TMAC Resources Inc.

Revisions to TMAC Resources Inc. Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323

Package 6: Engineering and Design Documents

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June 2015

Revisions to TMAC Resources Inc. - Amendment Application No. 1 of Project Certificate No. 003 and Water Licence 2AM-DOH1323

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TMAC RESOURCES

Package 6

Engineering and Design Documents

Package 6
Engineering and Design Documents

P6-1 Doris Central Vent Raise Pad and Access Road

TMAC RESOURCES

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Memo

To:	John Roberts, TMAC	**Client:**	TMAC Resources Inc.
From:	Lowell Wade, SRK Maritz Rykaart, SRK	**Project No:**	1CT022.002.200.1200
Cc:		**Date:**	May 29, 2015
Subject:	Doris North Project: Doris Central Vent Raise Pad and Access Road		

1 Introduction

TMAC Resources Inc. (TMAC) is currently in the process of developing their Doris North Project (Project) in the Kitikmeot region of Nunavut, Canada. Concurrent with this, TMAC recognizes that to expand the Doris North Project a vent raise may be required within Doris Central Zone.

This memo describes the design details of the infrastructure associated with the Doris Central Access Road and Doris Central Vent Raise Pad located within Quarry I. This memo should be read in conjunction with the attached Issued for Discussion (IFD) engineering drawings (Attachment 1).

2 Design Concept

All of the infrastructure pads and all-weather roads associated with the Hope Bay Project are located on Inuit Owned Land (IOL), administered by the Kitikmeot Inuit Association (KIA).

The Doris Central Vent Raise is located approximately 1.2 km south of the Doris North Camp accessible from the Doris-Windy All-Weather Road by the Doris Central Access Road. The design concept of the Vent Raise Pad is based on the same principles as adopted for elsewhere on the Doris North Project which is to construct all facilities either on bedrock or on rock fill thermal pads at least 1 m thick to preserve permafrost. Site layouts are designed to minimize the overall footprint.

The Doris Central Vent Raise Pad will measure 225 m^2, in area, to support a Vent Raise Fan and an Emergency Shelter. The Doris Central Vent Raise Pad will be located entirely on a bedrock outcrop. As no thermal rock fill pad is required, the vent raise pad will require a 0.15 m minimum thick surfacing material to create a level surface. Some Run-of-Quarry (ROQ) fill will be required to provide adequate area for accessibility.

Site roads are considered private roads, administered and controlled entirely by TMAC. To date, none of the site roads are used as, or classified as mine haul roads in accordance with the Mine Health and Safety Act pertaining to haul roads (GNU 2012). The proposed all-weather road to the Doris Central Vent Raise will also not be classified as a haul road. Notwithstanding this, TMAC has opted to ensure that all site roads are designed in accordance with the minimum requirements as set out for mine haul roads in the Mine Health and Safety Act.

The Doris Central Access Road concept applies the same primary design criteria as all existing all-weather roads, including allowance for dual lane traffic for frequently, travelled vehicles such as service trucks, and single lane traffic for occasional oversize vehicles. A strategically placed road turnout facilitates single lane use. The maximum design speed for any vehicle is 50 km/hr.

3 Design Concept Alternatives

Two options were considered for the design of the Doris Central Access Road and Doris Central Vent Raise Pad:

- Option A – Self Powered Heat and Ventilation Raise. This option would see significant development of Quarry I to support an Overburden Stockpile, a Fuel Transfer Station and a Mine Air Heating Facility. This option would provide heated air circulation to the underground workings without any underground support. *This option was not selected as this would require significant development of Quarry I and surface infrastructure pads.*

- Option B – Underground Powered Ventilation Raise Only. This option would locate the Vent Raise Fan, powered by the underground workings thereby eliminating the requirement to haul fuel for a generator. An Emergency Shelter will also be located on the cleared bedrock outcrop. This. Only minor drilling and blasting may be required, within Quarry I, to locate the Vent Raise Fan over the vent raise and a small pad constructed to support the Vent Raise Fan and Emergency Shelter. T*his option was selected as the preferred option as this requires minimal development of Quarry I as well as surface infrastructure pads.*

4 System Design

4.1 Design Criteria

The infrastructure associated with the Doris Central Vent Raise consists of an all-weather access road and an infrastructure pad. The infrastructure components associated with the vent raise are summarized in Table 1.

Table 1: Surface Infrastructure Facilities Associated With the Doris Central Vent Raise

Infrastructure Component	Surface Area	Limitations
Emergency Shelter	30 m^2 (3x10m)	Required in the vicinity of the Vent Raise Fan
Vent Raise Fan	20 m^2 (4.5x4.5 m)	Required immediately adjacent to vent raise

4.2 Survey Data

The design of the Doris Central Access Road and Doris Central Vent Raise Pad are based on topographic contours produced from 2007 aerial photography supplied by Hope Bay Mining Limited (HBML). No detailed ground surveys have been completed.

4.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms that the area 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 indicate that 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 below -2ºC. The ice-rich overburden soils are typically between 5 and 20 m deep, before encountering competent bedrock, predominantly basalt. Bedrock is frequently exposed, rising in columnar fashion 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 such as the Doris Central Vent Raise Access Road (SRK 2006). The Doris Central Vent Raise Access Road requires a minimum fill thickness of 0.15 m of surfacing material in areas where the foundation is bedrock. In areas of exposed tundra, the minimum fill thickness is 1 m with 1.5H;1V side slopes (Fill Zone 1) except where there is patterned ground where the minimum fill thickness will be increased to a minimum of 1.5 m with 1.5H:1V side slopes.

The geotechnical design parameters for Hope Bay have been summarized in SRK (2011a).

4.4 Doris Central Vent Raise Access Road

4.4.1 Design Criteria

The Doris Central Vent Raise Access Road is a 739 m long by 9.5 m wide access road to the Doris Central Vent Raise which extends from kilometer 1+200 along the Doris-Windy All-Weather Road east to the Vent Raise Pad.

The design criteria for the Vent Raise Access Road are the same as for the Doris-Windy All-Weather Road (SRK 2012). The key design criteria are:

- The maximum allowable grade is 10% (10H:1V); however, wherever possible grades less than 4% will be targeted;
- A minimum thickness of 1 m over tundra must be maintained and 0.3 m over bedrock;
- The roadway will be crowned to promote drainage by means of 0.5% surface grading in both directions from the centreline of the roadway;

- Road shoulders will be graded to 2H:1V in areas where fill thickness is more than 1.5 m otherwise the road shoulders will be graded to 1.5H:1V; and

- No cut is allowed, except in designated rock quarries, and then only to a grade at least 0.5 m above the surrounding tundra elevation.

4.4.2 Foundation and Road Fill Materials

The all-weather access road design incorporates ROQ fill material and a layer of surfacing material. On the tundra, fill thicknesses will typically range from 1 to 1.5 m. This is based on terrain conditions inferred from the satellite imagery of the area but will be revised based on aerial field reconnaissance as well as on experience gained from surrounding areas. On exposed bedrock, fill thicknesses will be determined by the grade of the alignment. To uphold minimum design requirements the following is required:

- From station 0+000 to 0+300 the minimum road thickness is required to be 1.5 m;

- From station 0+300 to 0+550 the access road thickness is required to be a minimum of 1.5 m thick and above elevation 71.5 m; and

- From station 0+550 to the vent raise pad the access road transitions from the tundra to the bedrock outcrop and has fill thicknesses determined by the road grades.

4.4.3 Drainage Crossings

No stream crossings are required for the Doris Central Access Road. Near station 0+375 there is a defined surface water preferential flow path. At this location of the road alignment, a double culvert will be installed to allow surface water drainage to pass under the all-weather road and into Doris Lake.

4.4.4 Animal Crossings

As for the Doris-Windy All-Weather Road, animal crossings will consist of designated sections of the roadway where shoulders will be flattened to 5H:1V and topped with surfacing material. Animal crossings will be at least 10 m wide and will generally be located at major horizontal bends in the road alignment and at junctions. Final animal crossing locations will be decided in consultation with the landowner and local Elders after inspection of the completed access road.

4.5 Doris Central Vent Raise Pad

4.5.1 Design Criteria

The design criteria for the Doris Central Vent Raise pad are:

- The pad will be located around the vent raise to accommodate the Vent Raise Fan and the Emergency Shelter;

- The pad will be placed on a cleared bedrock surface. It has been assumed that no major development of Quarry I will be required to prepare the Vent Raise Pad. Some drilling and blasting will be required to anchor the Vent Raise Fan to the vent raise;

- A safety barrier, of crushed rock or large boulders, will be placed along the top of the rock high wall to limit access. The exposed rock face may require stabilization using rock bolts and mesh;

- A minimal pad will be constructed consisting of a surfacing layer of crushed material placed over the prepared bedrock surface to create a levelling course on which to place the Vent Raise Fan, Emergency Shelter, and to accommodate traffic;

- If an elevation difference exceeds 3 m, safety barriers will be constructed along the edge of the pad.

4.5.2 Design

Based on the current survey information, no drilling or blasting will be required and the bedrock surface is free draining to the northeast side of the Doris Central Vent Raise bedrock outcrop. A 0.15 m minimum thick surfacing material of 1¼ inch crushed rock will be placed to create a smooth running surface for vehicle and foot traffic. As this area will measure 225 m^2 to support a Vent Raise Fan and an Emergency Shelter some additional ROQ fill will be required to construct a pad to provide adequate space.

5 Construction Methodology

The Doris Central Access Road will be constructed with ROQ material excavated from permitted and approved quarries along the Doris-Windy All-Weather Road (Quarry A, B, and D). Even though the Doris Central Vent Raise is located within Quarry I, this quarry will not be developed as the Doris Central Vent Raise has minimal surface infrastructure requirements. SRK (2008) contains complete details pertaining to geochemical characterization of the Doris-Windy All-Weather Road Quarries A, B, and D. The management and monitoring of the existing Quarries along the Doris-Windy All-Weather Road will be according to SRK (2014).

The road and pad will be constructed in accordance to SRK's Technical Specifications (SRK 2011b).

Surface grade material for both the all-weather road and vent raise pad will be from the crusher located in Quarry #2. Complete material quantities are included in Attachment 1.

6 References

GNU. 2012. Mine Health and Safety Act, SNu 2012, c 17. Government of Nunavut. Accessed on May 25, 2015, from http://www.wscc.nt.ca/occupational-health-safety/ohs-information/safety-legislation.

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., 2008. Geochemical Characterization of Quarry Materials for the Doris-Windy All-Weather Road. Hope Bay Project. Report Prepared for Hope Bay Mining Limited, Project Number 1CH008.000.300. August 2008.

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

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: 1CH008.027. March 2011.

SRK Consulting (Canada) Inc., 2012. Engineering Drawings for the Doris-Windy All-Weather Road, Doris Infrastructure Project, Nunavut, Canada. Revision 1 - As-Built. Drawing Package Prepared for Hope Bay Mining Ltd. Project Number 1CH008.033/.058. May 11, 2012.

SRK Consulting (Canada) Inc., 2014. Hope Bay Project Quarry Management and Monitoring Plan – Revision 02. Report prepared for TMAC Resources Inc. Project Number: 1CT022.001. December 2014.

Attachment 1

Engineering Drawings for the Doris Central Vent Raise

Engineering Drawings for the Doris Central Vent Raise Doris North, Nunavut, Canada

ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS	OLD/REPLACE REVISIONS	
DC-00	Engineering Drawings for the Doris Central Vent Raise Doris North, Nunavut, Canada	C	May 29, 2015	Issued For Discussion	Rev. B June 7, 2011	Rev. A Oct 22, 2010
DC-01	General Arrangement (with orthophoto)	C	May 29, 2015	Issued For Discussion	Rev. B June 7, 2011	Rev. A Oct 22, 2010
DC-02	Arrangement and Access Road Profile	C	May 29, 2015	Issued For Discussion	Rev. B June 7, 2011	Rev. A Oct 22, 2010
DC-03	Vent Raise Pad Sections	C	May 29, 2015	Issued For Discussion	Rev. B June 7, 2011	Rev. A Oct 22, 2010
DC-04	Typical Sections and Details	C	May 29, 2015	Issued For Discussion	Rev. B June 7, 2011	Rev. A Oct 22, 2010

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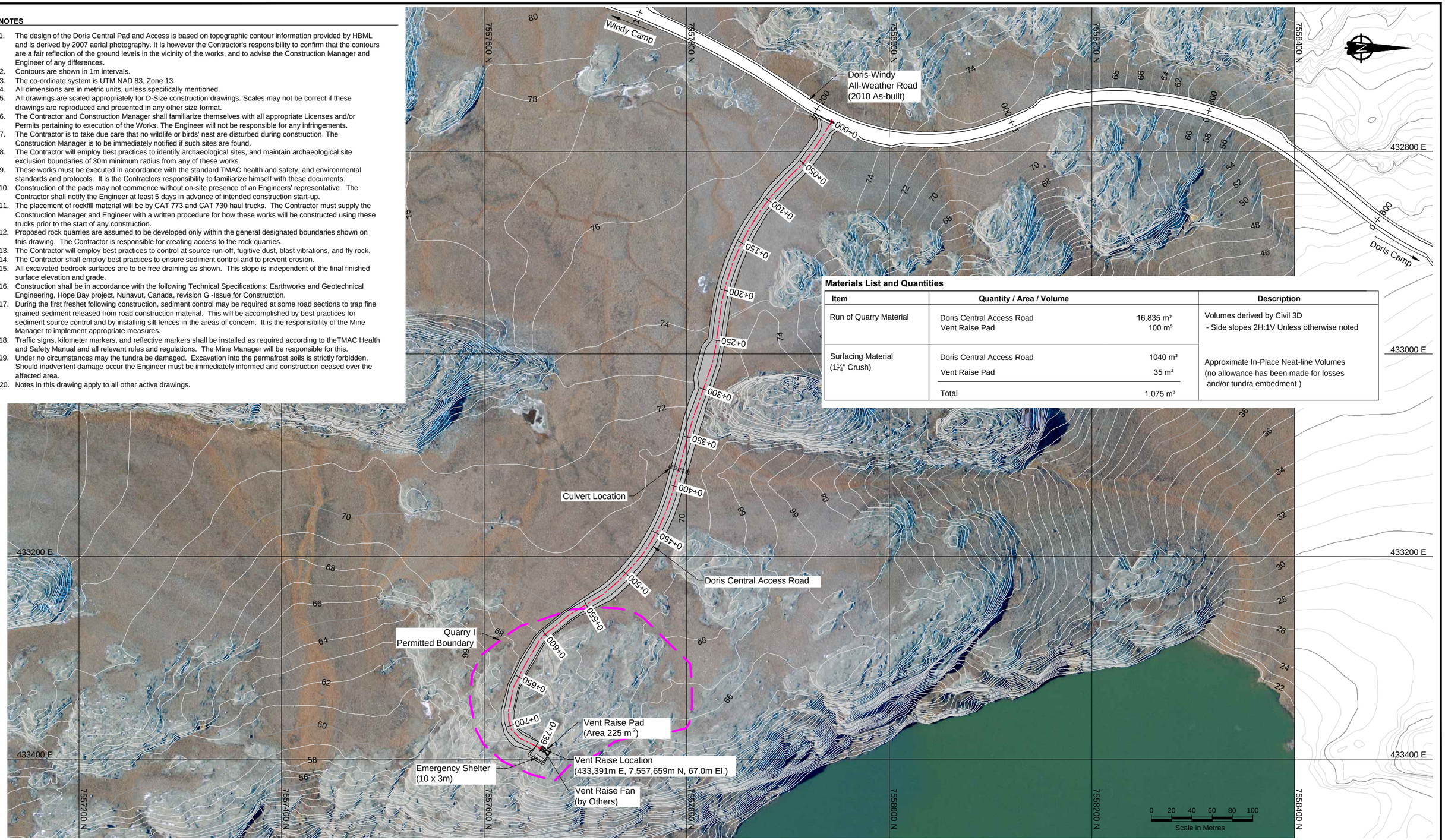
PROJECT NO: 1CT022.002.200.1200
Revision C
May 29, 2015
Drawing DC-00

NOTES

1. The design of the Doris Central Pad and Access is based on topographic contour information provided by HBML and is derived by 2007 aerial photography. 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. Contours are shown in 1m intervals.
3. The co-ordinate system is UTM NAD 83, Zone 13.
4. All dimensions are in metric units, unless specifically mentioned.
5. 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.
6. The Contractor and Construction Manager shall familiarize themselves with all appropriate Licenses and/or Permits pertaining 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 construction. The Construction Manager is to be immediately notified if such sites are found.
8. The Contractor will employ best practices to identify archaeological sites, and maintain archaeological site exclusion boundaries of 30m minimum radius from any of these works.
9. These works must be executed in accordance with the standard TMAC health and safety, and environmental standards and protocols. It is the Contractors responsibility to familiarize himself with these documents.
10. Construction of the 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.
11. 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.
12. Proposed rock quarries are assumed to be developed only within the general designated boundaries shown on this drawing. The Contractor is responsible for creating access to the rock quarries.
13. The Contractor will employ best practices to control at source run-off, fugitive dust, blast vibrations, and fly rock.
14. The Contractor shall employ best practices to ensure sediment control and to prevent erosion.
15. All excavated bedrock surfaces are to be free draining as shown. This slope is independent of the final finished surface elevation and grade.
16. Construction shall be in accordance with the following Technical Specifications: Earthworks and Geotechnical Engineering, Hope Bay project, Nunavut, Canada, revision G -Issue for Construction.
17. During the first freshet following construction, sediment control may be required at some road sections to trap fine grained sediment released from road construction material. This will be accomplished by best practices for sediment source control and by installing silt fences in the areas of concern. It is the responsibility of the Mine Manager to implement appropriate measures.
18. Traffic signs, kilometer markers, and reflective markers shall be installed as required according to theTMAC Health and Safety Manual and all relevant rules and regulations. The Mine Manager will be responsible for this.
19. Under no circumstances may the tundra be damaged. Excavation into the permafrost soils is strictly forbidden. Should inadvertent damage occur the Engineer must be immediately informed and construction ceased over the affected area.
20. Notes in this drawing apply to all other active drawings.



Materials List and Quantities

Item	Quantity / Area / Volume		Description
Run of Quarry Material	Doris Central Access Road	16,835 m³	Volumes derived by Civil 3D - Side slopes 2H:1V Unless otherwise noted
	Vent Raise Pad	100 m³	
Surfacing Material (1¼" Crush)	Doris Central Access Road	1040 m³	Approximate In-Place Neat-line Volumes (no allowance has been made for losses and/or tundra embedment)
	Vent Raise Pad	35 m³	
	Total	1,075 m³	

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	LW	EMR	29May15
B	Revisions Sed Berm Added	JK	EMR	7June11
A	Issued for Review	JK	EMR	22Oct10

REFERENCE DRAWINGS

DRAWING NO. | DRAWING TITLE | DRAWING NO. | DRAWING TITLE

REVISIONS

Original Drawings Stamped and Signed by Engineer

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DESIGN:	DRAWN:	REVIEWED:
JBK	NV\MDDS	LW
CHECKED:	APPROVED:	DATE:
JBK	EMR	May 29, 2015

FILE NAME: Doris Central Pads and Access Ramp DC-01_03_RevC.dwg

TMAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.002.200.1200

Doris Central Vent Raise

DRAWING TITLE: General Arrangement (with Orthophoto)

DRAWING NO.	SHEET	REVISION NO.
DC-01	2 of 5	C

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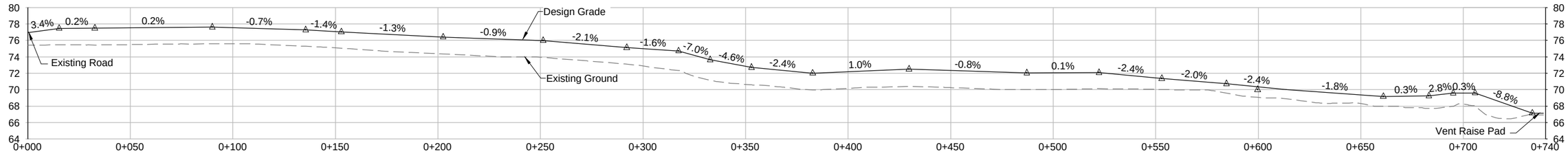


PROFILE DORIS CENTRAL ACCESS ROAD

0 10 20 30 40 50
Horizontal Scale in Metres

0 2 4 6 8 10
Vertical Scale in Metres

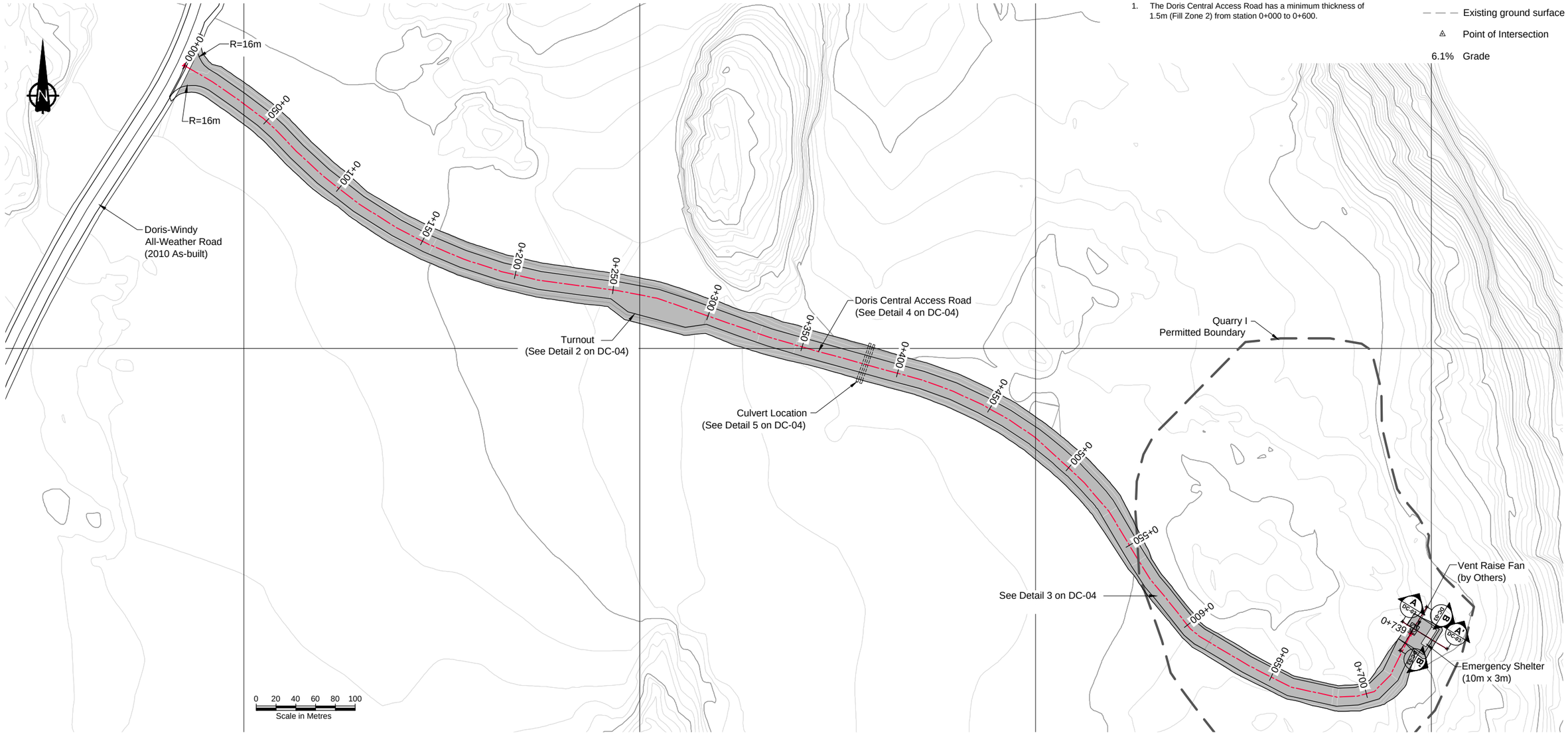
Vertical Exaggeration 4X

NOTE

1. The Doris Central Access Road has a minimum thickness of 1.5m (Fill Zone 2) from station 0+000 to 0+600.

LEGEND

- Existing ground surface
- Point of Intersection
- 6.1% Grade



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REVISIONS				

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JBK	EMR	May 29, 2015

FILE NAME: Doris Central Pads and Access Ramp DC-01_03_RevC.dwg

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SRK JOB NO.: 1CT022.002.200.1200

Doris Central Vent Raise

DRAWING TITLE:

Arrangements and Access Road Profile

DRAWING NO.	SHEET	REVISION NO.
DC-02	3 of 5	C

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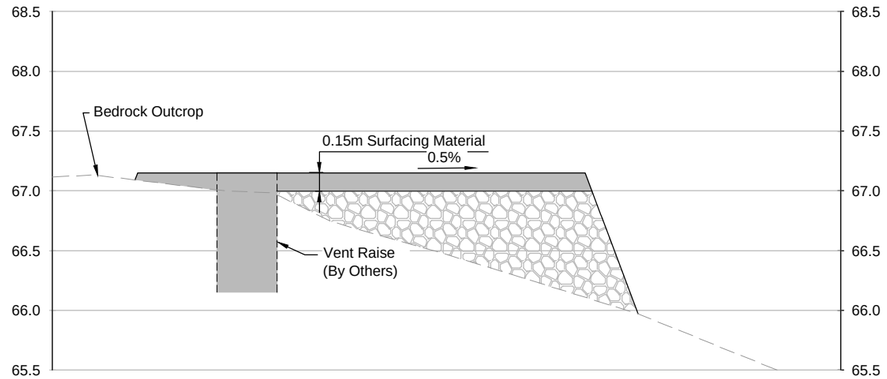
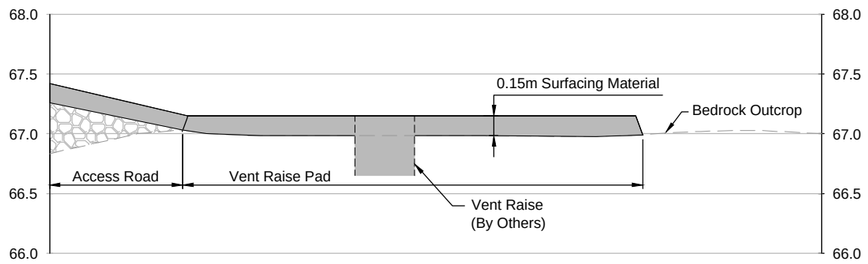


A DC-02 **VENT RAISE PAD**

0 1 2 3 4 5

Horizontal Scale in Metres
Vertical Exaggeration 4X



B DC-02 **VENT RAISE PAD**

0 1 2 3 4 5

Horizontal Scale in Metres
Vertical Exaggeration 4X

LEGEND

- Run of Quarry Material
- 1 ¼" Crushed Material
- Ground Surface

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
REFERENCE DRAWINGS			

NO.	DESCRIPTION	CHK'D	APP'D	DATE
C	Issued for Discussion	JK	EMR	29May15
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JBK	EMR	May 29, 2015

FILE NAME: Doris Central Pads and Access Ramp DC-01_03_RevC.dwg

MAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.002.200.1200

Doris Central Vent Raise

DRAWING TITLE:

Vent Raise Pad Sections

DRAWING NO.	SHEET	REVISION NO.
DC-03	4 OF 5	C

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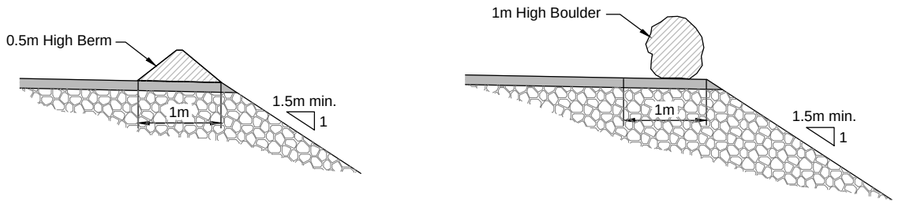
LEGEND

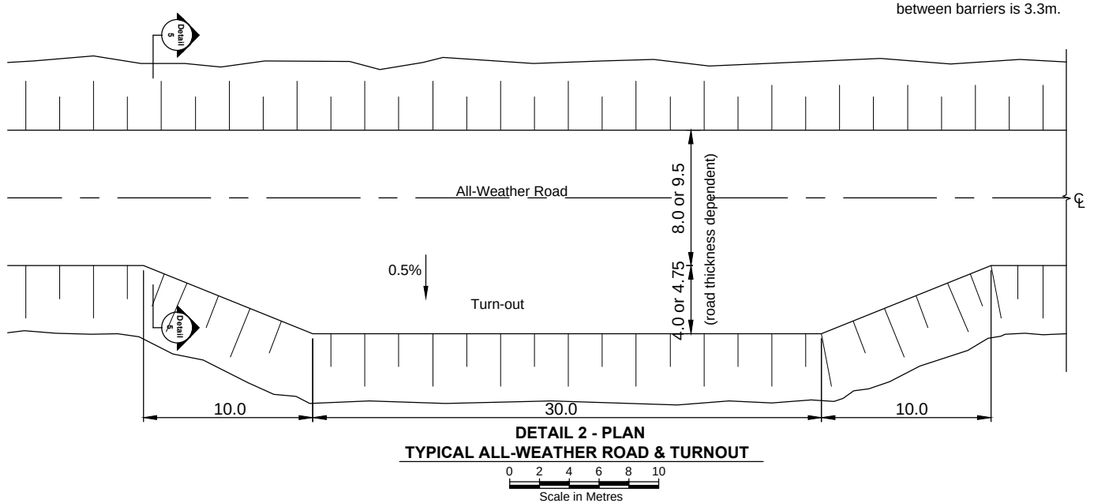
- Run of Quarry Material
- 1 ¼" Crushed Material
- Ground Surface

NOTES

1. Where the thickness of the roads/berm is greater than 2.0m allow for the placement of barriers.
2. 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.



DETAIL 1
TYPICAL BERM BARRIER OPTIONS
NTS



DETAIL 2 - PLAN
TYPICAL ALL-WEATHER ROAD & TURNOUT
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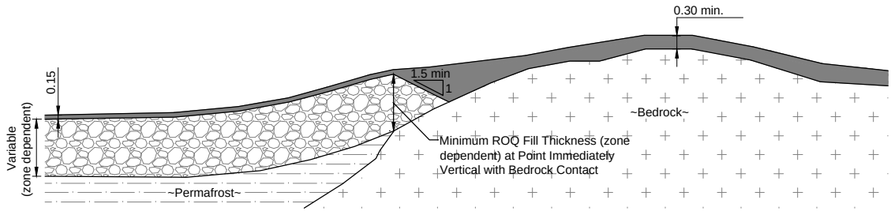
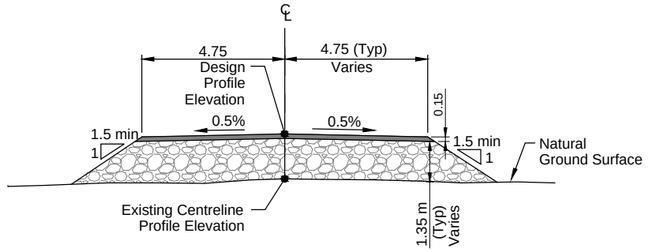
Scale in Metres



DETAIL 3 - ALL-WEATHER ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK
0 1 2 3 4 5
Scale in Metres



DETAIL 4
TYPICAL ACCESS ROAD SECTION
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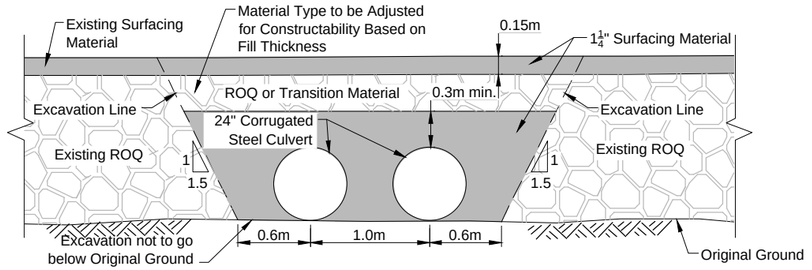
Scale in Metres



DETAIL 5
TYPICAL CROSS SECTION OF CULVERT CROSSING
6
NOT TO SCALE

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REFERENCE DRAWINGS			

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FILE NAME: Doris Central Pads and Access Ramp DC-04 RevC.dwg

MAC RESOURCES

HOPE BAY PROJECT

SRK JOB NO.: 1CT022.002.200.1200

Doris Central Vent Raise

DRAWING TITLE: Typical Sections and Details

DRAWING NO.	SHEET	REVISION NO.
DC-04	5 OF 5	C

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Package 6
Engineering and Design Documents

P6-2 Doris Connector Vent Raise Pad and Access Road

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Memo

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From:	Lowell Wade, SRK Maritz Rykaart, SRK	**Project No:**	1CT022.002.200.1100
Cc:		**Date:**	May 29, 2015
Subject:	Doris North Project: Doris Connector Vent Raise Pad and Access Road		

1 Introduction

TMAC Resources Inc. (TMAC) is currently in the process of developing their Doris North Project (Project) in the Kitikmeot region of Nunavut, Canada. Concurrent with this, TMAC recognizes that to expand the Doris North Project a vent raise may be required within the Doris Connector underground development.

This memo describes the design details of the infrastructure associated with the Doris Connector Access Road and Doris Connector Vent Raise Pad. This memo should be read in conjunction with the attached Issued for Discussion (IFD) engineering drawings (Attachment 1).

2 Design Concept

All of the infrastructure pads and all-weather roads associated with the Hope Bay Project are located on Inuit Owned Land (IOL), administered by the Kitikmeot Inuit Association (KIA).

The Doris Connector Vent Raise is located approximately 340 m south of the Doris North Camp accessible from the Float Plane Dock Access Road by the Doris Connector Access Road. The design concept of the Doris Connector Vent Raise Pad is based on the same design principles as applied elsewhere on the Doris North Project wherein all facilities are constructed either on bedrock or on thermal rock fill pads at least 1 m thick to preserve permafrost. Site layouts are designed to minimize the overall project footprint.

The Doris Connector Vent Raise Pad will measure 225 m^2, in area, to support a Vent Raise Fan and an Emergency Shelter. The Doris Connector Vent Raise Pad will be located entirely on a bedrock outcrop. As no thermal rock fill pad is required, the Vent Raise Pad will require a 0.15 m minimum thick surfacing material to create a level surface. Some Run-of-Quarry (ROQ) fill will be required to increase the size of the vent raise pad to provide adequate area for accessibility.

Site roads are considered private roads, administered and controlled entirely by TMAC. To date, none of the site roads are used as, or classified as, mine haul roads in accordance with the Mine Health and Safety Act pertaining to haul roads (GNU 2012). The proposed all-weather road to the Doris Connector Vent Raise area will also not be classified as a haul road. Notwithstanding this, TMAC has opted to ensure that all site roads are designed in accordance with the minimum requirements as set out for mine haul roads in the Mine Health and Safety Act.

The Doris Connector Access Road concept applies the same primary design criteria as all existing all-weather roads, including allowance for dual lane traffic for frequently, travelled vehicles such as service trucks and single lane traffic for occasional oversize vehicles. The maximum design speed for any vehicle is 50 km/hr.

3 Access Alternatives

Four alignments were considered for the Doris Connector Access Road (Figures 1 to 3):

- Option A – a 238 m alignment requiring a 35 m clear span bridge. This alignment extends along the east side of the Doris Connector bedrock outcrop and connects to the Float Plane Dock Access Road adjacent to the fresh water intake pump house pad. Given the ground conditions, most of this alignment would be designed to have a 2 m minimum road thickness with 2.0H:1V side slopes except where the alignment extends along the Doris Connector bedrock outcrop where grade requirements will determine road fill thickness. This option specifies a 35 m clear span bridge over the surface water drainage channels. The fresh water intake pipeline, running along the south side of the Float Plane Dock Access Road would have to be moved or protected to accommodate vehicle traffic. *This option was not selected due to the cost of a 35 m clear span bridge.*

- Option B – a 359 m alignment requiring a 25 m clear span bridge. This alignment extends along the east side of the Doris Connector bedrock outcrop and connects to the Float Plane Dock Access Road at the junction to the Secondary Road adjacent to Sump 1. The ground conditions would require most of this alignment to be designed to have a 2 m minimum road thickness with 2.0H:1V side slopes except along the Doris Connector bedrock outcrop where grade requirements will determine road fill thickness. A 25 m clear span bridge over the surface water drainage channels is specified and protection of the fresh water pipeline, located on the pipe bench, and the water management pipelines located on the tundra, is required. *This option was not selected due to the cost of a 25 m clear span bridge and the increased alignment length over ground conditions requiring thick fills.*

- Option C – a 354 m alignment requiring a 42 m clear span bridge. This alignment extends along the west side of the Doris Connector bedrock outcrop and connects to the Float Plane Dock Access Road at the junction to the Secondary Road adjacent to Sump 1. Similar to Option B, most of this alignment would be designed to have a 2 m minimum road thickness with 2.0H:1V side slopes except along the Doris Connector bedrock outcrop where grade requirements will determine road fill thickness. Protection of the fresh water pipeline, located on a pipe bench, and the water management pipelines, located on the tundra would also

required. This option specifies the longest clear span bridge of all options considered. *This option was not selected for the same reasons as for Options A and B.*

- Option D – a 450 m alignment. This alignment extends along the west side of the Doris Connector bedrock outcrop then turn west to connect to the Doris-Windy All-Weather Road at kilometre 0+400. Approximately half of the alignment's length is located on patterned ground which will require a 1.5 m minimum road thickness with 1.5H:1V side slopes to protect the permafrost. A double culvert at the base of the bedrock outcrop to allow the flow of surface water under the road alignment as it drains towards Doris Lake. *Even though this alignment was located on better ground conditions compared to Options A, B, and C, this option was not selected as it has the longest alignment length and does not connect directly to Doris North Camp. This option is considered the alternate option, in the event the preferred option is not approved.*

- Option E – a 238 m alignment with culverts. This option is the same alignment as Option A, above, but instead of a 35 m clear span bridge, two 0.5 m diameter corrugated steel culverts will be installed along the surface water drainage channels. *This option was selected as the preferred alignment to access the Doris Connector Vent Raise Pad because it has the shortest alignment length and would be the most economical to construct.*

4 System Design

4.1 Design Criteria

The infrastructure associated with the Doris Connector Vent Raise consists of an all-weather access road and an infrastructure pad supporting the facilities listed in Table 1.

Table 1: Surface Infrastructure Facilities Associated With the Doris Connector Vent Raise

Infrastructure Component	Surface Area	Limitations
Emergency Shelter	30 m^2 (3x10m)	Required in the vicinity of the Vent Raise Fan
Vent Raise Fan	20 m^2 (4.5x4.5 m)	Required immediately adjacent to vent raise

4.2 Survey Data

The design of the Doris Connector Access Road and Vent Raise Pad are based on 2012 Doris North Camp as-built information received from Nuna Logistics (SRK 2012a) and on topographic contours produced from 2007 aerial photography supplied by Hope Bay Mining Limited (HBML). No detailed ground surveys have been completed.

4.3 Foundation Conditions

Comprehensive geotechnical investigations have been carried out at the Doris North Site (SRK 2009). This information confirms that the area 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 indicate that 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 below -2ºC. The ice-rich overburden soils are typically between 5 and 20 m deep, before encountering competent bedrock, predominantly basalt. Bedrock is frequently exposed, rising in columnar fashion 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 such as the Doris Connector Vent Raise Access Road (SRK 2006). The Doris Connector Vent Raise Access Road requires a minimum fill thickness of 0.15 m of surfacing material in areas where the foundation is bedrock. In areas of exposed tundra, the minimum fill thickness is 1 m with 1.5H;1V side slopes except in wet areas where the minimum fill thickness will be increased to a minimum of 2.0 m with 2.0H:1V side slopes.

The geotechnical design parameters for Hope Bay have been summarized in SRK (2011a).

4.4 Doris Connector Vent Raise Access Road

4.4.1 Design Criteria

The Doris Connector Vent Raise Access Road is a 214 m long by 9.5 m wide Access Road to the Vent Raise which extends from the Float Plane Dock Access Road, adjacent to the fresh water intake pump house pad, south to the Vent Raise Pad.

The design criteria for the Vent Raise Access Road are the same as for the Doris-Windy All-Weather Road (SRK 2012b). The key design criteria are:

- The maximum allowable grade is 10% (10H:1V); however, wherever possible grades less than 4% will be targeted;
- A minimum thickness of 1 m over tundra must be maintained and 0.3 m over bedrock;
- The roadway will be crowned to promote drainage by means of 0.5% surface grading in both directions from the centreline of the roadway;
- Road shoulders will be graded to 2H:1V in areas where fill thickness is more than 1.5 m otherwise the road shoulders will be graded to 1.5H:1V; and
- No cut is allowed, except in designated rock quarries, and then only to a grade at least 0.5 m above the surrounding tundra elevation.

4.4.2 Foundation and Road Fill Materials

The all-weather access road design incorporates ROQ fill material and a layer of surfacing material. On the tundra, fill thicknesses will typically range from 2 m or greater. On exposed bedrock, fill thicknesses will be determined by the grade of the alignment. Fill zones were determined based on terrain conditions inferred from the satellite imagery of the area but will be revised based on aerial field reconnaissance as well as on experience gained from surrounding areas. To uphold minimum design requirements the following is required:

- From station 0+000 to 0+120 the minimum road thickness is required to be 2 m;
- From station 0+120 to the vent raise pad the access road transitions from the tundra to the bedrock outcrop and has fill thicknesses determined by the road grades.

4.4.3 Drainage Crossings

Two 0.5 m diameter corrugate steel culverts will be required for the Doris Connector Access Road. These culverts will be installed along the surface water drainage channels at the approximate chainage of 0+060.

4.4.4 Animal Crossings

As for the Doris-Windy All-Weather Road, animal crossings will consist of designated sections of the roadway where shoulders will be flattened to 5H:1V and topped with surfacing material. Animal crossings will be at least 10 m wide and will generally be located at major horizontal bends in the road alignment and at junctions. Final animal crossing locations will be decided in consultation with the landowner and local Elders after inspection of the completed access road.

4.5 Doris Connector Vent Raise Pad

4.5.1 Design Criteria

The design criteria for the Doris Central Vent Raise pad are:

- The pad will be located around the vent raise to accommodate the Vent Raise Fan and the Emergency Shelter;
- The pad will be placed on a cleared bedrock surface. It has been assumed that no quarry development will be required to prepare the Vent Raise Pad. To anchor the Vent Raise Fan to the vent raise some drilling and blasting will be required;
- A surfacing layer of crushed material will be placed over the bedrock surface and rock fill pad to create a levelling course to place the Vent Raise Fan, Emergency Shelter, and to accommodate traffic;
- Safety barriers, of crushed rock or large boulders, shall be placed along the edges of the pad for safety.

4.5.2 Design

Based on the current survey information, no drilling or blasting will be required and the bedrock surface is free draining to the east and west sides of the Doris Connector Vent Raise bedrock outcrop. A 0.15 m minimum thick surfacing material of 1¼ inch crushed rock will be placed to create a smooth running surface for vehicle and foot traffic. As this area will measure 225 m^2 to support a Vent Raise Fan and an Emergency Shelter some additional ROQ fill will be required to construct a pad to provide adequate space.

5 Construction Methodology

The Vent Raise Access Road and the Vent Raise Pad will be constructed with ROQ material excavated from permitted and approved Quarry #2. SRK (2007) discusses the complete details pertaining to geochemical characterization of this rock quarry confirming its suitability for use in construction. The management and monitoring of quarry development for the construction of the infrastructure pads and access roads is discussed in SRK (2014).

Surface grade material for both the all-weather road and the Vent Raise Pad will be from the crusher located in Quarry #2. Complete material quantities are included in Attachment 1.

The road and pad will be constructed in accordance to SRK's Technical Specifications (SRK 2011b).

6 References

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Figures