Engineering Drawings for the Tailings Management System Doris North Project, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS
DN-TIA-00	Engineering Drawings for the Tailings Management System Doris North Project, Nunavut, Canada	A	May 29, 2015	Issued for Discussion
DN-TIA-01	General Arrangement	A	May 29, 2015	Issued for Discussion
DN-TIA-02	Sub-Aerial Tailings Impoundment General Arrangement	A	May 29, 2015	Issued for Discussion
DN-TIA-03	Interim Dike Plan, Profile, and Section	A	May 29, 2015	Issued for Discussion
DN-TIA-04	Interim Dike Access Road Plan, Profile, and Section	A	May 29, 2015	Issued for Discussion
DN-TIA-05	South Dam Plan and Profile	A	May 29, 2015	Issued for Discussion
DN-TIA-06	South Dam Typical Section and Details	A	May 29, 2015	Issued for Discussion
DN-TIA-07	South Dam Construction Sequence	A	May 29, 2015	Issued for Discussion
DN-TIA-08	Material Specifications and Quantities	A	May 29, 2015	Issued for Discussion

TMAC RESOURCES

srk consulting

PROJECT NO: 1CT022.002
Revision A
May 29, 2015
Drawing DN-TIA-00

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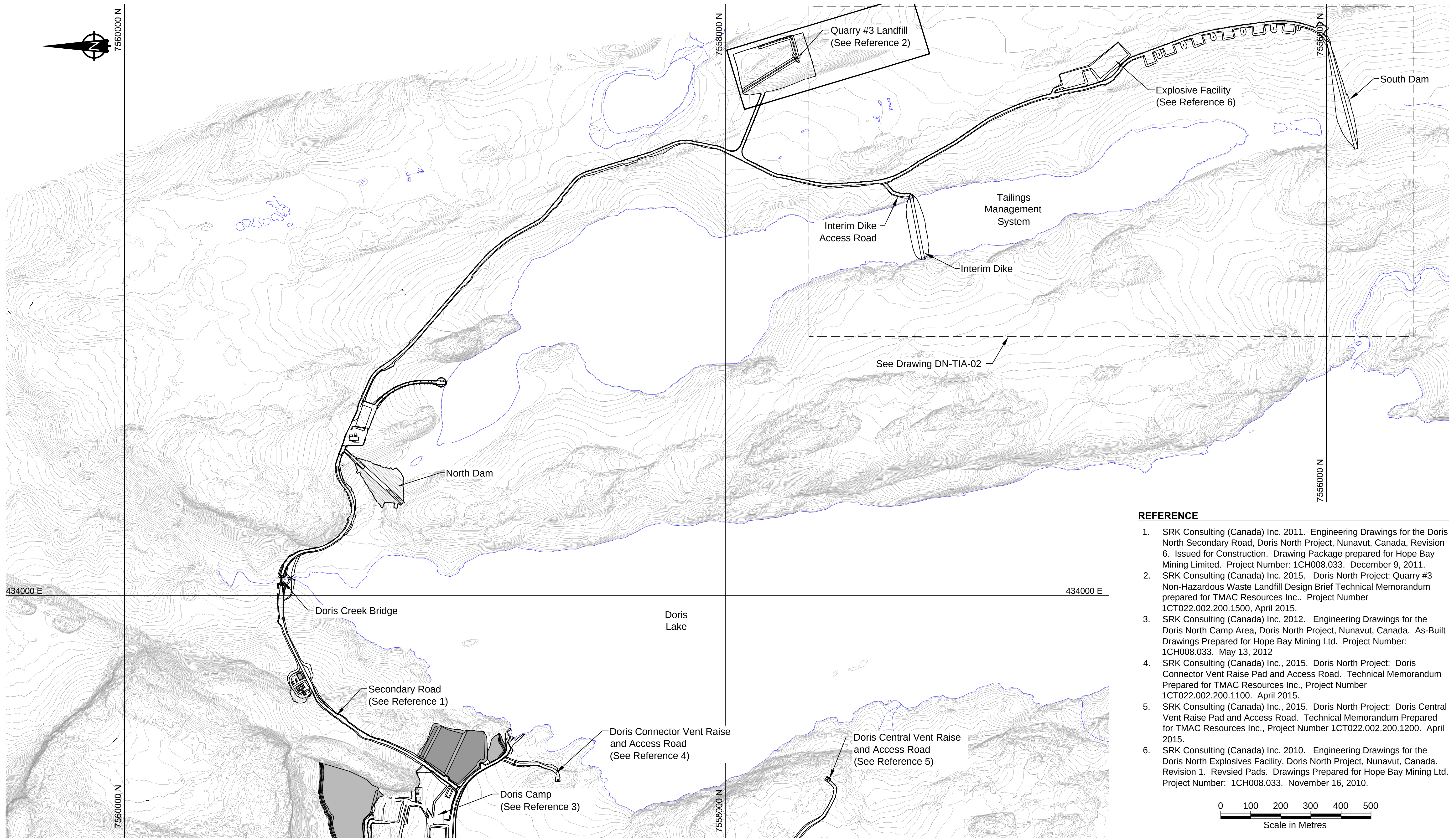

REFERENCE

1. SRK Consulting (Canada) Inc. 2011. Engineering Drawings for the Doris North Secondary Road, Doris North Project, Nunavut, Canada, Revision 6. Issued for Construction. Drawing Package prepared for Hope Bay Mining Limited. Project Number: 1CH008.033. December 9, 2011.
2. SRK Consulting (Canada) Inc. 2015. Doris North Project: Quarry #3 Non-Hazardous Waste Landfill Design Brief Technical Memorandum prepared for TMAC Resources Inc.. Project Number 1CT022.002.200.1500, April 2015.
3. SRK Consulting (Canada) Inc. 2012. Engineering Drawings for the Doris North Camp Area, Doris North Project, Nunavut, Canada. As-Built Drawings Prepared for Hope Bay Mining Ltd. Project Number: 1CH008.033. May 13, 2012
4. SRK Consulting (Canada) Inc., 2015. Doris North Project: Doris Connector Vent Raise Pad and Access Road. Technical Memorandum Prepared for TMAC Resources Inc., Project Number 1CT022.002.200.1100. April 2015.
5. SRK Consulting (Canada) Inc., 2015. Doris North Project: Doris Central Vent Raise Pad and Access Road. Technical Memorandum Prepared for TMAC Resources Inc., Project Number 1CT022.002.200.1200. April 2015.
6. SRK Consulting (Canada) Inc. 2010. Engineering Drawings for the Doris North Explosives Facility, Doris North Project, Nunavut, Canada. Revision 1. Revsied Pads. Drawings Prepared for Hope Bay Mining Ltd. Project Number: 1CH008.033. November 16, 2010.

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REVISIONS

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CHECKED: LW	APPROVED: EMR	DATE: May 29, 2015

FILE NAME: 1CT022.002 TIA-1.dwg

TMAC RESOURCES

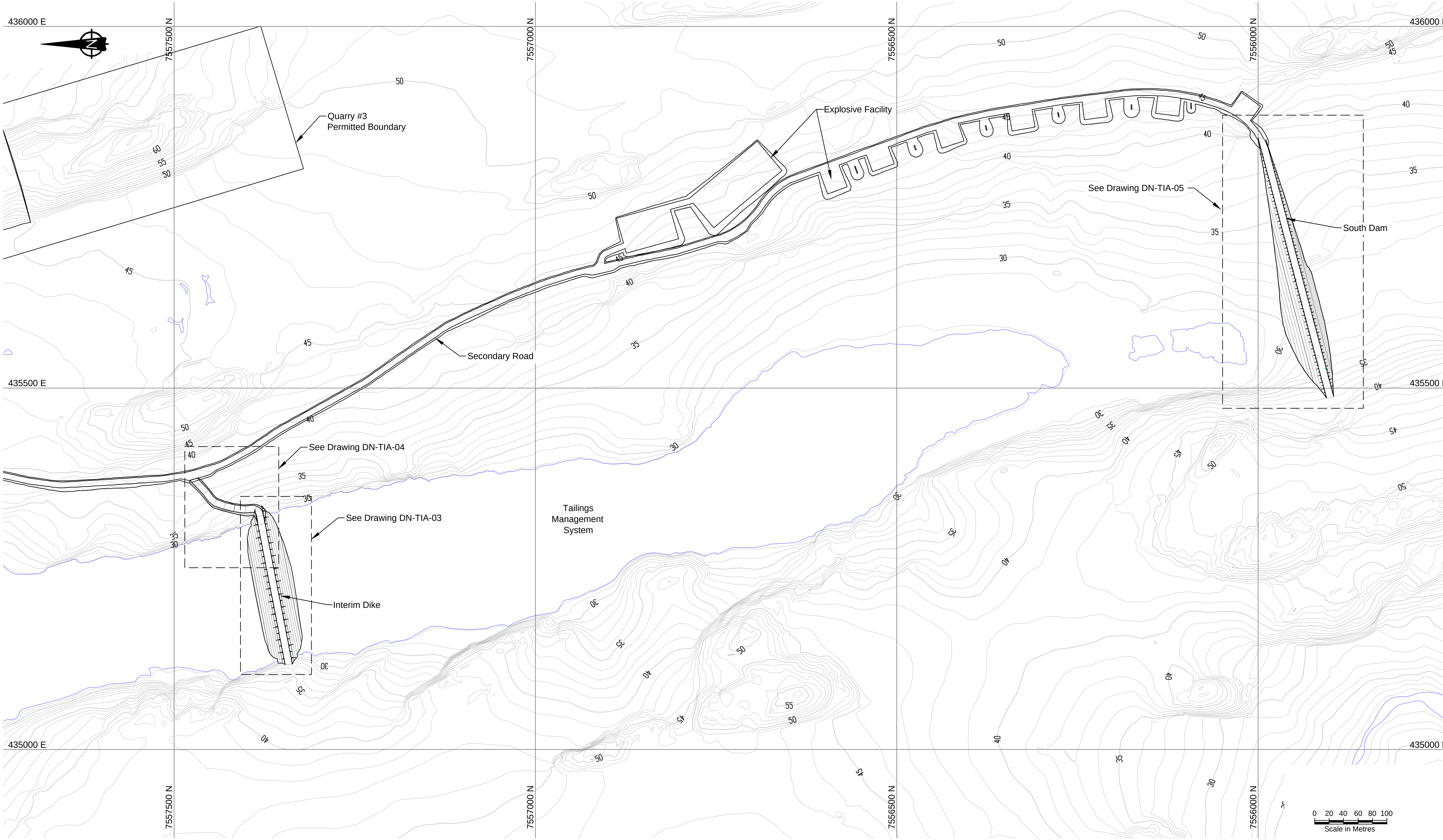
HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:
General Arrangement

DRAWING NO.	SHEET	REVISION NO.
DN-TIA-01	2 OF 9	A



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FILE NAME: 1CT022.002 TIA-2.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:

Sub-Aerial Tailings Impoundment
General Arrangement

DRAWING NO.	SHEET	REVISION NO.
DN-TIA-02	3 OF 9	A

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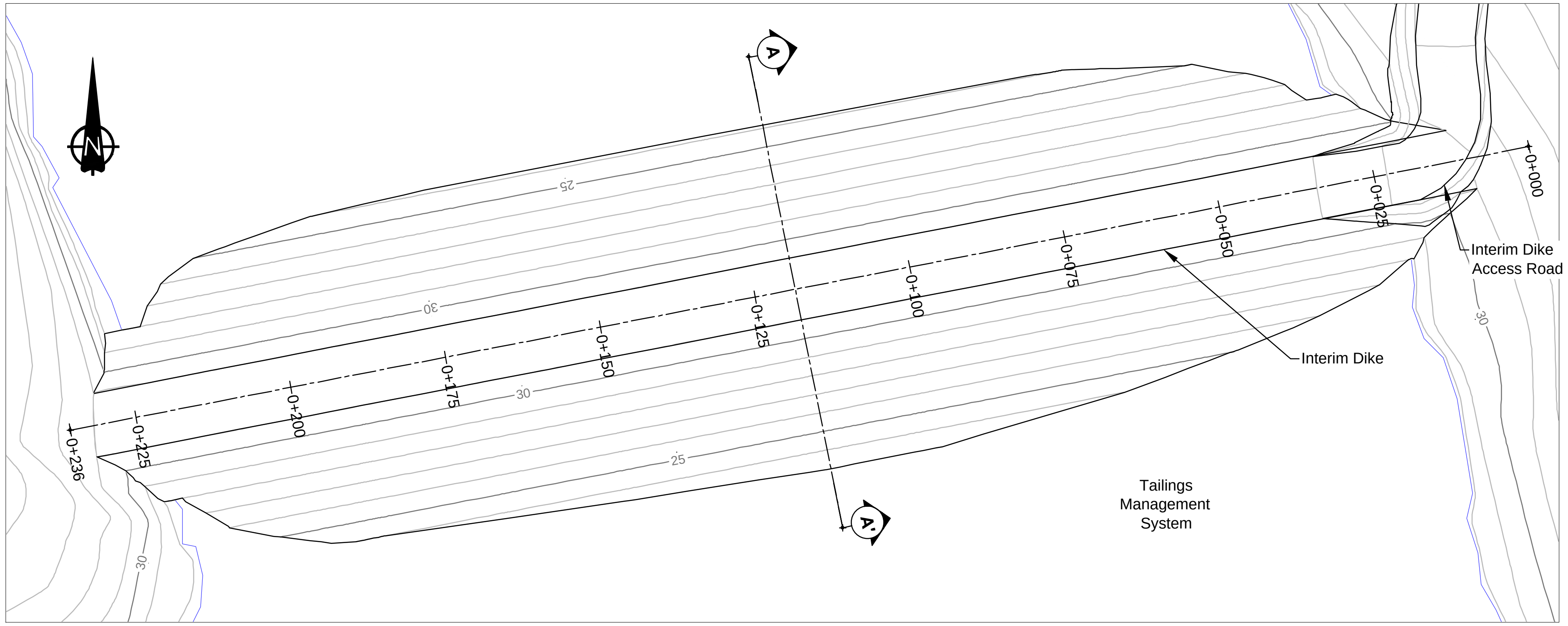

INTERIM DIKE PLAN VIEW

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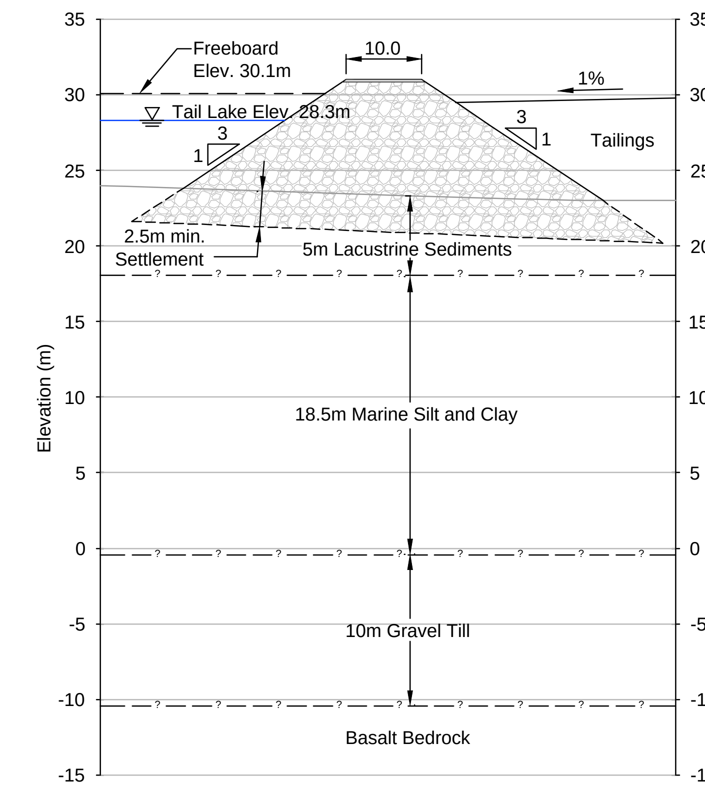
Scale in Metres



(A) INTERIM DIKE SECTION

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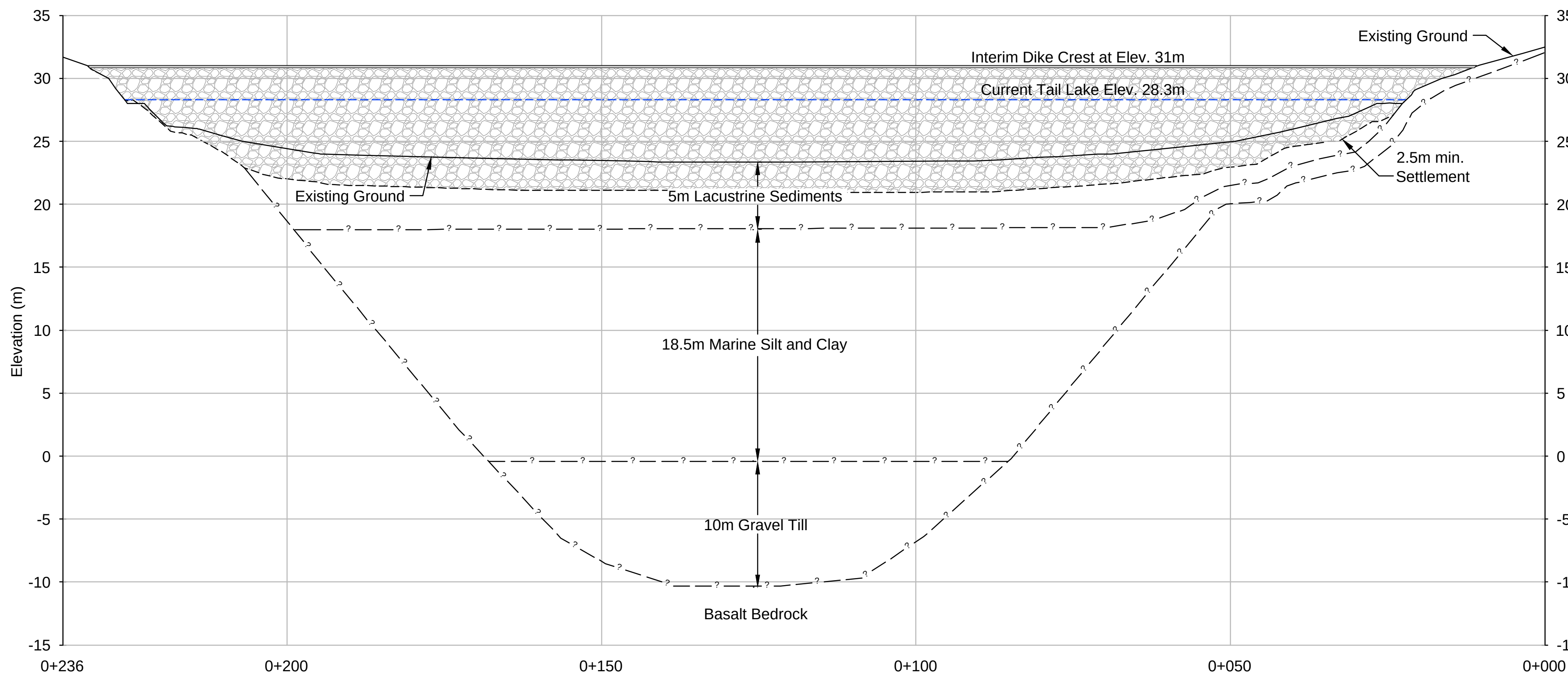
Horizontal Scale in Metres
Vertical Scale X2



INTERIM DIKE PROFILE

0 5 10 15 20 25
Horizontal Scale in Metres
Vertical Scale X2

LEGEND

- Surfacing Material
- Run of Quarry (ROQ)

NOTES

1. All dimensions and elevations are in meters unless stated otherwise.
2. The Contractor must ensure that all organic matter and peat is excavated from the dam foundation.

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FILE NAME: 1CT022.002 TIA-2.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:
Interim Dike
Plan, Profile, and Section

DRAWING NO.: DN-TIA-03 | SHEET 4 OF 9 | REVISION NO. A

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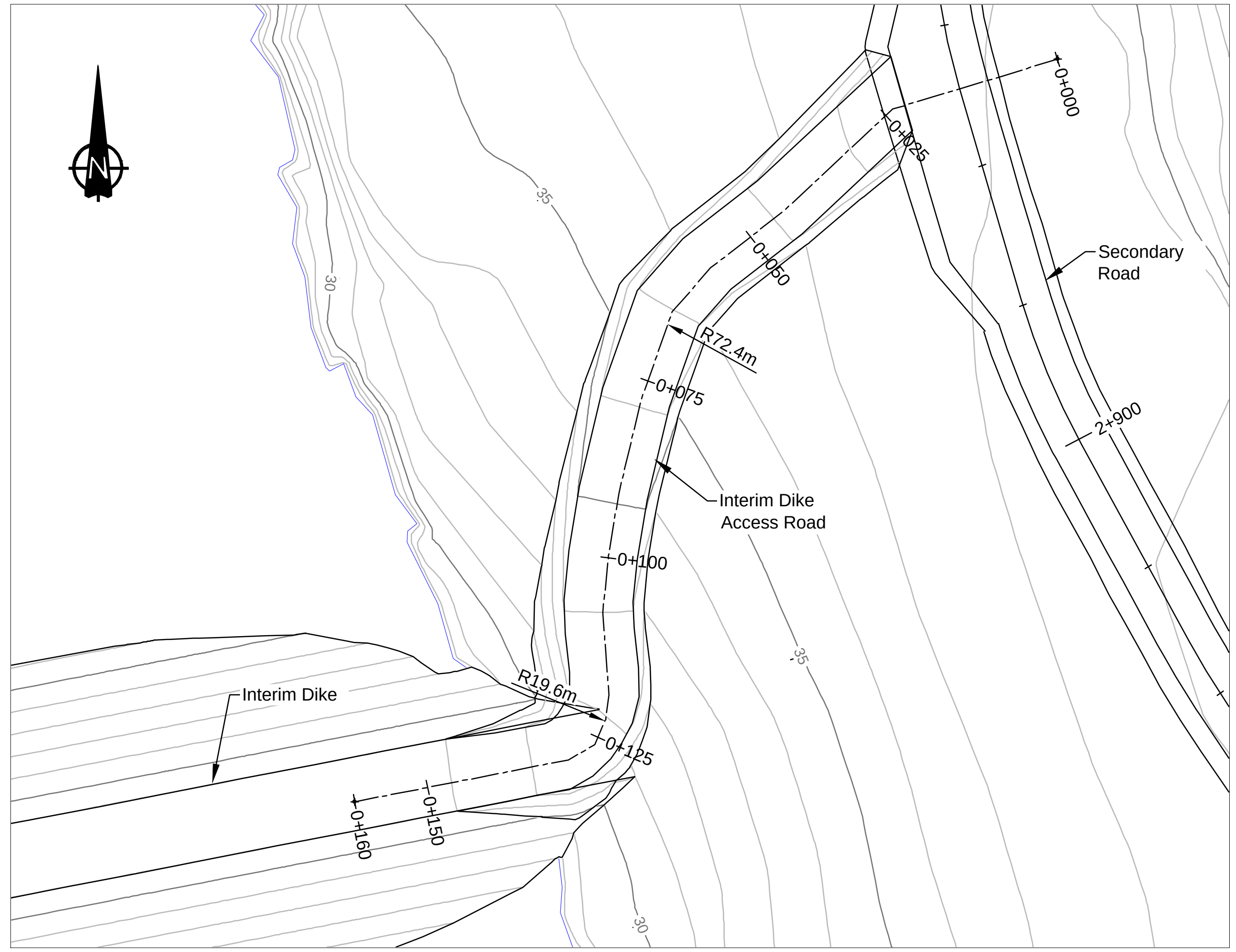

PLAN VIEW
INTERIM DIKE ACCESS ROAD

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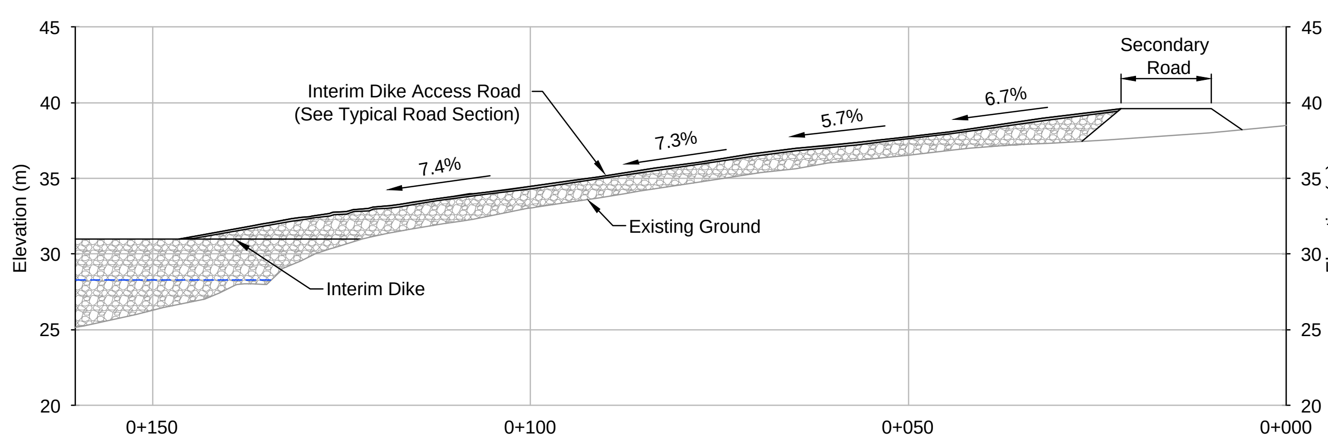
Scale in Metres



INTERIM DIKE ACCESS ROAD PROFILE

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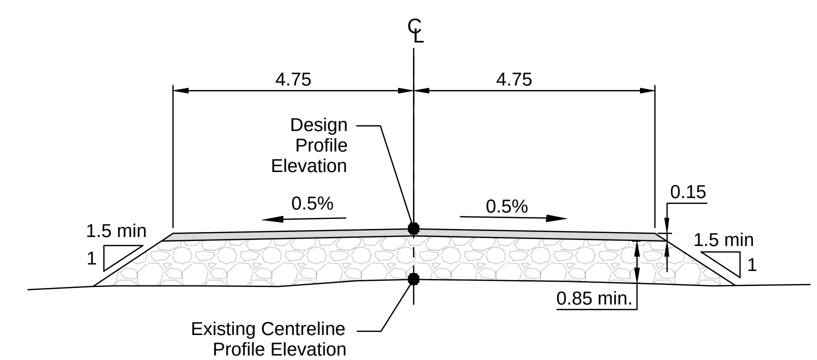
Horizontal Scale in Metres
Vertical Scale X2



TYPICAL
ACCESS ROAD SECTION

0 1 2 3 4 5
Scale in Metres

LEGEND

Surfacing Material

Run of Quarry (ROQ)

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TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:
Interim Dike Access Road
Plan, Profile, and Section

DRAWING NO.: DN-TIA-04 | SHEET 5 OF 9 | REVISION NO. A

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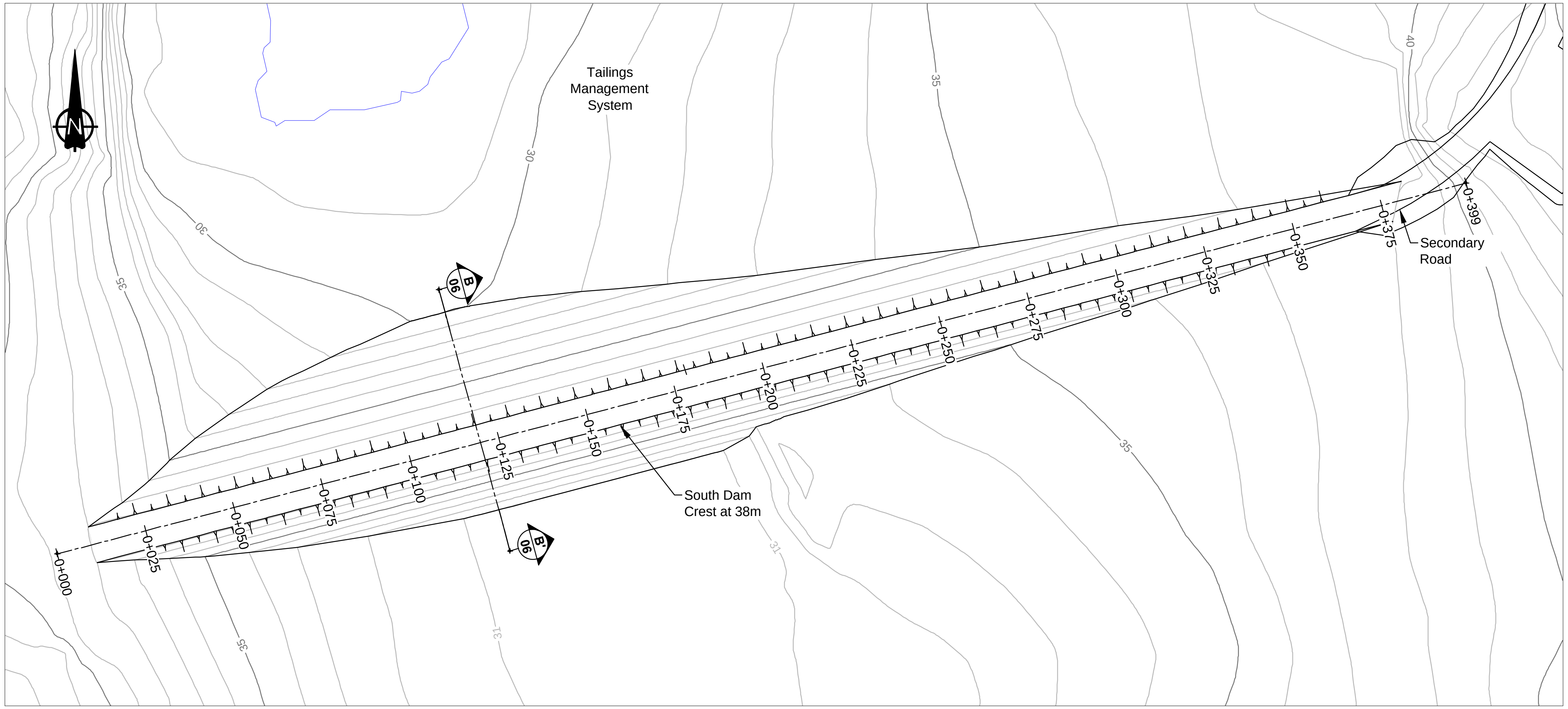
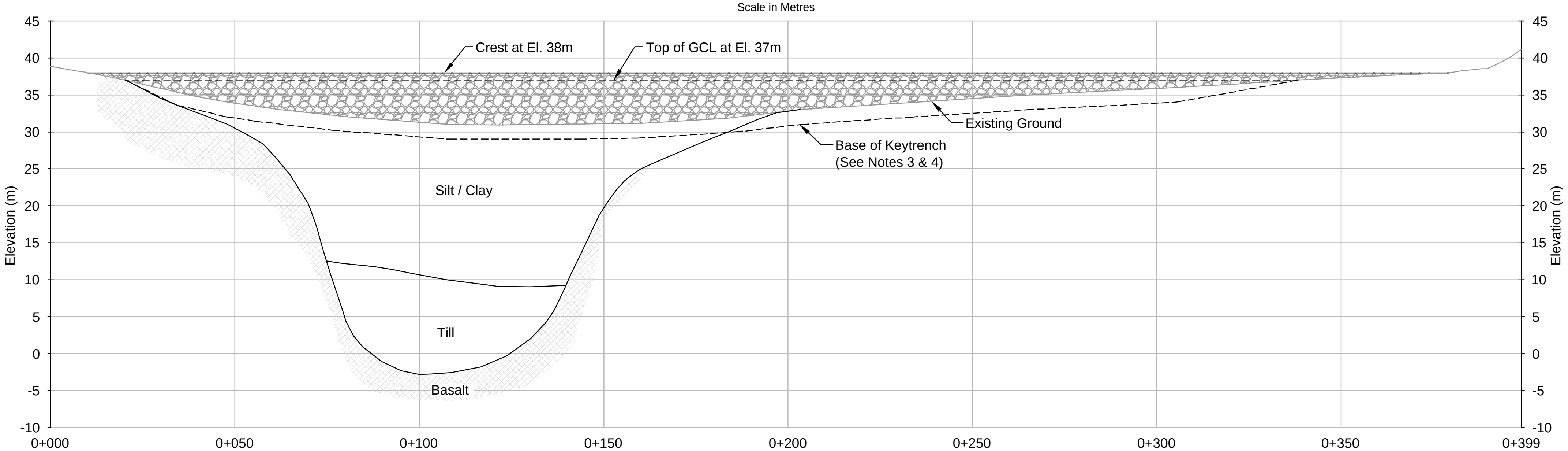


SOUTH DAM PLAN VIEW

0 5 10 15 20 25
Scale in Metres



SOUTH DAM PROFILE

0 5 10 15 20 25
Horizontal Scale in Metres
Vertical Scale X2

LEGEND

- Surfacing Material
- Liner Bedding Material
- Transition Material
- Run of Quarry (ROQ)
- Tailings
- Geosynthetic Clay Liner (GCL)

NOTES

1. All dimensions and elevations are in meters unless stated otherwise.
2. The subsurface geology has been extrapolated from a series of geotechnical investigations consisting of drill holes, auger holes and shallow test pits. Bedrock contact and geological unit contacts are therefore likely to vary somewhat during final excavation. The Engineer will inspect all excavations and approve the foundation conditions.
3. The extents of the key trench excavation will be confirmed on site by the Engineer after bulk excavation as indicated by the drawings.
4. Additional excavation may be required as the Contractor must ensure that all organic matter and peat is excavated from the dam foundation.
5. Overburden soils from the key trench must be stockpiled in an area designated by the Engineer.
6. The Contractor shall be responsible for water control during excavation and construction.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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Tailings Management System

DRAWING TITLE:
South Dam
Plan and Profile

DRAWING NO. DN-TIA-05 | SHEET 6 OF 9 | REVISION NO. A

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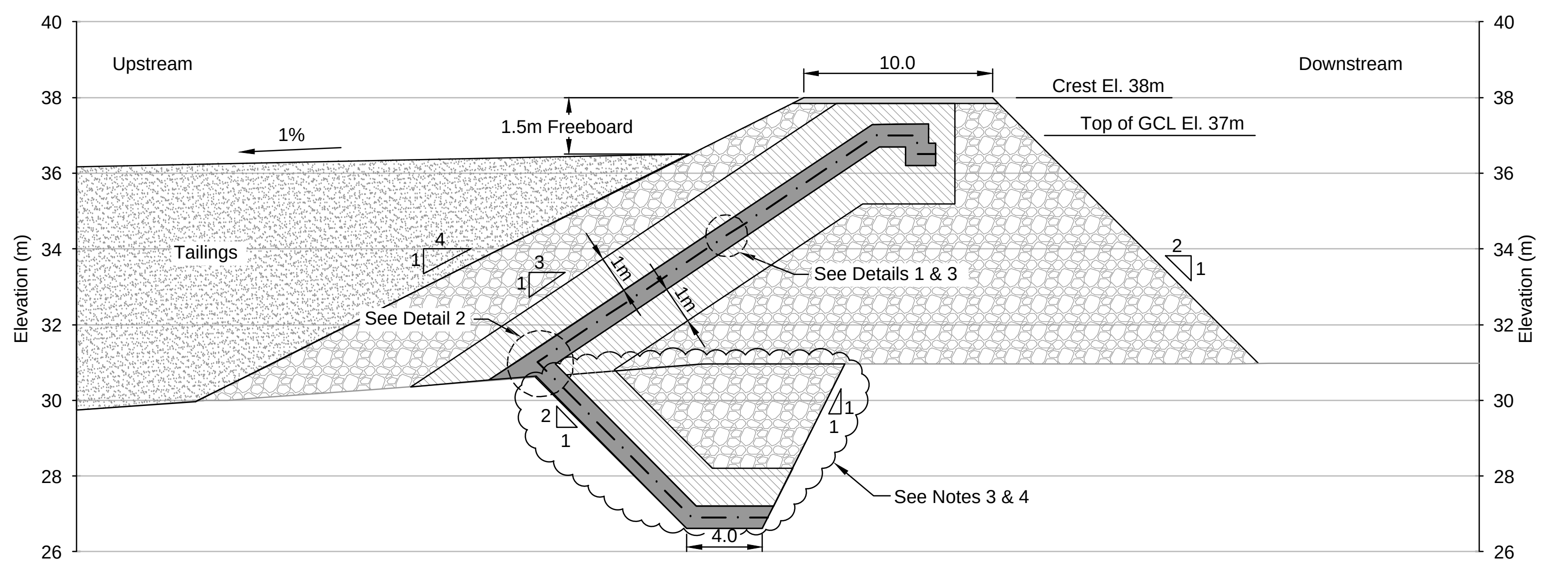

B 05 **SOUTH DAM SECTION**

0 2 4 6 8 10
Horizontal Scale in Metres
Vertical Scale X2

LEGEND

- Surfacing Material
- Liner Bedding Material
- Transition Material
- Run of Quarry (ROQ)
- Tailings
- Geosynthetic Clay Liner (GCL)

NOTES

1. All dimensions and elevations are in meters unless stated otherwise.
2. The subsurface geology has been extrapolated from a series of geotechnical investigations consisting of drill holes, auger holes and shallow test pits. Bedrock contact and geological unit contacts are therefore likely to vary somewhat during final excavation. The Engineer will inspect all excavations and approve the foundation conditions.
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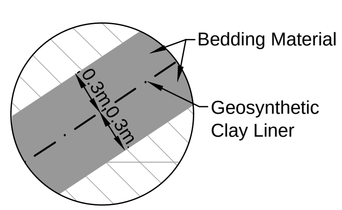

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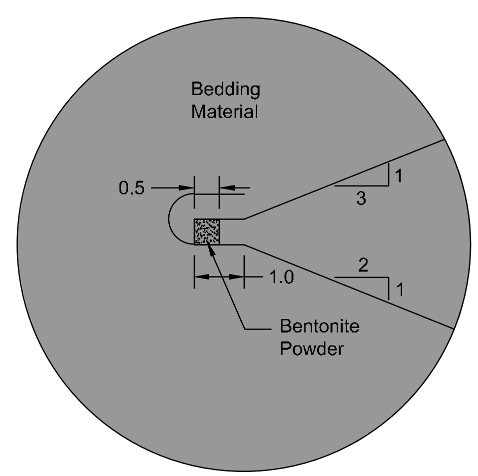
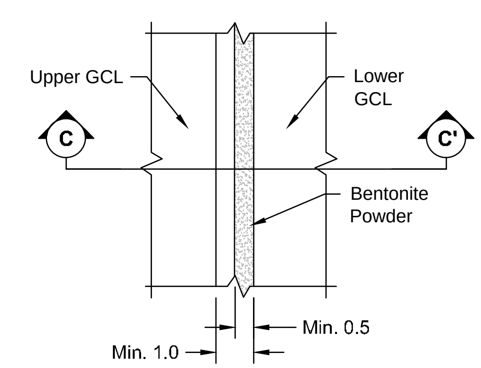
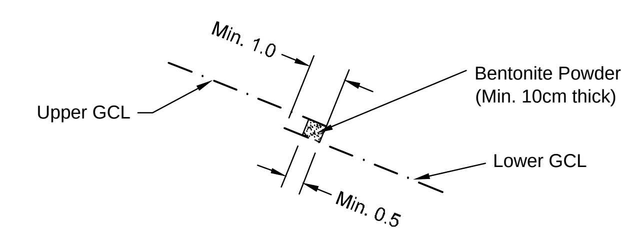
GCL DETAIL
not to scale



2 DETAIL 2
TYPICAL UPPER AND LOWER GCL JOINT
not to scale



3 DETAIL 3
TYPICAL GCL OVERLAP SEAM DETAIL - PLAN VIEW
not to scale



C TYPICAL GCL OVERLAP SECTION
not to scale

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HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:
South Dam
Typical Section and Details

DRAWING NO.: DN-TIA-06 | SHEET: 7 OF 9 | REVISION NO.: A

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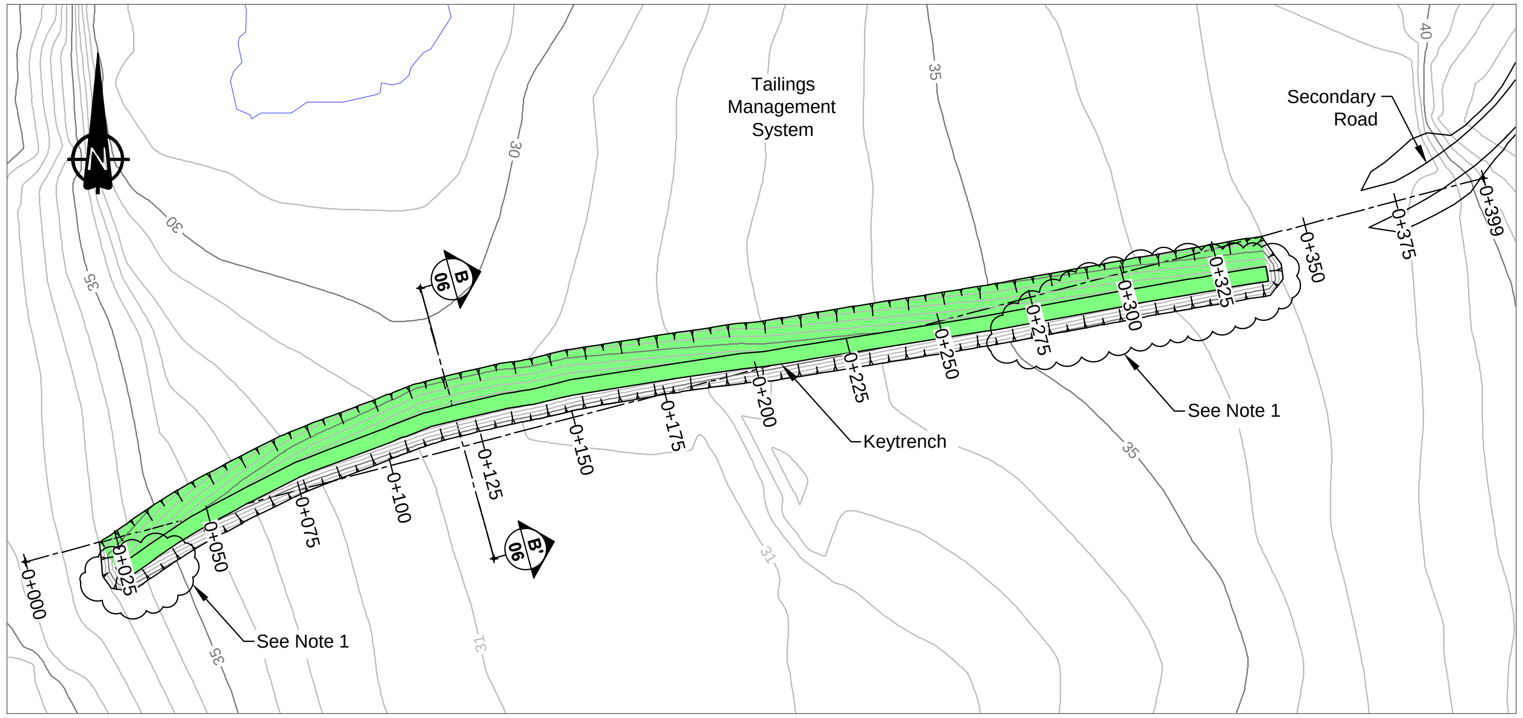
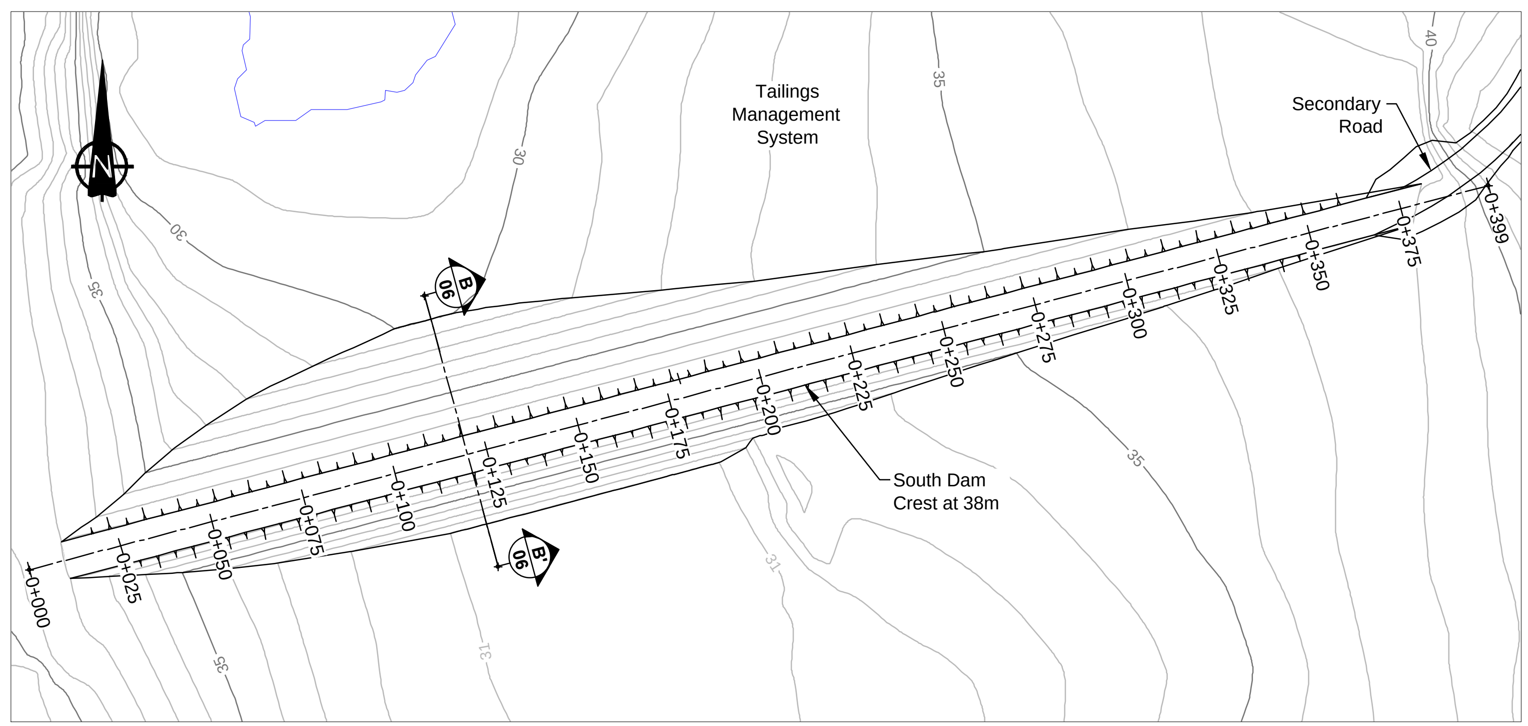


GCL ON KEYTRENCH EXCAVATION

0 10 20 30 40 50
Scale in Metres

GCL ON ROQ TO ELEVATION 37m

0 10 20 30 40 50
Scale in Metres



FINAL DAM SHELL TO ELEVATION 38m

0 10 20 30 40 50
Scale in Metres

LEGEND

Geosynthetic Clay Liner (GCL)

Crest Line

NOTE

1. ROQ dam shell on the dowstream side may need to be adjusted to cover the extents of the keytrench excavation.

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE	NO.	DESCRIPTION	CHK'D	APP'D	DATE
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HOPE BAY PROJECT

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Tailings Management System

DRAWING TITLE:
South Dam Construction Sequence

DRAWING NO. DN-TIA-07 — SHEET 8 OF 9 — REVISION NO. A

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Materials List and Quantity Estimates for Interim Dike

Item	Quantity / Area / Volume	Description
1. 2.5m Base Settlement	Total 19,145 cu.m.	Approximate In-Place Neat-line Volume
2. Run of Quarry Material	Total 60,580 cu.m.	Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)

Materials List and Quantity Estimates for Interim Dike Access Road

Item	Quantity / Area / Volume	Description
1. Run of Quarry Material	Total 1,915 cu.m.	Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)
2. Surface Grade Material	Total 170 cu.m.	Based on Final Crest Surface Area

Tolerances on Road Material Placement:

Location	Fill (mm)	Excavation (mm)
Vertical Tolerance on Roads	0 to +75	n/a
Horizontal Tolerance on Roads	-150 to +150	

Note: Grade shall not be uniformly high or low.

Materials List and Quantity Estimates for South Dam

Item	Quantity / Area / Volume	Description
1. Run of Quarry Material	Total 34,390 cu.m.	Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)
2. Surface Grade Material	Total 555 cu.m.	Based on Final Crest Surface Area
3. Geosynthetic Clay Liner (GCL)	Total 8,385 sq.m.	Based on Crest, Dike Face and Excavation Areas
4. Liner Bedding Material	Total 5,030 cu.m.	Based on Crest, Dike Face and Excavation Areas
5. Transition Material	Total 11,930 cu.m.	Based on Crest, Dike Face and Excavation Areas
6. 4m Key Trench Excavation Volume	Total 12,770 cu.m.	Approximate In-Place Neat-line Volume (3D volume based on Civil 3D surfaces - no allowance has been made for losses and/or tundra embedment)

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FILE NAME: 1CT022.002 TIA-2.dwg

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HOPE BAY PROJECT

SRK JOB NO.: 1CH022.002

Tailings Management System

DRAWING TITLE:

Material Specifications and Quantities

DRAWING NO. DN-TIA-08 | SHEET 9 OF 9 | REVISION NO. A

Appendix B – Tailings Management Strategies Alternatives Assessment

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Memo

To:	Project File	**Client:**	TMAC Resources Inc.
From:	Lowell Wade, MSc, PEng, PGeo	**Project No:**	1CT022.002.200.505
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	May 29, 2015
Subject:	Doris North Project: Tailings Management Strategies Alternatives Assessment		

1 Introduction

TMAC Resources Ltd. plan to revise their tailings management plan to accommodate a greater volume of tailings at the Doris North Project (Project), located in Nunavut, approximately 160 km southwest of Cambridge Bay. The revised volume of tailings exceeds the amount that can sub-aqueously be deposited in the Tailings Impoundment Area (TIA) with a permanent water cover after the North Dam gets breached. This memo describes the alternative tailings management strategies that were considered for managing the additional volume of tailings, and provides the rationale for selecting the preferred strategy.

2 Background

2.1 Tailings Make-up

The amount of ore processed is approximately equal to the amount of tailings produced since the amount of gold extracted in terms of the overall mass or volume is negligible. Tailings physical testing for the Project was carried out and confirmed that the tailings dry density will be about 1.293 tonnes/m^3 (SRK 2007). This is therefore the value that is used to convert tonnes to cubic meters in this document.

The tailings stream comprises of flotation tailings (about 94% of the stream) and detoxified cyanide leach tailings (about 6% of the stream). The flotation tailings are considered geochemically benign, i.e. not potentially acid generating (NPAG), with low neutral metal leaching potential. The detoxified cyanide leach tailings contain concentrated sulphides, and are therefore potentially acid generating (PAG) and have the potential to leach metals under neutral conditions (SRK 2015). If deposited subaqueously there is no need to segregate the flotation and leach tailings; however, if placed subaerially, the leach tailings will require rigorous environmental containment at closure.

This containment would be in the form of a thermal cover that would ensure that the tailings surface remain perpetually frozen, or a synthetic cover such as a High Density Polyethylene (HDPE) or Geosynthetic Clay Liner (GCL). Preliminary thermal modeling suggests, that a thermal cover constructed from quarry rock would have to be in the order of 4 to 5 m thick. These cover systems are sufficiently cost intensive to justify disposal of the leach tailings underground, especially in light of the fact that mine backfill is required.

2.2 Current Licensed Tailings Management Concept

The current licensed tailings management plan for the Project entails subaqueous tailings deposition within the designated TIA (SRK 2007). This TIA was a natural lake, Tail Lake, which was delisted in accordance with Schedule II of the Metal Mining Effluent Regulations (MMER) specifically for use as a tailings facility.

Under the current licenced plan, environmental containment for the TIA will be provided through the construction of two water retaining frozen core dams, the North Dam and the South Dam. About 458,000 tonnes (375,000 m^3) of slurry tailings is permitted for deposition subaqueously over a period of about two years at a planned tailings production rate of 668 tpd (SRK 2005). This includes both float and leach tailings. At closure, once environmental discharge criteria have been met, the North Dam would have been breached, allowing the TIA to return to its pre-mining elevation of 28.3 m, which meant the tailings would have a permanent water cover of 4 m.

2.3 Revised Tailings Management Concept (Amendment Application Submitted but Retracted)

In 2011, additional mineable resources were identified and a revised analysis of the required minimum water cover thickness was carried out, which concluded that the permanent water cover in the TIA could be reduced to 2.3 m (SRK 2011). This meant that the available capacity in the TIA for subaqueous tailings deposition, without changing the current licenced closure strategy of breaching the North Dam, increased to about 1,351,000 tonnes (1,047,287 m^3). At a production rate of 1,800 tpd, this increases the life of the project up to 6.5 years. Again, this included both the float and leach tailings.

2.4 New Tailings Management Requirements

Further mine planning has resulted in an overall revised mine plan for the Project with a targeted ore volume of about 2,500,000 tonnes (1,938,000 m^3). The tailings production rate will be 1,000 tpd for the first two years, after which it will increase to 2,000 tpd for the remainder of the life of the Project.

About 6% (i.e. 150,000 tonnes or 116,000 m^3) of the tailings are comprised of detoxified cyanide leach tailings, and this tailings will be sent underground where it will be mixed with underground waste rock for use as structural mine backfill. The remaining 2,350,000 tonnes (1,822,000 m^3) of flotation tailings will be sent to the TIA; however, this volume exceeds the amount that can subaqueously be deposited in the TIA while maintaining the current licenced closure strategy of breaching the North Dam.

3 Alternatives

3.1 Previous Alternatives Assessment

A rigorous multiple accounts analysis (MAA) tailings alternatives assessment was completed during the original Environmental Assessment phase of the Project (MHBL 2005, SRK 2005). This assessment preceded the release of Environment Canada's (EC) Guidelines for the Assessment of Alternatives for Mine Waste Disposal (EC 2011); however, this assessment was actually a precursor to development of the EC guidelines and as such is completely aligned.

This assessment concluded that Tail Lake was the preferred tailings impoundment area, and subsequently the lake was delisted in accordance with Schedule II of the MMER. An important component of the decision criteria for selecting this TIA as the preferred facility, was the ability to expand the facility should future mining resources materialize. At that time, it was acknowledged that expansion of the facility would require the tailings deposition strategy to change from subaqueous deposition to subaerial, unless perpetual water retaining dams were deemed acceptable.

3.2 Alternative Tailings Deposition Sites

The previous tailings alternatives assessment (SRK 2005) was revisited considering the revised tailings storage requirement of 2,500,000 tonnes (1,938,000 m^3). Specifically, consideration was given as to whether the existing licenced TIA would remain the preferred tailings disposal site. Because the facility is already licenced, and that the North Dam, the primary environmental control structure has been constructed (SRK 2012), weighed heavily in favour of not changing the tailings disposal site. The fact that the existing TIA has more than sufficient capacity to safely contain the additional tailings volume, as well as any foreseeably additional expansion, finally led to the conclusion that there was no justifiable reason to select a new tailings disposal site.

3.3 Alternative Tailings Deposition Methods

The possible tailings disposal strategies that was considered for the new tailings volume within the TIA were as follows:

- <u>Alternative #1 – Subaqueous hydraulic tailings deposition with a water cover at closure:</u> This alternative will require perpetual water retaining dams at closure. Both the North and South dams will retain water and saturated tailings in perpetuity, and a permanent overflow spillway will be constructed and maintained in perpetuity. This requires perpetual site presence. The current design of the North and South dams will have to be changed from frozen core technology to conventional unfrozen dams, which means that the North Dam would have to be reconstructed. The foundation conditions at the site beneath the North and South dams (SRK 2007) is however such that the use of conventional non-frozen dam construction methods would be technically challenging.

  Subaqueous tailings deposition provides the highest possible level of environmental containment from a tailings geochemistry perspective; however, since only flotation tailings will be deposited in the TIA this level of protection is not required. A water cover will however avoid any risks associated with fugitive tailings dust during the operational stage.

Subaqueous tailings deposition will maximize the opportunity for use of tailings reclaim water; however, the actual physical deposition plan is more challenging due to seasonal ice. There is however less risk of ice entrainment within the tailings mass which would require allowance for additional tailings storage capacity.

- Alternative #2 – Subaqueous hydraulic tailings deposition with a dry cover at closure: In this alternative the North and South dams would only be required to maintain water and saturated tailings during the operational life of the Project. At closure any remaining supernatant water would be discharged and the tailings surface closed with a dry cover. The North and South dams can be constructed and operated as frozen core dams, since at closure they will only retain tailings solids, which in the long term is expected to be unsaturated and frozen.

  The operational constraints described for Alternative #1 continues to apply. Between the period when the tailings is drained and the dry cover is placed, fugitive tailings dust will have to be managed. Placement of a dry cover on the tailing surface will be challenging, as the saturated tailings will take considerable time to drain and consolidate.

- Alternative #3 – Subaerial hydraulic tailings deposition with a water cover at closure: This alternative is identical to Alternative #1, except tailings is deposited subaerially. Subaerial tailings deposition is operationally simpler; however, experience has shown that there needs to be an allowance for ice entrainment which occupies tailings storage capacity (BGC 2003). In addition, during the operational phase when tailings beaches are exposed, fugitive tailings dust management will be required. It is possible that reclaim water opportunities may be limited, especially if the facility is operated with the intent of minimizing the supernatant pond size, which is desirable from an operational containment dam risk perspective.

- Alternative #4 – Subaerial hydraulic tailings deposition with a dry cover at closure: This alternative is identical to Alternative #3, from a tailings deposition perspective, but uses the closure approach of Alternative #2. It therefore combines the benefits from all the advantages of Alternatives #2 and #3. The negatives include fugitive tailings dust, ice entrainment and possible limited availability of reclaim water.

- Alternative #5 – Subaerial filtered (dry-stack) tailings deposition with a dry cover at closure: This alternative entails sending the tailings stream through a filter press, such that a dewatered tailings product is produced. This product can then be trucked or conveyed to the TIA where it gets placed in compacted lifts. At closure a dry cover is applied. Key benefits of this deposition strategy includes the ability to place the required volume of tailings within a smaller footprint, generation of an overall more stable landform unit, no requirement to make allowance for ice entrainment, reduced containment dam size, and eliminating the need for reclaiming water from the TIA. Drawbacks of this strategy includes high initial capital cost for the filter presses, increased operational cost for transport and compaction of the tailings and a requirement to manage fugitive tailings dust until such time as the closure cover is in place.

To maximize the benefits of this alternative, the area where dry stack tailings are to be placed within the TIA footprint will have to be drained prior to deposition.

- Alternative #6 – Subaerial hydraulic tailings deposition behind an Interim Dike with a dry cover at closure: This alternative is a refinement of Alternative #4 with the primary goal of minimizing the overall surface area of the tailings, to minimize the opportunity for fugitive dust and reduce the amount of cover material that would be required. The Interim Dike will have to be constructed within the TIA, and will act as a tailings containment structure (solids only) which will remain in perpetuity. Tailings will be deposited between the Interim Dike and the South Dam. The portion of the TIA between the Interim Dike and the North Dam will act as a Reclaim Pond for the tailings supernatant water during the operational phase, and post closure once water quality in the Reclaim Pond has reached discharge criteria, the North Dam will be breached returning the TIA to its pre-mining elevation of 28.3 m.

- Alternative #7 – Original licenced tailings management plan followed by subaerial tailings deposition behind an Interim Dyke with a dry cover at closure: In this alternative, tailings deposition would proceed in accordance with the original licenced plan which would allow for subaqueous deposition of 458,000 tonnes (375,000 m^3) of tailings initially. Once that volume has been placed, an Interim Dike would be constructed and the remainder of the tailings subaerially deposited similar to Alternative #6. The closure strategy would be the same as for Alternative #6, but in this case the Reclaim Pond would contain tailings with a 4 m water cover. This strategy will require a change in deposition strategy partly through the Project life which adds a level of technical complexity and cost.

- Alternative #8 – Subaqueous deposition of 1.3 M tonnes of all tailings followed by subaerial tailings disposition behind an Interim Dike with a dry cover at closure: This alternative is identical to Alterative #7, but the volume of tailings that is initially subaqueously deposited is 1,351,000 tonnes (1,047,287 m^3) which will leave a final water cover once the North Dam is breached of 2.3 m. A re-evaluation of the minimum required water cover in the TIA confirmed that 2.3 m would be sufficient to prevent any re-suspension or scour of tailings (SRK 2011).

4 Preferred Tailings Management Alternative

The qualitative description of alternative tailings management strategies described in this memo has resulted in the following conclusions:

- The preferred tailings disposal site is the existing licenced TIA.
- The preferred tailings disposal strategy is subaerial slurry tailings deposition between the South Dam and a new Interim Dike, confining tailings deposition to the southern limit of the TIA.
- The preferred tailings closure strategy is a dry cover over the subaerial tailings surface, and breaching of the North Dam which impounds the Reclaim Pond during the operational stage.
- To eliminate long-term closure risk with application of a dry cover, only flotation tailings will be discharged to the TIA. All leach tailings will be deposited underground as part of the mine backfill.

The optimal location of the Interim Dike will be determined based on tailings deposition modeling. The primary goal would be to minimize the differential height between the Interim Dike and the closure water level downstream of the Interim Dike of 28.3 m.

5 References

BGC Engineering Inc., 2003. Ice Entrapment in Tailings. Phase I Compilation Report prepared for Indian and Northern Affairs Canada. Project number 0131-009-01, March

Environment Canada (EC), 2011. Guidelines for the Assessment of Alternatives for Mine Waste Disposal.

Miramar Hope Bay Limited, 2005. Final Environmental Impact Statement, Doris North Project, Nunavut, Canada. Report Prepared for Nunavut Impact Review Board. October 2005.

SRK Consulting (Canada) Inc., 2005. Tailings Alternatives Assessment, Doris North Project, Hope Bay, Nunavut, Canada. Report Prepared for Miramar Hope Bay Limited. Project Number: 1CM014.006. October 2005.

SRK Consulting (Canada) Inc., 2007. Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada. Report prepared for Miramar Hope Bay Limited. Project Number: 1CM014.008.165. March 2007.

SRK Consulting (Canada) Inc., 2011. Tail Lake Water Cover Design: Motivation to Reduce Water Cover Thickness. Technical Memorandum Prepared for Hope Bay Mining Limited. Project Number 1CH008.049. November 4, 2011.

SRK Consulting (Canada) Inc., 2012. Hope Bay Project, North Dam As-Built Report. Report Prepared for Hope Bay Mining Limited. Project Number: 1CH008.058. October 2012.

SRK Consulting (Canada) Inc., 2015. Geochemical Characterization of Tailings form the Doris Deposits, Hope Bay. Report Prepared for TMAC Resources Inc. Project Number: 1CT022.002.200.200. May 2015.

Appendix C – Subaerial Tailings Deposition Plan

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Memo

To:	Project File	**Client:**	TMAC Resources Ltd
From:	Trevor Podaima, PEng	**Project No:**	1CT022.002.200.525
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	May 29, 2015
Subject:	Doris North Project: Subaerial Tailings Deposition Plan		

1 Introduction

The Doris North Project (Project) is a gold mining and milling undertaking of TMAC Resources Ltd. The site is located in the Kitikmeot Region of Nunavut, about 160 km southwest of Cambridge Bay. The estimated ore reserve for the Project is approximately 2.5 million tonnes (Mt), which is approximately equal to the total amount of tailings that will be produced.

Tailings generated during the milling process will be pumped via a pipeline and deposited in the Tailings Impoundment Area (TIA) approximately 5 kilometers from the plant site. The TIA was a natural Lake, Tail Lake, which has been delisted in accordance with Schedule II of the Metal Mining Effluent Regulations (MMER). Tailings will be deposited sub-aerially requiring construction of three retention structures; (1) a water retaining frozen core dam (North Dam), (2) a frozen foundation tailings containment dam (South Dam); and (3) an Interim Dike situated at approximately the midpoint of the facility (Figure 1). The intent of the configuration is to deposit and contain the tailings between the South Dam and Interim Dike and manage supernatant water between the Interim Dike and the North Dam. At closure the sub-aerial tailings will be free-draining and covered with a dry cover. The North Dam will be breached.

North Dam construction was completed in 2012 (SRK 2012) and the South Dam and Interim Dike need to be constructed.

This memorandum presents an evaluation of different tailings deposition scenarios, and concludes with a presentation of the preferred scenario. This preferred deposition plan was subsequently used to establish suitable design criteria for the South Dam and Interim Dike, as well as to inform development of the future Tailings Operations, Maintenance and Surveillance (OMS) Manual.

2 Objectives, Operational Criteria and Assumptions

Tailings deposition planning is required to establish the optimal geometric layout of the TIA such that the finished landform is consistent with the operational and final closure objectives of the facility. In addition, the deposition planning provides important operational optimization in terms of establishing where, and for how long, tailings discharge points (spigots) must be located at specific locations.

Tailings deposition planning was completed using Autodesk Civil3D 2014. Tailings were modeled with an assumed slope for the tailings surface based on past experience with tailings that have similar characteristics and a dry density based on site specific laboratory test data (SRK 2007, Knight Piesold 2009, and Pocock Industrial 2009). Table 1 summarizes the key design criteria adopted for the tailings deposition planning.

Table 1: Tailings Deposition Planning Design Criteria

Component	Value	Source
Tailings storage requirement	1.93 Mm^3 (2.5 Mt)	Quantity based on TMAC mine plan; volume conversion based on dry density listed below in this table.
Tailings production	1,000 tpd (Years 1 and 2) 2,000 tpd (Year 3 onwards)	Supplied by TMAC.
Tailings production period	4 years, 5 months	Based on total tailings volume processed at the stated production rates.
Ice entrainment allowance	0.39 Mm^3 (20% by volume)	Contingency allowance based on engineering judgement and case studies reported by BGC (2003).
Total storage requirement	2.32 Mm^3	Sum of tailings storage requirement and ice entrainment allowance.
Run-off and contact water allowance	Not required	Additional storage capacity not required as water will be directed towards the Interim Dike, which will retain solids but not water. Overall water management will be via the supernatant pond downstream of the Interim Dike.
Deposited tailings dry density	1.29 t/m^3	From laboratory testing (SRK 2007; Knight Piesold 2009, Pocock Industrial 2009).
Tailings beach slope	1.0%	This is an assumed average slope based on engineering judgement considering SRK's experience with tailings of similar properties.
South Dam crest elevation	38 m	Value set as a function of the deposition planning.
Interim Dike crest elevation	Variable based on the deposition scenario (32.5 m for scenarios 1 and 2 and 31.0 m for scenario 3)	Value set as a function of the deposition planning.
South Dam freeboard	1.5 m	Conservative allowance considering best practice. No water will ever pond against this dam and therefore the freeboard will never actually be required. Can accommodate a closure cover up to 1.5 m thick.
Interim Dike freeboard	1.5 m	Conservative allowance considering best practice. Water will not pond against the dike as the structure will be free draining. Can accommodate a closure cover up to 1.5 m thick.
Tailings discharge method	Single point spigot	Goal was to simplify deposition plan as far as practical and still achieve the tailings deposition strategy.

3 Operation Philosophy

3.1 Tailings Deposition

Tailings deposition would commence from the crest of the South Dam so that a continuous beach is formed along the upstream face of the structure. This configuration will ensure that the foundation of the dam remains frozen by keeping any heat source away from it. However, should for any reason the frozen foundation be compromised, the tailings beach will also increase the seepage path upstream of the low permeable element in the dam, lowering the hydraulic gradient and thus lower seepage rates through the structure.

Best Management Practices will be adopted to schedule seasonal changes in discharge locations to minimize ice buildup and possibly permanent entrapment of ice within the tailings mass. The deposition planning presented in this memorandum does not present complete details of such seasonality; that will be developed and presented in an Operations, Maintenance and Surveillance (OMS) Manual. This OMS Manual will be prepared by TMAC Resources Inc. (TMAC) in accordance with requirements under Part G of the mine’s current Water Licence.

An important consideration in the operational strategy is to ensure that the final tailings landform allows for free draining of the tailings surface at closure towards the pond downstream of the Interim Dike.

3.2 Tailings and Pond Management

Tailings will be deposited sub-aerially. The tailings supernatant pond will initially be located against the Interim Dike, but depending on the water level in the TIA, there may be no pond on the tailings surface. Although the Interim Dike is not designed to retain water, should the fluid retention time behind the Interim Dike be high, pumping from the tailings pond to downstream of the Interim Dike will be allowed for. The TIA water level will fluctuate, but will typically vary between the normal water level of 28.3 m and the Full Supply Level (FSL) of 32.5 m.

A tailings beach slope of 1% was assumed; however, it is possible that this slope could be as steep as 4% for tailings that are depositing into the supernatant pond. Monitoring of the tailings deposition and pond levels will be required to assess actual conditions that can be compared to the deposition plan. If the average slope is steeper than 1%, additional spigot locations may be required to achieve the required storage capacity.

4 Deposition Scenarios

Three tailings deposition scenarios were considered for tailings disposal into the TIA. The details of these are described as follows:

Scenario 1: Tailings deposition will initially occur from the South Dam and subsequently progress along the east flank of the TIA, forcing the supernatant pond to the northwest corner of the facility (Figure 2). This deposition plan requires ten discharge locations including three along the southwest flank of the TIA. To access these discharge locations and additional 500 m of all-weather road will have to be constructed. The final tailings landform is a “U Shape” configuration. In this scenario the Interim Dike has a crest elevation of 32.5 m, with a freeboard of 1.5 m. The final tailings elevation immediately upstream of the Interim Dike will range between 31.0 and 30.8 m, which means that at closure the elevation difference between the tailings surface and the natural outflow elevation of the TIA will be between 2.7 and 2.5 m once the North Dam is breached at 28.3 m.

Scenario 2: In this scenario the objective was to eliminate the need for discharge locations on the western flank of the TIA. To achieve this, tailings deposition will initially occur from three spigot locations along the South Dam, similar to scenario 1; however, a fourth and fifth spigot will be situated at the east flank of the TSF at elevations 38.5 and 36.5 m, respectively (Figure 2). In this case the Interim Dike has a crest elevation of 32.5 m with a 1.5 m freeboard. The final tailings elevation immediately upstream of the Interim Dike will range between 31.0 and 29.2 m, which means that at closure the elevation difference between the tailings surface and the natural outflow elevation of the TIA will be between 2.7 and 0.9 m once the North Dam is breached at 28.3 m.

Scenario 3: This deposition plan builds on the benefits of Scenario 2, but attempts to lower the final tailings surface immediately upstream of the Interim Dike such that the elevation difference with the natural outflow elevation once the North Dam is breached will be minimal. To achieve this, the Interim Dike needs to be relocated about 200 m downstream of the location used in scenarios 1 and 2, and an additional spigot point is added for a total of six (Figure 3). The Interim Dike will have a crest elevation of 31.0 m with a 1.5 m freeboard, and the final tailings elevation immediately upstream of the Interim Dike will range between 29.5 and 28.3 m, which means that at closure the elevation difference between the tailings surface and the natural outflow elevation of the TIA will be between 1.2 and 0 m once the North Dam is breached at 28.3 m.

The advantages and disadvantages for each tailings deposition scenario is provided in Table 2.

Table 2: Advantages and Disadvantages of Tailings Deposition Scenarios

Deposition Scenario	Advantages	Disadvantages
Scenario 1	• Smaller tailings footprint than Scenario 3. • “U-shaped” drainage swale arguably more defined and thus easier to close than the “L-shaped” configuration of scenarios 2 and 3. • More deposition points provides greater operational flexibility to manage ice entrainment.	• More spigot locations compared to other scenarios, thus more complex to operate. • Will require a longer tailings line to reach the west side of the TIA. • Will require additional all-weather access road to spigot locations on the western flank of the TIA. • High differential elevation between final tailings surface and the normal water level in the TIA at closure. • Larger Interim Dike structure than Scenario 3.

Deposition Scenario	Advantages	Disadvantages
Scenario 2	• Smaller tailings footprint than Scenario 3. • Requires the least amount of spigots. • Does not require access to the west flank of the TIA avoiding the need for an additional all-weather road and longer tailings line.	• Spigot No.4 is above the crest elevation of the dam and stringent monitoring would be required, since spigot elevations are typically lower than the crest elevation of containment structures. • Potential to trap supernatant water between the South Dam and tailings deposition surface, risking the functionality of the dam. • May be more susceptible to dust generation due to the higher tailings elevation. • May be more difficult to construct closure cover, as grading works may be required in the higher reaches. • Moderate differential elevation between final tailings surface and the normal water level in the TIA at closure. • Small amount of spigot points offer limited flexibility to manage ice entrainment. • Larger Interim Dike structure than Scenario 3.
Scenario 3	• Easier to create the “L-shape” configuration with six spigots (as compared to Scenario 2). • Low differential elevation between final tailings surface and the normal water level in the TIA at closure. • Final tailings surface will be easier to reclaim when compared to Scenario 2. • Smallest Interim Dike structure.	• Largest tailings footprint of all the scenarios. This results in increased potential for dust generation and closure cover cost.

5 Preferred Deposition Plan

Based on the evaluation presented in the preceding section and the summary of advantages and disadvantages listed in Table 1, tailings deposition Scenario 3 was selected as the preferred solution. It allows for creation of the desired landform using a number of spigot points that allows for operational flexibility, while avoiding the need to move towards the west flank of the TIA requiring additional discharge pipeline and surface infrastructure. While the larger surface area is a negative, this is offset by the fact that the Interim Dike is smaller and at closure there is virtually no differential elevation between the tailings surface and the normal water level in the TIA.

Two sections that illustrate the typical surface profile of the preferred tailings deposition plan is presented in Figure 4. Cross section A-A’ which is an East-West section shows that the final drainage swale will be along the western flank of the TIA. Similarly, section B-B’ which is a North-South section shows that the overall tailings surface generally slopes from the South Dam towards the Interim Dike.

Figures 5, 6 and 7 present the staged tailings depositional surface for each year of tailings deposition. The details are summarized in Table 3. Discharge durations were based on an average production rate of 773 m^3/day (1,000 tpd) for years 1 and 2, and 1,547 m^3/day (2,000 tpd) for the remaining mine life.

Table 3: Summary of Annual Tailings Deposition Details

Period	Active Spigots (Elevation)	Cumulative Discharge Volume (Mm^3)	Active Deposited Tailings Surface Area (km^2)[1]	Previous Tailings Surface Area not Impacted by Active Deposition (km^2)[2]	Total Tailings Surface Area (Cumulative - km^2)
Year 1	Spigot #1 (33.5 m)	0.34	0.17	0	0.17
Year 2	Spigot #1 (35.3 m)	0.68	0.23	0	0.23
Year 3	Spigot #1 (36.5 m) Spigot #2 (36.5 m) Spigot #3 (36.5 m) Spigot #4 (35.5 m)	1.35	0.34	0	0.34
Year 4	Spigot #4 (36.5 m) Spigot #5 (36.3 m)	2.03	0.36	0.06	0.42
End of Mine (Year 4, Month 5)	Spigot #5 (36.5 m) Spigot #6 (35.0 m)	2.32	0.30	0.14	0.44

Notes:

1. The deposited tailings surface area (shown in yellow on Figures 5, 6 and 7) is the resultant surface area from active tailings deposition for the period indicated.
2. The previous tailings surface area (shown in grey on Figures 6 and 7) is the exposed tailings surface that is not covered by active deposition (i.e. these areas could be progressively reclaimed).

References

BGC Engineering Inc., 2003. Ice Entrapment in Tailings. Phase I Compilation Report prepared for Indian and Northern Affairs Canada. Project number 0131-009-01, March

Knight Piesold Ltd. (KP 2009). Geotechnical Laboratory Test Results, Hope Bay Project, Nunavut, Canada. Report prepared for Newmont Metallurgical Services. Project number DV108-00147.04. Letter of Transmittal dated June 3, 2009.

Pocock Industrial Inc. (PI 2009). Flocculant Screening, Gravity Sedimentation, Pulp Rheology, Pressure Filtration and Vacuum Filtration Studies, Hope Bay Project, Nunavut, Canada. Report prepared for Newmont Mining Corporation. December 2008 – February 2009.

SRK Consulting (Canada) Inc. (SRK 2007). Design of the Tailings Containment Area, Doris North Project, Hope Bay, Nunavut, Canada. Report prepared for Miramar Hope Bay Ltd. Project Number 1CM014.008.165.

SRK Consulting (Canada) Inc. (SRK 2012). North Dam As-Built Report, Hope Bay Project. Report prepared for Hope Bay Mining Ltd. Project Number 1CH008.058. October 2012.

Figures