HEMMERA

# FINAL REPORT

## Mactung Mine Access Road Overview Assessment (Part B): A Comparison of Existing and Proposed Routes

Prepared for:
**YESAB**
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File: 1171-003.01
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October 21, 2011
File: 1171-003.01

YESAB
Suite 200 – 309 Strickland Street
Whitehorse, Yukon Y1A 2J9

**Attn: Michael Muller, Project Assessment Manager**

Dear Michael,

**Re: Comparison of Potential Routes for Mactung Mine**

We are pleased to provide you with a final report for Part B of the Mactung Mine Access Road Overview Assessment.

We have appreciated the opportunity to work with you on this project and trust that this report meets your requirements. Please feel free to contact the undersigned by phone or email regarding any questions or further information that you may require.

Regards,
**Hemmera**

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# 1.0 INTRODUCTION

The Yukon Environmental and Socio-economic Assessment Board (YESAB) is reviewing a proposal for the construction and upgrading of approximately 50 km of road (19 km of abandoned road and 31 km of new road) to access the Mactung Mine, located northwest of MacMillan Pass in the Yukon Territory. The mine is currently accessed by a spur road (Mactung spur) heading 10.8 km northwest from the North Canol road (Figure 1).

YESAB retained Hemmera to provide expert advice and an overview assessment on the existing and proposed routes to access the Mactung Mine. Hemmera engaged Timothy Smith, P.Geo, Eng. L. from Westrek Geotechnical Services Ltd. (Westrek). **Throughout this report, Hemmera refers to the work by Hemmera and Westrek.**

## 1.1 OBJECTIVES

Hemmera was engaged by YESAB to determine:

- Whether there were geotechnical or constructability constraints that could preclude the use of the existing North Canol road and Mactung spur for proposed mine haul traffic,
- Whether the existing North Canol road and Mactung spur could be upgraded or realigned to current engineering standards[1] for the proposed mine haul traffic,
- Whether there were geotechnical or constructability challenges with the proposed route, and
- Whether one route was more favourable from a geotechnical or constructability perspective.

## 1.2 APPROACH

Hemmera has addressed the objectives in two separate reports. Part B, this report, deals with constructability and geotechnical considerations of the existing North Canol road and Mactung spur (the first two objectives). Part A is a separate report that compares two routes and the existing design (where applicable), geotechnical and constructability challenges presented by each.

[1] During this study, Hemmera was informed that the Yukon government does not have specific engineering standards for the design of mine haul roads. As such, the design standards detailed in the BC Ministry of Forests “Forest Road Engineering Guidebook” were used.

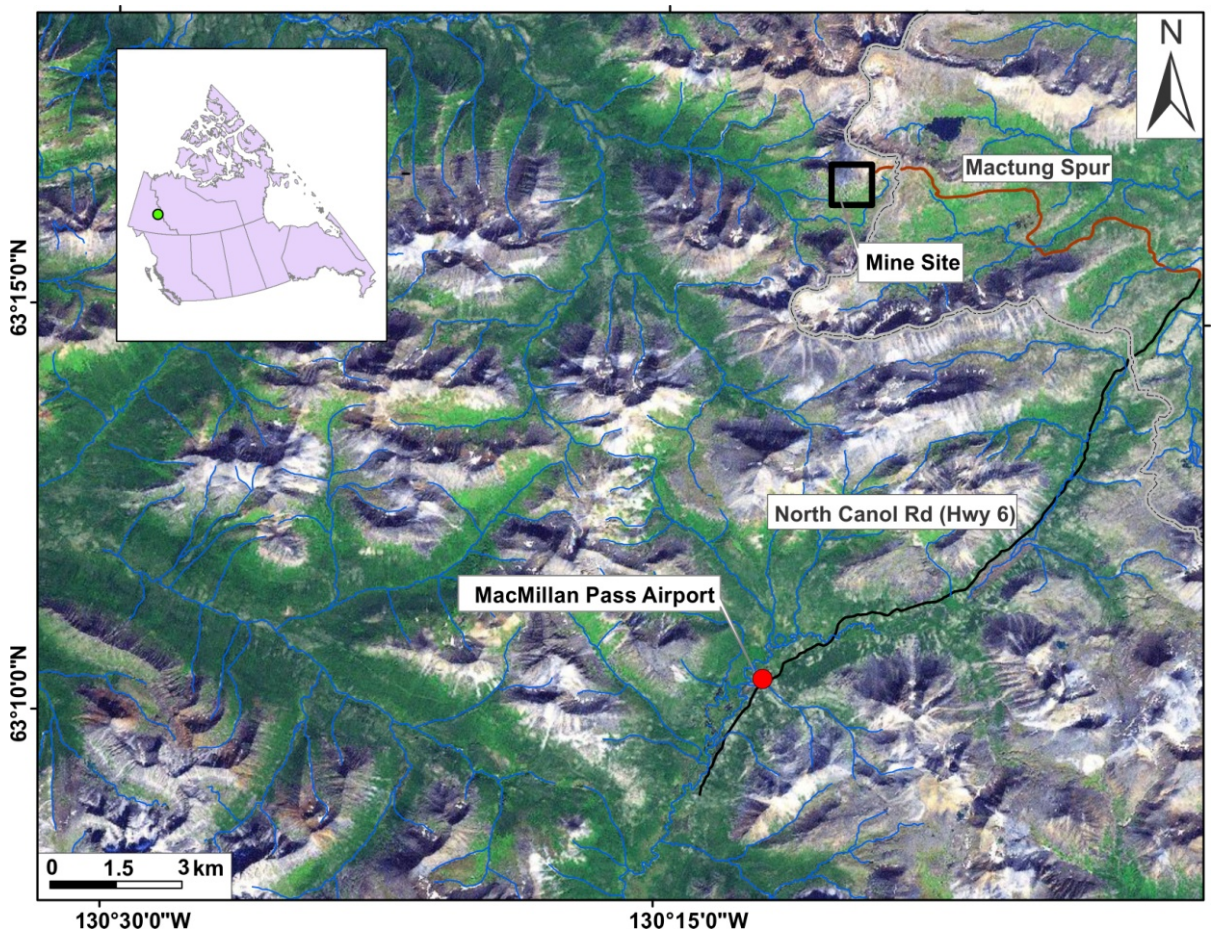
## 2.0 METHODS

The authors flew the two routes by helicopter on August 30, 2011. An image archive was collected, and portions of the existing North Canol road and the Mactung spur were walked in the field.

To compare the geotechnical challenges of both routes, the terrain was divided into three archetypical models based on field observations, post-field review of the photo-record, and Geographic Information Systems (GIS) analysis. Each model is an amalgam of features identified in the field, and was characterized according to terrain, and expected geotechnical challenges related to road construction and maintenance and road user safety.

Both routes were plotted in a GIS along with the National Topographic Survey (NTS) 1:50,000 stream line-work and digital elevation model (DEM). A 1 km buffer was established on either side of the route and terrain was analyzed within the buffers to determine, corroborate or confirm slopes and valley confinement observed in the field. The numbers of stream-crossings identified on the NTS maps were calculated. While additional stream-crossings were noted in the field, a standardized method of comparison was required, and the 1:50,000 stream line-work was taken as representative of the complexity of type and number of crossings.

**Figure 1 Location Map Showing Current Access to the Mactung Mine**



# 3.0 RESULTS

The three archetypical models are delineated as classes 1 (fewest challenges) to 3 (most challenges) and described below. The results of the classification process are mapped on the "Mactung Mine Access Road Constraints Map" in Appendix I:

## 3.1 CLASS 1

Class 1 terrain is shown in Figures 2 and 3 and characterized by broad, flat, stable valley floors with low and moderate slopes of till and colluvium. These slopes are connected to or surrounded by steeper elements, but at sufficient distance that the associated geotechnical hazards are largely avoidable and the potential impacts to road users will be negligible. Conventional cut and fill construction is likely and annual maintenance will be minimal.

The average slope in Class 1 terrain (includes all slopes within the 1 km buffer on either side of the routes) is 6.9$^{o}$ (12% slope). About 4% (3.8) of the slopes are steeper than 21$^{o}$ (38% slope), and less than 2% (1.3) are steeper than 27$^{o}$ (51% slope).

Key challenges in Class 1 terrain are expected to be seasonal flooding in the valley floor and the design and construction of stream crossings.

The portions of proposed routes in Class 1 terrain are mapped on the "Mactung Mine Access Road Constraints Map" in Appendix I.

**Figure 2 Terrain Model for Class 1 Showing Key Geomorphic Features**

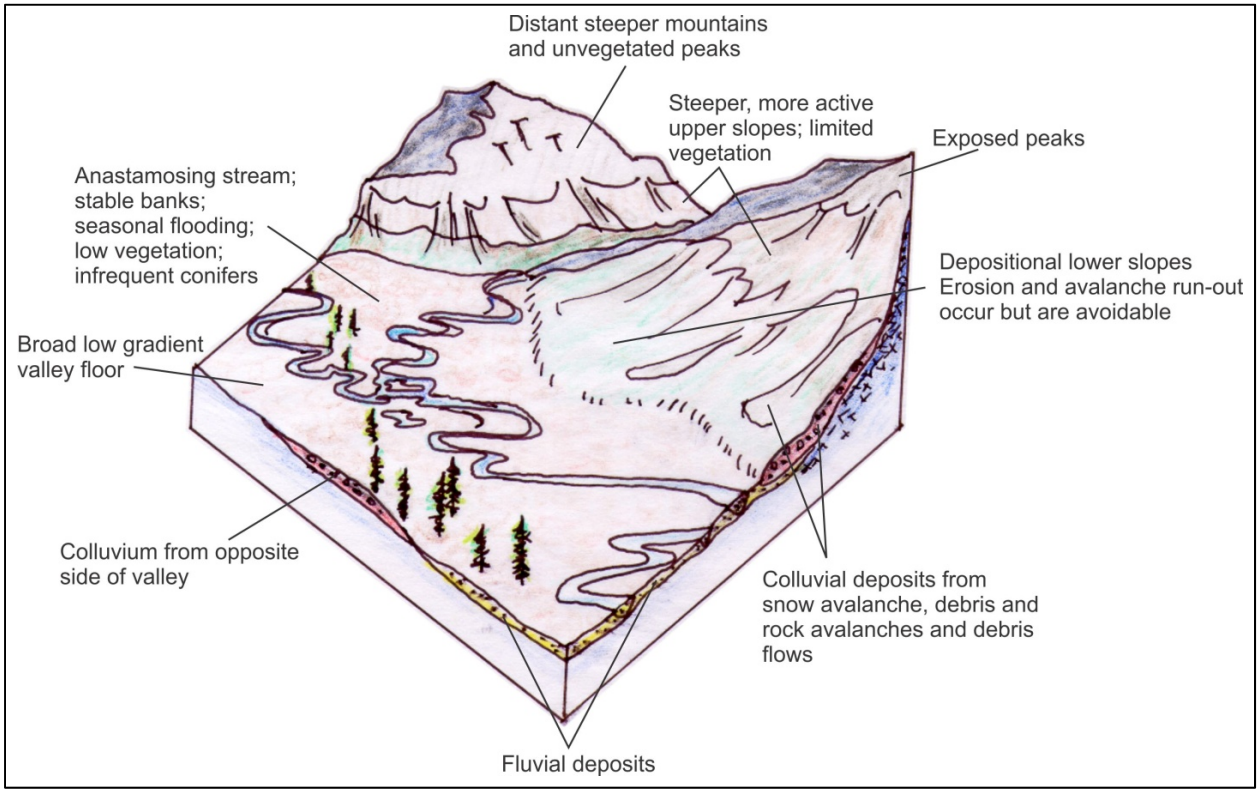
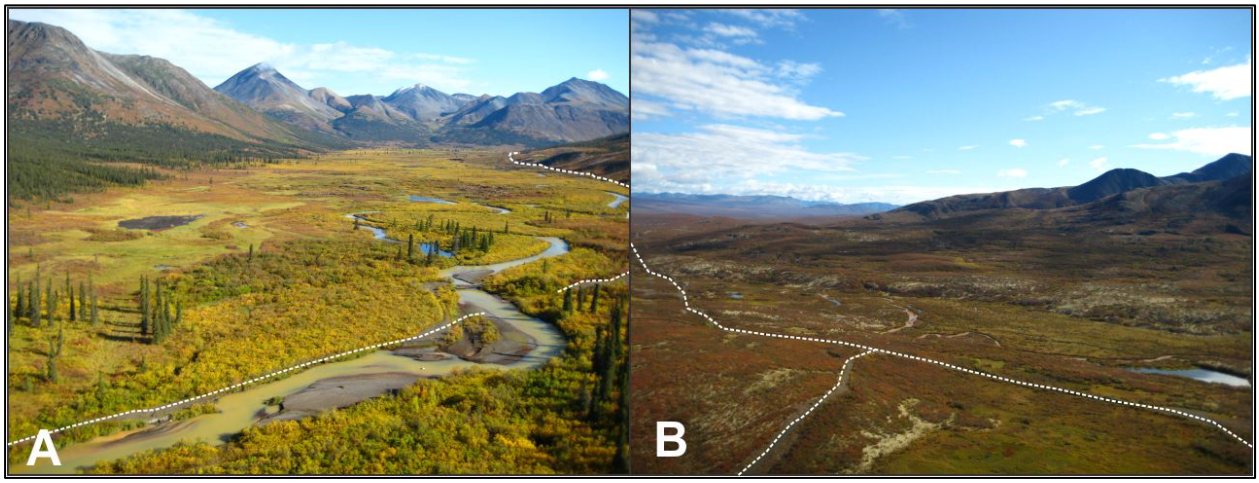



**Figure 3 Photographs of Class 1 Terrain**




**Notes:** (A) Shows the proposed route (along a abandoned road).
(B) Shows the existing North Canol road (left to right) and the Mactung spur.

### 3.2 CLASS 2

Class 2 terrain is shown in Figures 4 and 5 and primarily characterized by moderate colluvial slopes that are crossed by the routes above the valley floor. Snow avalanches, debris flows, and small rock falls cross these slopes from the steeper sources above and are expected to result in maintenance challenges. Snow avalanches will also pose safety challenges if the road is required year round. Conventional cut and fill construction is likely and will be reasonable under dry conditions, as Class 2 terrain is largely depositional or transitional in nature. Stream crossings will need to consider both high flows, and sediment transport (debris flows) as well as potential snow impact loads (from snow avalanches). Significant regularly scheduled road maintenance could be required.

Class 2 terrain may contain short sections of steep slopes with active rock fall, debris flows or slumps that could pose a risk to the road users. In this case they are distinguished from Class 3 terrain by sufficient adjacent low hazard terrain to allow for realignment of the route to avoid those hazards if necessary.

The average slope in Class 2 terrain (includes all slopes within the 1 km buffer on either side of the routes) is 13.7$^{o}$ (24% slope). About 21% (20.9) of the slopes are steeper than 21$^{o}$ (38% slope), and less than 9% (8.3) are steeper than 27$^{o}$ (51% slope).

Careful consideration should be given to route alignment to minimize maintenance costs, safety issues and impact in Class 2 terrain.

The portions of proposed routes in Class 2 terrain are mapped on the “Mactung Mine Access Road Constraints Map” in Appendix I.

**Figure 4 Terrain Model for Class 2 Showing Key Geomorphic Features**

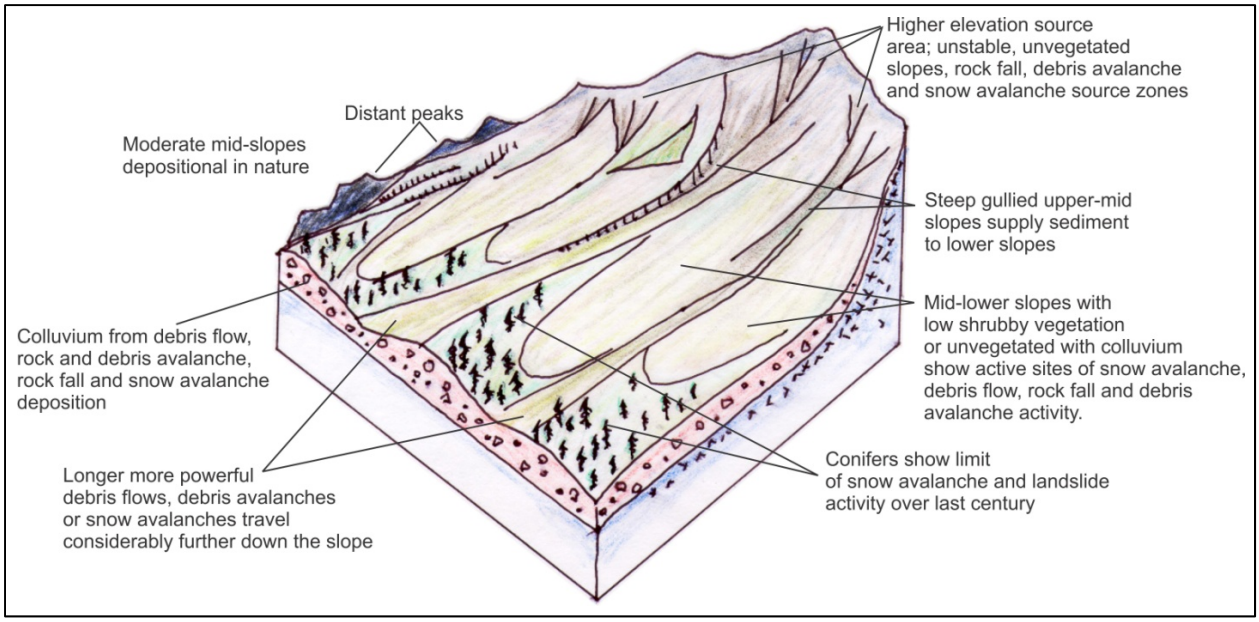
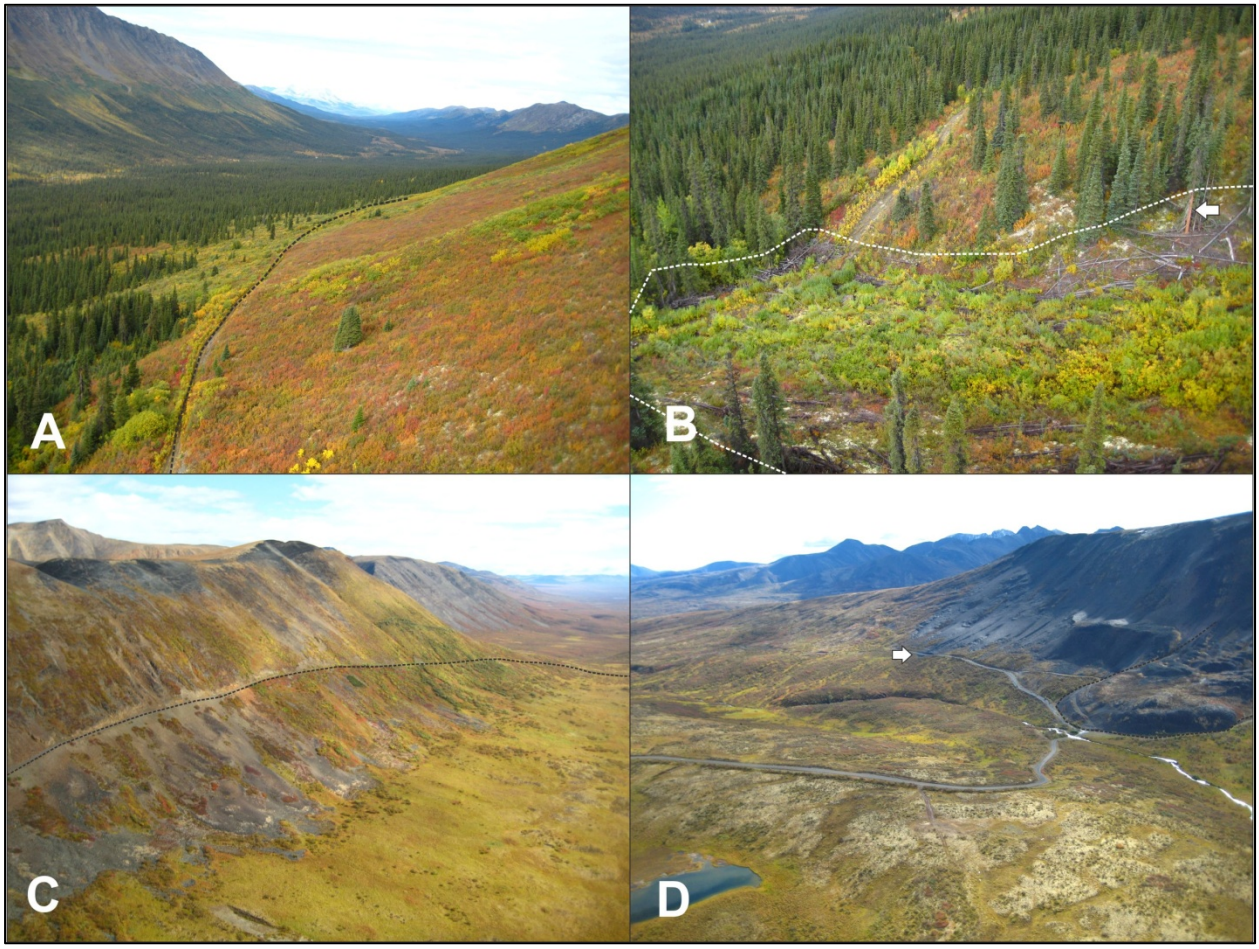


**Figure 5 Photographs of Challenges on Class 2 Terrain**




**Notes:** (A) Proposed route (along abandoned road) in snow avalanche zone.
(B) A recent snow avalanche (last winter) that buried the road along the proposed route. The arrow indicates the avalanche depth at the margin. Snow avalanches represent both a maintenance and safety issue for winter road users;
(C) Existing access road (Mactung spur) on a short steep section of slope. This section of road is in bedrock and is impacted by ongoing fragmental rock fall. Construction costs to upgrade the road would include scaling and protection measures (e.g. rock mesh). However, the terrain offers considerable opportunity to avoid the hazard altogether.
(D) Debris flow from a lateral moraine that collapsed near the Mactung spur. Arrow points to other debris flow/avalanche run-out. Hazard can be avoided if necessary by route realignment.

### 3.3 CLASS 3

Class 3 terrain is shown in Figure 6 and is typically characterized by a confined valley inundated on both sides by a combination of snow avalanches, debris flows and debris avalanches, rock fall, slumps and talus development (Figures 7A and 7B). Class 3 terrain is also characterized by long steep rocky slopes, associated landslides including rock fall and limited options to avoid the hazard (Figures 7C and 7D). Permafrost may be present in till and colluvial deposits. Geotechnical challenges and hazards will affect the design, construction and maintenance of the route, and will pose substantial safety hazards. All season access will be particularly difficult and expensive through this terrain. Significant regularly scheduled road maintenance will be required.

The average slope in Class 3 terrain (includes all slopes within the 1 km buffer on either side of the routes) is 18.6$^{o}$ (34% slope). About 42% (42.4) of the slopes are steeper than 21$^{o}$ (38% slope), and about 25% (24.9) are steeper than 27$^{o}$ (51% slope).

The portions of proposed routes in Class 3 terrain are mapped on the "Mactung Mine Access Road Constraints Map" in Appendix I.

Consideration should be given to avoiding or minimizing the length of road in Class 3 terrain.

**Figure 6 Terrain Model for Class 3 Showing Key Geomorphic Features**

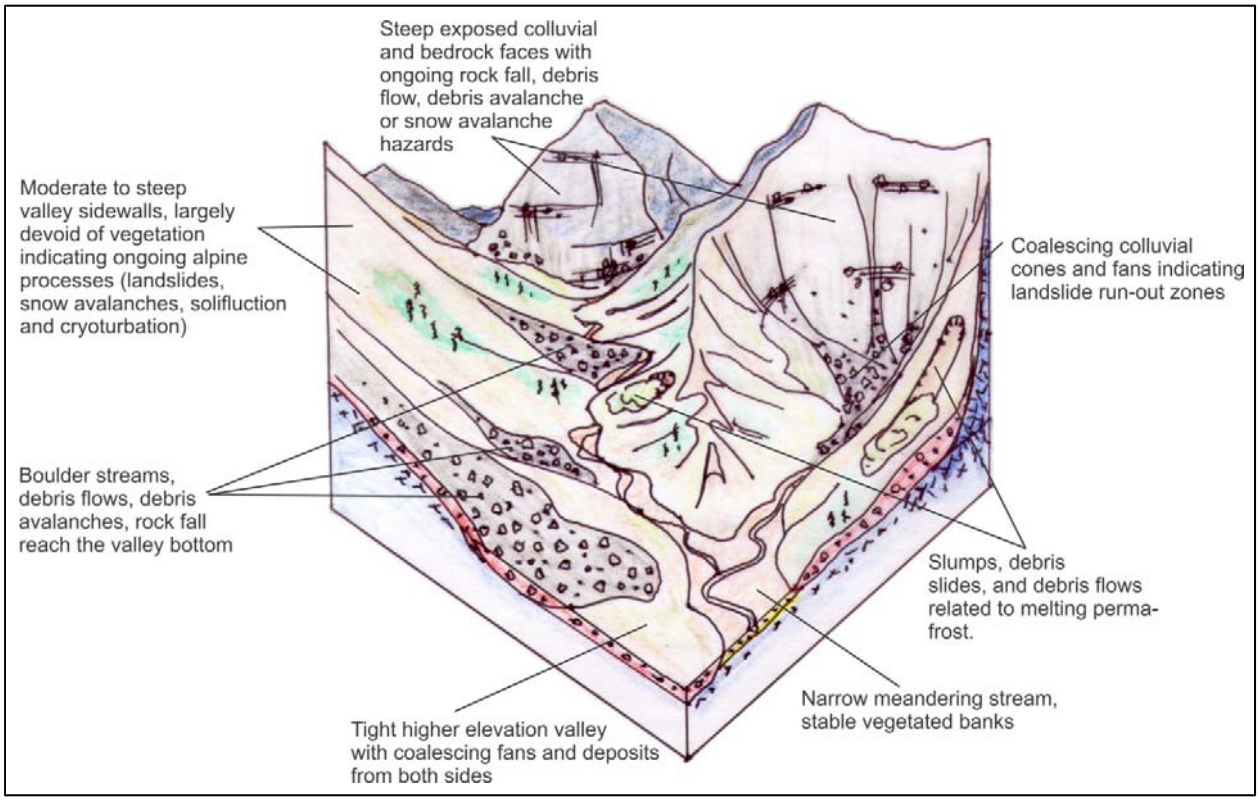
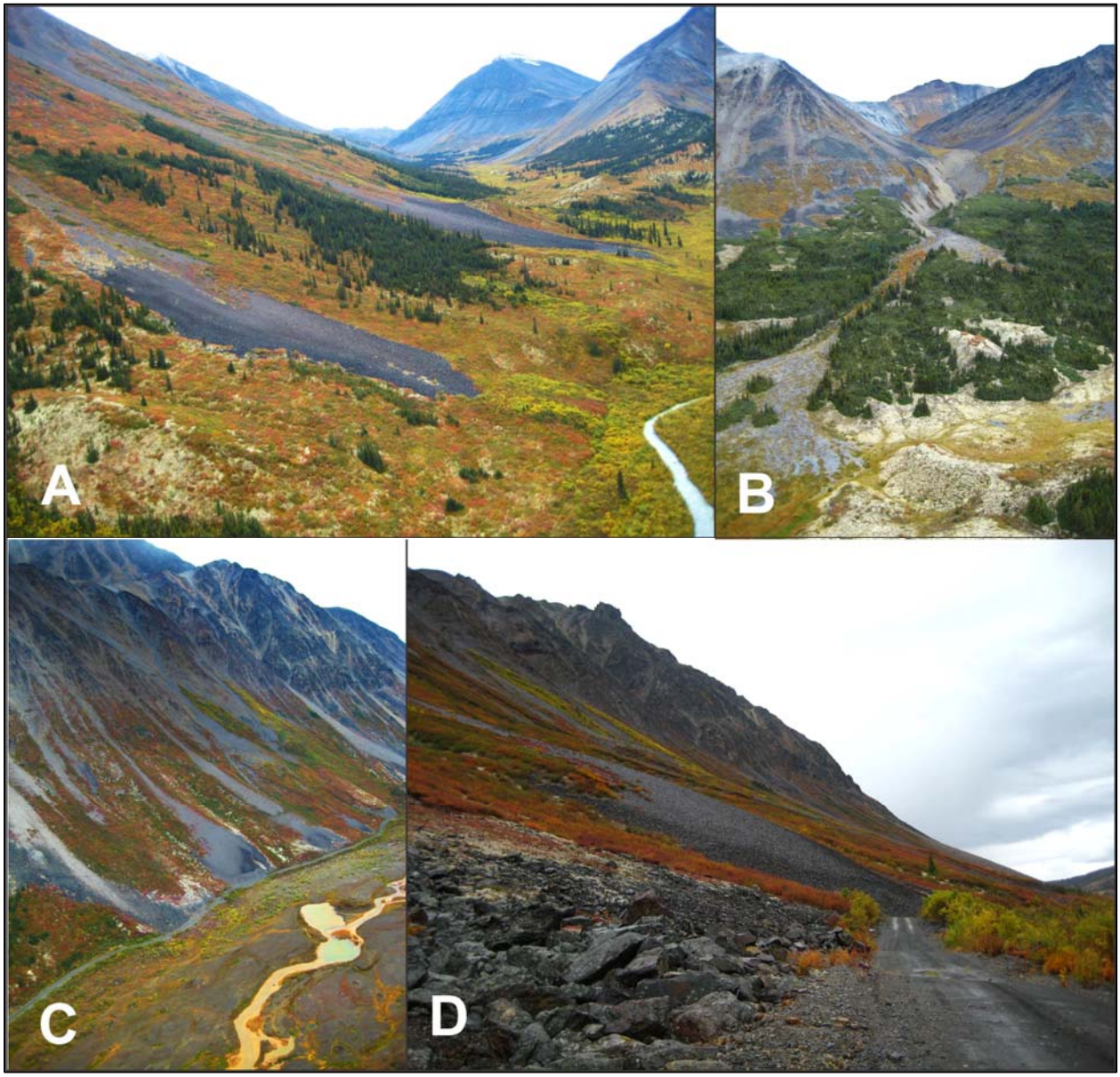


**Figure 7 Class 3 Terrain along the Routes**




**Notes:** (A) and (B) are along the proposed route. (C) and (D) are along the existing North Canol road (Highway 6). The road is at the base of the hazardous terrain, but clearly within the area impacted by snow avalanches and rock fall.

### 3.4 COMPARISON OF ROUTES

Analysis of the two routes is provided on the attached map "Mactung Mine Access Road Constraints Map" and in Table 1. The routes are broken into two major sections: R1 and R2 where R1 is the existing North Canol road (Highway 6) and the Mactung spur, and R2 is the proposed road. R2 is further broken into R2A and R2B where R2A is the portion of road already built but abandoned, and R2B is the portion of road that is not yet constructed.

Stream crossings normally present some challenges to road construction and are therefore tallied as an independent constraint in the same table, for each of the proposed routes.

**Table 1 Table of Constraints**

| Road Section | Total Length (km) | Length in Class 1 (km) | Length in Class 2 (km) | Length in Class 3 (km) | Number of Stream Crossings (at 1:50,000) |
|---|---|---|---|---|---|
| **R1** | 28.6 | 14.1 | 9.6 | 4.9 | 10 |
| **R2** | 50.1 | 5.5 | 23.5 | 23.1 | 26 |
| **R2A** | 19.3 | 2.9 | 18.4 | 0 | 8 |
| **R2B** | 30.8 | 2.6 | 5.1 | 23.1 | 18 |

Route R1 is shorter overall, has much less length of road in Class 2 and Class 3 terrain, and encounters approximately 1/3 of the stream crossings as route R2. R1 is already built, and the Yukon portion is maintained for summer use by the Yukon Highways and Public Works Department.

The majority of Route R2A is already built and will encounter maintenance challenges, particularly with respect to winter use. As R2A lies primarily in Class 2 terrain there could be opportunities along the alignment to avoid some of the geotechnical hazards.

Route R2B is the longest section, is currently not built, and traverses 23 km of Class 3 terrain with 18 stream crossings. The design, construction and maintenance challenges along this section will be significant. Sections of this road may not be able to be used year round.

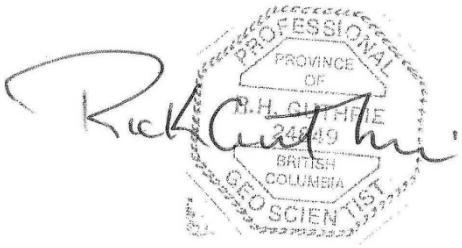
## 4.0 CONCLUSIONS AND RECOMMENDATIONS

This report compares the geotechnical constraints of two routes which propose to access the Mactung Mine.

- **Route R1 is shorter, crosses fewer streams, and encounters less difficult terrain than the proposed alternative (route R2).**
- **Route R2 is longer (50 km vs. 29 km) encounters almost three times as many stream crossings, and crosses substantially more steep and unstable terrain. It is unlikely that the risk to the road user could be mitigated along this option in a cost effective manner.**

**Based on the analysis herein, the existing North Canol road and Mactung spur (Route R1) is a better option with respect to geotechnical hazard avoidance, construction, maintenance and the risk to road users.**

Report prepared by:
**Hemmera**

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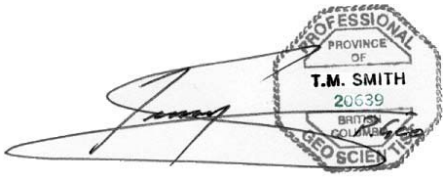



Timothy Smith, P.Geo., Eng.L.,

## 5.0 STATEMENT OF LIMITATIONS

This report contains information that compares the suitability of two routes to access the proposed mine haul traffic from the Mactung Mine. This assessment was conducted at an overview level with limited fieldwork and no detailed engineering.

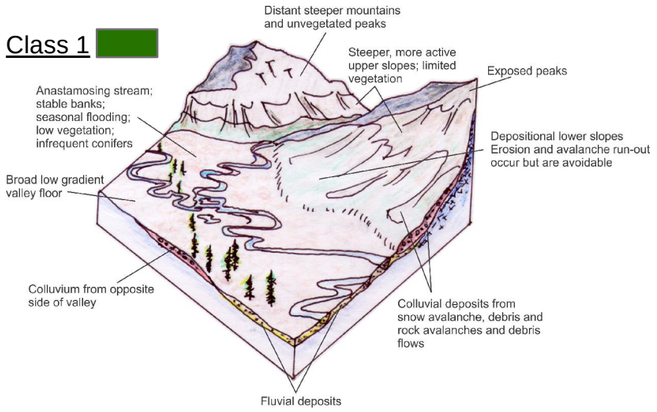
This report was prepared by Hemmera, based on office analysis and fieldwork conducted by Hemmera, for the sole benefit and exclusive use of the Yukon Environmental and Socio-economic Assessment Board (YESAB). The material in it reflects Hemmera's best judgment in light of the information available to it at the time of preparing this Report.

No other party may rely upon this report without the author's express written permission.

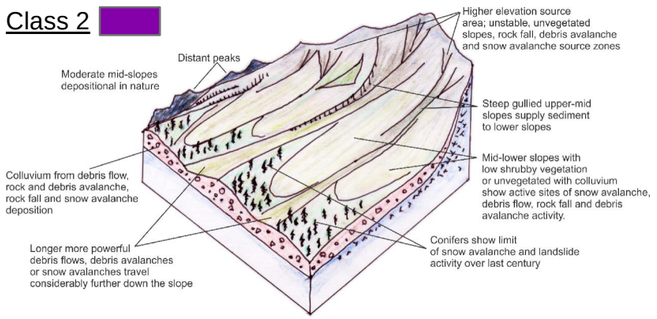
# APPENDIX 1

## Constraints Map

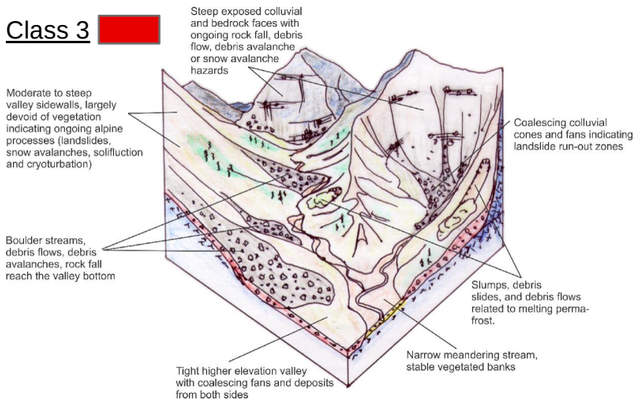
## Class 1




## Class 2




## Class 3




## Legend

- Macmillan Pass Airport
- Northwest Territories

**Proposed Access**

- Abandoned Road (R2A)
- Proposed Access Route (R2B)
- Proposed Access Route (R2A)

**Existing Access**

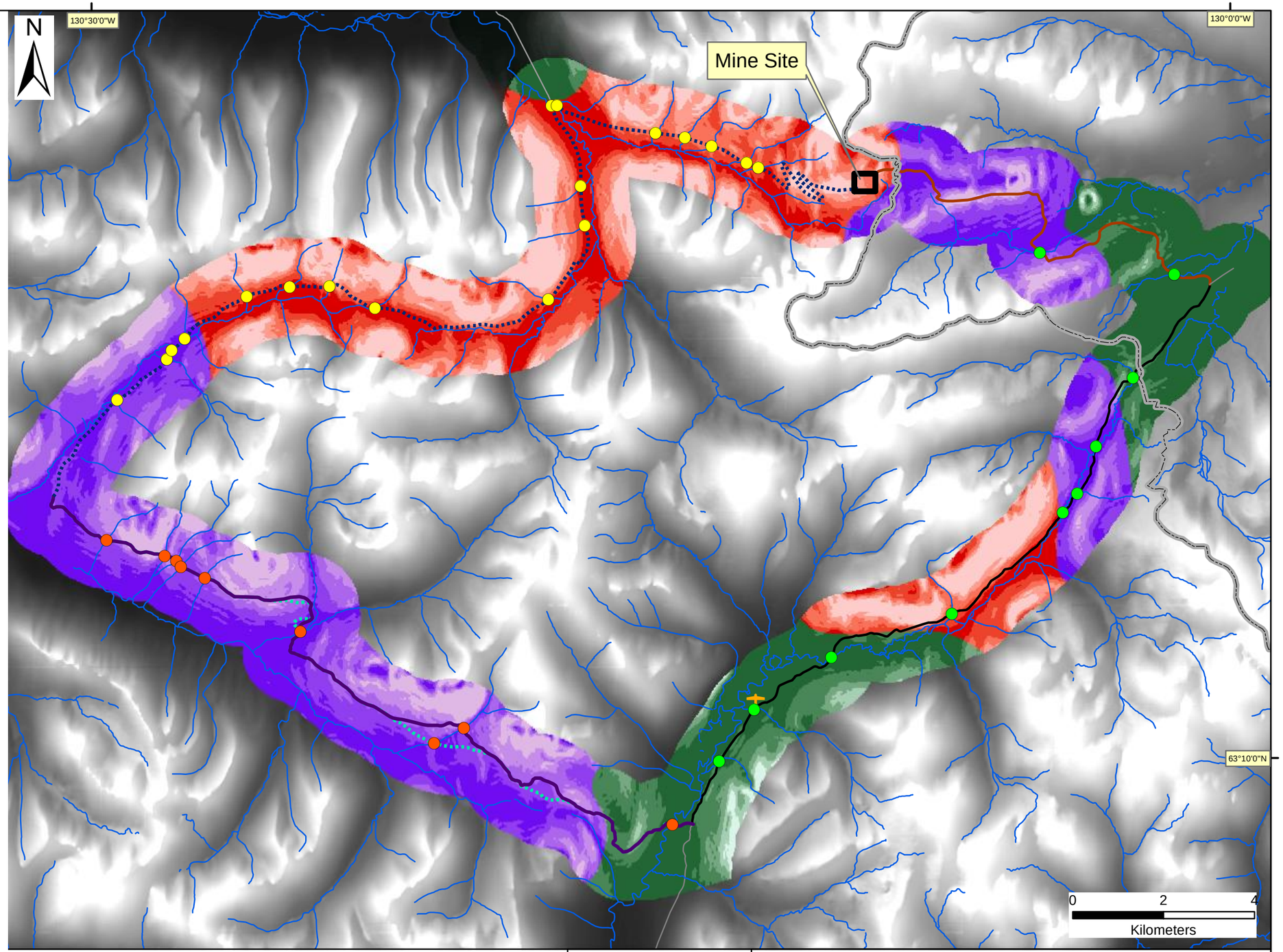
- Existing Access Road (R1)
- Highway (R1)
- Road (length not considered)

**Crossing**

- R1
- R2A
- R2B

Class

| 1 | 2 | 3 | Slope (°) |
|---|---|---|---|
| | | | 0 - 8 |
| | | | 8 - 15 |
| | | | 15 - 21 |
| | | | 21 - 27 |
| | | | >27 |




| Road Section | Length (km) Total | Class1 | Class2 | Class3 | No of Crossings |
|---|---|---|---|---|---|
| R1 | 28.6 | 14.1 | 9.6 | 4.9 | 10 |
| R2 | 50.1 | 5.5 | 23.5 | 23.1 | 26 |
| R2A | 19.3 | 2.9 | 18.4 | 0 | 8 |
| R2B | 28.2 | 0 | 5.1 | 23.1 | 18 |

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# Mactung Mine Access Road

## Constraints Map

PROJECT No. 1171-001.01

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