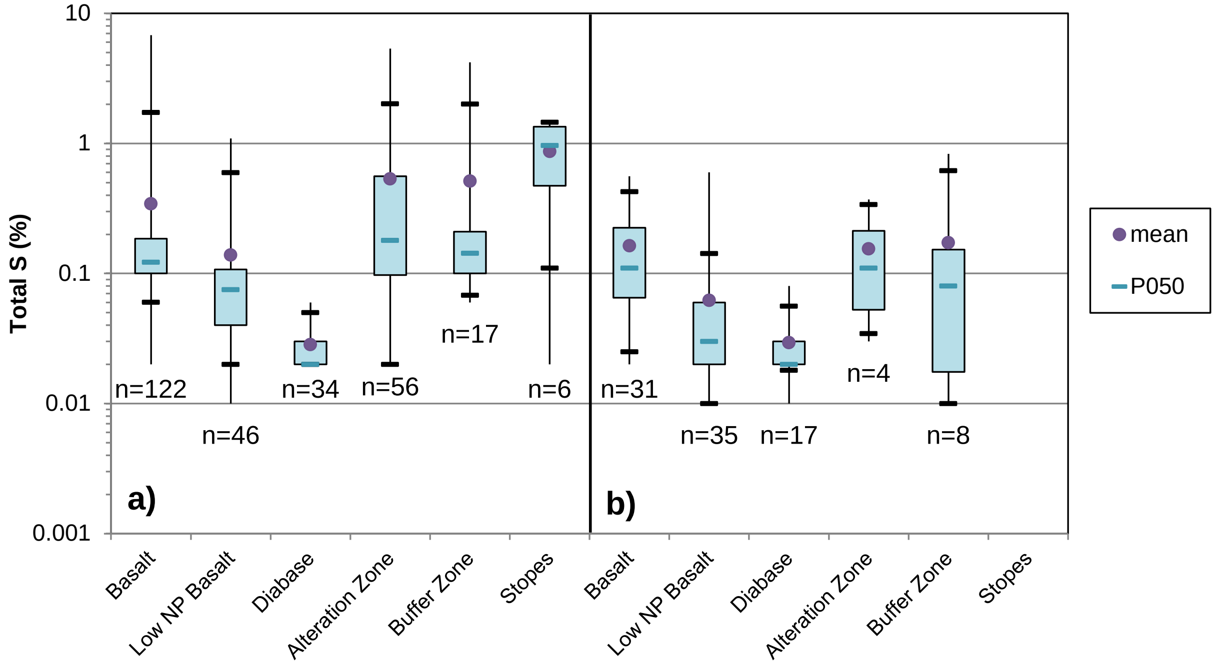
SRK Consulting (Canada) Inc., 2012b. Doris North Project Interim Water Management Plan. Revision 5. Prepared for Hope Bay Mining Ltd.. December 2012.

SRK Consulting (Canada) Inc., 2015a. Doris North Project: Expanded Waste Rock Storage Pile (Pad T) Design Brief. Technical Memorandum Prepared for TMAC Resources Ltd. Project Number: 1CT022.001.310. January 2015.

SRK Consulting (Canada) Inc., 2015b. Doris North Project: Expanded Waste Rock Storage Pile (Pad T) Stability Analysis. Technical Memorandum Prepared for TMAC Resources Ltd. Project Number: 1CT022.001.310. January 2015.

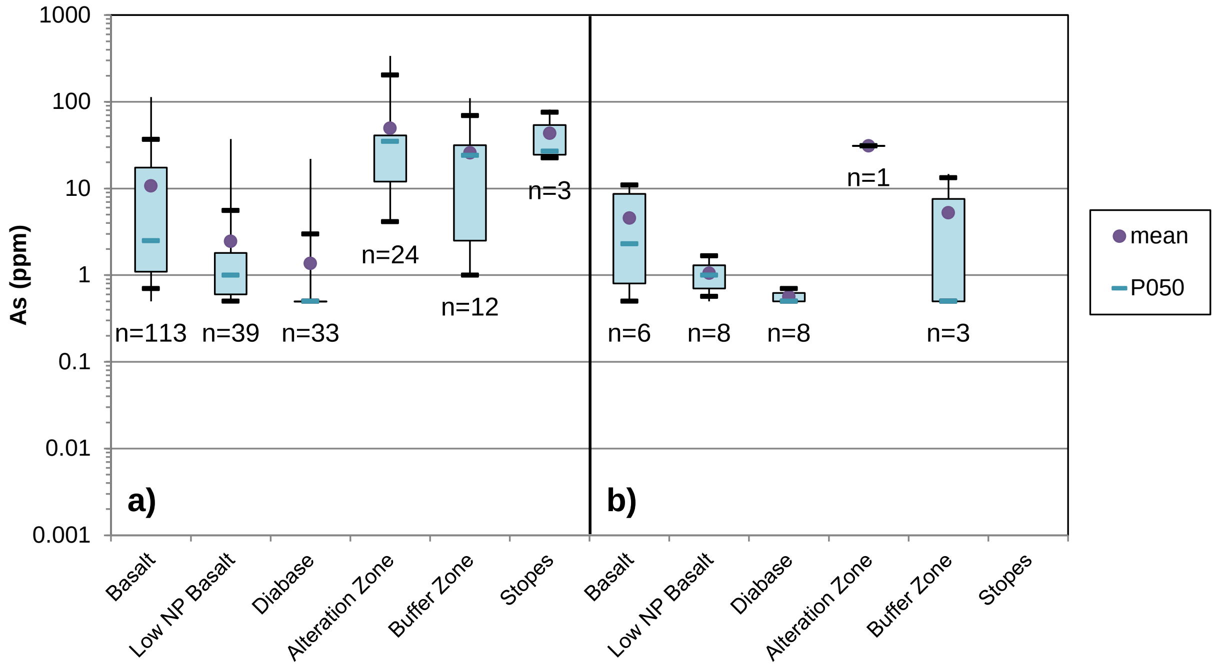
TMAC Resources Inc., 2014. Low Salt Brine Water Use Procedure. Version 001, Nov 5, 2014.

Appendix 1: Summary of Static Testing



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\Permitting Support\Doris UG WRMP\11_2014TMACRevisedPlan\3. Working files\[HBMASTERGeochemical_Rev29_2011DorisABA_Rev04_2014WRMP_Rev02.xlsx]

Figure A.1: Statistical Distribution of Total Sulphur a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\Permitting Support\Doris UG WRMP\11_2014TMACRevisedPlan\3. Working files\[HBMASTERGeochemical_Rev29_2011DorisABA_Rev04_2014WRMP_Rev02.xlsx]

Figure A2: Statistical Distribution of Arsenic a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)

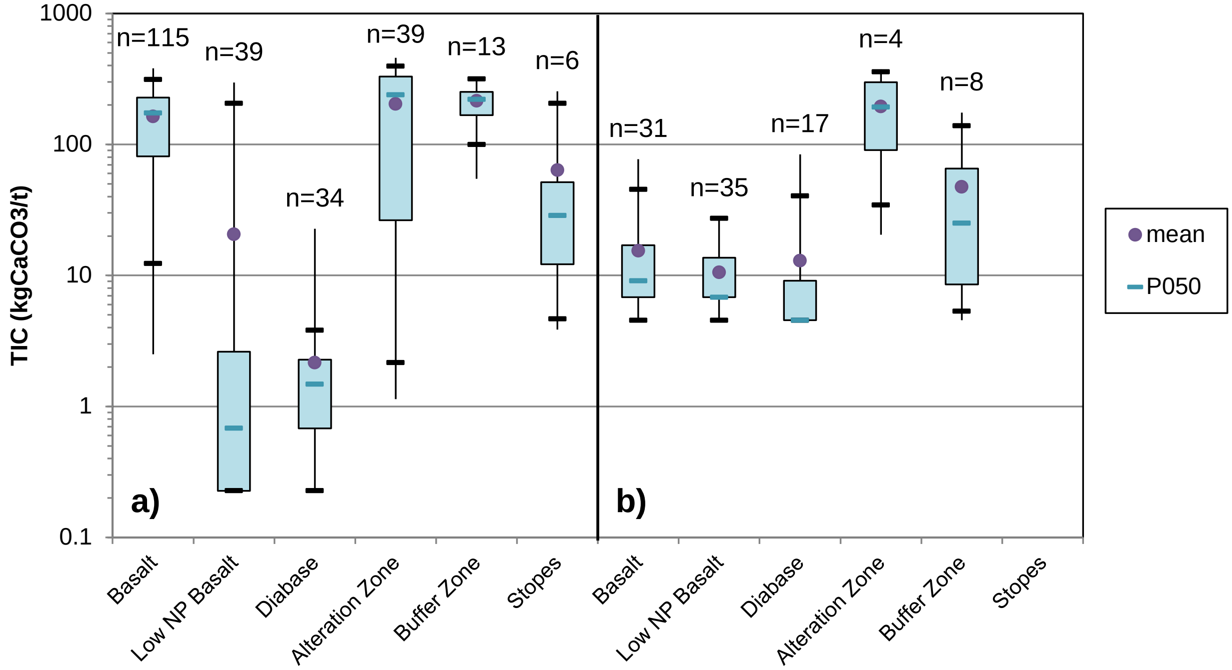


Figure A3: Statistical Distribution of TIC a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)

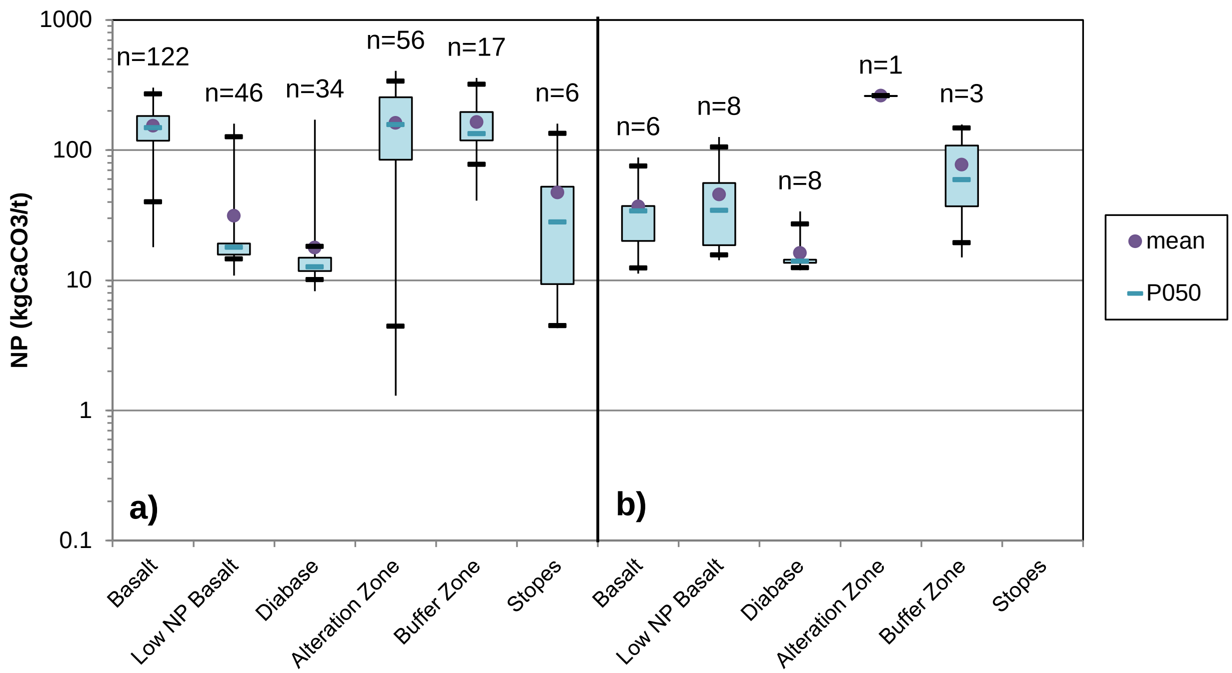
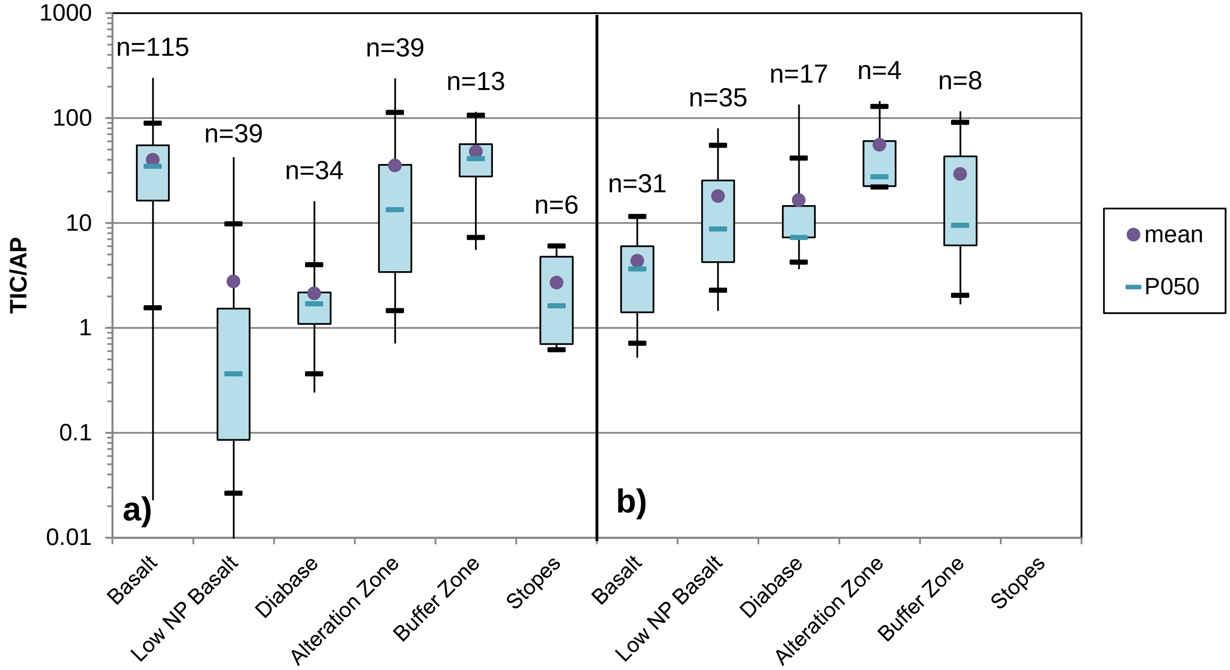
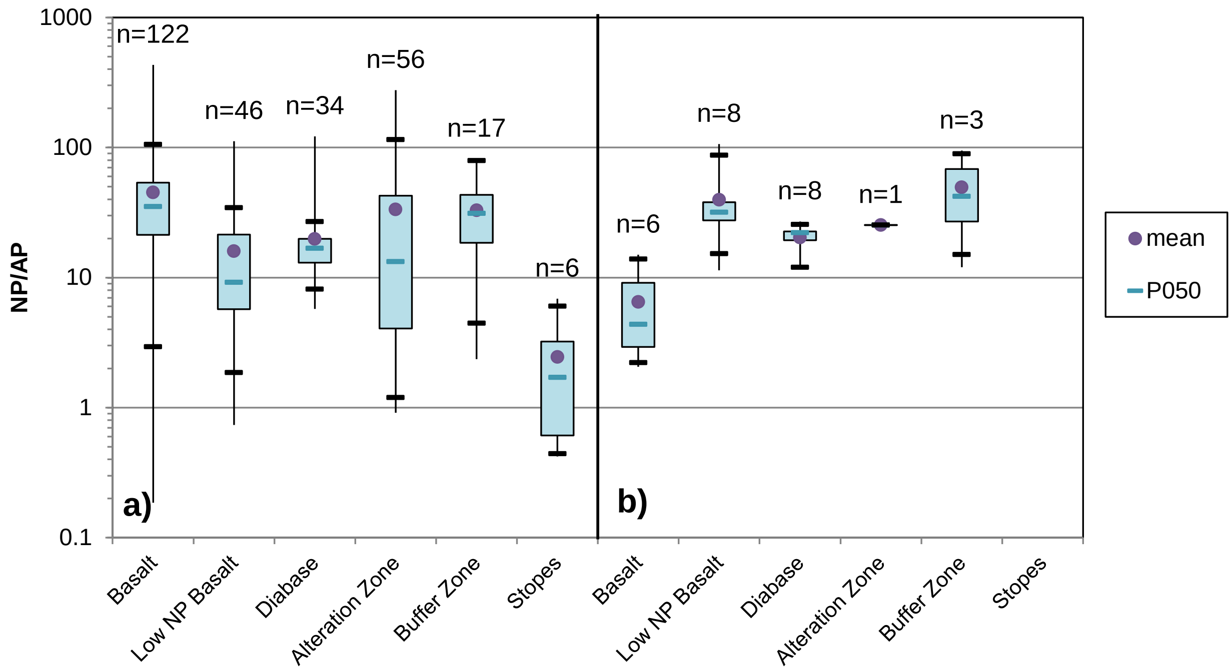


Figure A4: Statistical Distribution of NP a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\Permitting Support\Doris UG WRMP\11_2014TMACRevisedPlan\3. Working files\[HBMASTERGeochemical_Rev29_2011DorisABA_Rev04_2014WRMP_Rev02.xlsx]

Figure A5: Statistical Distribution of TIC/AP a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)



P:\01_SITES\Hope.Bay\1CH008.005_Geochemistry (Doris, Madrid, Boston)\Permitting Support\Doris UG WRMP\11_2014TMACRevisedPlan\3. Working files\[HBMASTERGeochemical_Rev29_2011DorisABA_Rev04_2014WRMP_Rev02.xlsx]

Figure A6: Statistical Distribution of NP/AP a) Doris North Geochemical Characterization Sample Set (SRK 2011) and b) Doris North Underground Monitoring Program (SRK 2012a)

SRK Consulting (Canada) Inc.
Suite 2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Ltd.
From:	Lowell Wade, MSc, PEng Maritz Rykaart, PhD, PEng	**Project No:**	1CT022.002.100
Cc:		**Date:**	March 27, 2015
Subject:	Doris North Project: Waste Rock Storage Pile (Pad T) Design Brief		

1 Introduction

TMAC Resources (TMAC) is currently in the process of reviewing the surface waste rock storage requirements for the Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada. A total of 556,000 t (309,000 m^3) of waste rock will need to be stored on surface.

All waste rock will be stored on the new waste rock storage pad, referred to as Pad T, constructed immediately north of Pad Q and extends to the Doris North Camp Area Diversion Berm (SRK 2012a). The use of Pad T will optimize waste rock handling and traffic flow, compared to the current practice of utilizing Pad I for waste rock storage. All existing waste rock, on Pad I, will be relocated to Pad T. Depending on the requirements for waste rock storage at any stage of the Project, Pad T may be used for additional waste rock storage or as general surface infrastructure pads, or any combination thereof.

Contact water from the waste rock pile will be collected in the existing Pollution Control Pond constructed immediately downstream, of Pad I, to ensure proper water management.

The Project, including the proposed Pad T is constructed on KIA land and TMAC has secured a Commercial Lease for the property, including the Pad T footprint area.

This memo provides details of the pad design, and should be read in conjunction with the attached set of engineering drawings (Attachment 1).

2 Design Concept Alternatives

Two options were considered for the design of Pad T:

- Tiered Pad T. Option 1 maximizes the usable surface area within the footprint of the proposed pad. This will result in constructing the pad as a tiered structure, with 3 tiers at elevation 57.0 m, 60.5 m, and 62.5 m. The width of each tier shall be maintained a minimum of 25 m for practical reasons. Maximum fill thickness was limited to ~8 m (excluding one small area in the 57 m elevation pad where this pad is slightly over this fill thickness due to the existing terrain), while minimum fill thickness was maintained at 1 m to ensure thermal protection of the foundation (SRK 2011a). Access to the various tiers of the pad will be along the Doris North Camp Area Diversion Berm (SRK, 2012a). This option was not selected as this design would only permit a maximum waste rock storage of 523,000 tonnes (290,000 m^3).

- Sloped Pad T. Option 2 is a design based on the existing ore stockpile pad (Pad Q) and the current waste rock pile (Pad I), wherein the pad is designed on the basis that immediately overlaying the tundra, there will be a continuous 1 m thick layer of geochemically acceptable material, upon which the ore and/or waste rock can be stockpiled. Access to the Sloped Pad T will be from the north end of Pad Q along the Doris North Access Road. This was selected as the preferred option as it would permit a maximum waste rock storage of 828,000 tonnes (460,000 m^3).

3 System Design

3.1 Design Criteria

The design criteria for the rock fill pad are as follows:

- Ramp grades for non-mining underground fleet shall not exceed 10%.
- Ramp grades for mining underground fleet shall not exceed 7%.
- Ramps shall have a minimum width of 8 m and a turning radius of 12 m.
- The minimum general drainage gradient shall be 0.5%.
- A minimum 0.85 m thick Run-of-Quarry (ROQ) or non-mineralized waste rock fill base overlain by a 0.15 m surfacing material shall be constructed. The surfacing material may be omitted, but then rock fill base must be at least 1 m thick.
- Maximum pad side-slope gradient shall be 1.5H:1V where fill thickness is less than 2 m and 2H:1V if the fill thickness exceeds 2 m.
- The overall slope of the waste rock pile should not exceed 2.5H:1V for long-term storage.
- If an elevation difference exceeds 3 m, safety barriers will be constructed along the edge of the pad (Option 1 only).

3.2 Survey Data

The design of Pad T is based on 2012 Doris North Camp as-built information received from Nuna Logistics (SRK 2012b) and a topographic contour set provided by Hope Bay Mining Limited, based on 2007 aerial photography. Contour intervals shown are typically 1 m.

3.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms Pad T lies within the zone of continuous permafrost, with the permafrost being up to 550 m deep. Permafrost temperature at the surface is about -8ºC and the active layer is generally less than 1 m thick. Laboratory and in-situ tests on disturbed and undisturbed samples indicates the overburden soils are predominantly comprised of marine silts and clays, and the pore-water, in these soils, has high salinity, depressing the freezing point to -2ºC. The ice rich overburden soils are typically between 5 and 20 m deep, before encountering competent bedrock which is predominantly basalt. Bedrock is frequently exposed columnar basalt rising 5 to 100 m above the surrounding landscape.

Thermal modeling was completed to determine how much fill would be required over the tundra to ensure the permafrost would be preserved for infrastructure construction (SRK 2006). In the case of Pad T, the minimum fill thickness would be 1 m; however due to the nature of the topography the pad's actual fill thickness will exceed this value.

3.4 Waste Rock Pile

Waste rock will be stockpiled on Pad T to a maximum height of about 20 m with an the overall side slopes of 2.5H:1V. Actual construction of the dump will be via end-dumping in benches of about 5 m thick, placed at angle of repose for the rock. Benches between lifts will be spaced to ensure compliance with the overall long-term slope angle. Haul ramps to the stockpile and between lifts will be limited to a 7% grade.

3.5 Construction Methodology

Pad T will be constructed in accordance to SRK's Technical Specifications (SRK 2011b). Geochemically acceptable rock (either ROQ or non-mineralized waste rock) will be used. The waste rock would originate from the Doris North Portal and quarried rock from any of the approved rock quarries forming part of the Project.

Complete material quantities for constructing Pad T are presented in Attachment 1.

4 References

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited. Project Number 1CM014.008. August 20, 2006.

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report. Report Prepared for Hope Bay Mining Limited. Project Number 1CH008.002. September 2009.

SRK Consulting (Canada) Inc., 2011a. Design Brief: Doris North Project Expanded Ore Storage Pad (Pad T). Technical Memorandum prepared for Hope Bay Mining Limited. Project No. 1CH008.049. August 2011.

SRK Consulting (Canada) Inc., 2011b. Technical Specifications Earthworks and Geotechnical Engineering. Hope Bay Project, Nunavut, Canada. Revision G – Issued for Construction. Report Prepared for Hope Bay Mining Ltd. Project Number: 1CH008.027. March 2011.

SRK Consulting (Canada) Inc., 2012a. Engineering Drawings for the Doris North Camp Area Diversion Berm, Doris North Project, Nunavut, Canada. As-built drawings prepared for Hope Bay Mining Ltd., Project No. 1CH008.058. July 2012.

SRK Consulting (Canada) Inc., 2012b. Engineering Drawings for the Doris North Camp Area, Doris North Project, Nunavut, Canada. Revision AB1. As-Built Drawings Prepared for Hope Bay Mining Limited. Project Number 1CH008.033. May 18, 2012

Attachment 1

Engineering Drawings for the Doris North Camp Area – Pad T

Engineering Drawings for the Doris North Camp Area - Pad T, Doris North Project, Nunavut, Canada Water License Amendment

ACTIVE DRAWING STATUS

SRK DWG NUMBER	DRAWING TITLE	REV.	DATE	STATUS
DN-DMC-T0	Engineering Drawings for the Doris North Camp Area - Pad T	B	Mar. 27, 2015	Issued for Discussion
DN-DMC-T1	Pad T General Arrangement	A	Mar. 27, 2015	Issued for Discussion
DN-DMC-T2	Pad T Waste Rock Storage Capacity	A	Mar. 27, 2015	Issued for Discussion
DN-DMC-T3	Pad T Sections & Details	A	Mar. 27, 2015	Issued for Discussion

TMAC RESOURCES

srk consulting

PROJECT NO: 1CT022.002.100
ISSUED FOR DISCUSSION
Revision B
March 27, 2015
DN-DMC-T0

LEGEND

Proposed Surface Infrastructure Pads

NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files of the pads for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licences and/or Permits petaining to execution of the Works. The Engineer will not be responsible for any infringements.
7. The Contractor is to take due care that no wildlife or birds' nest are disturbed during contruction. The Construction Manager is to be immediately notified if such sites are found.
8. These works must be executed in accordance with the standard TMAC health and safety, and enviromental standards and protocols. It is the Contractors responsibility to familiarize himself with these documents.
9. Construction of the camp pads may not commence without on-site presence of an Engineers' representative. The Contractor shall notify the Engineer at least 5 days in advance of intended construction start-up.
10. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
11. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
12. The terrain model is based on current original ground and 2010 as-built survey information by Nuna Logistics, and as-built survey by SNC Lavalin (pre-2010).
13. The lines on this drawing provides the final grade and elevation of the pads. These grades include an allowance for placing a 150mm thick layer of surfacing grade material on all surfaces. The Contractor must make the appropriate adjustments to the grades set out for the Works.
14. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay Project, Nunavut, Canada, revision G -Issue for Construction.
15. Notes in this drawing apply to all other active drawings.

C:\01_SITES\Hope Bay\Doris North\Pad T\DN-DMC-00_T1_T2_RevA.dwg

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REVISIONS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	LW	EMR	27MAR15

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: LW/JBK | DRAWN: NV | REVIEWED: LW

CHECKED: LW | APPROVED: EMR | DATE: Mar. 27, 2015

FILE NAME: DN-DMC-00_T1_T2_RevA.dwg

TMAC RESOURCES

HOPE BAY PROJECT

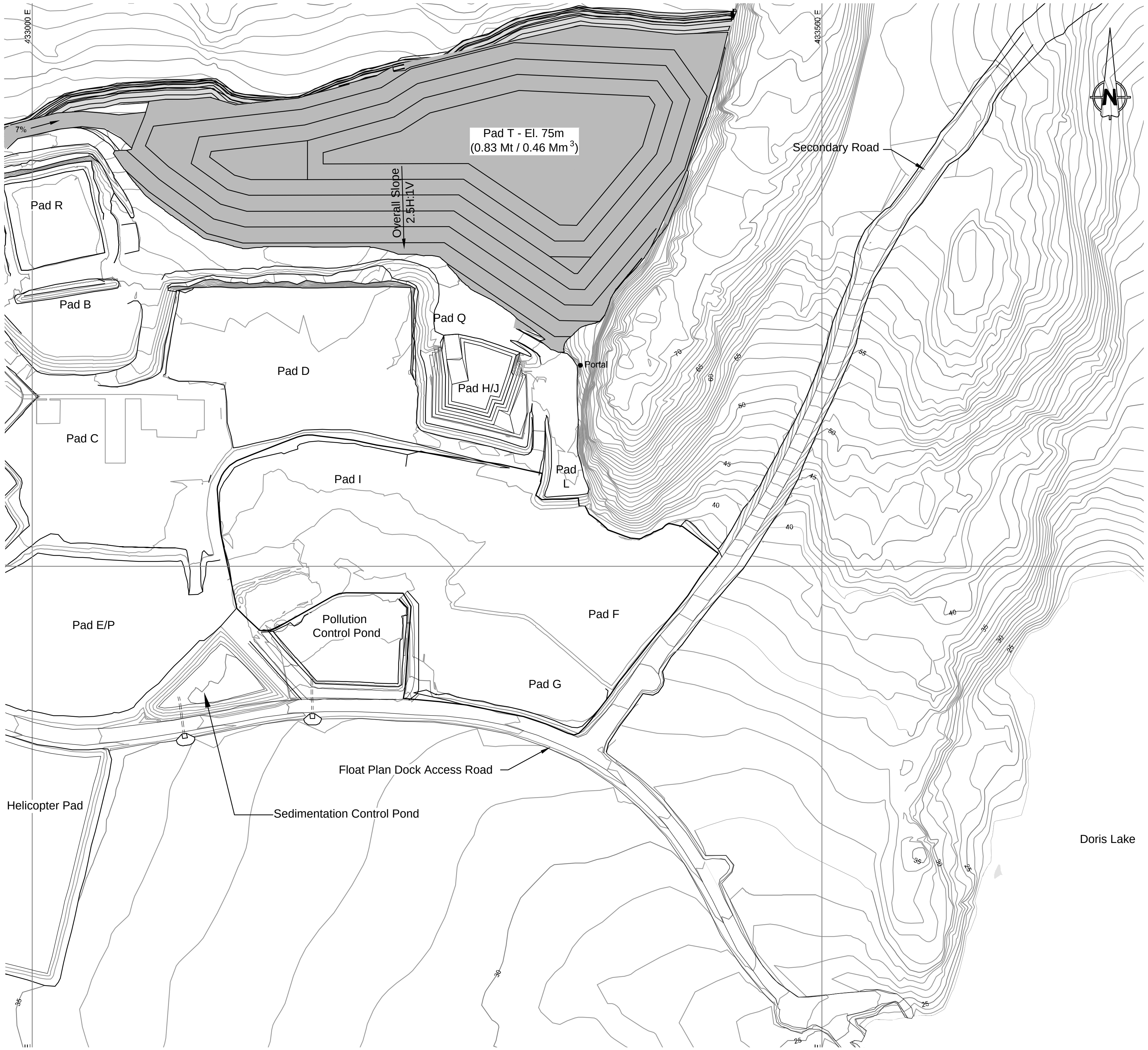
SRK JOB NO.: 1CT022.002.100

Doris North

DRAWING TITLE:

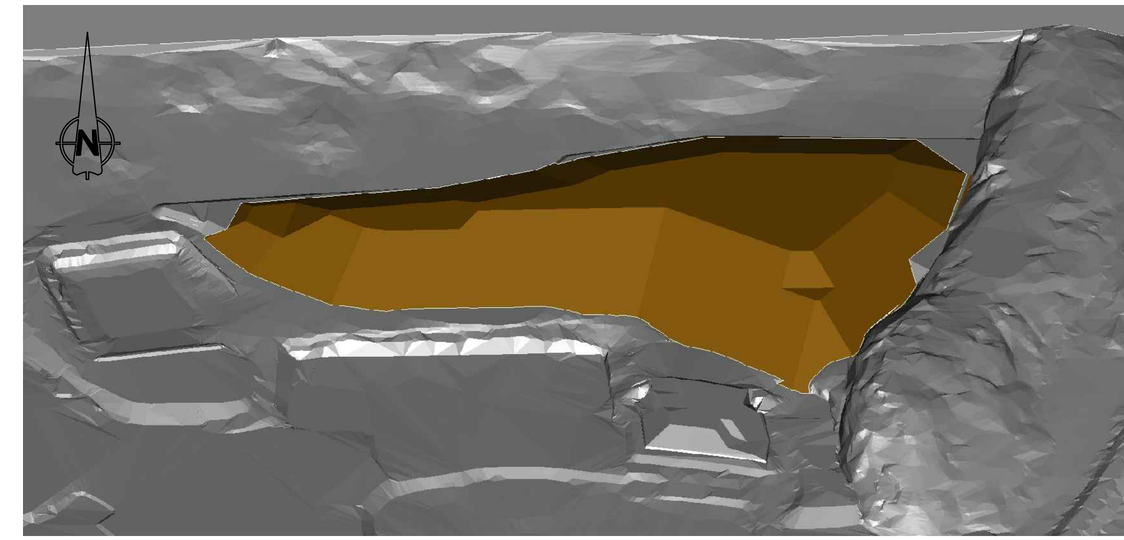
Pad T
General Arrangement

DRAWING NO. DN-DMC-T1 | SHEET 2 OF 4 | REVISION NO. A



WASTE ROCK EXPANSION STAGE 1

0 10 20 30 40 50
Scale in Metres



WASTE ROCK STORAGE PILE (PAD T)

NTS

NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licences and/or Permits petaining to execution of the Works. The Engineer will not be responsible for any infringements.
6. The Contractor is to take due care that no wildlife or birds' nest are disturbed during contruction. The Construction Manager is to be immediately notified if such sites are found.
7. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
8. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
9. Bulk density of waste rock is assumed to be 1.8 tonnes/m ^{3}.
10. Notes in this drawing apply to all other active drawings.

Materials List and Quantities

Item Description	Quantity / Area / Volume		Description
Run of Quarry Material	Base Pad (1m min.)	= 42,600 m³	Approximate in-Place Neat-line Volumes (no allowance has been made for losses and/ or tundra embedment)
Waste Rock Storage Volume	Stage 1	= 460,000 m³	Storage volumes derived by Gemcom.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	LW	EMR	27MAR15

REVISIONS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: LW/JBK | DRAWN: NV | REVIEWED: LW
CHECKED: LW | APPROVED: EMR | DATE: Mar. 27, 2015
FILE NAME: DN-DMC-00_T1_T2_RevA.dwg

TMAC RESOURCES

HOPE BAY PROJECT

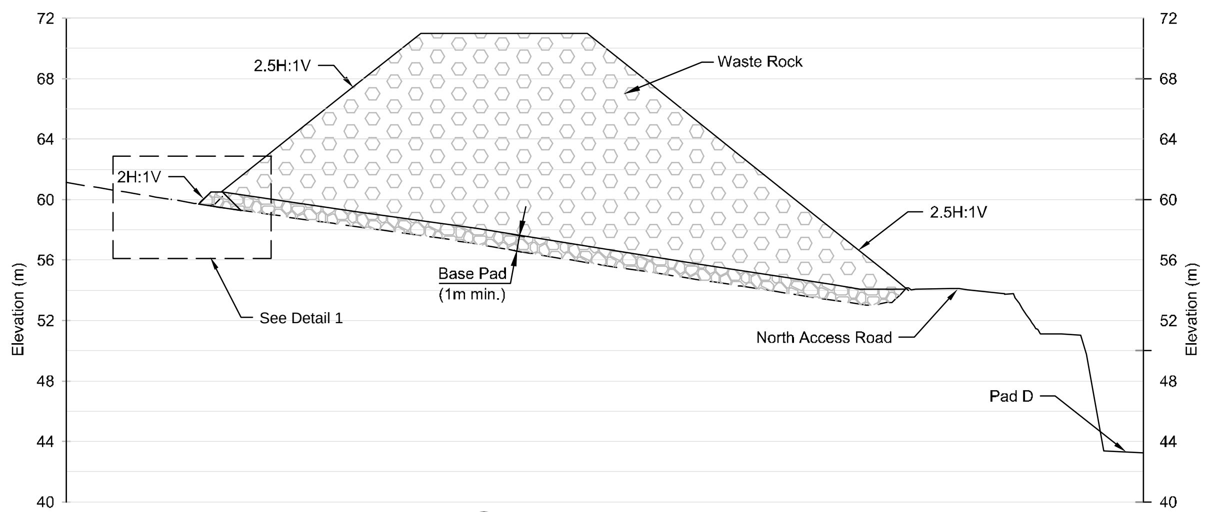
SRK JOB NO.: 1CT022.002.100

Doris North

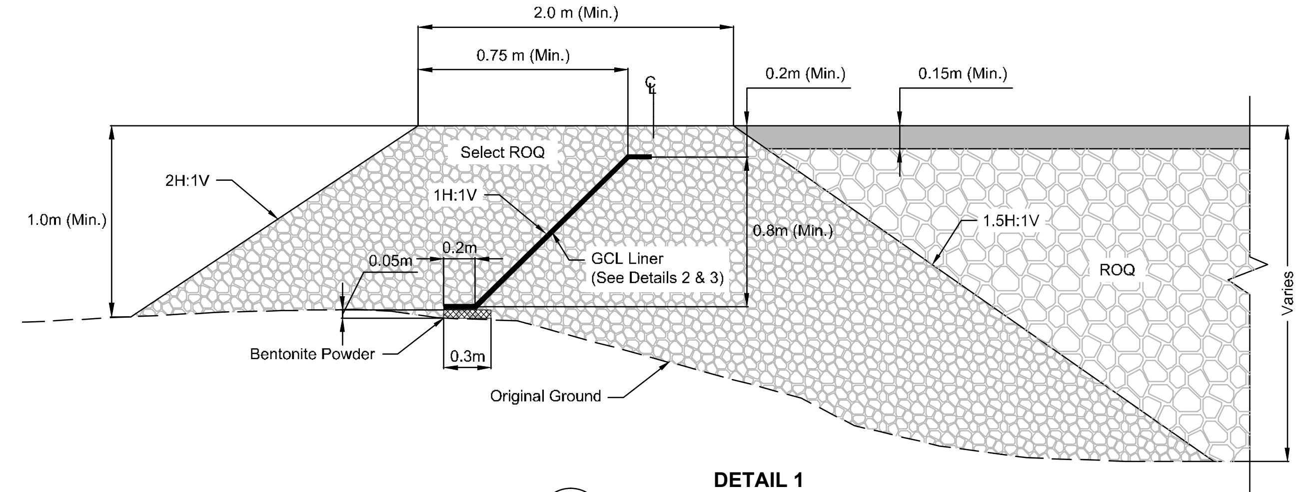
DRAWING TITLE: Pad T Waste Rock Storage Capacity

DRAWING NO.: DN-DMC-T2 | SHEET 3 OF 4 | REVISION NO. A

C:\01_SITES\Hope Bay\Doris North\Pad T\DN-DMC-00_T1_T2_RevA.dwg



A
DN-DMC-T3
SECTION A - A'



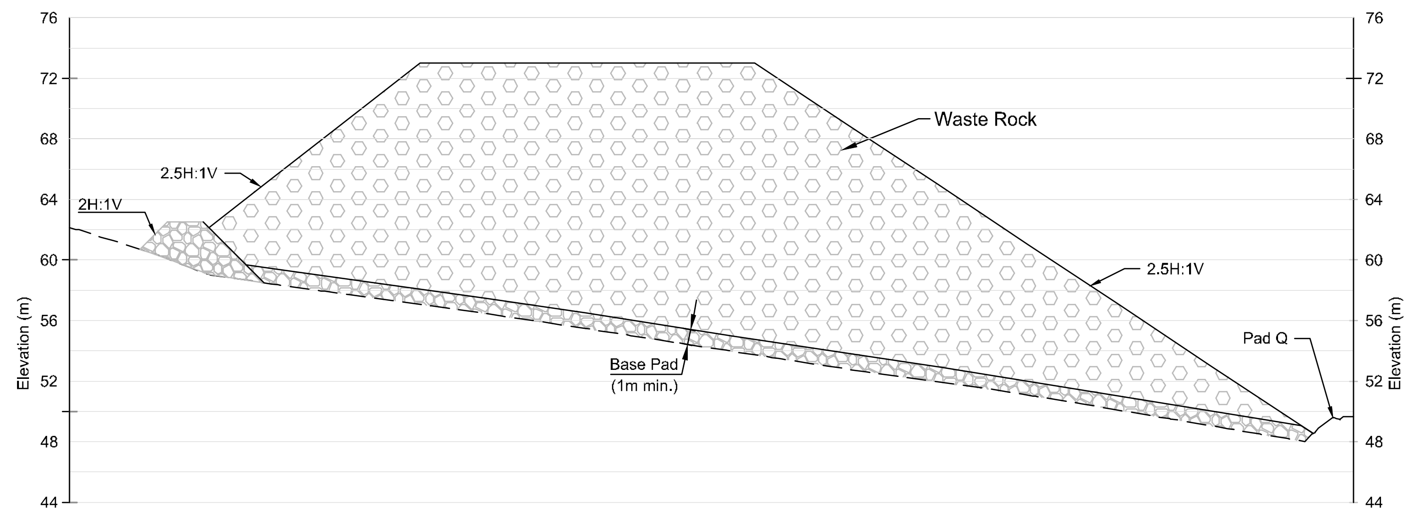
DETAIL 1
1
DN-DMC-T5
UPSTREAM DIVERSION BERM
See Reference 1

LEGEND

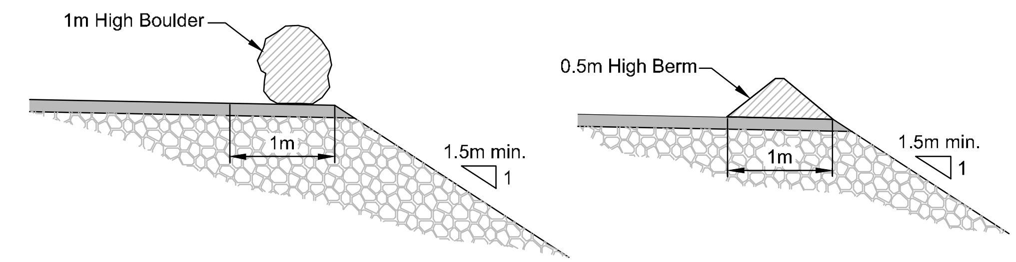
- Existing ground surface
- Surfacing Material
- Run of Quarry Material
- Select Run of Quarry Material
- 2010 As-built Surface

NOTES

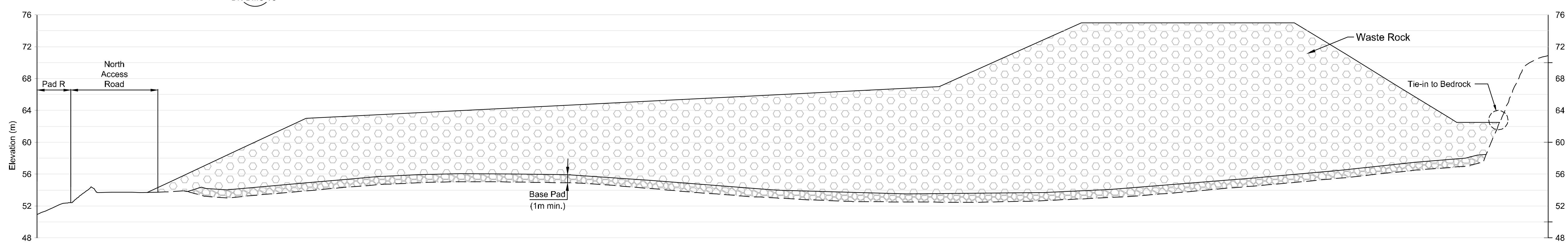
1. All dimensions in metres unless noted otherwise.
2. Where the thickness of the pads is greater than 3.0m allow for the placement of barriers.
3. The barriers are to consist of boulders larger than 1m in diameter or a rock fill berm 0.5m high. Maximum spacing between barriers is 3.3m.
4. Notes in this drawing apply to all other active drawings.



B
DN-DMC-T3
SECTION B - B'



DETAIL 4
4
-
TYPICAL BERM BARRIER OPTIONS
NOT TO SCALE



A
DN-DMC-T3
SECTION C - C'

0 5 10 15 20 25
Scale in Metres (Horizontal)

0 2 4 6 8 10
Scale in Metres (Vertical)

2X VERTICAL EXAGGERATION

REFERENCE

1. Engineering Drawings for the Doris North Camp Area Diversion Berm, Doris North Project, Nunavut, Canada, Water Licence Amendment, As-Built Drawings Prepared for Hope Bay Mining Ltd., Project No. 1CM008.058, July 16, 2012

C:\01_SITES\Hope Bay\Doris North\Pad T\DN-DMC-00_T3 RevA.dwg

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
–	–		

REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	ISSUED FOR DISCUSSION	LW	EMR	27MAR15

REVISIONS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: LW/JBK	DRAWN: NV	REVIEWED: LW
CHECKED: LW	APPROVED: EMR	DATE: Mar. 27, 2015

FILE NAME: DN-DMC-00_T3 RevA.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.002.100

Doris North

DRAWING TITLE: Pad T - Sections & Details

DRAWING NO.	SHEET	REVISION NO.
DN-DMC-T3	4 OF 4	A

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Inc.
From:	Lowell Wade, MSc, PEng Maritz Rykaart, PhD, PEng	**Project No:**	1CT022.002.100
Cc:		**Date:**	March 27, 2015
Subject:	Doris North Project: Waste Rock Storage Pile (Pad T) Reclamation and Security Brief to Doris North Type A Water License No. 2AM-DOH1323		

1 General

The Doris North Project (Project) is owned and operated by TMAC Resources Inc. (TMAC). The project is located on Inuit Owned Land administered by the Kitikmeot Inuit Association (KIA), in the West Kitikmeot Region of Nunavut, approximately 120 km south west of Cambridge Bay. The Doris North Project is authorized under the Nunavut Water Board (NWB) Type A Water Licence 2AM-DOH1323 (NWB 2013).

The closure and reclamation plan for the Project is described in the Doris North Closure and Remediation and Plan (SRK 2012). A revised waste rock and ore management plan (SRK 2015) calls for the construction of a 42,600 m^2 waste rock storage pile (Pad T) north of the portal and existing ore stockpile on Pads Q/H/J (Figure 1).

This memo describes the closure and reclamation plan for the Waste Rock Storage Pile (Pad T) and the incremental Security Estimate associated with construction of this surface infrastructure.

2 Pad T – Waste Rock Pile

According to the Doris North Closure and Reclamation and Plan (SRK 2012), all waste rock will to be sent back underground to be used as backfill. Subsequent changes associated with the Project being placed in Care and Maintenance allowed for any waste rock left on surface to be managed as follows:

- Consolidating, contouring and covering mineralized waste rock piles with an impermeable liner and a 0.3 m thick protective layer of crushed rock; or
- Relocating mineralized waste rock piles to the Tailings Impoundment Area to be deposited of sub-aqueously.

- Non-mineralized waste rock can be left in place provided it has been deemed to be physically stable.

Current plans allows for 188,000 t (105,000 m^3) of non-mineralized waste rock to be left on surface at closure. This waste rock will be located on Pad T. Stability analysis has confirmed that the waste rock piles will be physically stable in the long term, and therefore no significant stability related closure activity will need to be undertaken.

Just like all other rock fill pads on site, any exposed areas of Pad T, not covered by non-mineralized waste rock, will remain in place at closure, and only minimal regrading will be required to ensure positive drainage and prevent ponding.

The total incremental liability associated with Pad T is therefore CAD $6,000 in undiscounted 2014 Canadian dollars. This assumes 100% of the pad surface area requires regrading which is deemed conservative.

3 Closure

The total incremental liability associated with the Waste Rock Storage Pile (Pad T) is CAD $6,000 in undiscounted 2014 Canadian dollars. This has been calculated using the same principles and costing assumptions used in the current Doris North Closure and Reclamation and Plan (SRK 2012).

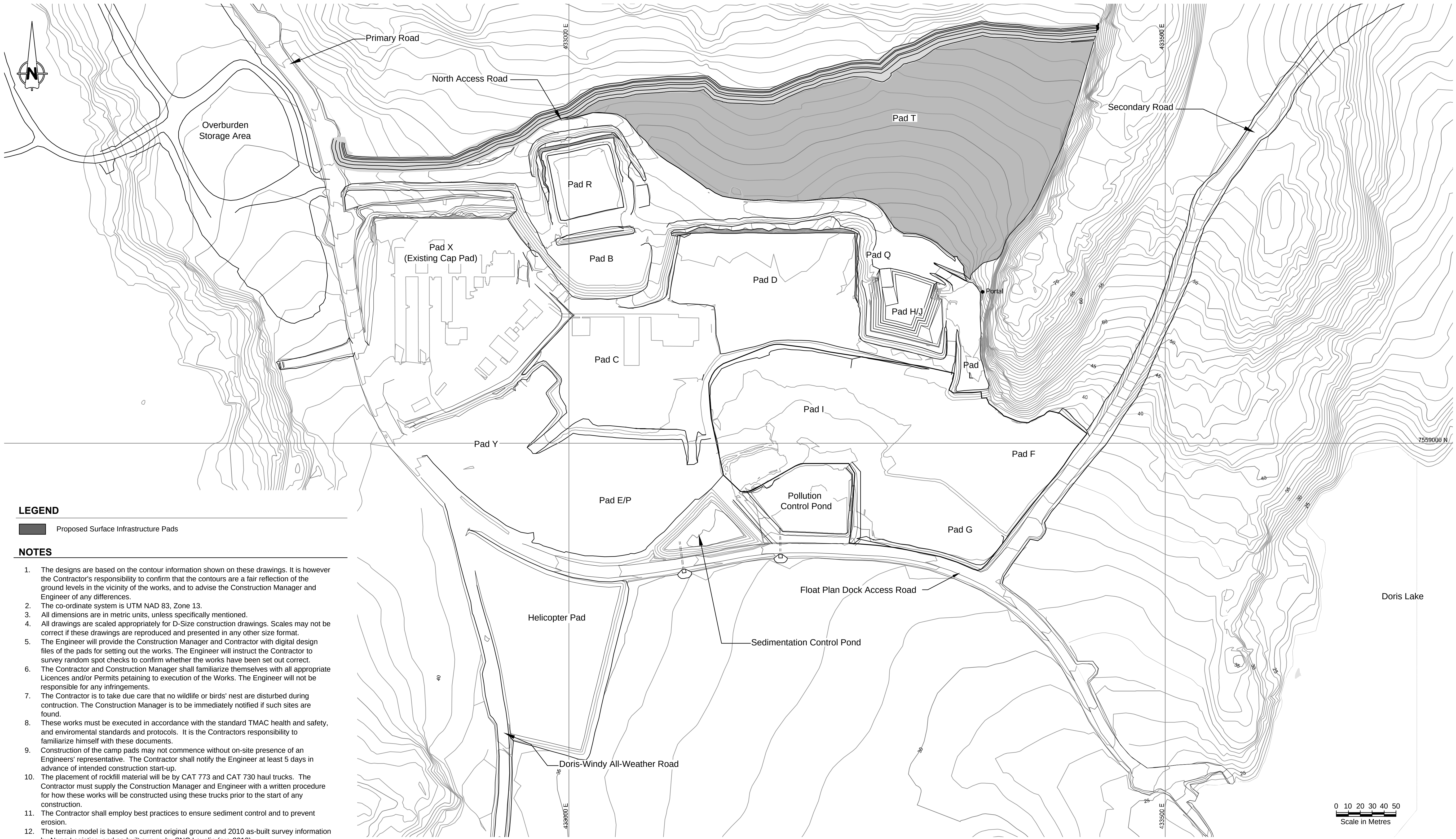
4 References

NWB, 2013. Nunavut Water Board Water Licence No: 2AM-DOH1323. Issued to TMAC Resources Inc., August 16, 2013.

SRK Consulting (Canada) Inc., 2012. Doris North Closure and Reclamation Plan. Report prepared for Hope Bay Mining Ltd., Project No. 1CH008.065. August 2012.

SRK Consulting (Canada) Inc., 2015. Hope Bay Project Doris North Waste Rock and Ore Management Plan – Revision 02. Report prepared for TMAC Resources Inc., Project No. 1CT022.002.100. March 2015.

Figure



LEGEND

Proposed Surface Infrastructure Pads

NOTES

1. The designs are based on the contour information shown on these drawings. It is however the Contractor's responsibility to confirm that the contours are a fair reflection of the ground levels in the vicinity of the works, and to advise the Construction Manager and Engineer of any differences.
2. The co-ordinate system is UTM NAD 83, Zone 13.
3. All dimensions are in metric units, unless specifically mentioned.
4. All drawings are scaled appropriately for D-Size construction drawings. Scales may not be correct if these drawings are reproduced and presented in any other size format.
5. The Engineer will provide the Construction Manager and Contractor with digital design files of the pads for setting out the works. The Engineer will instruct the Contractor to survey random spot checks to confirm whether the works have been set out correct.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licences and/or Permits petaining to execution of the Works. The Engineer will not be responsible for any infringements.
7. The Contractor is to take due care that no wildlife or birds' nest are disturbed during contruction. The Construction Manager is to be immediately notified if such sites are found.
8. These works must be executed in accordance with the standard TMAC health and safety, and enviromental standards and protocols. It is the Contractors responsibility to familiarize himself with these documents.
9. Construction of the camp pads may not commence without on-site presence of an Engineers' representative. The Contractor shall notify the Engineer at least 5 days in advance of intended construction start-up.
10. The placement of rockfill material will be by CAT 773 and CAT 730 haul trucks. The Contractor must supply the Construction Manager and Engineer with a written procedure for how these works will be constructed using these trucks prior to the start of any construction.
11. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
12. The terrain model is based on current original ground and 2010 as-built survey information by Nuna Logistics, and as-built survey by SNC Lavalin (pre-2010).
13. The lines on this drawing provides the final grade and elevation of the pads. These grades include an allowance for placing a 150mm thick layer of surfacing grade material on all surfaces. The Contractor must make the appropriate adjustments to the grades set out for the Works.
14. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay Project, Nunavut, Canada, revision G -Issue for Construction.
15. Notes in this drawing apply to all other active drawings.

srk consulting

SRK JOB NO.: 1CT022.001

FILE NAME: 1CT022.001_PadT Fig 1.dwg

TMAC RESOURCES

Doris North Project

Pad T Closure Plan

Doris North Camp Area

DATE:	APPROVED:	FIGURE:
Jan. 2015	LW	1

C:\01_SITES\Hope Bay\Doris North\Pad T\1CT022.001_PadT Fig 1.dwg

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Ltd.
From:	Peter Luedke, EIT Lowell Wade, MSc, PEng Maritz Rykaart, PhD, PEng.	**Project No:**	1CT022.002.100
Cc:		**Date:**	March 27, 2015
Subject:	Doris North Project: Waste Rock Storage Pile (Pad T) Stability Analysis		

1 Purpose

TMAC Resources is currently in the process of reviewing the waste rock storage requirements for the Doris North Project (Project) in the Kitikmeot Region of Nunavut, Canada. The four year mine life, of the Doris North Project, will have a total waste rock development of 556,000 t (309,000 m^3).

All waste rock will be stored on the new waste rock storage pad, referred to as Pad T, constructed immediately north of Pad Q and extends to the Doris North Camp Area Diversion Berm (SRK 2012). The use of Pad T will optimize waste rock handling and traffic flow, compared to the current practice of utilizing Pad I for waste rock storage. All existing waste rock, on Pad I, will be relocated to Pad T. Depending on the requirements for waste rock storage at any stage of the Project, Pad T may be used for additional waste rock storage or as general surface infrastructure pads, or any combination thereof.

To determine the stability of a waste rock storage pile, on Pad T, a stability analysis was carried out using the maximum amount of waste rock which can be stockpiled on Pad T. The maximum amount of waste rock that can be stockpiled, on Pad T, is 828,000 tonnes (460,000 m^3) which is 63% greater than is currently planned for.

Guidelines for mined rock and overburden piles suggest the waste rock storage pile, on Pad T, should meet minimum design values for Factors of Safety (FoS) presented in Table 1 (British Columbia Mine Waste Rock Pile Research Committee 1991). The ranges in FoS, for Cases A and B, reflect the different levels of confidence in understanding site conditions, material parameters, and consequences of instability.

Table 1. British Columbia Mine Dump Factor of Safety Guidelines

Stability Condition	Suggested Minimum Design Values for Factor of Safety	
	Case A	Case B
Stability of Waste Rock Pile Surface		
Short-term (during construction) - (Stability Condition 1)	1.0	1.0
Long-term (reclamation – abandonment) – (Stability Condition 2)	1.2	1.1
Overall Waste Rock Pile Stability (Deep Seated Stability)		
Short-term (static) – (Stability Condition 3)	1.3 - 1.5	1.1 – 1.3
Long-term (static) – (Stability Condition 4)	1.5	1.3
Pseudo-Static (earthquake)[2]	1.1 – 1.3	1.0
CASE A: -Low level of confidence in critical analysis parameters -Possibly unconservative interpretation of conditions, assumptions -Severe consequences of failure -Simplified stability analysis method (charts, simplified method of slices) -Stability analysis method poorly simulates physical conditions -Poor understanding of potential failure mechanism(s)		
CASE B: -High level of confidence in critical analysis parameters -Conservative interpretation of conditions, assumptions -Minimal consequences of failure -Rigorous stability analysis method -Stability analysis method simulates physical conditions well -High level of confidence in critical failure mechanism(s)		

Notes:
1. A range of suggested minimum design values are given to reflect different levels of confidence in understanding site conditions, material parameters, consequences of instability, and other factors.
2. Where pseudo-static analyses, based on peak ground accelerations which have a 10% probability of exceedance in 50 years, yield FoS < 1.0, dynamic analysis of stress-strain response, and comparison of results with stress-strain characteristics of dump materials is recommended.

2 Slope Stability Assessment

2.1 Material Properties

2.1.1 Overburden Material Properties

The general overburden profile consists of a thin veneer of hummocky organic soil covered by tundra heath vegetation. Under this organic layer is a layer of marine silts and clays (i.e. silty clay and clayey silt) typically between 5 and 20 m thick. Where the overburden exceeds 20 m in thickness, it appears to be underlain by clayey moraine till, which contains moderate amounts of cobbles and boulders. The bedrock contact zone consists of a relatively thin rubble zone of weathered blocky host rock (SRK 2009).

Pad T will be constructed on permafrost soils (i.e. directly onto the tundra) and is designed to promote freeze-back, thereby minimizing long-term environmental effects from possible acid rock drainage and/or metal leaching. Permafrost soils will provide suitable foundation conditions for waste rock piles, provided the foundation remains frozen. SRK (2006) presents the thermal analysis for the site that demonstrates the viability of this approach. The slope stability model was set up using the geotechnical properties, provided in SRK (2011a), for marine silts and clays as the foundation soils.

2.1.2 Borrow Properties

The physical properties of the Run-of-Quarry (ROQ) material for the Project have not been measured, but the physical properties used in the stability analyses are based on a comparison of the Project's ROQ material with similar materials as reported in the literature and SRK's internal database.

The ROQ used in the construction of Pad T will be placed directly on the tundra surface in accordance with SRK's Technical Specifications for the Project (SRK 2011b). The geotechnical properties of the ROQ and the waste rock pile are provided in SRK (2011a).

2.2 Model Setup

A slope stability model was set up in RocScience Slide (Version 6) (RocScience 2014) using the three types of materials described above. Table 2 summarizes the material properties used in the analyses. The properties used are consistent with previous analyses such as the Doris North Pad U Waste Rock Stability Analysis (SRK 2011c) and the Doris Creek Bridge Abutments stability analysis (SRK 2010).

Table 2: Material Properties Summarized from SRK (2011a)

Parameter		Marine Silt and Clay	Run of Quarry (Pad T)	Waste Rock Pile
Moist Unit Weight (kN/m^3)		18.5	20	20
Degree of Saturation		85%	30%	30%
Porosity		0.52	0.30	0.30
Volumetric Water Content		0.44	0.09	0.09
Unfrozen	Apparent Cohesion c' (kPa)	0	0	0
	Friction Angle, φ ^{0}	30	40	39
Frozen	Apparent Cohesion c' (kPa)	112	5	n/a
	Friction Angle, φ ^{0}	26	40	n/a

For the stability analyses, it was assumed that Pad T protects the permafrost in the marine silts and clays that it sits atop. Pad T and the waste rock pile is conservatively assumed to be unfrozen. This is conservative since in the long term freeze back will occur in both the pad and the waste rock pile.

A critical cross-section through the waste rock pile based on the slope of the foundation and ultimate waste rock pile height was selected to create the model used to run the analyses (Figure 1). The modeled cross-section is shown in Figure 2.

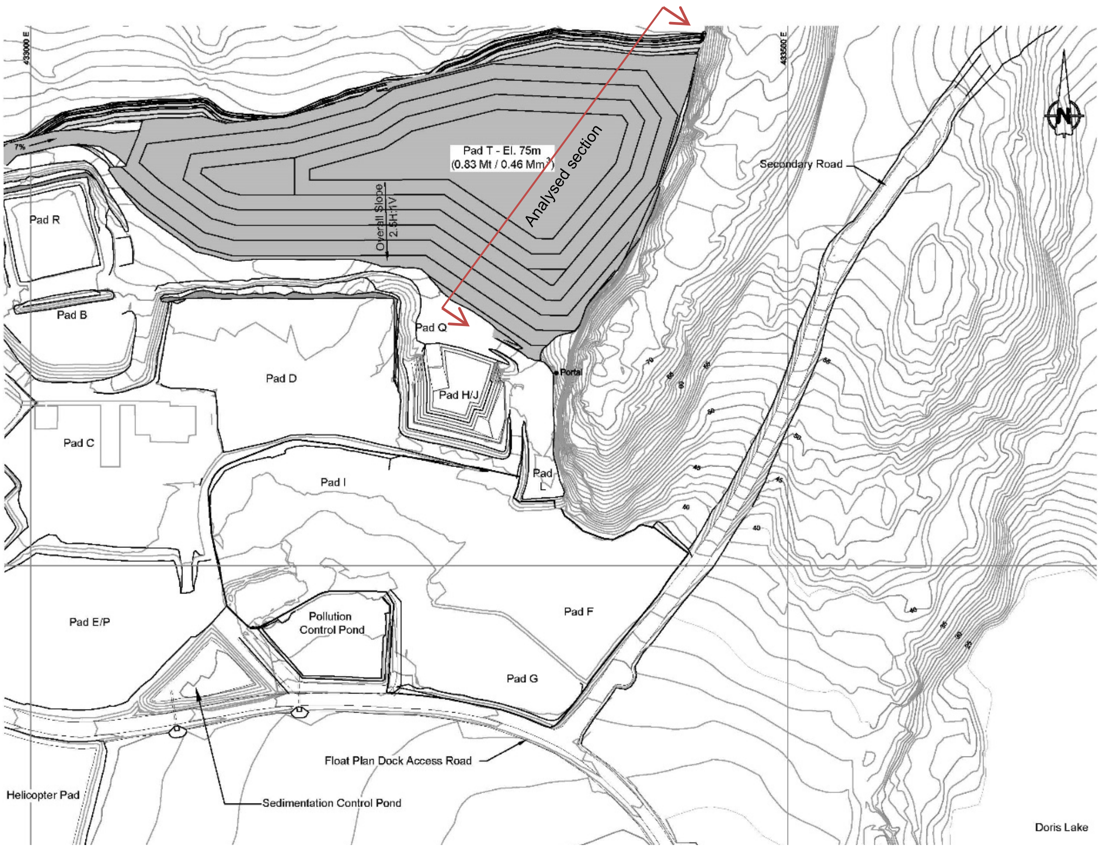


Figure 1. Plan View of the Section used as a Critical Section for Analysis (Figure taken from SRK 2014).

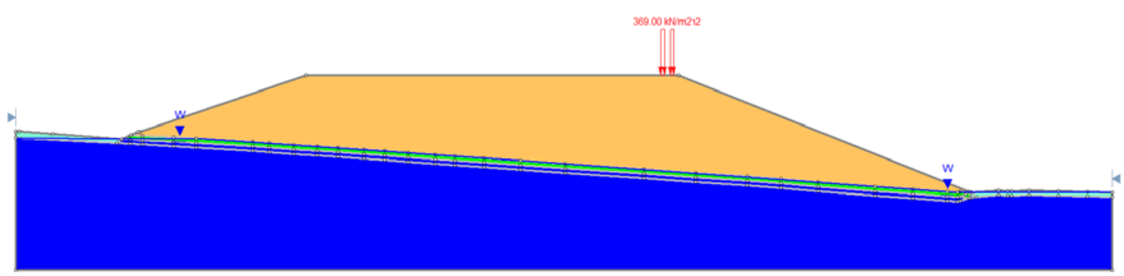


Figure 2. Section View of the Critical Section used for the Analyses in RocScience Slide.

2.3 Methodology

The stability, of the waste rock stockpile also took into consideration haul truck wheel loads applied near the crest of the waste rock stockpile. The loaded Sandvik TH540 was assumed to be the heaviest vehicle driving on the waste rock pile. The wheel loading calculation for the

TH540 haul truck is included as Attachment 1. For analysis purposes, the wheel loading was applied at a minimum of 1 m to the crest of the waste rock pile.

The slope stability of the waste rock pile was evaluated under four stability conditions listed in Table 1. The following three stability analyses were evaluated:

- Short-term (during construction) (Stability Condition 1): This stability case considers the stability of the waste rock pile surface with the truck loading applied at the crest of the waste rock pile.

- Long-term (reclamation/abandonment/static) (Stability Conditions 2 and 4): This stability case considers the stability of the waste rock pile surface and the overall waste rock pile stability without the haul truck wheel loads near the crest.

- Short-term (static) (Stability Conditions 3): This stability case considers the stability of the overall waste rock pile with the truck loading applied at the crest of the waste rock pile and only is analysed for deep seated stability by forcing the slip-surface to a particular path or certain depth.

The slope stability analyses were carried out using the Spencer Limit Equilibrium Method and the results checked using the Morgenstern-Price Limit Equilibrium Methods. These limit equilibrium methods satisfy all limit equilibrium conditions. Each differs in its assumptions. Spencer's method makes the least static assumptions while Morgenstern-Price method assumes the side forces follow a prescribed function, side forces can vary from slice to slice (ASCE 2002) and is considered to be more conservative.

Multiple analyses for each Limit Equilibrium Method were completed using the Auto-Refine (circular or non-circular), Block Search, and Simulated Annealing Slip-Surface Search Functions available within RocScience Slide. These Slip-Surface Search Functions are the methods by which Rocscience Slide identifies the critical slip surface(s). Additional refinement to the Slip-Surface Search Functions was applied by using constraints such as Entry-Exit, Minimum Depth or Optimized Search. The slip surface functions selected for each load case were based on the observed variability of the results and refinement of the slip surface mode.

The Project site is located in a stable seismic zone of Canada with low peak ground accelerations (SRK 2011a). Because of this, a pseudo-static stability analysis under seismic conditions was not assessed.

3 Results

The range of FoS calculated for each Stability Analysis is presented in Table 3 while all the results for all Stability Analyses are provided in Attachment 2. Although there is a good understanding of site conditions, material parameters, and consequences of instability, which suggests the waste rock stockpile, Pad T should meet the FoS required for Case B, as the calculated FoS was found to exceed those listed for Case A as well.

Table 3. Waste Rock Pile Stability Analysis Results

Stability Analysis	Suggested FoS (Case A)	Suggested FoS (Case B)	Calculated FoS	Comment
Short-term (during construction) (Stability Condition 1)	1.0	1.0	1.0 – 1.5	Shallow crest failures due to haul truck wheel loads 1 m from crest of waste rock pile.
Long-term (reclamation/ abandonment/ static) (Stability Conditions 2 and 4)	1.2 & 1.5	1.1 & 1.3	2.0	Shallow skin failures along the outer slope of the waste rock pile due to haul truck wheel loads 1 m from the crest of the waste rock pile. Deep seated slip surfaces found to have a FoS > 2.0.
Short-term (static) (Stability Conditions 3)	1.3 – 1.5	1.1 – 1.3	1.9 – 2.0	Larger slip surface initiating beneath the applied load.

3.1 Short-term (during construction) (Stability Condition 1)

Based on the Guidelines for mined rock and overburden piles (BCMDC, 1991), the FoS for the Short-term (during construction) (Stability Condition 1) must be 1.0. This FoS was met and exceeded for all but one analysis conducted for this Stability Condition. A minimum FoS of 0.9 was calculated using the Auto-Refine (Non-Circular) Search Function under Entry/Exit and Optimized Search Constraints. To determine the significance of this result, the bearing capacity of the waste rock pile was evaluated.

To eliminate the shallow crest failures, due to the haul truck wheel loads, the bearing capacity of the waste rock stockpile was evaluated to determine the distance which the wheels of a loaded haul truck must be from the crest of the waste rock stockpile, to achieve a FoS of 1.0. It was determined the wheels of a haul truck must not be within 1.2 m of the crest of the waste rock pile (Attachment 3). This means appropriate safety measures should be put in place to make sure the haul trucks must stop a minimum distance of 1.2 m from the edge of the waste rock pile.

A sensitivity analysis was also carried out for the lowest FoS = 0.9 (i.e. the Short-term (during construction) (Stability Condition 1) using the Auto-Refine (Non-Circular) Search Function under Entry/Exit and Optimized Search Constraints) by varying both the friction angle of the waste rock and the distance between the nearest haul truck wheel load and the crest of the waste rock pile. By increasing the waste rock pile's angle of friction, the FoS was found to increase from 0.9 (at a Friction Angle, φ^{0} = 39) to over 1.1 (at a Friction Angle, φ^{0} = 47) (Figure 3). By increasing the distance of the wheel loads from the crest of the waste rock pile, the FoS was found to increase from 0.9 (at a distance of 1 m) to over 1.7 (as a distance of 4 m) (Figure 4).

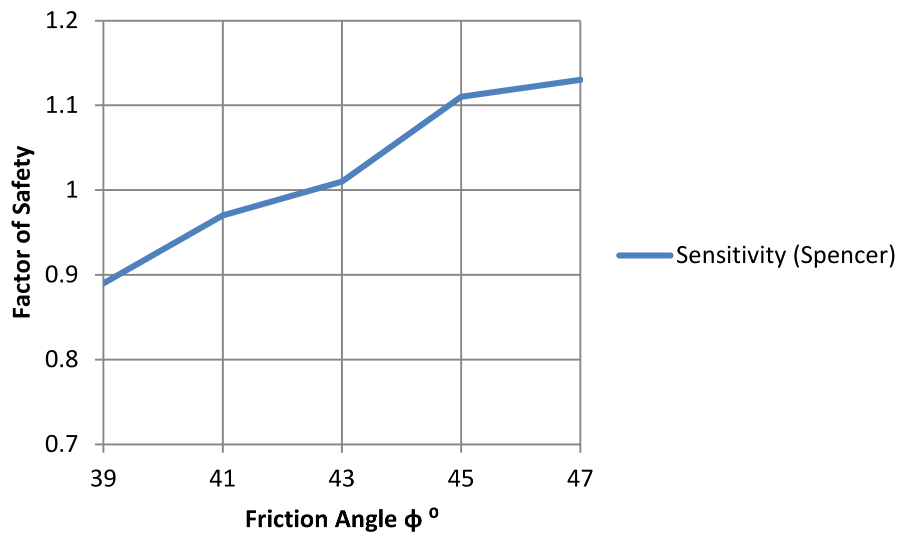


Figure 3. FoS v. Waste Rock Pile's Angle of Friction

Figure 4. FoS v. Distance of Wheel Loads from the Crest of the Waste Rock Pile

3.2 Long-term (Reclamation/Abandonment/Static) (Stability Conditions 2 and 4)

The failure surfaces which provided the lowest FoS, under Stability Condition 1, were analysed under Stability Condition 2. It was found that all slip surfaces occurred as shallow skin failures along the outer slope of the waste rock pile due to haul truck wheel loads 1 m from the crest of the waste rock pile. As this analysis searched the entire dump, and the FoS generally increased with depth, there was no further analysis carried out for deep seated failures without haul truck loading (Stability Condition 4).

3.3 Short-term (static) (Stability Conditions 3)

Deep seated slip surfaces (Stability Condition 3) were considered with the haul truck wheel loads applied 1 m from the crest of the waste rock pile. Analyses were carried out using a minimum depth of 7 and 10 m, as a constraint to force the critical slip surface to depth and a focus search window for the Block Slip Search Function to focus on a deeper area than the unrefined optimized search would.

4 Waste Rock Pile Stability Rating

A Dump Stability Rating (DSR) for the waste rock pile, on Pad T, was also completed in accordance with the guidelines set by the British Columbia Mine Waste Rock Pile Research Committee (1991). For frozen foundation conditions the stability rating for the waste rock pile, on Pad T, is 250 (Class I Stability). The rating selection is presented in Appendix D. The level of slope stability analyses presented in Section 3 was completed in accordance with the DSR Recommended Level of Effort shown in Attachment 4.

5 Discussion

The results of the slope stability analysis for three stability analyses which were evaluated can be summarized as follows:

Short-term (during construction) (Stability Condition 1): The minimum required FoS of 1.0 was met and exceeded for all but one analysis conducted for this Stability Condition. The Auto-Refine (Non-Circular) Search Function under Entry/Exit and Optimized Search Constraints had a FoS of 0.9. Based on all the slope stability analyses, the bearing capacity analysis, and sensitivity analyses along with some assessment of conservative aspects of the model, the FoS of 0.9 indicates a safe setback distance of a minimum 1.2 m, from the crest of the waste rock pile, must be maintained for the safe operation of the haul truck dumping waste rock at the crest of the waste rock pile.

The results of these slope stability and bearing capacity analyses indicate a minimum safe distance from the crest of the waste rock pile, of a minimum of 1.2 m, should be maintained for haul trucks dumping waste rock close to the crest of the waste rock pile. This minimum distance, of 1.2 m, from the crest of the waste rock pile is based on a FoS of 1.0 and does not take into consideration any additional distance from the crest of the waste rock pile that should be maintained for operational safety.

Long-term (reclamation/abandonment/static) (Stability Conditions 2 and 4): All stability analyses conducted, for this Stability Condition, had a FoS of 2.0 which exceeds the recommended FoS of 1.1. The entire waste rock pile was searched for potential slip surfaces and deep seated failures. The results of these analyses had FoS greater than 2.0. For this reason, no additional analyses were conducted for Stability Condition 4.

Short-term (static) (Stability Conditions 3): Slip surfaces were forced to a minimum depth of 7 to 10 m for a search focus window near the base of the waste rock pile resulted in FoS of 1.9 to 2.0 which exceeds the recommended FoS of 1.1.

The results of the slope stability analyses discussed above, can be considered to be conservative. The slope stability analyses assumes the wheel loads are applied along the entire crest of the crest of the waste rock pile (i.e. the assumption of a plane strain problem) and does not take into consideration the wheel loads are, in fact, a point load. Additional resistance, to a slope failure, can be achieved when a three dimensional slip surface is considered; however, these analyses do not make an allowance for this.

6 References

American Society of Civil Engineers, Committee of the ASCE Los Angeles Section Geotechnical Group, 2002. Recommended Procedures for Implementation of DMG Special Publication 117 – Guidelines for Analyzing and Mitigating Landslide Hazards in California.

British Columbia Mine Waste Rock Pile Research Committee, 1991. British Columbia Mined Rock and Overburden Piles Investigation and Design Manual, Interim Guidelines. May. ISBN 0- 7718-9118-0.

RocScience Inc., 2014, Slide Version 6.029 - 2D Limit Equilibrium Slope Stability Analysis. www.rocscience.com, Toronto, Ontario, Canada.

SRK Consulting (Canada) Inc., 2006. Doris North Project – Thermal modeling to support design thickness for granular pads. Technical Memorandum, Prepared for Miramar Hope Bay Limited, Project Number: 1CM014.008, August 20, 2006.

SRK Consulting (Canada) Inc., 2009. Hope Bay Gold Project: Stage 2 Overburden Characterization Report. Report prepared for Hope Bay Mining Ltd. Project Number: 1CH008.002. September 2009.

SRK Consulting (Canada) Inc., 2010. Secondary Road Bridge Abutment Slope Stability Analysis. Technical Memorandum prepared for Hope Bay Mining Limited. Project Number: 1CH008.033, May 25, 2010.

SRK Consulting (Canada) Inc., 2011a. Hope Bay Project – Geotechnical Design Parameters. Revision 0. Report prepared for Hope Bay Mining Limited. Project Number: 1CH008.033.216, October 2011.

SRK Consulting (Canada) Inc., 2011b. Technical Specifications – Earthworks and Geotechnical Engineering Hope Bay Project, Nunavut, Canada – Revision G – Issued for Construction. Report prepared for Hope Bay Mining Ltd., Project Number: 1CH008.033.300. March 2011.

SRK Consulting (Canada) Inc., 2011c. Doris North Pad U Waste Rock Pile Stability Analysis. Technical Memorandum prepared for Project File, Project Number: 1CH008.033, June 29, 2011.

SRK Consulting (Canada) Inc., 2012. Engineering Drawings for the Doris North Camp Area Diversion Berm, Doris North Project, Nunavut, Canada. As-built drawings prepared for Hope Bay Mining Ltd., Project No. 1CH008.058. July 2012.

SRK Consulting (Canada) Inc., 2014. Doris North Project: Waste Rock Storage Pile (Pad T) Design Brief. Technical Memorandum prepared for TMAC Resources Inc., Project Number 1CT022.001. January 16, 2014.

Turke, Henner, 1999. Statik im Erdbau 3. Auflage, Pages 100-103, Berlin, Ernst and Sohn.

Attachment 1

Sandvik TH540 Underground Haul Truck Wheel Loads

Wheel load approximation for the Sandvik TH540

			Reference
Operating Weight	34700	kg	(1)
Payload Capacity	40000	kg	(1)
Gross operating weight	74700	kg	(1)
Max operating weight	82700	kg	(2)
Loaded front axel weight	37200	kg	
% of gross operating weight	49.8%		
Loaded front rear weight	37500	kg	
% of gross operating weight	50.2%		
Front axel maximum weight	41184	kg	
Rear axel weight	41516	kg	
Load on each front tire	202.0072	kN	
Load on each rear tire	203.6363	kN	
Tire static loaded width	743	mm	(3)
Static loaded radius	784	mm	(3)
Assumed Contact length	743	mm	
Contact Area of one tire	0.552049	m2	
Ground pressure applied by each rear tire	368.87	kPa	

(1) Details on the Sandvik TH540 can be found in the Technical specs online

http://www.miningandconstruction.sandvik.com/sandvik/5100/SAM/Internet/cl01023.nsf/Alldocs/Products*5CLoad*and*haul*machines*5CUnderground*trucks*2ASandvik*40/$FILE/Sandvik%20TH540%20techspec.pdf

(2) 10-10-20 Payload Policy documents

Weight Calculation extracted from the Caterpillar 10-10-20 Payload Policy documents applied to the Sandvik Specs

Empty Chassis Weight (ECW) + Body and Liner = Empty Machine Weight (EMW) + Debris Fuel Attachments = Empty Operating Weight (EOW)

Target Gross Machine Weight (TGMW) -Empty Operating Weight (EOW) = Target Payload (TP)

Target Payload (TP) x 1.2 + Empty Operating Weight (EOW) < Maximum Gross Machine Weight (MGMW)

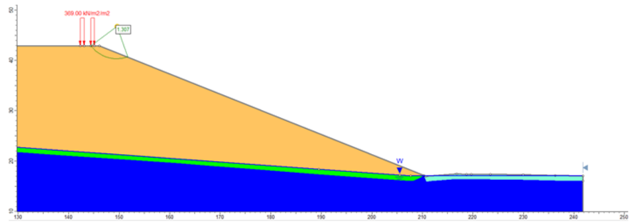
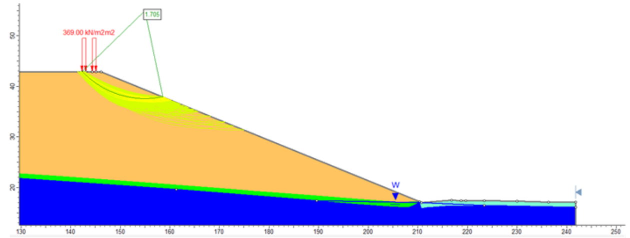
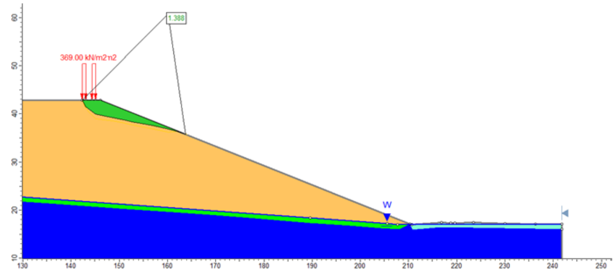
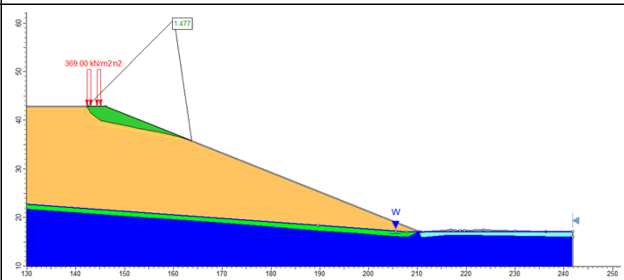
(3) Bridgestone tire specifications VLTS (26.5R25)

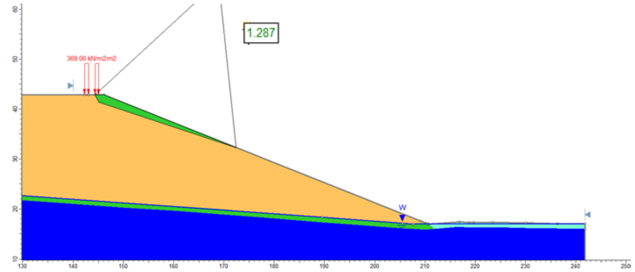
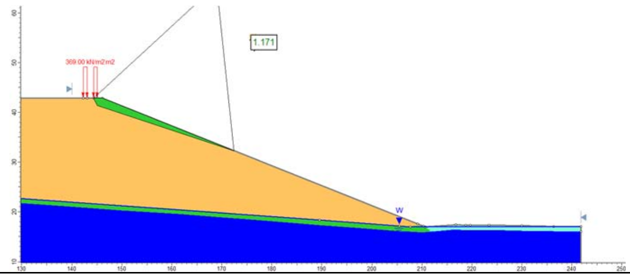
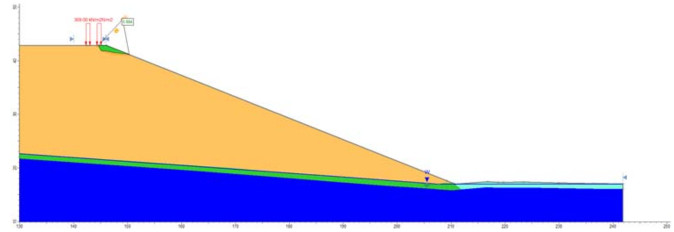
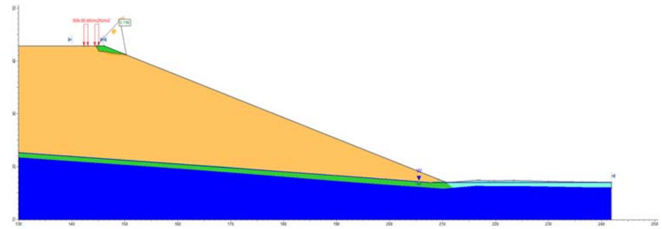
http://www.bridgestone.com/products/speciality_tires/off_the_road/products/pdf/brochure_earth_010.pdf

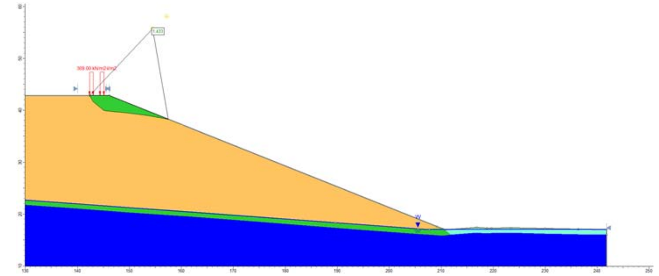
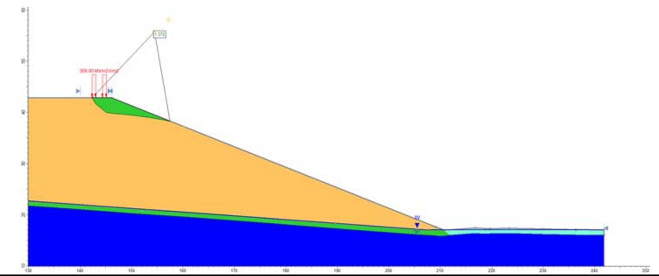
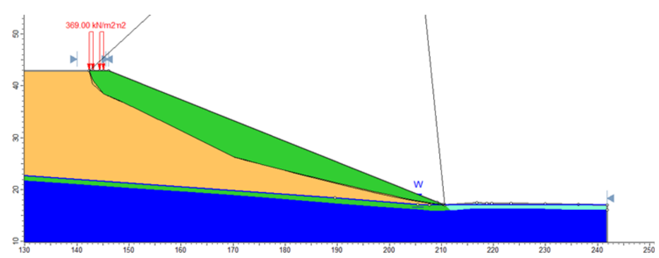
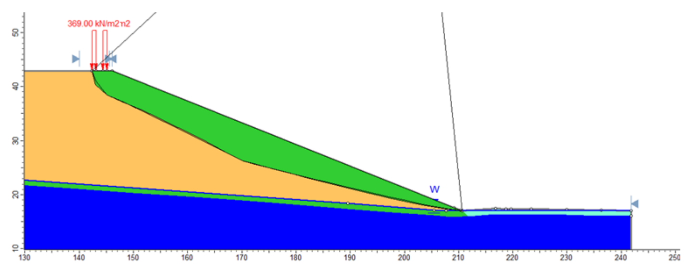
Attachment 2

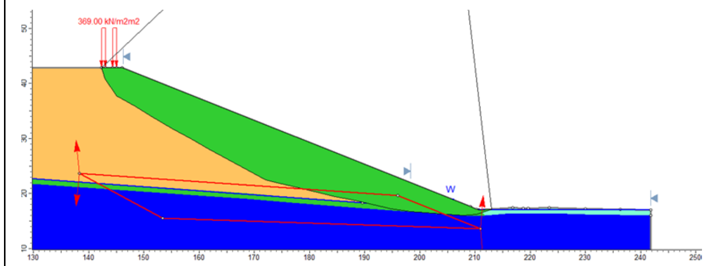
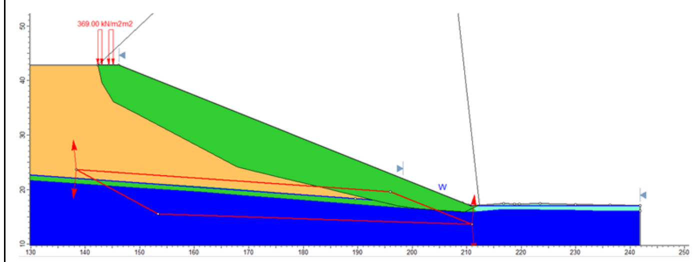
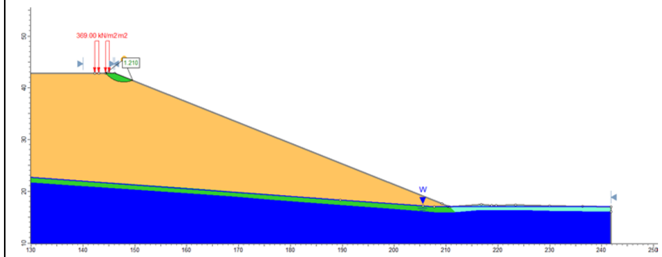
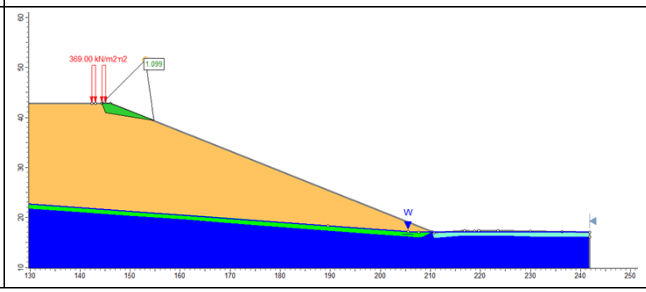
Summary of Slope Stability Analyses

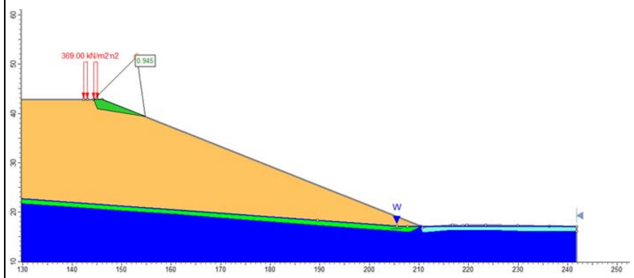
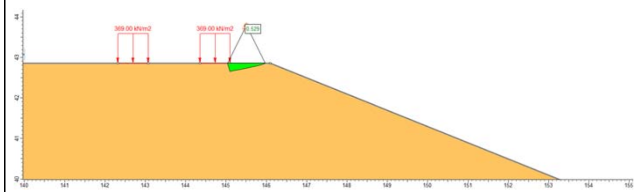
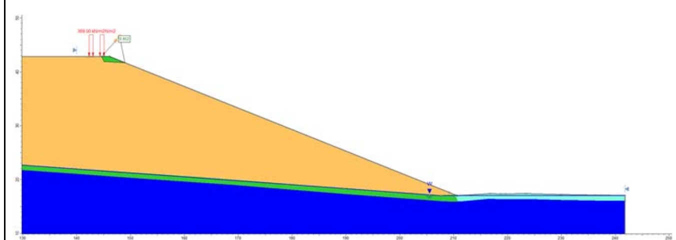
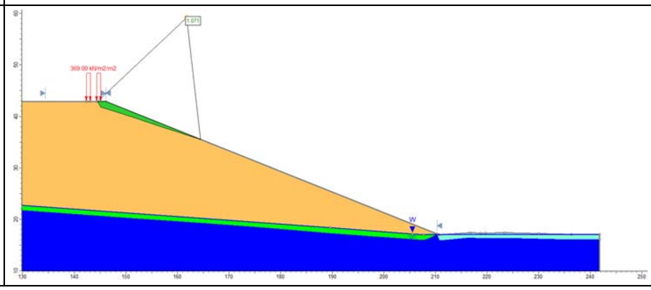
Stability Analysis with Wheel Loading Applied.

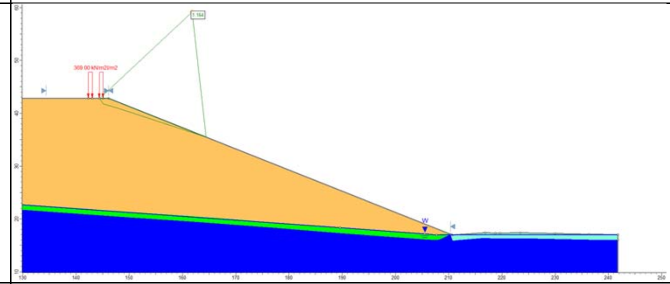
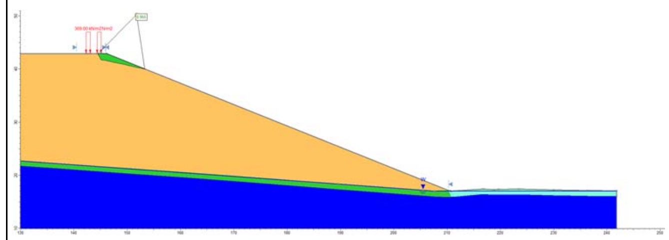
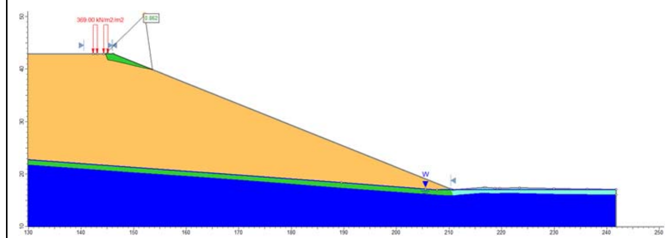
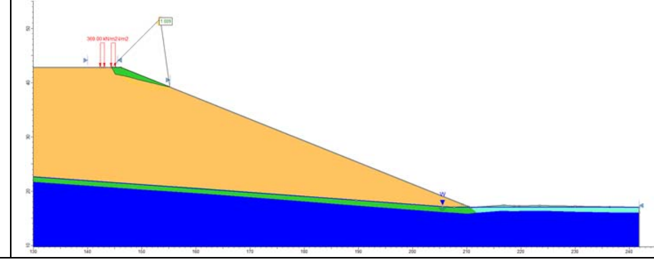
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
1	Stability Condition 1	Spencer	1.3	Auto-Refine (Circular)	-	-	
2	Stability Condition 1	Morgenstern-Price	1.7	Auto-Refine (Circular)	-	Minimum 1m depth	
3	Stability Condition 1	Morgenstern-Price	1.4	Auto-Refine (Non-circular)	-	-	
4	Stability Condition 1	Spencer	1.5	Auto-Refine (Non-circular)	-	-	

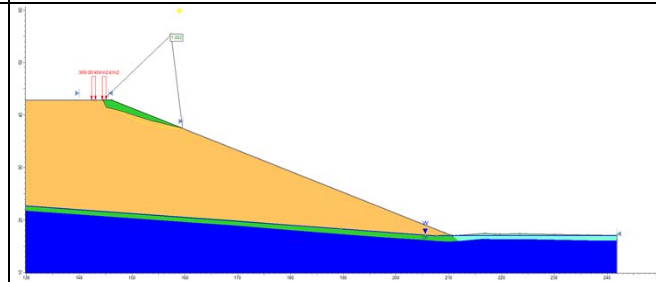
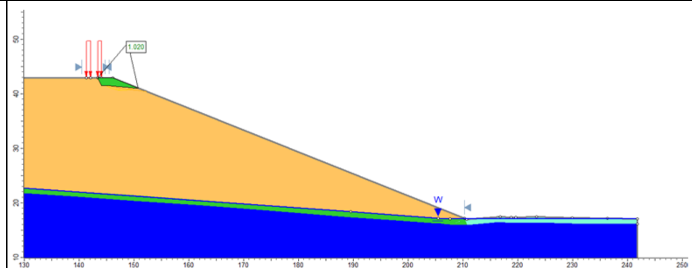
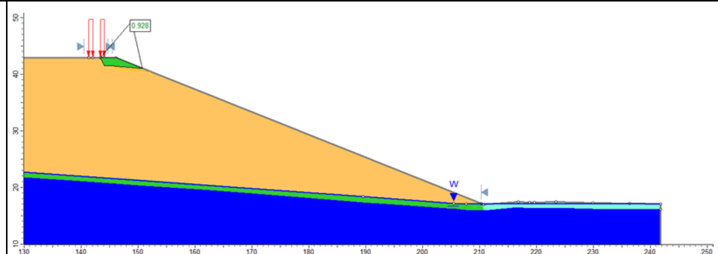
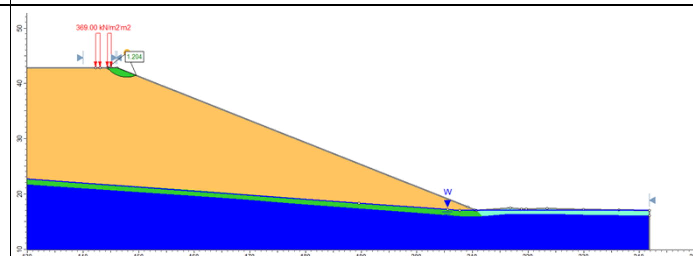
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
5	Stability Condition 1	Spencer	1.3	Auto-Refine (Non-circular)	Optimized	-	
6	Stability Condition 1	Morgenstern-Price	1.2	Auto-Refine (Non-circular)	Optimized	-	
7	Stability Condition 1	Spencer	0.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	
8	Stability Condition 1	Morgenstern-Price	0.8	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	

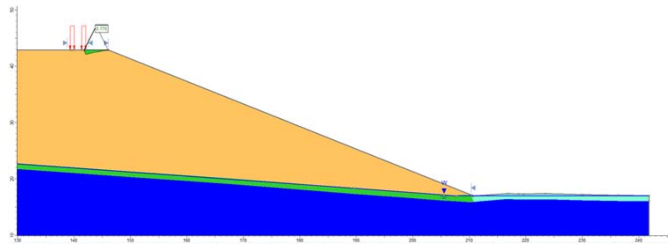
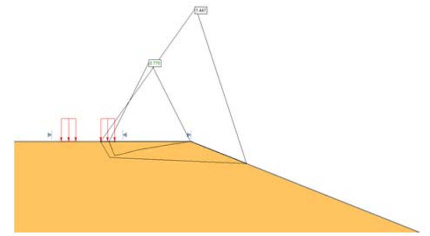
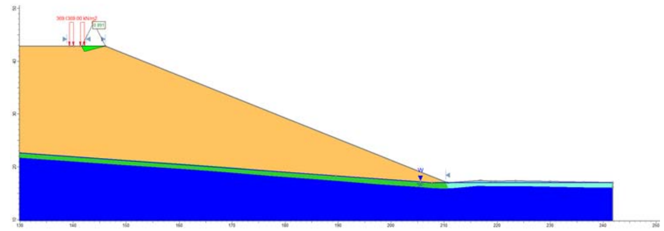
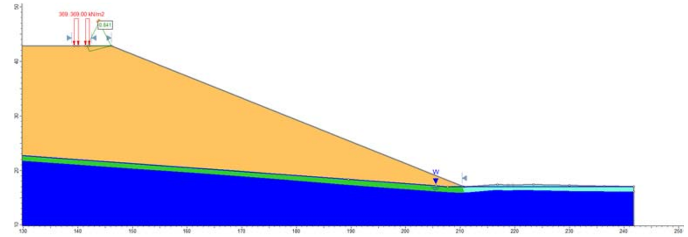
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
9	Stability Condition 1	Spencer	1.4	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 3m depth	
10	Stability Condition 1	Morgenstern-Price	1.4	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 3m depth	
11	Stability Condition 3	Spencer	1.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 7m depth	
12	Stability Condition 3	Morgenstern-Price	1.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 7m depth	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
13	Stability Condition 3	Spencer	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 10m depth	
14	Stability Condition 3	Morgenstern-Price	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 10m depth	
15	Stability Condition 1	Morgenstern-Price	1.2	Auto-Refine (Circular)	Entry/Exit Constrained	-	
16	Stability Condition 1	Spencer	1.1	Simulated Annealing	Optimized	-	

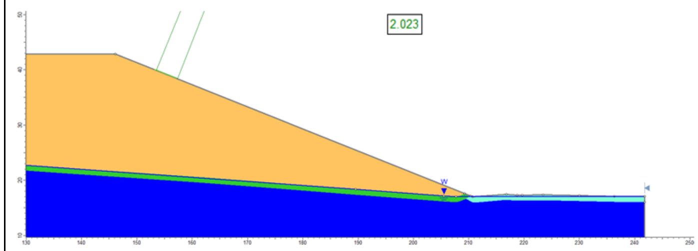
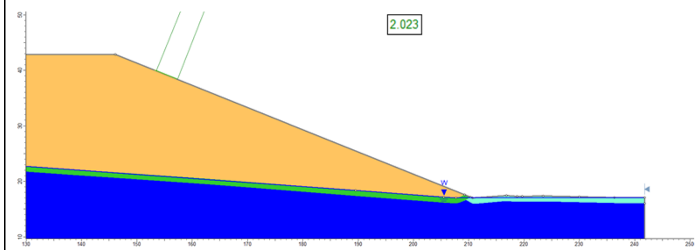
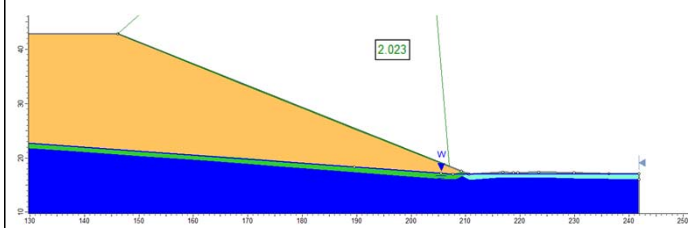
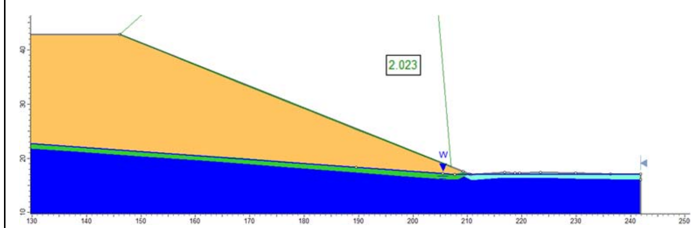
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
17	Stability Condition 1	Morgenstern-Price	0.9	Simulated Annealing	Optimized	-	
18	Stability Condition 1	Spencer	0.5	Simulated Annealing	Optimized	-	 The scale of this section view is increased to allow visibility of the failure surface
19	Stability Condition 1	Spencer	0.9	Simulated Annealing	Optimized	Minimum 1m depth	
20	Stability Condition 1	Morgenstern-Price	1.1	Block Slip	Optimized Entry/Exit Constrained	-	

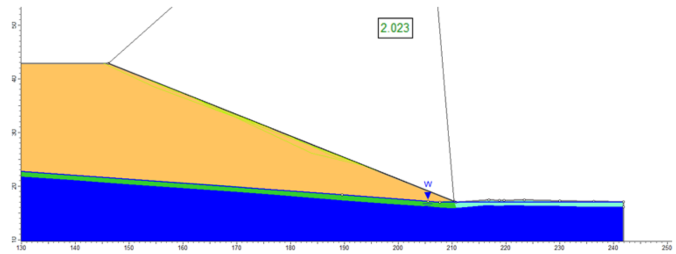
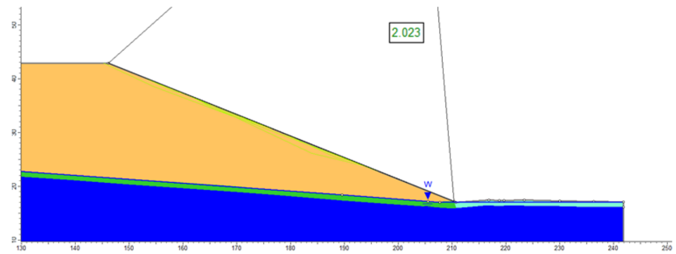
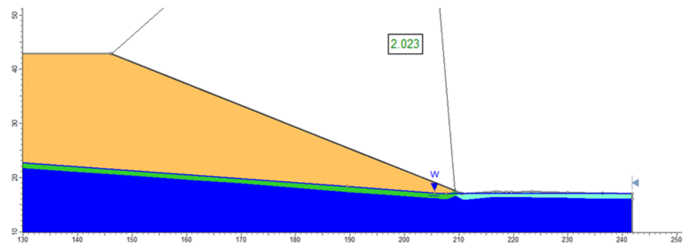
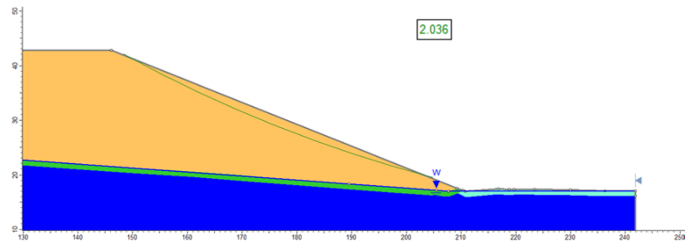
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
21	Stability Condition 1	Spencer	1.2	Block Slip	Optimized Entry/Exit Constrained	-	
22	Stability Condition 1	Spencer	1.0	Block Slip	Optimized Entry/Exit Constrained	-	
23	Stability Condition 1	Morgenstern-Price	0.9	Block Slip	Optimized Entry/Exit Constrained	-	
24	Stability Condition 1	Spencer	1.0	Auto Refine (Non-circular)	Optimized Entry/Exit Constrained	-	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
25	Stability Condition 1	Morgenstern-Price	1.0	Block Slip	Optimized Entry/Exit Constrained	-	
26	Stability Condition 1 (Modified for comparison)	Spencer	1.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 2m	
27	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 2m	
28	Stability Condition 1 (Modified for comparison)	Spencer	1.2	Auto-Refine (Non-circular)	Entry/Exit Constrained	Load Setback 2m	

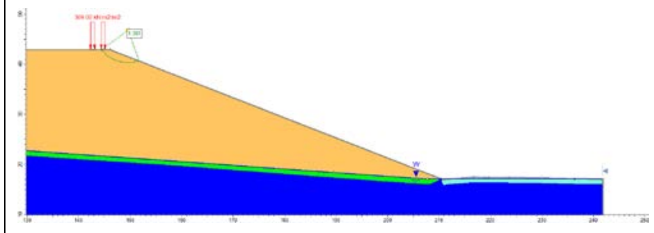
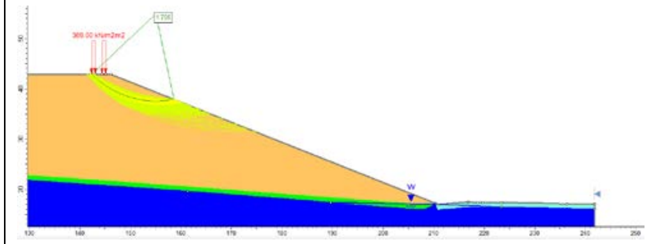
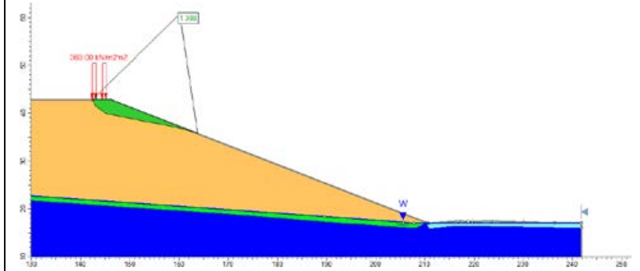
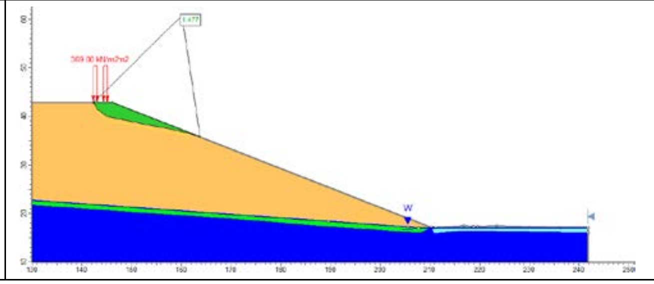
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
29	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.8	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 4m	
30	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	1.5	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 4m	 The scale of this section view is increased to allow visibility of the failure surface
31	Stability Condition 1 (Modified for comparison)	Spencer	0.9	Simulated Annealing	Optimized Entry/Exit Constrained	Load Setback 4m	
32	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.8	Simulated Annealing	Optimized Entry/Exit Constrained	Load Setback 4m	

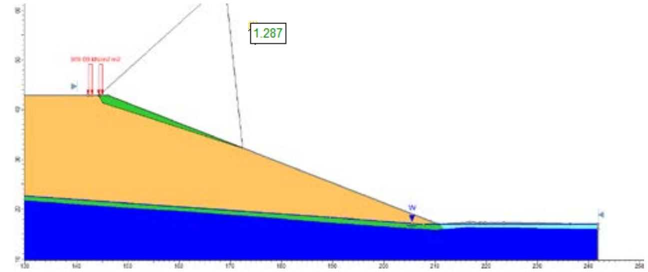
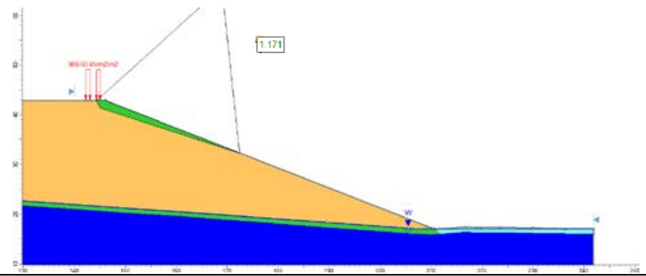
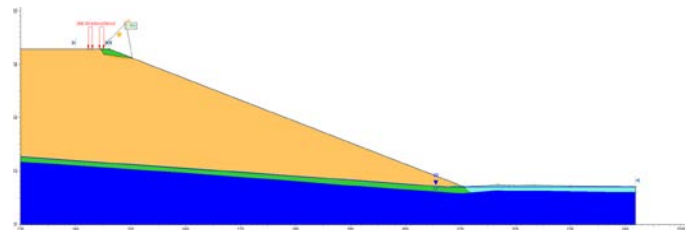
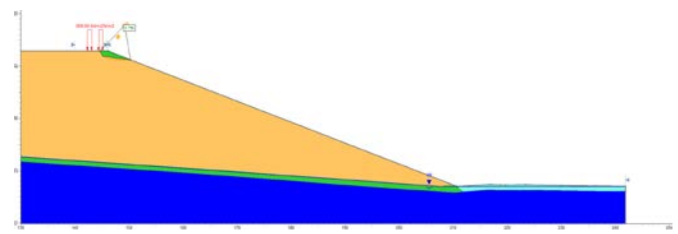
Stability Analysis with No Wheel Loading Applied.

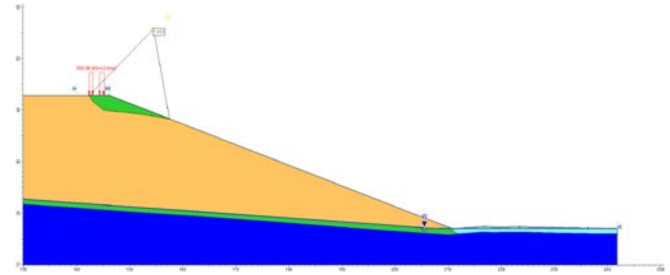
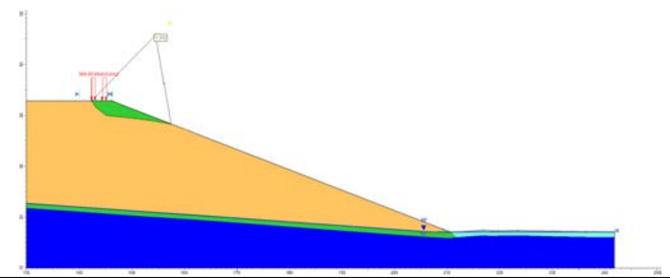
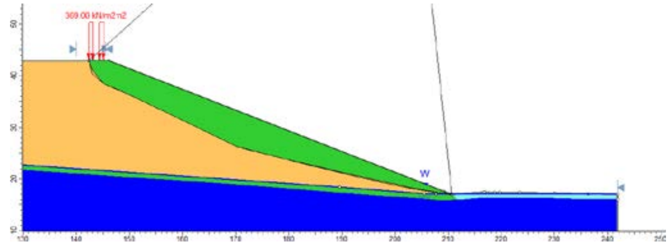
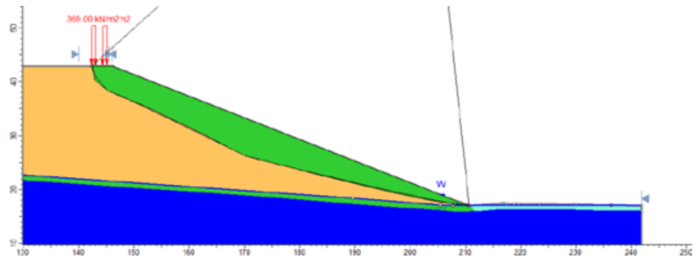
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
33	Stability Condition 2	Spencer	2.0	Auto-Refine (Circular)	Entry/Exit Constrained	-	
34	Stability Condition 2	Morgenstern-Price	2.0	Auto-Refine (Circular)	Entry/Exit Constrained	-	
35	Stability Condition 2	Spencer	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	
36	Stability Condition 2	Morgenstern-Price	2.0	Auto-Refine (Circular)	Optimized Entry/Exit Constrained	-	

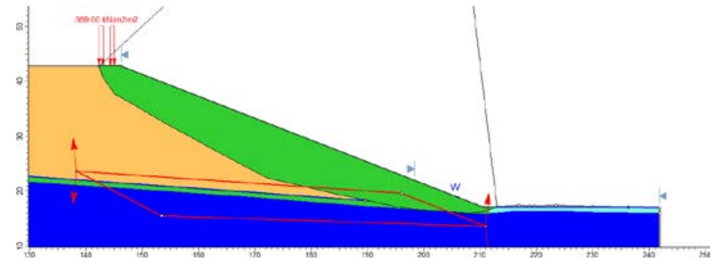
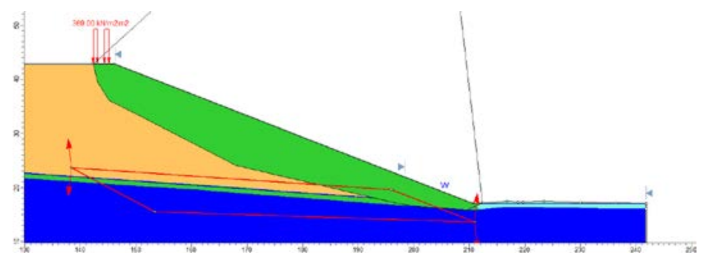
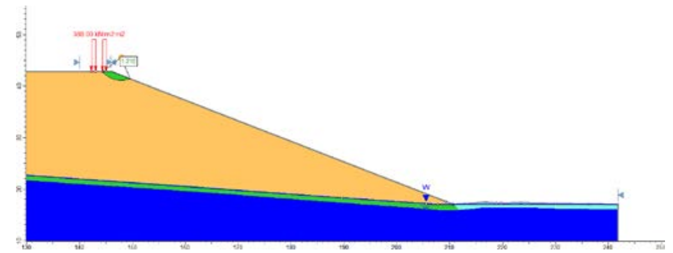
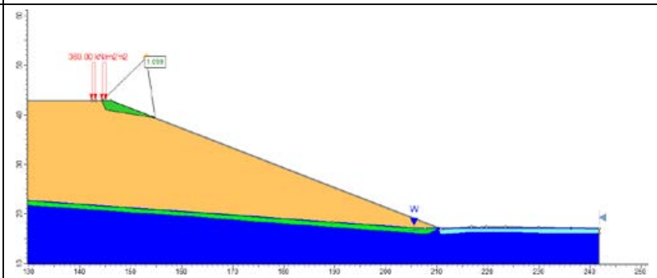
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
37	Stability Condition 2	Spencer	2.0	Block Slip	Optimized Search window over entire slope	The ten lowest surfaces are also shown	
38	Stability Condition 2	Morgenstern-Price	2.0	Block Slip	Optimized Search window over entire slope	The ten lowest surfaces are also shown	
39	Stability Condition 2	Spencer	2.0	Simulated Annealing	-	Shallow Skin Failure	
40	Stability Condition 2 (Modified for Comparison)	Spencer	2.0	Auto-Refine (Circular)	-	Minimum 1m Depth	

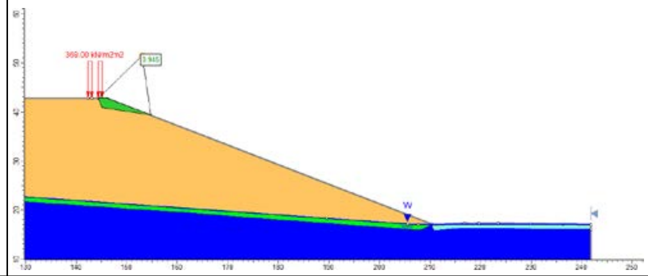
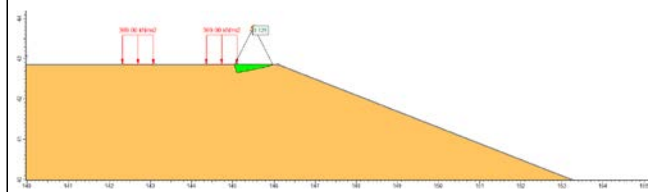
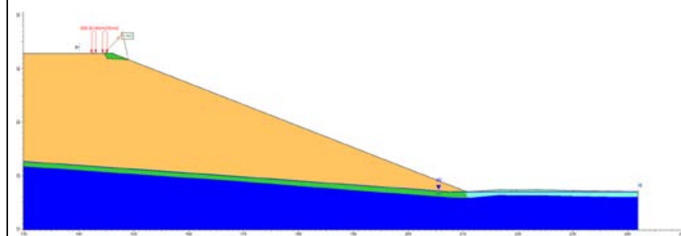
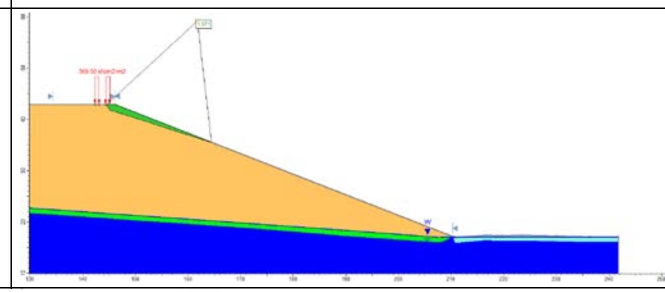
Stability Analysis with Wheel Loading Applied.

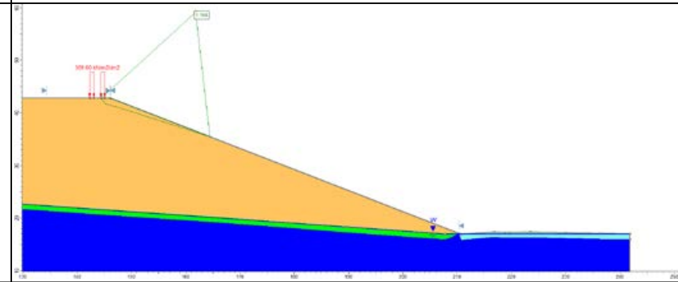
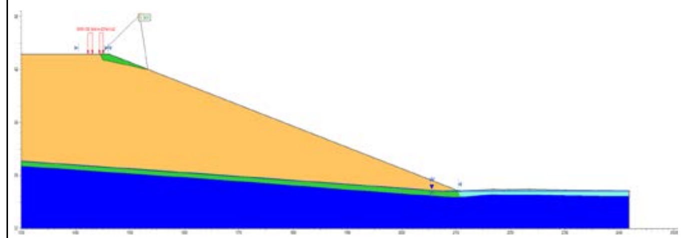
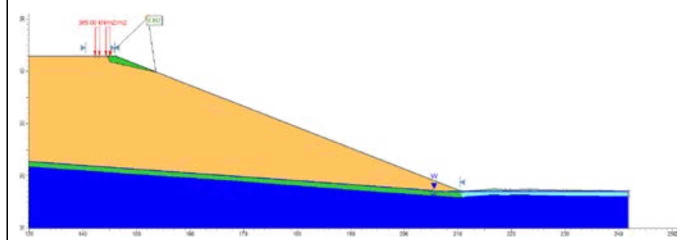
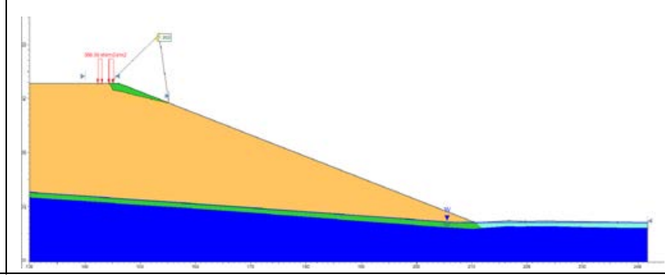
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
1	Stability Condition 1	Spencer	1.3	Auto-Refine (Circular)	-	-	
2	Stability Condition 1	Morgenstern-Price	1.7	Auto-Refine (Circular)	-	Minimum 1m depth	
3	Stability Condition 1	Morgenstern-Price	1.4	Auto-Refine (Non-circular)	-	-	
4	Stability Condition 1	Spencer	1.5	Auto-Refine (Non-circular)	-	-	

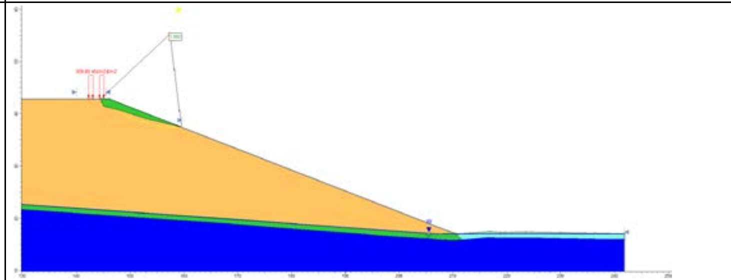
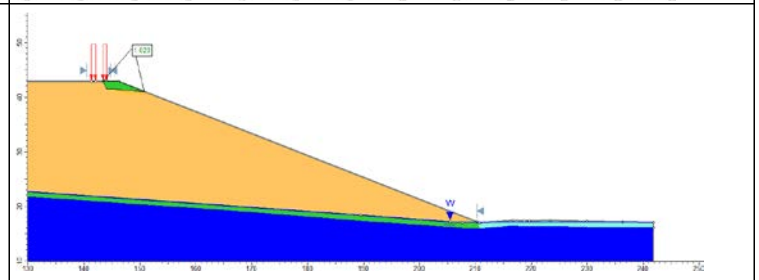
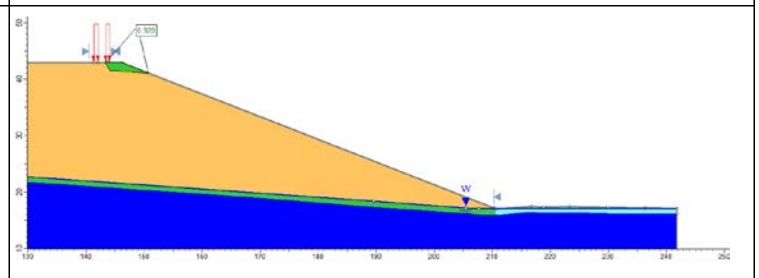
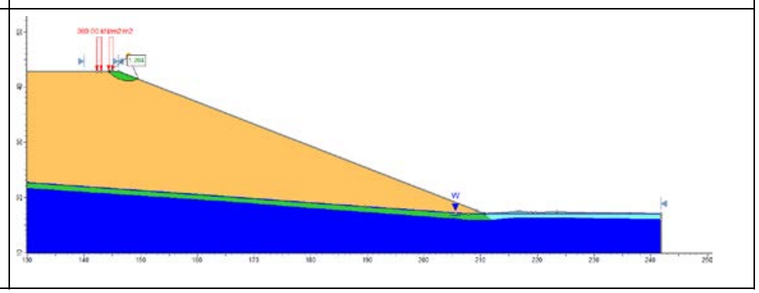
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
5	Stability Condition 1	Spencer	1.3	Auto-Refine (Non-circular)	Optimized	-	
6	Stability Condition 1	Morgenstern-Price	1.2	Auto-Refine (Non-circular)	Optimized	-	
7	Stability Condition 1	Spencer	0.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	
8	Stability Condition 1	Morgenstern-Price	0.8	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	

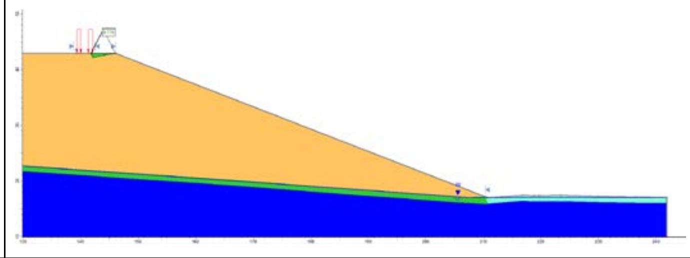
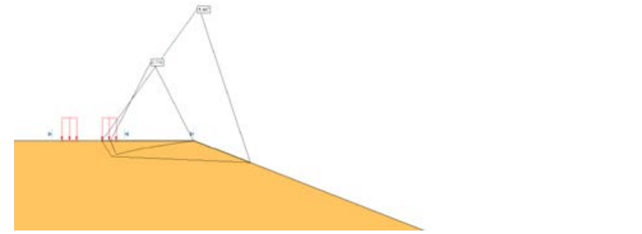
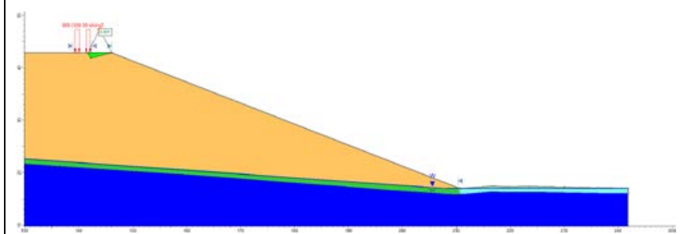
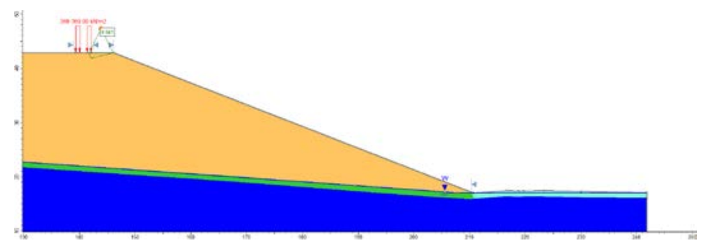
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
9	Stability Condition 1	Spencer	1.4	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 3m depth	
10	Stability Condition 1	Morgenstern-Price	1.4	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 3m depth	
11	Stability Condition 3	Spencer	1.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 7m depth	
12	Stability Condition 3	Morgenstern-Price	1.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 7m depth	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
13	Stability Condition 3	Spencer	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 10m depth	
14	Stability Condition 3	Morgenstern-Price	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Minimum 10m depth	
15	Stability Condition 1	Morgenstern-Price	1.2	Auto-Refine (Circular)	Entry/Exit Constrained	-	
16	Stability Condition 1	Spencer	1.1	Simulated Annealing	Optimized	-	

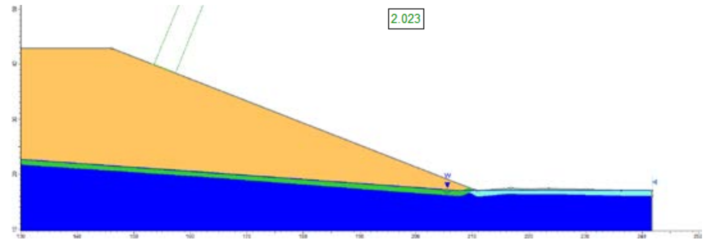
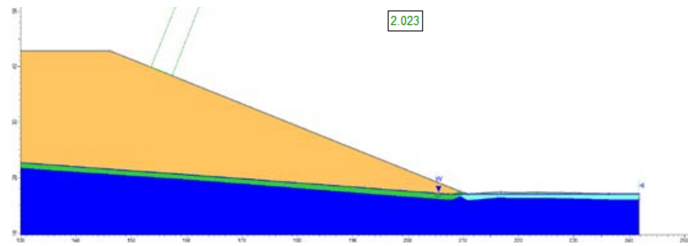
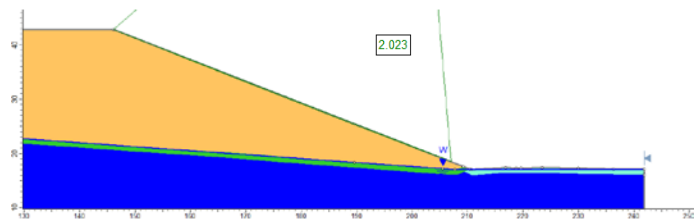
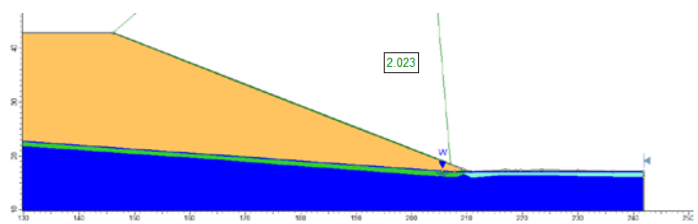
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
17	Stability Condition 1	Morgenstern-Price	0.9	Simulated Annealing	Optimized	-	
18	Stability Condition 1	Spencer	0.5	Simulated Annealing	Optimized	-	 The scale of this section view is increased to allow visibility of the failure surface
19	Stability Condition 1	Spencer	0.9	Simulated Annealing	Optimized	Minimum 1m depth	
20	Stability Condition 1	Morgenstern-Price	1.1	Block Slip	Optimized Entry/Exit Constrained	-	

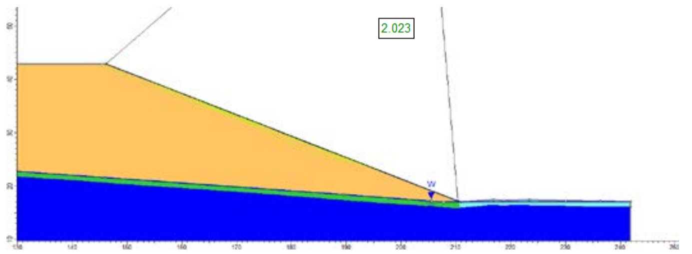
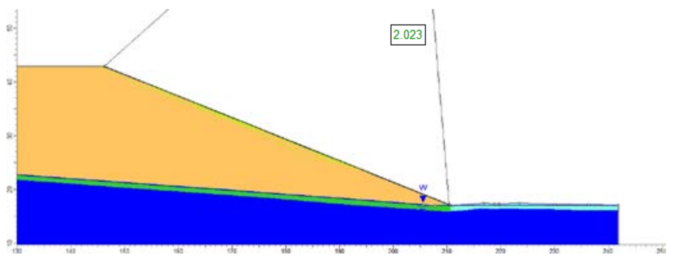
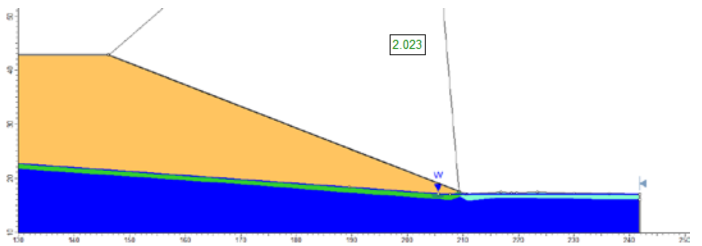
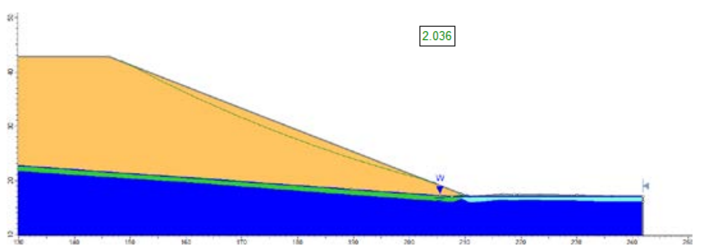
Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
21	Stability Condition 1	Spencer	1.2	Block Slip	Optimized Entry/Exit Constrained	-	
22	Stability Condition 1	Spencer	1.0	Block Slip	Optimized Entry/Exit Constrained	-	
23	Stability Condition 1	Morgenstern-Price	0.9	Block Slip	Optimized Entry/Exit Constrained	-	
24	Stability Condition 1	Spencer	1.0	Auto Refine (Non-circular)	Optimized Entry/Exit Constrained	-	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
25	Stability Condition 1	Morgenstern-Price	1.0	Block Slip	Optimized Entry/Exit Constrained	-	
26	Stability Condition 1 (Modified for comparison)	Spencer	1.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 2m	
27	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.9	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 2m	
28	Stability Condition 1 (Modified for comparison)	Spencer	1.2	Auto-Refine (Non-circular)	Entry/Exit Constrained	Load Setback 2m	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
29	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.8	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 4m	
30	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	1.5	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	Load Setback 4m	 The scale of this section view is increased to allow visibility of the failure surface
31	Stability Condition 1 (Modified for comparison)	Spencer	0.9	Simulated Annealing	Optimized Entry/Exit Constrained	Load Setback 4m	
32	Stability Condition 1 (Modified for comparison)	Morgenstern-Price	0.8	Simulated Annealing	Optimized Entry/Exit Constrained	Load Setback 4m	

Stability Analysis with No Wheel Loading Applied.

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
33	Stability Condition 2	Spencer	2.0	Auto-Refine (Circular)	Entry/Exit Constrained	-	
34	Stability Condition 2	Morgenstern-Price	2.0	Auto-Refine (Circular)	Entry/Exit Constrained	-	
35	Stability Condition 2	Spencer	2.0	Auto-Refine (Non-circular)	Optimized Entry/Exit Constrained	-	
36	Stability Condition 2	Morgenstern-Price	2.0	Auto-Refine (Circular)	Optimized Entry/Exit Constrained	-	

Run #	Stability Condition	Limit equilibrium Method	Minimum FoS	Search Function	Additional Refinement Options	Other Notes	Critical Slip Surface
37	Stability Condition 2	Spencer	2.0	Block Slip	Optimized Search window over entire slope	The ten lowest surfaces are also shown	
38	Stability Condition 2	Morgenstern-Price	2.0	Block Slip	Optimized Search window over entire slope	The ten lowest surfaces are also shown	
39	Stability Condition 2	Spencer	2.0	Simulated Annealing	-	Shallow Skin Failure	
40	Stability Condition 2 (Modified for Comparison)	Spencer	2.0	Auto-Refine (Circular)	-	Minimum 1m Depth	

Attachment 3

Bearing Capacity Failure Calculation

Bearing capacity near edge of Waste rock pile

Tire contact area 0.743 m × 0.743 m = 0.552 m²
Load on rear tires (each) = 203.6 kN

Ground pressure = 369 kPa

from Terzaghi's Bearing Capacity Theory (square footing)

$$q_{ult} = 1.3c' N_c + \sigma'_{z0} N_q + 0.4 \gamma' B N_\gamma$$

$$= 0 + 0 + 0.4(20) \cdot 0.743 \cdot 99.7 = \underline{\underline{592.8 \text{ kPa}}}$$

$$N_\gamma = \frac{2(N_q+1)\tan\phi'}{1+0.4\sin 4\phi'}$$

$$N_q = \frac{e^{2\pi(0.75-\phi'/360)\tan\phi'}}{2\cos^2(45+\phi'/2)} = \frac{e^{2\pi(0.75-39/360)\tan(39)}}{2\cos^2(45+39/2)} = 70.6$$

$$N_\gamma = \frac{2(70.6+1)\tan(39)}{1+0.4\sin(4(39))} = 99.7$$

$$FOS = \frac{q_{ult}}{q_{Tire}} = \frac{592.8}{369} = 1.61$$

SRK Consulting
Engineers and Scientists

Project No. 1CT002.001 Site Hope Bay Pad T
Prepared by PDL Date Nov 20/14
Approved by ______ Date ______
Subject ______ Sheet 2 of 3

$N_c = (N_d - 1)\cot(\phi) = (55.96-1)\cot(39) = \underline{67.87}$

$N_d = e^{\pi\tan(\phi)} \cdot \tan^2(45+\frac{1}{2}\phi) = e^{\pi\tan(39)} \cdot \tan^2(45+\frac{1}{2}(39)) = \underline{55.96}$

$N_b = (N_d - 1)\tan\phi = (55.96-1)\tan(39) = \underline{44.50}$

$\beta = 21.8^\circ$ (2.5:1)

$\sigma_{of} = C\cdot N_c \cdot \nu_c \cdot K_c \cdot \lambda_c + \gamma_1 d' N_d \cdot \nu_d \cdot K_d \cdot \lambda_d + \gamma_2 \cdot b' \cdot N_b \cdot \nu_b \cdot K_b \cdot \lambda_b$ (c = 0)

$$\lambda_c = \frac{N_d \cdot e^{-0.0349\cdot\beta\cdot\tan\phi} - 1}{N_d - 1} = \frac{55.96\cdot e^{-0.0349\cdot 21.8\cdot\tan(39)} - 1}{55.96-1} = \boxed{0.5317}$$

$\lambda_d = (1-\tan\beta)^{1.9} = (1-\tan 21.8)^{1.9} = \boxed{0.3789}$

$\lambda_b = (1-0.5\tan\beta)^6 = (1-0.5\tan 21.8)^6 = \boxed{0.2622}$

$\phi > 0$ $\nu_c = \frac{\nu_d \cdot N_d - 1}{N_d - 1} = \frac{(1.629\cdot 55.96)-1}{(55.96-1)} = \boxed{1.641}$

$\nu_d = 1 + \frac{b}{a}\sin\phi$ where $\frac{b}{a} = 1$ $= 1+\sin 39$ $\boxed{1.629}$

$\nu_b = 1 - 0.3\cdot\frac{b}{a} = \boxed{0.7}$

$K_c = K_d = K_b = 1$ (applied force Normal to surface)

$d' = d + 0.8\cdot B_o\tan\beta = 0 + 0.8\cdot\tan(21.8)\cdot B_o$

$B_o = 2$ m $d' = 0.64$ m

$B_o = 3$ m $d' = 0.96$ m

$B_o = 4$ m $d' = 1.28$ m

$B_o = 5.55$ m $d' = 1.78$ m (1)

Distance to edge of slip surface

for $\beta = 0$, $d' = d = 0$ case

$\lambda_b = (1-0.5\tan(0))^6 = 1$

$\nu_b = 0.7$ (as above)

$N_b = 44.5$ (as above)

σ_{of} with d' for $B_o = 2$ $d' = 0.64m$

$$\sigma_{of} = 0 + \gamma_1 d' N_d \cdot \nu_d \cdot k_d \cdot \lambda_d + \gamma_2 \cdot b' \cdot N_b \cdot \nu_b \cdot K_b \cdot \lambda_b$$

$$= 0 + 20 \cdot 0.64 \cdot 55.96 \cdot 1.629 \cdot 1 \cdot 0.3789 + \ldots$$

$$\ldots + 20 \cdot 0.743 \cdot 44.5 \cdot 0.7 \cdot 1 \cdot 0.2623$$

$\sigma_{of_d} =$ 563.5 kPa

$\sigma_{of(d'=d)} = 0 + 0 + 20 \cdot 0.743 \cdot 44.5 \cdot 0.7 \cdot =$

$\sigma_{of}(d'=d)_{\beta=0}$ 462.9 kPa

Try with $B_o = 5.55m$ $d'=d=0$ $\beta=0$

$\sigma_{of}(d'=d) = 0 + 0 + 20 \cdot 0.743 \cdot 44.5 \cdot 0.7 \cdot 1 = 462.9$ kPa

Distance does not affect the $\beta=0$, $d'=d=0$ check case

$B_o = 5.55m$ $d' = 1.78m$ (1) from page 2

$$\sigma_{of} = 20 \cdot 1.78 \cdot 55.96 \cdot 1.629 \cdot 1 \cdot 0.3789 + 20 \cdot 0.743 \cdot 44.5 \cdot 0.7 \cdot 1 \cdot 0.2622$$
$= 1348$ kPa

as d' is the only variable affected by the distance B_o solve for B_o where $\frac{\sigma_{of}}{q} = 1$ using Spreadsheet.

$B_o = 1.12m$ $d' = 0.358$ $\sigma_{of} = 369$ kpa

Bearing capacity vs distance to crest check

Soil unit weight (γ)	20	kN/m3
Φ	39.0	deg.
Slope angle β	21.8	deg.
Load width	0.74	m
Distance from crest B_o	1.12	m
depth of applied load d	0	m
effective depth d'	0.36	m
Bearing Capcity σ_{of}	369.4	kPa

$$\sigma_{0f} = c \cdot N_c \cdot \nu_c \cdot \kappa_c \cdot \lambda_c + \gamma_1 \cdot d' \cdot N_d \cdot \nu_d \cdot \kappa_d \cdot \lambda_d + \gamma_2 \cdot b' \cdot N_b \cdot \nu_b \cdot \kappa_b \cdot \lambda_b$$

Equation Factors

Nc	67.87
Nd	55.96
Nb	44.5

λc	0.5317
λd	0.3789
λb	0.2622

vc	1.641
vd	1.629
vb	0.7

κc	1
κd	1
κb	1

From the text

Turke, Henner. Statik im Erdbau 3. Auflage, Berlin, 1999, Pages 100-103

Attachment 4

British Columbia Waste Rock Pile Research Committee – Dump Stability Rating

Structure Name: Pad T - Frozen Foundation

Key Factor Affecting Stability	Conditions	Description	Rating Points
Dump height	<50m		0
Dump Volume	Small	< 1 million BCM's	0
Dump slope	Flat	<26 deg.	0
Foundation Slope	Flat	<10%	0
Degree of confinement	Moderately Confined	-Natural benches or terraces on slope -Even slopes, limited natural topographical diversity -Heaped, sidehill or broad valley or cross-valley fills	50
Foundation Type	Intermediate	- Intermediate between competent and weak -Soils gain strength with consolation -Adverse pore pressures dissipate if loading rate controlled	100
Dump Material Quality	High	- Strong, durable - Less than about 10% fines	0
Method of Construction	Favorable	- Thin lifts (<25m thick), wide platforms -Dumping along contours -Ascending construction -Wrap-arounds or terraces	0
Piezometric and Climatic Conditions	Intermediate	- Moderate piezometric pressures, some seeps in foundation - Limited development of phreatic surface in dump possible - Moderate precipitation - High infiltration into dump - Discontinuous snow or ice lenses or layers in dump	100
Dumping rate	Slow	- <25 BCM's per lineal metre of crest per day - Crest advancementrate < 0.1m per day	0
Seismicity	Low	Seismic Risk Zone 0 and 1	0
		Dump Stability Rating (DSR)	

Dump Stability Class	Failure Hazard	Recommended Level of Effort for Investigation, Design and Construction	Dump Rating (DSR)
1	**Negligible**	- Basic site reconaissance, baseline documentation -Minimal lab testing - Routine check of stability, possibly using charts - Minimal restriction on construction - Visual monitoring only	**250**
Comments:			

Based on the BC Mine Waste Rock Pile Research Committee; Mined Rock and Overburden Piles Investigation and Design Manual, Interm Guidelines, May 1991.

LOW SALT UNDERGROUND BRINE WATER USE PROCEDURE

PURPOSE

The purpose of this Procedure is to describe TMAC's approach to minimizing brine water use. Minimizing salt use underground is necessary to realize cost savings and minimize effects arising from excessive salt use. High levels of salt inhibit freezing and can be toxic to the environment. In a permafrost environment, the former is key to waste stabilization and infrastructure integrity. The effects of excessive salt use include:

- Impacts to structural integrity of infrastructure components arising from ground thaw.
- Increased/alternative need for wastewater treatment and disposal.
- Increased challenges with waste (waste rock, tails) disposal and stabilization.
- Decrease in potential to reuse/repurpose materials (i.e. waste rock use for construction).

Implementation of this Procedure will minimize these effects.

This Procedure outlines:

- Brine composition, mixing and storage;
- Dust suppression and muck pile management;
- Drilling and cuttings management;
- Bolt inflation; and
- Underground geological mapping.

SCOPE

This Procedure applies to all underground drilling (including development, bolting and exploration) and dust suppression. This Procedure is to be implemented throughout all underground drilling.

RESPONSIBILITY

Title or Position	Key Responsibilities
Mine Manager	Ensure the procedures for brine management are maintained current and communicated to Underground Supervisor and Exploration Drilling Supervisor and Geology Supervisor
Underground Supervisor	Provide brine management procedure to Drillers, Bolters and other miners. Ensure mine-supplied equipment required for compliant brine management is available and resources are in place to maintain equipment. Receive and review brine management reports from Operators. Train operators in compliant brine management. Maintain training records. Audit dust suppression techniques. Review findings with Operators.
Drilling Foreman	Train drillers in compliant brine management. Maintain training records. Audit brine management procedures. Review findings with Drillers and Underground Supervisor.
Geology Supervisor	Train mine geologists and technicians in compliant brine management. Maintain training records. Audit brine management procedures.
Mine Geologists and Technicians	Implement brine management procedures (Mapping).
Drillers and Bolters	Implement brine management procedures (drilling and bolting).
Miners and Operators	Implement brine management procedures (dust suppression).

SAFETY

All personnel working underground must receive training and induction in accordance with site standards. Standard underground PPE must be worn at all times. In addition to standard procedures, there are safety concerns particular to the procedures outlined herein. These, along with their respective mitigation steps, are summarized in Table 1.

Table 1. Potential risks and mitigation measures associated with implementation of the Low Salt Underground Drilling Procedure.

POTENTIAL RISK	MITIGATION MEASURES
Encountering steel rod, wire mesh, or other sharp debris in muck	• Always wear gloves when sampling. • Use a hand scoop or shovel for sampling where possible.
Loose or sharp rocks	• Scale first, scale well, and scale frequently. • Wear gloves at all time when sampling or scaling.
Heavy equipment operating underground	• Check with underground supervisor prior to going underground or to surface storage pads. • Communicate with workers nearby upon arrival at underground or surface worksite. • Carry a radio and notify mining personnel of changes in location or work plan.

PROCEDURES

1. *Brine Composition, Mixing and Storage*

Brine mixing tanks can include multiple 13,400 L tanks for exploration or 6,700 L for development.

Brine mixing tanks will either be located underground in the permafrost environment at -8°C (year round temperature), or in a contained enclosure reducing exposure to outdoor ambient temperature in winter. At this temperature underground or in a sheltered environment, lower salinity concentration brine can be used to keep the brine in liquid form up to -10°C. This approach removes the need to oversaturate the solution to keep it in liquid form.

With reference to the following phase diagram (Figure 1; DOW Calcium Chloride handbook), a 15 weight percent solution shall be utilized.

2. *Dust Suppression and Muck Pile Management*

Hose nozzle atomizers (nozzle that produces a fine mist) and/or a fogger will be used to create mist "curtain" for dust suppression at the muck pile prior to scooping. This decreases the amount of brine water used and the residual amount of salt in the waste rock.

It is not acceptable to use an open nozzle for dust suppression, nor is it acceptable to leave the hose running while not in use.

3. *Drilling and Cuttings Management*

Exploration Drilling

Conventional underground diamond drills are used for exploration. Brine water used for drilling is collected at the drift face in sumps and recycled underground by the brine water sump and pumping system. Most of this brine water is recycled but some is lost to fractures in the rock. Every opportunity to maximize brine recycle and reduce loss will be pursued.

Development Drilling

Jumbo drills and bolter drills equipped with water mist flushing systems will be utilized for development drilling. This system uses pressure and flow regulators and check valves to control the ratio of brine water and air going to the drill. The brine water and air is turned to mist in a mixing chamber and another regulating valve controls the mist going to the drill. This approach reduces the overall amount of brine used, while still washing cuttings from the holes and cooling the drill bits and steel.

Brine water used for drilling is collected at the drift face in sumps and recycled underground by the brine water sump and pumping system. Most of this brine water is recycled but some is lost to fractures in the rock. Every opportunity to maximize brine recycle and reduce loss will be pursued.

4. *Bolt Inflation*

According to TMAC's Ground Control Management Plan (insert document reference) swellex type inflatable friction bolts will be utilised. Brine water will be used to drill the bolt holes and inflate the bolts. A non-conventional swellex pump, the SWX DCS Fluid Recovery Kit swellex pump may be utilised as it is a closed system that recovers and recycles the water used for bolt inflation.

Brine water used for bolting is collected at the pump and recycled underground by the brine water sump and pumping system. Most of this brine water is recycled but some is lost to fractures in the rock. Every opportunity to maximize brine recycle and reduce loss will be pursued.

5. *Underground Mapping*

Brine water may be used to wash the back and walls prior to completing geological mapping underground. This is required to ensure geological features are visible and these features can be mapped for grade management and ground control purposes. The mine geologist and technicians will use the minimum amount of brine water required to clean the back and walls to ensure accurate mapping.

Brine water used for mapping is collected at the pump and recycled underground by the brine water sump and pumping system. Most of this brine water is recycled but some is lost to fractures in the rock. Every opportunity to maximize brine recycle and reduce loss will be pursued.

Figure 1 — Phase Diagram for $CaCl_2$ and Water Solutions