



January 29, 2016

JoAnne Deneron  
Chair  
Mackenzie Valley Environmental Impact Review Board  
200 Scotia Centre  
5102 50<sup>th</sup> Avenue,  
Yellowknife, NT  
X1A 2N7

Dear Ms. Deneron

**RE: Environmental Assessment EA1415-001, Prairie Creek Mine**  
**Reasons for Decision on the Adequacy of the DAR**

We refer to the Reasons for Decision (RfD) document from the Review Board on the above noted subject dated December 21, 2015. Canadian Zinc Corporation (CZN) is disappointed that CZN's Developer's Assessment Report (DAR) and DAR Addendum are still not considered to be adequate for this phase of the environmental assessment (EA). Our disappointment stems from our belief that the level of detail being requested in this EA is considerably greater than in EA0809-002 (Mine operations and winter road) which concluded 4 years ago in December 2011.

We have discussed the five items defined in the RfD as being inadequate with your staff and their consultants (reference Note to File January 22, 2016). For the most part, we are able, and agree, to provide the additional information requested in the RfD. However, we believe some of the information requested is either inappropriate or unnecessary at this stage of the project. In the text below, we provide rationale for our belief. We ask the Board to reconsider the request for this information in light of our rationale.

In the discussion below, we do not discuss the information requested that we are not contesting, rather, we are proceeding with work to provide such information in the near future.

**Sundog Creek Re-alignment**

From Km 35 to 38, where portions of a creek channel are to be removed to allow road construction, an adjacent channel in use relatively recently will be deepened by an equivalent measure to replace the lost capacity, and the adjacent channel will thus become the main or re-aligned channel. All channels in the area are relatively shallow (less than 40 cm), punctuated with occasional pools in proximity to rock abutments. In the absence of detailed site survey, which would be completed during the final design phase, it is difficult to estimate the quantity of material that would be excavated from the re-aligned channel and placed in the channel to be

filled with any degree of accuracy. The purpose of estimating the quantity of excavation at this stage is not clear to us. We assume it is related to a desire to know where excess material will be placed after channel filling, or where material will be sourced from if the excavated material is not sufficient for filling. Any excess material would be incorporated into the road prism. If there is a material deficit, fill would be sourced from the borrow sources that have been defined, or the considerable number of reserve borrow sources. Therefore, we do not expect to be able, and do not see the need at this stage, to estimate quantities of excavated material.

### **Permafrost/Karst Hazards Km 48-59**

The road section Km 48-59 is identified as the Polje Re-alignment. This re-alignment of the original winter road route was approved by the Review Board during EA0809-002. Figure 6-21 attached is reproduced from the 2010 DAR showing the re-alignment. The re-alignment replaces a winter road section that, from west to east, consists of two switch-backs which allowed the road to climb onto a plateau formed by the Nahanni Formation, followed by a traverse across the plateau before descending to cross the area of the Poljes between the Second and Third Poljes. During CZN-Parks Canada-Dehcho First Nations Technical Committee meetings during EA0809-002, Parks Canada asked CZN to investigate alternative road alignments to avoid bisecting the Poljes, which are considered to be unique karst related features of the region. The figure attached titled "Winter Road Alternatives" illustrates the re-alignment options that were initially considered in July 2008. Subsequent fieldwork ruled out these alternatives because of road grade limitations and proximity to other karst features. However, a more northerly re-alignment was ground-truthed as being acceptable, and was adopted as the Polje Re-alignment to mitigate concerns regarding impacts on karst features. The attached minutes from the committee meetings provide details of the engagement undertaken. Therefore, the re-alignment already represents mitigation in terms of the proposed all season road minimizing impacts on karst features. As a result of fieldwork conducted in 2014 for the all season road, additional minor adjustments were made to the re-alignment to further improve road grades, and avoid or set-back from areas of potential instability or karst feature presence. Subsequent terrain mapping has resulted in further minor adjustments in this regard.

The RfD requests detailed characterization of permafrost and karst using geophysics surveys. Our consultant, Tetra Tech EBA, has provided additional information for consideration in a letter, attached. Tetra Tech EBA concluded that geophysics is not warranted or practical at this stage, rather it should be considered during the field studies associated with the detailed design phase, during which further minor re-alignment adjustment might be made.

### **Description of Km 160-184**

Km 160-184 is the road section from the Liard River to the Liard Highway. From the river to Km 174, an old logging road built and used by the NDDDB exists which CZN plans to follow. At Km 174, the proposed road would tie into the existing Nahanni Butte all season road to the highway. In our opinion, the Liard River channel adjacent to the road is stable. We propose to confirm this by reviewing and presenting historical air photo evidence. Terrain mapping was not completed for this road section because our consultant considered it to be low risk in terms of

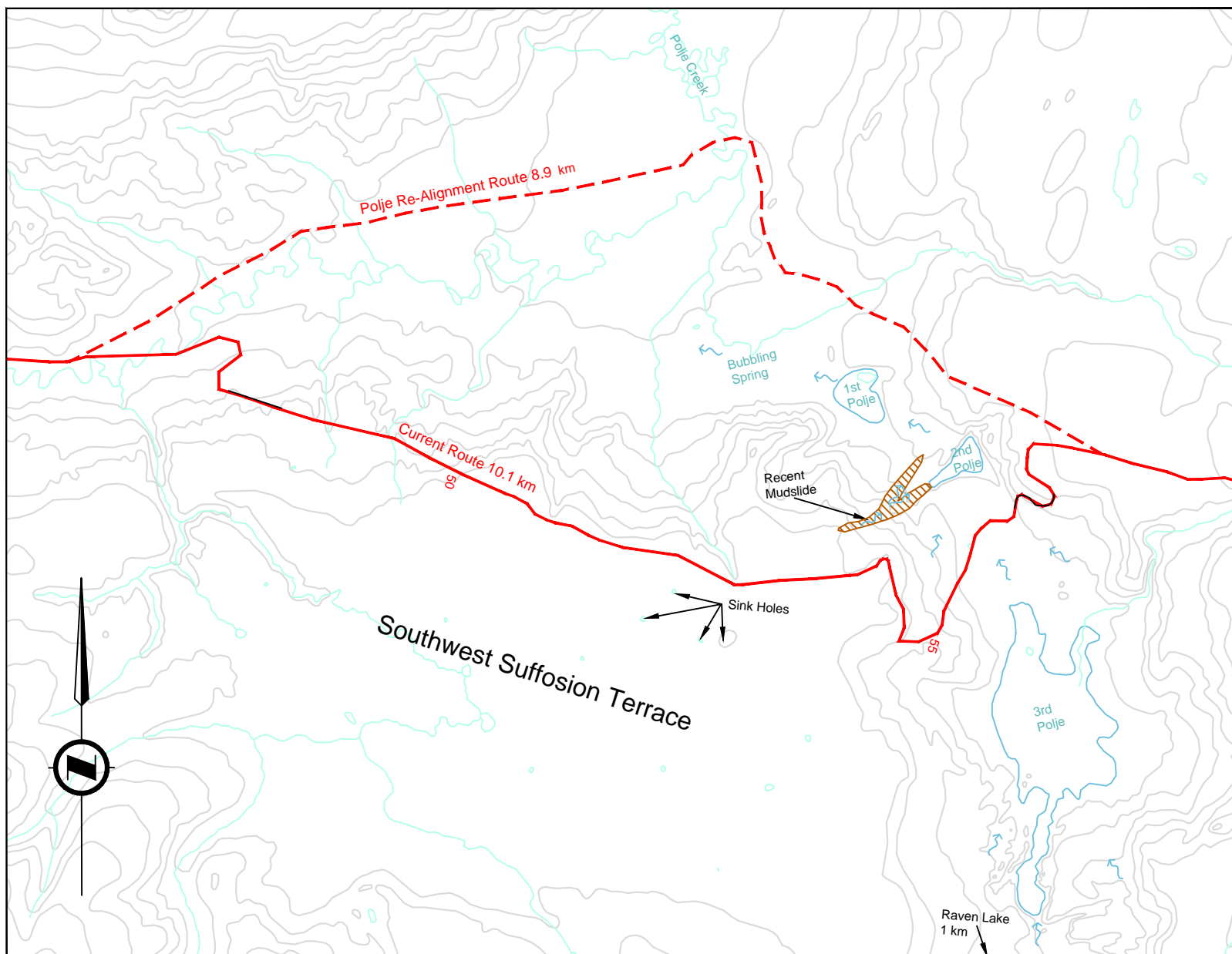
terrain issues and not necessary, and because of the presence and previous use of the logging access road. Permafrost effects appear to be minimal, and in any case would be addressed by fill placement for the all season road bed. Therefore, we do not see a need to complete additional terrain mapping.

We appreciate your consideration of the above matters in order to maintain the progress of this EA. If you have any questions, please contact us at 604 688 2001.

Yours truly,  
CANADIAN ZINC CORPORATION

A handwritten signature in blue ink, appearing to read "D. Harpley", is positioned above the printed name and title.

David P. Harpley, P. Geo.  
VP, Environment and Permitting Affairs

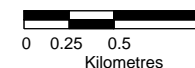


**Figure 6-21:**  
**Access Road;**  
**Polje By-Pass Alternative**

### Legend

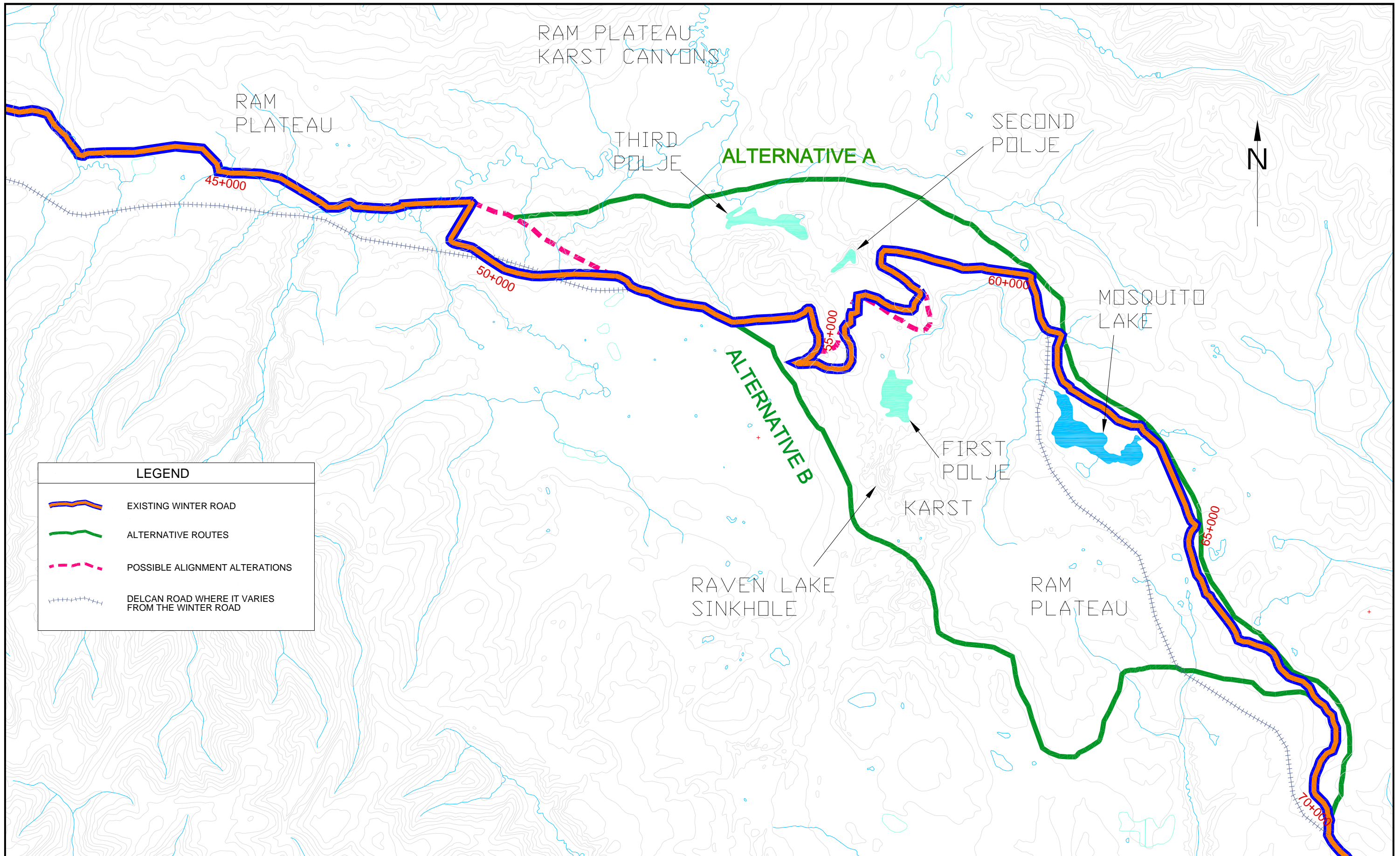
- 00 Road Markers from Minesite(km)
- Existing Access Road
- Proposed Alignment Changes
- Watercourses
- Contour Interval (100 ft)
- Subsurface Water Flow

Scale



Project File Name: DAR Fig 6-21.dwg	
Date October 2009	Sheet: Nad83 UTM: 95F
Scale As Shown	Drawn By C. Reeves





**Canadian Zinc – Parks Canada Agency Memorandum of Understand (MOU):  
Technical Team Meeting - #2**

**Date:** October 24<sup>th</sup>, 2008

**Time:** 10 am – 12 pm

**Attendance:**

Canadian Zinc

Alan Taylor, Vice President Exploration & Chief Operating Officer

Dave Harpley, Environmental Officer

Parks Canada Agency:

Ed Coulthard, Field Unit Superintendent

Katherine Cumming, Environmental Assessment Scientist

David Murray, Sr. Planner New Northern Parks Canada

Dehcho First Nations

Laura Pitkanen

Jonas Antoine

**1. Welcoming of Dehcho representatives**

Alan Taylor welcomed Dehcho representatives to the meeting.

**2. Discussion of previous minutes from July 3, 2008 meeting**

As minutes were distributed late by Parks Canada, comments will be submitted after the meeting.

**3. Update of CZN regulatory process and PC submission**

Canadian Zinc reported that scoping meetings were held in communities and Yellowknife. The deadline for submissions from parties was on October 20, 2008. Canadian Zinc expects to submit their comments at the beginning of November. The Mackenzie Valley Environmental Impact Review Board Staff will then present the findings to the Board.

Katherine Cumming reviewed and explained some of the key aspects in the Parks Canada Scoping Submission. Dehcho First Nations explained their concerns with respect to floods, earthquakes, ground water, and Prairie Creek water.

**4. Update of Status of Park expansion process**

David Murray indicated that the status had not changed a lot from the last meeting. The only outstanding issue that could affect Canadian Zinc is the question of how to manage the road. Parks Canada and Dehcho First Nations prefer that the road is a part of the park. Canadian Zinc indicated that they did not have a problem with the road being a part of the park. Parks Canada reported that the *Canada National Parks Act* should not cause an impediment to the construction and operation of the road. Permits and an agreement for construction and operation of the road could be used as legal instruments. Parks

Canada explained the approaches to managing winter roads in Wood Buffalo National Park of Canada. The timing of the decision is not known. Parks Canada reported that the Dehcho and park expansion land withdrawals had been extended until 2010.

#### **5. Revisions to MOU**

The potential need to revise the MOU to include the Dehcho First Nations was discussed. The Dehcho First Nations indicated that they did not want to be a signatory to the MOU, but would like their relationship with Parks Canada recognized. ***Parks Canada committed to circulate suggested wording changes for discussion at the next meeting.***

#### **6. Road alignment alternatives Ram Plateau**

David Harpley reported that flights over the Ram Plateau last summer had demonstrated that option A as presented on the maps was not feasible due to a deep depression on the route. He presented photos of the route. Canadian Zinc reported that they are looking into the other alternatives. ***Parks Canada committed to providing Canadian Zinc with any reports submitted on the karst.***

#### **7. Road access control and boundary location**

David Harpley reported that community scoping meetings had included comments about access. Canadian Zinc would like to control access for public safety during operation and to address community concerns about hunting. Canadian Zinc is trying to determine the best approach to restricting access. Canadian Zinc indicated that practically, it would be preferable for the boundary of the park to be further east at the first range gap to provide control of access at that point. Parks Canada indicated that there would likely not be an appetite for re-examining the boundary, but that it may be possible to put signs at that location to warn users that there is restricted access ahead. Dehcho First Nations indicated that they can help in monitoring and/or finding ways to restrict access. ***Parks Canada indicated that they would investigate the possibility of putting signs outside the park warning of restricted access ahead. Parks Canada also committed to discussing the legal instruments for restricting access with INAC and CZN.*** All parties agreed that it would be preferable to come to an understanding about the road ownership and access control prior to the announcement of the park boundary.

9. Alan Taylor thanked the Dehcho First Nations for attending and indicated that it was a positive step. Dehcho First Nations explained their relationship with Parks Canada and hopes for it to continue and improve. Next meeting was set for January 21, 10am in Vancouver. ***Canadian Zinc committed to circulating a draft agenda.***

## **Canadian Zinc – Parks Canada Agency Memorandum of Understand (MOU): Technical Team Meeting**

**Date:** October 21, 2009

**Time:** 10 am – 12 pm

**Attendance:**

Canadian Zinc

Alan Taylor, Vice President Exploration & Chief Operating Officer

David Harpley, Environmental Officer

Parks Canada Agency:

Jon Tsetso, Fort Simpson

Katherine Cumming, Environmental Assessment Scientist

David Murray, Sr. Planner New Northern Parks Canada

Dehcho First Nations

Jonas Antoine

Laura Pitkanen (phone)

### **1. Minutes from May 29, 2009**

All agreed to approve the minutes from May 29, 2009.

### **2. Prairie Creek Site Activities**

David Harpley presented information on site activities at Prairie Creek this summer.

- Water management – Canadian Zinc began treating water with lime in September as sodium sulphide was not available.
- Dike repairs – After inspection by a geotechnical and hydrologic engineer, Canadian Zinc made repairs to the dike by placing new coarse armour in places and recontouring.
- Road repairs – Road repairs concentrated on widening two sections on Prairie Creek and repairing one area on Funeral Creek.

### **3. Update on CZN regulatory process**

- Final terms of reference for the developers assessment report were released.
- Canadian Zinc sent a letter asking the MVEIRB if road route changes could be considered in the current environmental assessment process and they agreed. Potential route changes were discussed.
- Canadian Zinc is planning on submitting the developers assessment report at the end of the year at the earliest.
- Canadian Zinc conducted some work this fall on fisheries and heritage resources that will be included in the developers assessment report.
- A terrain assessment identified a potential alternate route through the karst landscape. Potential route changes were discussed.
- Discussion was held on the approach to monitoring after the mine began operating. Nahanni Butte has indicated they are interested in participating in monitoring activities. There is a desire to have an efficient and cost-effective approach that involves parties in monitoring. Parks Canada will discuss further



- internally item 5 of 3.3.3 of the terms of reference and report back to Canadian Zinc.
- Parks Canada reported that Katherine Cumming and Jon Tsetso had met with Canadian Parks and Wilderness Society to review Parks Canada's scoping submission with them.
  - Canadian Zinc has asked Monique Dubé to develop site specific guidelines for the protection of aquatic life.

#### **4. Access road: discussion of possible future land positions**

Canadian Zinc indicated that they would prefer a lease for the road. They are seeking fully assignable rights and security of access. Parks Canada has not decided on which tool would be most appropriate. Parks Canada will discuss and report back to Canadian Zinc and provide them with any application forms.

#### **5. Protocol for Accommodating Access**

Parks Canada agreed that an overarching permit could accommodate many requirements for access and research. Canadian Zinc committed to providing a list of potential activities that they would like to carry out in the park prior to authorization for full mine operation.

#### **6. Review of a Draft Guide to the Application of s. 41.1(1)-(4) of the *Canada National Parks Act***

Discussion was held on the guide. David Harpley will provide Parks Canada with written comments. Parks Canada agreed to provide updates to Canadian Zinc on the status of proposed regulation changes.

#### **7. Multi-jurisdictional issues**

Canadian Zinc indicated that they were seeking a seamless basis for operation. Parks Canada reported on discussions with Indian and Northern Affairs Canada and potential ways of operating.

#### **8. Update from DCFN**

Jonas Antoine described DCFN's relationship with Parks Canada and the balance that was used to achieve the final park boundary.

#### **9. Format and location of future committee meetings**

- David Murray indicated that he will no longer be involved in the committee.
- DCFN will discuss the involvement of the Nahanni Band on the committee.
- Next meeting in February in Vancouver after the Olympics or in Fort Simpson. In the summer a meeting will be held in Fort Simpson in order that Canadian Zinc can learn about Parks Canada's operations.

January 29, 2016

ISSUED FOR USE  
FILE: Y14103320-01

Canadian Zinc Corporation  
PO Box 11644  
Suite 1710, 650 West Georgia Street  
PO Box 11644  
Vancouver, BC V6B 4N9

Via Email: david@canadianzinc.com  
alan@canadianzinc.com

**Attention:** David Harpley, VP Environmental & Permitting Affairs

**Subject:** Permafrost-Karst Characterization  
Developer's Assessment Report for Environmental Assessment, EA1415-01  
Proposed All-Season Road Access to Prairie Creek Mine, NT

## 1.0 INTRODUCTION

This letter provides our comments on the requirements for detailed characterization of permafrost and karst using geophysics, contained in the Reasons for Decision (RfD) from the Review Board dated December 21, 2015. In our opinion, Canadian Zinc Corporation (CZN) has completed adequately detailed studies for this stage of the project, and the level of detail of these studies is consistent with that which we are familiar with from previous projects. We do not believe additional characterization using geophysics is warranted or practical at this stage. Our views are supported by the additional information below.

## 2.0 PERMAFROST-KARST CHARACTERIZATION

### 2.1 Permafrost

The road section KP048-054 crosses soils derived from the Fort Simpson Formation (predominantly shales) which overlies the Nahanni Formation (predominantly dolostone). Discontinuous permafrost is expected, and has been noted, in this area. Accordingly, the first strategy is to avoid thaw-sensitive terrain, where possible. If thaw-sensitive terrain cannot be avoided, cuts will be avoided and embankments can be designed and constructed with thickness and width based on terrain type. Additional and deeper drilling in this area is recommended during the detailed design phase to better guide specific construction requirements. However, more detailed characterization at this stage is not necessary, and in any event, geophysics would not be the preferred method for this characterization. Geophysics would not be expected to be conclusive given the generally low ice content expected and the fine-grained nature of the soils, and would require correlation with borehole data in any case. Geophysics can be a useful tool in continuous permafrost terrain where massive ice can occur in coarse material. Such was the case at the Mary River Rail Project in Baffin Island. Given the thick fills (over 5 m) required for that project, geophysics was used to delineate massive ice. The conditions occurring along the Prairie Creek road are very different, and the required fills much less. As such, geophysics is not considered to be required and is unlikely to produce useful results. Permafrost is not expected to be significant from about KP054.2 to KP059, due to the influence of coarser-grained soil layers and predominantly west- and south-facing slopes.

### 2.2 Karst

A number of terrain features linked to karst were noted in the terrain mapping. Each of these is discussed below, followed by our comments regarding additional characterization.

### 2.2.1 Features

At about KP025.6, three very small depressions, of which the largest was less than about 1.5 m in diameter and 0.6 m deep, were noted in soils along the route (Photo 1). The smallest depressions were just downslope, about 10 m from the route. At about KP026, a cluster of shallow depressions of unknown depth and up to about 15 m estimated diameter was identified on the 2012 aerial coverage between the route and the creek, about 60 to 80 m downslope of the road alignment. Within this area, two well-defined round depressions were identified and are thought to be potentially related to suffosion or piping (Photo 2). These are considered unlikely to pose a risk to the road, however, consistent with other areas where such features have been identified, they will be groundtruthed during the detailed design phase, as further discussed below.

At KP042, the road crosses wooded terrain overlying fine soils, and some depressions are visible on air photos (Photo 3). These are interpreted to be kettles from glacial ice melt, not karst features. These features are about 150 to 190 m away from the existing winter road, and about 100 to 220 m away from the proposed re-alignment to the south.

At KP055.3 and 055.7, depressions are noted approximately 250 m southwest and 330 m south of the proposed realignment, respectively. The former is near the Poljes area that has undermined the fluvial fan sediments (Photo 4), while the latter is a small depression visible on the 2012 bare earth LiDAR image (Photo 5). These are far enough away from the alignment to not pose an issue for the road. Another very small feature is located about 70 m south-southeast of the route near KP056, with a small pond in it. It was not visible on the aerial coverage but was seen from the helicopter (Photo 6). It appears to be only about 3 m metres wide. It could be either formed by thermokarst or by bedrock karst.

At KP058 and 058.7 south of the road, rock (slope) failures associated with the Poljes are present (Photo 7). At the top of these steep slopes, the overlying glaciofluvial sediments have also failed. Rounded depressions were also noted at a few locations in the glaciofluvial terrain to the north and east of the slope failures, ranging from 170 to 450 m away from the road route. These features were considered more likely to be kettles than sinkholes, although both are possibilities (Photos 7 and 8). The largest of these rounded areas is 70 m in diameter. We recommended that the road alignment be moved further north away from the slopes to avoid potential effects from slope failure retrogression. This move brings the route closer to the depressions (about 80 to 130 m), but proximity to these is considered a lower risk to the road than is presented by the slope failures to the south.

### 2.2.2 Feature Size, Occurrence and Development

The karst features noted above (except for the Poljes area slope failures) are small. The probability of others being present with no surface expression is low. In addition, examination of the available airphotos, some as early as 1949, do not show changes in the karst features over the 63-year timeframe covered by the airphotos and LiDAR imagery. Because the Nahanni Formation dolostone is quite massive and hard, these features develop very slowly over time, on the order of hundreds of thousands of years to millions of years. The potential for sinkhole development, lack of detection and rapid instability is very small. This terrain is very different from that in, say, Florida where relatively soft and soluble limestone can lead to rapid sinkhole development.

### 2.2.3 Geophysics

In recent discussions with Knight Piésold (KP) concerning the additional characterization issue, KP suggested that gravity surveys over a few days might be completed to detect the presence or absence of undetected cavities below the proposed road alignment. In our opinion, such an approach is seriously flawed. A survey of that type is highly unlikely to generate any meaningful results without a significant level of effort and a dense survey grid. For this reason, gravity surveys are usually notoriously slow and time-intensive. Many weeks of work would be required to

generate useful results, and even then the significance would not be known without correlation with borehole data and more accurate and detailed information regarding overburden depths. More practical geophysics techniques exist, such as ground penetrating radar (GPR) and electrical resistive tomography (ERT). However, any geophysical technique used would require a significant amount of work and correlation with borehole data.

## **2.2.4 Experience in Dolostone Terrain**

Geophysical methods that have been applied successfully to detect karst features include the use of GPR as a screening tool to identify potential karst features impinging on road embankments and sub-base material. This method can often be used to identify piping features (a pre-cursor of karst collapse) 5 to 10 metres below the road structure. The Government of the Northwest Territories, Department of Transportation, in fact uses this geophysical method to monitor and risk-manage karst areas and potential subsidence collapse along sections of existing public roads (Hwy 3 and Hwy 5). This is achieved by carrying out regular (3-year intervals) geophysical inventory surveys of the highways in question, comparing the GPR results with previous surveys, noting changes, and then assessing the significance and taking remedial action if deemed prudent. A similar approach of periodic geophysical screening might be appropriate for the Prairie Creek Road, once constructed.

## **2.2.5 Suggested Approach**

The potential for the occurrence of undetected solution features below or near the road alignment is low. If they are present, they almost certainly are very small as they would have some form of surface expression despite the existing soil cover, especially if solution were ongoing. The appropriate time to consider a confirmatory detection program is during the detailed design process prior to construction, and as part of monitoring after construction. We understand that CZN proposes to complete necessary survey and further investigation work on the road during the mine construction phase when a winter road will be available. This would be the appropriate time for a suitable geotechnical/geophysical program, allowing the necessary equipment to be mobilized. If potential solution features are detected, these are highly likely to be small, and relatively minor adjustments of the road alignment could be made. The attached images show that the distances between noted karst features is large enough to readily allow for alignment adjustments, if necessary. If adjustments are subsequently required, they would most likely be on the order of a few tens of metres. Therefore, from an effects perspective, either on karst or on the road itself, we would anticipate possible changes resulting from alignment adjustment during detailed design to be very limited. Certainly, we do not expect a need for alignment adjustments in the hundreds of metres or greater.

## **3.0 LIMITATIONS OF REPORT**

This report and its contents are intended for the sole use of Canadian Zinc Corporation and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Canadian Zinc Corporation or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

## 4.0 CLOSURE

The RfD requests detailed characterization of permafrost and karst using geophysics surveys. Tetra Tech EBA concludes that geophysics is not warranted or practical at this stage; rather, it should be considered during the detailed design phase in conjunction with winter road access. Any necessity for road alignment adjustment is likely to be minor, and is not expected to in any way invalidate the effects assessment. In our view, the studies we have undertaken for CZN to date are appropriate to address the requirements of the environmental assessment Terms of Reference, are suitable for this stage of the project, and are more detailed than those we have completed for others on similar projects.

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,  
Tetra Tech EBA Inc.

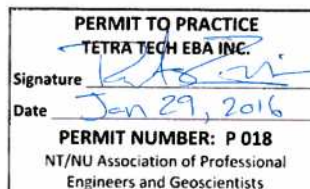


Prepared by:  
Rita Kors-Olthof, P.Eng., P.E.  
Senior Geotechnical Engineer, Arctic Region  
Engineering Practice  
Direct Line: 403.763.9881 (cell)  
Rita.Kors-Olthof @tetrattech.com



Reviewed by:  
Vlad Roujanski, Ph.D., P.Geo.  
Senior Project Geologist – Geocryologist  
Engineering Practice  
Direct Line: 780.451.2130 x289  
Vlad.Roujanski @tetrattech.com

Reviewed by:  
Kevin Jones, P.Eng.  
Vice President – Arctic Development  
Engineering Practice  
Direct Line: 780.451.2125  
Kevin.Jones @tetrattech.com



/KLA

Attachments: Tetra Tech EBA's General Conditions  
Photos 1-8

# GENERAL CONDITIONS

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## GEOTECHNICAL REPORT

This report incorporates and is subject to these “General Conditions”.

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### 1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of Tetra Tech EBA's Client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

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### 2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

### 3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

### 4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

### 5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

### 6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of testholes and/or soil/rock exposures. Stratigraphy is known only at the locations of the testhole or exposure. Actual geology and stratigraphy between testholes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.



## **7.0 PROTECTION OF EXPOSED GROUND**

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

## **8.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES**

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

## **9.0 INFLUENCE OF CONSTRUCTION ACTIVITY**

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

## **10.0 OBSERVATIONS DURING CONSTRUCTION**

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

## **11.0 DRAINAGE SYSTEMS**

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

## **12.0 BEARING CAPACITY**

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

## **13.0 SAMPLES**

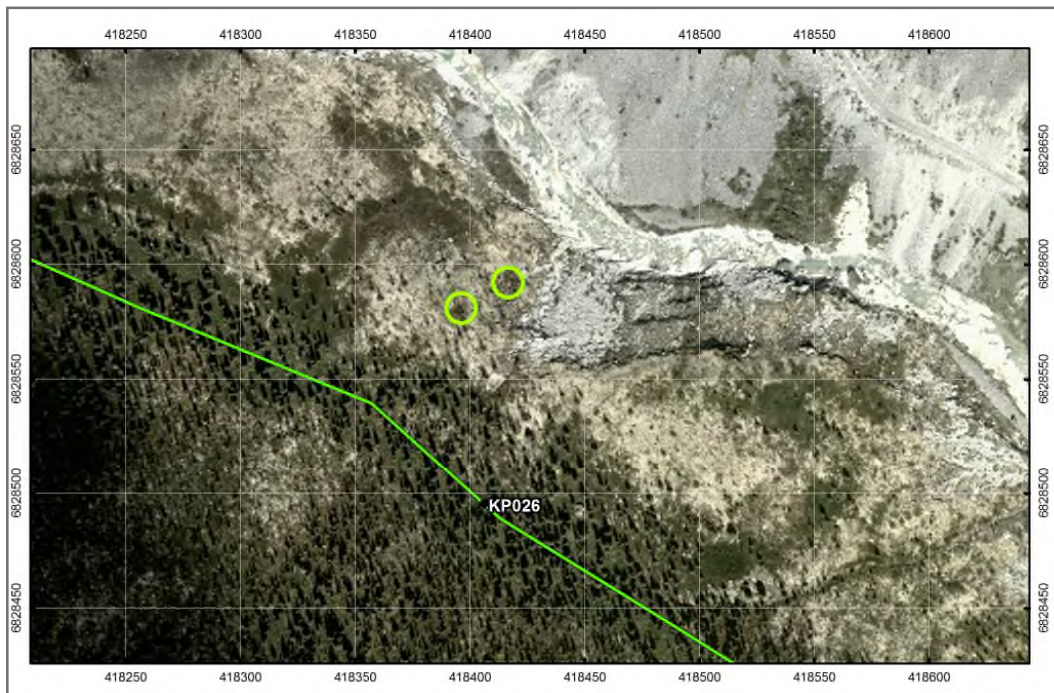
Tetra Tech EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

## **14.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS**

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

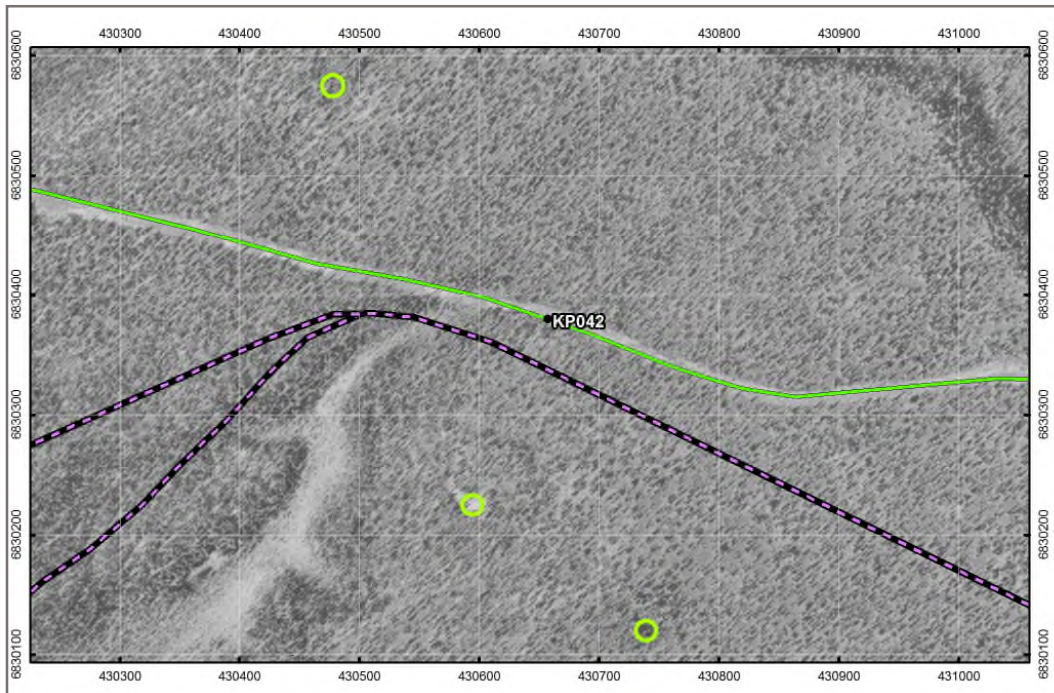


**Photo 1:** Suspected suffosion feature at about KP025.6. This is the largest of three micro-features in this area of the route, at about 0.6 m depth and 1.5 m diameter. This feature is nearly perfectly conical. Other features just below the route are less regular.

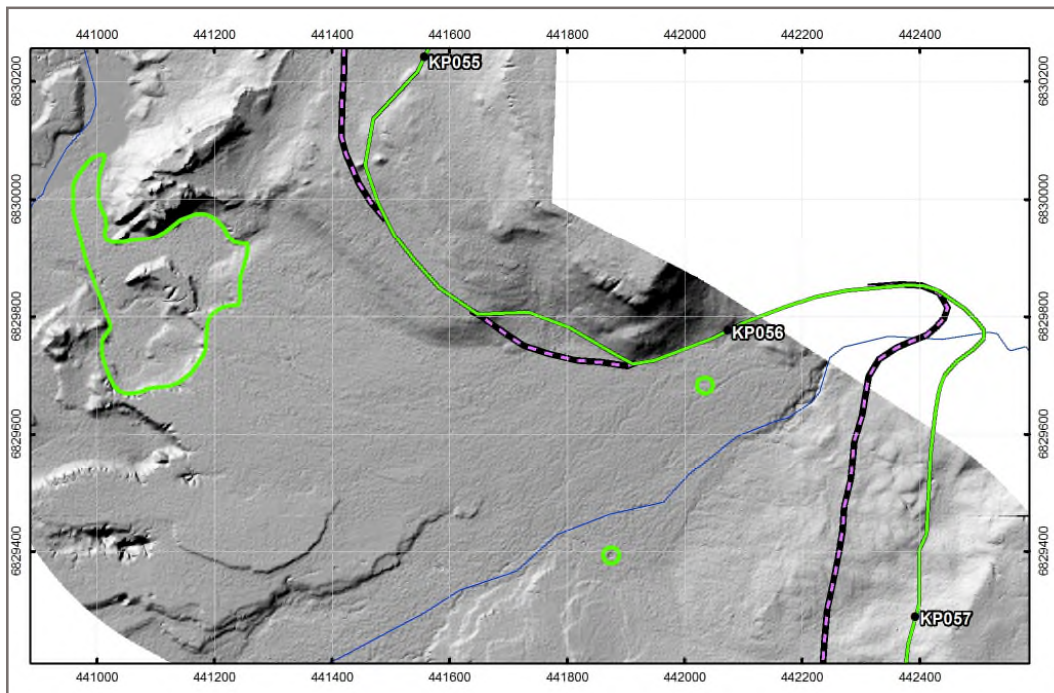


**Photo 2:** Excerpt from 2012 high-resolution imagery. Two suspected suffosion features are located about 60 to 80 m downslope of the route near KP026. They are about 25 m apart, and are likely very shallow as they are not visible on bare-earth LiDAR.



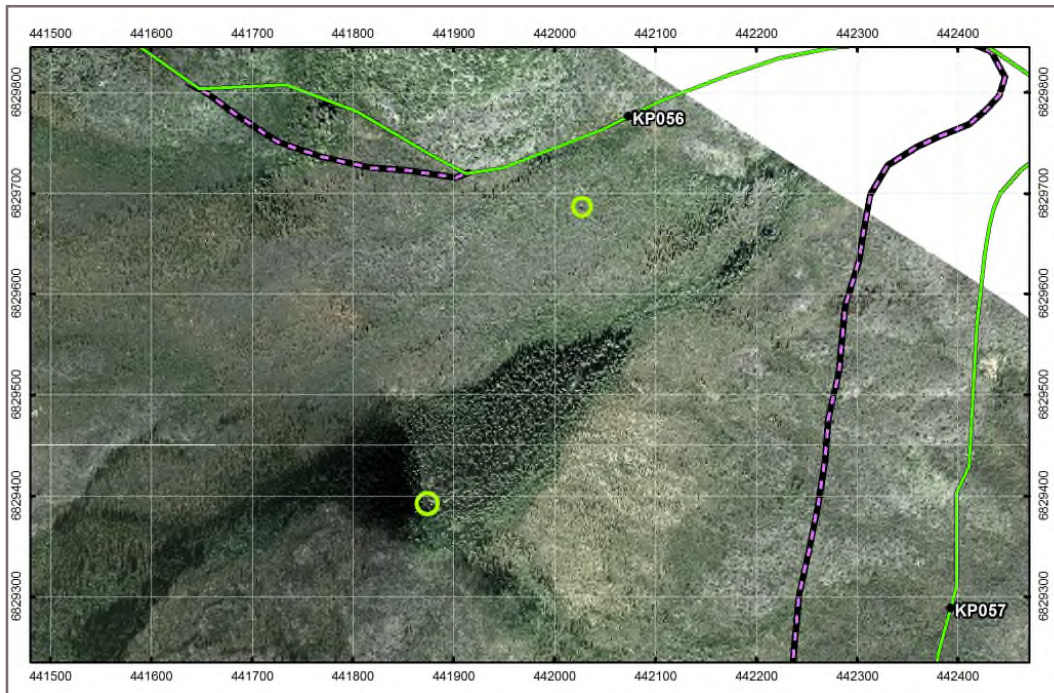


**Photo 3:** Kettles near KP042 in thick glaciofluvial deposit. These are unlikely to be sinkholes due to bedrock type and the lack of other karst features in the area. Green line is current route. Kettles are 100 to 220 m from proposed realignment (pink/black).



**Photo 4:** Excerpt from bare-earth LiDAR, showing locations of depressions that are suspected karst features. These features are located 250 m southwest of KP055.3 (edge of large subsidence at outcrops), 330 m south of KP055.7, and 70 m south of KP055.9.



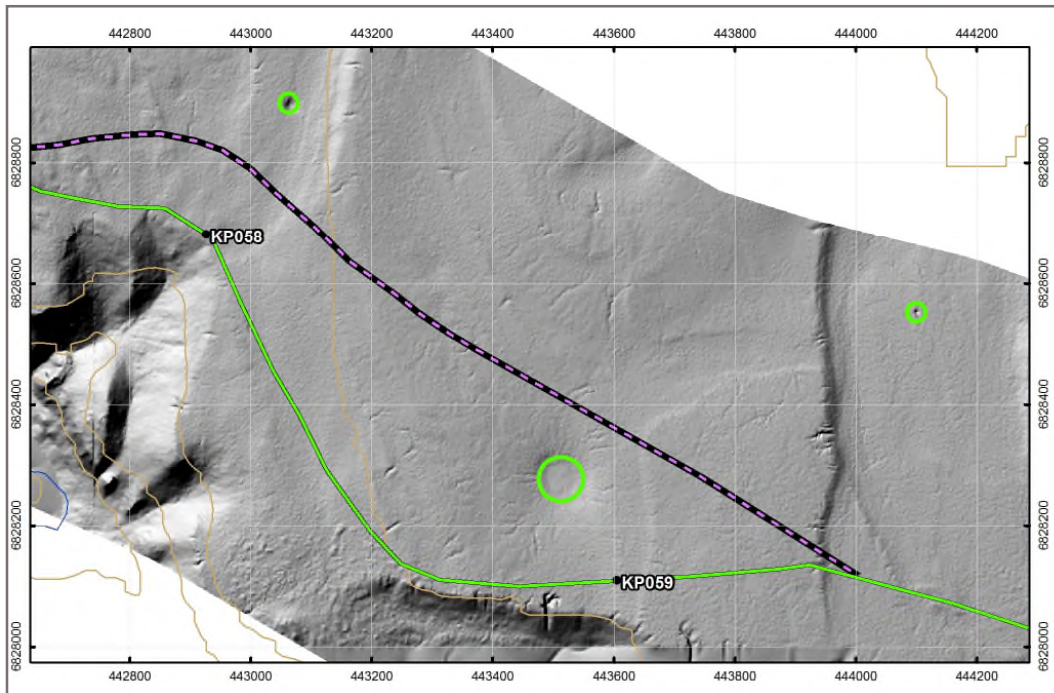


**Photo 5:** Excerpt from 2012 high-resolution imagery. Feature nearest KP056 is about 70 m from the route and contains a small pond (Photo 6). Feature along lower edge of photo is about 330 m from the route and 8 m diameter.



**Photo 6:** Suspected suffusion feature located about 70 m south-southeast of route near KP056, and estimated at about 3 m in diameter. This feature could also be thermo-karst-related. See also Photos 5 and 6 for location. (Photo credit: Allnorth.)





**Photo 7:** Excerpt from bare-earth LiDAR. Suspected kettles or sinkholes are about 80 and 130 m from the realignment at KP058 and KP058.8, and 420 m at KP059.5. Slope failures are about 130 to 250 m from the realignment at KP058 and KP058.8.



**Photo 8:** Looking west-northwest from about KP059.3, note lighter-coloured depression north of KP058.9. Possible sinkhole due to large size (70 m) and mapped so by Golder (2010). May be more likely a kettle (Tetra Tech EBA, 2015c). (Photo credit: Allnorth.)